Building Corporate Resilience: based on a case study of Spier Holding's search for a lower carbon future

by

Sumetee Pahwa-Gajjar

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Supervisor: Professor Mark Swilling
Co-supervisor: Professor Alan Brent
School of Public Leadership
Faculty of Economic and Management Sciences

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Declaration

By submitting this dissertation electronically, I declare that the entirety of the work contained therein is my own, original work, that I am the sole author thereof (save to the extent explicitly otherwise stated); that reproduction and publication thereof by Stellenbosch University will not infringe any third party rights and that I have not previously in its entirety or in part submitted it for obtaining any qualification.

December 2012

Abstract

A study of the sustainability journey of Spier Holdings, a well known wine and leisure business in South Africa, offers a unique opportunity for interrogating corporate drivers for a lower carbon future. The business has established sustainability as a brand identity, declared carbon neutrality as a macro organisational goal in response to the global challenge of climate change, and sought scientifically and technologically appropriate ways of addressing this challenge.

A preliminary analysis revealed various initiatives that are in place for measuring and reducing the business' environmental impact, including carbon emissions. However, an in-depth study of the establishment's environmental performance over two decades showed inconsistencies in year-on-year reporting, delays in shifting the supply chain, and gaps in implementation, particularly in the area of energy efficiency and adoption of renewable energy technology. Understanding and interrogating the business' sustainability journey through a systems ecology and corporate citizenship framework proved inadequate.

The case highlights that organizational goals for environmental performance areas, including the aim of carbon neutrality, and sustainability reporting are not sufficient catalysts for change. A complexity-based resilience approach allowed the business to be understood as an adaptive system. The sustainability story tracks different phases of a modified adaptive renewal cycle, which also determine the dominant management paradigms, strategic responses and forms of collaboration during each phase. Spier's sustainability journey was found to be underpinned by a quest for corporate resilience which includes the resilience of the business (enterprise resilience) and of the social-ecological system within which it resides (SES resilience). The business responded to interdependent risks and uncertainties in its internal and external contexts, through investment strategies in key areas of corporate environmental performance.

As a contribution to new knowledge, this thesis proposes an integrated corporate resilience framework for building enterprise resilience and ecological sustainability. This framework, and the accompanying mapping tool, reveals deep, ecological drivers for Spier's environmental performance across corporate areas of lower carbon emissions, water sustainability, wastewater treatment, solid waste recycling and ecological custodianship. The framework is recommended for use by similar businesses, eager to configure their relationship with natural resources and ecosystem services, and by scholars, for investigating corporate performance towards environmental sustainability.

Keywords: corporate environmental sustainability, social-ecological resilience, adaptive renewal cycle, lower carbon future

Opsomming

ŉ Studie van die volhoubaarheidsonderneming van Spier Holdings, ŉ bekende wyn- en ontspanningsaak in Suid-Afrika, bied ŉ unieke geleentheid vir die ondersoek van korporatiewe aandrywers vir ŉ laer koolstoftoekoms. Die onderneming het volhoubaarheid as ŉ handelsmerkidentiteit gevestig, koolstof-neutraliteit as ŉ makro- organisatoriese doel verklaar in reaksie op die wêreldwye uitdaging van klimaatsverandering, en het wetenskaplik en tegnologies gepaste wyses gesoek om hierdie uitdaging die hoof te bied.

ŉ Voorlopige analise het verskeie inisiatiewe wat gereed is vir meting en vermindering van die onderneming se omgewingsimpak aan die lig gebring, met inbegrip van koolstofvrystellings. ŉ Dieptestudie van die instelling se omgewingsprestasie oor twee dekades heen het egter inkonsekwenthede in jaar-tot-jaar-verslagdoening, vertragings in die verandering van die aanvoerketting, en gapings in implementering, in die besonder op die gebied van energiedoeltreffendheid en die ingebruikneming van hernubare energietegnologie getoon. Begrip en ondersoek van die onderneming se volhoubaarheidsonderneming aan die hand van ŉ raamwerk vir sisteemekologie en korporatiewe burgerskap het onvoldoende blyk te wees.

Die geval beklemtoon dat organisatoriese doelstellings vir omgewingsprestasiegebiede, met inbegrip van die oogmerk van koolstofneutraliteit, en volhoubaarheidsverslagdoening nie voldoende katalisators vir verandering is nie. ŉ Kompleksiteitgebaseerde veerkragtigheidsbenadering het dit moontlik gemaak dat die onderneming as ŉ aanpassingstelsel beskou kan word. Die volhoubaarheidsverslag gaan verskillende fases van ŉ gewysigde aanpassings- hernuwingsiklus, wat ook die dominante bestuursparadigmas, strategiese reaksies en vorme van samewerking gedurende elke fase bepaal, na. Daar is bevind dat Spier se volhoubaarheidsonderneming onderstut word deur ŉ soeke na korporatiewe veerkragtigheid wat die veerkragtigheid van die onderneming (ondernemingsveerkragtigheid) en van die sosiaal-ekologiese stelsel waarbinne dit gesetel is (SES-veerkragtigheid) insluit. Die onderneming het op onderling afhanklike risiko’s en onsekerhede in sy interne en eksterne samehange gereageer deur beleggingstrategieë in sleutelgebiede van korporatiewe omgewingsprestasie.

As ŉ bydrae tot nuwe kennis, doen hierdie tesis ŉ geïntegreerde korporatiewe veerkragtigheidsraamwerk vir die opbou van ondernemingsveerkragtigheid en ekologiese volhoubaarheid aan die hand. Hierdie raamwerk, en die gepaardgaande beskrywingsinstrument, lê diep, ekologiese aandrywers vir Spier se omgewingsprestasie oor korporatiewe gebiede van laer koolstof-vrystellings, watervolhoubaarheid, die behandeling van afloopwater, herbenutting van vaste afval en ekologiese bewaring bloot. Die raamwerk word aanbeveel vir gebruik deur soortgelyke ondernemings wat graag aan hulle verhouding met natuurlike hulpbronne en ekostelseldienste vorm wil gee, en deur vakkundiges vir die ondersoek van korporatiewe prestasie met betrekking tot omgewings-volhoubaarheid.

Sleutelwoorde: korporatiewe omgewingsvolhoubaarheid, sosiaal-ekologiese veerkragtigheid, aanpassings- hernuwingsiklus, laer koolstoftoekoms

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List of Acronyms and Abbreviations

ACCA	Association of Chartered Certificate Accountants
BCSD	Business Council for Sustainable Development,
BEE	Black Economic Empowerment
b-MFA	Bulk material flow analysis
CC	Corporate Citizenship
CCC	Confronting Climate Change
CEO	Chief Executive Officer
CER	Certifiable emission reductions
CF	Carbon footprint
CFCs	Carbon fluoro-chloride gases
CHP	Combined heat and power
CIRCLE	Centre for Innovation, Research and Competence in the Learning Economy
COO	Chief Operating Officer
CFO	Chief Financial Officer
CRSES	Centre for Renewable and Sustainable Energy Studies
CSI	Corporate Social Investment
CSIR	Council for Scientific and Industrial Research
CSP	Concentrated solar power
CSR	Corporate Social Responsibility
DWAF	the Department of Water Affairs and Forestry
EE	Ecological Economics
EF	Ecological footprint
EIP	Eco-industrial park
EIST	Environmental Innovation and Societal Transitions journal
EMCAs	Environmental management co-operative agreements
ExCo	Executive Committee
EXPO	Exposition
FTFA	Food and Trees for Africa’s
FTTSA	Fair Trade in Tourism South Africa
GBCSA	Green Building Council of South Africa
GCX	Global Carbon Exchange
GHG	Greenhouse gas
GRIHA	Green Rating for Integrated Habitat Assessment

GRI	Global Reporting Initiative
GWP	Global warming potential
IE	Industrial Ecology
IFF	Faculty for Interdisciplinary Studies
IPCC	Intergovernmental Panel on Climate Change
IO	Input-Output
ISO	International Organisation for Standardisation
IST	International conference on Sustainability Transitions
IT	Information Technology
JSE	Johannesburg Stock Exchange
LCA	life cycle analysis
LCM	life cycle management
LEDs	light emitting diodes
LEED	Leadership in Energy and Environmental Design
LUCSUS	Lund University Centre for Sustainability Studies
MEFA	Material and Energy Flow Analysis
MFA	Material flow accounting
MLP	Multi-Level Perspective
NGOs	Non-Governmental Organisations
NEMA	National Environmental Management Act
OECD	Organisation for Economic Cooperation and Development
PAS	Publicly Accessible Specification
PCB	Polychlorinated biphenyl
PPT	Pro Poor Tourism
PV	Photovoltaic
SAFWI	South African Fruit and Wine Initiative
SANBI	South African National Botanical Institute
SES	Social-ecological systems
SI	Sustainability Institute
SSPT	Spier Strategic Planning Team
STRN	Sustainability Transitions Research Network
TBL	Triple Bottom Line
TERI	The Energy and Resources Institute
TIS	Technological innovation systems
UCT	University of Cape Town
UN	United Nations

UNEP	United Nations Environmental Program
VER	Verifiable emission reduction
WBCSD	World Business Council on Sustainable Development
WCED	World Commission on Environment and Development
WIETA	Wine Industry Ethical Trading Association
WGBC	World Green Building Council
WSSD	World Summit on Sustainable Development

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Chapter 1: Introduction

1.1 Introduction

This thesis builds upon the basic assumption that private enterprises can and have contributed towards ameliorating social and environmental ills (Leisinger, 2007; Margolis and Walsh, 2003). It contributes to the ongoing constructive dialogue between the business sector and the research community, by unearthing deep, ecological drivers for corporate environmental sustainability and encouraging businesses to continually invest in their commitment to sustainability.

This thesis proposes a conceptual framework as a means of building resilience in a business enterprise, as well as in that of the larger social-ecological system. Carbon reduction, as a business response to the global challenge of climate change, is interrogated critically in the thesis, and incorporated meaningfully into the framework for building corporate resilience.

The thesis examines corporate carbon reduction through the different lenses of corporate citizenship, systems ecology and resilience thinking. The core argument of the thesis is that strategies aimed at carbon reduction are linked to the search for corporate resilience. The case study approach provides a unique opportunity for linking theory with practice, and producing new knowledge of direct value to a certain segment of the society. The conceptual framework should be useful for the case and similar businesses who are attempting to reconfigure their relationships to natural resources and eco-system services.

The doctoral research was triggered by a question that the case business Spier Holdings posed, namely ‘how can a business become carbon neutral?’ However, as the meaning and significance of this question was explored with managers and staff members at Spier over a period of 10 months, it became apparent that the business was in fact posing much more profound and deeper questions about what it means to build a resilient business.

The conceptual framework, proposed by this thesis is founded on the notion of businesses as social-ecological systems, vulnerable to, aware of and responding to risks in the larger social-ecological system. It provides businesses with a way of understanding how they can build corporate resilience; by using an instrument that helps businesses map where they are at, with regards to their strategies pertaining to environmental risks and resource uncertainties, including strategies aimed at a lower carbon profile (in response to climate change).

The chapter begins by stating the core research objectives (section 1.2), followed by a discussion on the evolution of the research questions (section 1.3); an overview of the thesis’ research direction and research framework (section 1.4); integration of the literature review chapters by drawing out their contributions and inadequacies (section 1.5); a brief background to the case study (section 1.6); the empirical work and analysis of case evidence (1.7); the original contributions of the thesis (section 1.8); the scope and limitations of the study (1.9); and ends with a chapter outline (section 1.10).

1.2 Core research objectives

The core research objectives of the thesis are as follows:

1.2.1 To understand the corporate drivers which underlie the search for a lower carbon future;

1.2.2 To propose a conceptual framework that should encourage and assist businesses in building corporate resilience, in response to environmental and resource uncertainties.

1.2.3 To situate the goal of carbon reduction, as well as additional aspects of environmental sustainability within a larger corporate resilience framework.

1.3 Evolution of the research focus

In order to find out how a business could become carbon neutral, it was important to articulate what constitutes carbon neutrality and how it can be measured and achieved. As a result of integrating carbon-related industry literature with case evidence, and relating it back to readings from systems ecology, far deeper research questions were posed:

- Why does a business want to become carbon neutral?
- Does carbon emissions calculation (and the goal of carbon neutrality) drive a business' search for a lower carbon future?
- If not, then what alternative measures or goals drive a business' search for a lower carbon future?
- Do the same alternative measures or goals drive a business' search for improved performance in additional aspects of environmental sustainability?

Information pertaining to organisational goals and performance in the area of environmental sustainability (as contained in Spier's annual sustainability reports) was verified through interviews and site visits. Frameworks and concepts from corporate citizenship, ecological economics, industrial ecology, systems thinking, complexity and resilience thinking were applied to case findings. The social-ecological systems construct, adaptive management, resilience thinking and its components were found to be most useful in understanding the drivers for Spier's search for a lower carbon future, as well as improved performance in additional aspects of environmental sustainability; such as wastewater treatment and solid waste recycling. In the end, a conceptual framework was developed which connects action and practice to theory; calls for adaptive management; provides a tool that can be used by businesses to map their strategies aimed at environmental sustainability; and thereby, build corporate resilience.

1.4 Research direction within a sustainable development framework

The thesis traverses and weaves together literature from various knowledge streams or discourses, each guided by the overall goal of sustainable development. The sustainable development knowledge framework (figure 1.1) assisted in identifying those discourses which are of most relevance to the core research objectives.

The low carbon research focus, and linked to that, an attention to technological innovation (for energy efficiency and renewable energy), determined the entry into the sustainable development knowledge framework (figure 1.1). The highlighted cells and words in figure 1.1 capture the direction taken by the research, as different knowledge streams were reviewed and integrated. Although political ecology utilises a highly insightful approach for understanding and articulating the challenge of sustainable development at a macro-level, it was not deemed useful for understanding corporate drivers. Environmental values and ethics are located in the corporate citizenship body of knowledge, as is the concept of managerialism. Environmental science as a scientific discipline contributes to both industrial ecology and ecological economics, which are multi-disciplines underpinned by the need for holism and systems thinking in addressing sustainability.

Spheres of concern within sustainable development	**Key challenges of political ecology**	**Literature categories**
Environmental context	Holism and co-evolution	Environmental Science Environmental History Human Geography Political ecology
Legal and institutional terrain	Empowerment and community building	Managerialism, policy and planning Social Conditions Environmental Law
Culture and civil society	Social justice and equity	Ecophilosophy Environmental values and ethics Utopianism, anarchism and bioregionalism Political ecology
Economy and technology	Sustainable production	Ecological economics Ecological design Industrial ecology

Entry into the research (low carbon focus)

Knowledge integration

Figure 1.1 Research direction with entry and exit points from a sustainable development / political ecology framework (adapted from Pezzoli, 1997)

The environmental context or concern with delivering on environmental corporate sustainability is where the core research objectives (section 1.2) of the thesis are located.

1.4.1 Research framework for the literature review

In order to understand the corporate drivers which underlie the search for a lower carbon future, as well as additional aspects of environmental sustainability – the following literature categories were reviewed:

- Corporate citizenship: The divergent interpretations of sustainable development along pro-development, social transformation or environmental responsiveness are resolved to some extent in the triple bottom line discourse of corporate citizenship. Importantly, corporate citizenship engages meaningfully with sustainability reporting and carbon management practices, including in the South African context.
- Ecological economics: Concepts and tools developed within the discourses of ecological economics and industrial ecology are offered in response to the challenge of sustainable production, as they work to bring society's patterns of production, reproduction and consumption into concert with the capacity of the ecosystem to perform life-giving functions over the long run (Pezzoli, 1997). Furthermore, ecological economics provides the intellectual roots for concepts such as ecological footprint and carbon footprint.
- Industrial ecology: Ecological economics and industrial ecology are founded on a 'systems ecology' perspective whereby insights gained from studying ecological systems may be applied to social issues (Ropke, 2003). Industrial Ecology is also the breeding ground of tools and concepts such as life cycle analysis, cradle to grave management and dematerialization.
- Social-ecological systems (SES) construct: Through the SES construct, businesses or human-activity systems may be conceived as individual SES embedded within local, regional and global SES. Decisions taken at the level of a local SES determine the flow of materials and energy at local, regional and sometimes global scales, such as in the case of the global carbon cycle. The SES construct also aids in the visualisation of a business as made up of flows of materials, energy, waste, water and information.
- Systems thinking: Systems thinking and complexity theory serve as an entry into resilience thinking. Complexity, in particular, allows for choosing and combining relevant analytical frameworks for understanding system behaviour.
- Resilience-based thinking: Also founded on a 'systems ecology' perspective, resilience thinking uses the metaphors of adaptive renewal cycle, thresholds and regimes, and panarchy to comprehend business decisions aimed at environmental sustainability, in the context of risks arising in the SES.

- Adaptive management and enterprise resilience: These are two approaches which extend resilience thinking and associated concepts towards a business management approach for reflexive learning and collaboration on the one hand, and for building response diversity towards interdependent risks on the other.

Figure 1.2 captures the basic framework of knowledge applied to the evolving research questions. It was envisioned that multiple perspectives would assist in unravelling the drivers which underpin a business' search for environmental sustainability, including carbon reduction. An explicit link is made between the rationales for each chapter of the literature review, with the intended outcomes of investigating each of the knowledge streams (Chapters 3 to 6).

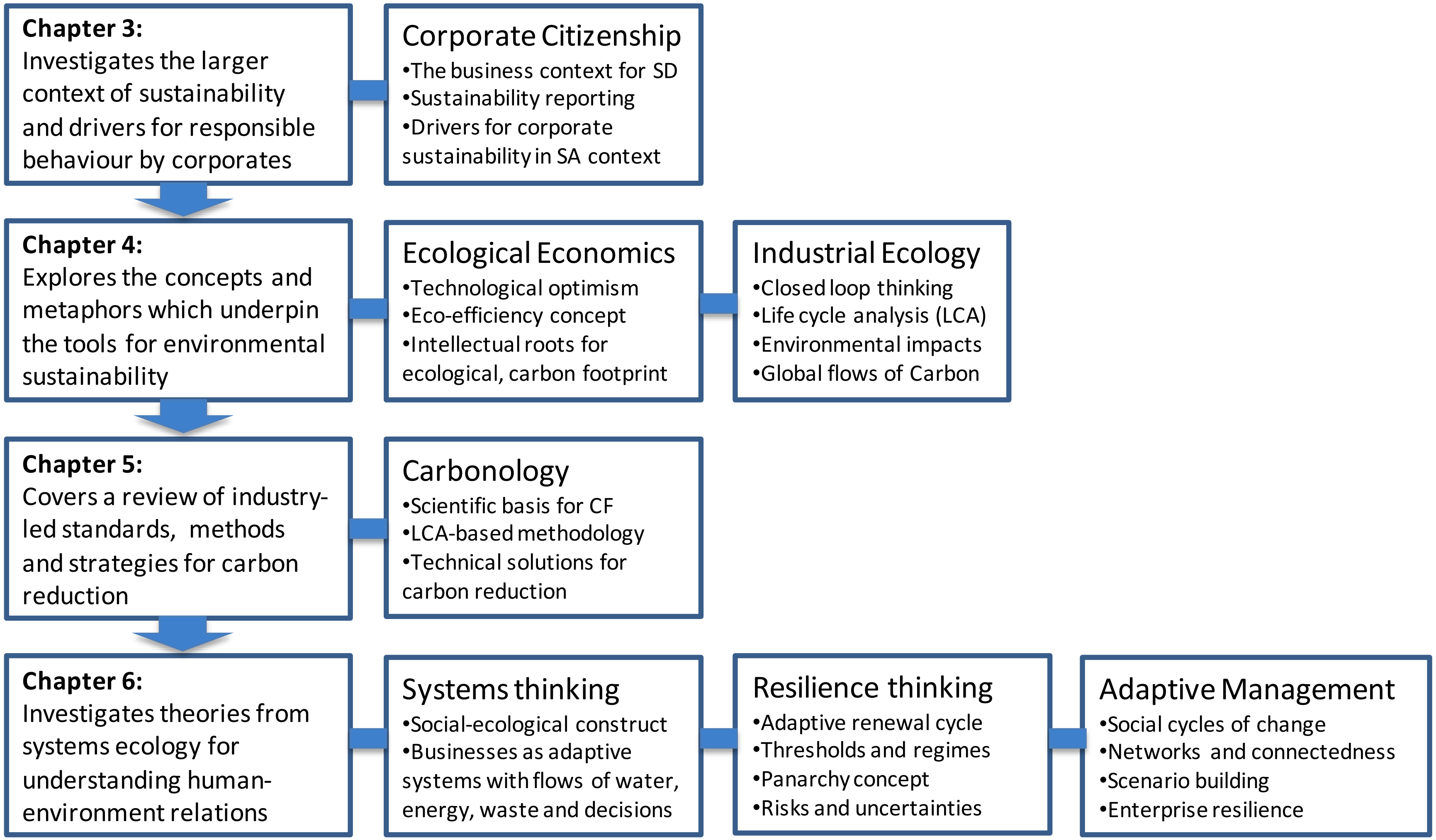

Figure 1.2 Research framework for the literature review (Chapters 3, 4, 5 and 6)

1.5 Contributions and inadequacies of investigated knowledge streams

Each of the knowledge streams or discourse investigated as part of the literature review in this thesis build up to a core argument, which is that **the search for a lower carbon future, and additional aspects of environmental sustainability, is driven by the need to build corporate resilience**. The case study analysis of Spier Holdings supports this argument.

However, the core argument of the thesis results from a gradual building up, of contributions from each of the knowledge streams delved into. Moreover, the inadequacies encountered in the knowledge areas or discourses in the preliminary research approach, motivated exploration into alternative frameworks and theoretical constructs. These contributions and gaps are listed in table 1.1 in relation to the chapters of the literature review where they are encountered, in order to ascertain what each chapter achieves and why it is needed.

Chapter 6 addresses several of the gaps encountered in the review of normative frameworks from corporate citizenship and concepts and tools from industrial ecology and ecological economics. Components of resilience thinking, adaptive management and the notion of enterprise resilience generate a common language for understanding corporate resilience. However, literature was still found to be either too focused on building general enterprise resilience (without adequate attention to ecological and resource challenges) or too centred on understanding governance and management typologies (adaptive management, network or planning-led organisational phases). A synthesis was required which could encourage businesses to map where they are at in terms of building resilience, while responding to the corporate goal of environmental sustainability, through various strategies and practices. This synthesis resulted in the development of a tool as part of the corporate resilience framework.

Each of the chapters 3, 4, 5 and 6 contributed to the design of the corporate resilience framework, some more than others. The core messages from each of the chapters are presented in figure 1.3, resulting in the core argument of the thesis, and in the integrated corporate resilience framework.

Thus there are two outcomes that each of the literature review chapters achieves – build the core argument of the thesis – but also contribute to new knowledge through the development of the corporate resilience framework.

The application of literature bodies to analysis of case evidence collected through the empirical work is captured in figure 1.4 and explained in section 1.7.

Table 1.1 Contributions and gaps in knowledge streams investigated in Chapters 3, 4, 5 and 6

Chapter details	**Contributions of knowledge stream**	**Gaps in the knowledge stream**
Chapter 3: Sustainable Development and Corporate Citizenship	A normative conceptualisation of business' role in achieving sustainable development	
	Non-legislative drivers for corporate social / environmental responsibility (CSR) include the moral imperative, market pressure or philanthropy (also in a South African context)	Lack of engagement with physical or geological determinants of corporate behaviour
	Critical examination of CC's role in changing corporate behaviour towards increased social / environmental responsibility	A nascent transformative agenda, requiring deeper engagement with the context of business practice
	Carbon management and sustainability reporting are situated in a larger framework of various CC practice areas (figure 3.3)	Use of scientific terms and concepts such as life cycle thinking, closed loops, natural capital and eco-efficiency, which require further investigation (rationale for Chapter 4)
Chapter 4: Ecological Economics and Industrial Ecology	The environmental science and systems ecology roots for ecological footprint allow linkages with 'carbon footprint' and 'water footprint' in Chapter 5	Engineering (IE) or economics (EE) focus dominates: Failure to integrate natural and social sciences in the literature
	The scientific basis for management concepts such as life cycle thinking, eco-efficiency and natural capital	Corporate decision-making processes not explained, especially when IE-inspired management tools fail
	A techno-optimistic conception of sustainable production	'Carbon footprint' calculation, measurement and strategies

	and consumption cycles, in which carbon reduction practices are rooted (renewable energy and energy efficiency solutions)	require a scientific enquiry and consolidation (rationale for Chapter 5)
Chapter 5: Carbonology	The market-led and industry-generated notion of carbon neutral, substantiated minimally through scientific investigation	Ambiguities related to carbon auditing techniques, even when derived from the same scientific principles
	Carbonology builds on the scientific foundations for footprint calculations, global nutrient cycles and life cycle analysis	A marketing or branding approach to carbon reduction sidelines a holistic systems change approach to environmental sustainability (rationale for Chapter 6)
	Brief case studies highlight the challenges of reducing carbon emissions through renewable energy solutions in the SA context	A carbon focus translates into a fossil fuel consumption focus, especially in South Africa
Chapter 6: A Resilience Framework for Corporate Sustainability	Systems thinking and complexity as foundations for investigating the social-ecological construct and resilience thinking	An integration of the different theories investigated in Chapter 6 is missing, especially for understanding drivers for corporate environmental sustainability
	Resilience thinking and its components are applied to a business context	Enterprise resilience ignores reliance on ecological systems, while ecological resilience ignores social and economic drivers
	The concept of risk response and resilience-building in a corporate context is introduced	A synthesis of all knowledge streams explored in Chapter 3 to 6 is required

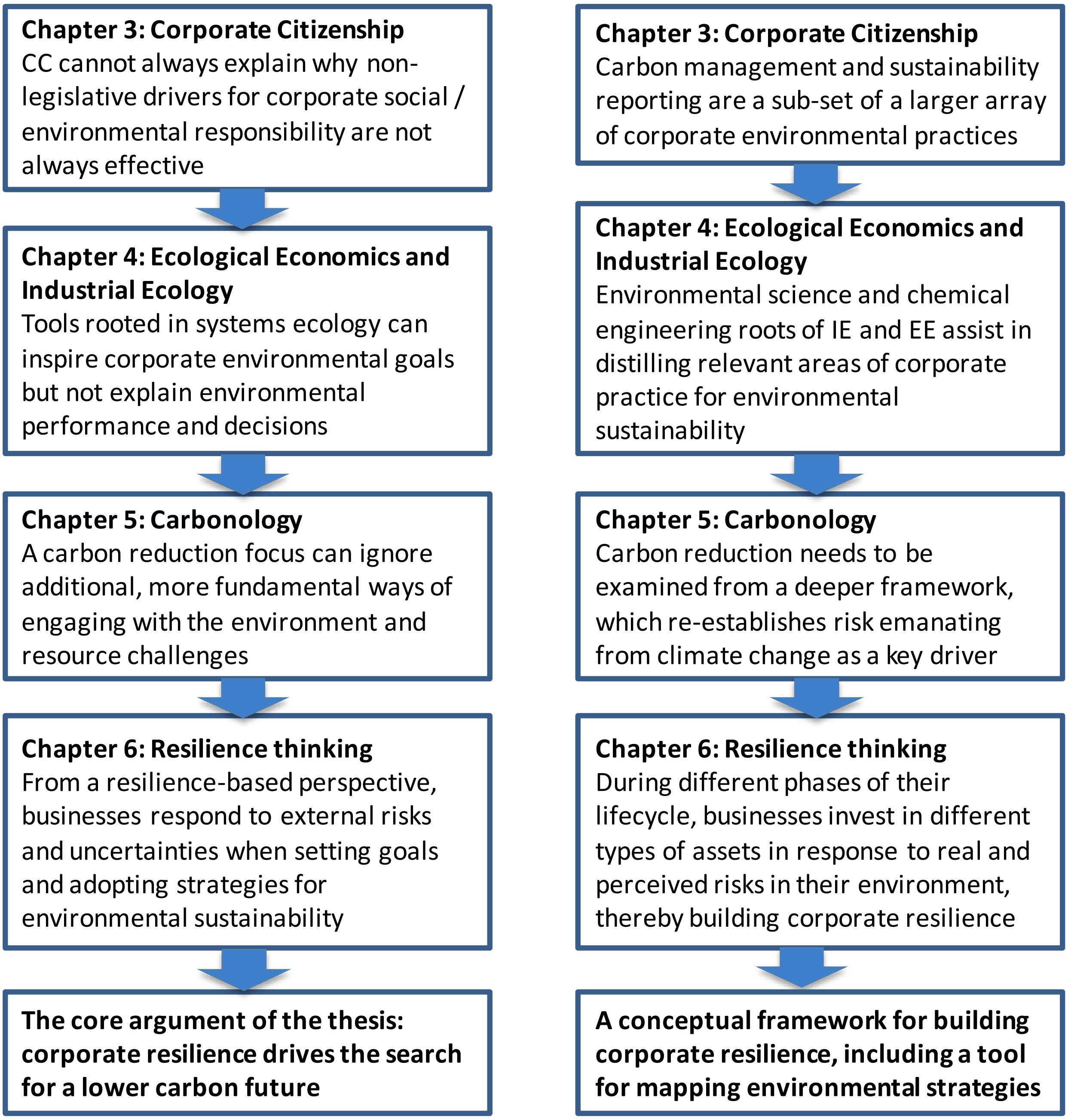

Figure 1.3 Key messages from Chapters 3, 4, 5 and 6: building the core argument of the thesis, and contributing towards the development of a conceptual framework for corporate resilience

1.6 Background to the case-study

Spier Holdings[1], a medium-sized wine producing and leisure business situated in the Boland District of the Western Cape, South Africa, has worked consistently towards establishing sustainability as a brand pillar over the last two decades. The business runs three main operations: farming, wine production and leisure where leisure includes a 155 room hotel and banqueting / conferencing services.

[1] http://www.spier.co.za

Spier has in one way or another presumed that it is pursuing sustainability as a brand and identity, as articulated in its vision and values. There is a miscellaneous assortment of ideas that informs Spier's search for environmental sustainability including adobe architecture, organic farming and river cleansing. In 2007, Spier defined certain macro-level organisational goals in response to climate change, one of which was the specific goal of achieving 'carbon neutral status' by 2017. Subsequently, it commissioned the calculation of its carbon footprint by Cape Town-based GCX. The goal of reduced carbon emissions as a response to the global challenge of climate change is also being pursued by fruit and wine producers in the Western Cape, as represented by the recently promoted carbon calculator of the South African Fruit and Wine Initiative (SAFWI). Spier encapsulates the aspiration for reduced carbon emissions in its climate change goal of carbon neutrality. Therefore, testing the goal and its validity in the larger context of corporate environmental sustainability was possible in the case of Spier.

Spier maintains a close learning relationship with the Sustainability Institute[2], which offers the Sustainable Development programmes of the Stellenbosch University. This doctoral thesis was co-funded by Spier as part of the learning relationship. The requirements for a low-carbon future, as articulated in scientific and practice-related literature, continue to elude businesses. This meant investigating the intellectual roots for carbon footprint, and the business practice of environmental reporting, two widely accepted aspects of corporate environmental sustainability. Spier allowed access to information pertaining to its business practices for scholarly scrutiny.

In trying to find answers related to carbon management in a corporate context, and seeking to understand business aspirations through the lens of resilience thinking, Spier's journey towards a lower carbon future provided a unique learning example. The starting points for the case study were provided by Spier management. However, the research focus shifted significantly over the 10 months during which the case evidence was collected and collaborated with actors from the Spier system and those closely affiliated with it. This shift is reflected in section 1.3. The final research objectives, to which the case study analysis contributed, are captured as the thesis' core research objectives (section 1.2).

1.6.1 Initial case study focus

The case study was commenced with two explicit aims: the first was to find out how a business (such as Spier) could become carbon neutral. The second aim was to chart the sustainability journey of Spier in order to interrogate business decisions aimed at environmental sustainability. The above starting points were useful in entering the case system, structuring interviews and collecting empirical evidence. However, the assumptions underpinning these

[2] http://www.sustainabilityinstitute.net

aims were challenged and eventually led to revised research objectives. The reformulation of research objectives as it links to the aims of the case study is explained in Section 2.3.6.

1.7 Empirical work and analysis of case evidence

The research focus was continually assessed and reframed as abstract and scientific knowledge was reviewed and empirical data was analysed (the research process is described in detail in Chapter 2: Research Methodology). Thus the case of Spier provided a useful starting point for the research as well as a means of testing the corporate resilience framework and the core argument of the thesis as presented in figure 1.3.

The presentation of empirical work and analysis of case evidence is explained in figure 1.4. A narrative was written, based on several desktop sources, interviews with key staff members at Spier and intermediaries across the three businesses of farming, wine production and leisure at Spier. The narrative begins to examine to some depth, the inter-related areas of environmental reporting, carbon emissions reduction, solid waste recycling, wastewater treatment and environmental custodianship. The narrative was used to take engagement with people involved in decision-making in the Spier businesses to the next level, and is captured in Chapter 7.

Next, questions around the relevance of macro-organisational goals for environmental sustainability and drivers which underpin the corporate search for a lower carbon future were posed in a preliminary analysis of case evidence. The value of normative frameworks from corporate citizenship and concepts rooted in ecological economics and industrial ecology was found to be limited in understanding corporate drivers for sustainability-oriented endeavours. Carbonology presented several ambiguities with respect to the scientific basis for carbon-related goals. However the opportunities for re-orienting an organisation towards lower carbon emissions by measuring and setting goals towards reductions were noted. The preliminary analysis of case evidence is presented in Chapter 8.

In Chapter 9 the analysis of the case is advanced and deepened by firstly, unravelling the sustainability story of Spier (Chapter 7) from the lens of resilience-based thinking and adaptive management, and secondly, by testing the corporate resilience framework proposed at the end of Chapter 6. Therefore, components of resilience thinking which include thresholds, adaptive renewal cycle and panarchy are used to make sense of the journey which the business followed in the last two decades, in its search for sustainability, including environmental sustainability. Furthermore, aspects of adaptive management such as networks and adaptive learning were applied to the use of different modes of collaboration during different phases of the business cycle.

Conclusions from all chapters of literature review and empirical work contribute towards generating the four original contributions of this thesis which are captured in section 1.8 and elaborated in Chapter 10.

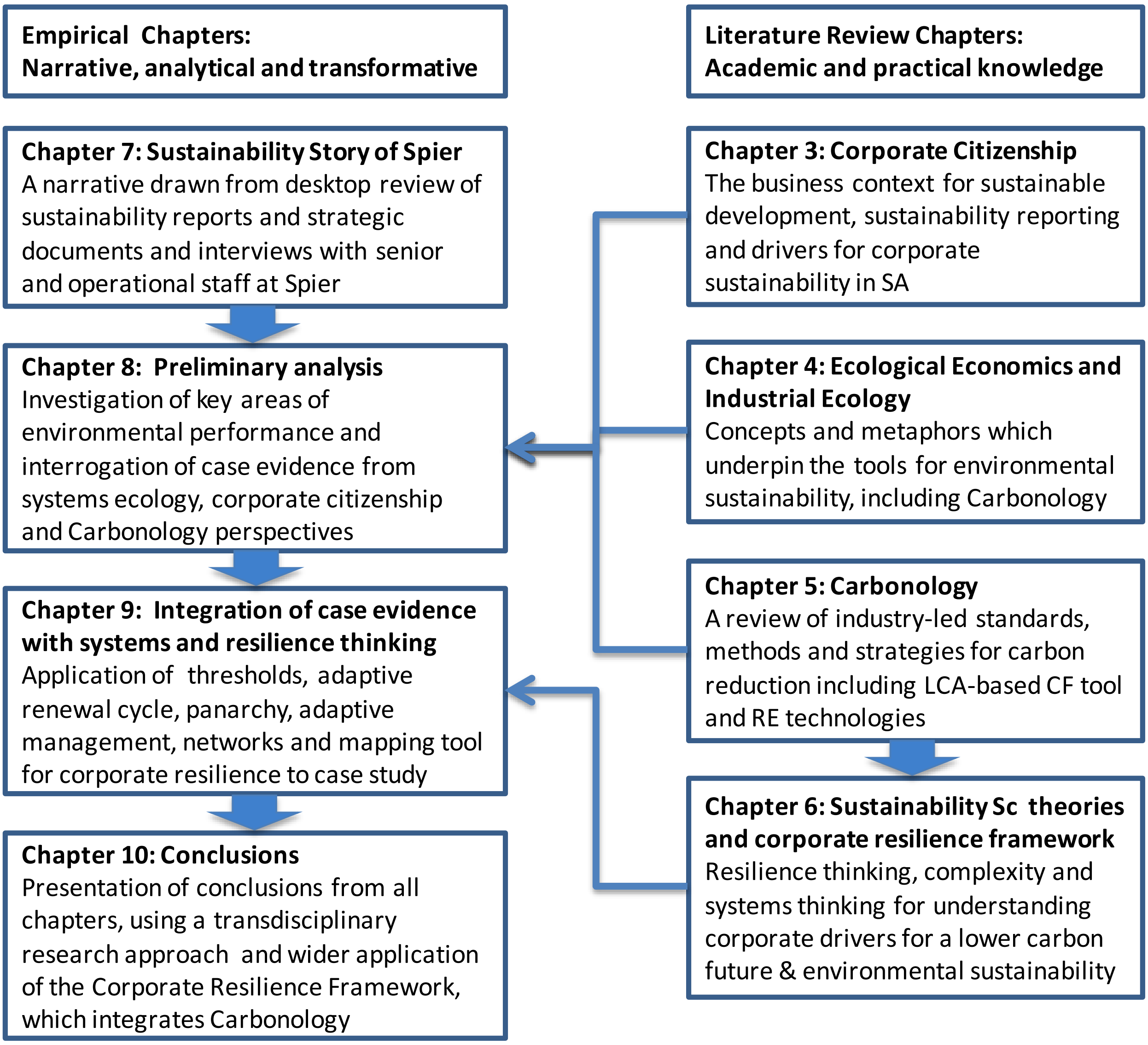

Figure 1.4 Empirical work and analysis in Chapters 7, 8 and 9 and the use of concepts and frameworks from the literature review chapters (3, 4, 5 and 6) towards analysis of case evidence, leading to the conclusions of the thesis

1.8 Original contribution of the thesis

The thesis has four main original contributions:

1 A theoretical synthesis, called the corporate resilience framework, which combines the different components of resilience thinking for understanding and describing complex system behaviour in businesses: thresholds, the adaptive renewal cycle and the panarchy framework with concepts and tools which inform corporate environmental sustainability

(from the applied fields of corporate citizenship, ecological economics and industrial ecology).

2 Application of the proposed corporate resilience framework to interrogate the case study (the Spier Holdings Group) with rare access to business operations and understandings of environmental sustainability among actors (at strategic and operational management levels) in a business environment.

3 A novel interrogation of carbon calculation methods, standards and strategies (termed Carbonology) driven by a resilience-based understanding and commitment to corporate sustainability, beyond footprint management.

4 An example of a modified transdisciplinary research approach applied in a developing country context, where the traditional tools for collaboration among academic and practitioner groups were not utilised, and yet the requirements of transdisciplinary research were satisfied.

1.9 Scope and limitations of the study

The first aspect of scope which the thesis attends to is the practical coverage of the conceptual framework in a business context. The extent of the conceptual framework is determined by the research focus, which is to situate the search for a lower carbon profile, as well as improved performance in additional areas of environmental performance, in a larger corporate context. Therefore, the concept of corporate resilience, which is developed and verified through the case study, is specific to corporate environmental sustainability, including carbon reduction. This means that although enterprise resilience is developed in performance across social and financial practice areas, these were not incorporated in the corporate resilience framework or analysed as far as they are practiced at Spier.

The second aspect of scope which the thesis tries to avoid is that of alternative theoretical perspectives that could have been adopted. Literature reviews in industrial ecology, ecological economics and corporate citizenship were conducted to establish their applicability to the research objectives, during the problem definition phase. The theoretical frameworks which were finally chosen for analysis (from systems thinking, complexity, the social-ecological construct and resilience thinking) were also culled from a larger group of sustainability science perspectives. However, there may be alternative ways of analysing addressing the research objectives from within the fields of corporate citizenship, industrial ecology, ecological economics or sustainability science which were overlooked and represent a limitation.

The limitations of the study are those characteristics of design or methodological tools employed to generate findings, analyse the findings and draw conclusions based on the findings, which affect the interpretation of the results of the study. This thesis utilises a qualitative approach for researching a medium-sized business in South Africa. The choice of methodology is a direct result of the researcher positioning herself with the research tradition followed in sustainability studies as well as transdisciplinary research, where case-specific and context-rich information is considered valuable towards generating solution-oriented knowledge. As such, all the limitations which are associated with qualitative methods and case comparisons will be applicable to this thesis. Sometimes, these limitations or critiques overlap.

This study does not utilise any quantitative tools for collecting or analysing data. Quantitative data with regards to the business' environmental performance and associated measures such as the carbon footprint were examined in detail to answer specific research questions, but as part of the larger qualitative study. Therefore, any inferences that may have been drawn if quantitative research tools were utilised data collection or for content analysis are not incorporated and may be regarded as a limitation of the study.

The claim that qualitative research, which requires the researcher to immerse herself in the research situation and does not yield detached observations, is also applicable to this thesis (Miles and Huberman, 1984; Lauer and Asher, 1988). Immersion is utilised as a research tool and the researcher's potential for influencing decisions in relation to the context being studied is acknowledged upfront. These aspects of the qualitative research methodology are detailed in Chapter 2.

With regards to limitations of the thesis which arise from utilising a case study approach, it is useful to consider Flyvberg's (2011) examination of the conventional view of the case study. The statements which he terms the five 'misunderstandings' about the case study pitch the value of theoretical knowledge against concrete case evidence and question the ability of case studies to contribute to scientific development, general propositions and theory building (Flyvberg, 2011).

In defence of the adopted approach, it is argued that using a case study generated great insight to the research questions. This would not have been possible by using survey responses from various business cases.

1.10 Chapter outlines

This section provides a brief overview of the Chapters (2-10) which together constitute the thesis titled: Building Corporate Resilience: a case study of Spier's search for a lower carbon future.

1.10.1 Chapter 2: Research Methodology

This chapter explains the research process that was followed in defining the preliminary literature review; investigating the case of Spier Holdings; embarking on additional literature review; reformulating research objectives and questions; synthesizing new, context-specific systems knowledge; writing the 'Sustainability Story of Spier'; analysing case findings against target knowledge drawn from several scientific and applied disciplines and finally, producing new knowledge in order to achieve the core research objectives.

Principles, requirements and phases of transdisciplinary research methodology provide the framework for describing the research process. Although the initial research question was posed by Spier, the empirical interrogation of the case revealed this question to be too narrowly defined and a different, resilience-based theoretical framework was required to conceptualise and analyse Spier's journey towards a lower carbon profile. Chapter 2 explains how this theoretical framework then became the basis for designing a corporate resilience framework, including a tool that businesses can use for mapping their strategies aimed at carbon reduction, as well as additional areas of environmental sustainability.

1.10.2 Chapter 3: Sustainable Development and Corporate Citizenship

Literatures from Sustainable Development and Corporate Citizenship were drawn on in the hope that these will assist in informing an understanding of corporate sustainability filtered down to a common sense level. The sustainability journey of many businesses is informed by the mainstream notion of sustainable development and more specifically, corporate citizenship, as defined and propagated by global business forums and councils such as the World Business Council on Sustainable Development and the UN Global Compact.

Corporate Citizenship and the accompanying sustainability reporting and social investment initiatives generate the normative context for a South African business to act responsibly from a developing country perspective. The divergent interpretations or applications of sustainable development along pro-development, social transformation or environmental responsiveness are resolved to some extent in the triple bottom line discourse of corporate citizenship. A framework for corporate citizenship is developed, based on which businesses can combine various practices to achieve their desired sustainability outcomes. Various practices also reflect evolution in the cultural and technical trends related to sustainability to which businesses are exposed.

However, there are critical inadequacies in these perspectives which are described in Chapter 3. Sustainable development is far too wide and general to generate a meaningful language in which to analyse business values, challenges and solutions. Furthermore, while the strategic advantage and business ethics literatures advocate reform within corporate notions of sustainability, they lack the multi-dimensional perspective required of business managers. In addition, management goals such as eco-efficiency and clean production, used in the corporate citizenship writings have clear links with industrial ecology principles, requiring deeper interrogation. The corporate citizenship framework integrates drivers of sustainability with examples of corporate practices but cannot explain when or why those drivers are not effective.

1.10.3 Chapter 4: Ecological Economics and Industrial Ecology

The interrogation of ecological economics and industrial ecology tools and concepts in Chapter 4 is underpinned by the need to disclose the intellectual roots of terms used within the corporate citizenship literature, in order to inform the ongoing pursuit of corporate sustainability. The aim was to supplant gaps and inadequacies found in the normative models and descriptive narratives of corporate citizenship with alternative perspectives with their roots in the natural sciences; in particular, systems ecology, environmental management and process engineering.

In Chapter 4 some of the scientific concepts which are used loosely in the corporate citizenship literature, are reviewed in more detail. For example, Natural Capitalism is explored through the natural capital concept of ecological economics; and ecological footprint as a fore-bearer of carbon footprint, is investigated as a tool for measuring a business' progress towards sustainability. Industrial ecology is the breeding ground of tools and concepts such as life cycle assessment, cradle to grave management and dematerialization.

The goal of carbon neutral is underpinned by a techno-optimistic conception of sustainability transition. Concepts and tools developed within the discourses of ecological economics and industrial ecology are offered in response to the challenge of sustainable production, as they work to bring society's patterns of production, reproduction and consumption in concert with the capacity of the ecosystem to perform life-giving functions over the long run (Pezzoli, 1997).

However, the concepts and tools studied in Chapter 4 do not explain or assist in understanding corporate behaviour, especially when principles such as eco-efficiency and life cycle management, fail to produce the expected results. The attempts at integrating natural and social sciences within industrial ecology especially points to its hitherto engineering focus, despite the valuable extension of the industrial metabolism concept into societal metabolism and global material flow analyses. The insufficient attention paid to the behavioural and human components of industrial systems within industrial ecology was subsequently addressed by new thinking around social-ecological systems, which led to the birth of a new discipline called sustainability science, explored in Chapter 6.

1.10.4 Chapter 5: Carbonology

Scholarly work in industrial ecology does not capture the large knowledge area represented by emissions calculation methods for goods and services (such as the GHG Protocol and PAS 2050: 2008), carbon standards and commonly promoted corporate strategies for mitigating and off-setting emissions. In recognition of this fact, Chapter 5 covers a largely industry-generated literature, termed Carbonology by the author. Carbonology reviews business practices which constitute a carbon reduction portfolio, how their contribution towards a lower carbon status is measured, and whether the measures for carbon emissions reduction are scientifically rigorous. Therefore, Chapter 5 builds on the scientific foundations for footprint calculations, global nutrient cycles and life cycle analysis covered in Chapter 4.

Secondly, the review of Carbonology critiques whether a predominantly reductionist tool for driving corporate behaviour can become a composite measure for ecological sustainability. A large section of this chapter is dedicated to technical solutions for renewable energy, specifically in the South African context. A brief case description at the end of the paper on the Backsberg Estate Cellars reveals that although carbon neutrality is achievable through a range of ecological practices and off-setting mechanisms, the adoption of renewable energy solutions by small to medium-sized businesses is not straightforward.

The important links which Chapter 5 uncovers are those between the goal of carbon reduction and the practice areas of corporate environmentalism and technological innovation. Thus carbon reduction strategies could drive resource productivity, waste minimisation, energy efficiency, sustainable production and, biome conservation, water saving, organic farming and responsible wastewater treatment. Carbon footprint calculation and the goal of carbon neutral status, at the very least generate a common language across three sets of corporate social responsibility practice areas. However, a single-minded approach of driving environmentally significant behaviour based on carbon reduction can be counter-productive. Chapter 5 presents the argument that the goal of carbon reduction needs to be situated in a larger context of corporate environmental practice.

1.10.5 Chapter 6: A Resilience Framework for Corporate Sustainability

Concepts from corporate citizenship writings were useful for understanding the mainstream notion of sustainable development, as pursued by businesses, internationally and in South

Africa. A scientific understanding of material and energy flows within a business did much to enhance the level of measuring and reporting on ecological indicators. However, each of the bodies of literature and its application were found to address only individual components of a business system. The dynamism of real business practice, which evolves as it is studied was absent in the knowledge areas visited.

Chapter 6 reflects upon the need for a resilience-based approach, underpinned by a complexity theory framework to make sense of a business as part of larger socio-technical and socio-ecological systems, allowing a deeper understanding of the initial research questions.

Chapter 6 builds upon the gaps and inadequacies identified in the knowledge areas covered in Chapters 3, 4 and 5. It describes an exploration of alternative frameworks and analytical perspectives, to work in collaboration with or as alternatives to those studied previously. The search for relevant models and frameworks was driven by the need to assist in understanding the case business, where the preliminary literature review had proven inadequate.

Thus, sustainability science constructs such as resilience and complexity which are derived from the study of ecosystems and have been transferred successfully to understand the behaviour of institutional and social systems are detailed. A resilience-based framework is proposed in the chapter, which enhances the preceding comprehensions of adaptive management and highlights the role of risk in the context of business decisions.

The resilience-based framework is meant to assist in understanding and enhancing the actual practice of corporate environmental sustainability, thus making up for the inadequacies in previous knowledge categories. The resilience framework brings together tools explored in Chapters 3 and 4 and at the same time, locates carbon-reduction strategies (Chapter 5) in a larger risk-oriented context (as outlined in figure 1.3), which should prove more meaningful to corporate entities.

1.10.6 Chapter 7: Sustainability Story of Spier

The empirical work conducted over the period February-August 2010 generated the narrative called the ‘Sustainability Story of Spier’. It is presented in the thesis as a non-biased representation of Spier’s sustainability journey, isolated from analysis. The stand-alone chapter provides a back-drop to Spier’s performance in key areas of environmental practice: sustainability reporting; renewable energy and energy efficiency solutions for reducing carbon emissions; wastewater recycling; and solid waste recycling.

1.10.7 Chapter 8: Case Findings and Preliminary Analysis of the 'Sustainability Story of Spier'

Relevant sections of the narrative are reviewed and documented in Chapter 8 so to ascertain the relevance of climate change goals for measuring Spier's progress towards environmental sustainability and driving Spier's commitment to sustainability.

A critical review of Spier's environmental reporting (quantitative) practices in Part 1 of Chapter 8 helps conclude that neither environmental reporting of the business (including carbon emissions measurement), nor life cycle analysis-based (LCA-based) carbon footprint of a bottle of wine, could successfully map an incontestable trend in the achievement of environmental goals over the full review period of 2004-2010. This finding however does not undermine the larger purpose which the environmental reporting practices served in gearing organisational decision-making in favour of reduced environmental impact. Application of various reporting formats and approaches such as the GHG Protocol, the GRI initiative and the PAS 2050:2008 standard at Spier also illustrated how sterile accounting principles fail to grasp the complexity of a real business environment.

A review of Spier's environmental goals in Part 2 of Chapter 8 finds that the goals do not capture some of the initiatives Spier undertook to address environmental sustainability. A range of external and internal barriers and drivers determines whether climate change goals will be met. Therefore, while climate change goals allowed Spier to articulate and communicate its vision for environmental sustainability both internally and externally to the organisation, the goals in and of themselves did not guide business decisions.

Part 3 of Chapter 8 explores whether the incongruity between goal-setting and organisational behaviour can be resolved through theoretical frameworks from the applied fields of corporate citizenship, industrial ecology and ecological economics. The application of these frameworks to case findings was found to be limited for understanding real business behaviour, which is why alternative theoretical constructs from sustainability science were applied to the case findings in Chapter 9.

1.10.8 Chapter 9: Integration of case findings with theoretical constructs from Sustainability Science

Chapter 9 presents the analysis of the 'Sustainability Story of Spier' (Chapter 7) through frameworks from resilience and complexity thinking, which are derived from the study of ecosystems and have been transferred successfully to understand the behaviour of institutional systems. Each of these constructs was applied to analyse relevant sections of the narrative.

The fieldwork conducted to generate the narrative and the research undertaken to make sense of the narrative were iterative processes.

Chapter 9 is therefore, a retelling of Spier's sustainability journey towards a lower carbon future in the language of sustainability science theories and concepts. The chapter includes graphical representations of the Spier system at micro and macro level; a mapping of Spier's sustainability journey onto a modified adaptive renewal cycle allowing a micro level analysis of system behaviour; and a discussion of various corporate behaviours such as sustainability reporting, waste treatment, water recycling and energy efficiency from a resilience perspective. Case findings are integrated with the notions of thresholds and panarchy to produce new frameworks for comprehending organisational systems. Finally, the corporate resilience framework proposed in Chapter 6 is populated and tested. Although case study findings may not be directly transferable outside of a particular context, it is hoped that the framework can be used and further developed by managers and management practitioners.

1.10.9 Chapter 10: Conclusions and Recommendations

The last chapter contains key conclusions drawn from each of the preceding chapters including those on the literature review and preliminary and systems analysis of case findings. The integration of empirical work with components of resilience thinking and related concepts of adaptive management and enterprise resilience produce the most significant conclusions of the thesis. The line of argument builds upon the inadequacies of the optimisation and efficiency-increasing approaches for minimising the environmental impact of production and consumption processes (which also underpin carbon reduction strategies). Spier's sustainability journey is argued to be underpinned by a search for social-ecological system and enterprise resilience.

Based on the conclusions derived from a resilience-based analysis, recommendations are made with the aim of guiding businesses who are attempting to reconfigure their relationships to natural resources and eco-system services. Business managers are encouraged to formulate strategies in response to ecological risks and uncertainties, through pre-assigned capital (manmade and/or natural capital) and commitments. Such strategies also need to be consonant with the particular business phase.

Chapter 2: Research Methodology

2.1 Introduction

This chapter explains the process that was followed in designing and conducting the preliminary literature review; investigating the case; synthesizing new, context-specific knowledge; and embarking on additional literature review, in order to defend the thesis. At first it was not clear to the researcher and her co-supervisors that a transdisciplinary research methodology was being followed. However, as the requirements of the research problem required new knowledge to be assembled on the industry-related concepts of carbon footprint and carbon neutral; the research problem evolved as a result of engagements with actors within the case system; and the empirical evidence required alternative theoretical constructs to be investigated, it began to emerge that a straightforward process of literature review, case findings, case analysis and conclusions was not going to be sufficient. An iterative research process evolved, implicitly underpinned by the key principles of a transdisciplinary methodology (Bergmann et al., 2005; Pohl and Hirsch Hadorn, 2007; Brundiers and Wiek, 2011).

In this chapter, firstly, a basic understanding of the ideal-typical transdisciplinary methodology is articulated, laying out the different requirements and phases in the research process that are recommended for addressing complex, real-life problems (Section 2.2). Importantly, the principles which underpin transdisciplinary research (as defended by Pohl and Hirsch Hadorn (2007)) across the different practical applications of this approach by different groups of scholars, are stated. This section also refers to certain tools for conducting transdisciplinary methodology, as promoted by practitioners from the North, which may or may not work in the developing country context of the case under study.

Secondly, the two complementary processes of literature review and empirical work are described by using the three phases of transdisciplinary research as a framework (Sections 2.3 and 2.4). The descriptions support the claim that the research process satisfies all the principles of transdisciplinary methodology, as a result of which it also meets the critical requirements of transdisciplinary research. A clear articulation of the researcher's relationship with Spier Holdings is included in this description, as it evolved during the research process (Section 2.4.6).

Finally, a generation of different types of knowledge in the course of the research process is described in relation to the three categories of systems, target and transformation knowledge in Section 2.5 (as defined in transdisciplinary research methodology).

2.2 Transdisciplinary research methodology

Complex global sustainability challenges relating, for example, to poverty, energy, water, waste, food security, biodiversity, urbanisation, conflict, gender, values and identity are hard to understand and address using mono-disciplinary approaches. Global sustainability, including climate change, is increasingly recognised as a transdisciplinary challenge (Van Breda, 2008).

Transdisciplinarity is a way of engaging society, designed to produce socially relevant as well as new scientific knowledge and insights. Transdisciplinary research and knowledge production attempts to combine learning, research, and application to learn competencies and skills necessary for understanding and facilitating sustainability transitions (Van Breda, 2008). Transdisciplinarity is defined and practised as a mode of research and knowledge production with society (Stauffacher et al, 2006) (Scholz and Tietje, 2002) (Scholz et al, 2006) (Scholz and Stauffacher, 2007) (Pohl and Hirsch Hadorn, 2007) (Hirsch Hadorn et al, 2006). There is a body of literature which challenges the current practice of transdisciplinary, most of it aimed at clarifying the understanding of transdisciplinarity and advancing its application (Wickson et al, 2006; Kueffer et al, 2007).

2.2.1 Embedded research in society and the scientific environment

Embedding transdisciplinary research knowledge in the life-world and in the scientific environment is a tool aimed at tailoring results for different target groups (Scholz and Tietje, 2002; Pohl and Hirsch Hadorn, 2007). This sharing of research at different stages of knowledge production yields recursiveness and learning (Pohl and Hirsch Hadorn, 2007), which means that a problem that is defined by a specific target group (in this case Spier management) can evolve through the phases of a transdisciplinary research process, and yield results which are useful to a broader target group (such as scholars interested in advancing the concepts of resilience thinking to institutional systems, and businesses who aspire towards a lower carbon future).

In another articulation of the same argument, proponents of Mode 2 science ask for a rethinking of the role of science (Gibbons et al, 1994). Principles that govern this form of research, and are relevant to this research include co-evolution of science and society, contextualisation and the production of socially robust knowledge (Gibbons, 1999). At the same time, scientists can use the data that results from Mode 2 research processes for knowledge integration and theory-building (Scholz, 2011).

Research knowledge (including Carbonology and the 'Sustainability Story of Spier') was produced through integration of case-specific knowledge with scientific knowledge, and shared with Spier management. The research process was initiated through questions posed by Spier management, but culminated in core research objectives of relevance to the larger business and academic communities. The process of the evolution of research questions, as a result of contextualisation, integration with open encounters and embedding research knowledge, is detailed in Sections 2.3.5 and 2.3.6. Sharing of research knowledge with the larger scientific community is covered in Section 2.4.2. The use of transdisciplinary tools and research methods or Mode 2 science, yielded the production of socially-relevant, new knowledge (Section 2.5).

2.2.2 Requirements of a transdisciplinary research methodology

The need for transdisciplinarity arises when our knowledge about problems under investigation is uncertain, when the concrete nature of these problems is disputed, and when there is a great deal at stake for those involved in these problems (Pohl and Hirsch Hadorn, 2007). Transdisciplinarity deals with problems in such a way that it can:

- Grasp the complexity of problems that are being encountered;
- Take into account the diversity of life-world and scientific perceptions of problems;
- Link and integrate the different theoretical-scientific and case-specific knowledge systems with their tacit understanding of the context and local conditions giving rise to problems;
- Produce knowledge, practices and strategies that promote long-term sustainable outcomes and what is perceived to be the common good.

The above requirements are met through a combination of four elements or themes which recur throughout different definitions of transdisciplinary research methodology (Pohl and Hirsch Hadorn, 2007) and include: transcending and integrating disciplinary paradigms; doing participatory research; relating to life-world problems and searching for unity of knowledge beyond disciplines. Different definitions of transdisciplinary research may begin by prioritising one or a combination of the components cited above.

For example, Nicolescu (1996) stresses pluridisciplinarity which requires studying a research topic in several disciplines at the same time in order to achieve unity of knowledge beyond disciplines; while Lawrence (2004) emphasises the co-production of new insight through the fusion of disciplinary knowledge and practical know-how, achieved through participatory processes.

2.2.3 Phases of a transdisciplinary research methodology

An ideal-typical model of a transdisciplinary research process (Jahn, 2008) comprises of three main phases as follows:

- Problem identification and structuring;
- Problem analysis and integration; and
- Bringing the results to fruition (through iterative knowledge production).

Although the research will generally move from one phase to another, it is anticipated that an iterative process will evolve, where the work done in previous phases may need to be revisited.

Scholars and practitioners of the transdisciplinary approach often promote 'joint' or collaborative visioning, problem framing, analysis, integration, whereby each of the three phases of the transdisciplinary research process require the coming together and collaboration between members of the research team and relevant social stakeholder groups with a stake in problem transformation and the transition to a more sustainable state (Bergmann et al., 2005; Jahn, 2008; Scholz et al, 2006, Scholz, 2011).

However, Pohl and Hirsch Hadorn (2007) clarify that the participatory nature of the research process and integrative collaboration among researchers towards solving a life-world problem is not sufficient to make research transdisciplinary. 'Research is only truly transdisciplinary if it develops knowledge and practices that promote what is perceived to be the common good, if it takes into account the complexity of a problem and the diversity of perceptions of a problem, and if it links abstract and concrete case-specific knowledge' (Pohl and Hirsch Hadorn, 2007). This statement elevates the status of the outcomes of transdisciplinary research such as the synthesis of abstract and concrete knowledge, above that of the particular modes of collaboration used for such integration.

2.2.4 Principles of transdisciplinary research methodology

The recommended principles for transdisciplinary research are designed to assist during all three phases of the research process, in order to meet the basic requirements of this methodology (Pohl and Hirsch Hadorn, 2007).

1. **Reduce complexity by specifying the need for knowledge and identifying those involved**: the need for knowledge is related to the research questions to be addressed by a project and therefore, the systems perception underlying a project, the normative targets that have been set and the potential societal transformations sought through the project. The stakeholders are identified with the aim of incorporating a diversity of relevant perspectives. This principle is particularly significant in the first phase of problem framing and structuring.
2. **Achieve effectiveness through contextualisation**: there are two components or stages of contextualisation. The first one deals with assessing the state of knowledge with regard to concrete societal practices and issues in the life-world. The second component relates to the reformulation of scientific insights for greater access to specific target groups. Thus this principle applies most to the first phase of problem structuring and the final phase of knowledge production.

3 **Achieve integration through open encounters**: this principle requires perceiving one's own perspective as only one among several others, in order for constructive discussions and collaboration to take place through various modes of integration among scholars and societal stakeholders. This principle is relevant to all three phases of transdisciplinary research.

4 **Develop reflexivity through recursiveness**: project processes may need to be repeated several times if needed. Iteration is recommended throughout the research process and within each of the phases in order to ensure that concepts and methods are repeatedly tested and the dangers of false underlying assumptions and early conclusions are avoided.

2.2.5 Tools for conducting transdisciplinary research

The following tools are recommended for achieving the collaborative problem framing, co-creation of solution-oriented and transferable knowledge and re-integrating and applying the created knowledge which constitute the three phases of transdisciplinary research:

- Build a collaborative research team: this tool requires identification of scientists from relevant disciplines / scientific fields and 'real-world actors' who have experience or expertise in the problem (Pohl and Hirsch Hadorn, 2007), develop a common language among all team members in order to build a joint understanding of key concepts relevant in the research process (Stokols et al, 2010).
- Design a methodological framework for collaborative knowledge production and integration: this may include agreement on a set of methods and transdisciplinary settings, providing a common orientation for all team members from the beginning (Scholz et al, 2006). The methodological framework can also define the mode used for collaborating with each group of team members (Pohl and Hirsch Hadorn, 2007) and may require adjustment during the course of the project.
- Assign and support appropriate roles for practitioners and researchers: including formative evaluation throughout the research project by an extended peer group (comprising experts from science and practice), which allows reviewing progress and reshaping the subsequent project steps and phases if necessary (Bergmann et al, 2005; Walter et al, 2007; Regeer et al, 2009).
- Position the need for knowledge with regard to the three forms of knowledge: this tool helps position the transdisciplinary research based on the research questions being asked and the particular challenge being faced through each of the research questions (Pohl and Hirsch Hadorn, 2007).
- Embed transdisciplinary research knowledge in the life-world and in the scientific environment: this tool is aimed at tailoring results for different target groups and as such

can take place at any time during the course of the research (Pohl and Hirsch Hadorn, 2007). In support of the principle of recursiveness, regular embedding of knowledge within different disciplinary domains provides the feedback necessary for enabling learning processes in the subsequent research phases.

The tools discussed above are not comprehensive. They are drawn from a number of writings in the transdisciplinary research field, with a view to highlight the difference between those which specifically require the establishment of research teams and forums (the first three tools) in order to achieve problem-framing, analysis and knowledge integration through collaborative means; and those which are concerned with knowledge production and its role in achieving recursiveness and reflexivity during a transdisciplinary research process (the last two tools), but are not specific about the mode of integration utilised.

As mentioned in the introduction to this chapter, the research methodology adopted to conclude this thesis did not start out being transdisciplinary. However, as the description of different integrative modes and research tools employed during different phases of the research process will reveal, all the requirements of a transdisciplinary research methodology were ultimately fulfilled.

2.3 Problem identification and framing

Transdisciplinary research requires that the problem field investigated through the research be socially relevant, whereby knowledge extension is required to address practice-oriented issues. A problem is considered to be socially relevant when those involved have considerable stake in the outcome and interest in finding solutions is high (Pohl and Hirsch Hadorn, 2007).

The three different forms of research as ideal types rely on different ways of identifying and defining research problems by different academic disciplines and consequently, different research and analytical methods employed (Max Weber (1949) in Pohl and Hirsch Hadorn, 2007). The chart for comparing basic, applied and transdisciplinary research in figure 2.1 represents how research questions are framed in transdisciplinary research whereby the complexity of a problem field, its interpretations and measures for improving practices towards the common good are addressed. Figure 2.1 is based on the problem field of climate change and corporate environmental sustainability within which the research objectives posed by Spier management are located.

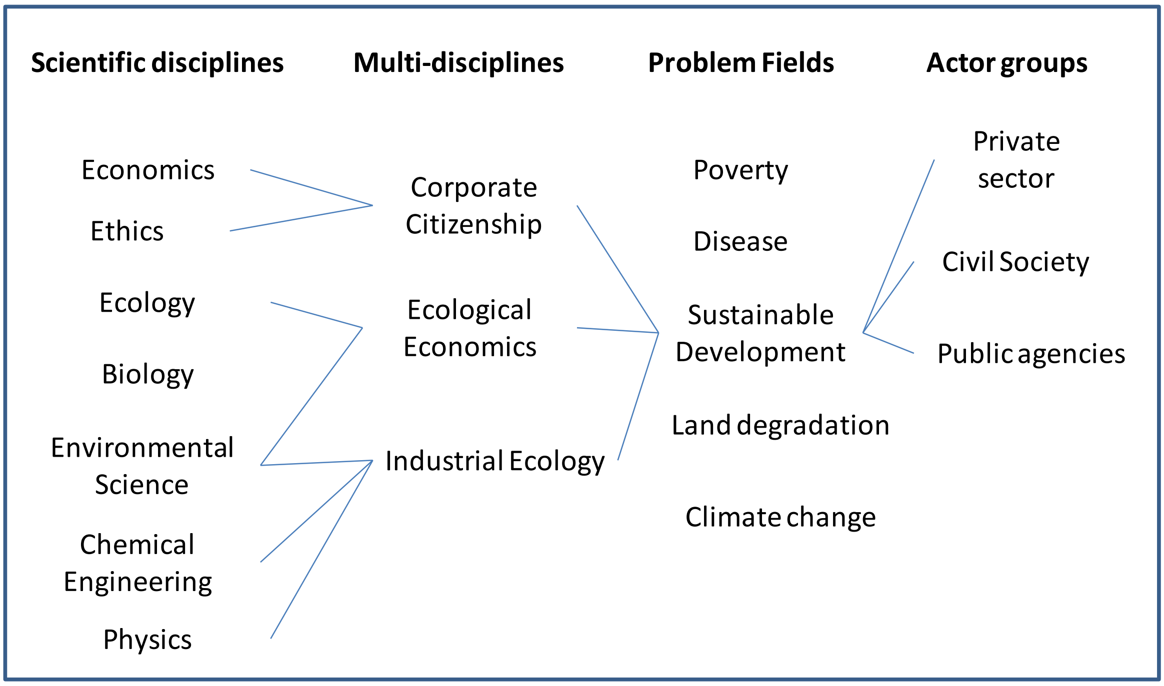

Figure 2.1 Identifying and structuring research questions in transdisciplinary research (adapted from Pohl and Hirsch Hadorn, 2007)

Reducing complexity by specifying the need for different types of knowledge (to be investigated and generated) and identifying those relevant to practice-oriented problem-solving is particularly important during this phase of the research process. The following sections explain how the primary research objectives helped in designing the preliminary literature review, and identify the individuals within and connected to the Spier business to be interviewed for achieving those objectives.

2.3.1 Entry into the problem field

There were two key determinants of how the research project was approached, both of which relate to the two funding agencies of the doctoral thesis. The first determinant was the specific interest of Spier Holdings in the research problem and the research objectives articulated by their senior management, right at the beginning of the research process. The second was the interest of the Centre for Renewable and Sustainable Studies (CRSES) in the research problem. Spier Holdings interest in the research project was twofold: charting Spier's sustainability trajectory to track progress over time and unravelling how a business becomes carbon neutral. CRSES's research interest in the thesis was related to the potential for exploring renewable energy solutions by a business aiming to achieve carbon neutral status.

A first meeting with the Chief Operating Officer (COO) at Spier, Heidi Newton-King, was on 8 October, 2008. Senior management at Spier was interested in discerning how far it was on the journey to integrate development and sustainability. At this point, history was seen as an important component of the process, and the narrative was envisioned to be rich in stories, relying on a qualitative framework, as well as significant quantitative data.

The research work was kicked off with a series of interviews at the Sustainability Institute, with people who had been intimately involved with Spier's sustainability trajectory during different stages of its history and were still involved, but to a lesser degree. Engagement with these individuals was designed to overlap slightly but for the most the interviews were scheduled to obtain specific information on different periods in the business' sustainability trajectory, as presented in table 2.1. (A list of questions that were posed at this first series of interviews is included in Addendum A: Interview Protocol).

Table 2.1 Interviews with intermediaries who were part of the Spier organisation during different periods of its history

Involved person / Designation / Time of interview	**Linked aspects of the sustainability story**
Eve Annecke and Mark Swilling Ex-members of the Spier Strategic Planning team (1999-2002) 13 November 2008 (10h00-12h00)	Period of Spier's history from 1999-2002 Orientation of the research process and problem field Information on other relevant intermediaries to be interviewed
Tanner Methvin Ex-Director for Sustainable Development (2002-2004) 13 November 2008 (12h00-13h00)	Intimate knowledge of Spier's operations from 2002-2004 Renewable energy projects exploration and implementation
Gareth Haysom Ex- Director of Spier Resort Management 13 November 2008 (14h00-16h00)	Intimate knowledge of Spier Leisure's operations from 1999-2003 Sustainability reporting at Spier (2004-2006)

The interviews conducted as per table 2.1 provided context-rich memories of the past as well as value-based perspectives, related by individuals' personal experiences at Spier over the period from 1999 to 2004. This case-specific knowledge needed to be contextualised in relation to abstract knowledge from the literature categories of sustainable development and corporate citizenship. The interviews, meetings and review of the Spier Sustainability Reports (2004-2007) in 2008 therefore guided in framing the literature review, which was then used to refine the research problem further.

2.3.2 TERI: an early source of technical knowledge on industrial and corporate sustainability practices

In early November 2008, the researcher established contact via electronic mail with TERI (The Energy and Resources Institute, www.teriin.org) headquarters in Delhi and approached their Technology dissemination and Enterprise Development division initially. A comprehensive list of all TERI technologies available for licensing and technology transfer was reviewed, based on what would be relevant to medium-sized businesses in South Africa seeking a lower carbon future. Some of the technologies relevant to reducing emissions were biomass gasification for heat, power, and CHP applications for rural, commercial, and industrial applications (up to 150-kWe capacity); arbuscular mycorrhizae biofertilizer as a natural alternative to chemical fertilizers; lighting systems (patent applied); process for biomethanation of organic wastes (patent applied); and biopesticide based on eucalyptus plant extract (patent applied).

A representative from the Indian chapter of BCSD: Business Council for Sustainable Development provided knowledge on corporate issues and governance for sustainability. BCSD India, based at TERI offers thematic advisory services on Energy efficiency (mainly around performance aspects of buildings) and Water (efficient water management practices).

In December 2008, these contacts were strengthened through personal meetings with the Manager for Technology Transfer, Albert Neil Trevor; Senior Fellow at the TERI University and Chair for Renewable Energy and Sustainable Development, Dr V.V.N. Kishore; Area Convenor for GRIHA (Green Rating for Integrated Habitat Assessment), Gaurav Shorey; and Area Convenor for BCSD India, Prateek Ghosh. At that time, BCSD India was providing advisory services to over 80 corporate clients such as energy audits, environmental impact assessment projects, corporate social responsibility projects in rural areas; and serving as an institutional mechanism for connecting businesses with particular research and technology units within TERI.

The meetings resulted in a visit to the Energy and Environment Technology EXPO, the first Indian exposition in the field of renewable energy held in New Delhi in mid-December 2008, inaugurated by Dr Rajendra K Pachauri, Director General of TERI and Chair of the Intergovernmental Panel on Climate Change (IPCC) since 2002. A visit to TERI Retreat in the national capital region, near the town of Gurgaon, exposed the researcher to ecological principles for building design such as wind tunnels for cooling, solar panels for water heating and reed-bed treatment of wastewater. A bio gasification plant was in operation at the site, providing a physical sense of technologies studied on paper. A year later, the researcher attended the first GRIHA conference co-hosted by TERI in Delhi.

2.3.3 Entry into the case

The empirical part of the project was conceived to follow a case-study approach in order to generate context-dependent knowledge required for delivering on both the research objectives, and for theory construction through the development of an understanding of context-dependent knowledge (Flyvberg, 2006; 2011). There were four types of entries into the case which laid the foundation for subsequent interviews and document analysis. These different entry types are listed in table 2.2, as they related to the three groups of semi-structured interviews and content analysis conducted during the empirical data collection phase in 2010.

Table 2.2 Four types of entry into the case as a basis for subsequent data collection

Type of access / entry into the case	Involved person / Designation / Date of first interview	Linked aspects of the sustainability story
Operational management	Christie Kruger Group Accountant 16 February 2010	Financial and environmental reporting Sustainability reporting Carbon footprint reporting LCA-bottle of wine
Senior management team	Heidi Newton-King Chief Operating Officer 8 February 2010	Business strategy with respect to sustainability Ongoing guidance on research objectives
Intermediaries	Eve Annecke, Mark Swilling Ex-members of the Spier Strategic Planning team 13 November 2008	Period of Spier's history (1999-2002) Sustainability-oriented projects and programmes
	Tanner Methvin Ex-Director for Sustainable Development 13 November 2008	Sustainability reporting and performance management at Spier (2002-2004) Renewable energy projects
	Gareth Haysom Ex- Director of Spier Resort Management 13 November 2008	Spier Leisure (1999-2003) Pro-poor tourism Sustainability reporting for Spier (2004-2006)
Documents and reports	Best Sustainability Report award – 2006	Sustainability reporting at Spier (2004 – 2010)

	October 2008	Organisational macro-goals

There was more than a full year's gap between the first articulation of the research objectives in October 2008 (based on preliminary meetings with the COO at Spier and intermediaries at the time of commencing the doctorate) and the commencing of the case study in February 2010. The full case-study or empirical work was conducted from February to August 2010 (with a final interview conducted on 13 October 2011). The period of empirical work can be considered part of the problem-framing and structuring phase as the research problem continued to be redefined during this period.

In-depth empirical work was carried out by engaging very closely with corporate practices of the different business units at Spier Holdings, aimed at environmental sustainability, through frequent site visits and numerous interviews at the estate at different levels in the organisation.

2.3.4 Immersion as a qualitative research tool

Re-entry into the case in February 2010 was commenced with Spier COO, Heidi Newton-King, who was the main point of reference for the thesis within the business. Empirical evidence in support of Spier's sustainability journey was collected by meeting with the Group Accountant Christie Kruger, who was responsible for consolidating environmental reporting through the office of the Director of Finance.

With a view to understanding Spier's environmental reporting process, primary data collectors: book-keepers, creditors and financial staff who collected and reported on environmental data within the three business units of wine, leisure and farming, were interviewed (details in Addendum A: Interview protocol). The environmental component of published and unpublished annual reports (2004-2009) was reviewed in order to test consistency and comparability between past and current years' figures. Thirdly, the Group Accountant's attempt at conducting an LCA-based carbon footprint of a bottle of wine was interrogated. Proximity to these processes as they were unfolding in the business, allowed great access to environmental data at Spier, and for the researcher to begin seeing the business as made up of material flows of waste, energy and water.

The option of establishing a forum of scholars and practitioners in the field of corporate sustainability and organising collaborative problem-framing and problem-defining sessions was not considered a valid research tool in the first phase of the research process. Instead, empirical data collection was sought through two methodologies: a series of semi-structured interviews and content analysis.

2.3.4.1 Semi-structured interviews with operation staff at Spier

In parallel with the interviews and data verification with respect to environmental reporting , numerous employees, management personnel and senior managers at Spier, as well as relevant intermediaries, were interviewed, in order to generate the information needed to deliver on firstly, the writing of the 'Sustainability Story of Spier'. The format for such engagement followed the method proposed by Weller (1998) whereby a combination of opened-ended and flexible questions is used to explore different topics. Such exploratory interviewing allowed informants to provide information which could be co-assessed and refined as the interview progressed, and generate knowledge which was of direct relevance to the research problem, through a process of learning and experience (Weller, 1998).

Firstly, several staff members at the implementation level provided great insight into the workings of the business, in order to inform meetings with senior managers. Operational staff members relevant to the case study were identified by reviewing Spier Sustainability Reports (2004-2007) and enquiring who in the business was responsible for implementing different components of environmental sustainability practices. The environmental practice areas of performance measurement and reporting, reduction in electricity and water consumption, waste recycling, wastewater recycling, biodiversity conservation and environmentally friendly farming were drawn from the goals listed under the organisation's environmental macro-goal of climate change in the Spier Sustainability Report, 2007. The operational staff members, who were interviewed in relation to the practice areas to be investigated, are listed in table 2.3.

Table 2.3 Operational staff members interviewed in relation to the different environmental practice areas

Corporate practice area	**Operational staff member / Designation**	**Responsibility in relation to environmental sustainability**
Environmental performance reporting	Christie Kruger Group Accountant	Collation of environmental and financial reporting for all 3 business units at Spier Calculation of Spier's carbon and water footprints Calculation of an LCA-based carbon footprint of 1 bottle of wine
Energy and water conservation	Cherie Immelman Facilities Manager for the North Block	Reduce consumption of electricity and water at the Hotel and Banqueting

		Engage with potential suppliers of renewable energy for Leisure unit
	Frans Smit Cellar Master	Reduce consumption of electricity and water at the cellar Engage with potential suppliers of renewable energy at the cellar
	Orlando Filander Farm Manager	Installation and maintenance of water meters on supply pipes to all the buildings on the estate
Solid waste recycling	Cherie Immelman Facilities Manager for the North Block	Reduce waste generation in all buildings on the estate Increase recycling rates Engage with waste recycling contractors
Wastewater treatment	Orlando Filander Farm Manager	Operational management of the wastewater recycling plant Water metering for pipes going to all the buildings on the estate Supervision of septic tanks at the cottages
Biodiversity conservation	Orlando Filander Farm Manager	Supervision of river cleansing Supervision of alien vegetation clearing Implementing the goal of converting 25% of estate to original wetland Establish a Protea Walk for guests and day-visitors
	Lesley Jumat Sustainability Projects Manager	Various sustainability programmes with Klapmuts community including planting of indigenous trees
Environmentally friendly farming	Orlando Filander Farm Manager	Investigate different organic farming techniques and practices

Interviews with Spier staff were initially scheduled such that the researcher would need to travel from Cape Town to the Spier estate in Stellenbosch twice a week. As the months progressed and a deep appreciation of the case began to emerge, the frequency of meetings slowed down. Sometimes, second or third interviews with the same personnel were sought if information contained in different interviews did not correspond. The physical nature of Spier's experimentation with different aspects of environmental sustainability meant that interviews were a combination of verbal interviews and site visits. This is especially true of the interviews with the Farm Manager, the Facilities Manager and the Cellar Master.

Interesting information was shared during interviews and site visits with the operational staff members. For example, Orlando Filander is also responsible for the management of the compost site and the transportation of certain types of organic waste to the site. Biodynamic Farming at Spier which carries the branding of Spier actually does not belong in any of the business units, is not reported on by Spier and runs as a separate entity on the estate. Eric Swarts, who was part of a Spier-run project called Go Organic in 1999, is also an independent entity on the estate and has been granted farming land by Spier, with free access to electricity and water.

2.3.4.2 Semi-structured interviews with senior managers at Spier

Based on the preliminary meetings with the COO, subsequent semi-structured interviews with the other members of the senior management team such as the CEO, the CFO and the Marketing Director were set up. This level of interviews was also structured around the environmental performance areas and goals listed under the organisation's macro-goal of climate change in the Spier Sustainability Report, 2007. The senior managers interviewed in relation to specific practice areas to be investigated, are listed in table 2.4.

Table 2.4 Senior managers at Spier interviewed in relation to environmental performance areas and strategies

Corporate practice area	**Senior Manager at Spier / Designation**	**Responsibility in relation to environmental sustainability**
Environmental performance reporting and management	Gerhard de Cock Chief Financial Officer	Management of environmental performance across the different businesses Liaise with external consultants for conducting carbon footprint Manage internal measurement of environmental performance through carbon footprint, water footprint and LCA

Sustainability reporting Marketing Spier's sustainability brand	Annebelle Schreuders Director Marketing	Producing sustainability reports since 2008 together with the COO Identify and liaise with external consultants for writing sustainability reports for 2009 and 2010 Enhancing the business' sustainability brand using existing practices in procurement and recycling
Sustainability strategy	Heidi Newton-King Chief Operating Officer	Responsibility for exploring sustainability-oriented innovations in the organisation (such as greening of the banqueting area, carbon-offsetting) Main point of reference for PhD
Sustainability strategy	Andrew Milne Chief Executive Officer	Over-all responsibility for sustainability-oriented innovation and funding for projects

Although senior managers were interviewed with specific focus on their areas of responsibility, the semi-structured nature of interviews allowed for the researcher to speak to them about lateral functions. For example, Annebelle Schreuders' opinion on the overall business strategy with regards to sustainability was queried, in addition to her role in the performance areas of sustainability reporting and marketing the sustainability brand. Links to important case evidence were provided by the senior managers during interviews, which had been overlooked by operational managers. For example, Gerhard de Cock alerted the researcher about the bio-diesel company from whom Spier bought transportation fuel. Andrew Milne provided crucial information about a past energy audit conducted at the leisure business in 2008.

In addition to the individual interviews with each of the four senior managers identified in table 2.4, the researcher attended one meeting with the Executive Committee (details in Addendum A), which includes the Director for Information Technology, Dale Simons. At one point there seemed a possibility of interviewing Mr Simons in relation to the consolidation of sustainability reporting at Spier. However, the interview was not pursued since the plan of consolidating different reporting streams was not put in action in the duration of the empirical work.

The meeting with the Executive Committee was also attended by Frans Smit, the Cellar Master and Jaco Durand, the Procurement Manager. Thus it proved to be a very useful forum for introducing the research to the full executive committee, establishing the researcher's presence on the estate and enabling her access to information on business operations.

2.3.4.3 Semi-structured interviews with intermediaries and experts linked to Spier's sustainability journey

A very important outcome of the semi-structured interviews conducted with operational managers and senior managers at Spier were the leads to intermediaries, individuals who had been part of Spier; were presently or had been contracted by Spier in the past for specialised services, projects and innovations related to sustainability.

The informants identified in relation to the practice areas to be investigated and interviewed during the period when empirical work had begun in earnest, are listed in table 2.5. Some informants were interviewed more than once during the course of the case study work, in order to verify information or technical knowledge shared by other intermediaries or experts, or drawn through content analysis.

Table 2.5 Intermediaries and experts who were interviewed in connection with sustainability reporting and environmental practice areas at Spier

Corporate practice area	**Intermediary, consultant, external agency**	**Responsibility in relation to environmental sustainability**
Sustainability reporting	Rob Worthington, Trialogue: Cape Town-based Corporate Social Investment consultancy	Producing sustainability reports for 2009 and 2010 Conducting a five year review of Spier's sustainability performance
	Prof Ralph Hamann, Advisor to Tanner Methvin in 2003	GRI-based logic of the sustainability performance indicators developed at Spier in 2003
	Gareth Haysom, Research Fellow at the Sustainability Institute (SI)	Sustainability reports prepared by SI for Spier (2004-2006)
	Lisa Smeddle-Thompson, Project Manager at SI	Sustainability reports prepared by SI for Spier (2004-2006)
Carbon footprint calculation and carbon reduction strategies	GCX: Cape Town based Carbon Management consultancy CEO: Kevin James	Spier's Carbon Footprint for 2008, Recommendations to Spier for reducing and off-setting emissions
	SAFWI: South African Fruit and	Development of a carbon calculator

	Wine Initiative Project co-ordinator for 'Confronting Climate Change': Shelley Fuller	for the South African fruit and wine industry (a predominantly Western Cape-based alliance of fruit farmers and wine producers)
	Jess Schulschenk, Project Manager at SI	Environmental Manager at Backsberg estate cellars claiming CN status
Renewable Energy projects	Tanner Methvin, Ex-Director for Sustainable Development	Investigation of bio fuel and bio diesel projects in collaboration with CRSES
	Riaan Meyer, Engineer at CRSES	Technical advice to Spier on the greening project at the banqueting area
	Frank Spencer CEO, G-Tech and Emergent Energy	Bidder for the greening project at the banqueting area Bidder for heat pumps for water heating at hotel
	Prof Jorgens Process Engineer	Investigation of the bio fuel project in collaboration with CRSES
	Prof Alan Brent Associate Director, CRSES	Proposal for a Concentrated Solar Plant on the Spier estate
Wastewater recycling	Tanner Methvin, Ex-Director for Sustainable Development	Design and construction of the wastewater treatment plant based on a combination of engineering and metaphysical principles

Additional intermediaries in the practice areas of solid waste recycling and wastewater treatment were identified for interviewing but not pursued, such as the hydrologist at HWT Engineering who co-designed the wastewater treatment plant with Tanner Methvin and previous and current solid waste contractors at Spier. Secondary data captured in annual reports and video clips on the Spier website and actual site visits to the solid waste recycling depot and the wastewater treatment plant were found sufficient to generate the information needed for understanding the business' sustainability journey, in addition to data collected through semi-structured interviews with operational staff and senior managers.

More than anything else, these intermediaries represent the knowledge and innovation networks to which Spier is connected through the exchange of various consulting, procurement and technical services. These networks are studied in Chapter 9. Addendum A lists all the interviews and exchanges in a chronological order.

2.3.4.4 Content analysis

Content analysis was conducted on the following sources of data: electronic mail and documentary sources, such as management documents, the Spier Development Framework, annual reports, periodic (business) plans and budgets, environmental reports and Spier's carbon footprint document submitted by GCX, collected during interviews and via electronic mail. An interesting piece of writing called '*A Place of Hope- the story of Spier'* by Mike Nicol (1999) provided useful information on the very early history of the Spier estate from when it was bought in 1993. The author, Mike Nicol had conducted detailed interviews with Dick Enthoven, main shareholder of Spier and Tom Darlington, the architect responsible for renovating the buildings on the estate.

Interrogation of the assignments undertaken by Group Accountant allowed the researcher access to recording of primary data on the business' environmental performance such as electricity and water (industrial and municipal) consumption bills; reports from the waste contractors and invoices for mobile and stationary fuels. It also provided a great opportunity for observing and documenting the real-world application of carbon measurement tools such as PAS 2050:2008 and the GHG protocol at product and organisation level, respectively.

Electronic copies of numerous exchanges between the Facilities Manager, Cherie Immelman, the CRSES technical advisor and vendors of renewable energy technologies over the period of 2006-2010 were reviewed. Knowledge of the actual events improved the structuring of interviews with relevant informants on the renewable energy adoption trends of the business. Exchanges between Trialogue and Spier management on electronic email and the strategy documents and drafts of sustainability reports prepared by Trialogue were also made available to the researcher. These assisted in understanding the strategic direction of the senior management at Spier with regards to sustainability as defined through corporate social investment practices.

A case-study map (figure 2.2) represents the different entries into the case, Spier Holdings via history (right bottom), documents and reports (left bottom), operational management at Spier (left top) and senior management at Spier (right top). It also represents how the main informants to different environmental performance areas generated links to further intermediaries and informants within and outside the business.

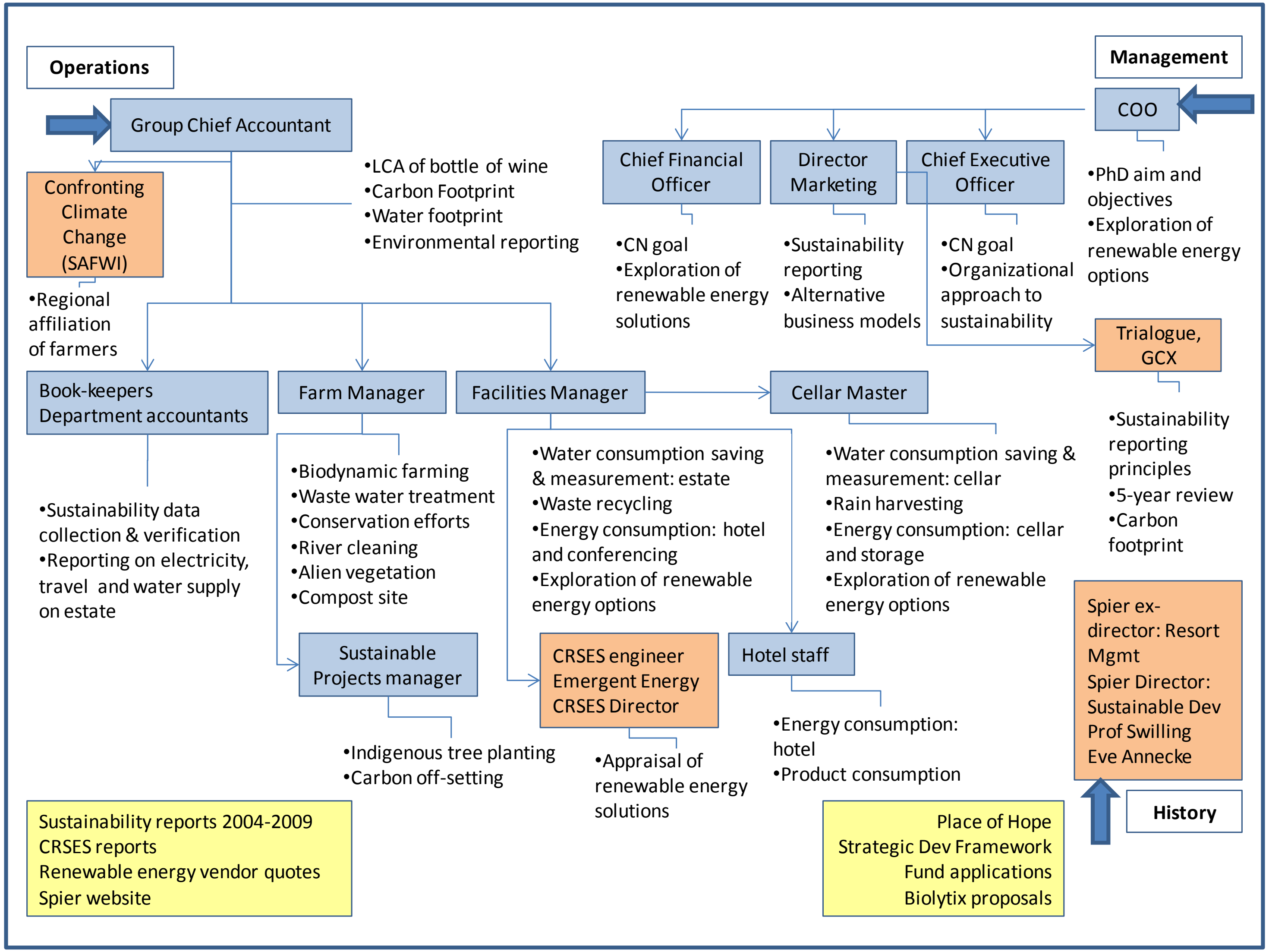

Figure 2.2 Map of informants and intermediaries, whose stories were woven together to write the 'Sustainability Story of Spier'

2.3.5 Integration through open encounters

Informed by the principles of transdisciplinary research, the researcher was open to the worldviews held by informants, senior managers and external agents who were or are close to the various projects and initiatives at the three Spier business units, oriented towards environmental sustainability.

Multiple perspectives from experts in different practice areas such as carbon reduction (Jess Schulschenk; Kevin James), process engineering (Prof Jorgens; Prof Brent), corporate sustainability (Prof Ralph Hamann) and renewable energy technologies (Frank Spencer; Prof Brent) and from decision-makers and implementers within the Spier system (senior and operational managers and financial staff members) contributed to the common undertaking of building and verifying various components of the business' sustainability journey.

Pohl and Hirsch Hadorn (2007) list several forms of collaboration to achieve integration during the three phases of a transdisciplinary research process, such as common learning as a group, negotiations among experts and integration through the project leader. Integration by the project leader does not require immediate exchange among the participants (Pohl and Hirsch Hadorn, 2007).

Integration of different perspectives and case-specific knowledge streams was achieved at the end of the thesis, when all sub-components are combined to produce results (Chapters 9 and 10). Different entries into the empirical data led the research to further informants and intermediaries. Each informant in turn required certain streams of abstract knowledge to be investigated.

Collaboration can also use different modes of integration (Pohl and Hirsch Hadorn, 2007) such as models, transference of concepts, glossaries, mutual adaptation of concepts and development of bridge concepts. This thesis utilised everyday language, experiences and stories for most interactions and models such as the carbon footprint of the business and environmental data for exchanges related towards researching the corporate performance area of sustainability reporting. Development of bridging concepts was explored through finding ways in which concepts from industrial ecology can improve business management and decision-making. The main concept around which significant mutual adaptation and learning took place was that of the relevance of carbon neutral as an appropriate response to climate change. This learning and how it transformed the research problem is described in the next section.

2.3.6 Reformulation of the research problem

The doctoral research was triggered by a question that the case business Spier Holdings posed, namely 'how can a business become carbon neutral?' However, as the meaning and significance of this question was explored with managers and staff members at Spier over a period of 10 months, it became apparent that the business was in fact posing much more profound and deeper questions about what it means to build a resilient business. The focus on carbon neutrality was found too narrow to understand Spier management's notions of sustainability. The progression from Carbonology to resilience, as a corporate driver of seeking a lower carbon future, is charted through the evolution of the two aims of the case study.

The case study was commenced with two explicit aims: the first was to find out how a business (such as Spier) could become carbon neutral. The second aim was to chart the sustainability journey of Spier in order to interrogate business decisions aimed at environmental sustainability. The above starting points were useful in entering the case system, structuring interviews and collecting empirical evidence (as explained in Section 2.3.4). However, during the data collection stage of the thesis, and as a result of integrating case findings with scientific and industry knowledge, these aims evolved significantly, in order to engage with a broader and deeper conceptualisation of corporate environmental sustainability.

As explained in Section 2.2.1, the thesis adopts the transdisciplinary principle of embedded research, which is enabled through regular sharing of knowledge with different disciplinary and societal domains.

This section charts how the research objectives of the thesis transformed as a result of integration of different forms of knowledge and their practical application by real-world actors throughout the problem structuring and definition phase. The phase itself is not a stand-alone period in the duration of the thesis. Problem structuring was followed by analysis, which required further inquiry of specific systems knowledge, which reformulated the problem and further analysis, and so on.

2.3.6.1 Interrogation of carbon-based goals for driving environmental sustainability

From the onset it was assumed that the two aims of the case study would be addressed in parallel. That is, while primary and secondary data was being collected to track the sustainability journey of Spier, opportunities for the business to become carbon neutral would present themselves. Therefore, interrogating practices for environmental reporting and measurement of GHG (greenhouse gas) emissions revealed areas where the emissions could be reduced. There were underlying assumptions embedded in this reasoning which were eventually questioned (in Section 2.4.6).

Importantly, during the first half of 2010, the macro-organisational goal of carbon neutral became diffused and almost abandoned by the Spier management. The fact that carbon neutral status was possible by off-setting emissions either through generating own renewable energy, planting trees or investing in a carbon-offsetting, development project, became clearer to the senior managers through engagements with the researcher, internal management team consultations which included the Group Accountant, and reassessment of past investigations such as the GCX report in 2008.

Senior managers realised that while electricity consumption, the biggest source of GHG emissions for the business could be reduced through efficiency and conservation measures, carbon off-setting was not feasible on two grounds. First, off-setting by planting trees or investment in an off-shore development project did not align with Spier's interpretation of locally-grounded sustainability. Second, Spier would only invest in renewable energy technologies which made economic sense.

Exploration of different renewable energy technologies had not yet produced a solution which was as ecologically and economically viable as the wastewater treatment plant was. Therefore, senior managers at Spier (Andrew Milne, CEO and Gerhard de Cock, CFO during individual interviews on 14 June, 2010) did not mention carbon neutral anymore, but rather focused on lowering carbon emissions across all business units.

Thus the assumptions underlying the carbon neutral goal as one of the climate change macro-goals came up for closer examination, raising the following questions, which became the focus of the case study:

- Why does a business want to become carbon neutral? (and embedded in that: What informs a business' understanding of corporate sustainability)
- Does carbon emissions calculation (and the goal of carbon neutrality) drive a business' search for a lower carbon future?

Additionally, the two aims of the case study became increasingly interlinked as the business' past and present strategies with regards to environmental sustainability, and lower carbon emissions, were examined from an internal, operational level (through interviews with operational managers) and from an external, often expert perspective (through interviews with intermediaries). As the case evidence was investigated from multiple disciplinary perspectives (refer to figure 1.4), additional research questions were raised and addressed:

- What alternative measures or goals drive a business' search for a lower carbon future?
- Do the same alternative measures or goals drive a business' search for improved performance in additional aspects of environmental sustainability?

The above research questions resulted from integrating case evidence with frameworks and concepts from corporate citizenship, ecological economics, industrial ecology, systems thinking, complexity and resilience thinking. A highly structured stage in collaborative problem-framing and articulation of the research questions, with links to different types of abstract and case-specific knowledge, is captured as figure 2.3.

The above questions, which formed the basis for interrogating the 'Sustainability Story of Spier' and additional case evidence, contributed towards the formulation of the core research objectives as discussed under Section 2.3.6.3. In particular, the core research objectives address long-term sustainable outcomes for the common good, as required of transdisciplinary research (Pohl and Hirsch Hadorn, 2007) and solution-oriented research (Scholz et al, 2006).

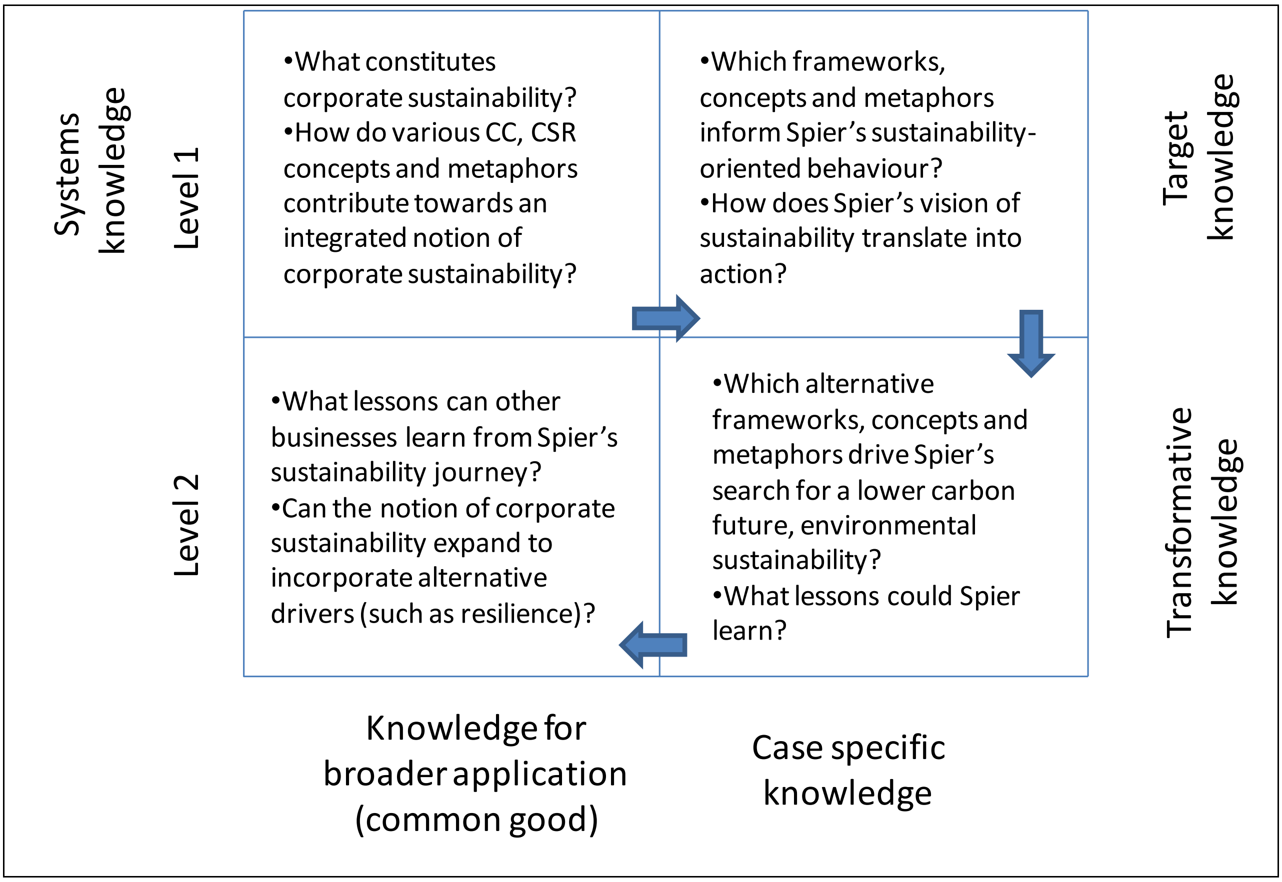

Figure 2.3 Problem-definition and articulation of the research questions, in relation to systems, target and transformative knowledge production

2.3.6.2 Focus of the 'Sustainability Story of Spier'

The writing of the narrative which describes the sustainability journey of Spier was conducted to satisfy the second aim of the case study, with a view to subsequently interrogate the story from different conceptual frameworks. The focus of the narrative and therefore the generation of case evidence which was analysed and scrutinised to understand corporate drivers for seeking a lower carbon future, and environmental sustainability, incorporated the world views of senior managers at Spier as well as intermediaries.

In October 2008, Spier COO Heidi Newton-King raised the issue of corporate innovation in the context of environmental sustainability, with linkages to examples of and opportunities for innovation implemented at various levels of the organisation. In his interview on 13 November 2008, Tanner Methvin also mentioned innovation in relation to the exploration of various renewable energy projects which he had initiated at Spier and the installation of the wastewater treatment plant. As a result, the narrative focuses on instances of radical environmental innovations, tried and tested during the different phases of the business' history.

In her second meeting with the researcher in February 2010, the COO stressed upon the need for credible, scientific basis for developing strategies aimed at environmental sustainability. Such strategies would go beyond common market trends such as achieving carbon neutral status by planting trees as an off-setting measure. Development of corporate strategies based on scientific knowledge resonated with the objective of industrial ecology: to advance business management and corporate strategy development through metaphors and analytical tools from the IE. The links between IE metaphors and environmental strategies were found limited (Chapter 4). However, the role of strategy formulation as an adaptive response to risks and uncertainties in the larger SES was incorporated in the development of the integrated corporate resilience framework (Chapter 6).

The input from CEO Andrew Milne was instructive to the extent that the purpose of the narrative was clarified – a way of substantiating Spier's delivery on its explicit sustainability commitment through its past practices. The 'Sustainability Story of Spier' was intended to be a balanced reflection of business practices. Management stressed that the search for a carbon neutral was driven by the need to drive the commitment towards a lower carbon future, and environmental sustainability. At this stage there was considerable interest but limited knowledge among the senior managers with regards to different carbon standards and reporting tools, especially the LCA-based methodology.

Based on the meetings and interviews, the following trends were covered in the 'Sustainability Story of Spier', which contain lessons for the larger business community:

- Corporate innovations aimed at a lower carbon future, and environmental sustainability
- Development of corporate strategies based on science-based environmental impact assessment tools such as water footprint and carbon footprint
- Likelihood of achieving a carbon neutral status through various innovations and / or investments in renewable energy and energy efficiency technologies, wastewater treatment, solid waste recycling and natural conservation.

2.3.6.3 Revised research objectives resulting from a transdisciplinary approach

The first aim of the case study to unravel how a business becomes carbon neutral, led to the deeper question of why a business seeks the status of carbon neutral. The second aim of the case study addressed issues of corporate innovation, the role of impact assessment tools and a milieu of corporate practices (knowledge, network and technology-based) for achieving a lower carbon future, and environmental sustainability. In trying to find answers related to carbon management in a corporate context, and seeking to understand business aspirations through various disciplinary lenses, Spier's journey provided a unique learning example.

Information pertaining to organisational goals and performance in the area of environmental sustainability (as contained in Spier's annual sustainability reports) was verified through interviews and site visits. The preliminary analysis of empirical evidence raised and attempted to answer the following case-specific research questions:

1. Is carbon emissions calculation a useful measure for tracking Spier's environmental sustainability journey?
2. Does the goal of carbon neutrality assist Spier in driving its search for lower carbon emissions or environmental sustainability?
3. Can Spier's environmental performance be understood by using frameworks from corporate citizenship and systems ecology?

Frameworks and concepts from corporate citizenship, ecological economics and industrial ecology were initially applied to case findings but proved inadequate. Finally, the social-ecological systems construct, adaptive management, resilience thinking and its components were found to be most useful in understanding the drivers for Spier's search for a lower carbon future. These frameworks, including the integrated corporate resilience framework, and mapping tool, were synthesised through literature reviews of several abstract and scientific knowledge streams, which are explained under Section 2.5. Corporate resilience as a bridging concept to engender both enterprise and ecological sustainability explained corporate behaviour across environmental practice areas.

As the integration of case-specific knowledge with abstract knowledge frameworks yielded a common logic and substantiated the application of resilience-based thinking and adaptive management to transform business systems, the thesis addressed the following core research objectives:

- To understand the corporate drivers which underlie the search for a lower carbon future;
- To propose a conceptual framework that should encourage and assist businesses in building corporate resilience, in response to environmental and resource uncertainties.
- To situate the goal of carbon reduction, as well as additional aspects of environmental sustainability within a larger corporate resilience framework.

Spier's performance in aspects of environmental sustainability, such as lower carbon emissions, wastewater treatment, water sustainability, solid waste recycling and nature conservation were plotted on the corporate resilience mapping tool. The integration of case evidence (systems knowledge) with target knowledge (building corporate resilience) substantiated a wider application of the transformative knowledge (resilience framework) produced. A resilience-based understanding of carbon reduction was re-incorporated into the framework.

2.4 Problem analysis and knowledge integration

The problem analysis phase of a transdisciplinary research process is designed in such a way so as to draw from the technical knowledge and practical know-how of experts from various disciplines, using different valid forms of collaboration. In the absence of a transdisciplinary team who could analyse the research objective from the perspective of different disciplines (Nicolescu, 1996) which could then be unified through different forms of integration, this thesis relied upon the researcher's own capacity to investigate and apply relevant focus areas from the disciplines of industrial ecology, ecological economics and corporate citizenship to the revised research objectives. In addition, findings and preliminary results from the research work were regularly embedded in the scientific environment by presenting them at local and international forums, thus allowing the testing of methods and results and enabling recursive learning.

Literature review of the abstract knowledge fields was supplemented by attendance at core modules offered through the School of Public Leadership at Stellenbosch University and interactions at international conferences and local symposia, discussed below.

2.4.1 Core training modules in sustainable development and transdisciplinary research

A crucial resource during 2009 when the different knowledge fields were being investigated were the week-long modules taught at the Sustainability Institute (SI) in Stellenbosch as part of the B Phil and M Phil in Sustainable Development. As a PhD student in Sustainable Development, the researcher was allowed free attendance at all the modules at the SI and invited to attend the training programme in Transdisciplinary Research organised by John van Breda, Programme Manager of the TSAMA Hub. The modules were attended to supplement literature review, take note of the latest thinking and best practices and speak to experts who were guest lecturers at the modules. The following modules were attended:

Transdisciplinary Doctoral Programme (4-6 May, 2009): introductory core module in the areas of transdisciplinary epistemology, methodology and complexity theory presented by local and international experts. Although the project did not start out utilising complexity theory for analysis or the transdisciplinary research methodology for designing the research process, the exposure to these theoretical constructs was critical for when problem definition and analysis were revisited in an iterative way and alternative concepts from sustainability science were studied and adopted for systems analysis of the case.

Renewable Energy Policy (20-25 July, 2009): focusing on policy interventions to promote renewable energy value chains, which are viewed as sustainable alternatives to conventional energy. This module served the important purpose of alerting the researcher to the larger (national and global) socio-technical conditions within which a business such as Spier defines its environmental goals for climate change, including a carbon neutral status through renewable energy technologies.

Corporate Citizenship (3-8 August, 2009): investigation of motives and manifestations of corporate citizenship, with special emphasis on developing country contexts, and including individual, organisational and social levels of analysis. Attendance at this module and discussions with Professor Malcolm MacIntosh confirmed the researcher's initial views that corporate sustainability concepts such as Natural Capitalism, eco-efficiency and life cycle thinking borrow significantly from the more scientifically structured disciplines of ecological economics and industrial ecology.

The task of interrogating Spier's understanding of a lower carbon future required a deep and well-integrated understanding of socio-technical knowledge systems (such as those determining renewable energy adoption), socio-political knowledge systems (such as those guiding renewable energy policy) and business management trends underpinned by principles from life cycle assessment and natural capital constancy.

2.4.2 International and local conferences for specialised knowledge input and embedding knowledge within different disciplinary domains

The researcher's basic knowledge in the field of ecological economics, life cycle management and green building ratings was extended by attending three international conferences in 2009 / early 2010 and her hypotheses and preliminary analysis of empirical findings by presenting at two symposia in 2010 and at an international conference in 2011. Presentations at some of the events allowed for research to be regularly embedded within different disciplinary domains, thus providing the feedback necessary for learning in subsequent research phases (Scholz and Tietje, 2002). Various forums, the value that was derived from each and the manner in which they guided the problem analysis phase are described below.

Environmental and Resource Economics conference, Cape Town (20-21 May 2009): The conference organised by SANBI (South African National Botanical Institute), showcased national and international examples of environmental resource conservation, such as biodiversity conservation corridors implemented in tracts of farming land in Venezuela. It was useful in highlighting the overlaps between ecological and environmental economics. The researcher made a highly resourceful connection with Shelley Fuller, the Project Co-ordinator for Confronting Climate Change (CCC), a project of SAFWI (South African Fruit and Wine Initiative, www.climatefruitandwine.co.za). One of the main outputs of the CCC project was a South African carbon calculator for the fruit and wine industry, launched in October 2009.

LCM4 (4th Life Cycle Management conference), Cape Town (5-9 September 2009): The conference organised by the Department of Chemical Engineering, University of Cape Town was a very intense training ground, well attended by scholars and commercial practitioners from all over the world. A range of environmental tools from the applied fields of industrial ecology and life cycle management (LCM) were demystified, such as carbon footprint, LCA, LCA-based carbon footprint, material and flow analysis, energy flow analysis, ecological footprint and their application to diverse academic and practical research areas in the building industry, carbon sequestration, commercial products, forest products, e-waste and the food and beverages sector.

From the point of view of the research objectives, a practitioner seminar introducing ‘LCA and carbon footprint according to PAS 2050’ generated the most useful insights, whereby presenters from PE International demonstrated several applications of the above methods in industry. Roland Clift, Distinguished Professor of Environmental Technology and Founding Director of the Centre for Environmental Strategy (CES) and a leading member of the technical team which developed PAS 2050, was the facilitator at the presentation and spoke about the value of carbon standards in achieving consistency in reporting on product and service emissions.

Just as the exposure to technical knowledge at the conference engendered several possibilities for measuring Spier’s progress towards sustainability by using a combination of ecological footprint with a material flow analysis, it also made the researcher realise, once the dust had settled, that each of the tools promoted under the LCM banner are merely accounting exercises. They are as accurate as the activity data and conversion factors used for calculation, and only useful when managers base their decisions and strategies on the results of these calculations. Therefore, different tools for measuring an entity or a product’s environmental impact were scrutinized in terms of their value in improving business practices.

GRIHA (Green Rating for Integrated Habitat Assessment) National Conference, New Delhi, India (4 January, 2010): The conference co-hosted by the Energy and Resources Institute (TERI) and the Indian Ministry for Renewable Energy, was a meeting ground for researchers at TERI, policy makers at the highest level, practicing professionals and concerned citizens, interested in attending to sustainability concerns at the stage of building design. GRIHA is a green rating system for buildings in India, similar to other such global standards such as LEED rating in the USA and recently, the Green Building Council in South Africa. GRIHA is different in that it attends to environmental concerns across the life cycle of a building to include site selection, site planning and treatment of construction waste, in addition to building materials and energy requirements for construction and post-occupancy. Colleagues in green / sustainable architecture shared experiences in practical application of sustainable design principles, in a developing country context. It was a different experience to the LCM conference in that scientifically developed validation procedures (originating in the global North) were finding application in a country (from the global South) with a history of ecologically-sensitive architecture.

First CRSES Research Symposium, Sustainability Institute, Stellenbosch (11-12 November 2010): Organised by the Centre for Renewable and Sustainable Energy Studies, this conference provided masters and doctoral students with the opportunity to present their research, after completion or while still in progress. The symposium was attended by students and academics interested in renewable energy and sustainability studies. Spier's case study was one of two transdisciplinary papers presented while most other presentations were from the applied fields of bio-energy, solar energy and life cycle assessment. The researcher presented the use of the adaptive renewal cycle as a framework for understanding Spier's quest for lower carbon emissions, especially through the investigation of renewable energy technologies.

Masters and Doctoral Research Colloquium in Sustainable Development, Sustainability Institute, Stellenbosch (7-8 December 2010): The event was organised by Professor Mark Swilling, as part of an annual presentation and feed-back session for post-graduate students, giving all participants an opportunity to benefit from dedicated attention on their research topic. At this event the findings and analysis of Spier's quest for lower carbon emissions were presented. Based on the input received at this event from Eve Annecke, Director of SI, innovations in wastewater treatment and recycling and efficiencies in solid waste recycling were included in the complete analysis of case findings in Chapters 8 and 9. The inclusion of additional aspects of environmental sustainability strengthened the resilience-based core argument of the thesis and allowed the investments towards lower carbon emissions to be compared to those made in other corporate areas. In the end, inclusion of additional corporate performance areas in the analysis proved the utility of the integrated corporate resilience framework.

IST 2011 2nd International conference on Sustainability Transitions, Lund University, Sweden (13 – 15 June 2011): The conference was organised by Lund University Centre for Sustainability Studies (LUCSUS), the Centre for Innovation, Research and Competence in the Learning Economy (CIRCLE) at Lund University and the Sustainability Transitions Research Network (STRN). The event was well represented by the European community with keynote speakers such as Carl Folke of the Stockholm Resilience Centre and Jill Jagger from the Sustainable Europe Research Institute. A noteworthy event was the launch of the Environmental Innovation and Societal Transitions journal (EIST) (see http://www.sciencedirect.com/science/journal/22104224).

The conference spanned a wide array of topics with focus on transitions analysis using MLP (multi level perspective) and TIS (technological innovation systems). The organisers wished to respond to a 'growing need for new connections within the transitions research community and links with other relevant disciplines.' Practitioners from the related fields of sustainability science, innovation studies, transitions analysis and environmental policy studies are looking for new analytical tools and fresh insights that can extend their own language of transitions and innovation. The paper titled 'Building Corporate Resilience: a case study of Spier's search for a low carbon and sustainable future', was presented at a dedicated panel at the IST on the role of firms and industry in sustainability transitions. Valuable comments from colleagues such as Fred Steward from Policy Studies Institute in London related to the 'Sustainability Story of Spier' as a sustainability transition. These inputs helped the researcher decide that in addition to water, energy and waste, sustainability reporting was a key medium through which findings could be described and assessed.

2.4.3 Recursiveness in the research process to allow adaptability

Recursiveness in a research process prevents employing incorrect methodological tools for assessing case evidence or reaching early conclusions based on incorrect assumptions. In the case of this thesis, the research process was defined in such a way that theoretical constructs used for analysing empirical findings could be revisited, changed and extended. The researcher was fortunate to be allowed access to Professor Mark Swilling's extended knowledge network. Two events are of particular relevance and are described below.

Seminar on global material flows and the implications for South Africa, Sustainability Institute, Stellenbosch (20 November): The purpose of this seminar was to provide South African researchers with an opportunity to interact with members of the International Panel for Sustainable Resource Management. The two presentations by Marina Fischer-Kowalski: introduction to material flow analysis and analysis of global material flows since 1900 and Stefan Bringezu: global material flows and international trade were particularly relevant to this research. The researcher had interrogated the MEFA (Material and Energy Flow Analysis) framework developed by Fischer-Kowalski and colleagues in connection with mapping Spier's sustainability impact. A brief exchange with Dr Fischer-Kowalski, professor of social ecology at Klagenfurt University and director of the Vienna based Institute of Social Ecology at the Faculty for Interdisciplinary Studies (IFF) ascertained that this framework was not applicable to the case, a medium-sized business. Application of the MEFA framework to regions the size of local municipalities or towns is still in its early stages.

Philip Spaeth's stay at Lynedoch, (10-30 March 2011): Philip Spaeth from the Institute of Forest and Environmental Policy at Freiburg University was based at the Sustainability Institute and living in Lynedoch in early 2011. His research is on socio-technical systems and energy transitions (using the Dutch literature on the Multi-Level Perspective (MLP)). The timing of Dr Spaeth's visit was extremely opportune as the researcher was considering using the MLP for the analysis of case findings. Dr Spaeth read through the first draft of the 'Sustainability Story of

Spier' and advised against using the MLP framework for the study of a business. His argument was based on the fact that the MLP is underpinned by certain assumptions regarding socio-technical systems and regimes which are not transferable to the level of a single organisation such as Spier. On his advice, the idea of using the MLP for this thesis was abandoned and saved considerable time and effort as a result. This decision was bolstered during later exposure to more applications of the MLP at the IST conference in Lund.

2.4.4 Choosing a resilience-based framework for systems analysis of Spier's environmental sustainability

The principle of iterative learning allowed the applicability of initially identified theoretical constructs to be re-examined, based on feedback and inputs received from experts and scholars who specialised in the application of these constructs. Similarly, preliminary case findings meant that the research objectives and their underlying assumptions were also interrogated. As a result of exposure to concepts and tools from sustainability science (Kates et al, 2001), in particular resilience thinking and the theoretical frameworks developed within this field, the researcher was keen to extend their application to corporate sustainability.

An important driver for resilience-based analysis came from recent appreciation for the risks and uncertainties faced by the SES within which business activities take place (Haywood et al, 2010; Hamel and Valikangas, 2003). The application of an SES framework to business management allowed an understanding of both large firms and small enterprises as part of a regional ecosystem and their investments as contributors to building their own and the larger system's resilience. An emerging research agenda is highlighted in assisting businesses of all sizes to comprehend the causal feedbacks and loops existing between entities within an SES (Haywood et al, 2010).

Various entities in an SES share the same natural resources, develop and deploy various technologies and solutions, for energy generation, waste recycling and wastewater treatment and must face the same societal and environmental risks and uncertainties (Haywood et al, 2010; Walker et al, 2002). Furthermore, it is possible to trace the trajectory of a business on a sustainability path as an adaptive cycle (Walker et al, 2006). There was clearly a research opportunity in the application of sustainability science tools such as resilience and risk frameworks to business analysis, incorporating the notions of system adaptability and transformability. Sustainability science is recognised as a 'mode of operation of transdisciplinarity known under other designations' (Pohl and Hirsch Hadorn, 2007: 88). This meant that extending the frameworks from resilience thinking to corporate sustainability required an approach which transcended single disciplines.

An in-depth analysis of the 'Sustainability Story of Spier', focusing on the multiple areas of sustainability reporting, renewable energy adoption and energy efficiency measures, wastewater treatment and solid waste recycling, using the different components of resilience thinking was undertaken and is presented in Chapter 9. The integration of case findings with different theoretical concepts engendered different types of knowledge during each of the three phases of research. The final phase of knowledge production is discussed in section 2.5, drawing from the different roles assumed by the researcher during the research process.

2.4.5 Different roles of the researcher in a transdisciplinary paradigm

Becoming fully engaged with the actual business dynamics at Spier required the researcher to play diverse roles during different phases of the research. The role of a scholar observing business practices and assessing them against academic recommendations and an integrator of practice and abstract knowledge streams was balanced with that of a facilitator seeking mutually-beneficial alliances.

The assignments undertaken by Group Accountant, Christie Kruger started out requiring the skills of an informed and detached observer, in order to investigate the area of environmental reporting within the three business units. As the assignments progressed and the implications of the application of particular methodologies became clearer, based on a detailed study of various carbon calculation standards, the researcher could discern which approach would be most suitable for a medium-sized business such as Spier.

The researcher also investigated the technical validity of the current water footprint methodology applied at Spier, from an academic perspective. The Group Accountant learnt about the carbon calculator project initiated by SAFWI from the researcher, which she was able to connect with and benefit from. Thus the researcher's engagement in the environmental reporting component of Spier's journey was both that of an observer and an informant.

A similar trend transpired in the area of renewable energy technology explorations. Interviews with Facilities Manager, Cherie Immelman; Riaan Meyer, an engineer from CRSES; Frank Spencer, a renewable energy consultant and Prof Alan Brent in his advisory capacity to the COO Heidi Newton-King, as well as detailed knowledge of past trends through analysis of electronic emails between Spier management and vendors of renewable energy required a journalistic investigatory approach. This component of Spier's sustainability journey was one of the hardest to unravel, despite having open access to hard evidence.

In late June 2010, Matti Lubkol undertook the feasibility study of a Concentrated Solar Thermal Plant at the Spier estate for his dissertation towards a Masters in Engineering from Stellenbosch University. He was introduced to relevant personnel at Spier by the researcher.

In July 2010, the researcher came across a pilot project showcasing Concentrix solar panels, a Concentrated Photo Voltaic (CPV) technology, owned and marketed by Soitec. With a view to exploring a viable renewable energy solution, a meeting between Prof Alan Brent, who represented the interests of Spier Holdings and Ross Swersky, responsible for Soitec's business development in South Africa, was set up by the researcher. The Soitec team needed daily electricity consumption figures at Spier in order to make a comprehensive proposal with regards to the size and number of Concentrix panels required to generate sufficient renewable energy. At the time of writing, Frank Spencer's company, Emergent Energy, had quoted on the installation of data loggers at Spier to measure electrical consumption levels. The proposal was under Spier management's consideration.

With regards to sustainability reporting and strategy, contact with the Trialogue team on the Spier projects was established by the researcher after being alerted to their appointment by Director of Marketing at Spier, Annebelle Schreuders. The Trialogue team included Rob Worthington, Managing Director at their Kenilworth offices and Denise Bester, a project manager. Trialogue had been assigned in early 2010 to produce two sustainability reports, conduct a five year review of Spier's sustainability performance and revisit Spier's organisational goals in keeping with GRI reporting principles. The relationship became mutually informative since there were aspects of Spier's business practices which the researcher had studied and Trialogue could use in their reports, and there were management perspectives which the Trialogue team had been exposed to which could inform this thesis.

Maintaining the balance between being the observer of a process and being an actor in different capacities in a process was only possible by being aware of these roles and articulating them at all times. Sometimes there was a continuous progression between roles, at other times the roles were acted out in parallel, or iteratively. Transdisciplinary research methodology encourages the manifestation of multiple roles required of a researcher in order to satisfy basic requirements of the research approach (Pohl and Hirsch Hadorn, 2007).

2.4.6 Evolution of the relationship with Spier

It is important to mention that an immersive research approach was only possible because Spier management opened the business and its operations to scholarly scrutiny, with the hope that their story would generate new insights into sustainability trajectories in the real world, of value to both the knowledge and practice communities (the common good).

Meetings and interviews with the senior management, in particular the COO and CEO, revealed Spier's initial position with regards to corporate citizenship and sustainable development as captured in the following inter-linked assumptions:

- Sustainability is pursued by Spier as an over-arching vision for activities across social, environmental and economic performance areas
- Charting investments and initiatives across the three areas of sustainable development over two decades (through the writing of the 'Sustainability Story of Spier') should reveal progress along a sustainability trajectory

- Knowledge of how carbon-neutrality can be achieved by a business will assist in achieving this macro-organisational goal for environmental sustainability

Engagements with senior management shaped an understanding of the strategic underpinnings of business operations and decision-making with regards to sustainability. Through interactions with operational staff and intermediaries the researcher was privy to information and perspectives across the organisation (as well as external agent insights) in an integrated fashion. Context-specific knowledge from multiple sources was enriched with scientific and abstract knowledge acquired through literature review, attending academic conferences and participating in other scholarly engagements. Thus, new insights into the business and its sustainability journey were produced, which in turn adapted senior management's perceptions of existing organisational macro goals, in particular the goal of achieving carbon neutral status.

As a result of problem analysis and knowledge integration (Section 2.4) each of the above assumptions were challenged by this thesis. These responses were based on a resilience-based analysis of case evidence in the following ways:

- It is the search for building resilience in the business as an SES and the larger SES which drives activities across social, economic and environmental performance areas.
- The charting of investments and initiatives across the three areas over two decades reveals a common logic of system behaviour where business strategies (including carbon reduction strategies and investments) respond to risks and uncertainties in the larger SES (as articulated in sections 9.2, 9.3 and 9.6.1).
- Knowledge of how carbon-neutrality can be achieved by a business is not fully utilised by Spier in achieving this macro-organisational goal for environmental sustainability because as a social-ecological system, the business is responding to risks.

As a result of the above arguments, which are based on a deep interrogation of the Spier system and the drivers and informants of its sustainability journey, Spier management lost interest in the direction in which the research ended up taking.

Finally, independence of the research process is confirmed by the fact that over time, the thesis actually ended up critiquing the research question posed by Spier. This, in turn, was partly due to the fact that the business did not fully understand at the time the full significance of its various activities. Senior managers did adjust their carbon-related goals to lower carbon emissions, instead of a carbon neutral status. However, to conceptualise and analyse the full significance of Spier's environmental sustainability activities, the researcher had to go beyond 'Carbonology' and ended up with 'resilience'.

2.5 Knowledge production in various forms

The knowledge production phase or implementation phase represents the culmination of efforts through-out the research process to assimilate heterogeneous research interests and management philosophies among the research group (Loibl, 2005 in Pohl and Hirsch Hadorn, 2007). Using Loibl (2005) framework of problem orientation vs. solution orientation, this iterative phase tackles the dual research challenge of making reality understandable by finding explanations; and changing reality by finding solutions. When applied to this thesis, the dual challenge can be framed as interrogating Spier's sustainability journey and finding ways of improving corporate decision-making in the area of environmental sustainability.

Transdisciplinary research requires that explanations and solutions for socially relevant problems be related back to scientific knowledge and practical frameworks for adoption by research and management communities. Systems knowledge (knowledge of the system or empirical knowledge) was assimilated and presented at two stages in the research process, which became a crucial source for management and research input respectively. Scientific and abstract knowledge was integrated and synthesised as target knowledge (or normative knowledge) each time a new body of knowledge was investigated. In the case of this thesis, a synthesis of systems and target knowledge produced transformation knowledge.

2.5.1 Contextualisation through systems knowledge

One of the requirements of transdisciplinary research is contextualisation, which means assessing the state of knowledge with respect to the research questions identified as well as societal practices and issues such as technologies, policies, regulations, power relations and potential for change (Hirsch Hadorn et al, 2006). With respect to this thesis, case-specific knowledge was collected and presented as the 'Sustainability Story of Spier' (Chapter 7). Societal practices and business strategies with respect to carbon reduction and management were presented as Carbonology (Chapter 5).

The 'Sustainability Story of Spier' attempted to provide a well-balanced view of the business' journey towards the vision of sustainable development while drawing on various sources of information, within and outside of the business system. The structure of the story follows three phases in the history of the business starting with 'revolutionary beginnings', moving on to 'organisational maturity' and presenting the current configuration of the business as 'internalising sustainability'. Most of the discussion pertaining to environmental sustainability relates to the last two phases, when initiatives in the practice areas of renewable energy, wastewater treatment and solid waste recycling took on considerable momentum.

The narrative was the first case-related output of the thesis and a significant milestone in the research process. Feedback from co-supervisors on the narrative helped identify which areas needed deeper investigation from an academic interest. The three phases identified in the narrative later formed the basis of analysing the story from a resilience perspective, specifically the adaptive renewal cycle.

A preliminary analysis of the sustainability story resulted in reformulation of the research questions. Goals such as carbon neutral were critiqued for driving sustainability-oriented behaviour in a business and the ability of the environmental reporting practice at Spier to provide a useful measure of its progress towards sustainability was challenged. Finding credible answers to these questions became the focus of Chapter 8.

Carbonology or Chapter 5 fulfils a critical function in the research process by merging scientific knowledge and knowledge pertaining to societal practices and industry standards for carbon management, with case-specific knowledge to produce a unique critique of the concepts of carbon footprint and carbon neutral, in the context of corporate sustainability. The chapter could only be written after abstract knowledge streams from the areas of life cycle assessment, carbon standards and protocols had been applied in the case of Spier's search for a carbon neutral status, referenced against a similar endeavour by another wine producer in the region and had generated outcomes which were not predicted by Spier managers or the researcher.

Carbonology describes measures for reducing carbon emissions, such as through the adoption of renewable energy, in the context of national policies and regulations pertaining to non-conventional energy sources. These linkages created the grounds for conceptualising Spier's sustainability journey through the lens of social-ecological systems and panarchy, whereby scales above and below the system of interest are factored into making sense of the research problem and seeking solutions.

2.5.2 Synthesis towards target knowledge

A wide review of journal articles and books from the knowledge areas of industrial ecology and ecological economics resulted in the researcher being able to draw out those tools, concepts and frameworks which were of relevance to the sustainability trajectory of a medium-sized business in South Africa. This synthesis is captured in table 4.1. In addition, table 4.2 presents a set of best corporate practices or target knowledge, based on the principles for strong sustainability and derived from life cycle management principles at a level which is of relevance to medium-sized business, interested in environmentally significant behaviour and its impact.

Similarly, a review of normative and descriptive literatures from CC generated a framework for each corporate practice area with intended sustainability outcomes (figure 3.3). The framework does not include unique aspects of the South African corporate social responsibility agenda, but allows businesses to balance their sustainability profile along the practice areas of philanthropy, stakeholder engagement, technological innovation, corporate environmentalism and sustainability reporting. Each of these practice areas has received significant scholarly and practitioner attention within the CC literature.

This particular target knowledge was used to interrogate Spier's quest for a lower carbon future in Chapter 8 and to highlight the linkages between carbon emissions reduction and technological innovations and nature conservation. The potential of carbon reduction strategies for achieving particular sustainability outcomes was thus highlighted, however it was not considered sufficient for transforming business practices, based on the case analysis of Spier.

2.5.3 Transformation towards building corporate resilience

The primary methodological and conceptual challenge for transdisciplinary research is to transcend disciplinary boundaries in the stages of both problem structuring and knowledge integration (Rosenblum, 1997). Development of scientific insight takes place through the verification of methods, findings and results through different methods such as communicating with relevant knowledge networks, presenting at conferences and publication of journal articles (Pohl and Hirsch Hadorn, 2007). The adaptation of results based on feedback from research communities in the life cycle management, renewable and sustainable energy studies, societal metabolism research and sustainability transitions fields was described under Section 2.4 Problem analysis and knowledge integration.

An integration of systems knowledge and target knowledge, based on the empirical data collection and preliminary literature review respectively resulted in the preliminary case analysis which is presented in Chapter 8. Gaps in the findings of this analysis were verified through interactions with different research communities and drove an exploration of alternative frameworks for studying corporate environmental sustainability. A research opportunity in the application of sustainability science tools such as resilience and risk frameworks to the analysis of corporate sustainability was explored and an in depth review of resilience thinking and its components was undertaken and resulted in Chapter 6. This review provided the basis for a detailed systems analysis of Spier and in essence constitutes transformation knowledge, allowing the business to view itself as part of a local, regional and global social-ecological system, facing risks and vulnerabilities arising at different scales in the panarchy.

As the literature review progressed from SES and complexity; past the principles of resilience thinking (rooted in the study of ecological systems); to the recent writings in enterprise resilience and risk management, intellectual space was created for concepts from corporate citizenship and systems ecology to re-enter the theoretical framework under construction.

Therefore, the resilience-based framework for corporate sustainability incorporates elements from the tools and concepts of industrial ecology, ecological economics and corporate social responsibility; in addition to the fundamentals from risk perception and adaptive learning. The framework was refined further after Spier's case evidence was reviewed from systems, complexity and resilience perspectives.

Thus the corporate resilience framework, and the mapping tool, truly is an amalgamation of case-specific and abstract knowledge streams, with the view to transforming current business practices shaped by disconnected responses to market pressures, financial risks and ecological discontinuities towards an integrated approach for building corporate resilience. And it is hoped that the analytical framework and transformation frameworks can be utilised by researchers, managers and other practitioners, thereby enhancing its usefulness and breadth of application.

Chapter 3: Sustainable Development and Corporate Citizenship: conceptualisations of corporate sustainability

3.1 Introduction

The sustainability journey of many businesses, from small enterprises to large multi-national corporations, is informed by the mainstream notion of sustainable development and more specifically, corporate citizenship, as defined and propagated by global business forums and councils such as the World Business Council on Sustainable Development, among others. This view maintains that business profit can be maximized while environmental concerns are addressed. For instance, Spier's vision of sustainable development states that defining, managing and setting goals against both financial and non-financial indicators will ensure their longevity as a business (Methvin, 2007).

In addition to the highly publicized corporatisation of sustainable development, is the ongoing academic search for refining and clarifying this concept of an integrated and balanced form of development. This search is accompanied by attempts at developing sustainability indicators, performance measures and footprints which entities across different scales can measure and report on.

A context-specific understanding of sustainable development underpins an organisation's search for a sustainable future, whether it operates in the public or private sector. Corporate citizenship generates the private-sector context for businesses to participate meaningfully in sustainability-oriented initiatives. Thus, this chapter draws upon a review of two bodies of literature: Sustainable Development and Corporate Citizenship. Literatures from these two bodies of knowledge were drawn on in the hope that they will assist in addressing the research objectives, which is to unearth the drivers for the corporate search for environmental sustainability, including a lower carbon profile. This understanding, it is hoped, will fulfil the core research objective of encouraging and assisting businesses who are interested in re-configuring their relationship with natural resources and ecosystem services.

3.2 Part 1: Sustainable Development

3.2.1 Mainstream articulations of sustainable development

More than two decades since the release of Our Common Future (WCED, 1987) and the most widely cited definition of sustainable development: *development that meets the needs of the present without compromising the ability of future generations to meet their own needs*; the meaning of the concept continues to be interrogated and enhanced. As a concept, sustainable development was a major shift away from the 'standard environmental agenda' adopted in

Stockholm in 1972 whereby environmental issues are attended to in the early part of the development cycle, and not as end-of-pipe solutions (MacNeill et al, 1991).

Mainstream understanding of the term, as laid out by the WCED, is linked to economic development in that it promotes a certain type of economic development, one that takes the environment into account (Pezzoli, 1997). MacNeill et al (1991) argue that *sustainability* is best regarded both as a social goal and as a criterion for development similar to other equally worthy yet conceptually difficult social goals such as democracy, justice or even national security.

Early literature on the subject explains the Brundtland Commission's notion of sustainable development as a process that helps achieve environmental, social and economic sustainability, famously captured in Elkington's triple bottom line (1998). However, this articulation of the concept is not sufficient, especially in explaining and learning from the success or failure of projects and policies aimed at sustainable development. Thus Clayton and Radcliffe's (1996: 8) motivation for sustainable development to include cultural values as one way of explaining socio-economic behaviour, is useful:

'Economic systems determine the rate and route of flows of energy and resources from the environment into patterns of human use, and the rate and route of flows of waste energy and materials from human economic operations back into the environment. These economic systems are, in turn, imbued by cultural values, and underpinned by social and psychological models that influence the way in which people understand their opinions and make their choices.'

3.2.2 Advancing the sustainable development debate

Further writings and analysis from a range of discourses on sustainable development raise the critical role of the ideological and political contents of 'sustainable development' and 'sustainability' in addition to their cultural, ecological and economic contents (Sneddon et al, 2005; Pezzoli, 1997; O'Connor, 1994). For instance, Sneddon et al (2005) claim that 'unsustainability' goes beyond ecological degradation and vast economic inequalities within and across societies to include a fractured set of institutional arrangements for global environmental governance. The authors use pluralism as a starting point for their analysis of sustainable development, paying attention to recent work in ecological economics, political ecology and 'development as freedom' (Sen, 1999) literatures to advance the sustainable development debate. They also highlight the divergent views held by practitioners and critics of sustainable development, based on their ideological positions.

Table 3.1: Defenders and critics of mainstream sustainable development (based on Sneddon et al, 2005)

Defenders	**Critics**	**Views on 'mainstream sustainable development'**
Development practitioners in • UN offices • Government agencies • Corporate boardrooms		Most tenable principle of collective action for resolving the twin crises of environment and development
Academics from • Ecological economics • Industrial ecology		An attractive alternative to conventional growth-oriented development thinking
	Socio-cultural critics	A ruse to discount the aspirations and needs of marginalized populations in the name of green development
	Ecological scientists	Unforgivably anthropocentric

Advocates of sustainable development place faith in quantitative representations of complex human-environment relations and in the role of national and international institutions in confronting sustainability (Sneddon et al, 2005). Conversely, critics stress qualitative measures grounded in a case study methodology and have lost faith in state-driven institutions as a means of change (Sneddon et al, 2005).

Using *political ecology*[3] as a lens to understand the four concerns of sustainable development, Pezzoli (1997) categorizes various discourses which have explicitly addressed the question of sustainability in terms of ideological, focus or area of concern (and practice) and dominant-approach basis. Therefore, sustainable development may be driven ideologically by capitalism, socialism or anarchism; it may have a built environment, natural environment, industry or human society focus and it may be inclined towards a techno-optimistic, eco-efficiency methodology or a techno-pessimistic, social-change approach. Pezzoli (1997) also manages to contain the various explorations of sustainable development within a concise and yet inclusive framework by corresponding them with the four intersecting challenges of political ecology.

[3] Political ecology is concerned with the analysis of power relationships as expressed through the discourse and practices of multiple actors including households, NGOs, social movements, communities, capitalist enterprises, state agents and institutional networks (Sneddon et al, 2005).

Table 3.2: Framework for literature categories contributing to sustainable development (adapted from Pezzoli, 1997)

Spheres of concern within sustainable development	**Key challenges of political ecology**	**Literature categories**
Environmental context	Holism and co-evolution	Environmental Science Environmental History and Human Geography Political ecology
Legal and institutional terrain	Empowerment and community building	Managerialism, policy and planning Social Conditions Environmental Law
Culture and civil society	Social justice and equity	Ecophilosophy, environmental values and ethics Utopianism, anarchism and bioregionalism Political ecology
Economy and technology	Sustainable production	Ecological economics Ecological design Industrial ecology

The categories of literature are not mutually exclusive. For instance, there is significant overlap in the managerialism, policy and planning categories with economics literature, exemplified through corporate concepts such as eco-efficiency and life cycle management (Pezzoli, 1997). In practice as well, managerial approaches to sustainable development such as goal-setting, performance management and monitoring are often accompanied by technological solutions to environmental management issues. Critics (such as Korhonen, 2008) from an ecological socialism perspective however, argue against such weak forms of ecological modernisation, which do not question the continuation of current technological, cultural and economic systems.

3.2.3 Sustainable development as the broad narrative for corporate sustainability

The above discussion strengthens the case for sustainable development as the broad narrative within which researchers and practitioners choose and adopt a particular understanding and application of the concept which resonates with their own area of interest. The popular definition of sustainable development from a pro-management and technological paradigm generates the normative language which can be readily adopted by a sustainability-oriented entity. A business could direct efforts on environmental custodianship, community empowerment, social justice and sustainable production, while paying attention to issues of institutional governance, cultural values and political ideologies.

Critical writings in the field capture some of the tensions which are faced when management decisions are guided by a sustainable development vision. Critical views also expose the complexity of issues involved in practising sustainable development, thereby enriching its comprehension by a range of agencies, including relevant international bodies, government departments and local actors, entrepreneurs and activists. This appreciation for a wider and pluralistic approach to sustainability contributes to the current intellectual backdrop to decision-making.

However, a more focused lens is required to fully appreciate business decisions aimed at sustainability and to evaluate the effectiveness of their outcomes. In short, a useful analysis of the case would require the debate to move beyond the two opposing positions with regards to sustainable development: a techno-optimistic, pro-managerial approach in support of institutional and technological adaptations to the current socio-technical system versus a techno-pessimistic, eco-socialist approach in favour of radical structural transformation of societal patterns of production and consumption.

Focusing on the positive role of business in society, the World Business Council on Sustainable Development (WBCSD), an international CEO-led business association, has consistently proposed mechanisms for implementing new partnerships between business, civil society and governments. The concept of eco-efficiency was coined by the WBCSD in 1992 (Holliday et al, 2002). Almost two decades later, the WBCSD's vision for 2050 still incorporates the original aim of incorporating environmental externalities into the structure of the market place. The WBCSD vision focuses on the need to feed nine billion people by the middle of the century without using additional land or resources, and at the same time orchestrating a transition to a low-carbon economy by changing energy systems, halting deforestation, and improving demand-side efficiency and access to low-carbon mobility (WBCSD, 2011).

A review of corporate citizenship literature incorporating core concepts from organisational theory, business ethics and business management, among others, is covered in the second part of this chapter. This review is aimed at distilling critical drivers and expressions of socially and environmentally responsible behaviour from normative and descriptive perspectives.

3.3 Part 2: Corporate Citizenship

3.3.1 Supporters and critics of corporate citizenship

Corporate citizenship (CC), or the managerial response to the challenge of sustainable development, is unpacked through business ethics, corporate accountability, strategic management and organisational theory lenses. Corporate citizenship is offered as an approach that goes beyond corporate social responsibility (CSR), by driving systemic and holistic cultural changes within the organisation (Birch, 2001; McIntosh, 2003; Holliday et al, 2002; Crane and Matten, 2004). Businesses are advised to grab this opportunity to change society, play their role as political actors and enable the civil, social and political rights of others (Crane and Matten, 2004; Holliday et al, 2002).

Other supporters, mainly from the pro-development and business ethics literature, consider corporate citizenship, corporate social responsibility and corporate social performance as interchangeable as long as the overall impact of business efforts under these banners is beneficial for the society and the environment (Leisenger, 2007; Ligteringen and Zadek, 2005; Porter and Kramer, 2006; Hamann, 2006; Fox, 2004; Margolis and Walsh, 2003).

Critics of the concepts from pro-development literature (Levy, 1997; Christian Aid, 2004;) as well as ethics (Roberts, 2003) reject the nuanced differences highlighted in the business case argument and draw one's attention instead to the consequences of corporate action in the name of CC or CSR.

The next few sections provide a review of international literature on the subject, picking up on drivers and defining practices which can inform the research objectives, followed by a discussion of the same in a South African context.

3.3.2 A diffused lens: legal, ethical and economic responsibilities of a company

Field studies on CSR over several decades have relied on Archie and Carroll's four-part integrative model: economic, legal, ethical and discretionary responsibilities, also known as the Wartick and Cochran model for data collection and analysis (as described in Crane and Matten, 2004 and Clarkson, 1995).

Understandably, firms will first focus on meeting shareholders' demand for a reasonable return on their investments, employees' need for secure and well-paid jobs and customer's demand for competitively priced, good quality products (Crane and Matten, 2004). Although Carroll (1991) suggests that satisfaction of legal requirements is required of all corporations seeking corporate responsiveness, Fox (2004) argues that in a developing country context where capacity to enforce regulation is poor the legal component of CSR is in reality more akin to ethical responsibilities which are expected by society over and above economic and legal responsibilities.

In their analysis of CSR literature across the US and Europe, Crane and Matten (2004) argue that most of the social issues on the corporate agenda in Europe can be placed in the area of ethical responsibilities which may or may not be legally enforceable. In South Africa for instance, companies are required by law to attend to ethical responsibilities such as redress of past inequalities through their recruitment and procurement practices. Thus application of the four-part model to empirical cases reveals overlaps and blurring of lines between the different parts.

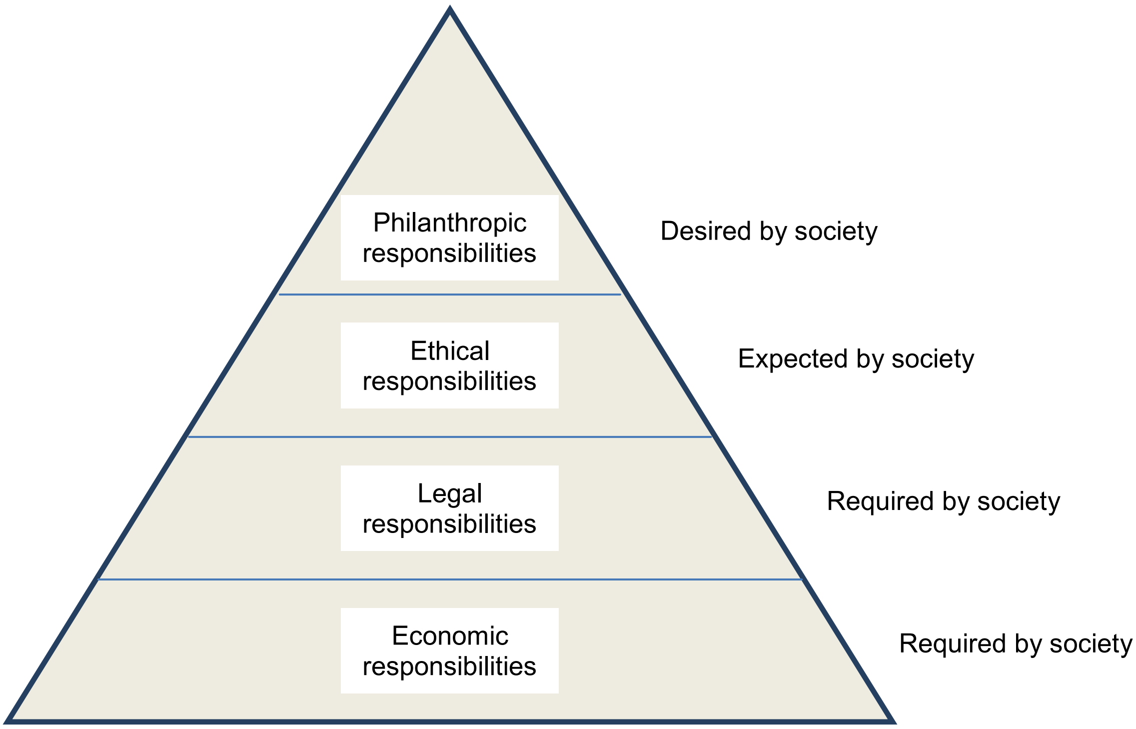

Figure 3.1 Carroll's four-part model of corporate social responsibility (source: Carroll, 1991)

3.3.3 Drivers of socially responsible behaviour

Normative literature advocating CC and CSR espouses the internalisation of an 'ethic of care' by a firm (Andriof and McIntosh, 2001) as opposed to a mere bending to legalistic codes. At the same time it is argued that as a result of rapid advances in communication technology and the rising power of the consumer, companies will have to deliver goods in a socially responsible manner or face commercial demise. CSR is thus promoted sometimes through a call for moral leadership and sometimes as a necessity to a firm's survival, often in the same article.

The moral imperative: Corporations, multinationals in particular, are reminded that globalization of which they are key beneficiaries has caused much of the social misery witnessed around the world today and therefore it is their moral duty to put people first and become socially responsible (Crane and Matten, 2004; Birch, 2001; Henderson, 2005; Hamann et al, 2003). This theme of addressing the ill that a business entity has caused is an important one. It is taken up by Margolis and Walsh (2003) when building up their normative theory on CSR, and is exhibited by the chemical industries in their life-cycle analysis for pollution prevention (Hoffman, 1999). However, underlying the moral imperative may be the more mundane ones of addressing risks to reputation and brand management for ensuring profits.

The strategic benefit argument: Porter and Kramer (2006) stress the strategic benefits from CSR initiatives which could accrue to a business, independent of why those initiatives were undertaken in the first place. The four prevailing justifications for CSR: the moral imperative, sustainability (or enlightened self-interest), license-to-operate (based on constructive dialogue with external stakeholders of the firm) and reputation (pursued through marketing campaigns) are unpacked and their primary weakness exposed. Porter and Kramer (2006) argue that all four arguments are based on a split between business and society rather than on their interdependence and that failure to integrate CSR efforts with a business' strategy results in a huge lost opportunity.

Fox (2004) argues that the quest for drivers of CSR has been counterproductive. According to him, key assumptions made in the building of the business case argument for CC do not apply in a developing country context, especially to small and medium enterprises. He goes on to stress the different factors in a firm's context including human and institutional capacity to respond to different drivers.

3.3.4 The practice of corporate social responsibility

Authors admit that the great research energy spent in defining a link between corporate social performance and corporate financial performance has not resolved the matter (Hamann, 2006, Andriof and McIntosh, 2001). If anything, the ongoing studies confirm the tension which exists between a firm's social initiatives and profit-maximization activities (Margolis and Walsh, 2003). A reorienting perspective is to build upon the basic assumption that companies can contribute towards ameliorating social and environmental ills instead of seeking a justification for CSR (Margolis and Walsh, 2003).

Philanthropy in many guises: Philanthropy from a CSR perspective encompasses myriad activities such as charitable donations, building recreational facilities for employees, support for local schools and sponsoring of art and sport events. While social impacts through some voluntary activities can be estimated, for instance, by examining literacy rates and exam grades, and employee and community satisfaction surveys, corporate philanthropy is eyed with suspicion by both proponents and dissidents of CC (Christian Aid, 2004), as corporations cannot be held accountable for activities undertaken under this banner (Hamann et al, 2003). Moreover, philanthropic activities lie external to the organisation and may not require major changes to the culture within the organisation, as envisioned in an extended view of corporate citizenship (Crane and Matten, 2004). In other words, it is hard to ascertain and enforce ongoing commitment to social responsiveness or sustainable development through philanthropic activities alone.

Stakeholder dialogue and ethical performance: Roberts (2003) tackles the different moral and business drivers of CSR and combines them with different versions of CSR implementation. His framework, grounded in ethical sensibility, differentiates between mere image and substance in corporate claims to social and environmental responsibility. Roberts

(2003) laments corporate need to be seen to be good; also reflected according to him in a narcissistic obsession with sustainability reporting. He questions the displacement of corporate responsibility (or sustainability vision) by a firm onto its employees through performance measures and goals. While Porter and Kramer (2006) call for an integration of business and society, Roberts (2003) attempts to understand how business and ethics got separated in the first place.

Roberts (2003) argues that if the driver of CSR is sincere corporate intent then it must manifest itself as a dialogue across the corporate boundary, with those who are most vulnerable to the effects of corporate conduct. In the absence of such extra-corporeal face-to-face contact, systems of accountability are limited to what can be easily measured and quantified such as environmental impacts as opposed to social impacts (Roberts, 2003).

The 2002 World Summit on Sustainable Development exhibited a polarization between the corporate responsibility and corporate accountability views of CC. These divergent views were consolidated by Hamann et al (2003) to put forth a synthesis model of CC with a new set of roles and responsibilities for the different sectors such as businesses, government agencies, NGOs and business associations. In particular, NGOs and businesses are advised to actively build cross-sector partnerships, within which common interests are identified and strengthened but a critical stance is maintained by civil society organisations (Hamann and Acutt, 2003).

Acceptance and recognition of stakeholder legitimacy places businesses squarely in the domain of ethical judgment and choices, whether they know it or not (Clarkson, 1995). An extended view from a business ethics perspective, describes CC as ‘the corporate function for administering the citizenship rights for individuals’ in which the rights to equality, participation and a safe and clean environment provide strong links to sustainability (Matten and Crane, 2005:69). Thus stakeholder theory, in one form or another has been a major contributor in the development of CC literature, suggesting stakeholder dialogue as a tool for weighing the social/environmental issues that require corporate attention and resources.

Resource productivity and technological innovation: Holliday et al (2002) argue that innovation is a sustainability issue, for designing ecologically sound products and services in a range of sectors such as agriculture, forestry, transport, construction and energy, while maintaining affordability for the masses. Innovation when linked to strategy and technological development is hailed as a powerful mix for achieving great savings while making businesses far more competitive (Porter and van der Linde, 1995). Targeted environmental regulations and tools for measuring environmental performance are suggested as potential drivers for corporate innovation towards resource productivity (Porter and van der Linde, 1995). Among the cited writings arising out of the World Business Council for Sustainable Development literature, entrepreneurial chief executives are noted for taking the concepts of eco-efficiency and corporate innovation seriously and translating them into action through radical changes.

Hawkens et al (1999) offer radical resource productivity, biomimicry (reducing the wasteful throughput of materials), a service and flow economy and investment in natural capital as components of the next industrial revolution which they have termed Natural Capitalism. They believe that there are immense possibilities for development without growth through increased energy (and water use) efficiency. The service and flow component borrows from the concept of closed loop cycles of materials use in industrial ecology. While mention is made of direct investment in natural capital, the approach remains largely techno-optimistic, placing great faith in the adoption of technological innovations by individuals and small businesses.

Korhonen (2008) critiques mainstream technological and management approaches such as eco-efficiency and resource productivity on various fronts. He highlights the need for businesses to think further and focus on biodiversity conservation, ecosystem continuance and material and energy flow types, in addition to increased efficiency measures and innovation in technology.

Corporate environmentalism: Hoffman (1999) provides us with an evolutionary perspective on corporate environmentalism based on his very specific study of the US chemical industry, which also considers the social and cultural contexts within which issues emerge and are addressed by organisational 'fields'. Hoffman (1999) brings to light the role of disruptive events in spurring institutional change such as oil spills and toxic fires (catastrophes), earth summits and issue-based international conventions (milestones) and parliamentary hearings, trials and the release of white papers (legal events). He thus tracks the rapid technical and cultural changes in US corporate environmental practice from end-of-pipe solutions in the 1970s, waste minimisation and pollution prevention practices in the 1980s, product stewardship and life-cycle analysis in the 1990s to concerns for environmental protection and sustainable development in the past decade in response to evolving public opinions, emerging environmental institutions and a string of disruptive events or shocks (Hoffman, 1999).

Sustainability reporting: Within international CC literature, reporting on more than financial performance through social and environmental audits is seen as part of business response to the need for increased transparency and accountability to stakeholders (Holliday et al, 2002). Furthermore, if companies are motivated by compliance with regulation and adherence to international standards to satisfy investors and asset managers, then sustainability reporting will be their chosen form of CC practice.

Global initiatives have brought more consistency across companies through standardized sustainability indicators which measure financial, environmental and social progress. One such initiative is the Global Reporting Initiative (GRI), a social partnership between non-state actors that include businesses, NGOs and accountancy organisations (McIntosh et al, 2003). In contrast to environmental management standards such as the ISO 14000 series, which are amenable for use by large companies, the GRI framework contains flexible reporting guidelines to assist companies of all sizes in communicating to their stakeholders. The GRI is also designed to serve as an internal tool for evaluating consistency between sustainability strategy and performance (GRI, 2002, 2006). For many companies sustainability reporting has been a voyage of discovery and the reporting frameworks have provided a way of telling their story. UN adoption of the GRI in early 2002 and UNEP's (United Nations Environmental Program) regular contribution to the improvement of the indicators has strengthened further support for the framework from NGOs and companies around the world. The four-part model of CSR (Carroll, 1991) is incorporated within the GRI framework as material issues which are unique for each enterprise and are identified through high-level stakeholder engagement.

In addition to the GRI and the ISO 14000 series, commitment to other reporting standards and principles such as the Social Accountability 8000 series, Fair Trade accreditation, the OECD Guidelines for MNCs and the Global Sullivan Principles is mainly a voluntary endeavour by businesses. Principles represent a set of overarching values that underpin behaviour and are non-specific; while international standards specify a set of benchmarks for business performance or process design (McIntosh et al, 2003).

Despite international support from various actors including governments, stock markets and civil society organisations, the practice of sustainability reporting is considered a non-starter on several accounts:

- <u>Credibility</u>: Not all reporting standards require verification through third-party audit which makes compliance claims less credible.
- <u>Unpredictability in the use of reported information</u>: While some authors hail standardization through sustainability reporting as a means of levelling the playing field for developing country companies to compete with international counterparts (Hamann et al, 2005) others contend that CSR tools such as codes of conduct and supply chain standards can exclude developing country manufacturers from global markets (Fox, 2004).
- <u>Reductionist approach</u>: GRI's long-term vision is to 'elevate' sustainability reporting to a level equivalent to financial reporting through the development of a generally accepted reporting framework. While accounting is accepted as the most authoritative means of rendering the effects of individual action within organisations visible for analysis , such a perspective lacks appreciation for systems thinking or complexity and adopts a

reductionist approach: the social is separated from the financial, the environmental from the social and so on (Roberts, 2003).

- Inconclusive capacity for organisational development: Ultimately, standardized measures for company performance towards sustainability are intended to bring about organisational learning and change in the absence of more radical changes to the 'genetic make-up' of businesses as espoused by White (2004). However, the role that sustainability reporting plays in increasing transparency or creating another layer of green-wash remains hotly contested (Roberts, 2003; White, 2004; McIntosh, 2004).

The following table unpacks the drivers and underlying ethos behind the above practices to develop a framework for corporate citizenship. Based on this businesses can combine various practices to achieve their desired sustainability outcomes. Practice areas reflect the evolution in cultural and technical trends related to corporate sustainability. The framework below does not include the nuanced features of CC in a South African context such as affirmative action, driven by sector-specific BEE charters. These are discussed in the next section.

Table 3.3: Framework for corporate citizenship practices with intended sustainability outcomes

CSR practice areas	**Philanthropy / CSI**	**Stakeholder engagement**	**Technological innovation**	**Corporate environmentalism**	**Sustainability reporting**
Key drivers	Moral imperative	Community pressure, moral imperative	Market and legal pressures, organisational culture	Legal compliance, environmental groups	Globalisation, market pressure
Underlying ideology	'ethic of care'	Stakeholder legitimacy	Techno-optimism	Environmental custodianship	Reporting increases transparency
Intended sustainability outcome	Social upliftment	Administration of citizenship rights of individuals	Sustainable production	Environmental justice	Accountability to stakeholders
Examples	Charitable donations	Critical collaboration	Ecological products and services	Biodiversity conservation	GRI guidelines
	Support for local schools	Industry alliances	Resource productivity	Water conservation	TBL reporting
	Support for the arts and sports	Knowledge networks	Waste minimisation and recycling	Energy saving	Carbon footprint
	Recreational	Dialogue with	Pollution	Organic farming	Industry

	facilities for employees	local community	control		standards
			Energy efficiency	Pollution prevention	Sustainability principles
				Responsible sewage disposal	
Key characteristics and inadequacies	Own discretion	In the domain of ethical choices	WBCSD promoted	UNEP promoted	International and local stock exchange promoted
	Non-measurable	Should inform corporate vision, goals	Competitive advantage	Legally enforceable	Reliability is standard dependent
	Hard to enforce	Hard to enforce	Process & product monitoring tools	Environmental impact measurement tools	Consistency depends upon info-gathering systems
	Hard to hold accountable		Legally enforceable	Company's own discretion in the absence of laws	
			Susceptible to green-wash		
			Reductionist approach		

3.3.5 Drivers of the evolving CC agenda in South Africa

The South African literature on CC often comes with a distinct flavour, grounded in case studies of actual corporate response towards locally prominent issues such as affirmative action, environmental justice, skills development and HIV/AIDS. Such work resonates with the approach described by Margolis and Walsh (2003) which recommends descriptive research methodology building towards a normative agenda for CSR. For a brief but comprehensive review of South African academic research in the CC field, see Visser, 2005. Visser (2005) draws attention to the additional role of private institutions such as KPMG and Trialogue in producing comprehensive research on South African CC practice.

Legislative reform: In the South African context, legislative reform is cited as the most effective driver for behavioural change alongside morality, profitability, enlightened self-interest and reputational risk by many thinkers. For example, Hamann attributes a significant increase in the CSR-related reporting and spending to local pressure and legislation, especially the BEE scorecard in the case of mining companies in SA (Hamann, 2004, Hamann et al, 2005). Visser

(2005) cites the Reconstruction and Development Program (RDP) of the newly elected ANC in 1994 as guiding CC in SA by drawing attention to critical areas such as poverty alleviation, environment, health, safety, workplace empowerment, affirmative action and human rights.

International market pressures: A second important driver for change among SA companies is scrutiny from overseas markets as a result of a number of local companies globalizing and listing internationally (Fig, 2005; Visser, 2005). International stock markets require listed companies to participate in indexes such as the Business in the community Indexes, FTSE4Good Global Index and Dow Jones Sustainability Index, thus forcing SA companies to meet global standards for corporate governance. Fig (2005) argues that the ambition to go global has meant that companies end up making real changes towards integrating social and environmental concerns into the workings of their organisation as part of listings procedures.

Local market pressures: The fairly new practice of sustainability reporting by SA companies represents an example of international market trends impacting on local corporate practice, now enforced through stock exchange listing requirements. Adherents to the UN Global Compact and the GRI exist among the larger SA firms and parastatals such as Eskom and Sasol (Malan, 2005; Fig, 2005). Compliance with King II (the 2002 updated King Report on Corporate Governance in South Africa), which refers extensively to the GRI Sustainability Reporting Guidelines, is now a listing requirement on the Johannesburg Securities Exchange (JSE) (Fig, 2005; Visser, 2005).

King III (released in September, 2009) which replaced the King II report on 1 March, 2010 highlights the inseparability of strategy, risk, performance and sustainability and stresses the importance of taking into consideration the social, economic and environmental impacts of a business. The review of King II was prompted by changes in international governance trends and the reform of South Africa's company laws with the promulgation of the new Companies Act of 2008 (Wentzel, 2009).

Community pressures: A fourth critical driver for CC in SA, cited in most writings as stakeholder activism or community resistance, ranges from political lobbying and public campaigning to litigation. Fig (2005) lists key campaigns conducted by activist community organisations against corporate malpractice in the absence of independent and critical journalism and effective oversight structures. Pressure from community groups and local actors is enabled through the judicial upholding of constitutional rights backed by a strong legislative and policy framework (Hamann, 2004; Fig, 2005).

3.3.6 Perceptions of CC in South Africa

Despite the acclaimed effectiveness of legislation and sectoral charters in transforming SA corporate intent, there are numerous cases resulting in dubious outcomes. For example, implementation of EMCAs (environmental management co-operative agreements) based on a Dutch model for voluntary accords between the government and businesses has largely failed (Fig, 2005); a socially transformative mining charter targeting 51% black ownership was abandoned due to strong negative response from international markets and replaced by a lower black ownership target and a broad-based BEE charter acceptable to all stakeholders (Hamann, 2004); and the phasing out of single sex hostels pushed by the post-apartheid Government and labour unions led to increased growth of informal settlements around mines, not necessarily a socially desirable outcome (Hamann, 2004).

Hamann et al (2005) note a high level of distrust from civil society organisations towards CSR claims by SA companies. The roots of this mistrust is attributed to the historical 'smokescreen' critique whereby what companies were 'saying' was far removed from what they were 'doing' (for instance the pre-apartheid SA mining sector which relied upon single sex hostels and promoted social malpractice in order to generate profits and at the same time made donations towards education or health initiative in proximate communities (Hamann, 2004)).

Philanthropic initiatives: CSR in SA has historically been practiced through philanthropic activities in the education, health and welfare domain sometimes through cultural, sport or art promotion (Hamann et al, 2005; Fig, 2005), recently promoted as Corporate Social Investment (CSI) initiatives. Fig (2005) criticizes levels of CSI spending in SA (statistically estimated by Trialogue in the 2004 Corporate Social Investment Handbook) as being far too low to address high income inequality among South Africans, while Visser (2005) presents the same data in a positive light. Irrespective of the perceived inadequacy of contributions, CSI is criticized for its vague description, discretionary nature and detachment from core business ethics.

Sustainability reporting versus stakeholder engagement: The inadequacy of a global standard for something as complex as CSR was noted by the advisory group to an ISO Technical Management Board set up to develop an international management standard for CSR (Hamann et al, 2005). Fox (2004) argues that in a developing world context companies should focus on increased transparency at the local level rather than glossy sustainability reports that cater to the needs of civil society in the North (mainly the consumers). However, Hamann's (2004) case study work on CSR practices among South African mines reveals the problematic nature of conducting interactions with local communities in the complex socio-economic environment of post-apartheid South Africa.

Sustainability reporting on its own, considered by some authors (such as McIntosh 2002, 2004) as a reliable indicator of CC practice, may or may not address the longer-term socio-ecological concerns of sustainable development (Hamann, 2004; Hamann et al, 2003; Visser, 2005).

Corporate environmentalism: In the realm of environmental performance of large companies, the ISO 14000 series have been increasingly adopted and reported on in recent years (Visser, 2005) even as failure to comply with the National Environmental Management Act (NEMA) is noted (Fig, 2005). It is consistently admitted that adhering to environmental standards by corporations does not change the fundamental effect a sector such as paper production has on biodiversity, land use, water quality or low-quality coal-based energy production has on air quality and global warming (Fig, 2005; Visser, 2005; Hamann et al, 2005).

3.3.7 A South African agenda for corporate citizenship

Zadek (2001) reflects upon the transformation in the corporate citizenship agenda, as it addressed different normative questions over three generations. The current generation calls into question the likelihood of CC addressing global and interconnected problems of social and environmental sustainability. In the South African context these challenges translate to growing levels of unemployment, gender-related abuse, crime, corruption and HIV/AIDS, among others.

There are two approaches to academic research and writing in a field dedicated to scrutinizing and encouraging corporate behaviour aimed at sustainability: a descriptive conceptualization, which focuses on trends observed in the practice of CC and a normative conceptualization, which concentrates on what should happen (Crane and Matten, 2004; Margolis and Walsh, 2003). While descriptive analyses rely on existing theories to explain observed behaviour, normative work concentrates on theory-building and transformation.

Examples of descriptive work include Hamann’s (2004) study of the mining sector grounded in institutional theory, Malan’s (2005) ethics-based analysis of large SA corporations’ investments and operations in the rest of Africa drawing on the integrated social contracts theory and Fig’s (2005) national level case-study of a wide range of activities labelled as CSR in SA in order to highlight corporate challenges and successes under various external stimuli and pressures.

Examples of normative endeavours include the synthesis model of CC developed by Hamann et al (2003) post-WSSD and a social responsibility versus political involvement matrix developed by Malan (2005). De Jongh and Prinsloo (2005) argue for reform in the teaching of CC in business schools, and propose a critical pedagogy, in order to effect real change in CC practices across Africa.

South African authors consistently point to the one business sector which is conspicuously missing from the emerging CC agenda: the small and medium-sized enterprises (Fig, 2005; Visser, 2005; Hamann et al, 2003). Several of the catalysts for change noted in the case of large firms such as brand management linked to international markets and scrutiny from local civil society organisations, are absent in the case of SMEs unless they are part of supply chains of bigger companies (Fig, 2005). Even so, SMEs may be reluctant to bear the cost burden of compliance with CSR standards required by upstream or downstream companies, thus losing significant market share (Hamann et al, 2003). Hamann et al (2003) note significant anecdotal evidence with regards to challenges faced by South African SMEs in a highly codified CSR environment. They argue that systematic analysis of the relationship between supply chain pressure and adherence to CSR standards by SMEs would strengthen the case for increased compliance.

Therefore, some of the recent SA-based research efforts are directed towards investigating how companies of all sizes appraise stimuli for sustainability-oriented action, generate strategic response options, evaluate these options, select a course of action and implement the selected course of action; and the consequences that follow from such action (Margolis and Walsh, 2003; Clarkson, 1995).

3.4 Conclusions: gaps and links with Chapters 4, 5 and 6

Corporate citizenship, and its extended meaning and connotation, have tried to justify the need for corporate attention to issues of social justice and environmental custodianship. The debate, internationally and in South Africa, has unpacked the political and social meanings of CC and CSR; produced models and frameworks for improving accountability to stakeholders; and unearthed a range of catalysts which work in concert to drive corporate sustainability. Recent work in the field has effectively scrutinised the outcomes of what are termed as CC practices. Critical gaps and inadequacies in the conceptualisation and implementation of CC practices are well documented. For example, many of the corporate sustainability practices discussed above are seen as examples of voluntary self-regulation, devised by corporations to discourage legal pressures (Christian Aid, 2004; White, 2004).

An area of consensus found among different writings is that the current model of CSR falls short of meeting societal expectations (Levy, 1997), and that the WBCSD-led model of CC is merely green-wash (Hamann et al, 2003). White (2004) argues that the emerging international norms and standards produce a package of best practices that do not necessarily transform corporate ethos. On the other hand, McIntosh (2004) suggests that most companies did not understand the full implications of what they were signing up to and are therefore, yet to fully implement the ten principles of the UN Global Compact.

Questions pertaining to the effectiveness of CC, raised in this thesis, are also reflected in the concerns of CC practitioners and academics, internationally. A special edition of the Journal of Corporate Citizenship (issue 28) is dedicated to probing the relevance of CC as a driver for global change. The special edition draws on the second international symposium organised by UNISA’s Centre of Corporate Citizenship, seeking answers to the question: ‘Is Corporate Citizenship making a difference?’ (de Jongh, 2007).

Advocates of corporate legal accountability lament the limited effectiveness of self-regulation as well as corporate social philanthropy (Christian Aid, 2004; White, 2004).[4] White (2004) claims, quite radically, that CC efforts thus far have been tinkering at the edges and that core elements of business design, such as shareholder primacy and limited liability need to change, to finally lay the discussion on profit versus social responsibility to rest.

This thesis is premised on the belief that the current model of a business is sufficient for driving sustainability-oriented behaviour, if the correct drivers are in place. Leisinger (2007) argues that businesses have been contributing their skills, resources and know-how towards sustainable solutions, but face the risk of defaulting to legal pressures, in the absence of acknowledgement of voluntary efforts and constructive dialogue for further co-operation among private and public sectors. This research is aimed at encouraging businesses to continually invest in their commitment to sustainability, by understanding what drives such behaviour in the first place.

Often it is the mainstream, normative conceptualisation of CC, supported by reporting tools, standards and compacts, which inform a business' understanding of its role in the larger goal of sustainable development. A challenge in SA is the distrustful perception of CC practices, to the point that legal pressure is considered the most effective driver. The distrust is linked to the fact that non-legislative catalysts for socially responsible behaviour are not always effective and CSI initiatives often remain external to the organisation.

The CC agenda was thus found lacking in addressing the research objectives on several accounts. Firstly, substantial effort is devoted to identifying drivers of CC, but these drivers do not always explain corporate endeavours for sustainable outcomes. Secondly, an evolutionary and integrated perspective of a business context, which evolves continually, was found lacking, especially in accounting-led tools for sustainability reporting. Thirdly, various science-based concepts are used extensively in the CC literature, as a way of substantiating CC practices with scientific rigour, without deeper explanation. The next three chapters of the literature review attempt to fill the above gaps.

In Chapter 4 some of these scientific concepts, introduced in CC writings, are reviewed in more detail. For example, Natural Capitalism is explored through the natural capital concept of ecological economics; ecological footprint as a fore-bearer of carbon footprint is investigated as a tool for measuring a business' progress towards sustainability; tools for measuring the environmental performance of an entity are studied; and the potential of industrial ecology concepts in transforming business management practices towards corporate sustainability is explored.

[4] Examples of legal accountability can be found in areas of both environmental and social corporate responsibility such as the NEMA and the BEE charter in SA.

Chapter 5 is devoted to interrogating the carbon emissions measurement and reporting aspect of environmental sustainability reporting.

The evolutionary approach to corporate environmentalism, which contains elements of a systems perspective, is addressed further in Chapter 6. The evolutionary perspective introduces the concept of phases and transitions on the sustainability path followed by a business. This argument stresses the importance of a range of drivers acting in consonance and creating the appropriate context to prompt corporate innovation.

Chapter 6 also expands upon the link between business risk and resilience, which is an approach followed by the Corporate Sustainability research project run by the CSIR's Natural Resources and the Environment section.

Chapter 4: Ecological economics and Industrial ecology: towards sustainable production and consumption systems

4.1 Introduction

Academics and practitioners from the fields of ecological economics and industrial ecology offer various concepts, approaches and tools developed within these discourses, as scientific responses to the societal challenge of sustainable production and consumption. Some writings in the two discourses generate a techno-optimistic worldview which corroborates an approach to environmental sustainability whereby environmental impacts of an entity can be measured scientifically (for instance through a carbon footprint), and reduced through appropriate technological interventions (such as energy efficiency and renewable energy solutions).

In this chapter, offerings from EE and IE are interrogated through a wide literature review of the two fields, to gain a deeper understanding of what drives corporate efforts towards environmental sustainability. This interrogation is underpinned by the need to disclose the intellectual roots of terms used within the CC literature. The aim was that gaps and inadequacies found in the normative frameworks and descriptive narratives of CC could be supplanted by alternative perspectives with their roots in the natural sciences; in particular, systems ecology, environmental management and process engineering.

EE has a rich and diverse history and is applied across a range of multi and trans-disciplinary projects. The concepts and terms spawned during its history have found their way into more widely known conceptualisations of sustainable development. A discussion on the notion of renewable and non-renewable natural capital, debated at length within the EE literature, provides the entry point for introducing and expanding on the ecological footprint (EF) measure. EF, originally a tool for measuring the ecological impact of populations and nations, may be used for assessing corporate entities' progress towards sustainability. There are direct parallels between methodologies for calculating EFs and carbon footprints of entities and products.

Although Pezzoli (1997) lists IE as a sub-field within the EE discourse, over the last two decades IE has become a discipline in its own right with a very active community and dedicated international journals. Applications explored within IE include studies of global nutrient cycles (as part of the industrial metabolism perspective), establishment of eco-industrial parks (producing their own energy and using one production plant's waste streams as resources for another plant) as well as environmental impact assessments of production processes (an extension of chemical and process engineering streams). Life cycle analysis or assessment, which originated as a tool within the IE discourse is also characterized by an active community, a dedicated international journal and specialized practitioners. However, for the purpose of this research, LCA is studied as a tool under the IE umbrella.

4.2 Ecological Economics

4.2.1 A mixed heritage

In the words of Sneddon et al (2005) ecological economics may be understood as an attempt to refine and implement the broad vision of sustainable development advanced by the Brundtland Commission, 1987. The discipline however, traces its foundations to almost two decades earlier with the emergence of the new environmental agenda in the 1960s, which itself was influenced by the scientific development in biology and ecology (Ropke, 2003). The observation that human decision-making takes place within particular social systems (Stanfield, 1977), that economic processes are also always natural processes and that human systems are part of a larger ecological system was drawn by forward thinking multi-disciplinarians long before the discipline itself was launched.

Ropke (2003), a social economist, provides an excellent overview of the early history of the discipline and attributes the various discussions and tensions currently seen within ecological economics to its mixed heritage. Ecological economists draw inspiration from the works of many thinkers including biologists Eugene and H.T. Odum's work in the 1950s on new methods to study energy flows in a systems perspective, the ground-breaking work by Nicholas Georgescu-Roegen captured in 'The Entropy Law and the Economic Process' in 1966, environmental economist K.E. Boulding's essay on spaceship earth (Boulding, 1966) and Herman Daly's work in the 1970s on steady state economics based on the 'homeostatis' of ecological systems. Ropke argues that during the long gestation period from early 1970s when the foundations for ecological economics were being cemented to the late 1980s/early 1990s when the discipline itself was formalized, the role of the physical-biological perspectives related to *entropy*, *metabolism* and *materials balance* diffused and developed inside mainstream environmental economics.

Key studies exploring the role of energy and other natural resources in social and economic development contributed to the growth of the sub-field. These include investigations on energy quality, relation between labour productivity and increased fossil fuel use and energy modelling to calculate direct and indirect costs of goods and services (Cleveland et al, 1984). Stanfield had argued that current socio-ecological problems require an economics which is 'holistic, evolutionary and philosophical' and that social economics as opposed to conventional economics is such an economics (Stanfield, 1977). However, within the field of social economics, the environment remained a minor issue (Ropke, 2003) and environmental resource economics expanded to fill the gap. The new discipline was eventually launched as a critique of neoclassical economic arguments and especially the 'development as growth' model or the neoclassical welfare theory (Gowdy, 2000). The late establishment period therefore includes efforts by MacNeill et al (1991), Costanza et al (1993), Daly (1996) and Douthwaite (1999).

A parallel stream of thinking grew from the work of the Ehrlichs (1970, 1989, 1990) which generated the formula I=PAT and focused on the manipulation of the three variables of population (P), affluence (A) and technology (T) to achieve reduced environmental impact (I) of a society. Paul Ehrlich, an ecologist by training extended the application of ecological principles to addressing economic/developmental concerns of governments. In fact, Paul Ehrlich maintains that 'ecological economists' as a group is identical to environment and resource economists (Ehrlich, 2008).

4.2.2 Multiple offerings

Authors such as Gowdy (2000) and Muller (2003) have argued that ecological economics through its application to socio-ecological problems is a 'post-normal' science (as defined by Funtowicz and Ravitz, 1993) relevant to decision-making characterized by a high degree of uncertainty, limited information and a very short time frame within which to function. Others such as Muller (2003) argue that the field is actually a 'flower in blossom: at the crossroads between normal and post-normal science'. Based on a citation analysis of influential publications, Costanza et al (2004) conclude that ecological economics is trans-disciplinary since it has been influenced heavily by books and articles published in other journals.

An extensive review of articles and writings within the ecological economics field reveals two distinct streams of work. The first stream is aimed at quantifying sustainability. For instance, various scientific methodologies have been developed within the field including differentiations of 'weak' versus 'strong' sustainability (Ayres, van der and Gowdy, 2001; Pearce and Atkinson, 1993); the valuation of ecosystem services (Daily, 1997; Costanza et al, 1998) and development of weak and strong sustainability indicators from an economics perspective (Hukkinen, 2003; Rennings and Wiggering, 1996). Work in the area of international trade contributes significantly by incorporating both the costs and benefits of globalization (Ehrlich, 2008) by using among others, the ecological footprint methodology. Material and energy flow analysis (Hannon, 1985), embodied energy (Costanza, 1980) and decoupling (Gallopin, 2003) are concepts that owe their origin to the mixed heritage of ecological economics and have subsequently thrived in industrial ecology, life cycle analysis and societal metabolism writings.

A second stream is dedicated to addressing specific environmental problems such as biodiversity loss through land use change and conservation of fragile ecosystems such as semi-arid rangelands by applying trans-disciplinary tools including optimal cropping production techniques (Weitzman, 2000) and increasingly, ecological-economic modelling (Watzold et al, 2005). Baumgartner et al (2008) have attempted a 'multi-level approach' that includes explicit reflection on the norms and notions of all disciplines involved, generic modelling: a cross between simulation and analytical techniques, and a practical case-study to generate and test a hypothesis.

Research work in ecological economics thus occurs at an expanding intersect of natural and social sciences with a range of tools applied to resolving a societal problem be it biodiversity loss, societal over-consumption or increasing global inequity. Current trends reviewed above and calls for future research on issues such as power relationships between the world's rich and poor, the costs associated with the toxification of the planet or with climate change and meta-resource depletion problems such as oil peak (Dasgupta, 2008; Ehrlich, 2008; Bahn and Gowdy, 2003) indicate practical efforts in examining social and environmental sustainability at regional and global levels (Bahn and Gowdy, 2003).

The above discussion demonstrates that ecological economics has contributed substantially to furthering the sustainable development debate and how it may be operationalised. The following sections delve into some of the concepts, principles and indicators developed within the field which lay the foundations for corporate sustainability and carbon footprint analysis.

4.2.3 Natural Capital

4.2.3.1 Renewable and non-renewable natural capital

A discussion on natural capital is a useful place to start covering some of the defining principles which underpin ecological economic thinking and set it apart from a neoclassical economic perspective. For example, a discussion on natural capital and the difference between renewable and non-renewable resources precedes a delineation of weak and strong sustainability and motivates the search for renewable alternatives to fossil fuels (Costanza, 1980; Cleveland et al, 1984; Costanza and Daly, 1992; Gowdy, 2000; Ayres et al, 2001; Bahn and Gowdy, 2003).

In ecological economics, starting with the functional definition of 'capital' as a 'stock that yields a flow of valuable goods and services into the future' as opposed to the traditional definition 'means of production', Costanza and Daly differentiate between 'natural capital and natural income as the aggregates of natural resources in their stock and flow dimensions' (Costanza and Daly, 1992: 37). Within this conception, renewable natural capital provides society with both ecosystem goods (such as fish and wood) and ecosystem services (such as erosion control) and renews itself using its own capital stock as well as solar energy. Ecosystem services range from maintaining aesthetic and ethical (cultural) values to provisioning goods, supporting agriculture (through pollination and soil regeneration) and regulating climate (Millennium Ecosystems Assessment Report, 2005).

'Natural capital' thus includes renewable or active resources such as land, soil, biodiversity and ecosystems (Meadows et al, 2004) and non-renewable natural resources such as fossil fuels and mineral deposits. However, beyond a point renewable sources can also become irretrievably non-renewable as is the case with thousands of species on a daily basis. A natural sciences distinction between the two types of natural resources defines renewable as resources which are replenished or restored through biological (e.g. wood) or geophysical (e.g. water) processes and non-renewable resources as those which are taken from geological deposits (Haberl et al, 2003; Wackernagel and Rees, 1996). Drawing on El Serafy (1989), ecological economists conclude that maintaining total natural capital (renewable and non-renewable) is the key to sustainability (e.g. Costanza and Daly, 1992; Wackernagel and Rees, 1996).

4.2.3.2 The non-substitutability of renewable natural capital

The idea that most forms of natural capital cannot be substituted by manufactured or human capital and that natural capital constancy is essential to sustainability is considered strong sustainability. The neoclassical notion of sustainability, also called weak sustainability by ecological economists (Gowdy, 2000; Ayres et al, 2001; Bahn and Gowdy, 2003), requires a sustained growth rate of the economy, measured by the Net National Product (the rate of return on a nation's capital stock) (Gowdy, 2000:27). This combined with the neoclassical assumption that all kinds of capital (manufactured, natural and human) are near perfect substitutes for one another means that 'sustainability becomes not a bio-physical problem but an exercise in portfolio management' (Gowdy, 2000: 33). Costanza and Daly (1992) explain that before human activities reached the scale they have, manufactured and human capital were the limiting factors in economic development while natural capital was abundant and considered a free good (and therefore substitutable). Herman Daly (1977) was the first to stress the importance of the scale of human activity vis a vis the natural world made possible by a steady state economy with a non-growing throughput of natural capital.

4.2.3.3 Saving natural capital through taxes and reserves

Two distinct approaches are applied to address depleting natural capital globally. The first method emerges out of the ecological economics discipline and emphasizes economic policy instruments to both regulate and encourage reduction in natural capital depletion, with potential for redistribution and reduced consumption. The second method covers on-the-ground efforts by conservation biologists, agriculturalists and restoration ecologists to preserve ecosystems and repair degraded landscapes and species habitats, sometimes in response to policy pressures.

Most ecological economists are suspicious of a voluntary, innovation-based change-over and in fact do not believe that the coupling between growth and energy (through technology) is so loose (e.g. Costanza, 1980; Cleveland et al, 1984; Ayres et al, 1996; Ehrlich, 2008). They argue that 'social sustainability depends much more on population control, consumption control and redistribution than on a purely technical fix of a five to ten fold increase in productivity as suggested by the Brundtland Commission' (Costanza and Daly, 1992: 44).

Technological progress which is efficiency-increasing rather than throughput-increasing is necessary for sustainable development; however, it is not sufficient. In order to maintain total natural capital, it is argued, that (a) harvesting of renewable resources should not exceed regeneration rates, (b) the exploitation of non-renewable natural resources should be at a rate equal to the creation of renewable substitutes and (c) waste emissions should not exceed renewable assimilative capacity of the environment (Costanza and Daly, 1992). The straightforward application of the above scientific principles requires that all natural capital used by an industry or business be maintained without depletion. However, the question arises as to where to draw the system boundaries for the affected ecosystem and how to calculate the regeneration and creation rates for a renewable resource within such a system (Costanza, 1980; Haberl et al, 2003).

Keeping in mind the practical difficulty of measuring the regenerative capacity of associated ecosystems by individual businesses and industrial sectors, and the insufficiency of technological innovations, it is suggested that strong sustainability be achieved by taxing total natural capital consumption, especially energy, very heavily (Costanza and Daly, 1992). In addition to a natural capital depletion tax, ecological economists have been making progress in finding market-based solutions such as the use of 'tradable fish-harvesting quotas, tradable water allocations for agriculture and cap-and-trade pollution abatement schemes' (Ehrlich and Ehrlich, 2008). Such solutions when combined with command and control mechanisms such as determination of the shrinking 'cap' in cap-and-trade have been quite successful in abating acid rain and thus protecting biodiversity and are recommended for bringing down society's carbon emissions (Flavin, 2008).

A second approach to saving natural capital comes from the work of conservation biologists who focus on the biodiversity and ecosystem component or the 'living' (renewable) natural capital. The traditional approach to protecting species by reversing habitat loss involves the establishment of 'reserves' including botanical or biological 'hotspots' such as the Cape floral kingdom. However, 'the reserve-island approach may not be sufficient in the face of climate change which will also change the habitat within which species and populations survive' (Ehrlich and Ehrlich, 2008). The new thinking within the field therefore favours the 'creation of corridors by connecting fragment reserves, thus providing paths that organisms can use to move rapidly in response to shifting climate' (Ehrlich and Ehrlich, 2008: 319).

4.2.4 Principles for strong sustainability

Ecological economists gave economic meaning to the term 'natural capital' and the linked monetization of ecosystem services thus rendering environmentalists and ecologists a powerful argument for rallying support around nature conservation and protection of biodiversity. Conservation biologists continue to find ways to maintain natural capital both in the form of biodiversity and ecosystem services while making it economically attractive to parties involved, especially in the face of rapid climate change. For example, initiatives such as The Natural Capital Project run by The Nature Conservancy aim to align economic forces with conservation (Ehrlich and Ehrlich, 2008). Such a shift is believed to be possible through the next industrial revolution: the emergence of the green or sustainability socio-ecological era (Swilling, forthcoming). It is also believed that efforts to link biodiversity conservation with local economic development projects (such as The Natural Capital Project) are examples of how strong sustainability may be operationalised (Gowdy, 2000).

In the absence of strong policy measures such as natural capital depletion taxes, it is possible to extract broad recommendations from the above discussion which a business, reaching for strong sustainability, can adopt as guiding principles for corporate behaviour:

- Become part of a closed loop in terms of resource consumption and waste generation
- Increase resource productivity radically through investment in efficiency-increasing technology
- Eliminate usage of materials that release toxins at any stage of their production, use or re-use

Specific to agricultural businesses from the field of conservation biology, the following recommendations are useful:

- Assist in the regeneration of soil by using techniques recommended as part of IPM (integrated pest management): mixed crops, minimal use of pesticides and encouraging natural predators of pests
- Create as large a reserve on your farm as possible and generate interest in neighbouring farms to connect into a corridor which can link up with a nearby regional reserve.

Sustainability scientists look beyond natural capital depletion since they maintain that neither the 'regenerative capacity of the biosphere nor the natural capital, can at present by measured appropriately' (Haberl et al, 2004: 200). Ecological footprint (EF) goes around the dilemmas posed by embodied energy accounting (Costanza, 1980) for calculating natural resources required for a production process and valuation of ecosystem services (Costanza et al, 1997), by adopting the human carrying capacity concept for maintaining constancy of natural capital. Footprint methodology is directly applicable in the enforcement of environmental taxes and cap-and-trade measures.

The following sections interrogate the EF as an approach for measuring society's progress towards sustainability. The transferability of analytical tools like the EF which is conceptualised at societal or national economy (macro) level to business (micro) level may pose a challenge, which is also interrogated. Later sections delve into methodologies from industrial ecology, in particular life cycle analysis that could assist in the operationalisation of strong sustainability at entity level.

4.2.5 Ecological Footprint

Ecological economic thinking is based on the premise that 'the human economy is a subsystem of a finite global ecosystem' (Daly, 1990). In the previous discussion on constancy of total natural capital, Costanza and Daly (1992) proposed that in order to be sustainable, the use of renewable resources must not surpass their regeneration rate. This criterion is the basis of the EF concept and model which was originally designed to calculate the hypothetical 'area of land and water ecosystems needed to sustain the resource consumption and waste assimilation of a given *population* wherever on Earth the land and water is located' (Rees, 1996; Wackernagel and Rees, 1997). It is a simple and elegant tool for comparing the sustainability of resource use among different populations (Lenzen and Murray, 2003).

4.2.5.1 Intellectual underpinnings

Wackernagel and Rees (1997) reflect on the EF model specifically to unravel the confusion around sustainability. A clarification of the terms sustainability and sustainable development they believe hinges on adopting a 'strong sustainability' which incorporates social equity. They combined the ecological economics concept of natural capital with the ecological/biophysical concept of carrying capacity[5] to recommend the EF model as an alternative to monetary assessments of scarce ecosystem services. The authors trace a fascinating history of ecological accounting as the basis for EF concept (Wackernagel and Rees, 1997; Wackernagel and Rees, 1996). Other examples of work based on the human carrying concept which they cite include the 'environmental space' concept and 'ghost acreage' which refers to imported agricultural carrying capacity.

The strength of the EF model when calculated for populations lies in accommodating to some extent the cultural determinants and the technological progress which affect ecological productivity of a region. Therefore, while the human carrying capacity of a region may vary depending on which people it needs to support, the total productive area required to support a specific population will always be constant.

4.2.5.2 Applications and methodology

The EF model was used to calculate a fair *earthshare* or 'the amount of ecologically productive land available per person on earth' and in 1994 it amounted to 1.5 hectares (World Resources

[5] Carrying capacity is defined as the 'maximum population of a given species that can be supported indefinitely in a specified habitat without permanently impairing the productivity of that habitat'.

Institute, 1994). The EF of persons from different parts of the world could then be compared to the global average as an indicator of a particular society's use of earth's finite resources beyond their fair share. For example, the EF for many developed countries ranges from 3 to 5 hectares/person while developing countries like India present a per capita EF of 0.4 hectares. Human overshoot of earth's carrying capacity is confirmed through a global average per capita EF of 1.8 hectares - 0.3 hectares per person more than the fair earthshare of 1.5 hectares (van den Bergh and Verbruggen, 1999; Wackernagel and Rees, 1997).

The EF model was used to assess activities (businesses) or regions, from a city to nations or the entire world (van den Bergh and Verbruggen, 1999). For instance, Wackernagel et al (1997) developed a framework for national and global natural capital accounting based on the EF concept and calculated the EF of 52 nations. The methodology used agricultural or biological yield figures to translate the consumption for each relevant category into areas of biological production. The five consumption categories included food, housing, transportation, consumer goods and services. The land area appropriated by each consumption category was then estimated for six land categories. This included land appropriated by fossil energy use called energy land, built or degraded land, gardens, crop land, pasture / grassland and managed forests. Existing data was collected from a range of sources including production and trade figures, environmental reports and agricultural, fuel use and emissions statistics. Summing all the area figures on a consumption/ land-use matrix gave an estimate of the EF of the region considered.

The EF methodology may be compared to its intellectual predecessor, the study on human appropriation of net primary production (Vitousek et al, 1986). Wackernagel et al (1997) claim that the EF studies of nations confirm the conservative findings through HANPP (human appropriation of net primary production) and extend them by firstly, including more ecological services such as the absorption of carbon dioxide (from fossil fuels) by forests, and secondly, by factoring the different productive quality of various ecological capacities of the environment, such as those of pastures versus arable land (1998). (For a detailed overview of the strengths and 'perceived' weaknesses of the EF approach see Rees, 2000 and Wackernagel and Silverstein, 2000. For a powerful critique of the EF approach and model see van den Bergh and Verbruggen, 1999).

4.2.5.3 Critique of the EF methodology

The dynamics of the EF concept were debated within an *Ecological Economics* forum, with the explicit purpose of extending use of the approach into new areas. The strength of the EF as an aggregate indicator was highlighted (Costanza, 2000) as was the need for decision makers to be aware of the uncertainties, weights and assumptions that inform aggregate indicators; in other words, the detail behind the simplicity. All aggregate indicators that use a single index, such as cash, welfare, equivalent land area or carbon emissions, must assign values and thereby weightings to a range of diverse factors and share the same limitation. Since some information loss must be accepted in order to gain clarity and simplicity, the choice of methodology for arriving at the single index is a very significant part of the decision-making process (Clayton and Radcliffe, 1996).

The methodology for arriving at the equivalent land area in the EF is criticised on various fronts. Firstly, as a model that sets out to measure society's progress towards sustainability by accounting for the flows between economies and supporting ecosystems (Wackernagel and Rees, 1997), the EF is critiqued for providing a static measure of complex interactions (van den Bergh and Verbruggen, 1999). Other approaches such as industrial metabolism (Ayres, 1998) and material and flow analysis (Haberl et al, 2004; Fischer-Kowalski and Haberl, 2007; Behrens et al, 2007) are based on a systems perspective of interconnected environmental problems.

Secondly, critics argue that the hypothetical land area generated through the EF method does not distinguish between sustainable or unsustainable land uses (Lenzen and Murray, 2001); nor are the multiple capacities of the same land category accommodated within the EF approach (van den Bergh and Verbruggen, 1999).

Thirdly, expressing the EF at 'world average productivity' allows comparison among different nations and populations, but renders the method useless for formulating regional policies which must be guided by local economic, political, climatic, technological and environmental conditions (Lenzen and Murray, 2003). Ayres (2000) also reflects on the shortcomings of the EF methodology for planning purposes at the national level, commenting particularly on its bias against trade. For instance, Ayres (2000) observes that consumption of fossil fuels accounts for a large part of a nation or region's EF.

It can be further argued that if energy were sourced from a renewable source, national EF's would exhibit a substantial reduction. The manner in which energy use and climate change is factored into the calculation is also considered problematic: emissions of greenhouse gases besides carbon dioxide are not considered; only carbon emissions from energy use are considered, not those from land clearing, enteric fermentation from livestock or industrial processes; calculation of 'energy land' is fraught with various difficulties since both 'carbon sequestration' land and 'fuel' land required to absorb emissions from and replace current fossil fuel consumption respectively does not factor in forest type, planting location and climate (Lenzen and Murray, 2003; Haberl et al, 2004). Ultimately, it is recommended that instead of including land for carbon sequestering in the EF, a greenhouse gas account should be presented alongside an EF account, especially for nations (Lenzen and Murray, 2001).

While the EF tool is generally acknowledged as a great educational tool in highlighting unsustainable consumption patterns, the aggregated forms of the index make it difficult to unravel unsustainable practices. In other words, the EF of a regional population does not provide information on where the impacts of human consumption on natural systems occur, the severity of these impacts, how they compare with the regenerative capacity of the land or water ecosystems involved or how they may be mitigated or avoided through, for instance, renewable energy and carbon sequestration technologies (Ayres, 2000; Lenzen and Murray, 2003; Lenzen and Murray, 2001).

4.2.5.4 A modified and richer EF methodology

As a result of the difficulties highlighted with using EF at scales of carrying capacity lower than global, (Costanza, 2000; van den Bergh and Verbruggen, 1999; Wackernagel and Silverstein, 2000), the methodology was modified significantly in order to calculate a comprehensive input-output based EF of populations, regions, cities, companies and nations (see Holland, 2003; Lenzen and Murray, 2003; Wiedmann and Lenzen, 2006; Wiedmann et al, 2006; Wiedmann, Lenzen and Barrett, 2007).

The modifications include the use of input output analysis, renewable energy scenarios, production layer decomposition, structural path analysis and multivariate regression in order to reveal rich footprint details (Lenzen and Murray, 2003). The modified EF gained from the natural science backgrounds of its developers but does not necessarily attend to the concerns raised by the economists (such as van den Bergh and Verbruggen, 1999; Ayres, 2000). Debate around the method therefore continues.

Short descriptions of the modifications (drawn from Dixon, 1996; Lenzen and Murray, 2001; Lenzen and Murray, 2003; Wiedmann, Lenzen and Barrett, 2007) to the EF approach are listed below:

- *The infinite upstream production tree*: in modern economies all industrial sectors are dependent on all other sectors. The process of industrial interdependence proceeds infinitely in an upstream direction through the whole life cycle of all products, like the branches of an infinite production tree. The bottom-most layer, called production layer zero is where consumption takes place in the case of a family that hypothetically consumes but does not produce food, goods, resources, energy or services. The land required by the population at production layer zero is called direct land requirement (for example, land occupied by the house, land required to absorb emissions) while the land requirements of providers of goods and services from production layer one upwards are called indirect land requirements.
- *Supply chain / structural path*: the path followed for the production of a good or service including the upstream layers of a production tree is called a structural path. For

example, a train journey taken by a family at production layer zero requires a train operator and associated emissions and land requirements at layer one, train manufacturer and associated requirements at production layer two, steel manufacturer and associated emissions at layer three and land mined for extracting the iron to make the steel at layer four. Thus, the ‘supply chain’ including iron ore for steel sheet for passenger train for train operation for train journey for a family is a ‘structural path of fourth order’. Calculations of emissions that focus only on layer zero may underestimate the complete ecological footprint of an activity or entity.

- *Input-output analysis*: complex supply chains, structural paths and indirect requirements of production layers beyond layer zero can be tackled to a large extent by using input-output analysis, a macro-economic technique developed by Nobel laureate Wassily Leontief (Dixon, 1996). Data on inter-industrial monetary transactions, usually compiled by national statistical agencies (such as the Australian Bureau of Statistics, 1996 in Lenzen and Murray, 2003) is used to calculate input-output based ecological footprints of industry sectors and product groups, for states, regions and cities and for companies and households.
- *Life cycle analysis*: allows examination of business activities beyond the physical boundaries of the entity walls (Holland, 2003). Using LCA, businesses can trace their production processes through a ‘cradle to grave’ pathway and analyse their supply chains (UNEP, 1999). Thus ecological impacts beyond a firm’s immediate influence may be analysed, requiring alliances with suppliers as a way of reducing environmental burdens along a larger part of the product’s life cycle. The challenge with a process-based LCA is the ‘boundary problem’ or the problem of incompleteness of an LCA inventory as a result of the truncation of the system by a subjectively set boundary (Wiedmann, Lenzen and Barrett, 2007). An arbitrary boundary to an LCA may hide critical upstream impacts from decision makers.
- *Incorporating climate change*: disturbance-based approach can also be used to measure ‘emissions land’ in order to produce a single-point indicator which incorporates the climate change impact of greenhouse gas emissions (Lenzen and Murray, 2001). Temperature and sea level rises and therefore disturbance to natural ecosystems resulting from the emissions of a certain population can be projected although with high uncertainty.

Lenzen and Murray (2003) state that despite the above modifications, the consumption-focused current EF method does not incorporate the EF of imported commodities, for which a multi-region EF framework may need to be compiled; or address the sustainability of regional land-use which is related more to the fragility or resilience of local ecosystems than to the intensity of land-use.

4.2.6 Two methods for calculating the EF of a business

The EF technique is explored by various authors as an alternative to broad-based management approaches such as environmental management systems and environmental accounting which assess in monetary units and may focus solely on pollution or emissions (see Holland, 2003; Simmons and Chambers, 1998; Chambers and Lewis, 2001; Wiedmann, Lenzen and Barrett, 2007). EF is used for internal measurement and external communication of sustainability performance and for consensus-building at strategy level. By assessing how much of the biosphere is required to maintain a business' activities, a link between the micro scale of an individual firm and its impact on the regional and global (macro) environment is made possible (Chambers and Lewis, 2001). The extension of EF methodology to firms or companies draws on engineering-based assessment techniques such as life cycle impact analysis, material and energy flow analysis and mass balance methodology.

Two methodologies for calculating the EF of an establishment are found in the literature. The first approach builds upon the original EF methodology as developed by Wackernagel and Rees (1996, 1997) and focuses on direct impacts, using information available in a business' existing systems (see for example, Simmons and Chambers, 1998 and Chambers and Lewis, 2001). The first step in this methodology involves establishment of a service unit such as EF value per ml or kg of product or EF value per unit of service such as a consultancy project. Following this, data scoping and data collection is required to assemble a footprint table and calculate a company's EF per service unit. The main strength of this approach lies in developing future scenarios of consumption projections based on current energy, transport, land, material and waste data in order to choose more sustainable business trajectories.

The second approach builds upon the modified EF methodology (Lenzen and Murray, 2001) using national input-output analyses to calculate an EF which incorporates structural-paths, unravels the supply chain and allows decomposition of indirect impacts. Researchers at the Centre for Integrated Sustainability Analysis, University of Sydney have developed a software tool called Bottomline^3 (cubed). Triple Bottom Line reporting (TBL) concepts and frameworks have been propagated through the Global Reporting Initiative (GRI 2002, 2006), while firms increasingly choose the EF or the carbon footprint as indicators of their environmental impacts (Wiedmann, Lenzen and Barrett, 2007). Bottomline^3 was developed to address the lack of quantification in sustainability reporting (such as TBL) as well as a limited understanding by companies of the effect of their upstream supply chains on the environment. The software tool allows consistent quantification of indirect TBL impacts that can be attributed to individual supply chains (Wiedmann and Lenzen, 2006). The software uses the company's financial accounts main source of information, supplemented by on-site fuel and land use data.

The second approach to calculating the EF for businesses is especially relevant when indirect impacts from upstream supply chains are significant. Management can then demand reduction in impacts at higher order production layers. Supply chains and structural paths are what bind an individual establishment to the rest of the economy and society as a whole through flows of energy, materials, products and waste. Therefore, while the EF remains a purely environmental indicator (one that does not address equity or fair trade practices irrespective of the modifications), the second approach at least begins to engage with the environmental impact of a larger section of the society than just the establishment.

4.3 Industrial Ecology

Ropke (2003) observes an interesting and parallel development typology in the field of industrial ecology (IE from here on) that shares several roots with EE. While EE is based on the notion that the human economy is embedded in nature, and economic processes are also always natural processes in the sense that they can be seen as biological, physical and chemical processes and transformations (Ropke, 2003), industrial ecologists systematically analyse the interactions between human activities and their physical and chemical impacts on the environment (Socolow et al, 1994). Both methods of enquiry and analysis seek sustainable development.

4.3.1 Intellectual underpinnings

At a conceptual level, IE can be understood as one of four ways in which industry (or technology), environment and society may interact in order to achieve global sustainability (Graedel and Allenby, 1995). The four options are radical ecology, deep ecology, industrial ecology and continuation of the status quo, each with a different view on the role of technology in the transition to a sustainable world. Within this framework IE is offered as part of a techno-optimistic vision of a sustainable future, requiring substantial adjustments to current economic and cultural systems, with great emphasis on technological evolution or green engineering that enables pursuit of current industrial activity within environmental constraints (Brent et al, 2008; Graedel and Allenby, 1995).

In the words of Thomas Graedel, the pioneer of IE, it is an ensemble systems-oriented concept which requires that the human industrial system be viewed in concert with the surrounding environmental, economic, cultural and technological systems (Graedel and Allenby, 1995). Powerful metaphors are employed to change currently unsustainable production systems into sustainable systems. Human industrial systems are seen as embedded in the natural ecosystem, requiring at a minimum, optimisation of total materials and energy cycles in industrial processes and lessening impacts through waste minimisation and recycling (Frosch and Gallopoulos, 1989; Graedel and Allenby, 1995; Garner and Keoleian, 1995).

The biological metaphor views industrial systems, like biological ecosystems, as made up of consumers, digesters and excreters of energy and materials (Graedel, 1994). Central to the IE philosophy is the idea of industrial systems emulating more efficient and sustainable natural ecosystems even as IE proponents recognize that the analogy is not perfect (Frosch and Gallopoulos, 1989; Graedel and Allenby, 1995). Three types of biological ecologies represent linear, quasicyclic and cyclic material flows (Graedel, 1994).

Current industrial systems typically exhibit type I or linear behaviour whereby materials are degraded, dispersed and lost to the economic system after a single use (Ayres, 1998). The biological metaphor encourages industrial systems to change from linear material flows to quasicyclic to cyclic or closed processes such as those found in natural systems, achieved in part by substantially decreasing resource inputs, increasing the flows within the four main nodes (the materials extractor or grower, the materials processor or manufacturer, the user and the scavenger who could be a first stage materials processor or recycler) and within the industrial ecological system as a whole and ultimately rejecting the idea of waste in type III ecological behaviour (Socolow et al, 1994; Graedel and Allenby, 1995).

4.3.2 Industrial metabolism

The word 'industrial' in IE extends beyond industrial complexes and manufacturing and refers more generally to how humans use natural resources in the production of goods and services including agriculture, forestry, urban infrastructure and businesses.

Up until the Global Change Group met in Snowmass in 1994, ‘industrial ecology’ and ‘industrial metabolism’ had parallel but slightly different meanings. IE emphasized the industrial firm as agent of change while industrial metabolism referred to the totality of civilization (Socolow et al, 1994). At the Snowmass Institute, IE was deliberately launched as a field with an extended meaning, within global change research. In its current definition and understanding, IE is concerned about the activities of *all* entities within the industrial system and individual firms become components of a larger industrial ‘ecosystem’.

Industrial metabolism meanwhile has contributed to the development of another stream of thinking and research called societal metabolism. The correlation between industrial ecology and industrial metabolism is another avatar of the macro-micro debate. Human industry including manufacturing, agriculture, the health sector, transportation and materials processing produces wastes at local or regional level such as numerous pesticides, PCBs, prescription drugs, industrial solvents, mine wastes, various components of plastics; and mercury, cadmium, lead, and other heavy metals, which now have nearly global distributions (Ehrlich and Ehrlich, 2008).

4.3.3 Environmental science and IE

The application of the above metaphors aids industrial engineers in studying the flows of selected materials within modern economic processes through supply chains and structural paths and analyse the factors which influence these flows. Such analysis involves the application of life cycle analysis (LCA) and material flow accounting (MFA). MFA is firmly established as an influential region-specific framework for quantifying the use of natural resources such as wood, energy or water and man-made materials such as steel, by modern societies (Behrens et al, 2007). A combination of IE tools and environmental science expertise is applied to problems at the scale of societal consumption and production processes, discussed below.

4.3.3.1 Mapping global nutrient cycles and planetary thresholds

A combination of MFA and geochemical techniques allows simplified quantification of global cycles of nutrients such as carbon, nitrogen, phosphorous and sulphur in their natural and perturbed forms (Socolow et al, 1994; Graedel and Allenby, 1995; Rockstrom et al, 2009). Earth system budgets or flow analyses are traditionally investigated by environmental scientists; however once the industrial component of a flow becomes substantial, the industrial engineer acquires a comparable role (Graedel and Allenby, 1995). Ayres, Schlesinger and Socolow (1994) combine geochemical and IE techniques to model stocks and flows of carbon dioxide and nitrogen among various reservoirs such as life forms (living and dead plants and animals or biosphere), the soil (or pedosphere to an ecologist), the oceans and other water bodies, the atmosphere and rocks. Creation of a world systems model on climate change with global warming scenarios based on regional flow analyses of carbon dioxide is also an application of MFA.

As the understanding of earth system science deepens, scientists have been able to quantify the ‘safe operating space for humanity’ or planetary boundaries for seven of nine earth system processes including climate change and the biogeochemical nitrogen cycle (see Rockstrom et al, 2009). The latest study supports the arguments of the earlier paper by Ayres and colleagues (1994): while there is greater public interest and research on climate change (for instance IPCC, 2007), humanity’s transgression of the planetary limit on nitrogen cycle perturbation is far more profound than that of the carbon cycle (Rockstrom et al, 2009). Climate change is a systemic change at planetary scale while the flows of nutrients such as nitrogen and phosphorous are aggregated processes (Ayres, Schlesinger and Socolow, 1994). And even as the boundary for nitrogen cycle perturbation is difficult to establish, transgressing one boundary may shift other boundaries and cause those to be transgressed (Rockstrom et al, 2009). Ayres, Schlesinger and Socolow (1994) call for strong policies against fertilizer use, a critical source of nitrous oxide emissions which has not received sufficient attention. They recommend development of nitrogen utilisation efficiency methods and technologies at a scale similar to the search for energy efficiency and renewable energy solutions.

When ecological economists define land equivalent of energy as the forest area required to grow biomass for equivalent fossil fuel and/or the forest area required to absorb carbon dioxide emissions from fossil fuel use (Wackernagel and Rees, 1996), they fail to incorporate the difference in biogeochemical processes, or starkly dissimilar impacts on global nutrient cycles involved in fossil fuel use and forest transpiration. IE practice incorporates latest environmental and earth system science research, in order to design processes that do not solve one problem by creating another.

While the dominance of engineering aspects of IE has been critiqued (Korhonen et al, 2004; Korhonen, 2008) and although huge knowledge gaps still exist within earth system science (Ayres, 1989; Rockstrom et al, 2009), efforts at quantifying human additions to the pre-industrial global cycles carries important messages for political and technological responses to global change. Possible strategies that arise from an analysis of human modifications to global carbon and nitrogen cycles include substituting plant matter or biomass for fossil fuel through a bio fuels industry based on renewable plantations and finding substitutes for fertilizer use (Socolow et al, 1994). Furthermore, researchers such as those at the Rodale Institute recommend low-tillage farming and organic management of soil in order to convert agricultural land into a carbon sink rather than a source of greenhouse gases (LaSalle and Happerly, 2008).

4.3.3.2 Prioritization of environmental impacts

Advanced IE can motivate product and process design that eliminates many impacts of industrial activity (Graedel, Horkeby and Norberg-Bohm, 1994; Graedel and Allenby, 1995). However, at some point choices between impacts have to be made. IE relies once again on the community of environmental scientists and their findings to assist in the ranking of global human health and ecological concerns. Although environmental scientists are more likely to study and model the impacts of individual hazards and earth system scientists to map individual global processes than to rank them, systematic efforts to compare impacts at different scales have been made. Graedel, Horkeby and Norberg-Bohm (1994) provide a useful summary of three different approaches, each using different parameters and degrees of quantification for ranking environmental problems.

Based on an initial ensemble assessment of impacts causing global change, Graedel (1994) makes the following IE recommendations relevant to manufacturing operations:

- Complete elimination of toxic substances in wastewater and elsewhere (as mentioned under the EF discussion, such substances are not even included in footprint calculations since they cannot be assimilated by the ecosphere)

- Maximum minimization of air emissions especially CFCs (ozone depletion), volatile organic carbon and sulphur and nitrogen oxides (greenhouse warming)
- Minimization of energy use in manufacturing and during the life of products (atmospheric impacts through greenhouse gas emissions and during extraction of fossil fuels)
- Reduction of solid waste from manufacturing processes
- Design for disassembly and reuse of materials following product obsolescence

Food production, as opposed to industrial activity is potentially sustainable (Graedel, 1994). However, current levels of resource inputs in the form of fossil fuel use, agrochemicals and water use require an overhaul of the sector if sustainability is to be achieved. Most of the above recommendations are adaptable to other sectors such as agriculture and corporate operations, and reappear as life cycle management principles (UNEP, 2007).

Graedel (1994) reminds us that the challenging part about ranking environmental hazards is that often an environmental impact will be caused by several sources, sometimes cumulative, and that a single source will often have more than one impact. An IE matrix template is a data presentation technique which attempts to bring together all the factors that IE considers, allowing comparative evaluation of different design and material options across all life-cycle stages (Graedel and Allenby, 1995). Matrices as opposed to detailed quantitative tools provide an overview of the main issues highlighting function specific threats and opportunities and are therefore easier to interpret by a range of scientific and non-scientific stakeholders of a production process, including regulators, industry representatives, the academic community, interest groups and professional bodies (Wrisberg et al, 2002).

In the following sections some of the concepts inspired by the IE thinking and tools employed by industrial ecologists such as LCA and material and energy flow accounting are outlined and critiqued.

4.3.4 IE-inspired management concepts

IE as a branch of analysis evolved into more than quantification techniques to yield management concepts and principles. At the level of a manufacturing plant, IE is offered as a potential umbrella for sustainable development strategies such as pollution prevention, total quality environmental management and cleaner production to reduce environmental impact (Garner and Keoleian, 1995). At a regional level, the larger industrial ecosystem has the potential to transform through IE methods such as dematerialization and eco-efficiency.

4.3.4.1 Dematerialisation from an industrial metabolism and product minimization perspective

Based on a thorough review of current literature in the field, Brent et al (2008) consider dematerialization, with its suite of analytical tools and technological innovations for green engineering, as one of two key elements of IE (the other being industrial ecosystems or the establishment of islands of sustainability such as eco-industrial parks). The underlying belief is that the quality of a service can be increased while material and energy inputs are reduced through an increase of resource efficiency by Factor X, a synonym for this concept (Wrisberg et al, 2002). In this format dematerialization has policy implications for region-oriented systems change (Brent et al, 2008). For instance, it has been suggested that resource requirements be reduced and where reduction is not possible, a 4 to 10-fold resource efficiency be achieved in developed economies within 30 to 50 years so as to half global resource requirements (Von Weizsacher et al, 1997; Swilling, 2007). Another component of this regional service economy vision of dematerialization is residue streams from one industry becoming resource streams for another sector, requiring a recasting of industrial metabolism. This may require a new set of technologies elaborated in the Decoupling study issued by the Working Group on the Scientific Understanding of Decoupling and Resource Productivity and Related Policies and Methodologies (Management, I.P.F.S.R. 2008).

Reduction in the size of electronic equipment, changing from copper wires to optical fibre cables as well as manufacture of lighter yet higher-strength automobiles are modern examples of dematerialization at product-level (Graedel and Allenby, 1995). One of the constraints on dematerialization in this form is that many industrial products are directly related to human size and any further reduction in size will render them worthless (Graedel and Allenby, 1995). Further research in materials science (in search for lighter yet longer-lasting components) and increased recycling and refurbishing of products and materials to replace resource extraction, with its huge environmental costs, are areas where efforts are being spent to achieve dematerialization.

4.3.4.2 Eco-efficiency and its limitations

Eco-efficiency, a management term with its roots in IE principles was coined by the WBCSD in 1992 (Holliday et al, 2002). The WBCSD defines it as ‘the delivery of competitively-priced goods and services, that satisfy human needs and bring quality of life, while progressively reducing ecological impacts and resource intensity through-out the life-cycle, to a level in line with earth’s carrying capacity’. Increased eco-efficiency means a quantitative reduction of wastes and emissions of production per unit of output costs, including use of less raw materials and fuels through cleaner technologies[6] and clean production systems (Korhonen, 2008). At a stretch,

[6] Cleaner production or cleaner technology is a concept used specifically in the manufacturing and processing industries for avoiding pollution and waste at source (Wrisberg et al, 2002). Clift (1995) defines it more broadly, as a means of providing a human benefit while overall using less resources and causing less environmental damage than alternative means with which it is economically competitive. UNEP (1996) views this approach as a means of promoting eco-efficiency which requires responsible environmental management and evaluation of technological options. As a concept it is quite specific in its scope of ‘preventing environmental impact’ and was a key driver for environmental policy during the

eco-efficiency encompasses the goals of both dematerialization and decarbonisation or energy efficiency[7].

Eco-efficiency incorporates the goal of sustainability but faces the danger of becoming a large, broad goal itself; much like sustainable development. An incisive critique of eco-efficiency on eight critical fronts is tackled by Korhonen (2008). Eco-efficiency as a weak form of ecological modernization (Korhonen, 2008) does not require structural change to or even substitution of current technological, cultural and economic systems. In its adoption by the environmentally responsible corporations, eco-efficiency does not retain the critical links with ecology which IE has. Biodiversity, ecosystem continuance, material and energy flow types and types of pollution generated are some of the qualitative issues absent from eco-efficiency (Korhonen, 2008). Finally, considering the convergence within sustainability thinking that a transition to a sustainable world would require a radical or structural change to the current systems of production and consumption, eco-efficiency may have a specific role as a first step in the transition phase (Korhonen, 2008).

The IE-related concepts discussed above provide ideas on how to achieve or progress towards sustainability. A concept could engender an achievable vision for sustainability but will require operational methods for implementation. In the next section, relevant analytical tools are reviewed, which assist in the adoption of corporate practices for environmental sustainability.

4.3.5 Analytical tools for decision support

This section covers two analytical tools with their roots in IE and environmental management studies: life cycle analysis or LCA and material flow accounting or MFA. LCA has generated a sizeable community of LCA analysts and practitioners over the last two decades. MFA as a concept and a framework for sustainability analysis has evolved significantly within sustainability science. Both tools focus on an analysis of physical flows.

4.3.5.1 LCA as a system tool

LCA as life cycle assessment can be understood as a family of methods or a protocol for looking at the environmental, economic and technological implications of products, processes,

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seventies and eighties (Wrisberg et al, 2002). Therefore, it cannot become the overarching corporate strategy for achieving sustainable development.

[7] In monetary terms energy efficiency is different to conservation of energy. Conservation is simply saving by using less energy while efficiency requires some form of spending in order to result in a future saving, a motivation; for instance, spending on subsidies in order to motivate installation of solar heaters. Energy efficiency as a concept emerges out of energy studies with an engineering approach, and comes equipped with scientific models and equations for reducing energy consumption for every unit of utility. At a regional or national level, the goal of energy efficiency would require large scale investments in areas such as research and development, setting up of a new industry that provides energy efficiency services and funds that incentivize energy efficiency projects (Zhenping, 1994).

materials and services over their entire life-span, from creation to waste, or reuse (cradle to grave, or cradle to cradle) (Graedel and Allenby, 1995).

Generation of aggregate consumption indicators such as ecological footprints of nations and companies and carbon footprints of consumers and entities are some of the latest applications of LCA, the most prominent and widely used process engineering tool to emerge out of IE practice. In its early days, LCA was used as a first step to identify problematic points in a chain, when companies or manufacturers decided to reduce their environmental impacts. There are many variations of the methodology but primarily, the tool consists of four stages: scoping, inventory analysis, impact analysis and improvement analysis (Graedel, 1998). Goal and scope definition prior to inventory analysis is critical and will depend upon the purpose of the study, the level of improvement or change required (whether it is at the level of redesign, functional innovation or system change), linked to that the complexity of system change, the aspirations of the decision maker as well as the resources that can be applied to the analysis (Graedel and Allenby, 1995; Graedel, 1998; Wrisberg et al, 2002).

Part of the scoping process is the definition of system boundary which depends on the level of influence a company has beyond its gates and data availability on upstream and downstream processes. The inventory analysis stage is the most intensive in terms of data collection requirements, especially if the analysis is process based. Over the years LCA has also evolved from being a purely process based analytical tool to Input-Output (IO) based and hybrid based. A detailed overview of the different advances in conducting an LCA is covered by Udo de Haes et al (2004). In particular, difficulties associated with including the spatial and temporal characteristics of processes that occur all over the world, as is the case with global production systems, is captured by Udo de Haes and colleagues (2004). Korhonen (2008) does not consider this a limitation of LCA as a tool, but rather a feature of the global product life cycle which is arguably difficult and costly to monitor and control. Therefore, instead of developing more complicated analytical tools that can model the complexity of reality, Korhonen (2008) calls for a systems change to localized product life cycles which are easier to govern and manage.

Finally, some of the challenges associated with a wider use of the tool, especially in developing countries are time and resources required for the data collection phase, and ambiguity around relative benefits versus costs of conducting the process (Cooper and Fava, 2006). One of the ways of tackling the complexity of LCA is by providing software and developing connected inventory databases at regional or global levels (Wrisberg et al, 2002). Generic databases include industry averages on resource consumption and emissions to support LCA type tools. Customized LCA such as ecopoints or eco-indicator, or checklists are also less demanding as compared to an ISO 14040 LCA (Wrisberg et al, 2002). In fact, a survey on the use of the tool found heavy reliance on the growing LCA computing infrastructure such as GABi, SimaPro and TEAM to name a few, among LCA practitioners (Cooper and Fava, 2006). It must be noted however, that published databases from developed countries may not conform to resource consumption patterns of developing country industries, which may also not have the resources available to generate their own sector-specific inventory databases.

Matthews and Lifset (2007) argue that the field of LCA with its focus on improving quantitative methods has much to gain from retaining synergies with IE where the emerging focus is on application of tools and concepts to real life problems. The cradle to grave approach encourages companies to look beyond their gates, upstream and downstream at their suppliers and users and their production and consumption choices, thus inspiring 'life cycle thinking'. In this form LCA, primarily a 'process improvement tool' finds application as a 'sustainable management principle', fitting in neatly with the eco-efficiency goal.

4.3.5.2 Material flow accounting

Material flow accounting (MFA) has been established as an influential region-specific framework for quantifying the use of natural resources by modern societies (Behrens et al, 2007). Tools in the MFA family specify the flows of materials in and out through the economy of a certain country or region over a given period of time (Graedel and Allenby, 1995). As a tool for environmental design and systems management, MFA can also be applied to a community, an industrial sector, business or household. MFA analysts will indicate whether material or energy flows are their object of analysis (Bringezu, 1997). Industrial flows and stocks can then be linked to environmental flows in order to ascertain the extent of anthropogenic disturbance to natural budgets (Graedel and Allenby, 1995) and to establish the driving forces of pollution problems and resource requirements (Wrisberg et al, 2002).

MFA methodology can be applied to analyse the flow of bulk materials such as steel, wood or total mass through an industrial system. Bulk material flow analysis or b-MFA at the company level may provide complementary information to allow eco-efficient process control and to design sustainable supply and waste management systems (Wrisberg et al, 2002). MFA can also be used to study the flow of a single substance or a group of substances associated with a specific environmental effect. Examples of substance flow analysis include quantitative studies of for instance lead, cadmium or mercury through the industrial and environmental systems allowing individual establishments such as a farm to account for their mineral inputs and outputs (Wrisberg et al, 2002). Such accounts help identify major sources for certain materials (such as phosphate or nitrogen from agrochemicals) and guide management decisions towards environmental impact reduction.

MFA is the only tool that has recently entered into dynamic modelling of time paths; all the other tools for environmental analysis of a product, process or service including LCA are static or model a steady state path (Wrisberg et al, 2002). One of the off-shoots of the dynamic application of MFA is the Material and Energy Flow Accounting framework or the MEFA framework. MEFA is based on the notion of socio-economic metabolism, which is an extension of industrial metabolism (Ayres, 1998) and is discussed in more detail in Chapter 6.

4.3.5.3 Combination of tools for environmental decision making

The search for a super-tool that incorporates all relevant questions and provides analysis across spatial and temporal scales is deemed unnecessary and impossible (Udo de Haes et al, 2004; Wrisberg et al, 2002) when tools can be used in combination to avoid problem shifting. The weakness or limitations of one tool can be overcome by using it in combination with other tools. For instance, LCA does not incorporate site-specific data; MFA is more applicable to modelling, while energy accounting has limited formal recognition (Wrisberg et al, 2002). However, integration of information from different tools may not be technically possible since tools can be function or region-oriented (Wrisberg et al, 2002). The solution to the challenge of combining tools therefore lies in looking outside of the domain of the supply side of environmental tools and considering what decision makers require from the demand side.

Viewing IE related tools from the demand side of environmental decision-making sets the stage for the last section drawn from this field. An emerging research agenda within IE explores the links between the engineering and natural science aspects of IE and the corporate management and public policy issues of sustainable development (Korhonen et al, 2003), also termed the integration of hard ecology with practical ecology (Hermansen, 2006).

4.3.6 Attempting an integrated and interdisciplinary research agenda within IE

A challenging aim to realize for IE is the full integration of natural and social science perspectives in order to truly contribute towards the achievement of sustainable development. While IE metaphors and tools used to steer and measure progress towards sustainability are derived from the natural and engineering sciences, practitioners realise that it is societal actors such as employees, managers or consumers in firms, government departments and households, who drive the physical flows of materials and energy (Boons and Roome, 2001). IE tools such as LCA, MFA and EFA which describe industrial metabolism and its environmental impact are admittedly inadequate especially when societal change in consumption and production patterns is sought (Korhonen et al, 2004). At this point, a cross-over of concepts and frameworks from the social sciences including organisational theory and rational choice theory is sought in order to position IE as environmental management, with the extension of LCA into LCM as a successful example.

An attempt at integrating natural and social science perspectives in IE was kick-started with an international symposium on the theme of Business and Industrial Ecology as part of the 2003 annual Business Strategy and the Environment Conference in Leicester, UK. Themes and issues that were identified as important in linking IE to management and policy studies through future research efforts are noted below (Korhonen et al, 2004):

- *Inter-organisational management for the rerouting of flows of matter, energy and information in complex production-consumption networks*. To this end stakeholder management theory is highlighted. In the IE context, stakeholders are many, including neighbours, NGOs and in industrial recycling networks, other organisations and firms that participate in waste utilisation. IE is thus offered as environmental management in inter-organisational networks which go beyond the tools of MFA and LCA applied to individual firms. Within this theme, LCM or life cycle management is identified as a source of strategic business management policy. LCM is the successful conversion of an analytical inventory-based impact-assessment tool into an organisational management framework and often software.

- *Development and management of industrial ecosystems* is aimed at the second key element of IE: establishment of islands of sustainability at industrial zone or regional level. This area of research focuses on different means of realizing the biological metaphor of IE. Two main approaches are offered: an example of the first is the extended producer responsibility (Ehrenfield, 2004) which couples public policy directives with individual incentives; the second approach looks at the role of local authorities in eco-industrial development serving as institutional anchor tenants (Burstrom and Korhonen, 2001).

- *IE as a vision and source of inspiration for management strategy*: The last area that needs further research based on the papers from the Business and IE symposium, in order to further ‘practical ecology’, is ‘soft ecology’ (Hermansen, 2006). Piece-meal and non-strategic application of IE by organisations can be counter-productive. For instance, measures such as eco-efficiency are known to have unintended outcomes through the rebound effect (Berkhout et al, 2000) or Jevons paradox (Jevons, 1990) which states that efficiency will increase consumption because of the desires inherent in human nature.

  The fact that IE, like sustainable development can be conceptualized in different ways through different ideological positions (Sneddon et al, 2003), means that the concept can be hijacked (Welford, 1997). For instance, there are known cases of local authorities in the United States using the notion of eco-industrial parks for place promotion (Korhonen et al, 2008). This particular research focus would uncover whether the ecosystem metaphor in IE has yielded radical new ideas and an alternative to the dominant paradigm of neoclassical modernity and business management.

The above targeted interventions into the cross-fertilisation of management approaches with IE thinking has contributed directly towards current research focus in the field, as exemplified by a South African study. One of the burning issues investigated was whether a private company or a local government department is more appropriate as a lead agency in achieving the type III industrial ecosystem vision (Brent et al, 2008). Limited success of industrial symbiosis[8] projects launched by local or regional authorities was noted. Cases were found locally where a development is called an eco-industrial park (EIP) without any description of IE principles such as the Capricorn Park near Muizenberg and an EIP between Pretoria and Hartbeespoort (Brent et al, 2008). Research efforts focused on reviewing and promoting best practice of industrial symbiosis are recommended in order to institutionalize the field in South Africa (Brent et al, 2008).

4.4 Linkages with the research focus

An investigation into the two complementary streams of EE and IE yields various concepts, initiatives and practices towards ecological sustainability, some ready for adoption by sustainability-oriented businesses. This section of the chapter summarizes application areas and analytical tools from the two fields; explains how EE and IE generate the scientific and intellectual roots for corporate citizenship concepts and carbon assessment tools; and presents a framework for assessing a business against best environmental practices, derived from the literature review of the two fields covered in this chapter.

4.4.1 Application areas, tools and impacts

Table 4.1 Summary of application areas and analytical tools from ecological economics and industrial ecology

Discipline	Application area	Analytical tools	Socio-ecological impact
Ecological economics	Definition of sustainability in ecological-economic terms	Indicators for 'strong' and 'weak' sustainability	Decoupling of economic development from natural resource consumption
		Principles for strong sustainability	
	Economic analysis of ecological problems	Valuation of ecosystem services	Constancy of renewable natural capital
		Ecological-economic modelling	
	Analysis of	Ecological footprints of nations	Equitable trade

[8] The prime and the most cited example of industrial symbiosis in action is the Kalundborg industrial park in Denmark since the early 1990s (Garner and Keoleian, 1995).

	international trade incorporating ecological costs	Material and energy flow analysis	practices
	Bio-diversity and ecosystem conservation	Ecological-economic modelling	Balancing human-environment interactions
		Trans-disciplinary methodologies	
		Case-study approach	
	Triple bottom line reporting	Ecological footprints of individual businesses	Measuring progress towards sustainability
		Water footprint of a business	
Industrial Ecology	Optimisation of resource consumption in industrial processes	Product / process life cycle analysis	Industrial activity within environmental constraints
		Total material and energy requirements accounting	
		Supply chain management	
		Life cycle costing	
	Eco-industrial parks	Closed cycles of use and re-use	Industrial systems exhibiting ecological system behaviour
		Design for environment	
		Waste minimisation	
	Mapping global nutrient cycles (with environmental scientists)	Simulation of material and energy flows through natural and industrial processes	Establishing planetary thresholds
	Prioritization of environmental hazards (with environmental scientists, material scientists and ecologists)	Qualitative matrix template	Industrial activity with reduced environmental impact
		Environmental impact assessment	
		Environmental Management System	
	Eco-efficiency	Clean production, clean technologies	Dematerialisation and decarbonisation
		Resource productivity	
		Energy efficiency	
		Product re-design	

4.4.2 Intellectual roots for corporate citizenship concepts and carbon assessment tools

EE has generated key concepts such as constancy of renewable natural capital as a basis for comprehending economic transactions in terms of ecological costs and benefits, which in turn laid the foundation for a range of sustainability indicators. In addition, investigation of EE literature provides the intellectual roots for various conceptions of corporate sustainability such as Natural Capitalism and Triple Bottom Line thinking. Of the numerous EE tools and methodologies available, it is primarily the ecological footprint as a metric of consumption, underpinned by the human carrying capacity concept, which has been honed to the level of corporate sustainability reporting.

The ecological footprint methodology has clear links with carbon footprint methodologies, as can be discerned from the literature review under section 4.2.6, which covers two methods for calculating the EF of a business. The two methodologies have direct co-relations with different scopes (1, 2 and 3) calculated within carbon footprint assessments of a product or entity, which are covered in more detail in Chapter 5. In the first method for calculating a business' EF, direct impacts are covered, which are also the basis for calculating scope 1 carbon emissions. The second methodology, using input-output analysis incorporates indirect impacts, which are also included for calculating scope 2 and 3 carbon emissions.

IE, based on a systems ecology metaphor for transforming industrial processes, generates several ideas for inspiring innovations aimed at corporate environmental sustainability, such as eco-efficiency, dematerialisation, cradle to grave approach and life cycle thinking. In addition, IE offers a range of analytical tools to assist in the transformation of production processes and product designs towards lower material and energy consumption. The regional flow analysis of carbon dioxide, based on which climate change models are built, is a type of material flow analysis. Studies of global thresholds warn us that humanity's transgression of the planetary limit on nitrogen cycle perturbation is far more profound than that of the carbon cycle (Rockstrom et al, 2009; Ayres, Schlesinger and Socolow, 1994).

Some of the latest applications of LCA are aggregate consumption indicators such as ecological footprints of populations and carbon footprints of products. IE practitioners advise us that the search for a super-tool that incorporates all environmental impacts as well as all spatial and temporal scales is deemed unnecessary (Udo de Haes et al, 2004; Wrisberg et al, 2002) since environmental tools can be used in combination with other tools. Therefore, carbon footprint as a proxy indicator of anthropogenic climate change can be used with additional indicators in order to develop a wider profile of an entity's environmental impact. The research agenda can then interrogate whether the goal of carbon neutral has yielded radical new ideas and an alternative to the dominant paradigm of business management.

4.4.3 Framework for assessing corporate environmental practices

IE practitioners have made significant advances in mapping an entity's environmental performance, with IT-based tools such as Eco-indicator and GABi software readily available and adopted, at least in the global North. While these tools bring consistency to performance measurement, the substance is often lost in the micro-detail. Therefore, a set of best corporate practices is drawn up, based on the principles for strong sustainability (Graedel, 1994) and derived from life cycle assessment and management principles (UNEP, 1999; 2007), at a level applicable to a medium-sized business.

Table 4.2 Framework for assessing a business against best environmental practices

Corporate performance area	**Best practices for environmental sustainability**
1. Water sustainability	• Complete elimination of toxic substances in wastewater • Reliable measurement of water consumption • Re-use of treated wastewater for irrigation • Optimal usage of rain-water catchment on the site • Optimal usage of fresh water on the site (municipal supply)
2. Waste minimisation and recycling	• 100% separation and recycling of paper, plastic and glass waste • 100% separation and recycling of organic waste • Continuous reduction in the use of non-recyclable materials towards complete elimination in production/consumption processes
3. Re-design of production processes	• Design for disassembly • Reuse of materials • Complete elimination of toxic substances during production processes • Green procurement (towards lower impact materials and products)
4. On-site nature conservation	• Biodiversity conservation • Endogenous tree planting • Integrated pest management
5. GHG emissions reduction	• Emissions calculation • Energy auditing • Energy efficient lighting • Solar water heating

	• Generation or use of renewable energy • Phasing out of refrigerant gases
6. Sustainability reporting	• Third party accreditation • Reporting standards for each of the 3 areas of economic, social and environmental performance • Recognised tools for measuring progress towards sustainability (e.g. ecological footprint, carbon footprint, material and energy flow analyses) • Comparability of data and information over the reporting period

The section on GHG emissions reduction is discussed in further detail in Chapter 5 on Carbonology. Sustainability reporting is included in the above framework as it assists businesses and their stakeholders to measure a business' progress towards sustainability. Therefore, tools such as carbon footprints and water consumption matrices acquire significance in that they allow year-on-year comparison of reduction in environmental impact through the five areas of best practice. Empirical studies of environmental practices in the wine industry focus on measurement and monitoring of environmental impacts as one of three key components of an environmental management system (EMS) that were achievable for smaller firms and relevant in the New Zealand and United States wine industries. The other two components are energy use reduction and recycling of materials (Marshall et al, 2009; 2005).

4.5 Conclusions: gaps and links with Chapters 5 and 6

EE and IE offerings take us far in unpacking the techno-optimistic worldview, linked to a range of best practices for environmental sustainability, which corporate strategies for a lower carbon future. In particular, the ecological footprint is a predecessor to the more commercially adopted carbon footprint. Clear similarities are found between the modified ecological footprint (Lenzen and Murray, 2003) and carbon footprint calculation methodologies. Life cycle thinking or life cycle assessment, used in both EE and IE tools for impact assessments of nations, processes and populations, underpins the LCA-based carbon footprint analysis of global products. Chapter 5 reviews definitions, standards and corporate strategies which support carbon footprint assessments and carbon reduction drawing on EE, IE and LCA literatures.

The modified and richer ecological footprint (reviewed in section 4.2.5.4) uses the infinite upstream production tree as a metaphor; introduces supply chains, structural paths and LCA; and attempts to incorporate the effects of climate change. Limitations of the modified EF include the inability of the method to incorporate fragility or resilience of local ecosystems, a concern which is taken up in the industrial metabolism discourse, but not at the level of a single business.

The review of EE and IE literatures also generate the intellectual roots for several terms used in corporate citizenship frameworks such as eco-efficiency, natural capital and life cycle management. However, with reference to the first thesis objective, the concepts and tools studied in this chapter do not assist in understanding corporate behaviour, especially when principles such as eco-efficiency and life cycle management, fail to produce the expected results. EE and IE do not offer us any theories to identify organisational or external drivers of sustainability-oriented corporate behaviour.

The attempts at integrating natural and social sciences within IE especially points to the hitherto engineering focus of IE, underpinned by metaphors from biology and ecology, with insufficient attention paid to the behavioural and human components of industrial systems. Symposia intended for a reform in IE should alert researchers to the growing need felt among the ‘sustainability community’ for a more integrated approach, which begins with a combined focus on all aspects of the ‘sustainability challenge’. This gap was in fact addressed by new thinking around social-ecological systems, exhibiting features of complex adaptive systems, which led to the birth and launch of a new discipline called sustainability science.

Chapter 6 reviews theoretical constructs such as resilience and complexity, which are derived from the study of ecosystems and have been transferred successfully to understand the behaviour of institutional systems.

Chapter 5: Carbonology: the study of definitions, standards and corporate strategies surrounding the concepts of ‘carbon footprint’ and ‘carbon neutral’

5.1 Introduction

Lower emissions require several environmental and technological innovations at various fronts, reflected in the recent impetus in the application of science and technology for sustainable development (Holdren, 2008; Fiksel, 2006; Turner et al., 2003; Kates et al., 2001). The quest for a lower carbon status by a business needs to be underpinned by an awareness of academic knowledge areas and at the same time, keep abreast of recent environmental and technological advancements.

This chapter delves into the definition of carbon neutral, carbon footprint and related terms and their refinement along the years through application; recently established industry standards for calculating the carbon footprints of goods and services; and an overview of commonly promoted corporate strategies for mitigating and off-setting greenhouse gas (GHG) emissions.

The chapter builds on the scientific foundations for footprint calculations, global nutrient cycles and life cycle analysis covered in Chapter 4 on Ecological Economics and Industrial Ecology. Case descriptions at the end of the paper, on the Backsberg Estate Cellars and on Spier, reveal that while carbon neutrality may be achievable through a range of ecological practices and off-setting mechanisms, the adoption of renewable energy solutions by small to medium – sized businesses remains a significant challenge.

The chapter concludes that current carbon management practices and industry jargon tend to obfuscate the larger goal of corporate environmental sustainability. However, it ends in a positive note by showcasing windows of opportunity for reducing carbon emissions and innovating for an environmentally sustainable future.

5.1.1 Study objectives

This chapter endeavours to investigate the entire process of calculating the climate change impact of a business, based on carbon emissions measurement and calculation; and further, reducing this impact through a range of interventions, as practiced by businesses and as marketed by industry role-players. The investigation is guided by two sets of objectives; the first aimed at academic and industry knowledge, and the second aimed at case-specific knowledge.

The first set of research objectives draws on a review of industrial ecology, ecological economics, climate science and life cycle management literatures; as well as industry knowledge of carbon auditing standards, green building design standards, renewable energy technologies and off-setting mechanisms.

Therefore, at the first, more general level, the chapter seeks to answer the following questions:

1. What is the scientific basis for terms such as carbon footprint and carbon neutral and how does it relate to the industry or market understanding of these terms?
2. What are the methodological approaches which underpin different carbon auditing techniques and how are they applied in practice?
3. What are the various strategies available to corporate entities within the practice areas of building design, technology adoption and environmental stewardship for reducing GHG emissions?

The second set of research objectives draws from the experiences of businesses who are trying to calculate and lower their GHG emissions, such as Spier and Backsberg Estate Cellars. Thus at a case-specific level, the chapter seeks to answer the following questions:

4. Does a carbon-related goal drive action in the corporate practice areas of environmental sustainability, such as ecological building design, technological innovation and environmental stewardship?
5. If not, then what secondary purpose is served by setting carbon-related goals and measuring GHG emissions?

5.2 Environmental footprints: competing origins

A critical review of the intellectual underpinnings of footprint analysis reveals that much of it originates from the analytical tools, scientific concepts and ecological metaphors developed within the fields of Industrial Ecology, Environmental Science and Ecological Economics. The scientific foundations include the concept of human carrying capacity, the ecological footprint, mapping of global nutrient cycles and life-cycle based analysis.

This section covers the intellectual, practical and market-based roots of popular environmental impact measures with respect to cumulative climate change impact and water consumption, such as carbon footprint, water footprint and carbon neutral.

5.2.1 Carbon Footprint: A corporate label for global warming impact

The analytical tool that is missing among the various tools and methods found in the EE and IE literatures and is yet high on political and business agendas is the carbon footprint (CF). Academic research and scientific undertakings in neither field have laid claim to this term. CF is defined more through common usage and the promotion by civil society sectors and businesses (Wiedmann and Minx, 2007; Murray and Dey, 2008; Wiedema et al., 2008) than through scientific rigour.

Wiedmann and Minx (2007) note the linguistic relation and intellectual roots that CF shares with Wackernagel and Rees (1996) Ecological Footprint (EF), and stress that the similarity ends there. While an EF is expressed in ‘global hectares’ as a land-based measure of an entity’s consumption trends, a CF represents the ‘carbon weight’ in tonnes of emissions associated with either the production of a good or the provision of a service (Hammond, 2007). Wiedema et al. (2008) comment on the broader appeal of the CF, compared to LCAs, and attribute it to the relative ease of calculation by company accountants with or without assistance from online calculators; and almost an intuitive understanding of what it denotes in terms of global warming. In other words, the merit of the measure lies in its ability to connect the actions of individual humans at a micro level to global ecological change at a macro level. LCA on the other hand provides a comprehensive view of a product’s environmental impact and has remained the ambit of professional LCA practitioners, often using extensive IT-supported tools and software packages (Gedija and Bryce, 2009).

Most early definitions of CF, such as those of the Carbon Trust (2007), the Parliamentary Office of Science and Technology (2006) and Patel (2006) refer to the inclusion of all greenhouse gases emitted, calculated as CO_2 equivalent, but lack consistency and clarity with regards to the sources of emissions to be incorporated. Wiedmann and Minx (2007) apply principles that have been explored in the EE and LCA literatures towards an unambiguous working definition of the term ‘carbon footprint’ as well as in exploring different methodologies for calculating a CF. In the end, they choose a definition of CF that only includes actual carbon emissions, a distinction which was not adopted by either the GHG protocol classification or the PAS 2050 in 2008, as discussed below.

5.2.2 Water footprint: defined through vigorous academic research

In a parallel yet significantly different trend, the water footprint methodology has been developed from within the water science community in response to the growing concerns about the unsustainable use of global freshwater resources. Hoekstra (2009) compares the ecological footprint and water footprint methodologies. Similar analogies could be drawn between carbon footprint and water footprint methodologies as well.

The water footprint is an indicator of water use that includes both direct and indirect water use by consumers and/or producers. Indirect water use includes what is called virtual or embedded water, which refers to the volume of freshwater that is used in the production of a good or service, measured at the place where the product was actually produced and not the physically present water in the product (Hoekstra, 2009). For instance, it takes 1,300 cubic meters or tonnes of water, on average, to produce one metric tonne of wheat.

Water footprints have been used to raise awareness of the water use associated with the production of a wide range of agriculturally-derived products. Taking full account of the water appropriated into product value chains creates awareness of the water intensive stages of each product life cycle, and enables the recognition of opportunities for water-use reduction and the assessment of risks to operations and supply chains from future water shortages (Ridoutt et al., 2009). Water footprints are expressed in terms of the volume of freshwater consumed towards the production of a functional unit (such as a bottle of wine).

5.2.3 Carbon neutral: Rooted in international carbon trading and markets schemes

While the terms carbon and water footprint have some links with scientific measures such as ecological footprints, carbon neutral status or carbon neutrality seems to be primarily driven in the public domain by the notion of cancelling out, or offsetting, one type of behaviour by invoking an opposite low-carbon or carbon reducing activity (Murray and Dey, 2008). The ethical intricacy of such an exchange appears to be as relevant as the physical, technical and management constraints associated with reducing actual greenhouse gas emissions by entities seeking or offering carbon neutrality.

Murray and Dey (2008) define the 'other' human activity that reduces or prevents emissions, based on a review of eleven commercial carbon offsetting websites, complete with on-line calculators:

- *'Takes an equal amount of existing CO_2 out of the atmosphere, like planting trees that, as they grow take in CO_2, or like conserving trees that otherwise would have been chopped down;*
- *Produces an essential commodity like power, in a way that does not cause, or reduces the amount of CO_2 usually emitted into the atmosphere by power generation;*
- *Reduces the amount of CO_2 from power generation through an increase in efficiency of energy use; or*
- *Conducts an essential human activity like waste disposal or recycling in a way that provides a commodity (like power or glass or paper) and at the same time prevents greenhouse gases being emitted into the atmosphere from both usual waste disposal methods and from usual power generation or product manufacturing.'*

While international bodies such as the United Nations (UN) were still investigating standards for measuring and reporting on carbon emissions, online carbon businesses have flourished by following simple strategies: carbon footprint assessments, energy audits (if physically possible), advice pertaining to energy efficiency, and carbon off-setting of remaining emissions, based on the preliminary measurements (Murray and Dey, 2008).

The goal of carbon neutral is offered through two mechanisms: emissions trading that takes place within a formal and legal framework, and carbon off-setting that refers to voluntary schemes, often arranged by non-profit organisations (Murray and Dey, 2008; Jindal et al., 2006). Jindal et al. (2006) explore four major kinds of transactions under carbon markets, noting Kyoto-compliance as a key distinction among emissions trading and project-based transactions. Niemack and Chevallier (2010) refer to the carbon market populated by companies and individuals who are not subject to regulatory limits but choose to neutralise their emissions, as voluntary carbon markets. These are described as distinct from Kyoto-compliant carbon markets[9] that apply to utilities or industries bound by treaty requirements, and from voluntary compliance markets whereby credits are traded on for instance, the Chicago Climate Exchange[10] (Niemack and Chevallier, 2010).

Murray and Dey (2008) trace two carbon off-setting schemes to their roots in community-based projects in developing countries and conclude that it is hard to uncover the real value of a project in reducing emissions, putting into question the reliance on such mechanisms for claiming carbon neutral status by a business. However, some of the carbon offsetting projects may be worthy of support in their own right, whether or not the emissions they claim to offset can be accurately accounted for.

In light of the growing voluntary carbon market, and in a bid to provide consistency and legitimacy for buyers and sellers, a standardisation process was initiated by the Carbon Trust and Defra aimed at developing Publicly Available Specifications (Wiedmann and Minx, 2007): the first one for the measurement of GHG emissions during the life cycle of a product – PAS 2050 in 2008; and a second one detailing how to demonstrate carbon neutrality – PAS 2060 in 2010.

5.3 Carbon Auditing: Different methodologies for emissions calculation

A hybrid, flexible approach that combines the use of input-output tables used in ecological economic modelling and LCA-based process analysis is recommended for both EF and CF calculations (Wiedmann and Minx, 2007; Lenzen, 2001). Two of the most prominent classifications for greenhouse gas (GHG) emissions calculation, the GHG Protocol and the PAS 2050, pertain to carbon management at corporate level and carbon auditing at product level respectively (Gedija and Bryce, 2009). Both standards promote incorporating CO_2 and CO_2e emissions along the full life cycle of a product and warn against double-counting along supply chains. Businesses in particular are encouraged to look beyond emissions from their own processes and consider opportunities for reducing embodied emissions in the design, manufacture and supply of their products (SAICA, 2008).

5.3.1 The GHG Protocol: Corporate carbon management principles

The approach used in the GHG Protocol is based on the universal accounting principles of relevance, completeness, consistency, transparency and accuracy (WRI and WBCSD, 2001). In 2007, the World Business Council on Sustainable Development and the World Resources Institute issued a revised version of the GHG Protocol: A Corporate Accounting and Reporting

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[9] http://siteresources.worldbank.org/INTCARBONFINANCE/Resources/State_and_Trends_Updated_June_2011.pdf

[10] http://www.chicagoclimatex.com/

Standard. The GHG Protocol uses the dual concepts of system boundaries and scopes (1, 2 and 3) for calculating the GHG emissions associated with an organisation's activities.

System boundary: The GHG Protocol recommends two categories for setting a system's boundaries: organisational and operational boundaries. Complex organisational structures require organisational boundaries to define which parts of a company to include in the GHG audit. Two approaches are recommended: the control and the equity share approach. Under the control approach, a company accounts for the emissions that are a result of activities and processes within a company's control. The equity share approach on the other hand reflects economic interest; meaning a company accounts for emissions from operations according to its share of equity in the operation. The International Wine Carbon Calculator[11], the South African Fruit and Wine Initiative's Carbon Calculator[12] and GCX use the control approach to consolidate all emissions controlled by a legal entity such as Spier Holdings.

Operational boundaries and scopes: Once organisational boundaries have been defined and agreed upon for calculating a company's carbon footprint, operational boundaries help determine which scope different sources of emissions fall into. Thus operational boundaries distinguish between direct (or scope 1) and indirect emissions (scope 2 and 3): direct emissions arise from sources that are owned or controlled by the reporting organisation such as company-owned vehicles and fuel combustion, while indirect emissions may result from a business' activity but occur at sources owned or controlled by another entity (WRI, 2004). Scope 2 includes indirect emissions from the consumption of purchased electricity, heat or steam generated by another organisation, while scope 3 emissions are other indirect emissions generated in the wider economy from business travel, outsourced activities, waste disposal, product use, contractor owned vehicles, and production of purchased materials.

Reporting on scope 1 and 2 emissions is considered mandatory within the GHG Protocol while reporting on scope 3 emissions is voluntary (WRI and WBCSD, 2007). However, various opportunities for an organisation to reduce its emissions towards a low carbon future may be those listed under scope 3. The status of carbon neutral for a business will depend upon whether it includes scope 3 emissions in its carbon footprint or not. Even when scope 3 emissions are included, the system boundaries will determine how comprehensive a footprint analysis is, since resource and time constraints may limit access to data.

Based on the GHG Protocol, the WRI and WBCSD recently released LCA-based product and Scope 3 (supply chain) emission accounting standards for public comment in 2011, similar to the PAS 2050.

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[11] http://www.ipw.co.za/content/pdfs/ghg/eng/International_Wine_Carbon_Calculator_Protocol_V1.2.pdf
[12] http://www.climatefruitandwine.co.za/

5.3.2 PAS 2050: 2008: LCA-based methodology for product carbon footprint

The Publicly Accessible Standard (PAS) 2050, released in 2008, is a specification for the measurement of GHG emissions occurring throughout the life cycle of goods and services (BSI, 2008). It takes a process-based life cycle analysis (LCA) approach to evaluating emissions associated with a product, enabling companies to identify minimization points across the entire product system. The driving force behind the development and establishment of this specification was a broad community and industry desire in the United Kingdom for a consistent and common method for calculating, comparing and communicating the carbon footprint of goods and services across different sectors (BSI, 2008).

Starting with the identification of a functional unit that reflects the way in which a product is actually consumed by the end user, the guidelines for conducting a PAS 2050 carbon footprint encourage producers to target product configurations that hold the maximum potential for reducing emissions, and identify alternative suppliers and manufacturers who are willing to measure and reduce the emissions, which they contribute (BSI, 2008). The focus shifts from defining emissions in terms of scope to understanding the implications of existing supply chains.

While the PAS 2050 uses an LCA-based methodology, it does not assist companies in conducting a comprehensive LCA of a product. For instance, the ISO 14044 standard for conducting LCAs, includes, among others, ozone depletion, acidification, eutrophication and photochemical ozone creation potentials associated with a product (Gedija and Byrne, 2009). The PAS 2050 only focuses on climate change.

In the end, calculating a carbon footprint is an accounting procedure relying on system boundaries, data types, emission factors and exclusions, all defined within an application protocol. PAS 2050 adopts data quality definitions from the ISO 14044, but contextualises the procedure for carbon auditing by including product category rules and process maps. Moreover, the PAS 2050 provides greater clarity with regards to certain emission drivers such as stored carbon (in plant-based products such as a wooden table) over the full life-cycle, the distinction between biogenic and fossil carbon, and aspects related to agriculture such as non-CO_2 emissions from livestock and land-use change (Gedija and Byrne, 2009).

5.3.3 The SAFWI carbon calculator: A practical application

The South African Fruit and Wine Initiative (SAFWI)'s Confronting Climate Change project was kicked off in response to demands from UK-based customers requiring the carbon footprint of South African fresh fruit and wine products, sold in their supermarkets. The South African fruit and wine sector chose to utilise this as an opportunity to prepare for another imminent pressure, namely, that of mandatory capping of emissions resulting from policy frameworks in support of national GHG emission reduction commitments (SAFWI Carbon Calculator, 2009). Within a wider and more strategic context of climate change mitigation and adaptation practices, the

SAFWI project was initiated early in 2009, and provides businesses within the sector with a reliable, flexible and industry-based protocol for calculating and reducing GHG emissions.

The on-line SAFWI calculator incorporates elements of the PAS 2050 such as the utilisation of process maps, boundary delineation and data requirements, while being underpinned by the GHG accounting principles. It is also aligned with the ISO 14064:1 standard, the International Wine Carbon Calculator Protocol, and the Australian Wine Carbon Calculator[13]. Individual businesses are expected to calculate product footprints and define their own boundaries, based on the guidance provided, and maintain transparency. In the absence of reliable emission factors for some data types for the South African industry, the calculator uses international figures. The developers claim that this is an appropriate compromise as long as the same emission factors are used by all users of the calculator.

The activity, location and usage data field on the SAFWI carbon calculator are designed to be regularly updated, based on increasing usage of the tool and the availability of industry-specific data. This is based on the 'principle of trust' where information from the industry is used for the industry. While there is no formal verification or labelling process in place yet, users are encouraged to adapt business practices based on GHG emission hotspots, realistic targets and reduction opportunities identified by other local businesses in the sector. Carbon neutral as an organisational goal is neither offered nor encouraged, since the focus is on lowering emissions within a user's control, prior to any offsetting mechanisms.

5.4 Carbon reduction strategies

Irrespective of the ethical and political dilemmas associated with neutralising emissions through off-site community-based projects, most commentators on the current trend of emission calculation and declaration agree that any reduction in energy and transport-related emissions, linked to fossil-fuel usage, is welcome (Niemack and Chevallier, 2010; Murray and Dey, 2008; Wiedema et al., 2008; Wiedmann and Minx, 2007).

Corporate carbon management involves three key steps: measure, set targets and reduce. This section provides a high-level discussion on the measurement and reduction of GHG emissions from various sources within a business' operations and a product's supply chains. Reduction strategies are further divided into knowledge-intensive endeavours such as raising organisational carbon-consciousness and technological adaptations, and capital-intensive ventures such as renewable energy solutions. In addition, a brief discussion on ecological design practices is included since many businesses are in a position to implement them but are not sure how they contribute to a lower carbon profile.

[13] http://www.wfa.org.au/entwineaustralia/carbon_calculator.aspx

5.4.1 Measure to change

Following the famous management adage that you can't manage what you don't measure, the first step in any carbon or water consumption reduction strategy is to measure current consumption or emission levels to establish a baseline against which future targets are set.

Specifications such as the GHG Protocol, the ISO 14064 or the PAS 2050, are used by organisations internally or with the assistance of external experts, to calculate entity-level or product-specific carbon footprints. Often a combination of different classifications is used. For instance, a corporate or institutional entity will implement carbon management through GHG principles for its office buildings, covering on-site emissions generated through electricity and water consumption; and augment this by a product-specific emissions measurement of a manufactured product (with significantly spread-out supply and distribution chains).

Entity-level calculations often rely on existing consumption data collated as part of an organisation's financial or environmental reporting. When activity data is not readily available, a company may need to invest in, for example, water meters or electrical data loggers for water or electricity consumption respectively. In addition, information systems may need to be established to capture the necessary consumption data linked to activities such as stationary and mobile fuel purchases, or solid waste generation. Product-level calculations will require information from upstream suppliers, who may need to establish data-capturing systems in their own operations.

The bulk of carbon emissions, often up to 80% for most enterprises, are linked to fossil fuel consumption for energy (Wiedema et al., 2008), to satisfy heating, cooling, lighting or transportation needs. The remaining emissions (roughly 20%) are waste-related, water-related (in the form of energy required to pump water from source to point of consumption) or coolant gases with global-warming potential (GCX, 2008). The next section covers some basic approaches to reducing GHG emissions in existing corporate and manufacturing establishments.

5.4.2 Reducing emissions through ecological awareness and technology changeover

Creating organisational consciousness around sustainability and lower carbon impact is aimed at very simple and yet effective results in the three key areas of energy conservation, water saving and waste minimisation, each of which contribute to lowering the collective carbon footprint. Changed individual behaviours include switching off of electrical appliances when not in use, reduced electrical consumption, car pooling, low-impact driving, reduced water consumption, waste separation at point of generation, and teleconferences to replace air travel, among others. Most of these are captured under scope 2 emissions as per the GHG protocol.

In some instances energy saving and efficiency may require minor capital investment. Examples include occupation detection sensors, smart keys and geyser blankets. The next step up in terms of financial costs to a business is investment in energy efficient technologies and appliances such as fridges, freezers and dishwashers. Thus electric geysers could be replaced with a combination of heat pumps and solar water heaters, lights retro-fitted with fluorescent bulbs or LEDs (light emitting diodes) and electronic ballasts, and showerheads and toilet flushes replaced with water-saving alternatives.

When an activity that requires energy is switched from coal-based electricity to LPG, which is deemed cleaner than coal, a sizeable carbon footprint remains attached to it, which varies with region-specific extraction and transportation footprints. Therefore, from the viewpoint of reducing scope 1 carbon emissions, bio-fuels such as bio-diesel and bio-ethanol are recommended. While dynamic LCA-based assessments of the entire supply chain of bio-fuels are still in their infancy (Pehnt, 2006), in terms of carbon footprint calculations, bio-fuels are considered carbon neutral (BSI, 2008).

In the area of waste and recycling, changeover would include switching to lower-carbon products such as recycled or recyclable paper and packaging, waste elimination or complete recycling, design for recovery and reuse of materials, and material reduction in manufacturing. Such initiatives would reduce scope 3 emissions as per the GHG protocol.

These technology-related adaptations rely heavily on individual mind-sets towards seeking and finding alternatives to current business practices, as there are a multitude of opportunities that cumulatively account for significantly lower emissions. Within management literature these have been referred to as ‘stratlets’ as opposed to organisation-wide, grand strategies (Hamel and Valikangas, 2003).

However, Hawken et al. (1999), the authors of Natural Capitalism, list several examples of energy saving or waste minimizing technology (knowledge) that would be profitable, but are not in general use. According to institutionalists, path dependencies and dominant behaviours can sometimes lock environmentally sensitive technologies out of the system (Greenwood and Holt, 2007). Therefore, investment in carbon-consciousness at individual employee level is an appealing emission reduction strategy, but it has to be backed up with regular monitoring and comparisons to ascertain whether awareness campaigns and training sessions have yielded lower emissions. And when behaviours remain unchanged, further investigation into locked-in trends may be required in order to bring about transformation.

5.4.3 Adopting renewable energy solutions

The next option that businesses can exercise for reducing emissions considerably is to meet their energy demand through renewable energy sources, as opposed to through the national electricity grid (largely coal-based in the case of South Africa). Martinot and McDoom (1999) list scientific and practical studies that substantiate the applicability of solar PV systems for home electrification, electricity from mini hydro power, wind and solar energy for rural establishments, wind power pumps for agricultural irrigation, biogas digesters for a range of energy demands, and solar technologies for hot water for buildings.

A diverse mix of energy resources, generated at different levels of the economy, is also considered essential for macro level energy security – 'diverse systems are more resilient against external shocks' (Winkler, 2009: 87). Small-scale solutions which rely on the bio-physical forms of solar energy range from industrial bio-digesters, biogas generators to combined heat and power (CHP) units. Wind turbines can range from off-grid small-scale to grid-connected large-scale applications.

One of the challenges or responsibilities of generating own power and not drawing from an external grid, is the management of energy output or supply against demand and energy storage. Therefore, a range of on-site renewable energy sources would need a multi-modal management system consisting of solar electric regulators, heat exchangers, inverters, chargers, charge controllers and battery banks. Solar thermal electric or concentrated solar power (CSP) generation is also more suitable for large scale operations. While CSP offers the advantage of storing energy in the form of a thermal fluid which is cheaper than battery banks, capital expenditure is driven up through investment in equipment which is required to feed generation excess into the grid.

Box 5.1: The South African context: incentives and barriers to adoption of renewable energy technologies

As a result of Eskom's rebates for demand side management investments such as solar water heaters, heat pumps and energy efficiency audit and interventions, the appetite for exploring these options has grown considerably in the South African residential and commercial sectors. Eskom sees both solar and heat pump technologies as complementary technologies, with great energy efficiency and environmental benefits.[14] As part of the roll-out mechanism, renewable energy vendors are required to gain Eskom accreditation in order to provide implementation services to interested consumers. Installation prices normally include piping, insulation, valves and fittings associated with solar water heaters and heat pumps. Once projections of future Eskom electricity prices are factored in, sizeable investments into energy-saving devices are recoverable through lower electricity consumption over the short to medium term.

Eskom rebates currently do not cover the installation of locally manufactured and imported solar photovoltaic (PV) energy systems, which use solid state materials like silicon semiconductors to convert solar radiation directly into electrical power. These systems require minimal

[14] http://www.eskomidm.co.za/

maintenance or monitoring and are considered highly suitable for smaller scale commercial establishments. In the absence of sufficient incentives from the electricity utility towards power generation, corporate entities may require political certainty in the arena of renewable energy and feed-in tariffs. However, tardy regulations prevent the diffusion of renewable energy technologies in the South African commercial sector. While new laws and policy provisions for the renewable energy sector were recorded as appearing in South Africa (REN21, 2009), Sebitosi and Pillay (2008) lament the lack of political will or capacity to promote the renewable energy sector, evident through the continued absence of implementation strategies mentioned in the SA White Paper on Renewable Energy, which was released in 2003 by the Department of Minerals and Energy.

The long delayed and much anticipated National Climate Change Response Green Paper, released by the Department of Environmental Affairs similarly hints at a climate change action plan relevant for commerce and manufacturing industries to be compiled and published subsequently. However, the voluntary, national GHG emission reduction targets of 34% by 2020 and 42% by 2025 below business as usual scenario as stated in the Green Paper do provide certainty in the emissions market. As does the reference to a carbon tax as well as the setting of mandatory targets for energy efficiency and demand-side management (DSM) initiatives, as means of promoting behaviour change to support the transition to a low carbon society (DEA, 2011). Therefore, slowly but surely, the policy and regulatory landscape in South Africa, with regards to Climate Change at least favours early investors in energy efficiency and DSM measures, even as the policy environment for investing in renewable energy technologies catches up.

Painuly (2001) categorises a comprehensive range of barriers to the adoption of renewable energy solutions worldwide, such as high investment requirements from entrepreneurs, subsidies for conventional energy, negative perceptions held by investors or users and commercial risks related to certification requirements, which may be specific to a certain technology or to a country or a region.

Despite noted barriers, a fundamental transition of the world’s energy markets in favour of renewable energy technologies is acknowledged in recent global status reports of the Renewable Energy Policy Network, despite the economic crash of 2008 (REN21, 2009; REN21, 2010; REN21, 2011). Favourable policy and economic frameworks are noted as key to the growth of the sector (Painuly, 2001; Sebitosi and Pillay, 2008).

5.4.4 Ecological design practices for off-setting emissions

Ecological design represents a holistic approach to the provision of services and infrastructure, including construction methods and materials, for urban establishments, housing developments and institutions. Popular thinking and approaches are informed by lessons learnt from on the ground experimentation within the fields of built environment studies, architecture and planning. Thus ecological design entails sensitive site selection and planning, sustainable water and sanitation systems, sustainable energy systems, waste management strategies and sustainable construction (Majumdar, 2003; Roaf et al., 2003; Birkeland, 2002; Hill and Powen, 1997). Often promoted and adopted at the level of local communities, ecological initiatives are now hailed as low carbon exemplars in the absence of a legally binding treaty post-Copenhagen to push large, nation-wide investments in carbon reduction technologies (Mulugetta et al., 2010).

The connection between building design and energy consumption in particular, has resurged in academic and professional discussions, with growing awareness about the global warming impact of different construction technologies as well as the lighting, heating and cooling of buildings. Internationally or nationally recognised green building rating systems such as the LEED (Leadership in Energy and Environmental Design)[15], the WGBC (World Green Building Council)[16] and the GBCSA (Green Building Council of South Africa)[17] and the GRIHA (Green Rating for Integrated Habitat Assessment)[18] provide builders and developers a concise, measurable and practical framework for building new structures or refurbishing existing buildings towards measurably lower carbon profiles (TERI, 2009). Policy frameworks in the form of planning and building by-laws issued at local, regional or national level work to reinforce commercial and institutional efforts at environmentally sensitive architecture.

Buildings seeking green-rating range from hotels, healthcare facilities, residential complexes, retail centres, multi-storey high rise buildings to offices and institutional buildings. The capacity of natural lighting and natural ventilation to achieve acceptable thermal and lighting comfort levels inside buildings; the role of orography or the study of the slope of hills to avoid dominant winds; the use of locally available building materials and techniques; conservation and efficient utilisation of resources, in particular non-renewable resources; and integration of renewable energy sources into the design of a building are critical sustainability principles referred to at the stage of new construction (Hill and Powen, 1997; TERI, 2009). Within the construction and building material design industry, LCAs are commonly utilised to compare alternative building techniques and materials. In addition, a range of interventions are also available to upgrade existing sites and buildings, which include retro-fitting lighting and heating systems and installing water-saving devices and a range of operations and maintenance solutions.

Alongside the green certification systems and policy guidelines applicable to building design, are the novel, sometimes radical, experiments dealing with energy, water and waste management systems that support human habitat. Such explorations include on-site

[15] http://www.usgbc.org/LEED/
[16] http://www.worldgbc.org/
[17] http://www.gbcsa.org.za
[18] http://www.grihaindia.org/

wastewater treatment, efficient source control sanitation, environmentally friendly farming methods[19], means of harnessing renewable energy and ways of solid waste minimisation and recycling (Otterpohl, 2000; Fehr and Calcado, 2003). Community level interventions are called upon to not only decentralise electricity, water provision and sewage treatment away from municipal networks, and thus increase service infrastructure resilience; but also to unravel the lifestyle sacrifices associated with low carbon living (Mulugetta et al, 2010). Thus while the role of technology in reducing emissions through a less energy intensive built environment is appreciated within the threads of ecological design literature, the cultural and creative aspects of societal change towards sustainability are also acknowledged.

The above discussion on ecological design practices relates to large bodies of knowledge, informed and enhanced through application. Calculating the footprint impact of ecological practices will require technical knowledge of emission factors associated with each type of emission-reducing activity. In a personal, telephonic discussion with the CEO of GCX Cape Town, Mr Kevin James, it was disclosed that such projects would be factored in as absorbing a certain amount of GHG emissions, and as such would locally off-set the total emissions generated by a business.

The journey of two medium-sized South African businesses, Backsberg Wine Cellars and Spier, as they defined and worked towards a carbon neutral status is described in the following text boxes.

Box 5.2: Case-study Backsberg Estate Cellars: 'the first carbon neutral wine estate in South Africa'

Based on an interview with Jess Schulschenk, Research Fellow at the Sustainability Institute

In 2006, Michael Back, the owner and founder of Backsberg and a self-professed environmentalist envisioned a carbon neutral status for his wine estate. The initial vision was to achieve carbon neutral status without off-setting emissions through voluntary trading schemes.

To start off, a recycling unit was established and efficiency improvement measures were put in place; but these projects were still on an ad-hoc basis. Meetings with various sustainable design vendors at the Cape Town Design Indaba exposed the team to Food and Trees for Africa's (FTFA) carbon standard, and the need to establish an emissions baseline.

Once business system boundaries were defined, activity data on materials used, electricity consumed, fuel used for trucking around the country and shipping around the world (distribution), waste generated and fertilizer purchased was collected. In the absence of carbon

[19] Such as biodynamic farming, organic farming and permaculture

calculation protocols specific to wine estates, internationally applicable emission factors were utilised and the GHG Protocol was used to calculate the business' carbon footprint.

Additional information was audited, such as the extent of green spaces on the farm, number of trees on the farm, and a soil carbon report was generated highlighting the carbon storage capacity of the soil and the cultivars. According to Jess, appointed as the Environmental Manager, a substantial part of the total environmental project, up to 30%, was spent on data collection.

Once the baseline carbon footprint was established, various projects were initiated such as skylights in the cellar instead of flood lights, shifting of harvest time to between 3am and 9am to reduce the energy required to cool grapes and converting all vehicles to 100% bio-diesel. However, light-weighting of bottles, labels using lighter paper and non-glossy print were non-negotiable at that point, based on the understanding that such changes would displease the conservative buyer.

In order to generate own energy, solar water heaters were installed and wood-lots were planted for a bio-digester. The forestry department of Stellenbosch University helped the Backsberg team in choosing appropriate trees for generating biomass. Roofs were greened to reduce energy requirements for cooling and water was pumped underground to cool the cellars. Thus, novel aspects of sustainable and ecological design were implemented, which drove down the estate's overall carbon footprint.

In order to neutralize the approximately 1800 tons of outstanding carbon, land on the estate was set-aside for biodiversity conservation, and 900 trees were planted in the nearby Klapmuts community (arranged through FTFA, a South African public benefit organisation).

Backsberg Estate Cellars were awarded the Climate Change Leadership Award for 2011 in the Food and Agriculture section, for their "inventive use of a light weight plastic bottle and ongoing leadership around climate change mitigation and adaptation."

Box 5.3: Case study Spier Holdings: the search for carbon neutrality

Based on qualitative information gathering among Spier staff and intermediaries over 6 months (February to August 2010) and review of formal management documents and sustainability reports

The macro goal of carbon neutral served as a key driver of various interventions at Spier, including the commissioning of a carbon footprint analysis of the business' operations by Global

Carbon Exchange, Cape Town (GCX)[20]. GCX proposed organisation-wide and unit-specific adjustments in current business practices, emphasizing the need to incorporate outsourced distribution and packaging in future footprint analyses and offering different off-setting options (GCX, 2008).

The carbon footprint analysis was conducted by collating information on the three core business units at Spier: wine, leisure and farming. The emissions for each business unit were calculated by using data from the reporting period August 2007-September 2008, which thus forms the baseline for future. While the information was analysed with due skill by the GCX team, the reliability and accuracy of data collected was the responsibility of the Spier financial team.

Ongoing association with the Centre for Renewable and Sustainable Energy Studies (CRSES), since 2007 to evaluate different renewable energy solutions, highlights a very interesting trend in Spier's journey towards a lower carbon future.

In order to substantially reduce GHG emissions, decisions were taken at Spier board level to explore methods for expanding the use of renewable energy across the different businesses. A biodiesel production facility was developed on the estate in 2006. Highly successful test-batches were run with the aim to begin full production of 1 million litres in 2007. However, due to the monopoly of oil manufacturers, the supply stream dried up and the project was abandoned in 2008. Spier vehicles now run on biodiesel purchased from local suppliers.

Subsequently, alternative options for generating renewable energy were considered including gasification of biomass from quick growing trees. The CRSES, located at the University of Stellenbosch was asked to assess on-site energy generation based on the electricity requirement of Spier. Three University departments were involved in the project for over six months: forestry, agricultural science and process engineering. Ultimately, the gasification project was not pursued mainly for economic reasons linked to scale of operations. The available land on the farm was reengaged for bio dynamic farming and natural conservation of the wetlands.

Efforts on the energy-saving front continued at the various businesses. In 2009, solar water heating was considered for the banqueting kitchen. Proposals were received from vendors and one was eventually asked to submit a solar energy proposal for the entire conferencing / banqueting area and the water heating requirement at the kitchen was subsumed within the larger 'greening project'. The greening project was based on the idea of marketing the conferencing and banqueting facility at Spier as 'conferencing with a conscience' through a combination of energy efficiency interventions and roof-mounted photo-voltaic panels with grid tied inverters. Proposals from several vendors were received and an engineer from the CRSES

[20] http://www.globalcarbonexchange.com/

was involved in appraising the different options. However, funds required to achieve sufficient energy generation were not available. Unfortunately, solar water heating and demand side interventions were also not implemented at the conference centre.

Since the funds allocated for the greening project at the banqueting facilities were still available, energy-saving technologies were adopted at The Village hotel complex. Timers were installed on each geyser and a trigger matrix system was put in place to switch off sections of the hotel in low occupancy months. More recently, a centralized hot water system powered by solar heat pumps is under consideration by Spier management. A reputable local supplier has been identified but the process is not yet concluded.

Subsequently, CRSES researchers (including Professor Alan Brent) explored the feasibility of a concentrated solar plant (CSP), located on the Spier estate and designed as an Eerste River valley solution. The aim was to generate renewable energy, feed it into the national grid, sell the excess to pre-arranged buyers and draw electricity from the grid as per required on the estate. Process heat from the plant could be used for cooling requirements at the wine cellar. While this will not be an energy-on-demand type of solution such as the biomass generation project, Spier will be able to off-set its total carbon emissions against the renewable energy generated on-site.

5.5 Discussion on the two cases

Carbon footprint calculation is a recent addition to the corporate practice area of sustainability reporting. Consumer awareness with regards to the globalisation of production and consumption chains and its impact on the environmental burden of daily-used products has resulted in an exponential increase in corporate entities eager to take actions that can allow them to claim a carbon neutral status, or at least a lower carbon profile for their products.

The review of carbon reduction strategies in Section 5.4, and the two case descriptions, supports the view that although carbon footprint assessment and communication is one component of sustainability reporting, it relates directly to at least three of the five practice areas which businesses employ towards achieving environmentally sustainable outcomes. Table 5.1 summarises five corporate practice areas with intended sustainability outcomes, drawn from a wide range of corporate social responsibility and corporate citizenship literatures (first presented in Chapter 3 as 3.3). In table 5.1 practice areas such as energy efficiency and water use minimisation which rely upon technological innovation, and energy saving and water conservation which are driven by a corporate environmental paradigm, contribute directly to a lower carbon footprint. However, this chapter aims to ascertain whether the reverse holds true; which is whether a carbon-related goal will achieve positive impacts across the categories of technological innovation and environmental custodianship in the CC framework below.

Table 5.1 Framework for corporate citizenship practices with intended sustainability outcomes

CSR practice areas	**Philanthropy / CSI**	**Stakeholder engagement**	**Technological innovation**	**Corporate environmentalism**	**Sustainability reporting**
Key drivers	Moral imperative	Community pressure, moral imperative	Market and legal pressures, organisational culture	Legal compliance, environmental groups	Globalisation, market pressure
Underlying ideology	'ethic of care'	Stakeholder legitimacy	Techno-optimism	Environmental custodianship	Reporting increases transparency
Intended sustainability outcome	Social upliftment	Administration of citizenship rights of individuals	Sustainable production	Environmental justice	Accountability to stakeholders
Practices	Charitable donations	Critical collaboration	Ecological design, products and services	Biodiversity conservation	GRI guidelines
	Support for local schools	Industry alliances	Resource productivity	Water conservation	TBL reporting
	Support for the arts and sports	Knowledge networks	Waste minimisation and recycling	Energy saving	**Carbon footprint calculation**
	Recreational facilities for employees	Dialogue with local community	Pollution control	Organic farming	Industry standards
			Energy efficiency	Responsible sewage disposal	Sustainability principles

5.5.1 The limited role of carbon-related goals

This paper is interested in establishing the role played by carbon-related goals in changing corporate practices. Based on the two cases described briefly above, it is argued that carbon-related goal-setting tends to skew management's attention onto those business practices which contribute the most to GHG emissions, at the cost of other, equally-relevant practices from an environmental sustainability perspective. This limitation manifests even when the source of most emissions, such as electricity generation or packaging are not in an organisation's direct control. The goal of carbon neutral in particular favours off-setting over reducing emissions through efficiency and conservation measures.

Whether driven by market pressure, brand enhancement or a sincere commitment to sustainability, public declaration of carbon footprints (of a business product, service or full enterprise) carries the implicit vision of a downward trending carbon profile. Year-on-year carbon footprint assessment tracks the reduction in a business' contribution to anthropogenic GHG emissions, and is not designed to incorporate approaches which build natural capital such as organic farming or biome conservation. Positive contributions, over and above energy efficiency and resource conservation measures, are also limited to off-setting mechanisms situated off-site or generation of own renewable energy. Current approaches to carbon management do not address untenable business models or unsustainable consumption and production trends.

For the above reasons, the goal of carbon neutral status is not necessarily endorsed by the developers of well-known standards for emissions calculations or by industry-specific carbon calculators. Instead, entities are encouraged to seek innovations which become low carbon exemplars (Mulugetta et al, 2010).

5.5.2 The informants of corporate carbon management

Once the decision is taken at a strategic level by shareholders of a business or senior management to pursue a lower carbon profile; a series of actions ensue, which are determined by a range of informants and determinants. These informants and determinants will establish to a large extent what resources are spent on each of the carbon reduction strategies described in section 5.4. Based on the two cases described above, the actual journey taken by a business in reducing its GHG emissions can be highly informative and provide several opportunities for learning and change.

The first phase of corporate carbon measurement is knowledge intensive, and is informed by external expertise, adoption of a particular emissions standard and the definition of system boundaries. Collection of activity data related to the environmental performance of a business which is used for calculating its carbon footprint allows the business to be viewed in terms of flows of energy, waste and water, as opposed to a conglomeration of business units and offices. Management can use this data to initiate real change and innovation in business practices by deploying available resources. In carbon-speak, life cycle analysis highlights hotspots in the supply chain which carry the most potential for reducing emissions.

The role of knowledge brokers and intermediaries such as industry alliances, developers of green building standards and sustainability service providers is also vital in shaping the trajectory a business takes in transitioning to a lower carbon profile. For example, sector-specific carbon calculators and local green rating systems set the benchmark which an average business is likely to adopt. Businesses are also responding to a range of market trends, legal requirements and industry pressures when adopting carbon reduction strategies, similar in nature to those which generate other corporate citizenship practices, as profiled in table 3.1.

With regards to renewable energy, national-level policies with respect to incentives and rebates offered towards the adoption of renewable energy technologies create the formal context within which business decisions are made. Unfortunately, the rapid rate of new designs and technologies entering the renewable energy market, often with markedly improved performance result in huge information asymmetry between the supplier and the investor. The need for in-house technical expertise to 'catch up' and evaluate different technologies introduces a high level of financial risk into the equation from the buyer's perspective, and may delay actual spending. Therefore, it is very important what level of technical advice is sought and is accessible to a business. Research institutes and university departments are more likely to provide a well-balanced view than vendors of new technologies.

5.6 Conclusions: limitations of an optimisation-oriented Carbonology

Based on the industry-generated literature review of Carbonology and a discussion of the two cases described in brief, various shortcomings and gaps were identified in the entire process of choosing a standard, measuring carbon emissions and finally claiming carbon neutral status. These limitations are listed in relation to the first set of research objectives.

5.6.1 Carbon footprint is not a comprehensive measure of climate change impact

Carbon footprint is an accounting approximation of a business' contribution to climate change. It focuses on the most significant GHG gases but is not a comprehensive measure of a business' climate change impact. Inclusion of water usage, waste generation, packaging and distribution networks, and employee commute can extend the coverage of a carbon footprint, as scopes 2 and 3 are captured. However, ambiguities related to carbon assessment techniques (described in 5.6.2), technical gaps in measurement, choice of boundary and scope definitions, and scientific uncertainties with regards to global warming potentials of included gases, mean that carbon emissions calculation is an accounting procedure relying on system boundaries, data types, emission factors and exclusions, all defined within an application protocol.

The goal of carbon neutral is primarily driven in the public domain by the notion of off-setting or cancelling out a business' or product's emissions by investing in a low-carbon activity (Murray and Dey, 2008). Even when off-setting is explored as an option for claiming carbon neutrality, it is hard to uncover the real value of a project in reducing emissions (Murray and Dey, 2008). The carbon calculation and off-setting industry is not motivated to incorporate ecologically sustainable practices. For example, Spier's biodiversity conservation efforts on the estate and tree-planting in Klapmuts cannot be factored into a reduced carbon footprint.

5.6.2 Ambiguities related to carbon auditing techniques

With respect to the methodological approaches which underpin different carbon auditing techniques, and their practical application, several sources of ambiguity are discovered. For example, in the absence of an industry-benchmark or standard, whereby all businesses in a sector adopt the same boundaries and scopes to calculate their footprint, even comparisons of footprints of similar products within the same industry in the same region can become meaningless.

Another example of a methodological compromise is when carbon calculators in developing countries such as the one developed by SAFWI, use international emission factors in the absence of corresponding figures for the local industry. This is acceptable as long as all users of the carbon calculator use the same emission factors. However, it does support the claim that the scientifically derived carbon footprint of a product is in fact a fair approximation, arrived at through an accounting exercise.

5.6.3 Biases in carbon reduction strategies

In terms of various strategies offered to corporate entities for reducing emissions, several biases are observed. For instance, although there is greater potential for reducing environmental impact by designing and building ecologically sound structures and reducing consumption patterns, the carbon-focus translates into a fossil fuel consumption focus. Since electricity consumption contributes up to 80% towards most establishments' carbon footprint (Wiedema et al, 2008), the carbon and fossil fuel focus translates into a renewable energy focus.

When grid electricity is largely coal based such as in South Africa, carbon neutral status at the level of an individual establishment can only be achieved by off-setting emissions (either by planting trees or generating renewable energy). Most renewable energy solutions are more effective at community or regional scale, or when connected to the national grid.

Carbon footprint standards such as PAS 2050 accord a carbon neutral status to all bio-fuels. Such specification does not take into account additional impacts of producing certain bio-fuels, such as on food security or the continuation of alternative agriculture-based industries. Therefore, even standards based on life cycle analysis thinking are not able to factor in the life cycle impacts, or complete sustainability outcomes of certain options.

5.6.4 Carbon footprint as a driver of environmental sustainability

In relation to the second set of research questions, derived from the case descriptions, it is concluded that carbon-related goals are limited in driving action in the corporate practice areas of sustainability reporting, building design, technological innovation and environmental custodianship; although such action holds the potential for reducing emissions significantly.

This is partly because investment in natural capital at the scale of a corporate enterprise may not be captured in a lower carbon footprint, unless it follows an established industry norm. Secondly, off-setting mechanisms driven by carbon neutrality take away the urgency for conserving resources and changing consumption and production patterns. The carbon focus often translates into a fossil fuel consumption focus, obfuscating opportunities for real, system-level change in a business.

5.7 Beyond the footprint: opportunities for learning and innovation

Despite methodological shortcomings of the carbon assessment tool as discussed above, a strategic intention to lower carbon emissions has the potential to create a common language across different areas of corporate practice areas to drive ecologically-sensitive behaviour in the organisation. In addition to the climate change benefits, innovating in the context of reduced GHG emissions makes great business sense, based on the following observations:

- When the vision is focused on measurement and reduction strategies as opposed to off-setting mechanisms, substantial organisational learning can take place in the areas of improved reporting and measurement, technological change-over, environmental innovation and raising ecological awareness.
- Firms can play a vital role in innovation cycles through early adoption of new technologies, which is followed by learning through appraisal and improvement of the technology.
- Shifts in trends, such as those in consumer preferences, requiring lower carbon process design and product design or service provision generate unique windows of opportunity, within which environmental motivation and financial sense converge.

The above preliminary conclusions (section 5.6 and 5.7) will be tested further in Chapter 8 when the sustainability trajectory of Spier, especially in the areas of renewable energy technology adoption, wastewater treatment and solid waste recycling, is interrogated.

A resilience-based view of Carbonology is offered at end of Chapter 6 which tries to re-incorporate carbon-based goals and performance into a corporate resilience framework.

Glossary of terms

Carbon Dioxide (CO_2): the gaseous form of carbon and the most abundant of human-induced greenhouse gases, and therefore the unit of measure against which all other GHG emissions are measured.

CO_2 equivalency (CO_2e): a quantity that describes, for a given mixture and amount of greenhouse gas, the amount of CO_2 that would have the same global warming potential (GWP), when measured over a specified timescale (generally, 100 years). The carbon dioxide equivalency for a gas is obtained by multiplying the mass and the GWP of the gas. The UN climate change panel IPCC uses the unit of billion metric tonnes of CO_2 equivalent ($GtCO_2eq$).

For example, the GWP for methane over 100 years is 25 and for nitrous oxide 298. This means that emissions of 1 million metric tonnes of methane and nitrous oxide respectively is equivalent to emissions of 25 and 298 million metric tonnes of carbon dioxide.

Greenhouse gases: gases in an atmosphere that absorb and emit radiation within the thermal infrared range. This process is the fundamental cause of the greenhouse effect. Greenhouse gases greatly affect the temperature of the Earth and ranked by their contribution to the greenhouse effect include water vapour, carbon dioxide, methane and ozone. The burning of fossil fuels since the beginning of the Industrial revolution has substantially increased the levels of carbon dioxide in the atmosphere. In an attempt to standardise reporting approaches, the GHG Protocol covers the same greenhouse gases as included in the Kyoto Protocol: carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride (WRI and WBCSD, 2001).

Global warming potential: The contribution to the greenhouse effect by a gas is affected by both the characteristics of the gas and its abundance and is classified as its global warming potential. For example, on a molecule-for-molecule basis methane is about an eight times stronger greenhouse gas than carbon dioxide, but it is present in much smaller concentrations so that its total contribution is smaller.

The global warming potential (GWP) depends on both the efficiency of the molecule as a greenhouse gas and its atmospheric lifetime. GWP is measured relative to the same mass of CO_2 and evaluated for a specific timescale. Examples of the atmospheric lifetime and GWP for several greenhouse gases include:

- Carbon dioxide has a variable atmospheric lifetime, and cannot be specified precisely. Recent work indicates that recovery from a large input of atmospheric CO_2 from burning fossil fuels will result in an effective lifetime of tens of thousands of years. Carbon dioxide is defined to have a GWP of 1 over all time periods.

- Methane has an atmospheric lifetime of 12 ± 3 years and a GWP of 72 over 20 years, 25 over 100 years and 7.6 over 500 years. The decrease in GWP at longer times is because methane is degraded to water and CO2 through chemical reactions in the atmosphere.
- Nitrous oxide has an atmospheric lifetime of 114 years and a GWP of 289 over 20 years, 298 over 100 years and 153 over 500 years.

Emission factor: a mathematical factor that converts activity data, such as fuel usage (litres), into emission values (tCO2e/litre fuel)

Chapter 6: Alternative frameworks for understanding corporate sustainability

6.1 Introduction

Inadequacies of the preliminary research design became clear after the first phase of empirical work, which led to the writing of the 'Sustainability Story of Spier' (Chapter 7) and the detailed research into corporate motivation for a range of carbon reduction strategies were undertaken (Chapter 5). The gaps include, but are not limited to, the realization that while integrative disciplines such as industrial ecology and ecological economics utilise a systems ecology perspective, they do not assist in comprehending a complete business system; knowledge areas such as corporate citizenship and corporate social responsibility delve into drivers of sustainability-oriented corporate practices, but cannot explain when or why those drivers are not effective; and the dynamism of real business practice is absent from the theories, constructs and in particular, the environmental assessment tools on offer in the disciplines, knowledge areas and carbon-related literature (scientific and commercial) studied up to this point.

In acknowledgement of the gaps in the preliminary research design, alternative frameworks and analytical perspectives were explored, to work in collaboration with or as alternatives to those studied through the preliminary research design. The search for relevant models and frameworks was driven by the need to assist in an analysis of the case where the preliminary literature review had proven inadequate. The peculiarities of the case such as a context for innovations and a niche operation in search of a sustainability transition, offered some guidance in finding a way of seeing the links and inter-relations between a business system and larger technical and ecological systems.

The frameworks described in this chapter arise from work conducted within research areas labelled as sustainability science, sustainability transitions and resilience thinking respectively, and include the following:

- The material and energy flow analysis (MEFA) framework for calculating societal metabolism (see Haberl et al, 2003; Fischer-Kowalski and Haberl, 2007; Behrens et al, 2007)
- The multi-level perspective (MLP) within a wider sustainability transitions literature (see Geels, 2002; Smith et al, 2010)
- Resilience-based management and governance approach grounded in complexity and resilience thinking

The MEFA framework and the MLP were found inapplicable at the scale and unsuitable for the type of research problem being addressed, as explained in the next section. Resilience thinking and its components were found to be increasingly relevant for defining and transitioning towards sustainability, across various contexts such as natural ecosystems, managed ecosystems and human activity systems; and across different scales, using the notion and framing of social-ecological systems (SES) as complex adaptive systems. In support, recent research has revealed general principles in the structural and functional organisation of complex networks which are shared by various natural, social and technological systems (Cilliers, 2008).

Systems thinking and complexity theory are covered in this chapter, as an entry into resilience thinking and the metaphors which underpin resilience-based analysis: adaptive renewal cycle, thresholds and regimes and panarchy. The application of these metaphors to the real-world practice of institutional governance and business administration yields adaptive management. Special attention is paid to decision-making tools such as dynamic modelling and scenario building, and trends in organisational networking and cyclical learning, which have been studied, documented and refined by social scientists with the aim of understanding and building institutional resilience.

A resilience-based framework is proposed in the last section of the chapter, which enhances the preceding comprehensions of adaptive management. In particular, the framework highlights the role of risk in the context of business management, in order to situate the argument at the level of the SES of concern: a medium-sized business. A growing literature on enterprise resilience is briefly covered to position the proposed framework in relation to existing conceptions of resilience. The resilience-based framework should assist in understanding and enhancing the actual practice of corporate environmental sustainability, thus making up for the inadequacies in previous knowledge categories.

The next section gives brief overviews of the MEFA framework and the MLP, which were highly useful in advancing the researcher’s comprehension of SES and niche actors within socio-technical systems.

6.2 Initial investigations into alternative analytical frameworks

The two alternative frameworks covered in this section rely upon a systems approach, each trying to generate an integrated vision of society’s transition to sustainability. The MEFA framework builds upon work conducted in the fields of social ecology and environmental economics and carries concepts encountered in researching the roots of ecological footprint calculations (some of these are covered in Chapter 4). MEFA approaches the problem of mapping sustainability from a geographical standpoint and defines its unit of analysis as a region, a country or the entire planet. The MLP, with its articulation of niche innovators, is very alluring as a framework for comprehending societal transitions from one socio-technical regime to another. The unit of analysis in the case of the MLP is usually an economic or technological sector in transition. Each of these frameworks was interrogated for its relevance to the case: understanding innovations at the level of an individual enterprise such as Spier.

6.2.1 The material and energy flow analysis (MEFA) framework

Although a work in progress, the MEFA framework is proposed to consistently integrate three parts: MFA (material flow accounting), EFA (energy flow accounting) and HANPP (human appropriation of net primary production (Vitousek et al, 1986) through extended input output analysis. HANPP is included to capture the environmental impact from changes in land use, an important driving force of global change which many other methods such as ecological footprint struggle to take account of.

Sustainability scientists (such as Haberl et al, 2003; Fischer-Kowalski and Haberl, 2007; Behrens et al, 2007) believe that the calculation of societal metabolism through a MEFA framework allows a more holistic assessment of a society's 'progress towards sustainability' vis a vis its 'colonization of natural ecosystems' through agriculture and forestry and extraction of renewable resources through fishing, hunting etc. than does either ecological footprint calculation or the economic valuation of ecosystem services. Sustainability from this perspective requires that human perturbations to ecosystems do not affect the society-nature interaction in a way that threatens society's survival in the long run. The proponents of the MEFA framework argue the need to look beyond the environmental aspects of society-nature interaction to include the cultural or symbolic system (Haberl et al, 2003).

The utility and application of the MEFA framework is most appropriate at global, regional or national spatial scales due to methodological reasons (Haberl et al, 2003). Its application to very small scales of individual establishments will therefore be methodologically challenging. The smallest scale, at which the framework has been applied, to the author's knowledge, is a village in Austria (Fischer-Kowalski and Haberl, 2007).

The MEFA framework is embedded in the conception of human-environment interactions as taking place within social-ecological systems. The view that a social-ecological system (SES) results from the overlap of natural and cultural spheres of causation allows monetary flows and lifestyle choices to be linked to bio-physical stocks and flows and these in turn to ecosystem processes. The conception of SES is also a building block of resilience thinking and is explained in more detail further in the chapter.

6.2.2 The multi-level perspective and sustainable niches

As the problem-framing of sustainability broadens, frameworks which can capture the multi-layered complexity of global institutional, cultural, economic, technological and political processes become the choice for sustainability transitions analysis (Smith et al, 2010). One such framework is the multi-level perspective (MLP), which isolates the causal feedbacks and multiple interactions within a socio-technical system into the three inter-connected and layers of landscape (macro), regimes (meso) and niche (micro) (see Geels, 2002; Geels and Schot, 2007). The MLP works on the notion of a 'nested hierarchy of structuring processes' (Smith et al, 2010:6). Innovations may be understood as emergent behaviours of complex socio-technical systems occurring as interactions between different components across hierarchies. The MLP attempts to order this broad meaning of innovations by firstly, limiting regime-actor innovations to incremental or adaptive changes; and secondly, by nesting niches within regimes, and regimes within landscapes.

Thus at a conceptual level, socio-technical landscape creates a structural context for both regimes and niches; regimes convey the dominant configuration of institutions, rules, culture and techniques, and social practices for realizing a societal function at any given time; and niches provide protective spaces for radical innovations to germinate and eventually transform regimes (Geels, 2002; Smith et al, 2010; Rip, 1992). Geels (2002) considers the landscape level exogenous to the levels at which regime and niche actors operate; thus providing external stimuli for incremental or radical change. A regime is pressured to transform through landscape changes, which in turn generate opportunities for niches (Geels, 2002). Regimes adapt to exogenous change and are known to transition through incremental technological change but over very long periods of time (Smith et al, 2010).

Smith et al (2010) describe the norms and rules within niches as less established than those in stable regimes; niche actors as more adventurous than regime actors and accepting of experiments. However, Spaeth and Rohracher (2010) maintain that ultimately niche success requires more powerful regime actors to become involved and therefore socially legitimize niche developments. The initial neat articulation of the MLP is further challenged by recent work (see Geels and Schot, 2007; Hand et al, 2010). For example, the relations between niche, regime and landscape levels are found to be less distinctive and other social theories are sought to explain the typologies of multi-level interaction and transition pathway developed by Smith et al (2005) and Geels and Schot (2007) (Geels, 2010).

In discussion with Philipp Spaeth (10 March 2011), it was agreed that transferring assumptions which are conceptualised at the level of socio-technical systems can prove problematic when utilised for mapping processes which occur at the level of an individual enterprise. Components of the MLP such as the notion that external developments to which a business responds arise within higher levels of regime and landscape, are useful in comprehending the business cycle. However, the appropriate unit of analysis for the MLP is for instance, the South African energy sector, and not the adoption of different energy technologies by an individual business. Therefore, while the MLP perspective generated interesting insights into Spier's sustainability trajectory, it was not used to track and analyse the business' decisions in the area of ecological sustainability.[21]

6.2.3 Guiding points for choosing analytical framework

Although the MEFA framework and MLP were not applied as tools for case analysis, key points could be identified from the preliminary investigation of these frameworks, which assisted in choosing resilience thinking as the appropriate framework for analysis and include the following:

- An alternate framework for understanding Spier's sustainability journey should be based on a systems approach, allowing for an integrated and connected view of business decisions, their drivers, and their impacts.
- An alternate framework for comprehending business decisions aimed at sustainability should be able to connect the social / cultural sphere where decisions are made with the physical / ecological sphere where they are acted out (such as is attempted in the MEFA framework). In other words, the appropriate framework would take cognisance of the SES conception of human-environment interactions.
- An alternate framework for unravelling a business' transition towards sustainability should be applicable at the scale of an individual business, unlike MEFA framework and the MLP which are more suitable for units of analysis at higher scales (of regions/nations or industries/sectors).
- An alternative framework for studying a human-activity system such as a business should be able to map dynamic processes and interactions taking place within an evolving system which is responding to a changing context, while seeking sustainability.
- And finally, an alternate framework for analysing a business and the flows of energy, water and information through its physical, administrative and knowledge networks should also focus on issues of management and institutional learning, and networks which communicate meaning, in addition to information.

Each of the above points became a criterion for verifying the applicability of resilience-based analysis for comprehending and assessing Spier's search for a sustainable future. The next section delves into systems thinking, the notion of social-ecological systems and complexity theory as foundations for the application of resilience thinking to understand the evolving practice of corporate sustainability.

[21] What may hold promise as future research work according to Philipp Spaeth, is to understand how shocks experienced by a socio-technical system at the level of an enterprise lead to shifts in the regime. In other words, how can the micro-perspective and the MLP relate to each other? And furthermore, what information needs to be gathered from the micro level in order to assess opportunities for intervention to aid sustainability transition.

6.3 Systems thinking, SES and complexity theory as foundations for resilience-based analysis

For many practitioners and researchers, complexity theory, systems thinking and the social-ecological system (SES) construct are inextricably connected to resilience thinking, especially in the context of sustainability (for example Burns and Weaver, 2008; Gunderson et al, 1995). Complexity theory is offered as a general framework for sustainability science (Cilliers, 2008), complexity-based modelling is offered as a means to mapping and achieving sustainability (Peter, 2008), resilience-based frameworks are applied in the pursuit of sustainable ecosystem management (O'Farrell et al, 2008; Walker and Salt, 2006; Gunderson et al, 1995) and a range of philosophical constructs are explored as conceptual frameworks for understanding SES (Du Plessis, 2008).

An interrogation of the related concepts of systems, complexity and resilience is surmised on the assumption that an aspiration for resilience is the key to unlocking the sustainability of complex systems (Walker and Salt, 2006). Therefore, in order to begin exploring the potential of resilience thinking, the researcher needs to first establish the relevance of a systems approach to real-world sustainability problems and allow knowledge integration across disciplines, then more specifically the construct of social-ecological systems as a depiction of reality and finally, the distinctions defined within complexity theory, which are useful for sustainability studies and some of which resonate closely with the defining components of resilience-based analysis.

6.3.1 Systems thinking and mapping

In the standard reductionist approach, discrete contribution from each of the elements is identified and it is assumed that separation does not affect the operation of the parts. A reductionist approach is considered less useful to understand and achieve sustainability (Stanfield, 1977; Clayton and Radcliffe, 1996; Cilliers, 2008). Clayton and Radcliffe (1996) argue that sustainability problems linked to economic and human economic systems, display characteristics which are different to both large scale phenomena such as population dynamics and small or well-defined problems such as production efficiency measures. It is further argued that these phenomena are easier to understand from a systems approach which provides a multi-dimensional framework for integrating information from different disciplines and domains (Stanfield, 1977; Clayton and Radcliffe, 1996). A systems approach also opens the door for applying complexity theory to study and analyse problems of sustainability.

A systems approach to sustainability entails considering the various agents in the world interacting as systems (Clayton and Radcliffe, 1996). Systems can be natural (atoms, ecosystems), designed physical systems (machines, industrial plants), designed abstract systems (mathematical systems, financial management systems), human activity systems (political structures, businesses) or transcendental (beyond knowledge). The recent extension of systems theory to include social and economic systems has required an evolution of the concept of communication. In human systems communication of meaning as opposed to information is more important (Clayton and Radcliffe, 1996). A business may be understood as a human activity system incorporating elements of designed physical and abstract systems. A business such as Spier with agricultural, wine producing and leisure activities is a complex human activity system within which natural and economic systems intersect.

The General System Theory (Von Bertalanffy, 1968) helps us understand that human economic systems are embedded within the larger ecological system, otherwise termed the 'environment'. Economic systems are also 'open' systems in that they require a continuous exchange of energy with their 'environment' in order to maintain their steady state. The understanding that all living natural systems and man-made physical systems sustain themselves by continually obtaining energy from their environment is based on the second law of thermodynamics: the universal principle of increasing entropy. In simple terms, the second law is an expression of the fact that over time, ignoring the effects of self-gravity, differences in temperature, pressure, and density tend to even out in a physical system that is isolated from the outside world. In other words, the entropy of any system which is not receiving energy input will, with overwhelming probability, increase over time (Clayton and Radcliffe, 1996). Just as living systems, human systems attempt to build, reproduce and create order and while doing so, draw energy from their environment and sink wastes into it.

In order to effect systems change it is considered necessary to first model the system in a manner that can reflect reality before and after the systems change (Morecroft and Sterman, 1994). Material and energy flow analysis is offered as a tool for understanding a system as made up of flows as opposed to separate components, while life cycle analysis attempts to capture system processes and flows in their entirety. However, these tools are limited to describing the physical aspects of a system and at best may include biogeophysical analyses. Such tools attempt to reduce complex human systems such as a business to their physical components (operational, manufacturing, energy and water consumption) through designed abstract systems (financial reporting, accounting, sustainability reporting). Societal and cultural dimensions of a system are harder to model. As discussed in the previous section, the MEFA framework is one such attempt at capturing human-environment interactions as overlapping biogeophysical and socio-cultural spheres.

Systems dynamic modelling (Morecroft and Sterman, 1994; Coyle, 1996) is a methodological tool from the field of organisational learning (Senge, 1995), which also attempts to capture the more nuanced aspects of socio-cultural and socio-technical systems. System dynamics provides a framework involving qualitative description, exploration and analysis of systemic problems in terms of processes, business rules, information and boundaries. This enables the facilitation of quantitative computer simulation modelling and analysis to assist understanding of the underlying reasons for observed behaviour. The complex interrelationships between various parts of real-world problems including human behaviour are visualized through feedback structures and system-mapping tools. Based on systems thinking, the systems dynamic modelling process is offered as an alternative to conventional reductionist methodologies when they prove ineffective in understanding real-world systemic problems.

6.3.2 Social-ecological systems (SES)

An SES is an integrative construct that views humans simultaneously as an indivisible part of the biosphere and as initiators of novel responses and actions through the development and adoption of technology (Du Plessis, 2008). A vital characteristic of SES which separates them from other ecological systems is human sense-making at organisational and societal levels, which drives social and technical responses to environmental stimuli, and is defined as the adaptive capacity of SES (Peter, 2008).

Frameworks for SES are useful in understanding the complex, systemic challenges of sustainable development (Peter, 2008; Walker and Salt, 2006). A number of frameworks are identified for studying and understanding SES (see Du Plessis, 2008). Those which focus on analysing system resilience or vulnerability to change, tend to favour participatory approaches to scenario-building (for instance the case of The Kristianstads Vattenrike, Sweden described in Walker and Salt, 2006) and may incorporate regime shifts and linked adaptive systems at multiple scales (explained further under components of resilience thinking).

A dedicated focus on resilience/vulnerability may however leave gaps in SES understanding which is addressed by other methodological frameworks (Du Plessis, 2008). Du Plessis (2008) mentions two additional frameworks of relevance to the study of a business: the first is underpinned by network theory to describe institutional structure (promoted by Janssen et al, 2006) and the second is based on properties which differentiate human ecosystems from non-human ecosystems (developed by Westley et al, 2002). However, all these frameworks provide a limited understanding of the structure and behaviour of real SES, as is expected in any modelling of complex systems.

The noosystem conception of SES, as described by Du Plessis (2008) assists in understanding system behaviour with respect to agency for sustainability transition. An SES as a noosystem is an integrated framework of three spheres: geosphere (matter), biosphere (life) and noosphere (mind). The geosphere includes all materials, natural and man-made; the lithosphere, atmosphere, energy and water while the biosphere represents all forms of life, land-based and aquatic. The noosphere is composed of structures of meaning and significance, domination or power structures (the realm of political ecology) and legitimization through norms, standards and law (Du Plessis, 2008). Humankind presents simultaneously as matter, life and mind and thus exists in all spheres.

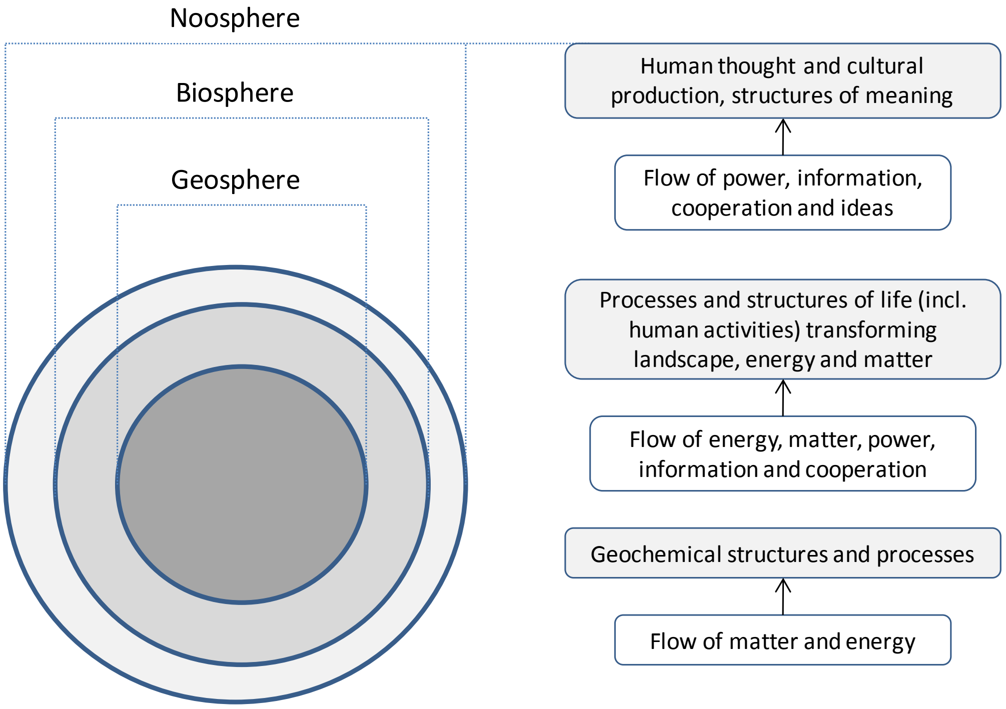

Figure 6.1 The Noosystem Framework Based on the 'spheres of evolution' of Vladimir Vernadsky in du Plessis, 2008

This comprehension of the human-environment interaction circumvents the limitations of the two extreme paradigms: humanity in control of the environment (environmental resource management) or human systems as completely embedded in natural systems (ecological economics). Forces which transform the geosphere and the biosphere are generated in the sphere of abstract human thought and the cultural phenomena this generates, particularly in the current anthropocene (Crutzen, 2002). In other words, the biogeophyiscal force represented by human activities such as mining, farming, fishing, industrial production and societal consumption, is guided by mental phenomena based upon human values and opinions or perceptions. The noo or mind is also adaptive and capacity for change towards sustainability therefore resides in the noosphere.

Key features of SES, which become increasingly relevant for resilience-based analysis, are the propensity to re-organise and disorganise in a variety of ways, at different levels of description and scale (Peter, 2008); and an ability to result in any of multiple futures which cannot be predicted, but can be imagined (Walker and Salt, 2006).

6.3.3 Complexity theory

Cilliers (2008) argues that complexity theory or the understanding of complex systems can be immensely helpful in developing a general framework for studying social-ecological systems. Especially, when the objective of study is to understand and describe efforts aimed at sustainability, and the notion of sustainability remains complex (Cilliers, 2008; Peter, 2008). He offers complexity theory as an alternative perspective to the reductionist, scientific method as well as to post-modern or holistic approaches.

Key distinctions (from Cilliers, 2008; 2001) which assist in an understanding of the nature of complexity and become the guiding principles for this thesis are summarized below:

- *Interactions* Complexity is a characteristic of a system. Complex behaviour emerges as a result of the interactions between the individual components of a business. These interactions are dynamic which means the strength of interactions is not constant. The focus of study of complex systems should therefore be on the relationships between components, and not on the individual components.
- *Self-organisation* A complex system displays the property of self-organisation, which means that it can generate new order internally and is not reliant on an external designer. Thus systems adjust some of their internal structure in response to environmental conditions. A study of complex systems thus needs to understand the complexities of the internal structure of a system and its environment.
- *Emergence* Complexity includes the notion of emergence, which may be argued as the inability of the human mind to model or describe a complex system in its entirety. Any modelling of a complex system is necessarily limiting. Importantly, emergence is not metaphysical (Peter, 2008). It results from uncertainties introduced by observer-subject rationality. Therefore, it is the responsibility of the researcher who has taken up the task of studying; describing and analysing a complex system, to acknowledge that there will always be a gap between complex reality, its perception and observation, and therefore its model.
- *Multiplicity of descriptions* This distinction is linked to the above point in that it is possible to decompose and assemble, as in understand and describe a complex system in more than one legitimate way. Different descriptions may have different degrees of complexity, depending upon the perspective from which the description was made. Any specific description will only take into account a limited number of system

characteristics. A study of complex systems can therefore be undertaken from a variety of perspectives, using a multitude of frameworks and each description will yield different results, some more interesting than others.

Cilliers (2001) discusses the problematic status of our knowledge of complexity in more detail, especially with regards to the scientific claims made in relation to our understanding of complex systems. The first concern deals with the notion of boundaries and the framing of the boundary of a system. This concern is as much about where a system's boundary can be drawn as it is about how a boundary may be treated in systems analysis. Complexity-based thinking advocates an operational framing of the system. Within an extended understanding, 'boundaries are not just perimeters, but become functional constitutive components of a given system' (Zeleny quoted in Cilliers, 2008: 48). Further discussion on the 'placing' of a boundary in a spatial context has implications for the analysis of social-ecological systems. While biological and ecological systems can be visualized in a contained geographical location, social systems especially of global production and consumption are often widely distributed in space.

The second concern deals with the importance of hierarchies in the study of complex systems. Cilliers (1998) maintains that hierarchies are necessary to system analysis, although not in a conventional or classical understanding. This means that system hierarchies need not be nested, symmetrical or rigid but are asymmetrical and can be transformed. Just as boundaries become components of a complex system and their interactions with other system components are critical to system analysis, so do the cross-communications between hierarchies establish vital system behaviour, especially adaptability (Cilliers, 2001).

Cilliers (2008: 50) refers to system vitality as the 'ability of a system to transform hierarchies'. The notion of system vitality finds parallels in resilience thinking, whereby a system adapts or changes its structure in order to remain in an existing stable state. Transformation of hierarchies may entail subversion of dominant or obsolete structures through alternative routes of communication or the resurrection of latent cross communications in a changed context (Cilliers, 2008).

The third and very important area of concern in applying complexity theory to systems analysis covers the limits to knowledge when trying to model reality and how this limitation can be used as a creative energy in critical thinking. Cilliers (2008) argues that humans cannot deal with reality in all its complexity and must therefore reduce this reality; as in use models, laws, theories and frameworks in order to understand it. Previously mentioned limitations, such as the place and treatment of boundaries and structures in a complex system, the openness of complex systems, latent interactions which may appear unimportant at the time of study and be left out in the description but become vital later, means that models of reality will always be flawed (Cilliers, 1998).

Cilliers (2008) urges that the gap between the model and the complex system be used as a creative impulse for transforming models. However, he also warns us that no matter how sophisticated the framework utilised, insights gained from the study of complex systems are context and case-specific and cannot be treated as universally applicable. The nature of complex systems is such that ‘we are confronted by a complex problem which is transforming not only while we are investigating it; but because we are investigating it’ (Cilliers, 2008:53).

In the context of sustainability, or the application of complexity theory to the study of SES, Peter (2008) argues that human actors account for emergent system behaviours through their individual and collective actions. The predictability of system behaviour (encountered in mapping and modelling exercises) is therefore compromised through event-driven dynamics resulting from human decision-making and human perceptions based on value systems and beliefs (including those of the observer). The property of self-organisation of SES is also considered subject to the unpredictability of human agent behaviour (Peter, 2008).

6.3.4 Guiding points for adopting and applying analytical framework

The above discussion provides useful starting points for adopting and applying any framework for conducting a case analysis, especially when the case incorporates critical human elements in addition to ecological and physical components.

- Through the SES construct, businesses or human-activity systems may be conceived as individual SES embedded within local, regional and global SES. Decisions taken at the level of a local SES determines the flow of materials and energy at local, regional and sometimes global scales, such as in the case of the global carbon cycle. The SES construct also aids in the visualisation of a business as made up of multiple flows of materials, energy, waste, water and information.
- Modelling human activity systems (such as a business) poses a specific challenge as it incorporates mapping flows of matter and energy through not only physical systems which may be natural or human-designed, but also feedbacks and decisions within abstract systems of information, structural legitimisation and cultural meaning. This problem is only avoided when mapping for instance natural ecological systems (of which very few exist on Earth) or technically specified and calibrated production processes.
- SESs are complex, adaptive systems due to the presence of human agents, who generate the adaptive capacity of a system to respond to its environment (Peter, 2008; Du Plessis, 2008). This means that SES should display discontinuities between levels, exhibit emergence and utilise communication in some form in order to regulate or control the behaviour of certain components by other system components (Cilliers, 2008).
- Even when highly sophisticated models and techniques are used to incorporate the human-driven behaviours of complex and adaptive SES, complexity theory tells us that

multiple ways of perceiving and describing the system exist and each perspective is equally valid.

- Resilience-based analysis may not be sufficient to describe or understand SES since it may tend to focus on vulnerability to change. A framework for unravelling the sustainability journey of a business would incorporate additional aspects, such as the role of different types of organisational decision-making structures within a human activity system. In other words it would take cognisance of the design of governance and the management of change and learning (Westley, 1995).

It is important to establish at this point that complexity theory was introduced in this chapter as a means to ascertain the complex nature of SES, and following on that the verity of SES characteristics as aligned with key distinctions of complexity; in particular, the multiplicity of legitimate descriptions possible for the study and analysis of SES. Complexity theory thus provides a general framework for studying corporate sustainability, and will not be used exclusively for the case analysis. Resilience thinking and its extension into adaptive management and enterprise resilience literatures will provide the framework for detailed case analysis.

The next few sections address components of resilience thinking and the attributes of a resilient SES.

6.4 Interpretations and components of resilience thinking

Holling (1995) builds an argument to support the use of complexity and resilience as theories of change and of transitions, towards an integrated understanding of system behaviour: knowledge of the system being observed is always incomplete, surprise is inevitable and science is incomplete; at the same time the system itself is a moving target, defined by evolving impact of management decisions (micro level) and the scale of human influences on the planet (macro level). Therefore, inductively-based theories of change (complexity and resilience) that can contain short and long-term changes, gradual and abrupt changes and support the existence of multi-stable states, order and disorder in self-organising systems are required.

Resilience thinking is in ideological opposition to the increased efficiency, incremental growth and optimal performance paradigm since the latter has led to the irreversible loss or near demise of ecosystem functions in various parts of the world (Holling et al, 1995; Walker and Salt, 2006; Burns and Weaver, 2008).

The term resilience in the context of natural systems was defined as the amount of change or disturbance required to move an ecosystem from one state to another (Holling, 1973). The generation of practical policies for the management of SES derived from the study and analysis of complex ecological systems, led to the definition of SES resilience, as the capacity to absorb disturbances and reorganise while undergoing change so as to continue functioning in essentially the same way through structure, identity and feedbacks (Walker *et al*, 2002; Peter, 2008).

More recently, the extension of resilience thinking to the private sector has generated a third interpretation: that of enterprise resilience as the ability to withstand systemic discontinuities and adapt to new risk environments (Hamel and Valikangas, 2003; Starr et al, 2002) such as technological discontinuity, regulatory upheaval, geopolitical shocks, industry deverticalisation and abrupt shifts in consumer tastes, among others. Resilience in all three contexts above focuses on the ability of a system to recover, rather than the speed with which it is able to ‘bounce back’ (Walker and Salt, 2006:63).

In summary, from a resilience perspective, sustainability involves maintaining the functionality of a system in the face of unexpected events and uncertainties (Walker et al, 2002). In order to explain how an SES could maintain functionality through unpredictable change, resilience thinking utilises three metaphors: thresholds and alternate regimes (or stable system states), the adaptive renewal cycle with four distinct phases and panarchy (Walker and Salt, 2006; Gunderson and Holling, 2002).

6.4.1 Thresholds and regimes

Thresholds are defined as crossing or tipping points that can potentially change the feedbacks to the rest of the system, thus altering the future of SES (Walker and Salt, 2006). In terms of ecological resilience, the system crosses a threshold (or a level in a particular variable) when it moves from one state, or regime, to another (Holling, 1973). SES are known to be affected by many variables but are usually driven by a few controlling (often slow moving) variables (Holling, 1995; Walker and Salt, 2006). Walker and Salt (2006) use the example of a lake that receives plant nutrients such as phosphorous, to single out the few controlling variables that determine whether the lake water will stay clear or cross a threshold and turn murky through irreversible algal growth.

Two and three dimensional representations of a Ball-in-a-Basin Model are utilised to help the reader visualise the movement from one stable regime to another (Peter, 2008; Folke et al, 2004; Holling, 1995). The current state of the SES is represented by a ball while the basin represents the set of states which have the same kinds of functions and feedbacks (Folke et al, 2004). The shape of the basin is continuously changing in response to external conditions as is the position of the ball within the basin. The edge of the basin is a threshold separating alternate basins or alternative regimes (Walker et al, 2004).

The relevance of thresholds to both resilience and sustainability are explained as follows: a system behaves differently once it moves beyond a threshold into an alternate regime where system structure, identity and feedbacks are different (Walker et al, 2004). These differences may be unforeseen and undesirable as in the case of lake eutrophication and may be expensive to reverse, which means it may be difficult or impossible for a system to cross back to a previous regime once a threshold has been crossed (Walker and Salt, 2006). A system's resilience is measured by its distance from thresholds along a few key variables and by the depth and size of the basin (Walker and Salt, 2006; Folke et al, 2004). In other words, a resilient system can absorb more shocks and disturbances while crossing a threshold into a new regime. And finally, the sustainability of an SES is unlocked by knowing if and where thresholds exist and managing the SES in relation to these thresholds (Walker and Salt, 2006).

The capacity to recognise SES thresholds and to plan for them is thus a critical element of SES management for sustainability. Related to thresholds is the knowledge of the slow controlling variables and key drivers which cause an SES to cross thresholds between alternative regimes (Walker et al, 2004). The capacity of actors or agents in a system to influence resilience (distance from thresholds) is called adaptability (Walker et al, 2004). If adaptability is not sufficient and the existing system is untenable, then transformability is required (Walker and Salt, 2006).The adaptive cycle metaphor discussed in the next section incorporates the transition of an SES from one stable state to another, without alluding to the Ball-in-a-Basin model.

6.4.2 Adaptive renewal cycle

An adaptive cycle is a resilience theory-based conceptual framework used to represent different stable phases in which a complex system may be identified (Peter, 2008; Walker and Salt, 2006; Holling, 1995).

Recent resilience-related research suggests that a range of systems including ecosystems, institutional systems and SES display adaptive capacity and appear to move through the four phases of an adaptive cycle (Walker et al, 2006; Holling, 1986; Janssen, 2002). In Holling's (1995:31) words: 'institutions and societies achieve periodic advances in understanding and learning through the same four cycles of growth, production, release and renewal that shape the spatial and temporal dynamics of ecosystems'. The first two phases of the cycle are typified by slow growth and capital accumulation – natural and manmade followed by fast disturbance and renewal followed by re-establishment (Holling, 1986). Holling (1995) compares a system's trajectory in the first two phases with sustainable development and a system's capacity to self-renew with the ideal of sustainability.

Empirical evidence suggests that in the case of social and institutional systems, human intent can suppress transition from one phase to another (Walker et al, 2006). A business, which is a human activity system, is known to display the characteristics of a complex adaptive system and therefore, it is possible to trace the trajectory of a business on a sustainability path as an adaptive renewal cycle (Walker et al, 2006). Proponents of resilience thinking argue that the original idea of 'creative destruction' which underpins the adaptive cycle metaphor was sparked by an Austrian Economist Joseph Schumpeter who observed economic and business boom and bust cycles and concluded that capitalism was a perennial source of creative destruction (Walker and Salt, 2006; Holling, 1995). The term is used in resilience literature to describe the shocks and uncertainties which breakdown the stability of a conservation phase in order to release resources for innovation and regeneration.

Figure 6.2: Adaptive renewal cycle (Gunderson and Holling, 2002) based on Holling (1973)

Various types of resilience analysis seek to identify where resilience resides in a system and understand how and when it is lost or gained with the aim of developing strategies which increase system resilience (Fiksel, 2006; Walker et al, 2002). Each phase is characterized by response strategies linked to the transition or continuation needs of a particular phase as well as agents such as leaders or experts which assist an SES to remain stable in a certain phase, or transition to another phase.

In some instances, actors can strategize a release phase without allowing the system to go through the upheaval of collapse while in other cases a system can remain stable in a conservation phase for a long time by allowing collapse and regeneration to occur at the scale of sub-systems (Walker et al, 2002; Westley, 1995). The dynamic interaction among adaptive renewal cycles at different scales, while in different phases, is explained further in the section under panarchy.

Table 6.1: Characteristics of each phase of an adaptive cycle (summarised from Walker and Salt, 2006)

	Fore loop: stability and productivity		**Back loop: resilience and recovery**	
Phase / Characteristic	**Rapid growth**	**Conservation**	**Release**	**Reorganisation**
transition	incremental	Incremental, slow	quick	fast
strategies	Exploitation of niches, new opportunities	Conservative and efficient resource use, capital accumulation	Bound resources released, source of renewal	creative ideas, new alliances
structure	High external variation, uncertainty	Increased actor connections, structure rigidity	Loss of structure, connections break	Forming, new linkages
flexibility	High flexibility, redundancies	Loss of flexibility over time	High uncertainty, chaotic	High potential for resilience
agents	Entrepreneurs	specialists, strong competitors	Ecosystem: fire, draught, disease Industry: market shock, new tech	opportunists, pioneers
resilience	High resilience, accessible resources	decreasing resilience, system stable over a small range, climax	Loss of resilience, collapse	Initiation of change (creative or destructive)

Walker and Salt (2006) emphasise that the sequence in the adaptive cycle is not an absolute and that variations exist in both natural and social systems. The most important variation, as discussed previously is the movement from conservation into growth and not necessarily into release, mostly through human intention. Another is the transition from growth directly into release, bypassing the conservation phase. All of the above variants to the adaptive cycle are possible and have been observed, except for a transition from release directly into conservation (Walker and Salt, 2006; Westley, 1995)

6.4.3 Panarchy

The term panarchy was first used by Gunderson and Holling (2002) to describe the cross-scale and dynamic character of interactions between human and natural systems. While the structure and dynamics of the system at each scale are driven by a small set of key variables, the behaviour of the entire system is governed by the linked set of hierarchies (Walker and Salt, 2006). A panarchy framework consists of nested, multi-scale adaptive cycles arranged in space and time where adaptive cycle phases interact and connect with one another in a dynamic and unpredictable manner (Peter, 2008). Walker and Salt (2006) utilise a one-dimensional representation of adaptive cycles consisting of fore loops and back loops in order to visualise cross-scale interactions.

A typical example of linked adaptive cycles from the natural world is a boreal forest, in which fresh needles regenerate yearly; foliage crown cycles every decade; and trees, gaps and stands cycle at a period of a century or more (Holling, 1995). Each level has its own distinct spatial and temporal features as well as sources of creative destruction (figure 6.3). For example, leaf or needle structure is measured in centimetres; canopies operate in scales of metres while forest stands are measured in tens of meters and the entire forest over kilometres of distances.

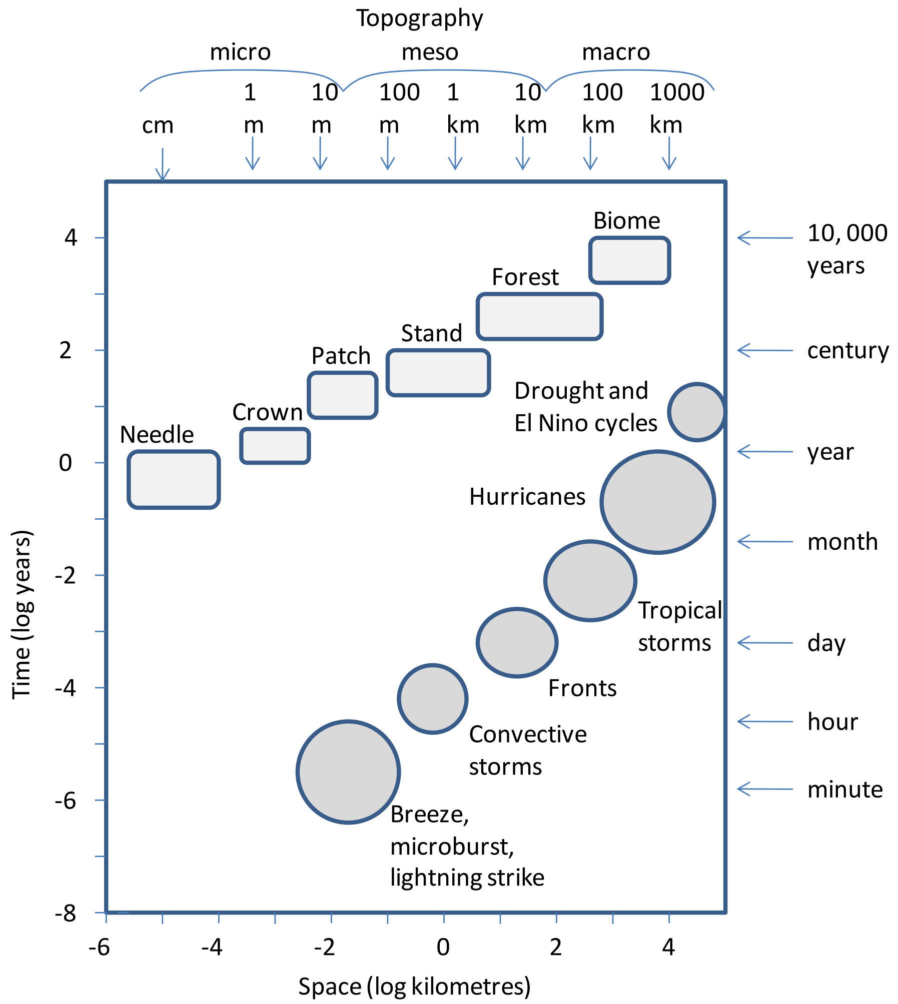

Figure 6.3: Space/time hierarchy of the boreal forest and of atmosphere (source Holling, 1995)

A set of social adaptive cycles exists at different temporal and spatial scales of individual workers, operation of the forestry business, the capital investments, the industrial sector and the economic demand for forestry products which also interact with the natural hierarchy (figure 6.4). Individual workers also interact with cycles at the scales of family, community and the larger society. Together, these natural and social sets of cycles and the interactions between them (determined by climate, geomorphologic, biological, societal and economic processes) generate the panarchy of the complex social-ecological system.

Appreciation for panarchy will encourage management practitioners to look beyond the scale of concern (such as a farm, a business or an institution) to understand and factor in top-down and bottom-up linkages (Walker and Salt, 2006). System behaviour at one scale can influence or even drive behaviour at other scales. For example, reinforcing connections with larger scales can perpetuate a conservation phase at smaller scales that might have ended otherwise, through an injection of additional resources.

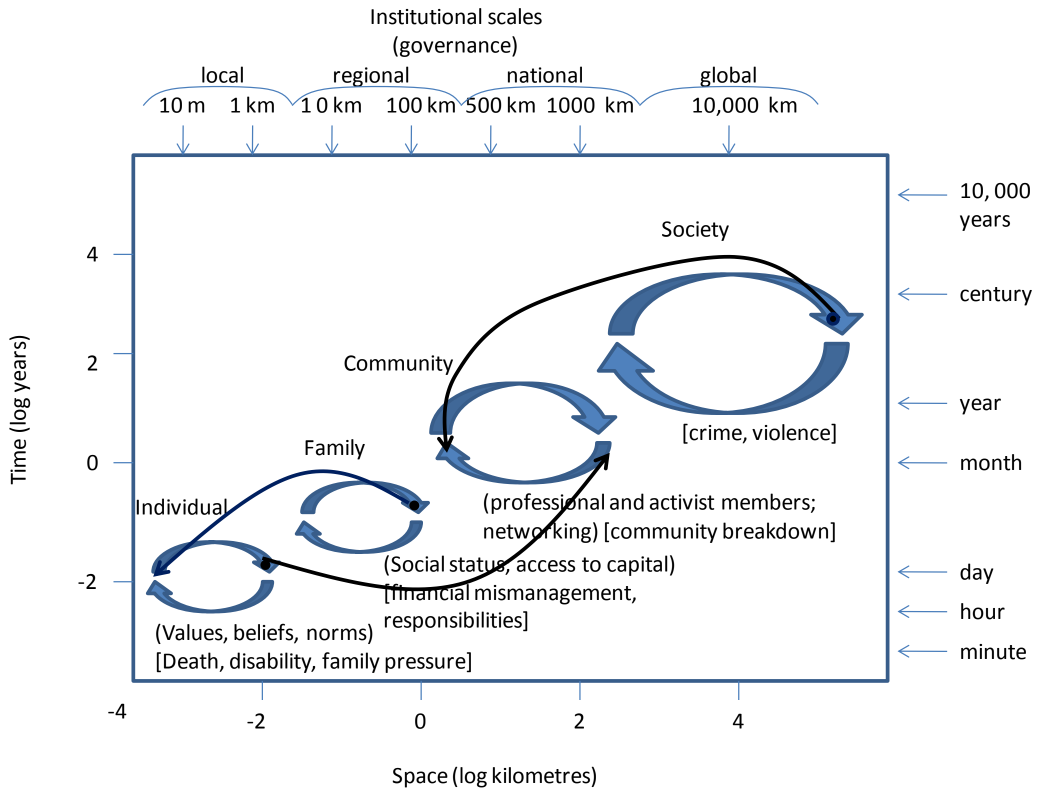

Figure 6.4 Space/time hierarchy of social adaptive systems and determinants of behaviour and sources of disturbance at different scale (based on Walker and Salt, 2006)

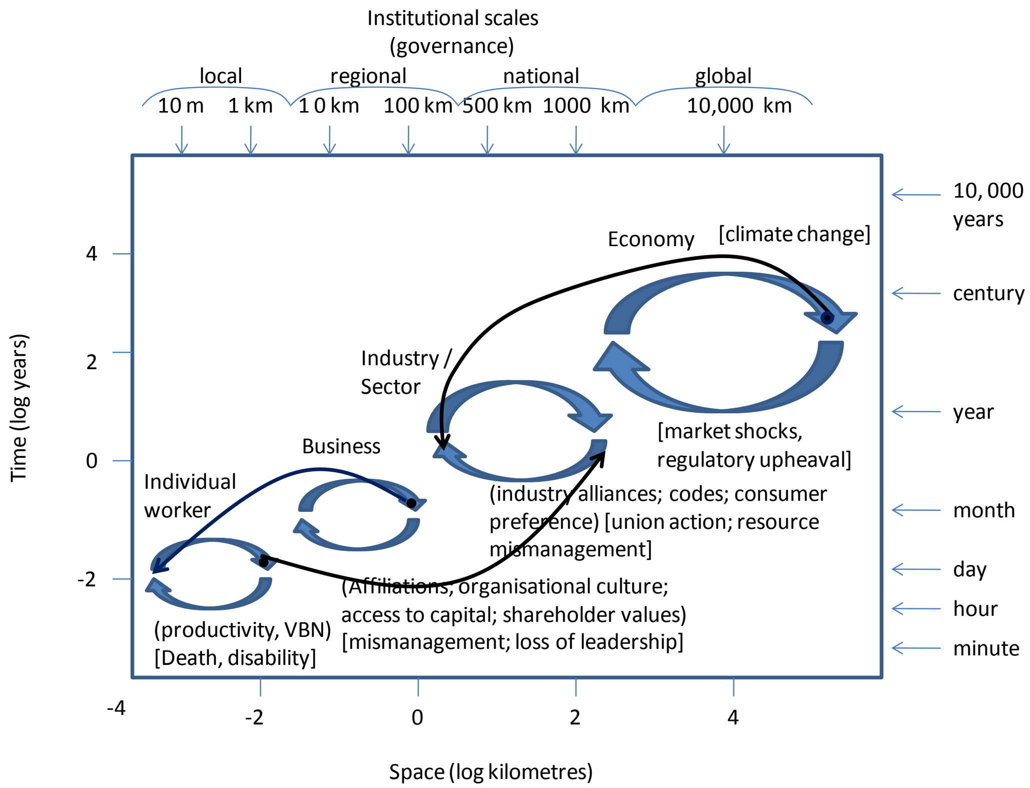

Figure 6.4 (continued) Space/time hierarchy of social adaptive systems and determinants of behaviour and sources of disturbance at different scale (based on Walker and Salt, 2006)

Application of the three core metaphors of resilience thinking (adaptive renewal cycle, thresholds and panarchy) to management practices through various tools (systems modelling, scenario building and networking) is termed adaptive management and is the main focus of the next section.

6.5 Adaptive management and resilience-based governance

Three major sustainability science ventures, listed below, have sought to apply resilience thinking to problems of ecosystem resource and ecosystem services management and have in the process generated greater understanding of what constitutes adaptive management of SES:

- *Barriers and Bridges to the Renewal of Ecosystems and Institutions* (Gunderson, Holling and Light, editors, 1995) showcases six complex, natural resource management cases in North America and in Europe, with commentaries from political and social scientists
- *Resilience Thinking* (Brian Walker and David Salt, 2006) presents key insights on the application of resilience thinking metaphors through examples of mismanaged, well-managed and unmanaged SES across the globe

- *Exploring Sustainability Science from a South African perspective* (Michael Burns and Alex Weaver, 2008) contains an ensemble of water governance, land management and mining cases in Southern Africa from a resilience and complexity-based perspective, and creates a dialogue among spatial planners, philosophers and social scientists in order to reflect upon the transdisciplinary nature of sustainability problems

A review of resilience literature with specific reference to adaptive management yields key recurring themes: the use of dynamic modelling techniques to aid decision-making, scenario-building as a start to networking and networking as a means of strengthening general resilience in the SES. *Barriers and Bridges* and *Exploring Sustainability Science* in particular devote considerable sections to incorporate the views of social scientists and management practitioners in examining whether the metaphors of adaptive cycles and regime thresholds can be transferred from the domain of ecosystems to that of institutions.

Sanderson (1995) questions this transference of metaphors and associated assumptions from the developed Global North to the politically weaker context of a developing country. He heralds the dangers of applying imported frameworks without full appreciation of the history and the current development paradigm that have been shaped by forces external to developing countries. The need for understanding the cross-scale interactions between local level initiatives and globally determined agendas therefore becomes ever more pertinent in a structurally weaker developing country (Sanderson, 1995). At the scale of individual institutions, the related theme of adaptive learning for responding to external and organisational change is encountered.

6.5.1 Dynamic modelling

An array of dynamic modelling techniques such as bio-complexity, system dynamics and thermodynamic analysis are being pursued by different research groups to analyse the impact of ambiguities or uncertainties resulting from key variables such as climate change, technological innovation and policy response on human-environment systems or SES (Fiksel, 2006; Walker et al, 2002). What these qualitative techniques have in common is the recognition that steady state sustainability models are simplistic, that SESs are complex and adaptive and that effective decision-making with regard to sustainability needs to increase system resilience in the face of shocks and disturbances (Holling, 2001; Gunderson & Holling, 2002).

Bayesian nets are yet another integrative tool for modelling systems which enable interdisciplinary and transdisciplinary inputs towards adaptive management (Peter, 2008; Dawid, 2002). Peter (2008) argues that Bayesian modelling is not restricted to mapping flows between variables, and can therefore incorporate much broader influences and causal sensitivities. It is a strategic modelling tool which allows multiple scales, different perspectives and ethical systems to be included when representing observed and planned interventions (Peter, 2008).

6.5.2 Scenario-building

The ability to identify multiple explanations for system behaviour under different scenarios arising from a variety of hypothesis, views and opinions yields adaptive or resilience management (Walker et al, 2002; Peter, 2008). Scenario-building as a form of engagement with key stakeholders, sometimes in conjunction with dynamic modelling techniques, is recommended for not only improved decision-making, but also for building SES resilience.

Key sources of innovation, possible unforeseen events and the visions, hopes and fears of participants as drivers of change are identified by innovative institutions when building scenarios (Walker and Salt, 2006; Walker et al, 2002). Innovative institutions can thus carve their future through scenario building by incorporating a mix of threshold knowledge, vulnerability or risk perceptions and innovation potential by tapping into the mind-maps of participating stakeholders.

The following questions are suggested as starting points for building SES scenarios, once participants appreciate that the SES they are interested in, is a complex adaptive system (Walker and Salt, 2006):

- What are the key attributes of the SES?
- What are the slow variables that define this system?
- What are the thresholds beyond which the system will start behaving differently?
- Or which are the important feedbacks which are likely to change under certain conditions?
- What phase of adaptive cycle is the system moving through?
- What is happening above and below the scale of interest?
- What are the linkages between scales?

Where knowledge of possible thresholds, the slow controlling variables and system regimes / states is not accessible or certain, then institutions are encouraged to build general resilience and adaptive capacity through adaptive learning and inter-organisational networking (Gunderson et al, 1995; Walker and Salt, 2006).

6.5.3 Networking

More connections among key people and groups are deemed necessary for adaptive change, whether the requirement is maintaining or changing the SES under consideration (Gunderson et al, 1995; Walker et al, 2002; Burns and Weaver, 2008). Furthermore, networking is believed to improve mutual understanding and co-operation amongst real agent actors who participate in the use and management of SES resources to yield collective recognition of the mechanisms that create system resilience in certain scenarios (Peter, 2008).

Westley (1995) reflects at length upon the theme of networking in her discussion of the ecosystem management cases covered in *Barriers and Bridges*, focusing on the role, the origins and different types of collaboration / consensus-building needed for the successful implementation of adaptive management. Westley (1995) notes the need for inter-organisational collaboration stressed in each case and uses collaborative theory to differentiate between various forms of collaboration found in the actual case descriptions. These forms of collaboration are typically planning-led, vision-led or learning-led and correspond with strategy making within the organisation from which the collaboration originates (Westley and Vredenburg, 1991).

Each collaborative mode is characterised by varying ability to complete different tasks associated with management such as issue definition, resource mobilisation, action mobilisation and institutionalisation (Westley, 1995). For example, visionaries are strong at issue definition and action mobilisation but weak in creating the structures necessary for ensuring ongoing collaboration. Planning-led networks, often instituted by governmental organisations are particularly strong at resource mobilisation but may lack the creativity to extend issue definition beyond the given mandate or expand networks beyond existing bureaucratic structures.

Westley (1995) cites examples of learning-led networks such as social movements, scientific consortia and community forums. Adhocracies such as research institutes and university departments are used to freer association and individuals from such organisations are conducive to coalesce around a common issue and able to mobilise action easily but may struggle to secure committed resources (Zald and McCarthy, 1987). Such collaborations are also called shadow networks in comparison to the more institutionalised parent organisations, and are linked to emergent strategies and unpredictable behaviours.

6.5.4 Adaptive learning

The three collaborative modes of vision, planning and learning discussed above are likened to the phase-specific response strategies identified in the different phases of the adaptive renewal cycle. This transference of notions from collaborative theory and social change to the transition of institutions is made with the express aim of supporting the notion that human systems have been observed to follow a trajectory which is similar to the adaptive cycle.

For example, as cited by Westley (1995), Wallace's cycle of revitalisation (1966) (figure 6.5) charts a path for social systems that correlates very closely with the two-dimensional representation of Holling's (1973) adaptive cycle for ecosystems (figure 6.2). The consolidation state of an organisation would be dominated by planning processes; the revitalisation state by visionary-led processes and that of reorganisation or renewal by innovation and learning processes.

Adaptive learning is about managing SES (made up of natural and social systems going through synchronised or unsynchronised cycles of change) in such a way as to avoid the extreme states of late consolidation (when learning and adaptability gives way to efficiency and routine) and release (characterised by chaos and disorder not necessarily desirable to managers) (Westley, 1995; Walker et al, 2002).

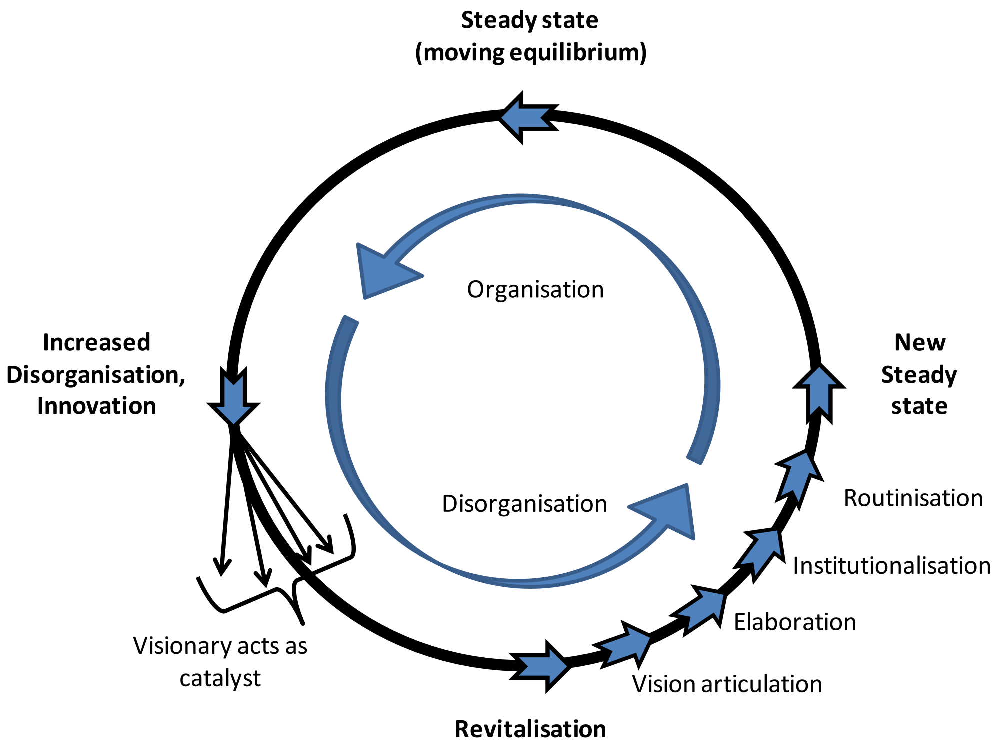

Figure 6.5 Cycle of revitalisation (Wallace, 1966)

Building on the principles that adaptive management is responsive action, triggered by change in the environment and that grand order is found in small processes, Westley (1995) proposes that institutions in different stages of the cycle above practice adaptive management in slightly different ways. For instance, the planning-led steady state must promote strategic conversations to take place across levels and between functions, allowing for seeds of innovation to be planted, some of which can become dominant and contribute to the revitalisation of the organisation. Conversely, the learning-led stage of innovation would also need to create structures for continued convergence and direction.

Baets (2006) applies the principles of complexity, chaos theory and quantum structures to generate a practical framework for organisational learning. It is not possible to repeat in this thesis, the intellectual development of each scientific concept used by Baets for substantiating his argument that organisations are complex, agent-actor networks and display dynamic and non-linear behaviour (terms which have been defined through observations conducted in the fields of meteorology and liquid thermodynamics). Baets (2006) argues that change cannot be introduced at the level of mental models, or at the individual or organisational level except through a new cycle of individual learning through new experiences, which can lead to new mental models and after significant collaboration, to new routines and shared models.

6.5.5 Key points from extending resilience thinking into adaptive management

In this section, the conceptual components of resilience thinking as they have been taken up by social scientists and management theorists to generate ideas on what constitutes adaptive management, were covered. Following are the core thoughts that can be distilled from the above discussion:

- Adaptive management as a management paradigm seeks to align the institutional processes of learning, innovation and exploration followed by the establishment of routines and planned processes with the cyclic patterns of growth, consolidation, release and rejuvenation observed in the trajectories of ecosystems at various levels.
- In order to equip decision-making with an adaptive quality, the different components, agents and drivers of institutional systems must first be modelled, for which a range of modelling techniques (with or without IT support) may be utilised.
- Scenario building is a qualitative, modelling technique which can incorporate a wide variety of hypothesis, views and opinions to generate probable SES scenarios and at the same time build SES resilience through its networking quality.
- Networking is considered imperative to building institutional resilience at both multi-organisational and inter-organisational levels.
- The type of collaboration initiated by an organisation with other entities is a reflection of the internal structures of that organisation: bureaucratic institutions establish planned, heavily-structured forums; visionaries generate action and resources around their visions without necessarily utilising procedural set-ups; while individuals from adhocracies assemble organically around a central theme often without resource or structure commitments.
- The actual management of adaptive renewal cycles and distinct collaborative styles which manifest in internal and external institutional networks requires organisational learning, at individual employee, manager and complete organisational levels.
- The cycle of learning within an organisation is the cycle of change, which means that a business which is not allowed to experience revitalisation or change at the level of the organisation, or components within the parent organisation, or individuals, has very little chance of learning.

The main idea to take forward from the above synthesis is that the resilience of an organisational SES has a lot to do with the ability to cope with change and that organisations who have learnt to learn differently during different stages of their life-cycle are more adept at responding to change, and are also more resilient than those who have not. These notions are expanded further in the next section which draws upon enterprise resilience writings.

6.6 Resilience and ecological sustainability

Resilience thinking and the ensemble of theoretical constructs which underpin resilience-based analysis of SES is useful for understanding the system not only at the level of a business, but also for factoring in impacts and drivers from levels below and above in the panarchy. The cycles of creative destruction or adaptive renewal present themselves in the analysis of both natural systems, managed ecosystems and social systems, as revealed through the work of economists, management scientists, ecologists and complexity theorists who have studied and mapped these patterns. This suggests a balanced management paradigm which incorporates learning-led, planning-led or vision-led networking during different phases of an organisation's trajectory, and thus engenders system resilience.

However, the cycle of social change or the renewal cycle of birth, growth and release may not necessarily culminate into revitalization, rebirth or reorganisation for a business. In other words, organisations face the risk of discontinuity or demise, of crossing over into an alternative regime where the survival of a business as it was before an upheaval, is untenable. From the perspective of a business and those who are responsible for its continuity and success, there are two main concerns when seeking sustainability:

- Enterprise sustainability of the business against potential, irreversible collapse which could lead to outsider acquisition of the complete business or components thereof, whereby greatest losses are suffered in terms of institutional memory, staff members and shareholder investment.
- Ecological sustainability of the ecosystem services and resources upon which a business relies. These services as mentioned in Chapter 4 range from aesthetic value (for leisure-related businesses), climate regulation, provisioning of materials and energy (carbon-based or renewable) and waste absorbing functions. Materials, energy and waste disposal services are drawn from the environment but more often than not rely upon human-designed infrastructure and networks to be ultimately utilised by a business. Erosion of the ecological resource-base on which a business relies can result in lower productivity, reduced profits and ultimately loss of market share.

Thus the two facets of sustainability above: enterprise and ecological, are located at the level of the business as a social-ecological system, and as part of the larger social-ecological system at local, regional and global levels.

The concept of enterprise resilience has developed particularly in response to the question of the economic or financial sustainability of a business. Ecological or environmental sustainability in the context of corporate best practice is extensively reviewed in Chapters 3 and 4 with reference to CC, IE and EE literatures, and in Chapter 5, with reference to carbon-related strategies. Adaptive management strategies and the related tools of networking, learning and scenario-building assist in building resilience at institutional level and in aligning business cycles with natural or ecological resource cycles.

The following sections establish what enterprise resilience entails; how it has drawn from the larger resilience literature and writings; to what extent it incorporates ecological sustainability; and what gaps if any, can be addressed through a bridging concept of corporate resilience. Finally, this bridging concept is expanded further into a conceptual framework which incorporates elements of literature reviews studied in previous chapters, and nuanced interpretations of building resilience from SES and enterprise resilience discourses, specifically the extension of SES resilience into adaptive management. Principles for building corporate resilience are enumerated and carbon reduction is discussed from a resilience perspective.

6.6.1 Enterprise Resilience

The discussion on adaptive management in section 6.5 touched briefly on the notions of risk and vulnerabilities as perceived by different stakeholders participating in a scenario building exercise. Incorporation of risk perception and threats to survival in strategic and operational management is linked to the first component of resilience thinking, which is the crossing of thresholds by a system from one stable regime into another. Recent writings under the banner of enterprise resilience and strategic resilience (with strong links to risk management literature) investigate risk and resilience associated with predictable and unpredictable change faced by businesses in particular.

As mentioned before, the journey from release to re-birth is not automatic, for both social and natural systems. For example, the Caribbean coral reef ecosystem is in steep decline, in part due to a loss of species diversity some two million years ago, exacerbated by current overfishing and tourism trends (Walker and Salt, 2006). Similarly, a business may lose its market-leader position as a result of insufficient innovative strategies (or response diversity) to supplant decaying legacy strategies (Hamel and Valikangas, 2003; Starr et al, 2002).

Hamel and Valikangas (2003) challenge the position that success is self-perpetuating and argue that companies need to take bold steps to promote continued production of new ideas, experimentation and exploration at the front end of an organisation’s pipeline to ensure that there are enough ideas that will prove successful and yield profits at the back end. The authors call these small but strategically powerful interventions ‘stratlets’ and recommend supporting these through pre-assigned capital and labour commitments in order to ensure a business' strategic resilience.

Reference is made to 'creative destruction' at the level of the industry, 'strategic renewal' at organisational level and 'resilience' is referred to as the capacity for perpetual reconstruction and innovation at the level of organisational processes, values and behaviours as adaptations to new risk environments (Hamel and Valikangas, 2003; Starr et al, 2002). Reference is also made to setting up of a 'shadow' executive committee with members who are on average twenty years younger than the actual senior management team, allowing them to review budgets, divisional strategies and acquisition plans and reporting directly to the board (Hamel and Valikangas, 2003).

The links with risk management are strong, as authors explain the changing nature of risk in a highly interconnected and networked economy and the need for resilient enterprises to adapt to continually changing risk environments (Starr et al, 2002; Cleary and Mallert, 2006). Vulnerability through exposure to a range of networks, including knowledge alliances, infrastructure networks, global supply chains of products and consumers, each of which can disrupt in unexpected ways, results in what is termed interdependence risk (Starr et al, 2002).

Diagnostic steps to identify enterprise-wide risk and interdependencies, earnings-driver classification and resilience profiling and base-lining are recommended in order to devise a corporate-level resilience strategy (Starr et al, 2002). If adaptive SES management requires taking cognizance of the interlinked cycles of change played out by social (organisational, economic) and natural (ecological) systems, then enterprise resilience is about creating an organisation that can foresee and strategise ahead of these renewal cycles, and build the innovative capacity and response diversity to act before change manifests.

While buzzwords within enterprise literature draw from resilience thinking, generated with respect to adaptive management of ecosystems, management theorists are in fact alerting businesses to the risks associated with current networks of capital, labour, product and knowledge production, even as they afford efficiency and accumulation benefits.

6.6.2 Corporate resilience as a bridging concept

Resilience thinking was founded by Holling (1973) based on observed behaviours of natural systems. Ecosystem resilience builds on principles of systems ecology and knowledge from the natural sciences, and its language is derived from interactions between nested adaptive cycles, capacity for regeneration and the presence of controlling variables and thresholds.

SES resilience is an extension of the concepts from ecosystem or ecological resilience to human-nature systems of which institutional systems are a critical component. Within this body of knowledge, adaptive governance or adaptive management connects natural cycles to social cycles of change and the role of information, communication and connectedness comes to the fore as a source of phase-appropriate strategies. Adaptive capacity is inextricably linked to human actor-agents, who respond to internal vulnerabilities and external uncertainties.

There is recent recognition that various risks surrounding energy security, food security, water scarcity, demographic shifts and uncertainty in labour markets, experienced at a socio-economic level are in fact manifestations of natural resource shortages and ecosystem management failures (Swilling and Fischer-Kowalski, 2010). However, enterprise resilience literature tends to focus on business response to a volatile market-driven risk environment. Notions of ecological sustainability and recognition of the business as a social-ecological system are marginally explored. For instance, ecological sources of risk are captured with the impact of Hurricane Katrina on businesses cited in at least two scholarly endeavours (see Cleary and Mallert, 2006 and CSIR, 2011).

Figure 6.6 captures how each of the resilience concepts relates to one another, with parent knowledge categories and terms that build the vocabulary in each of the literatures.

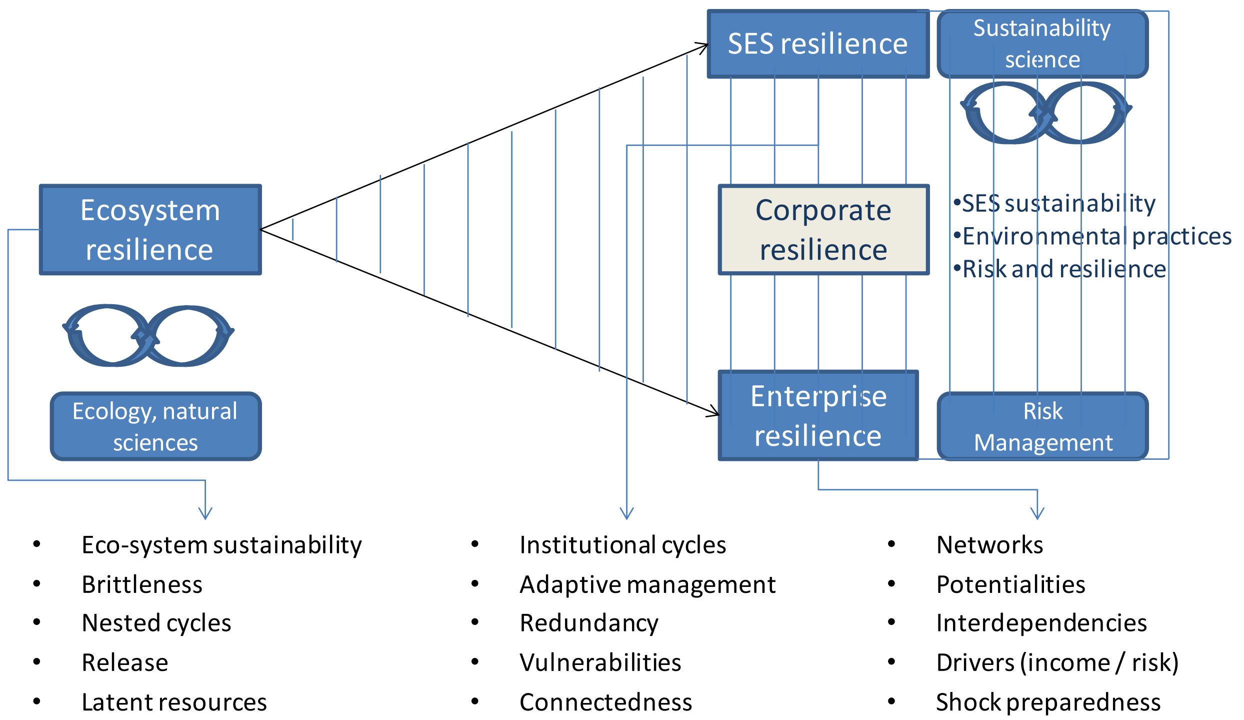

Figure 6.6 Ecosystem, SES and enterprise resilience concepts and Corporate Resilience as a bridging concept

Corporate resilience is presented as a bridging concept which retains the essence of SES resilience but is also informed by the fact that human agents, especially in a private sector context, use networks, explore alternative futures (scenarios) and technological solutions, as adaptive management responses to shocks from the larger SES, interdependency risks and gaps in scientific knowledge (surrounding technologies and environmental assessment tools).

6.6.3 A conceptual framework for corporate resilience

Within resilience analysis, the process of attempting to increase resilience to unforeseen change is clearly distinguished from the process of attempting to improve system performance during times of stability and growth (Walker et al, 2002). Attention to the adaptive capacity and cyclic pattern of a resilient system is found lacking in continuous improvement management principles, newly expressed in downward trending carbon footprints of entities (Korhonen and Seager, 2008) and in reductionist decision analysis processes such as cost benefit analysis and LCA, which aim to continually maximize profits or minimize environmental impacts.

The current lack of systems-oriented management and analytical tools to address corporate risk arising from global ambiguities and uncertainties is cited as a leading constraint preventing SA businesses from making meaningful contributions to sustainable development (Cleary and Mallert, 2006; Haywood et al, 2010; CSIR, 2011). An expanded view of risk is also embraced in the recent King III report, stating that the need for businesses to appreciate, ‘strategy, risk, performance, and sustainability are inseparable’ (CSIR, 2011).

The proposed framework for corporate resilience attempts to ground both scholarly recommendations as well as regulatory requirements for businesses noted above, by drawing on the core principles of resilience thinking, as they are understood in the parallel discourses of ecosystem, SES and enterprise resilience. This means that the framework (table 6.2) is designed with the dual aim of assisting businesses and other organisations to prepare for and respond to interconnected (external and internal) risks, and at the same time, to contribute towards increased resilience in the SES. The framework can also be used to asses the performance of businesses with regards to corporate environmental sustainability, and examine the drivers which inform corporate decisions.

The framework is premised on an adaptive management approach which supports the need for businesses to act ahead of cycles of change across different scales in the panarchy (source of potential, external risks) by generating renewal cycles at the scale of sub-systems and thus avoiding the dangers of late conservation and extreme release (internal systemic risk). Based on the adaptive renewal cycle, where rebirth and early consolidation phases are characterised by capital accumulation or investment in growing the potential of products, ideas and species, the framework suggests investing in different types of assets (whether technological, ecosystem-based, infrastructure-based or knowledge networks) in order to build system potentiality and therefore, resilience. This distinction between different types of investment should become clearer as the framework is applied to the case in Chapter 9.

Based on the interplay between risk and resilience emphasised in enterprise resilience literature, each of the strategies that yield different types of assets, are expected to respond to certain real or perceived risks, which can arise in ecological, social or economic spheres.

Table 6.2 Integrated corporate framework for enterprise resilience and ecological sustainability

Corporate practice areas for ecological sustainability	**Asset and potentiality building categories for different adaptive cycle phases**				**Related Risks (ecological, economic or social)**
	Capital investment (natural and technological)	Knowledge networks and partnerships	Supply Chain aspects	Infrastructure networks	
Lower carbon emissions					
Water sustainability					
Wastewater treatment					
Waste recycling					
Environmental custodianship					

The framework can be populated with various 'stratlets', proposed initiatives and ideas to establish how a particular intervention creates agility in the over-all enterprise and at the same time delivers on the corporate practice areas for ecological sustainability. Categories for asset-building and for ecological sustainability are kept to a minimum, in keeping with the notion that business resilience can be managed by focusing on a few slow-changing, key variables.

The proposed framework for corporate resilience also draws from previous frameworks developed in Chapters 3 and 4 and is therefore, an interdisciplinary tool for addressing the multi-faceted challenge of corporate environmental sustainability, enabled through a resilience-approach. Within the corporate resilience framework, corporate areas for ecological sustainability are based on the principles for strong sustainability (Graedel, 1994) and derived from life cycle assessment and management principles (UNEP, 1999; 2007), presented in Chapter 4 as a framework for assessing a business against best environmental practices (table 4.2).

The approach for designing a conceptual framework for corporate resilience is inspired by the synthesis framework in Chapter 3 for corporate citizenship (table 3.3). The CC framework exhibits, as does the corporate resilience framework, that corporate practice spans multiple areas such as infrastructure investments, knowledge networks and biodiversity management.

Stakeholder engagement pertaining to environmental sustainability is absorbed in the proposed corporate resilience framework as one type of knowledge network or partnership.

The common ideological paradigm for the proposed framework is that of concurrent enterprise and SES resilience-building. In other words, managers may not uphold enterprise resilience over SES resilience or vice versa. Therefore, several seemingly disconnected business strategies and management decisions may present a common inner logic when analysed from a resilience-based governance perspective.

However, the populated framework evolves and changes with the business. Since the framework is an instrument which represents investments made within different corporate practice areas (which build enterprise resilience and SES sustainability) to be linked to risks faced by a business at a certain time, the information contained in it changes depending upon when in the life cycle of the business it is populated.

The next section examines carbon reduction practices from a complexity and resilience perspective, culminating in the conclusion that lower carbon emissions are in fact an adaptive response of a business seeking resilience in the face of multiple risks from the larger SES, which may not necessarily have ecological sources (such as climate change mitigation).

6.6.4 Carbon reduction from a complexity and resilience perspective

Management strategies aimed at carbon reduction were reviewed in Chapter 5: Carbonology. Carbonology concluded that ambiguities exist in relation to carbon assessment techniques, in particular because of choice of boundary and scope definitions, and scientific uncertainties with regards to global warming potentials of included gases. The treatment of boundaries from a complexity-based perspective is very different to an accounting-based procedural approach, used by carbon assessment tools. When viewed from a complexity perspective, boundaries become components of a complex system and their interactions with other system components are critical to system analysis (Cilliers, 2001).

The adoption of system boundaries for calculating scope 2 or scope 3 emissions is determined by decisions made by agents within the system. However, these boundaries interact with other system components such as human actors and processes, and shape future strategies for carbon reduction and management.

Carbon reduction is one of the corporate practice areas for ecological or environmental sustainability in the resilience framework (table 6.2), listed as lower carbon emissions. From an SES sustainability perspective, lower carbon emissions engender a climate change mitigation benefit, and may also result in reduced energy consumption through efficiency measures or renewable energy options.

The format of the framework allows for both ecological and non-ecological drivers of investments to be identified and highlighted. This means that whether carbon reduction strategies are set into motion in response to environmental, social or economic reasons, they can be reflected as such on the framework and are regarded as being underpinned by a search for corporate resilience.

Since the framework is a representation of the business at a specific moment in time, the external or internal informants to the vision for a lower carbon future may change over time as well. These informants will be linked to both the state of the larger SES within which a business resides, as well as the particular phase of the cycle of change, of the business under observation.

And finally, the numerous organisation-wide 'stratlets' which can be generated using carbon reduction as an overarching goal (also explored under section 5.7 beyond the footprint: opportunities for learning and innovation) encourage response diversity, crucial for enterprise resilience when confronting interdependent risks.

6.6.5 Principles for building corporate resilience

The following principles for building business resilience are appropriate when devising strategies to populate the framework (based on the vision of Walker and Salt (2006) of a resilient world):

- Promote and sustain diversity in all forms (landscape, culture, values, ideologies and knowledge).
- Accept and promote ecological variability (rather than trying to control and optimise it for efficiency gains).
- Build and sustain modular components since over-connected systems are susceptible to shocks which are rapidly transmitted through the organisation.
- Focus on the few slow, controlling variables associated with key thresholds; so as to increase the size (or space) of the desirable regime and absorb more disturbances, without shifting into an undesirable regime.
- Possess and generate tight feedbacks, allowing thresholds to be detected before they are crossed (as opposed to feedbacks along current globalised production and consumption chains which generate interdependent risks but possess weak feedback signals)
- Promote trusted and strong knowledge networks and leadership to respond collectively and effectively to unforeseen change and risks
- Emphasise learning, experimentation, locally developed rules and embrace change
- Create governance institutions that include redundancy in their structures, so as to possess overlapping ways of responding to change

6.7 Conclusions

Inductively-based theories such as complexity and resilience thinking are theories of change and transitions, used to gain an integrated understanding of the system (Holling, 1995). Knowledge of an SES is incomplete, even as the system is a moving target, defined by the evolving impact of management and scale of human influences on the planet. Chapter 6 tracked how complexity and resilience thinking in particular, transfer the knowledge gained from studying and understanding complex natural systems to generate practical policies for sustainable development of complex and adaptive social-ecological systems. The complexity framework acknowledges the existence of non-linear interactions between system components, such as the sudden and far-reaching changes experienced by organisations, with the potential to push them from one stable regime into another with completely unpredictable system definition and behaviours, as opposed to gradual changes for which optimisation and efficiency oriented policies are devised.

The framing of a business as a social-ecological system and at the same time, as part of larger SES, allows for a systems analysis of a business to be undertaken in terms of co-existing and interacting physical/ecological and social/cultural spheres. The noosphere conception of SES aids in the visualisation of a business as made up of flows of matter, energy, water, waste and information. At the same time, complexity theory warns us that resilience-based analysis is but one way of describing and understanding complex system behaviour.

Adaptive management and enterprise resilience are two approaches which extend resilience thinking and associated concepts towards a business management approach for reflexive learning and collaboration on the one hand, and for building response diversity towards interdependent risks on the other. Both approaches embrace the role of complex human drivers (attitudinal, structural, and institutional factors) at multiple scales, which influence management practices and therefore, feedbacks with the biophysical characteristics of a business' ecological setting (Cook et al, 2011). Scenario-building is a powerful tool for defining an SES in terms of system thresholds, renewal cycles and panarchy, as well as for building system resilience.

Finally, the proposed corporate resilience framework aims to develop and test business strategies which address sustainability at both enterprise-level and SES-level. The framework does so by focusing on the need for businesses to create renewal cycles and therefore asset-build at sub-system level, within corporate practice areas which attend to ecological sustainability. Lower carbon emissions are included as one of these corporate practice areas, which also represent the few, controlling variables upon which the environmental sustainability of the system depends. Preventing the business from crossing thresholds along these variables ensures resilience. The resilience framework brings together tools explored in Chapters 3 and 4 and at the same time, locates carbon reduction strategies in a larger risk-oriented context.

The corporate resilience framework shall be tested and populated with case findings from a detailed, systems analysis of Spier Holdings. From the case analysis the framework will be modified and presented as a contribution to theory-building from the thesis. Although case study findings may not be directly transferable outside of a particular context, it is hoped that the framework can further an understanding of corporate drivers for environmental sustainability, including lower carbon emissions.

Chapter 7: Sustainability Story of Spier

7.1 Introduction

Spier has grown into a prime destination in the Western Cape Province of South Africa: for conferencing or banqueting, for international tourists visiting the winelands or attending the annual arts festival, and for day visitors interested in the endangered species protection programs, dining at one of the on-site restaurants, wine-tasting or simply hiking or horse-riding on the estate[22]. However, it is Spier's commitment to a sustainable way of life which defines the business, its popular image and own identity (www.spier.co.za).

This narrative is written by the researcher by way of consolidating information gathered through semi-structured interviews and desk top review of strategic documents and sustainability reports, into a story on Spier's journey of understanding and implementing sustainable development. The narrative was later used for further engagements and reflections from intermediaries and senior management and operational staff members at Spier.

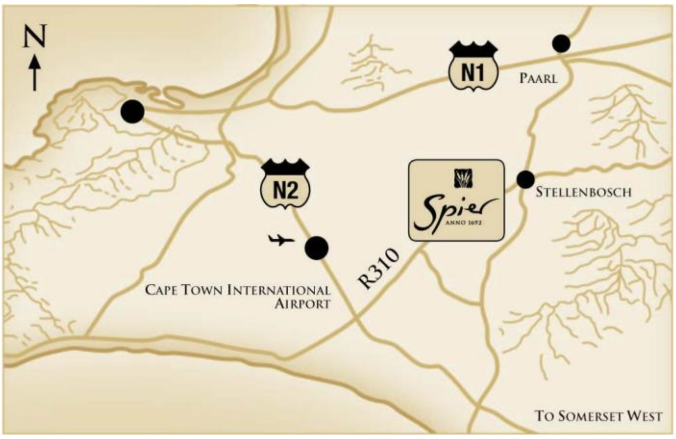

Figure 7.1 Location of the Spier estate near the town of Stellenbosch

The trajectory on which Spier is currently at was set almost two decades ago when the business was bought by Dick Enthoven and injected with the owner's passion for innovation and thought leadership. Over the years, through experimentation and deliberation, Spier has come to choose sustainability as one of its brand pillars, alongside arts and cultural expression. This narrative explores the translation of the ideal of sustainability into business practice.

The 'Sustainability Story of Spier' can be narrated at many levels. At one level it is the story of uniquely different leadership styles which accentuated specific aspects of sustainability. Starting out as a business exploring diverse socio-economic and environmental aspirations, Spier set out on a journey of embedded sustainability, which meant moving beyond once-off external

[22] A detailed map of Spier estate and another of Spier's location in the wine growing areas of South Africa are provided as Addendum B and Addendum C, respectively.

projects to transforming own business operations. This required cascading Spier shareholders' vision into top and senior management's performance measures with the hope that the vision will be embraced and realized.

From an academic viewpoint, it should be possible to map Spier's quest for sustainability through daily choices made across a range of business functions and their effectiveness in reducing the overall environmental footprint of Spier.

At another level, the story is the challenge of balancing of financial stability against ecological custodianship, as the Spier businesses developed and matured. Since 2005, Spier measures and accounts for activities, expenditures and goals pertaining to economic, social and environmental aspects of the business. The tools, protocols and partner associations used for triple-bottom line reporting over the last five years represent another key component of the sustainability journey.

Spier's ongoing journey to sustainability is captured through various themes pertaining to different phases in time. The themes and phases consolidate events, trends and practices which emerged through a study of the Spier Development Framework, Spier Sustainability Reports (2004-2007), management level documents and proposals and interviews and interactions with a range of Spier staff including creditors, book-keepers, accountants, group accountant Christie Kruger, farm manager Orlando Filander, facilities manager Cherie Immelman, cellar master Frans Smit, key senior management personnel including the CEO, the COO, Director Finance and Director Marketing and several intermediaries.

The intermediaries are external to Spier but provided valuable personal insight into Spier's pursuit of a sustainable, lower carbon future. They include but are not limited to Eve Annecke and Mark Swilling: co-founders of the Sustainability Institute, Tanner Methvin: Spier's non-executive Director of Sustainable Development at board level, Gareth Haysom: ex-Director of Spier Resort Management, Riaan Meyer: research engineer at the Centre for Renewable and Sustainable Energy Studies, Rob Worthington and Denise Bester from Trialogue: the firm commissioned to write the sustainability reports for the financial years 2008-2009 and 2009-2010 and Frank Spencer from Emergent Solutions: a service provider of renewable energy.

The first of the evolving strands of the narrative captures the pioneering years of the story from when the estate was bought in 1993 to roughly 2002. This exciting phase of the business' evolution laid the foundation for future endeavours and created the brand Spier as it is now recognized in South Africa and internationally. Efforts to achieve commercial success and organisational stability at the wine and leisure businesses received extra impetus near the end of the first phase but are articulated in two separate yet inter-connected strands that take the story into mid-2003.

The next phase described in the narrative begins when Adrian Enthoven entered the business, first as chairman of the board and later as CEO in 2004. Under his leadership, various disparate efforts under the banner of sustainable development were consolidated for the first time, as was the reporting thereof in an annual sustainability report. Alongside the organisational processes aimed at embedding sustainability into the core of the business are three key ongoing endeavours aimed at reducing Spier's ecological footprint – the search for effective renewable energy solutions for Spier's existing infrastructure; experiments with wastewater treatment and solid waste recycling. The adoption of 10-year macro-goals such as carbon neutrality and poverty alleviation in 2007 signifies the latest phase in the business' journey; a period when Adrian Enthoven is no longer at the helm of management or governance at Spier. The last section is a mirror of where Spier was at when the narrative was written, end of financial year 2010, in terms of tracking progress on the sustainability path and devising an effective strategy for the future.

7.2 Revolutionary beginnings

The Spier estate was bought by Dick Enthoven in 1993. As custodian of its unique heritage, Dick Enthoven wanted to imbue Spier with all that felt special and positive to him such as contemporary art, wine-making and community development. Importantly, he wanted to protect and conserve the special characteristics of the site in terms of both architecture and landscape. Although the site boasts 21 Cape Dutch gables on a single site and the oldest dated wine cellar in South Africa (1767), the original buildings including slave quarters and a cattle barn were in an appalling state of disrepair at that time. The site was originally a marshland as the name Spier suggests (Speyer is Dutch for 'marsh of bulrushes') and rising damp from the marsh had damaged the buildings. Dick Enthoven sought the expertise of architect Tom Darlington in restoring the historical buildings at Spier including the Manor House, which has National Monument status.

A network of drains was created throughout the main estate which now carries ground water away from the buildings into a dam built for this additional flow. The mud excavated from the building of the dam was eventually turned into adobe bricks and used in the construction of an amphitheatre. Tom Darlington also designed and supervised the construction of new buildings for restaurants and a conference centre, with great care and respect for the existing architectural heritage. The resultant mix of old and new buildings is creative and at the same time ingenuous in the way that it blends in with the natural beauty of the estate. A total investment of R60 million in restoration and construction created the set of facilities including the restaurants, shops, conference centre, offices, amphitheatre, equestrian centre and cheetah park on the current North Bank.

The pioneering phase of Spier's history is marked by Dick Enthoven's direct involvement through bringing in key people with their particular strengths and expertise and thus directing Spier forward on its journey towards sustainability. In 1998, Eve Annecke and Mark Swilling were brought in to provide a social and community development perspective and guidance on various ventures geared towards sustainable development. The business at that time was facing severe financial difficulties and the organisation lacked cohesion. Together with Ralph Freese, an entrepreneur from Cape Town and Tom Darlington, the resident architect, Eve and Mark were appointed as the Spier Strategic Planning Team (SSPT).

While a range of projects including clearing of alien vegetation, river management, waste management and the development of the Spier Arts Trust were ongoing, the business was in need of a clear strategy, a framework and a spatial pattern to guide its programs and projects. The SSPT undertook strategic discussions with Spier management to clarify a common vision centred on leadership for transformation and sustainability. Finally, with the professional assistance of planners, engineers, architects, environmentalist and an economist, the Spier Development Framework (SDF) containing a vision, values and strategic objectives was proposed in March 1999 and signed off in May 1999 by the Spier board.

With an overarching vision of creating a sustainable 'micro-ecology' in the Winelands, the SDF emphasized a balance of custodianship and heritage with financial and economic viability; underpinned by sustainable resource use, community building and learning for development. Each program recommended in the SDF aimed to achieve a range of sustainable development outcomes whereby organic farming practices also helped realize land reform and early childhood development and leadership training were part of a community development project. Through adoption of some of the SDF initiatives, Spier got involved in various on-site and off-site interventions with indirect links to the commercial aspect of the business, which were to have longer-term impacts on its image, operations and identity.

A land reform project was initiated in 1998 through a trust for emerging black farmers, with 12 managers farming between two to five hectares each, and receiving free electricity and water from Spier. After a year of ground preparation and market research, the project linked to organic farming and on-site packing of produce was begun in 1999. Large and prominent retailers were identified as potential buyers of the organic produce. The project represented Dick Enthoven's desire to support an effort which showed respect for the soil and at the same time presented previously disadvantaged individuals with an opportunity to farm. Go Organic was managed for some years by Gerrit Hendricks but could not be sustained for a variety of financial, management and resource reasons.

Today, Eric Swarts is the only farmer who planted for the first time in September 1999 and twelve years later, still produces organic vegetables and supplies them locally. He is the manager of the Land Reform Project and is supported by Spier to this day through free electricity, water and fuel. The packing shed continues as an independent business that buys produce from organic and non-organic farmers in the region and compost from Spier.

Certain wealth-generating developments on the North Bank such as a resort hotel and plans for a Craft Village and museum were not adopted. However, an executive decision was taken to build a hotel on the estate in order to reverse the dire financial situation. The Village Hotel built in 2000 and opened in early 2001, was styled by Darlington to blend in with the existing architecture on the site, while at the same time celebrating the heritage of Cape Town's famous Bo-Kaap suburb. Principles such as north-south orientation and solar water heating were implemented at the hotel in the spirit of ecological design. Wood was sourced from sustainable forests and the rooms were connected to gas for warming. The fact that seventy five percent funding for the hotel construction was raised from IDC (Industrial Development Corp) is a source of great pride for Spier and a kind of legitimization of the search for sustainability. Some of the initiatives such as solar water heating through roof panels and the unique on-site sewerage treatment system called Biolytix[23] did not pan out in the long run as they were originally intended but they do represent the shareholders' support for innovation.

The vision of a socially transformed community eventually translated into the re-establishment of the Lynedoch village, imagined as the future home of a diverse mix of people ranging from farm labourers to professionals. The core of the village was proposed to be a community centre with a school, a preschool, a library, seminar rooms and a hall for indoor sports and performances. Early childhood development was considered critical for boosting the community from which Spier and neighbouring farms would draw future staff members. Spier lent towards the re-housing of the primary school against which further funds could be raised through commercial loans for buying additional land. All the development work at Lynedoch village was achieved by setting up Lynedoch Development as a Section 21 property development company. The process of acquiring and re-establishing the land was difficult at times, involving contentious evictions.

Spier and other wine estates that participated in the Lynedoch village development see it as an alternative, revolutionary way of complying with land tenure whereby tenant-farmers can receive financial assistance from their employers to own their own homes and at the same time be able to take charge of their living environment. In addition to the unusual organisational and financing mechanism for local development, a range of design options and technologies were also introduced to reduce the ecological footprint of the revived Lynedoch village. These options included on-site manufacture of adobe bricks for all new construction, a ventilation system for

[23] The Biolytix system is discussed to greater detail in section 7.7 of the narrative.

the community hall, passive heating and cooling of the classrooms, solid waste recycling and waste water treatment through the decentralized Biolytix system.

Another success story from this revolutionary phase is the establishment of a leadership institute, envisioned as a think tank or a place of learning linked to the Spier business and its activities while at the same time having a developmental impact on the surrounding community. The institute was proposed by the SSPT as a debating forum for green technologies being tested and implemented at Spier, with the hope of commercializing successful ones, for inducting new employees at Spier with core values around sustainability and for propagating the practices aimed at ecological design, sustainable agriculture and community development.

The first project to be implemented by the Spier Leadership Institute was negotiating with the Education Department to locate the new primary school at Lynedoch, once the proposal to have it on Spier-owned agricultural land was rejected. Originally planned on the main Spier estate in 1999, the Spier Leadership Institute was finally located at Lynedoch and its name was formally changed to the Sustainability Institute Trust in 2002. An affiliation between the SI and the University of Stellenbosch was also formalized in 2002. The first intake of students for the Masters in Sustainable Development took place in January 2003. Since then the SI has grown to become a major learning centre linked to the University of Stellenbosch that offers programs on a range of disciplines including sustainable agriculture, ecological design, applied economics and most recently, renewable energy. The learning partnership between Spier and the Sustainability Institute continues through various agreements.

The founding of the school and the Sustainability Institute at the Lynedoch site mark the end of an era at Spier – a period of time when immense learning took place among all who participated in and witnessed the growth of Spier from a set of beautifully restored buildings to an institution.

7.3 Wine and water

Interwoven with the work of the SSPT and their focus on commercial projects on the one hand for generating a sustainable source of revenue and on community development projects on the other hand, was another strand that is an integral part of Spier's sustainability trajectory – the stupendous growth and current stabilization of the wine-making operation at Spier.

This story is put together through interviews with Frans Smith, the cellar master and a walk through the cellar with him. In 1996 when Frans started in a junior capacity there was a small cellar and 60-65 hectares of vineyards on the estate. Of the land under cultivation, half was for growing fruits and a carrot operation which was eventually abandoned in 2000. In year one of the wine-making operation, 200 tons of grapes were harvested, a small quantity for any wine producer interested in establishing a quality brand name. By the end of 1996 however, as recorded in '*A Place of Hope – the story of Spier*', 'the old cellar was completely renovated, fitted with stainless steel tanks and enlarged to handle a harvest of nine hundred tons of grapes at a volume of fifty tons a day.' In 1997, Spier started replanting own vines to improve quality and to increase land under vines from fifty-seven to a hundred and twenty hectares. From 1996 to 1999 wine had to be sold under the 'IV Spears' label since the Spier business did not own the wine label Spier.

The wine-making operation at that time suffered from the same issues as were prevalent in the resort management branch of the business – lack of direction and confusion around desired scale of operations. Therefore in 1999, at the same time when major changes were also being made at other parts of the business, Dick Enthoven bought the Spier label and two other established labels, Savannah and Longridge. This marked the birth of the wine business under the name of Trilogy, later changed to Winecorp SA, Ltd.

Although the physical assets linked to Savannah and Longridge were subsequently sold off, the personnel from their marketing and sales teams were retained, as were the well-established labels. In the tradition of bringing in the right people with the right expertise to make a significant difference, Faisal Rahmatallah was brought in from London to transform the wine-making business. Faisal advised that in order to produce good quality grapes for premium quality wine, Spier needed to further upgrade their cellar and buy additional vineyards. As a result, Spier bought farmland at Nooitgadacht and near Darling and in 2000 the cellar was upgraded to its current capacity. By the end of 2000, Ashwood, a primarily bottling company, was also purchased.

As a result of these strategic investments, the wine business changed from producing 5,000-10,000 cases a year in 2001 to 700,000 cases in 2002. From producing small quantities of premium wine, the business focus changed to producing entry level wine in bulk. By 2004, management was keen to grow Spier into a large volume wine business. The management team in place then had the vision to promote Spier as a very significant ladder brand with a bottle of wine at four to five levels under the two labels of Spier in the UK and Savannah in Denmark. Within two years, production was up to 300,000 cases of wine in each of the two entry level bands as a result of dedicated marketing aimed at low-end consumers. However, it was soon realized that business at this end was not raising the brand value of Spier. This trend was not appreciated by the shareholders who were also not keen to make the kind of investment required to grow the wine making operation to its next level in terms of volume.

The financial crash of 2008 and the weakened EU currencies in its wake took away the business case for producing bulk wine. The entry level band under the label of Spier was completely dropped and bulk wine produced under other labels was also abandoned. Spier wines production dropped from 2 million cases a year to 1 million cases in 2009. Spier wine is now available in three ranges: Signature, Graded and Private Collection and Savannah is available at entry level, Wine Maker Selection, Reserve and the African Ethnology Range. The business still generates substantial revenue and Frans feels that it is finally aligned with the shareholders' vision.

Since the focus in this arm of the business was always revenue generation and financial stability, other sustainability aspects were largely left unattended. In the last five to six years, efforts have been re-directed towards harmonizing the wine-making business with the sustainability concerns of the rest of the business. For instance, proper water meters at the different sections of the operation were only installed in 2008. It is also acknowledged that the cellar was not designed keeping in mind tourists' interest in observing the workings of wine production. In Frans' view, the physical separation of the winery from the rest of the front estate delinks it from the day visitors, wine tasters and tourists staying at the hotel.

Other design issues which would have been cheaper to accommodate when the building was first designed and are expensive to address as refurbishments include energy losses and rain water harvesting. The steel tanks in which fermentation takes place lose up to 50% of cooling energy to the outside. The buildings were not designed to collect and store rain-water which can be used in the cooling system of the cellar. Initiatives are now underway to use humidifiers in the wine store in order to utilise less air-conditioning. Alternative ways of allowing light through solar tubes instead of conventional lighting are being explored in the store.

A method for using long metal pipes on the roof to produce hot water for cleaning wine barrels is under investigation. Currently, barrels are cleaned with water heated up to 80 degree Celsius using electricity. Keeping in mind the high water table of the site, the cellar master needs to come up with creative ideas on how to harness the sizeable rainwater run-off from the roofs of the winery buildings during winter.

The recent focus on sustainability within the wine business can be traced to two trends that surfaced since a new management structure was created in 2007: the first is linked to a unified management team for Spier Leisure, Spier Farms and Spier Wine with the organisational culture of translating shareholder vision into the performance measures of senior and operational management; the second is linked to stability in the scale and levels of wine-production. These mutually reinforcing trends encourage innovation to occur in areas such as reduced energy and water consumption and marketing the brand with greater confidence.

There are further endeavours targeted specifically at reducing the carbon footprint of a bottle of wine through for instance, lighter weight bottles, alternative materials for bottles, labels or corks, and recycled cardboard for cases. The exercise of calculating an LCA-based carbon footprint of a bottle of wine, discussed in more detail in the last section of the narrative, was undertaken in

2010 by the group accountant, in an effort to compare the merits of different decisions on the basis of how they impact on lowering carbon emissions attributable to one bottle of wine.

The story of wine at Spier is entwined with the story of water in its many forms: natural water rising up from the marsh and the relocation of the winery to its current site, huge volumes of rain water on the estate that should be harvested, mountain water in the Bonte River flowing near the winery, municipal and industrial water supplies to the estate, water mixed with anti-freeze flowing through pipes for cooling the cellar, ongoing experiments with wastewater treatment on the estate, the water that is embedded in the grapes from different vineyards arriving at the Spier winery and the water that gets transformed with the red or white grapes and finally ends up in the bottles of wine. An in-house project to conduct the water footprint of one bottle of wine is in its infancy, the science behind it is in the process of development. Spier management is curious to know how much virtual water is captured in 750ml of wine.

7.4 Organisational maturity

The shareholder decisions and investments made into the Spier wine business had turned it into a viable venture. Similar turnaround was desired for the leisure component, especially once construction of The Village at the Spier Hotel complex was completed in early 2001. Growing public awareness of the ethos which Spier represented in terms of cultural and environmental custodianship had built a loyal clientele in the region: among individual patrons of the restaurants and the picnic area and among institutes such as banks and the Stellenbosch University as users of the conference and banqueting facility. The availability of overnight accommodation at The Village was designed to attract tourists and conference organisers from further afield, in particular internationally. For this to work, the different leisure facilities had to function as a team since the existing restaurants would be serving guests staying at the new hotel who might also be attending a conference on the estate.

In 2001, Spier shareholders initiated important changes to the management structure of the two ends of the leisure business – the old Spier comprising of three restaurants, the wine shop, the picnic area and the conference centre and the new Spier which had been created as a separate entity for funding purposes, located at the hotel complex. Significantly, Ivan Palframan, former director of Group Finance and Operations at Nedcor Investment Bank was appointed as group CEO. The old and new Spier Leisure businesses were amalgamated into Spier Resort Management under one director, Gareth Haysom, who reported directly to group CEO. Gareth in turn appointed deputy managers to run the hotel and the restaurants and the conference centre. These changes meant that two separate entities could be managed as one but several management levels would still be required. The main aim was to positively transform the organisational culture at Spier and realize the vision of a quick financial recovery.

In his interview with Mike Nicol, Ivan Palframan highlighted the need for instilling financial prudence and budgeting among the staff at different entities. By the end of the 2001 financial year, a reduced loss was reported and projections were made to the effect that by 2002, the company would start generating a profit. Gareth, who started at Spier in 1999 to run the conference centre, recounts his personal experience of a shift that Spier staff underwent from when he started to when he instituted the new management structure in 2001.

As Executive Director of Spier Resort Management, and in line with Ivan Palframan's leadership style, Gareth gave each facility increased financial and operational responsibility but also encouraged greater co-operation among them. This was a period when management was convinced that they were meeting shareholder expectations pertaining to financial targets, fulfilling staff needs as per industry charters and upholding the brand value of Spier for existing and new customers.

In 2002 however, an interesting study conducted by management students from the London School of Economics uncovered the wide gap between management and staff perceptions of management philosophy. Spier management thought that they were attending to triple-bottom line issues by creating dedicated committees for financial, environmental and social concerns. On the environmental side, the hotel construction was guided by ecological principles and the Go Organic project and the nature conservation programs were commenced and on the social side, Spier was investing in establishing Lynedoch primary school and enrolling students. Staff members however, felt that although environmental and financial matters were sufficiently addressed, but that the vast area of social concerns was left largely unattended. This finding prompted a critical, self-reflecting and analytical process whereby the management sought an unambiguous way of validating its attention to the social component of sustainability, in the midst of ongoing financial difficulties.

In late 2002, Gareth Haysom approached Pro Poor Tourism (PPT), an international organisation dedicated to applying principles and practices in tourism, which are beneficial to poor communities, in particular those within the immediate vicinity of a tourism operation. Spier Leisure conducted a large amount of work to identify potential partners in Kayamandi, Cloetesville and Idas Valley with the intent of establishing a gateway for the distribution of tourists visiting Spier to other tourism properties in the neighbouring disadvantaged areas.

In April 2003, negotiations were also begun with Fair Trade in Tourism South Africa (FTTSA) to understand the requirements for FTTSA accreditation. FTTSA is an independent, not-for-profit organisation that encourages and publicizes fair and responsible business practice by SA tourism establishments. The accreditation process was highly complex and required input from in-house HR specialists such as Heidi Newton-King, the current COO of Spier. The ensuing engagement with staff around FTTSA core principles such as fair share, democracy, respect, reliability, transparency and sustainability helped clarify what achieving these criteria meant at an operational, organisational level. Fair Trade accreditation was granted to Spier Leisure in early 2004, making it one of only five such organisations in South Africa at that time. This was a great achievement for not only the team dedicated to the process but for the entire organisation for participating in it.

Subsequently, a similar third-party validation was sought for the wine component of the business. In May 2004, Winecorp SA, Ltd and Afrika Vineyards became the first fully accredited members of the Wine Industry Ethical Trading Association (WIETA). WIETA, a voluntary association of different stakeholders is committed to the promotion of ethical trade in the South African wine industry. The WIETA code has more than 130 individual indicators to measure compliance towards fair employment practices including freedom of association, living wage, healthy working environment and non-excessive working hours.

These were crucial steps which led to far-reaching changes in the interaction and relationship between management and staff at Spier. At the very least, the external validation processes brought key gaps to the fore and prepared the organisation for the next phase in its maturity; when Adrian Enthoven became focused on embedding sustainability into the core of the business.

7.5 Internalizing sustainability: from projects to goals

In June 2003, Adrian Enthoven, Chairman of the Spier Holdings board, brought Tanner Methvin as Director of Sustainable Development to deliver on the specific task of managing Spier's transition from investigating the idea and concept of sustainability into actual implementation. Tanner's past experience was in establishing and running NGOs and the assignment at Spier was a journey of great learning for him as well. When Tanner started at Spier, a range of projects were at different stages of implementation including the Biolytix system for on-site treatment of wastewater, the Go Organic project and the establishment of the Sustainability Institute and the Lynedoch village. A useful starting point for the desired transition to embedded sustainability was for Spier to understand what among the various projects was relevant and/or important to the business. In order to make a shift, the entities within Spier needed to become collectively self-aware of where they were in relation to international best practice as well as national legislative requirements.

In 2003, the first version of the Global Reporting Initiative (GRI) Sustainability Reporting Guidelines was the de facto framework adopted by organisations internationally for measuring and reporting on sustainability. Tanner began a process of drawing up measurable indicators based on the GRI guidelines while at the same time ensuring compliance with South African legislation. He received some guidance from Ralph Hamann, a UCT academic leading the corporate citizenship module at the Sustainability Institute.

A list of 158 indicators was used to engage with staff across the leisure, winery and farming businesses in order to determine the issues which were most critical to Spier. These indicators were used at a series of learning sessions at the Sustainability Institute to facilitate an understanding of sustainability and sustainable business among 250 Spier employees from different entities and levels.

The indicators also became a framework for the businesses at Spier to identify and engage with their stakeholders. Although the initial expectation was to narrow the list down to the most critical, most indicators stayed on and it became necessary to manage the information that would allow measurement against each indicator. Next, systems were put in place for collecting information for each indicator at monthly, quarterly or annual basis and the necessary training was provided to employees responsible for the task. It was critical that employees understand the value of the information they were garnering from the system and how it would change the way in which they engaged with their stakeholders. In retrospect Tanner feels that he may have overburdened the staff with too many monthly indicators, considering the complexity of businesses contained within Spier Holdings. Measurement of the final 150 sustainability indicators was added to the customary financial data collection by administrators and financial accountants at Spier.

The consultative process around the indicators helped build an organisational language for sustainability and spurred broad-based stakeholder engagement around Spier values. Significantly, the indicators were used to derive what should be contained in the first Spier sustainability report. While the measurement systems were still being formalized, existing records were used to report retrospectively on the 2003 and 2004 financial years in the first annual report. The aim was to portray a snapshot of where Spier was at, as a baseline for where it wanted to be. Thus the first annual report of Spier marked a critical point in the sustainability transition; a point where Spier started tracking progress in an area which its owners and managers had been exploring for more than a decade, through a construct which was now universally appreciated.

Titled ‘In Search of a Sustainable Future’, the Spier Sustainability Report, 2004 captures Spier’s values, which were arrived at through an intensive review process in each of the Spier businesses, starting with the leisure business. It also contains the CEO’s statement; Spier’s vision of sustainable development; the organisational structure comprising of the different entities under Spier Holdings; the governance structure; and the principles on which the report is based, which are primarily derived from the GRI sustainability reporting guidelines.

Dedicated sections on third party recognition and stakeholder engagement present the intensive work done from 2002 onwards in these areas as the organisation matured from undertaking projects targeting different aspects of sustainable development to a new business model based on the principles of sustainability. The principal focus was on external validation of efforts in the area of social justice. Spier's performance in 2003 and 2004 against financial and non-financial indicators is summarized in engaging tables and charts under distinct economic, environmental and social reviews. The next intuitive step was to establish goals for 2005 in relation to the indicators. These were also summarized under each of the reviews.

According to Tanner Methvin, the shift from financial reporting to triple-bottom line reporting was challenging for most people on the management team. Success was associated with financial progress, due in part to the previous CEO who had instilled the importance of sound financial management among managers. It would take time for improvement on other aspects of sustainability such as economic development, employment equity and environmental conservation to become the norm. As a result, the Director of Sustainable Development drafted somewhat ambitious social, economic and environmental goals for 2005 based on his own understanding of what the organisation needed to aspire towards, with little consultation.

This was also the time when Adrian Enthoven took on the role of CEO of Spier Holdings in addition to being Chairman of the board. He was very keen to use the processes of goal-setting and performance measurement in order to create an organisation-wide impetus and bring the goal of sustainability into management decisions. Managers were thus continually educated on the need for non-financial goals and associated measurement against indicators. It took three years for meaningful non-financial goals to be developed by managers themselves. Finally in 2007, a balanced scorecard approach was adopted whereby non-financial and financial goals were equally weighted on a manager's contract. Funds were set aside so that achievement of non-financial goals would be rewarded regardless of financial performance as a way of communicating the seriousness of shareholder commitment to sustainability. Thus a financial incentive was instituted in order to drive organisational behaviour towards engaging with non-financial performance.

The need for measuring against sustainability indicators had diverse material outcomes. For instance, it was realized that extra water meters had to be installed on the estate to measure reduction in consumption linked to a specific business and its facilities. Energy-saving devices were installed in the buildings and waste management was handled in a completely new way, with focus on separation of refuse at the point of generation. Components of environmental sustainability such as lower energy consumption, reduced water consumption, waste water treatment and solid waste recycling across the businesses were each handled as a project.

Initiatives such as the Pro Poor Tourism project were also reviewed in the light of the improved understanding gained through the goal-setting process. The tourism-linked approach had not been successful and a decision was taken in 2004 to shift focus. Tanner worked with Gareth Haysom to understand where the largest impact from business practices could be gained towards the aims of sustainable development. This prompted a strategic interest in the supply chain of the different Spier businesses. A review of the suppliers of goods and services to the different entities was a huge undertaking since the leisure business alone has close to 400 suppliers.

Small BEE businesses in the neighbouring communities that could become part of Spier's supply chain were identified and developed. However, procurement officers had to make a philosophical shift to use small, black and local businesses. Significant changes were made to the Spier Leisure procurement policy and PDI suppliers were incorporated in key areas including LPG, laundry, wood, vegetables, cleaning chemicals, guest supplies, building repair and crafts. Gareth Haysom who formally left his management position at Spier in 2003 but took on the role of monitoring Spier Leisure's performance on behalf of PPT, noted it as one of the most successful sites among the PPT pilots launched in South Africa. Gareth now works at the Sustainability Institute and teaches on the Sustainable Agriculture program.

The annual reports for 2005 and 2006 financial years adopted a format consistent with the first report which encourages comparability across the three years. External expertise in the form of Mark Borchers from Sustainable Energy Africa was used to configure data such as the emissions and waste associated with electricity consumption and business transport. The reports were designed in an accessible magazine format with personalized information to draw in readers, especially Spier staff, and encourage them to sift through the tables and charts.

The two purposes of sustainability: management tool for decision-makers and communication tool for customers and staff were met sufficiently by the first three reports. Inclusion of third party recognition goes a long way in building trust among readers. Especially the brand of Fair Trade in Tourism which is a rule-based standard, requiring much stringent adherence as compared to the principle-based GRI framework.

The sustainability reports have a gap in that they do not contain industry benchmarks for the economic, social and environmental goals. This may be attributed to the fact that Spier belongs to more than one sector through its farming, wine-making and leisure businesses and establishing industry standards takes many years of diligent reporting by many firms in a sector. Even now, although calculating the carbon footprint for a bottle of wine, an intensity measure, has taken off in a big way in the Cape wine industry as a result of international market pressure, sustainability reporting is still rare among small and medium-sized South African businesses.

The Spier Sustainability Report, 2006 won the Best Sustainability Report Award from both the SA Publications Forum and the Association of Chartered Certificate Accountants (ACCA) in August and September, 2007 respectively. Thereafter, Spier recognized that glossy publication on non-recyclable paper had its own carbon footprint which they preferred to avoid. Subsequent sustainability reports for financial years 2007 and 2008 have been available on-line at the Spier website and limited copies were printed on recyclable paper. They were compiled by Heidi Newton King and Annebelle Schreuders for whom it was a huge learning curve to collect and consolidate information from all component businesses based on GRI guidelines.

Heidi and Annebelle were innovative in their approach and were able to further instil the relevance of sustainability reporting into other members of the staff while preparing the reports. The handing over of the annual reporting task to senior management was thus another positive step towards embedding sustainability into the organisation.

Tanner Methvin believes that in his tenure as Director for Sustainable Development from 2003 to 2007, he was successful in establishing systems at Spier that should incentivise staff and management to move out of their core financial competence and accept a wider platform for performance. The last thing that he did before advancing into a primarily governance role on the board was to help identify macro-goals for Spier on a ten-year horizon, placing the company he believed, on the right trajectory for achieving sustainability. All Spier managers had to do was work towards annual goals and track where they were year on year in relation to the strategic goals for 2017!

The macro-goals were designed around two core categories: a socio-economic theme which requires Spier management to find ways in which the private sector can shift the social dynamics in the country and an ecological theme that persuades managers to demonstrate environmental custodianship through every business decision. Managers of business units set up meetings with their staff members around a range of issues to brainstorm effective approaches that can help achieve their performance objectives for 2008. Some creative and dynamic solutions were suggested and implemented over the last couple of years to realize sustainability objectives such as carbon neutrality and poverty alleviation over the long term.

7.6 In search of renewable energy

Now that Spier had translated its commitment to environmental sustainability into organisational targets for reduced GHG emissions, decisions were taken at Spier board level to explore methods for expanding the use of renewable energy across the different businesses. In 2007, biodiesel production was added to the existing green investments of adobe brick-making, vermiculture and Biolytix housed under a subsidiary called Spier Green Capital. Also in 2007, Tanner started his own company by the name of Earth Capital and was contracted to manage Spier's green investments.

A biodiesel production facility was developed in 2006 within the Spier estate under a partnership and was funded one third by Spier. On-site cooking oil was identified as one source to the input stream of the plant. Highly successful test-batches were run in the 2006 reporting cycle with the aim to begin full production in 2007. The plant was projected to produce 1 million litres of biodiesel per annum, thus meeting consumption demands of Spier vehicles and generators and allowing for sale to external parties. However, due to the monopoly of oil manufacturers, the supply stream dried up. Manufacturers made it mandatory for users of their virgin oil to return used oil if they wanted future supply to continue.

Alternative sources of economical oil could not be located and the biodiesel project was abandoned in 2008. Since then, Spier management has preferred to purchase biodiesel from professional suppliers such as Skoon Biodiesel in Bellville. Currently Spier uses a 50% biodiesel and normal diesel blend for its vehicles, which includes transportation of wine bottles to the warehouse. Spier has experienced problems such as unused oil staying behind in the engine suggesting that biodiesel generation is still an imperfect art, even in the hands of professionals. At the time of writing, Skoon Biodiesel had agreed to look at their production process to address this issue. Thus, the use of biodiesel in company vehicles changed from being an on-site production issue to a procurement concern.

In recognition of the fact that Spier exists in a socio-ecological system with environmental issues beyond its own business operations, a venture capital fund was kicked-off to invest in a broad spectrum of green innovations originating in the private sector. A business plan competition was held and the winning business called Green Cabs operating in Cape Town received start-up funds through Spier Green Capital. As from May 2010, Spier Green Capital is closed based on a strategic decision that green investments are not a core function of the group. The Biolytix business was bought by Earth Capital and the vermi-composting business was taken in-house as part of Spier's on-site composting.

In 2008 Tanner was managing a property project for Spier called South Bank which was intended to be designed ecologically, house a mixed-income community and be completely off the national electricity grid. Several options of generating renewable energy were considered for the South Bank community as well as for Spier's existing infrastructure. One of the options was generating biomass from quick-growing trees on available land at the Spier estate and producing electricity from either burning the biomass in a gasifier or converting it into biodiesel.

The biomass option appeared to have several benefits compared to solar energy at that time. For one, in the case of solar thermal or PVC, additional expense is incurred in either setting up for energy storage or in generating excess energy to feed into the national grid since energy generation does not always match with energy demand. Biomass gasification appeared to be an energy-on-tap type of solution at one third the cost of wind or solar solutions for the same energy requirements, simply by not requiring a storage facility.

In July 2008 the Centre for Renewable and Sustainable Energy Studies (CRSES) of Stellenbosch University was asked by Spier to make an assessment for on-site energy generation based on the electricity requirement of Spier, just below 1 megawatt in 2008, and that of a community of 500-1200 households. According to Riaan Meyer, research engineer at CRSES, three University departments were involved in the project for over six months: forestry, agricultural science and process engineering to address the problem.

A hundred-page report was produced to find out how much land was required to grow which crop to produce required energy at the lowest financial and ecological cost, using a life-cycle perspective. The CRSES recommended planting of fast growing eucalyptus trees and using a gasifier for electricity generation. The design of the South Bank houses was also advertised as an architectural competition. Ultimately, the renewable energy generation project was not pursued for mainly economic reasons: the amount of land required for the energy demand was viewed as too much. Prof Johann Jorgens who brought his process engineering expertise to the project and has done more bio-energy proposals subsequently, believes that energy generation from biomass only begins to make economic sense at a certain scale of operations, not feasible on the Spier property. Since the decision was taken not to pursue the South Bank property development or the biomass gasification project, the available land on the farm has been reengaged for bio dynamic farming and natural conservation of the wetlands.

Efforts on the energy-saving front continued at the various businesses. For instance, re-commissioning of Spier Village Hotel's solar water heating system was considered in March 2008 but not undertaken. In 2009, in an effort towards reducing reliance on Eskom electricity, solar water heating was considered for the banqueting kitchen. A proposal was received from Zingaro which claimed that at least 90% of the annual hot water consumption at the banqueting and conferencing facility could be generated through solar energy with an investment of almost R 450,000. While the investment was substantial, the projected savings in terms of electricity would also be huge, considering high hot water consumption in the banqueting kitchen. Zingaro was eventually asked to submit a solar energy proposal for the entire conferencing / banqueting area and the water heating requirement at the kitchen was subsumed within the larger 'greening project'.

The greening project as it came to be called was based on the idea of marketing the conferencing and banqueting facility at Spier as 'conferencing with a conscience' through a combination of energy efficiency interventions and use of renewable energy. Over September and October 2009, four service providers including Zingaro and J-Linx submitted proposals and made presentations to Spier management with more or less the same recommendation: roof-mounted photo-voltaic panels with grid tied inverters. One of the contractors by the name of Solek gave comprehensive advice on demand side management of electricity consumption. G-

Tech proposed a detailed energy audit of the conferencing area, highlighting a tax allowance of up to 15% on any large energy efficiency interventions.

Riaan Meyer from the CRSES was requested to appraise the different contractors and make recommendations since Spier lacked in-house expertise in renewable energy applications. Riaan was able to discern that contractors had erroneously used different monthly consumption data and that in order to compare proposed systems; price per Watt installed would have to be calculated. Once the calculations were done and track records verified, G-Tech appeared to be the best choice mainly on cost and were awarded the project. However, it was not followed through since senior management at Spier felt that a 10% saving on conventional energy at the cost of R 700, 000 was not justified; a PV system with an installation peak of 168, 000 Watts could take the conferencing area off the grid but would cost R 5,7m, which was beyond the allocated budget. Unfortunately, demand side management or energy efficiency interventions at the conference centre were also not implemented.

Since the funds allocated for the greening project at the banqueting facilities were still available, the facilities manager for the North Bank Cherie Immelman began considering alternative energy-saving options at The Village hotel complex. An electrical load survey study of the hotel rooms by Gyso Bird in 2008 had revealed that maximum energy drawn at the leisure business was for heating water and for air-conditioning in occupied rooms during summer months. Simply by addressing these two areas, Spier could reduce its electricity consumption substantially. As a result, timers were installed on each geyser and a trigger matrix system was put in place to switch off certain sections of the hotel in low occupancy months. However, in view of recent and imminent tariff hikes in Eskom electricity, further investment in a system that reduced energy consumption made economic sense.

Installation of an alternative, preferably renewable energy system for hot water received attention first, primarily because of complaints from hotel occupants. The current hot water system which is essentially 2 X 250L geysers for each block of rooms (4 rooms in most blocks, 8 rooms in some blocks) heated by conventional electricity, is clearly inadequate during full occupancy.

Proposals were received from two companies before end of financial year 2010 (July). Both Tekniheat (Cape) (Pty) Ltd and Emergent Energy proposed a heat pump approach that generates hot water at 30% the cost of other conventional systems. Both companies gave a couple of options but recommended a centralized hot water system with a total capacity of 20,000L serviced by a hot water ring main to bring heated water to each of the 32 blocks of rooms at the hotel. Spier management favoured the solution from Emergent Energy since they supply solar heat pumps. At the time of writing, there were two options on the table with Spier: to either buy the solar heat pump plant from Emergent Energy for just over R 800,000, or go for a full maintenance lease, whereby all risks associated with the equipment are carried by the supplier. The process is not yet concluded.

In September 2009, Alan Brent joined the CRSES as Associate Professor to teach and coordinate a series of renewable energy modules at the Sustainability Institute to both sustainable development and engineering students. Alan brought his background in technology management, innovation and process engineering to the ongoing discussions between Spier, the CRSES and the Institute around renewable energy solutions at Spier. Given his exposure to current solar energy applications, Alan suggested a concentrated solar plant (CSP) to be located on the Spier estate and designed as an Eerste River valley solution. The aim would be to generate renewable energy, feed it into the national grid and draw electricity from the grid as per required on the estate. Process heat from the plant could be used for cooling requirements at the wine cellar. Mattie Lubkol, an engineering student at the University of Stellenbosch conducted the feasibility of a CSP at Spier as his master's dissertation project under Alan's guidance. While this will not be an energy-on-demand type of solution such as the biomass generation project, Spier will be able to off-set its total carbon emissions against the renewable energy generated on-site.

7.7 Experiments with wastewater treatment

Spier has a history of finding alternative, decentralized ways of treating wastewater on site, based on the ecological principles of re-use of resources and waste minimization. The first of these experiments was the consideration and installation of the Biolytic filtration system to treat the sewerage and kitchen waste from the hotel complex. Prior to 2003, all sewage on site was treated through septic tanks and pit latrines for houses and 'package' plants for the commercial areas that required constant maintenance. The risk of overload or malfunction of the plants could cause unacceptable quality of effluent being allowed into the river, which went against Spier's environmental commitment.

Introducing the Biolytic system at Spier and planning its viability as a business operation in the wider South African market was Adrian Enthoven's first project in connection with Spier, and one of the first projects to receive support from Spier as a green investment. Adrian Enthoven set up his office at Lynedoch and gained experience in establishing a business from scratch, which included client liaison, identifying technical partners, researching investment strategies and business modelling.

The SSPT had made contact with an Australian company, Dowmus Pty Ltd and proposed the use of biolytic filters in the Spier Development Framework of 1999. Dowmus had developed and patented the technology used in a Biolytic filtration process in 1997 and made significant design improvements in 2000 as the process fundamentals of aerobic treatment of organic waste became better understood. In 2002, Spier entered into a partnership with Dowmus and brought in technical people from Australia to assist with the setting up the filtration plants.

The filtration process involves separating solid and liquid waste at the point of generation and then treating the solids aerobically using a vermiculture process and the liquids aerobically by slow passage through a vermiculture matrix. Other inputs into the system are sufficient oxygen through passive ventilation and minimal power needed to recycle the separated liquid through the vermiculture matrix. The composted solids require annual removal. The treated effluent is nutrient rich, largely pathogen-free and can be used for irrigation or drained through a reed-bed before seeping into the ground.

Since 2003, as recorded in the annual report for 2003-2004, Spier Leisure had two Biolytix facilities where all the grey and black water from the hotel, restaurants and retail outlets was treated. The wastewater from the filtration facilities was used to irrigate a small section of the land and plants at a local nursery. The wine business also used a Biolytix system for wastewater treatment. The effluent from the wine business however was not being re-used. Based on flow regulator readings and estimates from management at the treatment facility, the Biolytix systems were projected to help re-use 20% of Spier's wastewater. The remaining wastewater moved through additional filtration in a wetland area, before disposal.

In 2006, Spier staff discovered that the Biolytix systems were not treating the water to acceptable levels for re-use for irrigation. Furthermore, some buildings on the estate had separate septic tanks, not connected to the Biolytix system. Spier management was faced with three choices: to connect all facilities to the municipal sewer line; to upgrade the Biolytix plants and septic tanks; or to treat wastewater on-site through an alternative centralized system.

The Department of Water Affairs and Forestry (DWAF) was called in to test the quality of the treated water from the current on-site system and search for a long-term, sustainable solution. Although Biolytix as a company was owned by Spier, it was managed separately and sold its services back to Spier. At first, a major overhaul of the Biolytix system was explored in order to reach compliance with DWAF requirements. However, it was realized within two months that the different types of effluent generated at the various facilities on the estate such as the kitchens of the restaurants and the wine cellar were of such chemical composition that the micro-organisms and worms, a critical component of the filtration plants, could not survive.

Finally, an alternative approach was decided upon and bids were received from three suppliers. The aim was not to burden the municipal system further and instead create a sustainable solution on-site which would be easy to report on and maintain.

The winning bidder, Andrew Olsman from HWT was willing to consider an approach which combined scientific and metaphysical techniques to cleanse the water. Tanner Methvin as

Sustainability Director was closely involved in the conception and design of the treatment plant which took just under four months to build on the South Bank of Eerste River and uses two of the existing dams on the site for storage of treated water. Spier's website describes the filtration process:

"A biological effluent treatment plant was created that uses a bioreactor, coupled with aerobic bacteria, to cleanse the water. An Archimedes Screw compacts the solid waste, separates the matter and removes the solids for collection. The liquid remnants are moved into an open tank where aerobic bacteria continue the process. This bioreactor, which is an open-air tank divided into four sections, accepts water into the first tank, and subsequently forces the water into each of the remaining tanks in an anti-clockwise direction. The aeration pumps switch off between 3am and 7am, allowing the bacteria and waste to settle at the bottom. The cleaner water is skimmed from the top and moved through pipes that irrigate an oval-shaped reed bed. This reed bed is ideal for the natural growth of bacteria, which continue the breakdown of pollutants as the water seeps into the soil.

The water passes through the reed bed into the yin-yang pond where it is pumped through a number of flow forms before being transported to an irrigation dam, from where it is used to irrigate the grounds and gardens on the estate."

The metaphysical components such as the reed bed and flow forms oxygenate and bring life and energy to the water in ways not easy to test scientifically. Water quality is measured before and after bioreactor treatment, before and after the reed bed, and before and after the flow forms and no trace of e-coli has been found which is critical to meeting DWAF requirements for re-use. Water sample and effluent usage reports are provided by HWT to Spier facilities management on a monthly basis. Linking of the solid waste recycling depot and some cottages to the bioreactor is still out-standing. Meanwhile, the cottages are serviced by a septic tank and the waste water from the recycling depot is filtered and used to irrigate grounds in the vicinity, but not allowed to flow into the river.

The current wastewater treatment plant was the first of its kind in South Africa to successfully combine art, science and healing techniques. Its purification capacity over a 24-hour cycle has been compared roughly to the cleansing action of 344km of flow in a natural river system.

7.8 Solid waste recycling

The Spier Development Framework (SDF) records that solid waste handling was a 'substantial problem' on the estate. In 1999 solid waste from all buildings was being disposed off on a tip site on the estate and a truck owned and operated by Spier regularly transported it to a nearby municipal dump. The system clearly did not conform to Spier's vision of waste minimization and re-use. At the same time, the SDF proposed the use of the biolytic filtration system to deal with organic waste and contaminated paper disposal and exploring partnerships with large-scale recyclers such as Collect-a-Can and Sappi for paper, plastic, metal and glass waste streams.

By 2002, an on-site waste removal company called Nov-Waste was collecting organic waste from the estate and delivering it to the Go Organic farmers. The company was run by Louis November who started out at the estate felling alien trees and sought a waste removal contract with Spier as an opportunity to run his own business and employ others. Louis had his own truck and collected all types of waste from the different buildings: vegetable matter, paper, plastic, tins, bottles and brought it to a sorting depot on the estate, where a team of six people sorted the refuse into bins to be bought by commercial recycling companies. As a result of these interventions, only five percent of Spier's waste ended up at the municipal dump.

According to the 2004 annual report, food-based waste was given to a local pig-farming co-operative. This practice continues till today. Teabags, coffee, egg-skins, vegetable and fruit peels are separated from other organic waste at the depot and are collected by the farm manager, Orlando Filander for the composting site at Spier. Spier also pays in half towards the transportation of green waste, rich in carbon, from the outsourced packing shed to the composting site. Moreover, all Spier's used oil is collected and recycled. Based on figures available for nine months of 2004, it is estimated that 56% of the 788, 494 kg of solid waste generated by the leisure and wine businesses was recycled during the reporting period. The amount of tin and glass recycled over a two-year period was equated to the energy required to light all 5,000 houses in Kayamandi for 6 months.

The percentage of recycled waste versus compacted for a landfill increased to 80% by 2006 (in excess of the management goals) and stood at 89% at the time of writing this report. Currently, refuse is measured on a daily basis and reported on a weekly basis by Wasteplan, the current waste management contractor. Cherie Immelman places the credit for current performance on the primarily female sorting staff. Cherie also thinks that Spier businesses have reached a ceiling on percentage of waste recycled despite operational staff attending learning programs on sustainability at the SI and visiting the local landfill sites. When restaurant and banqueting staff work under pressure, they do not separate plastic and paper products from food, which leads to contamination of recyclable waste. Cherie is not sure how management can drive behavioural change towards sustainable practices on a daily basis.

The location of the sorting depot was an environmental hazard until a filtration sump was installed in 2010. The waste water from the cleaning of the bins is now filtered and used for irrigating nearby grounds. However, there is still a risk of contaminated water from the site leaching into the ground and eventually ending up in the nearby stream.

Future upgrades in terms of relocation closer to the composting site for ease of refuse collection from Annandale Road; and health and safety infrastructure for the cleaning staff require considerable investment, awaiting management approval.

Another source of pollutants entering the stream is the packing shed where chlorine is used for cleaning organic produce. A treatment plant was set up to remove chlorine from the packing shed effluent in 2009 but does not work anymore. A long term solution would be to connect the packing shed and sorting depot to the centralized bioreactor filtration plant, once the decision to relocate the depot is finalized.

There is a very important reason why Spier focuses on solid waste re-use and recycling (as an independent output stream) with no reference to input streams of products and materials into the business and the estate. The reason as stated in the Spier Sustainability Report, 2006 is that the production processes at Spier do not generate most waste; rather it is the consumption by customers and staff through eating and drinking which produces most of on-site solid waste.

Thus a flow analysis of the weight of food versus the weight of packaging to gain an understanding of what is eaten and what becomes waste is not considered meaningful by Spier. For now, waste is separated at source by the various Spier operations and guests on the estate are also encouraged to assist by placing waste in the correct bins. Efforts are underway to encourage separation of pig-food type of organic waste from compostable organic waste at the various operations.

However, it was noted in annual reports from 2004, 2005 and 2006 that Spier could modify input streams by changing procurement/consumption practices and buying products made from recycled materials. In 2006, less that 1% of materials purchased for the various businesses were derived from recycled materials. Interviews with procurement managers at leisure and wine operations reveal that major efforts are underway to source lower carbon products such as wine bottles made of lighter and alternative materials and recyclable packaging for wine cases which make a sizeable contribution to carbon emissions. The aim is to reach a 50% target of using paper, plastic and glass from recycled sources by 2017.

7.9 Carbon footprint as a composite measure for climate change impact

A significant organisational milestone for Spier in 2007 was the macro level amalgamation of environmental and socio-economic goals under the broad themes of climate change and poverty alleviation. Climate change goals include **carbon neutrality**, zero waste solids, zero wastewater, water sustainability, biodiversity enhancement and environmentally friendly farming. Poverty alleviation goals include supply chain transformation, living conditions, education and healthcare, HIV/AIDS, empowerment and diversity. It is envisaged that combined progress on all areas under the two macro themes by 2017, will mean significant advancement on the path to sustainability.

'We cannot change what we do not measure' is an oft-quoted business reason for monitoring behaviour year-on-year against pre-defined goals in order to drive and sustain positive organisational change. Carbon footprint, as discussed in Carbonology provides a concise and comparable indicator of an entity's contribution to climate change through a range of activities, which can be aggregated into a single measure. Carbonology concluded that despite ambiguities across different carbon auditing techniques, the use of carbon-related goals has the potential to engender a common language across business units towards ecologically-sensitive behaviour. In the case of Spier, calculation of their carbon footprint was a first step towards achieving the macro-organisational goal of carbon neutral status by 2017.

In 2008, Spier Holdings commissioned Global Carbon Exchange (GCX) to conduct a carbon footprint analysis of the business' operations. GCX is a leading international carbon and energy measurement, management and reduction consultancy. The analysis was conducted by collating information on the three core business units of Spier Holdings: Wine, Leisure and Farming. The emissions for each business unit were calculated by using data from the reporting period August 2007-September 2008, which thus forms the baseline for future financial years.

The overall annual carbon footprint of Spier for the financial year 2007-2008 came to 6, 055 tonnes of CO_2e (carbon dioxide equivalent), with Leisure accounting for 49%, Wines accounting for 47% and Farms accounting for 4% of the total.

GCX proposed adjustments in the current business practices at Spier in order to reduce environmental and financial costs burden and suggested carbon off-setting options that GCX could help implement. Recommendations for the wine business included detailed energy audit, an LCA-based carbon footprint of one bottle of wine, switching to an alternative coolant gas and lighter glass bottles.

Use of bio-diesel and soil carbon improvement were recommended by GCX for the farm business while the leisure business was advised to undertake a detailed energy audit, install energy saving devices such as motion sensors, smart keys, solar water heaters, geyser blankets and electronic ballasts among others. The GCX report (2008) made key observations with regards to scope 3 emissions[24], emphasizing the need to incorporate outsourced

[24] Operational boundaries distinguish between direct (or scope 1) and indirect emissions (scope 2 and 3): direct emissions arise from sources that are owned or controlled by the reporting organisation such as company owned vehicles and fuel combustion, while indirect emissions may result from a business' activity but occur at sources owned or controlled by another entity (WRI, 2004).

Scope 2 includes indirect emissions from the consumption of purchased electricity, heat or steam generated by another organisation while scope 3 emissions are other indirect emissions generated in the distribution and packaging in future footprint analysis. While the information was analysed with due skill by the GCX team, the reliability and accuracy of data collected was the responsibility of the Spier financial team.

In 2009, Spier management decided to add the task of carbon footprint analysis to the financial director's portfolio. Group Accountant, Christie Kruger, is now responsible for collating the information from the different Spier business units and generating a consolidated carbon footprint for Spier Holding as part of the company's annual environmental review. Among the matters which the Group Accountant must attend to in order to improve on the process, is incorporate more scope 3 emissions and ensure reliability, completeness and accuracy of data collected by financial officers on each business unit.

Scope 3 emissions represent a critical area where various opportunities may exist for an organisation to reduce emissions towards a low carbon future. With goals such as recycling 100% of waste produced on site and purchasing 50% of all paper, plastic and glass products from recycled sources, Spier is already attending to a major contributor to scope 3 emissions.

Substantial reductions in municipal and industrial water use (25% and 35% respectively in relation to 2007 water use levels) contribute to the larger goal of water sustainability, but also to reduction in scope 3 emissions and therefore the carbon footprint. All water brought to the estate contains embedded emissions in the form of electricity that is required to pump the water from its source to the point of use.

By comparison, rain water harvested on site will have very little embedded carbon. Measuring performance against the water sustainability goal has been problematic and is attributed to anomalies in the way water usage is measured and reported on as well as faulty water meters. Improvements in water usage measurement and reporting were a key focus for 2009, which should reflect in the next sustainability report due by October 2010. Similarly, sourcing 30% of vegetables used in the kitchens from the farm on the estate will reduce emissions from transportation and packaging, with the opportunity to farm in environmentally friendly ways.

Importantly, carbon off-setting options for Spier may exist through the extension of existing environmentally beneficial projects such as the effluent treatment plant; conversion of 25% of all land holding into conservation and restoring it to its indigenous wetland state; and environmentally friendly farming on 200 hectares of estate as potential carbon emissions reduction projects. It was not verifiable through interviews with senior managers whether a reduced carbon footprint of the business could thus reflect not only water saving, waste

wider economy from business travel, outsourced activities, waste disposal, product use, contractor owned vehicles and production of purchased materials. Scope 3 emissions are all other emissions that are not directly emitted at the point of use of the company. As they are potentially endless, only those emissions that are significant or that can be influenced by the company are accounted for.

reduction and energy saving efforts, but also incorporate harder to quantify endeavours such as wetland conservation and biodynamic farming, allowing it to become a composite measure of Spier's climate change goals.

The project of calculating an LCA-based carbon footprint of a bottle of wine was undertaken by the Group Accountant in 2010, who was guided by the research conducted for this thesis. It was among one of the recommendations made by GCX pertaining to the wine business, as a prelude to identifying ways to reduce related impacts. Two methodologies were tested to base Spier's model on.

Firstly, the PAS 2050: 2008 (Publicly Accessible Standard 2050 released by the British Standards Institution in 2008), which is a specification for the measurement of GHG emissions occurring throughout the life cycle of goods and services (BSI, 2008), was explored. The PAS 2050: 2008 takes a process-based life cycle analysis (LCA) approach to evaluating emissions associated with a product, enabling companies to identify minimization points across the entire product system. Secondly, the SAFWI (South African Fruit and Wine Initiative) carbon calculator released in September 2009 (based on the International Wine carbon calculator), was interrogated. The SAFWI carbon calculator incorporates elements of the PAS 2050:2008 such as utilisation of process maps, boundary delineation and data requirements. The focus shifts from defining emissions in terms of scope to understanding the implications of existing supply chains.

Whether it is through emphasis on scope 3 emissions of the GHG Protocol or unravelling a product's emissions through its cradle to grave life-cycle, carbon calculation has provided Spier's staff at operational, management and senior management level to align diverse activities towards a lower carbon profile. Interviews with Sherieen Pretorius, Jaco Durand, Frans Smit, Cherie Immelman and Orlando Filander reveal that efforts are underway on various fronts with the common aim of mitigating climate change through operational decisions – be they lighter weight bottles, recyclable wine cases, humidifiers and solar bulbs in the cellar, harvesting of rain water from the cellar buildings, installation of water meters and water saving devices, solar water pumps or using treated wastewater for irrigation purposes, managing a composting site and organic farming.

It must be noted, however, that lowering of scope 2 emissions has been part of the sustainability approach at Spier for longer than the stated macro goal of carbon neutrality. Energy efficiency measures such as installation of electrical meters at individual businesses was undertaken in 2005, to hold each entity accountable for their usage and thereby encourage saving. 2004 was a year for establishing a baseline in energy consumption for lighting, heating and transportation purposes from various sources including electricity, LPG, petrol, diesel and wood. A 1% reduction in energy consumption was observed in 2005, while it was noted that benefits from energy conservation measures such as electrical meters, resetting of water heaters, geyser blankets and light-saving bulbs in all hotel rooms will only be realized in 2006. A sizeable decrease in energy consumption of almost 10% was measured in 2006, resulting directly from the company reducing its consumption of electricity and petrol/diesel.

7.10 Strategy for a sustainable future: organisation-wide sustainability-oriented behaviour

The last thread of this narrative is very much centred on the confluence of strategy and goals and how the various initiatives at Spier attempt to bring the business closer to the vision of sustainability with two key elements: climate change and poverty alleviation.

There has been noteworthy progress on the measurement of performance on climate change goals, exemplified through the carbon footprint analysis for 2008 by GCX, commencing the life cycle analysis of a bottle of wine in 2010 and nascent discussions around a thorough water footprint of the estate[25]. Comparison of carbon footprints for the three years since 2008 would be very useful, but at the time of writing this report, the 2009 and 2010 figures still needed to be finalised. Preliminary data suggests that the consolidated Spier footprint reduced by 175 tonnes of CO_2e in 2009, although the separate assessment of Spier Leisure indicates an increase in emissions.

Spier management was unable to produce an annual sustainability report for the 2008-09 reporting cycle for multiple reasons. Consequently, Trialogue, a local consulting firm specializing in Corporate Social Investment (CSI) and sustainability reporting was hired in May 2010, to produce a delayed 2009 annual report and a 2010 annual report with a 5-year review of performance against goals by October 2010.

In preparation for the writing of the sustainability report, Trialogue met with a number of managers in order to identify material issues, of importance and relevance to the business. This led to a framework of 42 indicators from six different categories. Revision of the issues and categories yielded seven main issues which describe, at a high level, what sustainability means

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[25] The water footprint is an indicator of water use that includes both direct and indirect water use by consumers and/or producers. Indirect water use includes what is called virtual or embedded water, which refers to the volume of freshwater used in the production of a good or service, measured at the place where the product was actually produced and not the physically present water in the product (Hoekstra, 2009). For instance, it takes 1,300 cubic meters of water, on average, to produce one metric tonne of wheat.

Currently, Spier reports on the total blue water consumed on the estate, the total green water which falls on the land owned by Spier as well as the grey water produced on-site. In order to develop a water footprint as per a top-down balance-based methodology, Spier will need to add the virtual-water embedded in the goods consumed on the estate, for example the water embodied in a tin of tomato paste used in the restaurant; and subtract the virtual-water embedded in the wine bottles that leave the cellar for consumption off-site. This can be a daunting exercise and in the meantime the water footprint of one bottle of wine could be calculated, using process maps similar to the ones used for calculating the carbon footprint of a bottle of wine.

to Spier. The approach taken by Trialogue ascribes to sustainability dashboard reporting whereby each of the seven sustainability issues is informed by several more detailed sub-issues and progress on each issue is reflected through an aggregation of performance against each sub-issue.

The seven material issues in the Spier sustainability framework as articulated by Trialogue are based on GRI performance goals and are drawn from high-level interaction with senior and operational management. They include transformation, influencing the social and environmental impact of business partners, caring for Spier people and their communities, reaching out to broader society, labour practices and decent work, environmental impact and product responsibility.

In this framework, global warming or climate change becomes one of the sub-issues informing the higher level issue of environmental impact alongside pollution, through the generation of solid waste, water use, biodiversity, and farming practices and landscaping at Spier. In the current alignment, the carbon footprint is simply an indicator of climate change caused by a company's activities and is one of the performance areas of Spier. The reconfigured structure for sustainability reporting fails to account for the global warming potential of waste recycling, waste water treatment or biodiversity conservation. The framework requires individual sub-issues to be measured separately for progress against each goal.

It is interesting to compare the current focus on GRI-inspired material issues to the core values which informed Spier's strategy in the development framework of 1999. The vision more than a decade ago was to create a sustainable 'micro-ecology' in the Winelands through a combination of attention to heritage and culture, wealth generation, meeting social and economic needs and provision of infrastructure to encourage new community lifestyles compatible with an equitable vision for South Africa.

The phase identified as internalizing sustainability typified organisational maturity and an eagerness to connect the organisation through financial and non-financial goal-setting and alignment of Spier's vision with Spier values, and of Spier's management strategy with vision. The vision of organisational inter-connectedness is carried through to the current time-period, when management is also looking to achieve the sustainability objective through innovation at individual employee level. The desire to remain true to the purpose of the business is perceived by senior management as a sufficient driver of sustainability-oriented behaviour. The current paradigm at Spier of 'sustainability reporting' is displayed through increased focus on carbon footprint, water footprint and consolidated environmental reporting.

7.11 Conclusion

The ‘Sustainability Story of Spier’ charts the sustainability trajectory of the business, as revealed through desk-top review of key strategic documents, including annual reports, and interviews with senior management and operational staff members at Spier. The stand-alone chapter provides an integrated back-drop to Spier’s performance over almost two decades, in key areas of corporate environmental practice: sustainability reporting; renewable energy and energy efficiency solutions for reducing carbon emissions; wastewater recycling; and solid waste recycling.

The story was a useful milestone which generated critical responses from key stakeholders on the project, in order to gauge progress along the research direction. As the research progressed and the research problem was redefined through iterations between theoretical analysis and practical engagements with agents within and external to the Spier system, the purpose of the narrative evolved and shifted.

From a wide requirement of charting the sustainability story with somewhat equal weight on past and present trends, research interest shifted to a greater focus on the business’ current performance, with a view towards informing strategy going forward. In particular, the three trends of energy efficiency, solid waste recycling and wastewater treatment received special attention in order to capture and affirm Spier’s progress towards environmental sustainability goals.

Detailed analysis of the narrative was consciously avoided, since the aim was to provide a well-balanced view of the sustainability journey after amalgamating multiple perspectives. Clues as to the analysis begin to emerge at this stage but are pursued in earnest in Chapters 8 and 9 where trends and informants of corporate environmental sustainability are examined in detail. For example, the three phases along which the sustainability story is told become the basis for analysing the business’ trajectory along the adaptive renewal cycle in Chapter 9.

It is important to note that not all aspects of the sustainability story are analysed fully. Corporate practice performance areas with direct relevance to the research objective of understanding the drivers which underlie the corporate search for a lower carbon future are interrogated to greater depth in Chapters 8 and 9. These include the performance areas of sustainability reporting, environmental goal setting, energy efficiency and renewable energy projects, solid waste recycling and wastewater treatment.

Chapter 8: Case Findings and preliminary analysis of the 'Sustainability Story of Spier'

8.1 Introduction

The case study of Spier Holdings was undertaken under two different but interlinked objectives. The first objective was to find out how a medium-sized business such as Spier could become carbon neutral, as required through scientific definitions of carbon footprint, carbon neutral and lower carbon status. The second objective was to chart the sustainability journey of Spier with the aim of interrogating business decisions aimed at environmental sustainability.

In relation to the first objective, a review of industry-generated literature on carbon footprint and related standards on emissions calculation and carbon neutrality was undertaken in Chapter 5: Carbonology. The general conclusions from a review of definitions, standards, corporate strategies for carbon reduction suggest that carbon footprint is not a comprehensive measure of climate change impact, ambiguities related to carbon auditing tools and technologies exist, biases in carbon reduction strategies are found so that a carbon focus translates into a fossil fuel consumption focus (see section 5.6). The sustainability journey of Spier, especially the corporate practice area of energy efficiency and renewable energy technology adoption provides case-specific evidence to take these general conclusions further, and test the validity of the carbon neutral goal in the context of corporate environmental sustainability.

A preliminary analysis of the 'Sustainability Story of Spier' is undertaken with the aim of interrogating business decisions in key areas of corporate environmental sustainability. This interrogation is enabled through a critical examination of corporate citizenship frameworks and sustainable development literature in Chapter 3; and an unravelling of the intellectual roots of corporate environmental sustainability terms and concepts, through a review of ecological economics and industrial ecology bodies of knowledge in Chapter 4.

What emerged as a result of the two separate and yet interlinked objectives was the question: Why does a business such as Spier pursue the goal of carbon neutral? As a result of the case findings, especially in respect of Spier's environmental reporting practices and pursuit of energy efficiency, additional research questions began to emerge: Do carbon emissions calculation (and the goal of carbon neutrality) drive a business' search for a lower carbon future? If not, then what alternative measures or goals could drive a business' search for a lower carbon future, and the corporate quest for environmental or ecological sustainability?

The above questions arose as a result of conducting over 40 interviews with Spier management, staff and intermediaries and reviewing strategic business documents (including 4 published and 2 unpublished sustainability reports). The case study work conducted over the period February-August 2010 generated the narrative called the 'Sustainability Story of Spier' (Chapter 7). This chapter reviews relevant sections of the narrative to answer the questions:

1. Is carbon emissions calculation a useful measure for tracking Spier's environmental sustainability journey?
2. Does the goal of carbon neutrality assist Spier in driving its search for lower carbon emissions or environmental sustainability?
3. Can Spier's environmental performance be understood by using frameworks from corporate citizenship and systems ecology?

8.1.1 Chapter structure

This chapter is divided into three distinct parts, each answering one of the three research questions articulated above.

The first part of this chapter supports the claim that past environmental reporting practices at Spier do not allow a consistent, year-on-year comparison of progress towards the achievement of organisational goals for environmental sustainability (under the macro goal of climate change).This may not necessarily be a bad trend since it represents evolution in the business' perception, measurement and communication of its own sustainability profile. The potential of carbon footprint as a comprehensive measure for mapping the sustainability trajectory of the business is also found to be problematic. The question addressed by the first part of the chapter is whether environmental reporting, including emissions calculation, is a useful measure for tracking Spier's environmental sustainability journey.

The second part of the chapter presents empirical evidence, gleaned from the sustainability reports and personal interviews, on critical corporate practice areas relevant to environmental sustainability. This evidence and its interrogation and analysis support the claim that environmentally significant behaviour at Spier is not driven solely by the need to achieve a carbon neutral status. A close analysis of past decisions and investments in three core areas of environmental performance typify completely different decision-making patterns, driven by a range of internal and external factors. The second part of the chapter therefore addresses the question whether carbon neutrality (and zero wastewater and zero solid waste) can be discerned as a meaningful driver of Spier's quest for lower carbon emissions, or environmental sustainability.

In the third part of this chapter, Spier's environmental performance and reporting thereof is transferred to the two frameworks generated in conclusion of Chapters 3 and 4 (Table 3.3: Framework for corporate citizenship practices with intended sustainability outcomes and Table 4.2: Framework for assessing a business against best environmental practices) to explore how Spier's environmentally-significant behaviour corresponds with a) the drivers and perceptions of corporate citizenship in the South African context and b) corporate best practice in terms of environmental sustainability based on the principles of ecological economics and industrial ecology. The aim is to resolve contradictions observed in organisational goal-setting and management decisions and to ascertain whether these contradictions can be resolved using the purview of corporate citizenship, industrial ecology and ecological economics literatures.

Chapter 8 builds a case for Chapter 9, which integrates analysis of case findings with alternative frameworks and constructs from sustainability science to produce new knowledge.

8.2 Part 1: Analysis of Spier's environmental reporting practices

Environmental reporting, and carbon footprint calculation of the business in particular, is considered an important tracking system for measuring the business' progress towards environmental sustainability. Spier began reporting on its environmental performance from the year 2005, when the business published its first sustainability report (based on data collected in the financial year 2004). Table 8.1 captures key milestones in the sustainability reporting practice (including environmental reporting and carbon footprint calculations) at Spier Holdings.

Table 8.1 Sustainability reporting, accreditations and footprint calculations at Spier (2003-2010)

Time frame	Key milestone, accreditation or new reporting practice
2003	Fair Trade in Tourism South Africa (FTTSA) accreditation for Spier Resort Management, one of five in the country
2004	Wine Industry Ethical Trading Association (WIETA) accreditation for Spier wine
2004	158 measurable indicators drawn up based on GRI-based guidelines and South African legislative requirements
2004-2006	Sustainability reports from the office of the sustainability director capture an intense review process of the Spier businesses and maintain a consistent reporting style over the 3 year period SR for 2006 won 2 industry awards for best Sustainability Report
2007	Ten year macro-goals established including achievement of carbon neutral status, water sustainability and zero waste by 2017
2007-2008	Limited copies printed on paper, available on-line. Produced by the Directors of HR and Marketing (Heidi Newton-King and Annebelle Schreuders)
2008	Global Carbon Exchange (GCX)[26] commissioned to conduct a carbon footprint analysis of Spier operations based on available information
2009-2010	Trialogue commissioned to write a belated 2009 SR and a 2010 SR Internal calculation of Spier's carbon footprint by the group accountant
2010	LCA-based carbon footprint of a bottle of wine to draw attention to emissions

[26] http://www.globalcarbonexchange.com/

	in the packaging and distribution stages of wine production Preliminary water footprint of estate (excluding embedded water in procured products) to aid management decision-making Ongoing processes to receive BEE accreditation for all business units

When the empirical research was initiated in 2010, Spier management was in the process of consolidating environmental reporting through the office of the Director of Finance, with data being collected by the financial reporting staff. The Group Accountant at Spier, at a level just below the Directors (also referred to as senior management), was the point of entry for this investigation.

Firstly, a review of the environmental component of published and unpublished annual reports (2004-2009) was undertaken, with a view to test consistency and comparability between past and current years' figures for energy and water consumption and waste generation.

Secondly, primary data collectors (such as book-keepers, creditors and accounting practitioners in different business units) were interviewed in order to gauge reliability of data used for producing annual carbon footprints of Spier Holdings.

Thirdly, a process map to calculate an LCA-based carbon footprint of a bottle of wine and the water footprint of the estate were initiated, as part of engagements with the Group Accountant. Findings from the three legs of investigating Spier's environmental reporting practices, including carbon footprint calculations, are documented in the following sections.

8.2.1 Trends in year-on-year environmental reporting

The following inconsistencies and sources of incomparability among the environmental sections of 6 annual reports were identified, based on a detailed review, followed by interviews with the main report authors (Gareth Haysom: 2004-2005, 2005-2006 and 2006-2007; Heidi Newton-King and Annebelle Schreuders: 2007-2008 and Christy Kruger (environmental reporting): 2008-2009):

- Total electricity consumption figures vary significantly from one year to the next depending upon whether tenants' consumption is included or not. These tenants are on the Spier estate, draw electricity from the site cables, would be considered when designing a whole-site renewable energy solution but may not aspire to the same sustainability principles as Spier.
- Reporting on direct consumption of petrol, diesel and LPG for the years 2004, 2005 and 2006 is not split along usage by mobile sources and stationary sources. This makes comparison with reporting from 2006 onwards difficult unless primary data is accessed and utilised.

- Furthermore, LPG consumption figures are missing from the Spier Sustainability Reports, 2007 and 2008.
- Prior to 2007, different sources of electricity consumption are disaggregated into greenhouse gases (CO_2, SOX, NOX) as a measure of climate change impact and a consolidated figure of CO_2 equivalent is not provided. This represents an evolving perception of how the business maps its own climate change impact.
- The Spier Sustainability Report, 2007 follows a completely new format for reporting on water consumption, not comparable with previous years. The Spier Sustainability Report, 2008 admits to anomalies in the way water usage is measured and reported on as well as faulty water meters. Improvements in water usage measurement and reporting were a key focus for 2009.
- Spier relies on their waste contractor to provide them with the information which is presented in the sustainability reports. The contractor changed in 2007 and provided waste-related information in a different disaggregated format.

Reporting format changed drastically in 2007 making desk-top comparison across years difficult. Another shift began in 2008 when GCX was contracted to calculate the carbon footprint (also desk-top, based on information provided by Spier; no physical data collection or verification was undertaken). In sum, comparison of Spier’s performance in the key areas of energy consumption, water consumption and waste generation across the 6 years since sustainability reporting began (in 2004) was found highly problematic.

In a parallel process, Trialogue, a private consulting firm specialising in CSI (Corporate Sustainability Investment) was commissioned in mid-2010 by Spier Holdings to conclude writing the sustainability reports for 2008-2009 and 2009-2010 (for publication) and review Spier’s progress along sustainability measures over the five year period 2006-2010.

In respect of the Spier Sustainability Report, 2008-2009, Trialogue changed the format by articulating seven material issues in the Spier sustainability framework based on GRI (Global Reporting Initiative) performance goals (Trialogue, 2010). These included transformation, influencing the social and environmental impact of business partners, caring for Spier people and their communities, reaching out to broader society, labour practices and decent work, environmental impact and product responsibility.

In respect of the five year review, Trialogue struggled to populate the framework they had designed for comparing progress towards sustainability over the review period. Sustainability reports did not contain the information required to populate all the cells, and managers were not always able to provide quantitative, comparable information (personal communication with Trialogue researcher Denise Bester).

8.2.2 Components of the organisational carbon footprint

Calculation of their carbon footprint can be considered a first step in Spier's strategy for achieving carbon neutral status by 2017. The analysis was conducted by collating information on the three core business units of Spier Holdings: Wine, Leisure and Farming. The emissions for each business unit were calculated by using data from the reporting period August 2007-September 2008, which thus forms the baseline for future financial years. The overall annual carbon footprint of Spier for financial year 2007-2008 was reported as 6, 055 tonnes of CO_2e, with Leisure accounting for 49%, Wines accounting for 47% and Farms accounting for 4% of the total (Spier Sustainability Report, 2008-2009).

As stated in the carbon footprint report by GCX (2008), and seen in figure 8.1, the following sources for CO_2 emissions were incorporated to produce a carbon footprint of the business in 2008, based on the GHG protocol methodology for corporate carbon management (see Chapter 5):

- company-owned transport or mobile equipment (such as tractors and forklifts) under scope 1 if petrol, diesel or LPG is used and under scope 2 for electric vehicles[27] using a quantity-based approach (as opposed to distance-based)
- electricity consumption (for heating, cooling and cooking) under scope 2
- stationary fuel consumption (for heating such as LPG, firelighters and jellies) under scope 1
- business travel under scope 3
- employee commute to the business site (extrapolation for Spier wines and Spier leisure was difficult because of low response rate to the employ commute survey form)
- waste under scope 1 (CO_2 equivalent of methane from landfill waste)
- water under scope 2 (electricity required to pump water from its source)
- fertiliser use (at Spier farms)

[27] Non-company owned transport including distribution (such as trucks on national roads) was not accounted for in the 2008 carbon footprint. According to GCX, outsourced distribution is a major contributor to scope 3 emissions, which needs to be investigated in subsequent footprints: "distribution, particularly to and from Spier Wines, is very complex and would be a significant source of emissions from a broad range of third party service providers" (GCX, 2008: 14)

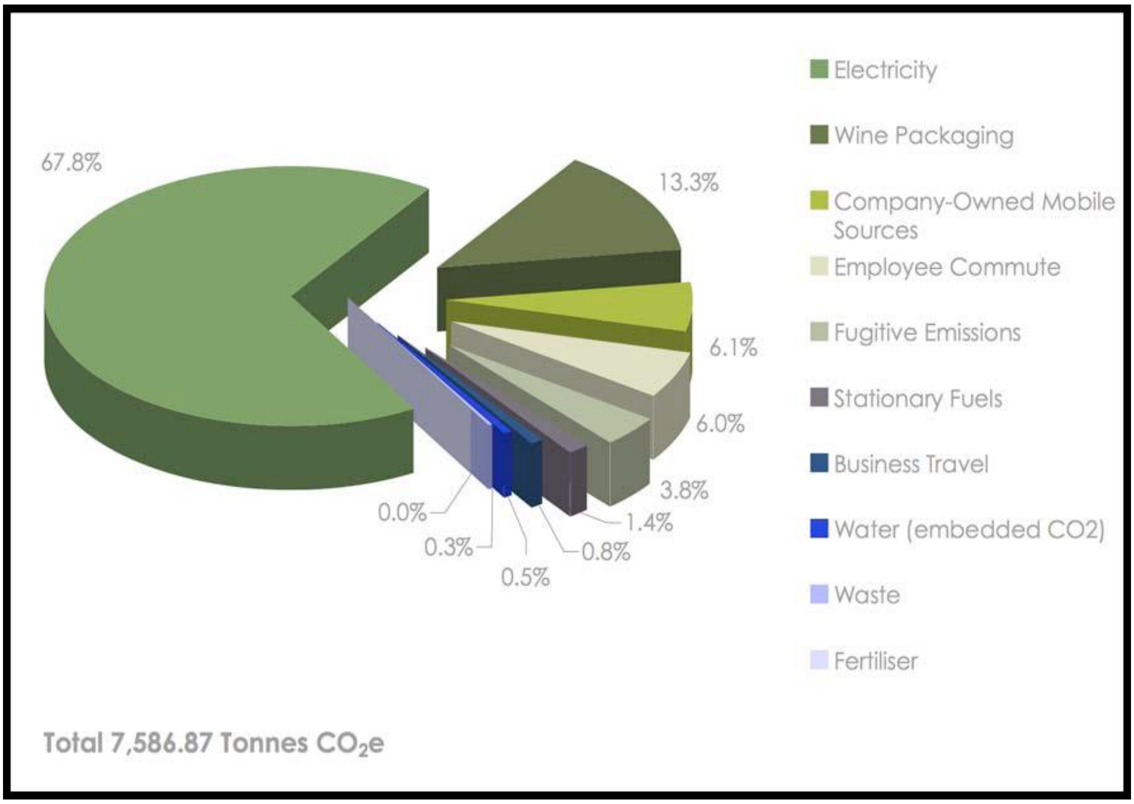

Figure 8.1 Spier's carbon footprint (Source: Spier Holdings Carbon Footprint Report submitted by GCX on 24 December, 2008)

Several inconsistencies and gaps were noted when comparing general environmental reporting (pre-carbon footprint) by Spier and the data fields for carbon footprint calculation with on-site findings and interviews with (accounting staff, the farm manager and the facilities manager). These include:

- Emissions generated from composting organic waste (on site) are not incorporated in the carbon footprint of the business.
- There is a difference in perception of what constitutes stationary fuel between accounting staff at Spier and GCX accountants responsible for calculating the first Spier carbon footprint.
- Total waste generated figures are not publicized in sustainability reports but become relevant when calculating the carbon footprint. Therefore, the focus shifts from successes in terms of recycling rates to glass ceilings in increasing those rates past 90%.
- Spier may choose to use the PAS 2050:2008 or elements of the method for calculating their footprint for the next financial year: 2010, increasing consumer appreciation but decreasing comparability across the years even further.

When the thesis case-study was initiated in February 2010, a consolidation phase was underway to prepare a format for the Group Accountant to conduct carbon and water footprints in-house. The above findings were aimed at assessing whether there was any value in producing carbon footprints for past years, based on the information collected for environmental reporting, in order to corroborate a downward trending footprint, and therefore achievement of environmental sustainability goals. This was found difficult based on the inconsistencies identified between year-on-year reporting formats.

8.2.3 LCA-based carbon and water footprints of a bottle of wine

Among the recommendations made by GCX to Spier Wines as an emission reduction opportunity, was the calculation of a life cycle-based carbon footprint of one of the brands of Spier Wines. The aim as spelt out by GCX was to identify cradle-to-grave emission sources in order to capture upstream and downstream contributions which are not necessarily captured in the total business carbon footprint (GCX, 2008). A clear benefit of this exercise was the potentiality of off-setting and declaring the product carbon neutral (GCX, 2008).

The PAS 2050:2008 (Publicly Accessible Standard 2050 released by the British Standards Institution in 2008) standard for calculating product carbon footprints was studied in order to design process maps for a bottle of Spier wine. Wine carbon calculators such as the South African Fruit and Wine Calculator (based on the International Wine Carbon calculator) and the Australian Wine Carbon Calculator were also reviewed to verify details on how for instance soil carbon is incorporated in emissions calculations. The Group Accountant collected activity data in order to calculate and compare the carbon footprints of a number of wine labels simultaneously. Emission factors for the South African industry were not always available, and international figures were used.

The exercise of calculating the full LCA-based carbon footprint of even one bottle of wine was highly challenging, since information from key upstream sources was not always available.

A similar trend was experienced with regards to calculating the estate's water footprint. Currently, Spier reports on the total blue water consumed on the estate, the total green water which falls on the land owned by Spier as well as the grey water produced on-site. In order to develop a water footprint as per the top-down balance-based methodology (Hoekstra et al, 2009), Spier would need to add the virtual-water embedded in the goods consumed on the estate, for example the water embodied in a tin of tomato paste used in the restaurant; and subtract the virtual-water embedded in the wine bottles that leave the cellar for consumption off-site. In theory, Spier could calculate the water footprint of one bottle of wine, using process maps similar to the ones used for calculating the carbon footprint of a bottle of wine.

However, the data demands for calculating a technically sound water footprint for a bottle of wine require far more resources than senior management can set aside for such a project.

8.2.4 Trends in Spier's environmental reporting

The above discussion captures key findings from the three ways in which Spier's environmental reporting practices were interrogated, in collaboration with the Group Accountant. These investigations allowed the researcher great access to the processes which underpin measurement and reporting on the business' environmental impact. They also became the basis for future interactions with other actors in the organisation at various levels, involved in improving the business environmental performance. The findings from the investigation are encapsulated in the following trends:

- While environmental reporting is produced for total energy, total water and total waste figures on the site, data is collected through different business units. This creates an asymmetry in the data collection and reporting processes (because the total is not always equal to the sum of the parts).
- The environmental sections of the (published and unpublished) sustainability reports for the years 2004 to 2010 were found incomparable by the researcher due to changes in main authors who used different formats, inclusions and evolving scientific tools (such as the representation of the global warming potential of greenhouse gases). Therefore, comparison of Spier's energy consumption, water consumption and waste generation figures across the 6 years was found highly problematic.
- Independent consultants (Trialogue) also struggled to present sound evidence (as per sound accounting principles of reliability, comparability, consistency and transparency) over the review period of 2004-2009 to support Spier's progress on sustainability indicators.
- The carbon footprint could not be extrapolated back to past years, mainly due to the incomparability of data across past sustainability reports.
- GCX recommended that the carbon footprint calculation will improve (more thorough) through incorporation of scope 3 emissions (GCX, 2008). Scope 3 emissions include among others, emissions from employees commuting to work and packaging and distribution of products (mainly wine bottles). There remains a big question around the impact or control that an individual business has on these aspects.
- Furthermore, the carbon footprint of a product changes substantially depending upon whether scope 3 emissions are included or not. Carbon disclosure on products, especially claims of carbon neutrality, may not require declaration on whether scope 3 emissions are included or not.
- The processes undertaken for calculating an LCA-based carbon footprint and the water footprint of a bottle of wine were facing serious challenges in terms of data collection, both at Spier and from suppliers of upstream products and services.

8.2.5 Conclusion: Part 1

Based on the above points, it is concluded that neither environmental reporting of the business (including carbon emissions measurement), nor LCA-based carbon footprint of a bottle of wine, could successfully map an incontestable trend in the achievement of environmental (climate change) goals over the full review period of 2004-2010 (to the extent that the goals are articulated in table 5.2). This finding however does not undermine the larger purpose which the environmental reporting practices served in gearing organisational decision-making in favour of reduced environmental impact.

Application of various reporting formats and approaches such as the GHG Protocol, the GRI initiative and the PAS 2050:2008 standard (reviewed in detail in Chapter 5) at Spier Holdings illustrate how sterile accounting principles fail to grasp the complexity of a real business environment, which is rich in context and evolutionary in practice. For instance, the shifts in reporting styles corresponds as much with the informants to the process (in the form of external experts and internal champions) as it does to trends in the market (reporting principles, accounting standards and consumer demands for product carbon footprints).

The above case-specific conclusions, derived from the practical application of carbon measurement tools, add a critical layer of knowledge to the general conclusions related to emissions reporting, as stated in Chapter 5: Carbonology. Therefore, in addition to ambiguities related to carbon auditing tools, changes in real business practice make it hard to capture a downward trending carbon footprint. However, as suggested in section 5.7: Beyond the footprint, clear opportunities for learning across the organisation presented themselves, as the researcher, in collaboration with the Group Accountant, tried to capture environmental performance through available environmental reporting and emissions measurement tools.

A critical review of Spier's environmental reporting (quantitative) practices was a decisive step in the research process, as it triggered deeper analysis of trends in Spier's environmental performance (qualitative) in key areas geared to meet the macro-goal of climate change. This analysis is covered in Part 2 of this chapter.

8.3 Part 2: Analysis of Spier's performance on climate change goals

Empirical work for the PhD was undertaken over six months (February-August 2010) and included qualitative information gathering among Spier staff and intermediaries (as listed in the methodology section) through semi-structured interviews and interactions; and a review of formal management documents (such as the Spier Development Framework, management statements and proposals) and Spier Sustainability Reports, 2004-2007.

Key events, trends and practices emerged through an investigation of three ongoing endeavours aimed at reducing Spier's environmental impact – the search for effective renewable energy solutions for Spier's existing infrastructure; experiments with wastewater treatment and solid waste recycling. These three corporate practice areas are directly linked to climate change goals in table 8.2. Findings and critical elements of decision-making in each of the performance areas are captured individually at the end of each section, and collectively at the end of the chapter.

Table 8.2 Spier environmental goals under the macro-goal of climate change (adapted from the Spier Sustainability Report, 2007)

Climate change goals	**Goals for 2017**	**Goals for 2012**	**Observed corporate practice areas**
Carbon Neutrality	Zero carbon emissions through energy conservation and renewable energy sources	GHG emissions reduction by 40% from 2007 levels On-site production of 30% of all food consumed	• Energy efficiency measures • Adoption of renewable energy
Zero waste solids	• 100% recycling or re-use • 50% of all paper, plastic and glass products from recycled sources	• 100% recycling or re-use • 25% of all paper, plastic and glass products from recycled sources	• Solid waste recycling • Sourcing of recycled materials
Zero wastewater	100% on-site treatment of wastewater and re-use	100% recycling of all wastewater	Wastewater treatment and recycling methods
Water sustainability	Conservation, efficient usage and water harvesting • reduction of municipal supply usage to 25% of 2007 levels • reduction of industrial supply usage to 35%	• reduction of municipal supply usage to 50% of 2007 levels • reduction of industrial supply usage to 50% of 2007 levels	• Rain water harvesting • Measurement of water consumption • Trends towards reduction in water consumption
Biodiversity enhancement	25% of land holding into conservation	• 25% of land holding into conservation • Conversion of all grounds and gardens to indigenous gardens	Conservation and conversion efforts
Environmentally	100% conversion of 200	50% conversion of viable	Organic farming

friendly farming	hectares (including 60 hectares of wine farm)	farming land to environmentally friendly	

8.3.1 Renewable energy and energy conservation projects at Spier

The global challenge of climate change (translated into an organisational macro-goal and the specific carbon neutral goal in 2007) served as a key driver of various interventions at Spier, including the commissioning of a carbon footprint analysis of the business' operations by GCX in 2008 and the exploration of a range of renewable energy options. Table 8.3 summarises investments and explorations into various renewable energy projects and energy conservation initiatives at Spier since 2005 (full description in Chapter 7: Sustainability Story of Spier).

Table 8.3 Summary of renewable energy and energy efficiency projects at Spier (2005 -2010)

Renewable energy generation projects	
2006	Biodiesel production plant: highly successful test batches run with on-site cooking oil with full production of 1 million litres (using externally-sourced oil) expected in 2007
2007	Biodiesel production plant discontinued due to external supply reduction
2008	Biomass generation from quick growing trees on estate for gasification or conversion to biodiesel, CRSES commissioned to conduct LCA-based feasibility study in July, 2008 with input from agricultural science, forestry and process engineering departments
2009	Biomass generation not pursued: economic reasons and scale imperative Available land reengaged for biodynamic farming and wetland conservation
2009	Proposals received for greening of the conference and banqueting facility included roof-mounted PV panels, not implemented due to financial reasons
2010	Concentrated Solar Plant (CSP) proposed by CRSES as an Eerste Valley solution Unlike energy-on-tap type of solutions such as biodiesel and biomass, a CSP will feed into the national grid and offset conventional energy consumption at Spier
2011	Concentrated Photo Voltaic (CPV) under investigation to generate 3MegaWatts of power on site as an alternative to CSP proposal using Concentrix^{TM} technology
Energy-efficiency and energy saving projects	
2005	Installation of electrical meters at individual businesses, to hold each entity accountable for their usage and thereby encourage saving
2006	Resetting of water heaters, geyser blankets and light-saving bulbs in all hotel rooms leading to a reported 10% saving in energy consumption in that year

	(including LPG and petrol for stationary and mobile fuel needs)
2008	An electrical load survey study of hotel rooms reveals high usage through water heating and air-conditioning As a result, timers installed on geysers and trigger matrix system to switch off sections of the hotel during low season
2008	Re-commissioning of hotel's solar water heating system considered but not pursued
2009	Proposals received for solar water heating of banqueting kitchen as part of 'conferencing with a conscience', subsumed into greening projects
2009	Proposals received for greening of the conference and banqueting facility: • Detailed energy audit • Energy efficiency interventions • Roof-mounted photo-voltaic panels with grid tied inverters CRSES involved in comparative evaluation of proposals and presentations G-Tech proposal considered the best, not pursued due to financial reasons
2009	Carbon Footprint assessment of the business by GCX, which includes the following recommendations: • occupation detection sensors in the Spa area • smart keys for the hotel rooms • changing over to energy efficient appliances such as fridges, freezers and dishwashers • replacing electric geysers with a combination of heat pumps and solar water heaters • LEDs (light emitting diodes) and electronic ballasts in fluorescent lights
2010	Proposals received for energy-saving at Hotel through a centralized hot water systems using solar heat pumps CRSES involved in comparative evaluation of proposals G-Tech proposal considered better, not adopted in 2010

Empirical evidence suggests that while Spier management explores energy efficiency measures and renewable energy options, the business continues to rely on Eskom's carbon-intensive grid electricity. Investments were made in 2005 and 2006 on the energy efficiency front, prior to the carbon neutral goal-setting in 2007. Since then, no major spending has occurred in this corporate practice area since 2008, when the geyser blankets and the trigger matrix system were installed at the hotel.

8.3.1.1 Additional findings on deeper interrogation of events and trends

Further interrogation of events and trends was conducted through a review of emails between Spier management and renewable energy vendors, proposals for both energy efficiency and renewable energy projects and interviews with the Facilities Manager at Spier; the Cellar Master Frans Smit; Spier CEO Andrew Milne; CRSES engineer Riaan Meyer and CEO of GTech Frank Spencer. This interrogation reveals interesting dynamics played out in the organisation, which needs to be considered, along with each of the findings in table 5.3.

The engineers at the Centre for Renewable and Sustainable Energy Studies (CRSES), located at the University of Stellenbosch are involved in the exploration of several renewable energy options, in the capacity of either research co-ordination or technical advice: the biomass feasibility study, evaluation of the conferencing greening proposals, evaluation of heat pump solution and most recently, a Concentrated Solar Plant (CSP) proposal. While this trend reveals a positive collaboration between Spier Holdings and a University research centre, it also reflects a gap in technical knowledge within the business itself.

The gap or lack of technical capacity was highlighted in the evaluation of greening project proposals in 2009. The consumption levels calculated for the greening project by one of the vendors were incorrect, producing a far lower amount required for investment in PV panels by Spier Holdings. The incorrect levels and subsequent results were picked up by the CRSES engineer. Spier management realized that asymmetry exists in terms of technical knowledge between the business and renewable energy vendors and this did not bode well for the implementation of the project. Funds required to achieve sufficient energy generation once the figures were corrected were not available. Unfortunately, solar water heating and demand side interventions were also not implemented at the conference centre.

An interesting correlation was noted between the last investments towards electricity conservation and events in the larger socio-technical system. The electrical load survey and subsequent investment in the timers on the geysers and the trigger matrix system coincided with rolling black-outs by Eskom in 2008. At the same time, other measures such as a load management system and an on-site diesel generator were also explored by the Facilities Manager. This connection between shifts at the scale of national service providers and decisions at the scale of a private establishment had significant implication for the research direction adopted after conducting the preliminary analysis of empirical data.

In the area of bio energy, Spier has made necessary trade-offs to ensure that resources which were previously directed towards the production of bio energy remained engaged in initiatives aimed at environmental sustainability. While Spier management recognises the need to shift mobile fuel consumption towards lower carbon fuels (such as biodiesel), the on-site production of bio fuels may not always make financial sense. For instance, the biodiesel plant was shut down in 2007 but Spier vehicles now run on biodiesel purchased from local suppliers. Therefore, the technology changeover was achieved through procurement, rather than production. Similarly, the land on the estate earmarked for fast growing eucalyptus was reengaged for bio dynamic farming and natural conservation of the wetlands, when it became clear that biomass gasification would not be pursued for economic reasons linked to scale of operations.

Further indication of a commitment to the energy efficiency goal, irrespective of the lack of implementation in the area, is the fact that funds allocated for greening of the conference and banqueting facility remained ear-marked for alternative spend on energy efficiency measures, and were not transferred to a different organisational goal. Interviews with senior managers at Spier revealed that management is more successful at motivating investment in energy efficiency technologies / appliances at the time of replacing existing technologies. Interviews with senior managers also revealed an awareness that the goal of 40% reduction in GHG emissions from 2007 levels by 2012, and carbon neutral by 2017, through energy efficiency and renewable energy adoption was going to be difficult, and may have to be revised to reflect this awareness.

In the meantime, ongoing exploration of less expensive, organisation-wide initiatives by business unit managers is underway, in order to reduce energy consumption through installation of humidifiers and solar bulbs in the wine cellar. Furthermore, ongoing sustainability education of new Spier staff members continues at the Sustainability Institute (SI) to raise awareness with regards to energy and water saving habits.

8.3.1.2 Critical elements of decision-making

A preliminary analysis of decision-making at Spier Holdings aimed at achieving the climate change goal of carbon-neutral by 2017, and in the area of energy efficiency and conservation prior to carbon-related goal-setting, allows critical factors to be singled out in relation to the Spier's reliance on a network of technical experts whose role evolves throughout their association with Spier, qualitative (as opposed to carbon footprint-supported) evidence of Spier's commitment to environmental sustainability and alternative, risk-related drivers of investments in energy efficiency measures.

In the first instance, Spier relies on a network of technical advisors as well as renewable energy vendors when exploring energy efficiency and renewable energy projects. In its engagements with vendors and suppliers, Spier expects integrity and transparency. Therefore, the need for trustworthy, technical advice from engineers who are affiliated to research centres and Stellenbosch University departments arises.

Since the establishment of the CRSES at Stellenbosch University and actors within that centre, the role of this centre also evolved from that of a technical advisor, to that of a solutions provider as illustrated through the recent, academic exploration of a CSP at the Spier estate. Similarly, the role of the researcher also evolved from that of an observer of explorations in renewable energy technologies to that of a facilitator, by introducing CPV technology vendors to Spier‘s technical advisors.

In the second instance, there is evidence to support the claim that Spier management retains the allocation of financial and natural resources towards the broader climate change goal, even as investigated capital projects are not pursued due to perceptions of technical knowledge asymmetry between Spier management and renewable energy vendors; the need for capital-intensive renewable energy projects to make economic sense before they are approved by shareholders, especially in the economic recession post-financial crash of 2008; or late consideration of external supply chains such as in the case of oil for bio fuel project.

Perceptions of discontinuity in the provision of grid electricity from national utility Eskom comes across as a critical driver of renewed investment in energy efficiency measures in 2008, after the initial 10% saving in energy consumption which was achieved through efforts in 2005 and 2006. The notion of risk and vulnerability to external factors which threaten business continuity begins to surface.

8.3.1.3 Concluding remarks

Based on the above findings, additional findings and interpretation of trends in the corporate practice area of renewable energy and energy efficiency projects, as discovered while researching and narrating the sustainability story, two conclusions are drawn. Firstly, while electricity consumption forms the largest component of Spier’s carbon footprint at 67.8% (figure 8.1) and carbon reduction dominates the organisation’s climate change goals, there are various external and internal barriers which inhibit substantive capital spending on renewable energy and energy efficiency projects (for offsetting electricity consumption).

Secondly, despite these barriers, Spier continues to explore effective and affordable renewable energy and energy efficiency options for its existing infrastructure, in collaboration with the CRSES. The business also creates ecological awareness among staff members and encourages managers to implement low-investment projects to reduce energy consumption. These organisational trends substantiate through case-specific evidence, one of the general conclusion stated in Chapter 5: Carbonology, whereby, a carbon reduction focus often translates into fossil-fuel consumption focus (see section 5.6).

The above two statements support the claim that the goal of carbon neutrality is not the main driver of Spier’s environmentally-significant behaviour. Spier’s sustainability journey appears to be in pursuit of a reduced carbon footprint as a proxy for a reduced environmental impact but within certain constraints. The evidence in table 8.3 is quite confusing when viewed from a carbonology or corporate citizenship lens. Only deeper investigation reveals myriad factors and organisational dynamics at play, both at the level of organisational goal-setting and at the level of project implementation by management.

The above discussion and analysis pose further questions: how can the contradiction between the organisational goal of carbon neutrality and the limited implementation of energy efficiency projects at Spier be resolved? Which is another way of saying: why has the goal of carbon neutral at Spier, elevated as the foremost among environmental goals, not resulted in significant investments in renewable energy or energy efficiency projects? Clearly, there are factors beyond the straightforward implementation of carbon assessment and reduction strategies (drawn from knowledge of industry practices and reviewed in Chapter 5: Carbonology) which result in the current state of affairs at Spier.

Part 3 of this chapter describes an attempt at resolving the inconsistency between organisational goals and organisational behaviour, by drawing on scientific and social practice knowledge from industrial ecology, ecological economics and corporate citizenship frameworks.

8.3.2 Experiments with wastewater treatment

Spier has a history of finding alternative, decentralized ways of treating wastewater on site, based on the ecological principles of re-use of resources and waste minimization. The achievement of zero wastewater, a climate change goal (table 8.2) is one of the success stories of Spier's environmental performance.

It contains interesting parallels to the exploration of renewable energy solutions, but charts a very different trajectory. In terms of the larger macro-goal of climate change, wastewater recycling contributes indirectly by taking away the need for pumping additional water for irrigation. Table 8.4 provides a timeline on the different solutions for wastewater treatment used on the estate since it was bought by Dick Enthoven in 1998 (full description in Chapter 7: Sustainability Story of Spier).

Table 8.4 Experiments with on-site wastewater treatment by Spier (2002-2007)

Up-till 2003	Septic tanks and pit latrines for houses Package plants for commercial areas requiring constant maintenance
2002	Partnership with Dowmus (Pty) Ltd, an Australian company to set up a Biolytix filtration plant
2003	2 Biolytix facilities installed and functional at Spier Leisure, wastewater used for irrigation of a small section of the land and plants at a local nursery

	1 Biolytix plant installed at Spier Wines, effluent not being reused Septic tanks still in use for some buildings Biolytix systems estimated to reuse 20% of Spier's wastewater, remaining wastewater moved through additional filtration in a wetland area, before disposal
2006	Discovery that Biolytix plant not functional to meet DWAF regulations re effluent Bids were received from 3 suppliers Winning bidder, Andrew Olsman from HWT willing to consider an alternative solution using a combination of scientific engineering and metaphysical cleansing techniques
2007	A biological effluent treatment plant installed using a bioreactor, aeration pump, a reed bed and a yin-yang pond (filtration process in detail on Spier's website) Construction took under four months on the South Bank of Eerste River Two existing dams on the site used for storage of treated water Monthly reports by contacted maintenance company indicate waste water meets DWAF standards for treated effluent, used for irrigation Cleansing action equated to 344 km of flow in a natural river system

Empirical evidence suggests that once a certain method for treating wastewater was found to be inadequate, Spier management was able to replace it with a more advanced technology. This trend is observed in the changeover from septic tanks and package plants to Biolytix facilities in 2003 and from Biolytix to a biological effluent plant in 2007. A deeper investigation of this trend sheds light on various determinants and informants to decision-making which shaped the positive environmental outcome.

8.3.2.1 Additional findings on deeper interrogation of events and trends

The timeline of experiments with on-site wastewater treatment (table 8.4) was built through a review of Spier Sustainability Reports (2004-2008), the Spier Development Framework of 1999, technical literature on Dowmus (Pty) Ltd and their Biolytic filtration plant and interviews with the Sustainability Director (2005-2007) Tanner Methvin, Facilities Manager at Spier, Cherie Immelman and Farm Manager, Orlando Filander, Mark Swilling and Eve Annecke (and their involvement as members of the Spier Strategic Planning Team 1999-2002). The interviews provided greater insight into the events and trends that need to be considered along with each of the findings in table 8.4.

Prior to the identification and adoption of Biolytix treatment technology, package plants for treatment of wastewater from commercial areas on the Spier estate required constant maintenance and the risk of overload or malfunction could cause unacceptable quality of effluent into the river. The immediate replacement of this solution with a Biolytic filtration plant was proposed in the Spier Development Framework.

Introducing the Biolytix system (product name changed from Biolytic to Biolytix for the South African market) at Spier and planning its viability as a business operation in the wider South African market was Adrian Enthoven's (CEO of Spier from 2004-2007 and current Chairman) first project in connection with Spier. It was one of the first projects to receive support from Spier as a green investment, whereby Spier entered into a partnership with Dowmus (Pty) Ltd in 2002. Therefore, there was a larger purpose linked to the process of identifying, financing and implementing this technology as a pilot project at the Spier estate. This purpose was the perpetuation of Spier's sustainability image as a leader and a visionary, and an exemplar in the employment of ecological practices and technologies.

The treated effluent was largely pathogen-free and retained a level of nutrients suitable for irrigation purposes. However, the option of using the treated effluent for irrigation of agricultural land did not materialise and 100% wastewater recycling rates with the Biolytix systems were not achieved.

In 2006, Spier staff discovered that the Biolytix systems were not treating the water to acceptable levels even for irrigation of surrounding gardens and nursery plants. Spier management was faced with three choices: to upgrade the Biolytix plants; connect all facilities to the municipal sewer line; or treat wastewater through an alternative on-site system. At first, a major overhaul of the Biolytix system was explored in order to reach compliance with DWAF requirements. However, it was realized within two months that the different types of effluent generated on the estate such as the restaurant kitchens and the wine cellar were of such chemical composition that the micro-organisms and worms, a critical component of the filtration plants, could not survive. That left the two options of a new centralised system or connection to the Stellenbosch Municipality's sewage network.

According to Orlando Filander, at the time of considering the option of connecting to the municipal sewers, problems were being experienced at the municipal wastewater treatment facility, generating the perception that the municipal network was working to capacity and would not be able to cope with additional wastewater. This condition was later linked to mismanagement of the municipal treatment plant.

The final choice of a new centralized system meant a bidding process and tenders from three local, engineering companies. According to the Sustainability Director at Spier Tanner Methvin, the winning bidder HWT Engineering was chosen because of the company's willingness to incorporate metaphysical components into the design of the bioreactor. Tanner Methvin was closely involved in the design and conception of the alternative method of treating wastewater. The location of two existing dams on the estate proved convenient for siting the plant, reed bed and yin-yang pond.

Another important association during the process of implementation was with DWAF officials, who were called in to test the quality of water and were involved throughout the project to verify and approve the effluent quality as it changed over a period of six months after commencement of operation. However, linking of the solid waste recycling depot and some cottages to the bioreactor is still out-standing. The cottages are serviced by a septic tank and wastewater from the recycling depot is filtered and used to irrigate grounds in the vicinity. Therefore, the goal of 100% recycling of wastewater is still achieved.

8.3.2.2 Critical elements of decision-making

A preliminary analysis of the endeavours at Spier, aimed at achieving the climate change goal of zero wastewater by 2017, reveals that the implementation of Biolytix plants on the estate was the outcome of multiple positive factors, such as high-level and strategic input from the Spier Strategic Planning Team (comprising of Mark Swilling, Eve Annecke and Tom Darlington, the resident architect); a shareholder’s interest in the commercial success of the product (Adrian Enthoven) and the initial perception that the solution could lead to 100% recycling of wastewater and could be showcased as an example of Spier’s commitment to a sustainable micro-ecology, at the scale of the estate and the surrounding Eerste Valley region.

In a different phase of Spier’s sustainability journey, the implementation of the bioreactor plant was shaped by the direct involvement of the Director of Sustainable Development; external pressure in the form of DWAF regulations with regards to effluent quality; the perception that connection to the municipal wastewater network was not a viable long term solution and the convenience of existing topography (2 dams and slope towards them) which took care of expenditure which would have otherwise been incurred on the plant infrastructure. The project invariably gained from the involvement of DWAF technical officials who also ensured successful project outcome.

In addition, both innovative projects (directly or indirectly) were driven by the immediate environmental impact of not treating wastewater to government stipulations which can be perceived through on-site odours and poor quality of river water flowing through the estate; and the fact that the site was not connected to the municipal sewage infrastructure to begin with, thereby allowing on-site wastewater treatment solutions to be considered.

8.3.2.3 Concluding remarks

Based on the findings, additional findings and interpretations of trends in the corporate practice area of wastewater recycling projects, as discovered while researching and narrating the Spier sustainability story, following conclusions are drawn.

Firstly, the presence of champions (involved organisational leaders or contracted experts) on each of the projects was extremely valuable in finding sustainable and innovative solutions to the wastewater problem.

Secondly, investment decisions were determined to a large extent by the perceived or actual benefits pertaining to the long-term viability of a particular solution; such as commercial success in the larger South African market with Spier as a pilot project, recycling rates and financial viability. Furthermore, exposure to uncertainties from external sources came into play such as the risk of non-compliance with governmental regulations, vulnerability from connecting with unreliable municipal services or the negative brand image as a potential polluter.

Comparisons with the trajectory followed in the area of energy conservation are particularly interesting. For instance, it was noted in the previous section that perceptions regarding the unreliability of state infrastructure (Eskom) because of rolling black-outs in 2008 also triggered immediate spending on energy efficiency measures at Spier. Furthermore, the environmental impact of air and water pollution by not addressing this performance area is directly perceivable, as compared to the proxy measure of carbon footprint for human-induced global warming, which is at best, an accounting figure.

Thus the trajectory of Spier's sustainability performance in the environmental area of wastewater treatment appears to be more successful than in the area of energy efficiency because of consistent management involvement, presence of reliable and powerful technical referees in the form of DWAF officials and existence of clear benefits of implementation and risks from non-performance. These drivers of performance appear far more compelling than the goal of zero wastewater on its own. Once again, it was hard to relate these diverse drivers and informants to business performance through the conceptual frameworks in systems ecology and corporate citizenship.

8.3.3 Solid waste recycling

The Spier Development Framework of 1999 states that solid waste handling was a 'substantial problem' on the Spier estate. In the ensuing 11 years the environmental performance area of solid waste has witnessed several improvements, underpinned by the ecological principle of waste minimisation and re-use. Table 8.5 charts the past and current trends and shift in the focus of this area since the setting up of the organisational goal of zero solid waste by 2017 under the climate change macro-goal, in 2007 (full description in Chapter 7: Sustainability Story of Spier).

Table 8.5 Trends in solid waste recycling and cleansing solutions (2002-2010)

1999	Disposal on a tip site on estate and transported by Spier to a municipal dump Proposal for on-site sewage filtration system to deal with organic waste and contaminated paper in the Spier Development Framework Proposal for partnerships with large-scale recyclers
2002	On-site waste removal by a local, black-owned company called Nov Waste, reporting very high recycling rates (only 5% waste ending up at municipal dump) Food-based waste given to a local pig farming co-operative till today
2006	80% recycling achieved of waste collected by Waste Plan Focus on separation of refuse at the point of generation
2009	Treatment plant set up to remove chlorine from the packing shed effluent Not in operation since 2009
2010	89% recycling achieved: management believe a ceiling has been reached Filtration sump installed at the waste depot and water used for cleaning the bins now used to irrigate surrounding grounds
Focus on procurement	Shifting procurement and consumption patterns: Products made from recycled materials, 1% achieved in 2010 Target of using 50% paper, plastic and glass from recycled sources by 2017

Empirical evidence suggests that Spier has consistently tried to improve on the waste disposal system on the estate, through various strategic and operational interventions. Waste contributes .3% to the total carbon footprint of Spier (figure 8.1) currently and may have had a larger impact if high recycling rates were not achieved. A deeper investigation of the trajectory followed in this corporate performance area reveals that pursuing numerical targets may leave critical behavioural and ecological issues unaddressed.

8.3.3.1 Additional findings on deeper interrogation of events and trends

The timeline of trends in solid waste recycling (table 8.5) was built through a review of the Spier Sustainability Reports (2004-2008) and the Spier Development Framework of 1999 and interviews with Facilities Manager at Spier, Cherie Immelman; Farm Manager, Orlando Filander and procurement managers at leisure and wine operations, as well as interviews with Mark Swilling and Eve Annecke (and their involvement as members of the Spier Strategic Planning Team 1999-2002). The interviews provided greater insight into the events and trends that need to be considered along with each of the findings in table 8.5.

According to the facilities manager Cherie Immelman, Spier businesses have reached a ceiling on percentage of waste recycled despite management efforts at educating the operational staff. The consumption by customers and staff through eating and drinking produces most on-site solid waste (as stated in the Spier Sustainability Report, 2006). Staff members and guests are encouraged to assist by placing waste in the correct bins; however their consumption patterns are not necessarily challenged. The kitchen staff members contribute significantly to the contaminated plastic waste stream because the hospitality industry requires food to be stored in plastic wrapping, and Spier is yet to find an innovative solution which satisfies regulations and at the same time does not generate non-recyclable waste.

There are gaps in terms of some sources of environmental pollutants not being accounted for in either the wastewater or solid waste streams. For example, the removal of chlorine from packing shed effluent is not factored into the organisational targets listed against zero wastewater. Furthermore, the organic waste from the packing shed lands up at the compost site on the Spier estate, thereby polluting this otherwise organic source of fertiliser.

The recycling depot is in dire need of upgrades both in terms of capacity, drainage of rainwater around the building and basic changing and resting facilities for the staff members who separate different waste streams. Management has not directed requisite funds towards this upgrade although treatment of wastewater from the depot has been addressed through the installation of a filtration pump and an irrigation system.

Targets (in table 8.2) for using recyclable and alternative materials (such as lighter wine bottles and recyclable packaging for wine cases) in production processes are proving very hard to meet. However, managers seek interesting ways of communicating recycling rates in low carbon-language for marketing and brand enhancement purposes. For example, the amount of tin and glass recycled over a two-year period is equated to the energy required to light all 5,000 houses in Kayamandi for 6 months (as stated in the Spier Sustainability Report, 2007) and the amount of glass not consumed by shifting over to lighter bottles over a 20 month period is equated to planting 600 trees.

8.3.3.2 Critical elements of decision-making

Underlying motivations can be filtered out pertaining to decision-making at Spier Holdings aimed at achieving the climate change goal of zero solid waste by 2017. The waste removal contract with Nov-Waste (the first waste contract for Spier and Nov Waste) proved beneficial to both parties as it provided employment opportunities for local individuals which reflected well upon Spier’s social sustainability profile. The shift to a more established firm such as Waste Plan, who are in turn linked to large-scale recyclers such as Sappi and Mondi, helped Spier achieve greater efficiency in its recycling levels.

Solid waste recycling is an area of corporate practice which requires relatively limited investment in terms of infrastructure. In the case of Spier this means a recycling depot, a compactor and a filtration pump.

Changed procurement practices in favour of packaging made from recycled materials can get factored into the business carbon footprint as reduced scope 3 emissions but are difficult to achieve due to external supply chain factors. However, the supply chain constraint creates room for innovation.

8.3.3.3 Concluding remarks

Based on the findings, additional findings and interpretations of trends in the corporate practice area of solid waste recycling projects, as discovered while researching and narrating the 'Sustainability Story of Spier', conclusions are put forth. The efficiencies in recycling rates achieved at Spier are linked as much to the maturity in the recycling sector in the Western Cape, as they are to the training of staff members and visitors.

Comparisons with the trajectory followed in the area of energy conservation and wastewater recycling are of particular interest. Efficiency improvements in the area of solid waste recycling are contracted out to waste recyclers, which is different to energy efficiency measures in buildings requiring significant capital investment by Spier. External supply chains play a significant role in meeting organisational goals in both the renewable energy and solid waste recycling performance areas, as illustrated through the case of bio-fuel project and the difficulty in sourcing low-carbon materials and products.

A factor peculiar to the leisure industry is that while energy and water saving habits, and waste recycling can be encouraged to some extent among the customer base, it is harder to promote reduced consumption of manufactured and agricultural products, which in turn produce most waste.

8.3.4 Conclusion: Part 2

The preceding paragraphs of Part 2 presented empirical evidence and discussion on each of the three environmental performance areas of energy efficiency, wastewater recycling and solid waste minimisation and recycling at the three businesses of wine, leisure and farming at Spier.

This section attempts to summarise the evidence and discussion in an accessible format which can address the question which Part 2 of the chapter was intended to: Does a review of Spier's environmental performance reflect that the goals of carbon neutrality (and zero wastewater and zero solid waste) assist Spier in driving its search for lower carbon emissions, or environmental sustainability?

Table 8.2 captured Spier's macro-goal of climate change as translated into six environmental performance areas. The relevant sections of table 8.2 are repeated below as table 8.6.

Table 8.6 Spier environmental goals (of carbon neutrality, zero waste solids and zero wastewater) under the macro-goal of climate change (adapted from the Spier Sustainability Report, 2007)

	Goals for 2017	**Goals for 2012**	**Observed corporate practice areas**
Carbon Neutrality	Zero carbon emissions through energy conservation and renewable energy sources	GHG emissions reduction by 40% from 2007 levels On-site production of 30% of all food consumed	• Energy efficiency measures • Adoption of renewable energy
Zero waste solids	• 100% recycling or re-use • 50% of all paper, plastic and glass products from recycled sources	• 100% recycling or re-use • 25% of all paper, plastic and glass products from recycled sources	• Solid waste recycling • Sourcing of recycled materials
Zero wastewater	100% on-site treatment of wastewater and re-use	100% recycling of all wastewater	Wastewater treatment and recycling methods

Tables 8.3, 8.4 and 8.5 provided timelines for the individual trajectories followed by the Spier businesses towards the goals of carbon neutrality, zero waste solids and zero wastewater. It is important to note that while wastewater recycling and solid waste recycling address environmental impacts in their own right, these areas also contribute in lowering the carbon footprint of the business. Thus they are factored into the carbon neutrality goal but to a lesser degree since their contribution to emissions is not as significant as that of energy consumption.

However, the fact that the category of environmental goals at a macro-organisational level are clustered under Climate Change means that the individual goals against wastewater treatment, solid waste recycling, water sustainability, biodiversity conservation and environmentally farming are somehow subsumed under the overarching objective of reducing the business' contribution to climate change. Implied in this nomenclature is the assumption that action on the other environmental performance areas can also be achieved through pursuing a reduced carbon footprint (the industry-accepted measure of product and entity contribution to climate change).

The case findings and their deeper interrogation is summarised in table 8.7 in order to make collective sense of the business' environmentally-significant behaviour with respect to the climate change goals set out in the Spier Sustainability Report, 2007. In order to answer the question of the relevance of Spier's environmental goals (such as carbon neutral, zero waste solids and zero wastewater) in actually driving environmental performance, three additional sub-questions are raised and answered through the empirical evidence captured in Part 2.

Table 8.7 Spier's performance with respect to environmental goals

How well is Spier doing in terms of meeting environmental goals?	
Energy efficiency	Not very well, the goal of 40% reduction of GHG emissions by 2012 seems unlikely
Wastewater treatment	Very well, zero wastewater achieved 100% as per definition of wastewater sources in sustainability reports
Solid waste recycling	Very well on recycling: 89% rates achieved Not very well on procurement of all paper, plastic and glass products from recycled sources: 1% target achieved, 25% target by 2012 seems very unlikely
What steps does Spier need to take in order to meet the climate change goals?	
Energy efficiency	• Move to 100% bio fuel for mobile fuel consumption • Significant capital investments to shift to renewable energy for heating, cooling and lighting (currently met through grid electricity) • Investment in various energy efficiency measures throughout the buildings and businesses (some proposed by GCX in table 5.3)
Wastewater treatment	• Goals are met. However, further investment needed to connect outstanding buildings and depot to the wastewater treatment plant and address chlorine contamination of groundwater
Solid waste recycling	• Radical measures to identify and reduce consumption of products and processes which result in waste ending up at a land-fill site
What do the environmental goals and goal-setting processes not factor in?	
Energy efficiency	• Range of external and internal barriers which inhibit successful implementation of renewable energy and energy efficiency projects • Incorporation of other investments such as environmentally friendly farming and nature conservation into the carbon footprint calculation
Wastewater treatment	• Range of perceived and actual benefits and risks from external and internal sources which drive investment and implementation • Equally relevant but unaddressed ecological concerns linked to grey water cleansing
Solid waste recycling	• Societal trends such as consumption patterns of clients • Hospitality industry standards

	• Industry trends which determine availability of materials from recycled sources • Unaddressed aspects of employee well-being linked to waste recycling

A review of Spier's environmental performance in respect of the goals of carbon neutrality, zero wastewater and zero solid waste, driving the business' search for lower carbon emissions and environmental sustainability, yields a mixed (yes and no) response through four main conclusions:

- Spier is performing very well against some environmental goals and poorly against others.
- Spier will require substantial investment and radical changes in order to meet outstanding environmental goals.
- The goals do not capture some of the initiatives Spier has undertaken to address environmental sustainability, and others which have not been addressed by Spier yet.
- A range of external and internal barriers and drivers shape decision-making, irrespective of whether performance meets set targets or not.

Therefore, while the climate change goals have helped Spier articulate and communicate its vision for environmental sustainability both internally and externally to the organisation, the goals in and of themselves do not capture Spier's sustainability trajectory. Furthermore, it is argued that reviewing Spier's environmental performance in terms of its carbon footprint does not reflect a downward trend.

The goals for energy efficiency and procurement of recycled materials are used to drive organisation-wide sustainability-oriented initiatives, but these over-optimistic goals are unlikely to be met.

The next part of this chapter explores whether the incongruity between goal-setting and organisational behaviour can be resolved through theoretical frameworks from the applied fields of corporate citizenship, industrial ecology and ecological economics.

8.4 Part 3: Transferring findings to conceptual frameworks

Firstly, Part 2 of Chapter 3 on Corporate Citizenship (CC) is devoted to integrating the views of international and South African scholars and practitioners on the underlying drivers of ecologically and socially responsible behaviour by corporations. The normative proposals and descriptive observations, which try to promote and explain business' sustainability initiatives respectively, will be discussed with the aim of understanding Spier's environmental reporting practices and goal-derived performance.

Secondly, Chapter 4 described an investigation into the two complementary streams of ecological economics and industrial ecology, which yielded various concepts, initiatives and practices towards ecological sustainability, some ready for adoption by sustainability-oriented businesses. Relevant contributions from both streams were combined to generate a framework of best practices for corporate environmental sustainability. Climate change goals as stated by Spier's management and the business' environmental performance will be compared to this framework, in an attempt to resolve underlying tensions and contradictions.

8.4.1 Spier's sustainability performance and Corporate Citizenship practice areas

Application of the four-part model consisting of economic, legal, ethical and discretionary responsibilities to empirical cases revealed overlaps and blurring of lines between the different parts (Crane and Matten, 2004; Fox, 2004). Normative literature promotes CC both through a call for moral leadership (Zadek, 2001; Henderson, 2005; Hamann et al, 2003) and as a strategic necessity (Porter and Kramer, 2006). Fox (2004) stresses the different factors in a firm's context including human and institutional capacity to respond to different drivers. A reorienting perspective moves away from justifying CC, towards the assumption that businesses can contribute to ecological and social well-being (Margolis and Walsh, 2003).

The following CC framework unpacks the drivers and underlying ethos which underpin CC practices, reflecting a wide range of cultural and technical trends related to sustainability, to which businesses are exposed. It is important to note that CC encapsulates both environmental and social responsibility. And that the CC framework integrates normative writings and descriptive findings.

Table 8.8 Framework for corporate citizenship practices with examples from Spier's observed socially and environmentally responsible behaviour

CSR practice areas	**Philanthropy / CSI**	**Stakeholder engagement**	**Technological innovation**	**Corporate environmentalism**	**Sustainability reporting**
Key drivers	Moral imperative	Community pressure, moral imperative	Market and legal pressures, organisational culture	Legal compliance, environmental groups	Globalisation, market pressure
Underlying ideology	'ethic of care'	Stakeholder legitimacy	Techno-optimism	Environmental custodianship	Reporting increases transparency
Intended sustainability outcome	Social upliftment	Administration of citizenship rights of individuals	Sustainable production	Environmental justice	Accountability to stakeholders

Examples from Spier	Support for Lynedoch primary school	Fair Trade, Wine in Ethical Trading Association	Products made from recycled materials	Conservation of 25% estate as natural wetland	TBL reporting since 2004
	Support for Sustainability Institute	Industry alliances: SA Fruit &Wine	Lighter weight wine bottles	Water metering and water saving efforts	Carbon footprint assessment
	Support for the Spier Arts Academy	Knowledge networks with the SI and CRSES	Waste minimisation and recycling	Timers on geysers, matrix system, smart keys, CFL lighting	LCA-based CF of a bottle of wine
			Exploration of renewable energy options	Biodynamic farming	Reporting on industry standards for wine-making and hospitality
			Humidifiers in cellar, additive in coolant	Wastewater recycling plant	Sustainability principles
Key characteristics	Hard to enforce	Hard to enforce	Legally enforceable	Regular monitoring of environmental performance required	Reliability is standard dependent
			Reductionist approach	Company's own discretion in the absence of regulations	Consistency depends upon info-gathering systems

Based on the transferring of Spier's environmental behaviour (reporting and performance) to the CC framework (table 8.8) succinct observations are made pertaining to firstly, the reporting practices at Spier, and secondly, environmental performance. This structure is followed in order to continue the logic of Part 1: Analysis of Spier's environmental reporting practices and Part 2: Analysis of Spier's performance on climate change goals, of this chapter.

With regards to overall sustainability reporting practices, Spier represents an example of **international market trends** impacting on local corporate practice, also enforced through stock exchange listing requirements and compliance with the King Report on Corporate Governance in South Africa, 2002 (Fig, 2005; Visser, 2005; Hamann, 2004). In line with Fox's (2005) recommendation, Spier is increasingly embracing transparency at the local level rather than glossy sustainability reports. In support, the Spier Sustainability Report, 2006 was a glossy publication; since then limited copies have been printed on recycled paper.

Partly with a view to keeping abreast of latest market trends in reporting, and in particular environmental reporting, Spier recently established alliances with Trialogue and GCX. The alliance with Trialogue (in 2010) resulted in a re-orientation towards GRI (Global Reporting Initiative) which was also the basis for the 158 indicators developed in the first sustainability reporting cycle (in 2004). Recent engagements with GCX (in 2008) built up organisational capacity in environmental reporting and emissions calculation as per latest industry trends.

Assessing case findings with regards to environmental performance, as per CC framework suggests that **legislation** is an effective driver for behavioural change (especially where it can be implemented by government officials) as in the case of meeting DWAF regulations in the on-site treatment of wastewater by Spier. In other words, organisational goals for environmental performance areas are more effective when they can be enforced through laws and regulations.

Furthermore, the two areas of technological innovation and corporate environmentalism contribute directly to the actual achievement of climate change goals. Stakeholder engagement, in particular through industry alliances and knowledge networks, has the potential to build organisational capacity in technological and environmental innovation.

The CC framework is effective in capturing diverse drivers and intended sustainability outcomes for different CSR practice areas. However, that only tells part of the story. As evidenced through the case of Spier, triple bottom line reporting may not bring a firm any closer to its own vision of sustainability. Life cycle analysis does not provide straight answers for reducing a product's carbon emissions. There are no straightforward ways for acknowledging efforts towards natural capital conservation or institutional learning in downward trending carbon footprints or reporting standards. As a matter of fact, the very standardisation of sustainability-oriented behaviour robs it of business reality and the dynamic interaction of different corporate practice areas.

Therefore, businesses can benefit from the CC framework as a means of orienting their CSR practice portfolio since it incorporates a range of drivers and performance areas. Furthermore, the framework can be populated with initiatives and sustainability efforts which are at different stages of implementation and planning. However, when implementation or performance does not go according to plan, the CC framework and the extended literature it is derived from, does not provide answers.

The morality/ethics versus strategic importance/enlightened self-interest language in the normative conceptualisation of CC is static, with limited application, especially in not being able to consider the evolutionary nature of real-life problems and business context and the organisational learning which takes place in responding to sustainability challenges.

In the next section, contributions from ecological economics (EE) and industrial ecology (IE) are revisited to focus on Spier's environmental behaviour, with reference to a set of best practices.

8.4.2 Spier's environmental performance and systems ecology principles

EE literature provides key concepts such as constancy of renewable natural capital, various sustainability indicators including the ecological footprint and intellectual roots for numerous conceptions of corporate sustainability such as Natural Capitalism and Triple Bottom Line thinking. IE, based on a systems ecology metaphor for transforming industrial processes, provides concepts such as eco-efficiency, dematerialisation, cradle to grave approach and life cycle thinking.

A set of best corporate practices was drawn up in Chapter 4, based on the principles for strong sustainability (Graedel, 1994) and derived from life cycle assessment and life cycle management principles (UNEP, 1999; 2007), as an alternative to lengthy IT-based environmental performance mapping tools such as Eco-indicator and GABi. Table 8.9 tracks Spier's achievement on each of the corporate performance areas covered by table 4.2 in Chapter 4.

Table 8.9 Assessment of Spier's performance against best environmental practices

Corporate performance area	**Best practices for environmental sustainability**	**Spier environmental performance**
Water sustainability	Complete elimination of toxic substances in wastewater	Removal of chlorine from packing shed effluent
	Reliable measurement of water consumption	Achieved
	Re-use of treated wastewater for irrigation	Achieved
	Optimal usage of rain-water catchment on the site	Recognized, not achieved
	Optimal usage of fresh water on the site (municipal supply)	Several water saving methods in place
Waste minimisation and recycling	100% separation and recycling of paper, plastic and glass waste	89% achieved
	100% separation and recycling of organic waste	100% achieved
	Continuous reduction in the use of non-recyclable materials towards complete elimination in production/consumption processes	Incorporated in goals, hard to achieve
Re-design of production processes	Design for disassembly	Not applicable
	Reuse of materials (wine bottles)	PET bottles explored
	Complete elimination of toxic substances during production processes	Not achieved

	Green procurement (towards lower impact materials and products)	Incorporated in goals, hard to achieve
On-site nature conservation	Biodiversity conservation	Program in place
	Endogenous tree planting	Program implemented as part of social investment
	Integrated pest management	Under investigation
GHG emissions reduction	Emissions calculation	Achieved
	Energy auditing	Not achieved
	Energy efficient lighting	Installed in some buildings
	Solar water heating	Not achieved
	Generation or use of renewable energy	Not achieved
	Phasing out of refrigerant gases	Achieved
Sustainability reporting	Third party accreditation	Achieved
	Reporting standards for each of the 3 areas of economic, social and environmental performance	In progress
	Recognised tools for measuring progress towards sustainability (e.g. ecological footprint, carbon footprint, material and energy flow analyses)	Carbon footprint calculated
	Comparability of data and information over the reporting period	Possible from 2009 onwards

Table 8.9 gives a fuller picture of Spier's environmental performance as compared to against its climate change goals. This supports the claim that Spier's climate change goals do not capture all aspects of the business' environmental performance, of which chemical pollution is one.

Carbon footprint is a proxy measure for an entity's contribution to anthropogenic greenhouse gases. It does not encapsulate the full breadth of environmental impacts which a business has unless they have a global warming component. In Part 2 it was explained that the goals of zero wastewater and zero solid waste have environmental significance over and above their incorporation in the carbon footprint of the business. An ecological footprint would have been able to provide a more wholesome reflection of all components of the business activities and their toll on the ecosystem. However, it was not pursued due to its limited communication and marketing value in the leisure and winemaking industries.

Finally, while concepts and tools from EE and IE provide another reference for gauging the meaningfulness of Spier's climate change goals, they do not explain or assist in understanding corporate behaviour, especially when principles such as eco-efficiency and life cycle management fail to produce the expected results.

8.4.3 Conclusion: Part 3

Based on the above discussion, it is firstly argued that corporate citizenship as a concept and its explorations through the different lenses of business ethics; organisational theory and strategic advantage do not resolve the dilemmas faced by businesses on their sustainability journey.

Secondly, it is argued that the concepts and tools of EE and IE motivate and enable the designing of highly efficient production processes, but fail to fully integrate the cultural and human components of industrial systems, especially those arising in a business context.

Transferring findings from the review of Spier’s environmental performance to frameworks from corporate citizenship and systems ecology yields a mixed (yes, up to a point) response through four main conclusions, which relate back to previous analyses in Part 3.

Inadequacy of the CC and CSR frameworks: CC and CSR highlight drivers of sustainable practices but cannot explain when or why those drivers are not effective. For example, Spier has embraced the market-driven trend of carbon footprint assessment and goal-setting but is not necessarily pursuing carbon-related goals through sufficient investment in energy efficiency and conservation measures. Its performance in this area has been irregular in the least and CC writings proved inadequate in explaining inconsistent behaviour.

The detection of legal pressures (from a CC perspective) in prompting consistent action in the area of wastewater treatment was useful for analysis. However, there were multiple factors which resulted in innovations to be regularly investigated and implemented.

The CC and CSR literature, rooted in social, management and organisational theories does not engage with physical or geological determinants of corporate behaviour. There is thus a critical gap which these knowledge fields and the frameworks emanating from them, fail to account for when explaining (problem-framing) or guiding (solution-oriented) corporate decision-making towards sustainable outcomes.

Inadequacy of the IE and EE frameworks: Although IE and EE use a systems ecology perspective, they do not assist in understanding Spier as a system. IE and EE have contributed remarkably towards the promotion of strong sustainability principles and life cycle thinking among corporate entities. Operating from within the integrated and closed loop paradigms of these applied disciplines, scholars have generated highly useful tools such as footprint analysis and energy flow analyses to map the environmental impacts of populations, establishments and production processes.

However, the focus on mapping interlinked chains of production and consumption or designing matrices which capture the entire range of environmental impacts from a production process somehow leaves the aspect of human actors unattended. This gap has been duly recognized by the scientific and practitioner community within IE and the sub-field of life cycle management has tried to address it by encouraging the extension of IE and LCM principles into business management through dedicated panels in conferences (for example LCM 4 in 2010).

Despite this recognition by scholars, suitable research agendas within IE and LCM that incorporated human actors and drivers of human response, to the extent that is required for understanding Spier's environmental performance were found lacking.

Absence of an evolutionary perspective: The dynamism of real business practice, which evolves as it is studied is absent in CC, IE and EE knowledge areas. Over the three years during which Spier management was engaged with and quite intensively in the first half of 2010, the business context was found to be never static.

Under the leadership of different managers and with varying involvement of shareholders, the business targeted each of the environmental practice areas in diverse ways. The 'Sustainability Story of Spier' tracks the journey of the enterprise through at least three identifiable phases, characterised by distinct management philosophies with regards to sustainability, resource minimisation efforts, and attention to different aspects of sustainability reporting. As the business matured, niche experiments were replaced with structural connectivity among the three business units. These and other evidences of the transformation in business practices as they respond to an altering environment are not tackled by the discourses encountered in the IE, EE and CC disciplines.

Absence of a learning perspective: Inadequacies are identified in the consideration of organisational learning and the impact of external and internal determinants on a business' sustainability journey. Through personal interactions will managers and operational staff members at Spier, changes in perceptions and therefore, decision-making by certain actors in the establishment were brought to surface.

Sometimes as a result of external stimulus and sometimes through their own learning and experiences, operational and senior managers at Spier evolved, with respect to the meaning and relevance they attached to various sustainability concepts and management philosophies be it the goal of carbon neutral, the value of calculating an LCA-based carbon footprint or the application of ecological design principles to new constructions on the estate.

As managers and operational staff members engaged with knowledge experts, engineers, technical advisors, community members, teachers and students of sustainable development, international business counterparts, service providers, government officials and each other, learning was taking place. This learning at an individual level was constantly referred back to the collective system, the business, through changed practices and new ways of doing the same things.

The above gaps in the preliminary research design and knowledge categories were identified post-empirical work. The target knowledge (frameworks to aid transformation of business practices) derived from abstract and scientific streams hitherto interrogated, did not provide the conceptual basis for understanding various interconnected aspects of Spier's sustainability journey. Such considerations triggered the need to seek out alternative theories which could hopefully, explain organisational behaviour in the context of sustainability transitions and tackle the inconsistency between environmental goals and environmental behaviour.

The application of sustainability science constructs (detailed in Chapter 6) was therefore undertaken to understand Spier's journey, resolve observed contradictions by taking into account the evolutionary nature of human learning and generate meaningful insights which could be transferred back to augment existing knowledge.

Chapter 9 is devoted to the analysis of the 'Sustainability Story of Spier' through frameworks from resilience and complexity thinking, which are derived from the study of ecosystems and have been transferred successfully to understand the behaviour of institutional systems.

Chapter 9: Integration of case findings with theoretical constructs from sustainability science

9.1 Introduction

In Chapter 8, a range of theoretical constructs were utilised to interrogate trends in Spier's environmental behaviour with a view to ascertain how far Spier is from reaching the half-way environmental goals for 2017. At the end of Chapter 8, it was argued that organisational goals such as the status of carbon neutral, zero solid waste and zero wastewater are not driving the quest for a lower carbon future or environmental sustainability at Spier. A preliminary analysis of case findings in respect of Spier's environmental reporting practices and initiatives aimed at meeting climate change goals (Parts 1 and 2 of Chapter 8), additional research questions began to emerge such as: **What alternative measures or goals could underpin Spier's quest for a lower carbon future and environmental sustainability?**

Part 3 of Chapter 8 illustrated the limited application of frameworks from corporate citizenship, ecological economics and industrial ecology literatures for understanding real business behaviour, through the application of these frameworks to the case of Spier's search for environmental sustainability. As a result, alternative frameworks for understanding sustainability transitions, which were found suitable for application to a single establishment and also incorporate external spheres of influence, are needed (described in Chapter 6). These alternative constructs include systems analysis, complexity theory and resilience thinking.

In this chapter, case findings are integrated with alternative frameworks from systems thinking, complexity and resilience thinking in order to critically engage with the sustainability journey of Spier. Each of these constructs is applied to the analysis of the narrative (written by the researcher) called the 'Sustainability Story of Spier' (Chapter 7).

The fieldwork conducted to generate the narrative and the research undertaken to make sense of the narrative were iterative processes. Observations and descriptions of systems are necessarily limiting (Cilliers, 2001). Therefore multiple descriptions are explored as each of the constructs is applied. However, there is a logical flow to the articulation of these descriptions. For instance, the resilience-based analysis of the business as a social-ecological system builds upon the description of the business as flows. This chapter is therefore, a retelling of Spier's sustainability journey towards a lower carbon future in the language of sustainability science theories and concepts.

In section 9.2, the systems analysis of Spier is presented at two levels: Spier as a business defined by material and information flows (section 9.2.1) and Spier as part of the larger social-ecological system (section 9.2.2). The extended view of Spier, as influenced by risks and uncertainties unfolding at different social-ecological system levels, enables the researcher to acknowledge system complexity. The social-ecological conception of the Spier system (section 9.2.3) follows from a reflection on the logic of the preliminary research design (section 9.2.4).

Building upon the SES conception, a resilience-based analysis of the business' trajectory is undertaken to great detail in section 9.3; whereby, distinct yet interacting adaptive renewal cycles in different phases of the business are brought to light (section 9.3.3). Case findings are integrated with notions of thresholds, as linked to both windows of opportunity and to perceptions of risk (sections 9.3.1 and 9.3.2). The panarchy component of resilience thinking allows Spier as an SES to interact with cycles on lower and higher scales (section 9.3.4). Therefore, new frameworks for comprehending organisational systems are produced as cycles within the Spier system are pulled out and analysed as multi-scale interactions (section 9.3.5).

Case findings are interrogated through an application of adaptive management at Spier (section 9.4). Different tools for adaptive management and resilience-based governance such as scenario-building (9.4.2), networking (9.4.3) and adaptive learning (9.4.4) are individually discussed, drawing upon interviews and case evidence.

Finally, in section 9.5, the corporate resilience framework proposed in Chapter 6 is populated and tested. The development of the mapping tool as part of the resilience framework, also covered in section 6.6.3 is revisited in section 9.5.1. The numerous strategies and initiatives undertaken at Spier under the banner of environmental sustainability (towards climate change goals) are discussed from the perspective of simultaneously building enterprise resilience and ecological sustainability (section 9.2).

It is important to note that each of the sections of this chapter build up to a systems and resilience-based analysis of the case business Spier. The application of the corporate resilience framework is the last step of the argument – which is that a business can be understood as a social-ecological system, exhibiting resilience-building and adaptive management in its decision-making processes; and that sustainability-oriented behaviours (aimed at a lower carbon future and environmental sustainability) can be understood as being driven by a search for enterprise and ecological resilience – termed corporate resilience.

9.2 Analysis of Spier using systems thinking and SES construct

The systems analysis of Spier can be mapped at two levels. The first outcome of analysing Spier from a systems perspective was a view of the business as made up of different performance areas or flows instead of as business units. The second outcome was a systems perspective on different drivers of environmentally significant behaviour which lie internal and external to the business system, at local, regional, national and global levels.

This section builds up a systems view of the business and a myriad drivers influencing management decision-making in order to situate the discussion on the simultaneous goals of carbon neutrality and environmental sustainability within a larger context. Firstly, a view of Spier Holdings as a self-contained system with inter-connected performance areas, highlighting the area of environmental performance is presented (components of the environmental performance of the business are drawn from organisational goals clubbed under the climate change macro-goal). Secondly, a view of Spier as part of various systems at local, regional and global levels is presented.

9.2.1 Spier as a system

Two contrasting views of Spier are presented in figures 9.1 and 9.2. Figure 9.1 reflects the organisational and ownership structure of the business which evolves annually (as discerned from reviewing annual reports from 2004-2008). Shareholder decisions determine this evolution and while it does impact on the business' overall sustainability profile, it is not the subject of analysis for understanding corporate behaviour in this thesis.

Figure 9.2 represents a hierarchical model of flows (of energy, water, waste and information), which is a fair approximation of real system behaviour, governed by strategic and operational decision-making. All areas of performance are inter-related. For instance, environmental performance should enhance financial performance, just as financial imperatives determine the success of environmentally significant behaviours. The three areas of environmental, social and financial performance were derived from the corporate trend of triple bottom-line reporting and ease of access to related information on the business. Spier business units of wine, farming and leisure underlie the triple performance areas.

Environmental performance is the subject of deeper analysis in order to deliver on the two research objectives: Does charting Spier's sustainability journey reveal that the business is driving its quest for a lower carbon future and environmental sustainability by pursuing the goal of carbon neutrality? If not, then what alternative measures or aspirations underpin Spier's quest for environmental sustainability?

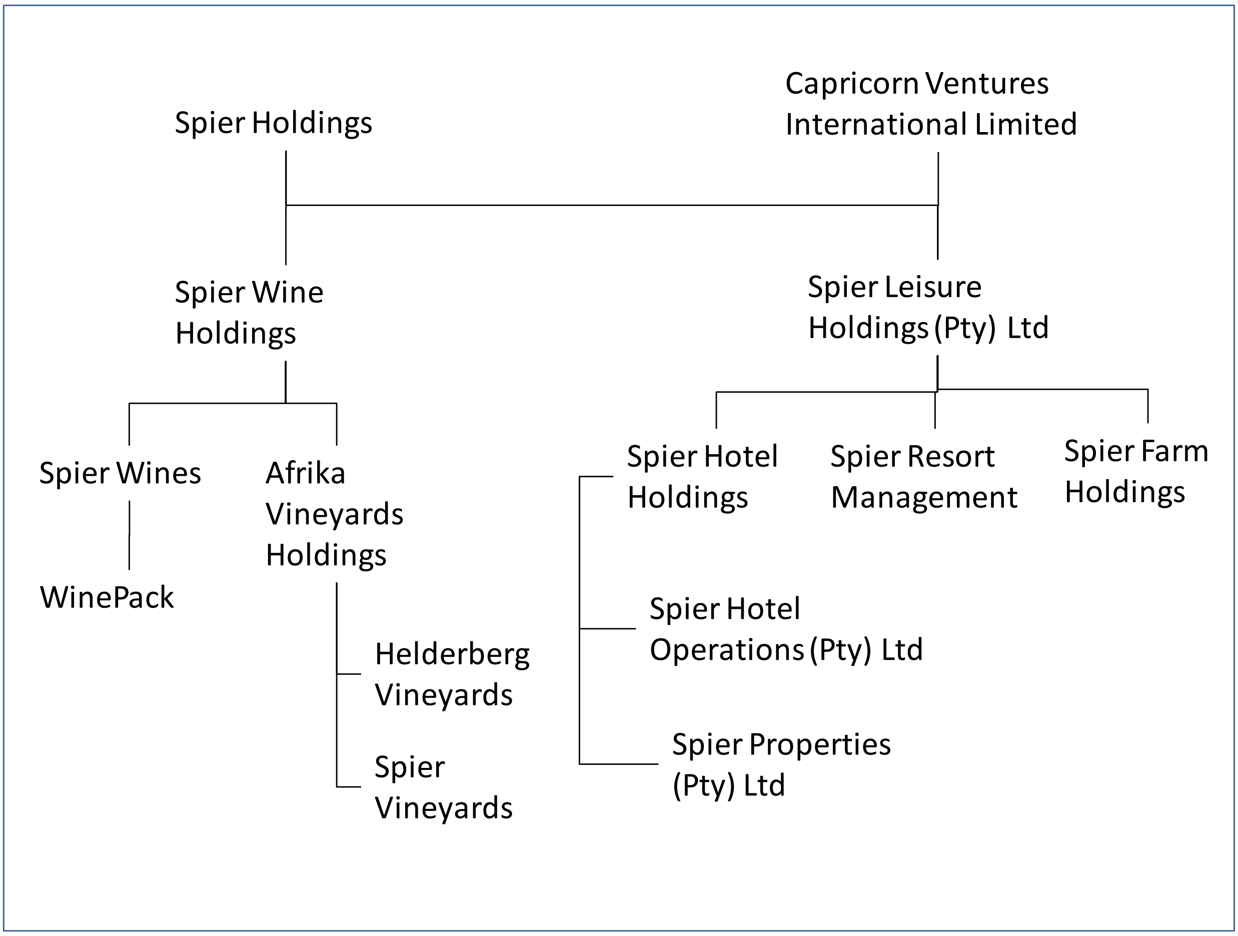

Figure 9.1 A partial ownership structure of the three business units of Wine, Farming and Leisure (from the Spier Sustainability Report, 2007)

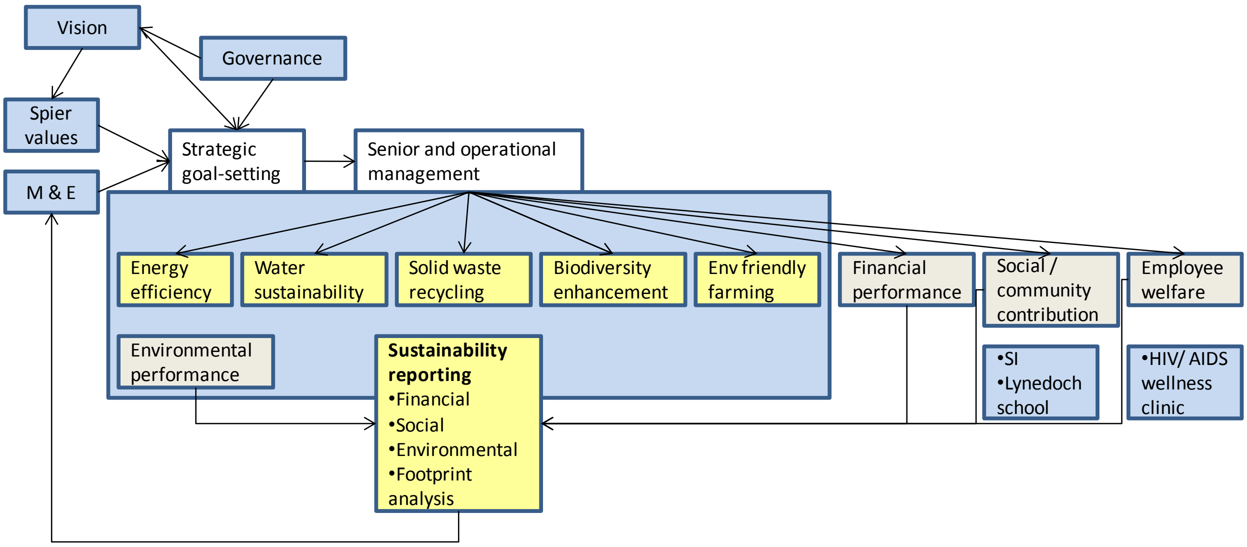

Figure 9.2 Spier as a system made up of material, energy, waste and information flows

The five sub-performance areas within environmental performance: energy efficiency, water sustainability, waste recycling, biodiversity enhancement and environmental farming are derived from Spier's macro organisational goals grouped under climate change (listed in table 9.2). The goal for carbon neutrality has been changed to energy efficiency in figure 9.2, to encompass Spier management's evolving notion of this goal and zero wastewater is subsumed within the goal for water sustainability.

The view of Spier as made up of flows designed to achieve environmental goals is starkly different to the view of Spier as made up of business units, on which environmental information is collected to prove transition to sustainability through reporting.

9.2.2 An extended systems map of Spier sustainability drivers

Based on the information collected to narrate the sustainability journey of Spier, some of which is described in detail in Chapter 8 for the environmental performance areas of energy efficiency; wastewater recycling; solid waste recycling, as well as sustainability reporting, an extended systems map of Spier is configured (figure 9.3).

Figure 9.2 may be considered a key to the extended map in figure 9.3. Linkages between various determinants and informants to decision-making (as barriers and drivers of investment and exploration) are revealed once different actors and their direct and indirect influences are plotted on the flow analysis of Spier expanding it from figure 9.2 to figure 9.3. The visual quality of an interlinked map allows Spier to be viewed as a human-activity system embedded within a larger social, technical and ecological system with institutional aspects of governance and management philosophies interacting with scientifically determined thresholds on the planetary cycles of carbon, nitrogen and water.

As actors and their influences are mapped in an extended model of the Spier system, interesting linkages between different sources of decision-making determinants emerge. For instance, Stellenbosch municipality impacts in the form of a physical service provider (wastewater treatment, electricity grid) as well as strategic direction through a developmental vision for the region.

In addition to the various influences listed above which sway decision-making at different levels of the Spier businesses in achieving climate change goals, another critical aspect which impacts performance is staff capability and capacity for innovation, especially under the current management paradigm of organisation-wide sustainability-oriented behaviour.

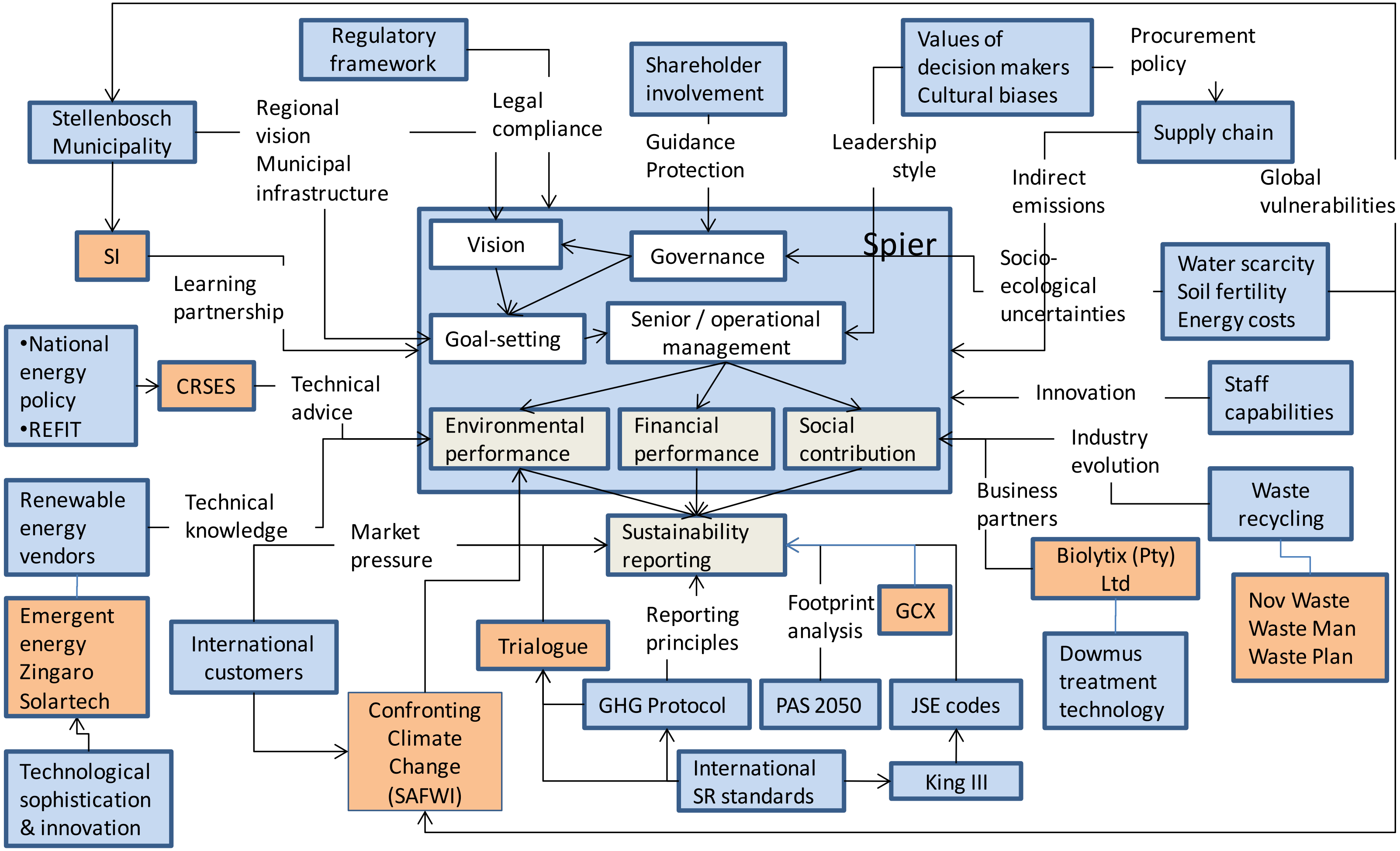

Figure 9.3 An extended map of the Spier system in relation to external and internal informants and determinants of environmentally significant behaviour

Table 9.1 Actors and influences on corporate performance areas linked to environmental sustainability

Corporate Performance Areas	**Actors**	**Influences, contribution**	**Indirect influences**	**Collective influences**
Renewable energy / energy efficiency	CRSES	Technical advice, Energy projects research	Technical and engineering capacity	National energy policy, Technological innovation and sophistication in the field of RE, Energy costs
	Renewable energy vendors	Technical knowledge	Information asymmetry	
Wastewater recycling	Sustainability Institute, Biolytix (Pty) Ltd	Knowledge partnership, New business model	Wastewater treatment technology developers	Technological innovation in the field of wastewater recycling, Regional vision, Compliance with regulatory framework, Water scarcity
	Stellenbosch Municipality	Sewage infrastructure	Management capacity	
	National department (DWAF)	Effluent quality standards	Implementation capacity	
Solid waste recycling	Waste recycling service providers	Recycling rates	Maturity of industry	Global production chains, Global consumption trends
	Employees, clients	Waste separation / minimisation habits	Ecological awareness, sensitivity	
Goal-setting	Shareholders	Governance and oversight	Guidance, values	Knowledge of socio-ecological vulnerabilities, International trends (carbon neutral), Compliance requirements
	Senior management	Decision-making	Technical and management capacity, Cultural biases	
	Sustainability Institute	Capacity building in Spier employees	Training ability	

Sustainability reporting	Trialogue	Industry knowledge on reporting	JSE codes, King III requirements	International standards and best practice, Market pressure from international customers, Global climate consciousness
	GCX	Carbon footprint analysis	GHG Protocol, PAS 2050	
	Local affiliations of fruit growers (SAFWI)	Carbon calculation and reduction strategies, Access to information along supply chain	International wine carbon calculators	
	Supply chain through procurement		Indirect emissions	

Goal-setting especially at macro-organisational levels is recognised as a key environmental performance area since it represents management perception of ecological vulnerabilities to which the business must respond, whereas sustainability reporting captures performance as per internationally recognised standards and reporting formats. A further extrapolation of the drivers and barriers listed in table 9.1 and connected in the extended systems map (figure 9.3) generates generic drivers of corporate behaviour, with corresponding knowledge areas from where these drivers may be investigated and possible holders or bearers of these knowledge areas (captured in table 9.2).

9.2.3 Logic of the preliminary research design

The extraction of generic drivers across environmental performance areas including the organisational practices of goal-setting and sustainability reporting, allows the researcher to reflect upon the logic of the preliminary research design for the thesis.

For instance, significant drivers of Spier' system behaviour such as leadership styles and organisational culture, which are studied through social theories such as values, behaviours and norms (VBN) theory, reasoned action theory and organisational theory are investigated in corporate citizenship writings (in Chapter 3). An environmental focus engendered research into environmental science and related disciplines of ecological economics and industrial ecology, incorporating aspects of climate science and industrial metabolism (in Chapter 4). The carbon neutral focus of the research objectives and the researcher's own background in the natural sciences and project management assisted in delving into renewable energy engineering and relevant policy frameworks (in Chapter 5).

Furthermore, current trends for utilising environmental reporting as a means of tracking progress on sustainability meant that local and international pressures in the form of global reporting principles and standards were studied in detail (Chapters 3 and 5). However, legal pressures through regulatory frameworks in all areas of corporate environmental performance are not understood in detail. Some of the knowledge bearers or experts were interviewed during the course of the empirical research work, either as intermediaries with direct involvement with Spier or as experts in their particular fields of specialisation.

Table 9.2 Drivers of corporate behaviour across different environmental performance areas

Drivers of corporate behaviour	**Sources of different drivers**	**Corresponding knowledge areas**	**Knowledge bearers**
Legal pressures	Environmental and social regulatory frameworks	Legal and institutional studies	Lawyers, HR specialists
Leadership styles	Values of decision-makers Cultural biases of decision-makers Perceptions of risk	VBN theory Reasoned action theory Risk assessment and analysis	Behavioural scientists
Organisational culture	Recruitment policies Embedded values and vision Staff capabilities Affirmative action requirements	Organisational theory OD literature Change management literature	Learning institutes, OD and change management specialists (Sustainability Institute)
Regional social context	Municipal vision and goals Regional demographics Community needs for development	Public sector knowledge Institutional theory Stakeholder theory Development studies	Social scientists, Political scientists, community workers (Stellenbosch municipality, Lynedoch)
Physical services provision	Existing and planned municipal infrastructure Technological sophistication among local and international service providers of wastewater treatment	Civil engineering, planning Electrical engineering Hydrological science Renewable energy engineering Relevant policy	Engineers (CRSES, Riaan Meyer, Frank Spencer, Prof Alan Brent, Matti Lubkol)

	and renewable energy National and regional regulatory requirements and standards	frameworks	
Regional and global ecological vulnerabilities	Water scarcity Soil fertility Climate change	Environmental science Agricultural / soil science Climate change science	Natural scientists, farmers
Local and international market pressures	International consumer consciousness Local industry standards Marketing and brand management Transformation in the supply chain	Global reporting principles and standards Business ethics Industrial ecology and metabolism	Sustainability reporting practitioners, industry alliances (Trialogue, GCX, SAFWI)
Governance	Shareholder interest Understanding of sustainability	Business management studies Corporate sustainability Underlying metaphors	Practitioners (Ralph Hamann, Tanner Methvin)

9.2.4 The social-ecological system (SES) conception of Spier

The integrative construct of SES (Du Plessis, 2008) allows Spier to be conceived simultaneously as a human-activity system constituted by physical flows of energy, matter, water and waste which are determined through cultural notions, scientific interpretation and organisational decisions. The noosystem conception of SES (Vladimir Vernadsky in du Plessis, 2008) is especially useful in understanding system behaviour with respect to agency for sustainability transition.

An SES as a noosystem is an integrated framework of three spheres: geosphere (matter), biosphere (life) and noosphere (mind) (figure 6.1 explained in detail in Chapter 6). The drivers of corporate behaviour are transferred into an SES conception of Spier's extended map (as figure 9.4). The aim of this iterative process from map to table, back to a map is to generate an integrated understanding of the Spier system; to discover how the drivers of system behaviour and system responses interact to build different states in which the business exists over the years.

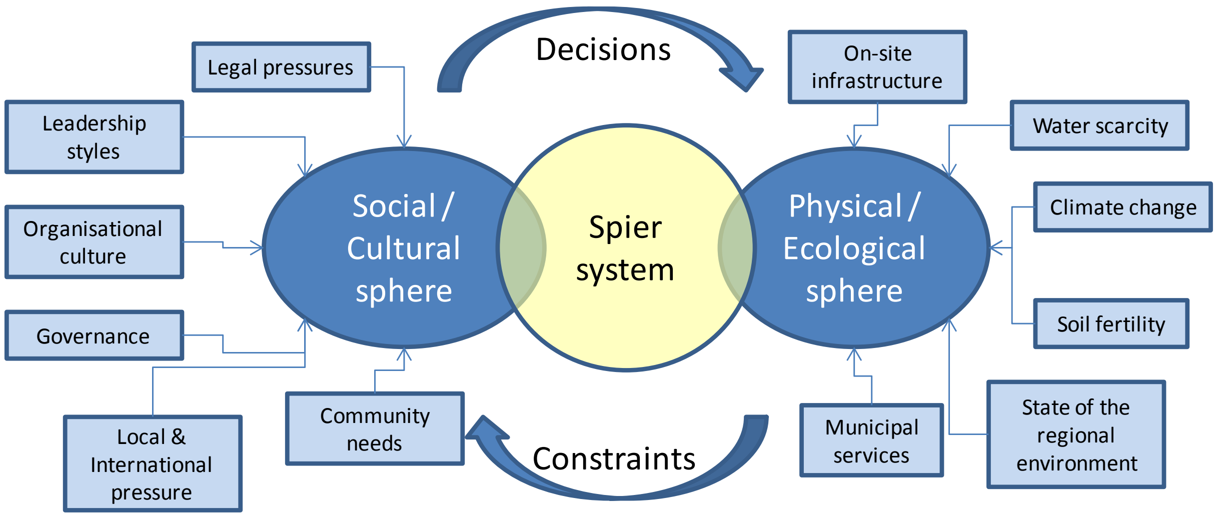

Figure 9.4 Social and ecological spheres intersecting within the Spier (business) system

The SES conception illustrates the point that an integrated, systems view of Spier requires more than just an unpacking of all external and internal drivers of corporate environmental behaviour. As required by complexity thinking (Cilliers, 2008; Peter, 2008), the focus of study is on the interactions between the components of the Spier system and not on the individual components.

These components (at different system levels) include the different business units of wine, leisure and farming; the agents and actors within those business units; various institutions with whom Spier engages for different services; the agents within those institutions acting as suppliers, vendors, consultants, researchers, technical advisors, regulators and trainers; the regional, global and local drivers and barriers (social, technical, ecological and economic contexts) and more. Different environmental performance areas (including goal-setting and sustainability reporting) are the results of dynamic interactions between these components, often activated through human decision-making at operational, management and governance levels of Spier.

The transference of case findings to the SES construct acknowledges the properties of the observed business system, which are listed below:

- A business is a human activity system incorporating elements of designed physical (infrastructure) and abstract systems (financial, management systems) always taking resources from and sinking waste into the environment (Clayton and Radcliffe, 1996).
- A business represents human-environment interaction where flows of information, power, cooperation and ideas control the flow of matter and energy through the SES.

- Decision-making within the business system is based on the values, beliefs and norms of decision-makers, which are diverse and not completely disclosed. Thus absolute predictability cannot be achieved and emergence is observed when mapping the SES.
- Decisions are made in response to external stimuli (including incomplete scientific knowledge and information asymmetry) and result in various social and technical interventions, representing the adaptive capacity of the complex and adaptive SES.

9.2.5 Concluding remarks

The preceding sections of Chapter 9 captured a systems view of Spier, first at a basic, environmental flows level which was later elaborated to incorporate various determinants and informants of system behaviour. Iterative analytical processes sought to extract generic drivers of corporate behaviour, which are specific to the case study of Spier, but could very easily be applied to similar institutions performing under a range of legal, market and organisational pressures and exposed to global and local vulnerabilities. These generic drivers could then be utilised in drawing a social-ecological map of the Spier system where a range of decisions across different corporate performance areas result from the interaction of drivers arising simultaneously in social/cultural and physical/ecological spheres.

Therefore, the above analysis of Spier's sustainability journey using systems and complexity thinking and the SES conception of human-environment interactions, allows the following:

- An integrated and connected view of business decisions, their drivers, and their impacts.
- Connecting the social / cultural sphere where decisions are made with the physical / ecological sphere where they are acted out.
- Map interactions taking place within an evolving system which is responding to a changing context, while seeking aspects of sustainability.
- And finally, focus on issues of management and institutional learning, and networks which communicate meaning, in addition to information.

However, the SES-based description of Spier lacks spatial and temporal qualities. In particular, the dynamic nature of interactions within a system over time, as well as adaptive learning which changes system response; begins to make sense once the SES conception of the Spier business is utilised for integrating case findings with components of resilience thinking in the next two sections. The adaptive renewal cycle is specifically geared to capture linkages and connections as they occur in space and time.

9.3 Integration of case findings with resilience thinking

Resilience thinking (Holling et al, 1995; Walker and Salt, 2006; Burns and Weaver, 2008) was presented in Chapter 6 as an ideological converse of the optimization paradigm represented by downward trending environmental impacts such as carbon and water footprints. The optimisation approach focuses on increasing efficiency, increasing control over change and optimising the systems we manage. Resilience thinking on the other hand, focuses on maintaining the functionality of a system in the face of unexpected events and uncertainties. The proponents of the resilience perspective realise that there are limits to optimisation. The case of Spier substantiates this belief in three ways:

- The business' carbon footprint can only be reduced up to a point, beyond which renewable sources of energy are required to offset consumption. It is clear that human activity systems are not designed to be carbon neutral yet!
- Wastewater quality reached unacceptable quality levels which could not be reversed by improving the performance of the Biolytix plant in place. A completely radical method for wastewater treatment had to be installed.
- Recycling rates cannot be reduced beyond 89% through a pure optimisation / efficiency increasing approach.

In order to explain how an SES could maintain functionality through unpredictable change, resilience thinking utilises three metaphors: thresholds and alternate regimes (or stable system states), the adaptive renewal cycle with four distinct phases and panarchy (Walker and Salt, 2006; Gunderson and Holling, 2002). Each of these metaphors is applied to the case findings in the 'Sustainability Story of Spier' with the aim of understanding corporate behaviour driven by the search for a lower carbon future, and environmental sustainability.

9.3.1 Thresholds and windows of opportunity

A system is known to behave differently once it moves beyond a threshold into an alternate regime where system structure, identity and feedbacks are different (Walker et al, 2004). The transition from one stable regime into another is also a mechanism for an SES to absorb more disturbances and shocks. The knowledge and management of the few, slow controlling variables and key drivers which cause an SES to crossover are essential for system resilience (Walker and Salt, 2006).

In sustainability transitions thinking, the movement from one alternative regime to another also offers a window of opportunity, for transformation from an unsustainable regime to a more sustainable one. There are two clear examples of opportunities for transition into sustainable regimes in Spier's journey, identified through sudden changes in key variables which determine which state the SES stays in or transitions to.

Discontinuity in the reliability of grid electricity

From late 2007 to mid-2008, as mentioned in the 'Sustainability Story of Spier' and identified as a critical factor affecting decision-making, businesses and households in South Africa suffered from rolling blackouts. Eskom, the national electricity utility, attributed this 'load-shedding' to insufficient electricity generation capacity in the face of increasing demand.

Irrespective of the controversy surrounding the rolling blackouts, they triggered a renewed exploration into energy efficiency measures and renewable energy projects at Spier. Prior to the discontinuity in grid supply, the bio fuel and bio diesel projects were driven by the need to rely less on carbon heavy Eskom electricity, as Spier's response to the global challenge of climate change from anthropogenic sources of greenhouse gases.

However, once the blackouts were experienced, Spier's sustainability as a leisure business was threatened. An energy audit of the hotel complex was commissioned, load management equipment was considered for installation and various energy conservation methods were explored. As a result, timers were installed on the hot water cylinders at the hotel and a trigger matrix system was introduced to switch off supply to unoccupied sections of the hotel.

Solar water heating was a serious contender for investment due to energy audit findings. However, grid supply stabilised from mid-2008 and the window of opportunity for further investments in renewable energy or energy efficiency measures was closed. Once the external driver of change was removed, the Spier system reverted back to its current regime without crossing over into an alternative regime, despite being very close to the threshold.

At the moment, the main driver for switching from grid-based electricity to renewable electricity is once again the sustainability commitment to reducing contribution to global warming: climate change mitigation. It is no longer a threat to business continuity as was presented by the discontinuity of Eskom supply.

Unreliability of on-site treatment of wastewater

As captured in the timeline for experiments with wastewater treatment at Spier (table 8.3) and detailed under related additional findings, the Biolytix filtration plant was found to be inadequate for treating wastewater from the kitchens and the wine cellar. It appears that for at least a few years after they were installed (in 2002), the Biolytix plants functioned effectively. However, at some point in 2006 the treated wastewater reached a threshold beyond which it failed to comply with effluent standards as stipulated by the national Department of Water Affairs and Forestry (DWAF). The direct involvement of DWAF officials in the discovery of this breach posed a significant risk for the business if it was to continue providing services to its clients and keep its business units functioning.

The discovery of the unreliability of the Biolytix filtration system also provided a window of opportunity for the business to seek alternative, more sustainable regimes. As discussed in Chapter 8, various options were considered including connecting to the municipal sewage system, upgrading the Biolytix plants and lastly, an alternative centralised treatment facility for the entire estate.

For various reasons detailed in Chapter 8, Spier management decided to pursue the last option. Complexity thinking requires that analysis not be focused solely on the different components of the system such as the DWAF regulations and officials, Spier managers and their technical capacities, the reliability or unreliability of different wastewater treatment technologies, but on the interaction between them which produced a unique window of opportunity for the Spier system to transition from an unsustainable regime to a more sustainable alternative.

9.3.2 Thresholds and perceptions of risk

The discussion on the two parallel and seemingly very different trajectories of renewable energy adoption and wastewater treatment gives great insights into system response as it is linked to perceptions of risk. Two arguments summarise this link:

- Reliable provision of electricity is a key driver of response, with the perceived potential to push the Spier system over a threshold into alternative, probably more sustainable states. The goal of carbon neutrality on the other hand, is not a key variable, of relevance to corporate sustainability, because at the moment it does not represent any risk or threat to the system. This can change very quickly if carbon emissions by businesses are capped through national regulations, once again an external driver of change.
- Reliability of basic services such as wastewater treatment is a key variable, with the potential to push the Spier system into alternative regimes. The goal of zero wastewater is a key variable only in that it can be enforced externally through DWAF-regulated effluent quality standards.

It can be further argued that decision-making in both trajectories was underpinned by a quest for system resilience against perceived and real uncertainties arising in the larger SES of which the business is a part. Pro-resilience decisions in both cases ensured the sustainability of the business, and the risks were external to the system. The role of management-defined environmental goals was not critical.

9.3.3 Spier's sustainability trajectory along the adaptive renewal cycle

An adaptive cycle is a resilience theory-based conceptual framework used to represent different stable phases in which a complex system may be identified including institutional systems (Peter, 2008; Walker and Salt, 2006; Holling, 1995). Transition over time is critical as the first two phases of the cycle are typified by slow growth and capital accumulation followed by the two fast phases of disturbance and renewal or collapse (Holling, 1986).

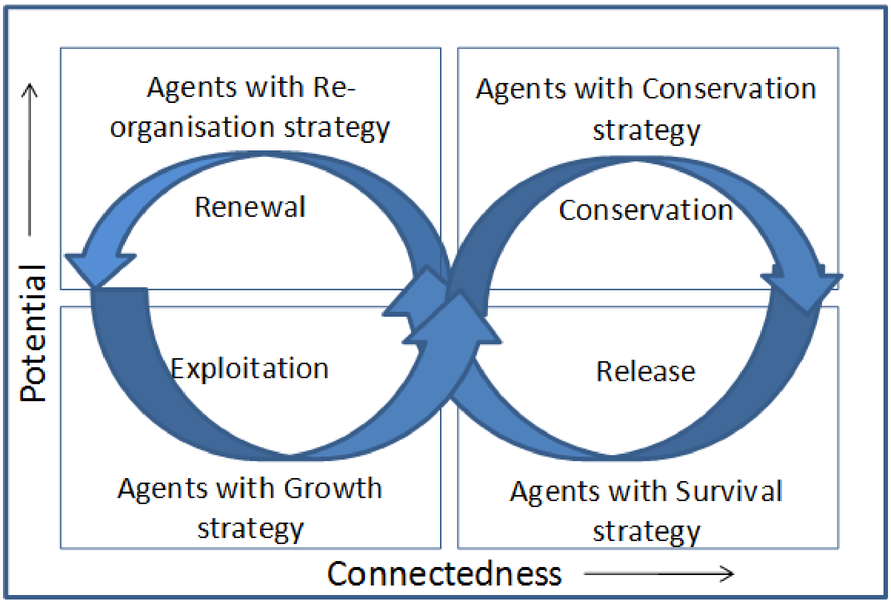

Figure 9.5: Adaptive renewal cycle (Gunderson and Holling, 2002), based on Holling (1973)

Human activity systems such as businesses are known to display the characteristics of a complex adaptive system and therefore, it is possible to trace the trajectory of a business on a sustainability path as an adaptive renewal cycle (Walker et al, 2006). Strong evidence of the adaptive renewal cycle was indeed found in the sustainability trajectory followed by Spier over the years covered in the narrative – 1993-2010. The narrative is divided along three recognisable phases in Spier's history:

- Revolutionary beginnings (1993-2002)
- Organisational maturity (2003-2007)
- Internalizing sustainability: from projects to goals (2008-2010)

The correlation between each of the above phases and the phases of the adaptive renewal cycle emerged as characterising features, scale of capital investment, response strategies by leaders and consultants in each of the phases, critical trends, cycles of innovation and experimentation, resource minimisation efforts, instruments driving sustainability and sources of information pertaining to specific periods were extracted from the narrative (listed in table 9.3).

Table 9.3 Three distinct periods in Spier's sustainability journey mapped as adaptive renewal phases

A modified adaptive cycle (based on Holling, 1986)			
Three definitive phases	**Growth: revolutionary beginnings (1993-2003)**	**Conservation: organisational stabilization (2004-2007)**	**Continued conservation: (2008-2010)**
Characterizing features of adaptive cycle phases	Readily available, large investments Accumulation of infrastructure and capital	Reduced capital investment Slower growth Stabilisation of individual business units	Post-financial crash Contained spending Innovative solutions to address financial and environmental issues
Critical events / trends	Establishment of Village Hotel Extension of wine production facilities	Third party validation GRI-based sustainability reporting Culture of goal-setting Discussion on and commitment to Spier values	Rationalization of organisational goals into 2 macro themes: • Socio-economic: poverty alleviation • Environmental: climate change Carbon footprint calculation LCA-based CF of a bottle of wine
External investments	Establishment of • Lynedoch primary school • Sustainability Institute (SI) Pro-poor tourism: promotion of black-owned tourism ventures	Ongoing financial commitment to • Lynedoch primary school • Training of employees at SI Redefinition of pro-poor projects	Ongoing financial commitment to • Lynedoch primary school • Training of employees at SI
Experimentation / innovation wrt sustainability	Vermiculture Adobe brick-making Go organic Ecological design principles Biolytix	Bio-diesel plant Unique, centralized waste water treatment plant (combining science, art and metaphysics) Investigation of bio-fuel project Green venture capital started	Investigation of greening projects Biodynamic farming Wetland conservation Investigation of CSP Procurement of recycled materials

			Biodiesel plant shut down Bio-fuel project not pursued Biolytix sold to Earth Capital Green Capital closed
Resource minimization efforts		Installation of water meters Energy saving devices: 10% reduction in electricity consumption	Installation of more water meters Timers installed on geysers Trigger matrix system installed to switch off sections of the Hotel
Defining ideologies wrt sustainability	Sustainable micro-ecology	Sustainable business management	Organisation-wide sustainability
Dominant paradigms during different phases	Local community development and environmental custodianship alongside financial success for brand establishment	Organisational and financial stability to house innovation in renewable energy generation, green venture capital	Financial stability, integration of goals with business purpose Financial incentives for organisation-wide sustainability-oriented innovation
Instruments driving sustainability	Guidance from external experts: Tom Darlington (architect) Ralph Freese (entrepreneur) Mark Swilling and Eve Annecke (community development projects, ecological design)	Informed leadership: CEO: Adrian Enthoven Director of Sustainable Development: Tanner Methvin	Employee and manager-level sustainability learning and implementation (decentralization)
Sources of information pertaining to specific periods for the case study	Semi-structured interviews: Mark Swilling and Eve Annecke Spier Development Framework, 1999 A Place of Hope Gareth Haysom, Director: Spier Resort Management	Sustainability Reports (2004-2007) Semi-structured interviews: Tanner Methvin, Spier board member Gareth Haysom, Director of Sustainable Agriculture Module, SI Cherie Immelman, facilities manager	Sustainability Report (2008) Organisation-wide and intermediary semi-structured interviews: Cherie Immelman, facilities manager Christie Kruger, group accountant Accounting staff Senior management team including CEO, COO,

		Frans Smit, cellar master Orlando Filander, farm manager	Director: Finance and Director: Marketing Frank Spencer, Emergent Energy Riaan Meyer, CRSES Alan Brent, CRSES Rob Worthington and Denise Bester, Trialogue

Integrating the temporal aspects of the ‘Sustainability Story of Spier’ (as contained in table 9.3) with the characteristics of different phases of the adaptive renewal cycle (as listed in table 6.1) allowed the researcher to make the following observations with regards to the inner logic of Spier’s journey:

- As argued by resilience thinkers (Walker et al, 2006; Holling, 1986; Janssen, 2002), Spier, a business SES follows the adaptive renewal cycle beginning with the **rapid growth phase** (1993-2002) during which the businesses and the physical structures housing it were established.
- The growth phase exhibits exploitation of new opportunities, high uncertainty matched by high system flexibility, a significant role for entrepreneurial thinking and easy access to resources.
- The growth phase is followed by the **conservation phase** (2003-2007), a period of slow accumulation of capital also matched with a certain level of organisational maturity, reflected through dedicated building up of the different business units, such as building human and physical capital in the wine section and building up of infrastructure in hotel.
- The conservation phase is also when the organisational structure acquired rigidity and when specialists were brought into the system to advance productivity and increase efficiency.
- The latest phase starts in 2008, which also happens to be the year of a financial crash, followed by an economic recession. This period reflects a continuation of trends observed in the previous phase but with significantly reduced access to capital.
- In terms of the renewal cycle phase characteristics, the latest phase (2008-2010) exhibits increasing interconnectedness among system components, increased focus on internal processes and efforts by management to create cycles of innovation at lower levels of the organisation. This phase is therefore closest in its characteristics to a **late conservation phase**.
- Organisation-wide sustainability-oriented behaviour is an example of conservation being nudged into growth phase at the scale of individual actors instead of allowing the system at the scale of the entire business to reach late conservation stage.

The mapping of the Spier sustainability journey along the phases of an adaptive renewal cycle addressed the question: 'If Spier is a system in transition, then how can this transition be understood?'

Further understanding of the Spier system and decisions taken with respect to ecological sustainability requires detailed consideration of systems at scales below and above the scale of the business SES. In other words, impacts and drivers from external and internal spheres of influences can be visualized through the application of the panarchy concept of resilience thinking.

9.3.4 Multi-scale interactions above and below the Spier SES

A panarchy framework consists of nested, multi-scale adaptive cycles arranged in space and time where adaptive cycle phases interact and connect with one another in a dynamic and unpredictable manner (Peter, 2008). A business is both an SES and part of a larger SES but at different scales. As an SES the Spier system interacts with adaptive cycles at multiple scales, both above and below it. This analysis utilises the one-dimensional representation of adaptive cycles consisting of fore loops and back loops adapted from Walker and Salt (2006) in order to visualise cross-scale interactions.

Using a panarchy framework, various determinants of behaviour and sources of disturbances (risks) can be plotted at appropriate scales which interact to produce environmentally-significant behaviour at the scale of the business.

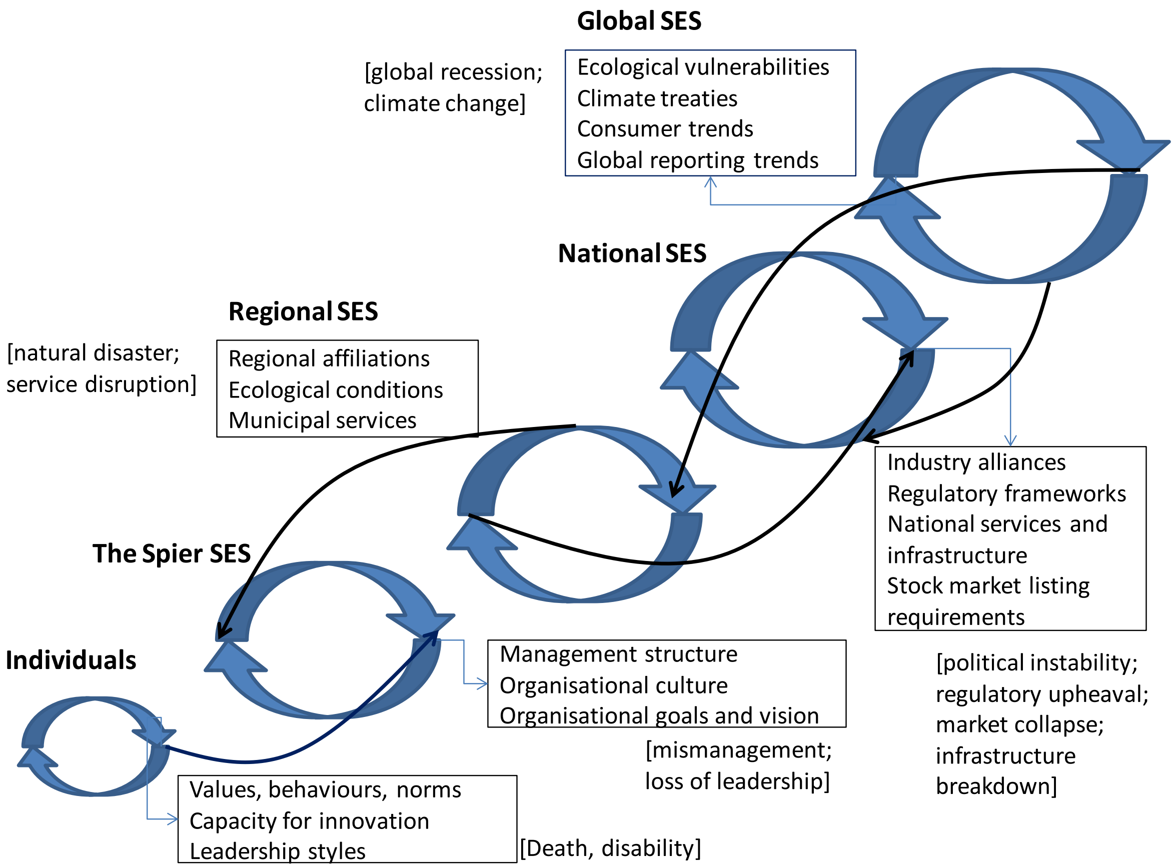

Figure 9.6: Various determinants of corporate behaviour and sources of shocks and risks to the Spier system arising in a panarchy of adaptive renewal cycles at different temporal / spatial scales

Following Walker et al (2002, 2006) the observed shifts, crises or non-linearities in the Spier business system result from processes and structures interacting across scales. The macro scales (regional, national and global) comprise of socio-economic forces such as union membership, urban transport unreliability, coal-based conventional electricity and global financial cycles over which Spier has little control. The following inferences reflect upon the multi-scale interactions within the social, economic, technical and ecological elements of the panarchy in figure 9.6.

Climate change policy and adoption of renewable energy technologies and energy efficiency measures: As a reflection of multi-scale interactions between international and national policy directives, international climate treaties are dependent upon climate change policies adopted by national governments. The more the number of countries that adopt effective climate mitigation policies, the more likely it is for global agreements to move forward. As a reflection of connections between national and industrial cycles, climate change policies at the national level will impact decisions pertaining to incentives for adoption of renewable energy technologies along with carbon capping for different industrial sectors. The manner in which renewable energy technologies are adopted and applied by leaders at provincial, national and global levels will impact on how managers at small and medium-sized businesses such as Spier approach this area of technical innovation.

Another critical linkage is that the renewable energy profile of the national electricity grid will determine the renewable energy profile of a small business that is unable to invest in small-scale renewable energy. Furthermore, unreliability of national grid electricity will encourage exploration of alternative sources of energy at provincial, regional and local scales and especially, at the scale of an individual establishment.

Global and national economic cycles and business response: Global boom and bust cycles impact on national economic cycles depending upon the openness of an economy's markets to international volatility. The South African economy is completely exposed to global cycles and will therefore track global economic cycles. This means that individual businesses, at whichever phase of their own development, are directly impacted by a global economic recession.

Economic recessions, market collapses and financial breakdowns offer an opportunity for SES at all scales to reconfigure by entering a quick collapse and renewal, and emerge as either more resilient systems or disperse and get absorbed as components of other lasting systems. For less resilient South African businesses, the financial crash of 2008 meant business demise. For others such as Spier, it spelled financial austerity and a redefined way of seeking enterprise sustainability.

Global reporting trends, consumer trends and regional affiliations and goals: There are multiple ways in which global trends impact on changes at the level of an individual establishment some of which have been discussed in previous chapters. Firstly, a number of local companies globalizing and listing internationally, forces SA companies to meet global standards for corporate governance by participating in a range of indexes such as the Dow Jones Sustainability Index (Fig, 2005; Visser, 2005; Hamann, 2004). Secondly, the South African market adopts similar requirements to international stock exchanges. For example, sustainability reporting is a requirement for listing on the JSE. The recommendations pertaining to the GRI (Global Reporting Initiative) determine the formats adopted by South African companies such as Spier for meeting their annual reporting.

In a parallel but reinforcing trend, international consumers demand the carbon footprints of Spier's products and services (leisure and wine). Similarly, international consumers of various South African products, including those from the fruit and wine sector demand product footprints in order to make ecologically-informed choices. This results in the creation of alliances at the regional scale of agricultural economists and fruit growers and wine producers in the Western

Cape such as the South African Fruit and Wine Initiative (SAFWI) and their initiatives such as ‘confronting climate change’.

The SAFWI in turn look to international carbon assessment tools such as the Australian Wine Carbon Calculator and carbon standards such as PAS 2050:2008 to develop the South African equivalent carbon calculator. Therefore, numerous cross-scale linkages between international, regional and local SES determine decisions made at the level of a private enterprise.

9.3.5 Multi-scale interactions within the Spier SES

The micro scale (at the scale of Spier and below) compromises of processes and structures within the business such as the separate procurement drives within the wine and leisure businesses to address environmental and social concerns, the greening projects, and various environmental initiatives driven by shareholder interest (biodynamic farming, wetland conservation, composting site using waste from packing-shed and Eerste River management).

The micro processes are the focus of integration efforts by management. At the same level as Spier are organisations such as the SI and the CRSES, containing experts with distinct mental models and knowledge areas and providing a platform for social learning to take place within Spier, necessary to navigate the transition to sustainability. The following inferences reflect upon the multi-scale interactions at the scale of the Spier SES.

Renewable energy innovation and experimentation is a separate structure following its own adaptive cycle within the larger business cycle. Innovation in renewable energy at Spier was begun in 2003 with investigation of biomass and bio diesel production facilities, when considerable resources were invested in this area. The last investments in this cycle were at the time of the Eskom blackouts in 2008 and the cycle currently seems locked into exploring solutions as opposed to implementation, also because of the impact of industry-specific and economic cycles at larger scales.

The cycle of wastewater treatment was initiated early in the history of Spier’s environmental sustainability journey with experiments in new business-models for marketing the Biolytix treatment plant. The cycle crossed a threshold when the treatment capacity of the plant was found inadequate and transformed into an alternative stable-state with the establishment of the new bioreactor.

The structure for solid waste recycling was also initiated early in Spier’s environmental sustainability journey. This cycle interacts with a mature industry (in a predictable and reliable conservation phase) with many and more experienced players as compared to a fairly new and developing renewable energy sector (in a less predictable and riskier growth phase).

The stimulus for innovation and sustainability-oriented experimentation, driven by senior management also creates redundancies in the organisation in that there is not just one person (the Director for Sustainable Development) responsible for sustainability but all managers. This approach is described in further detail under adaptive management.

Institutions such as the SI and the CRSES also follow their own adaptive cycles. For example, initially Spier collaborated with Mark Swilling and Eve Annecke as individuals. Spier now engages with the Sustainability Institute. As organisations become more institutionalised, so does the relationship between them.

9.3.6 Concluding remarks

Sustainability process and causation reveals driving forces relevant to a sustainability transition; guidance from institutions and incentives; and impacts and response (Clark, 2007). The case analysis of Spier using sustainability science constructs supports the flow of causation from driving forces to guidance to response. Integration of case analysis with components of resilience thinking illustrates this flow of causation.

The existence of thresholds between alternative regimes and the management of the Spier SES based on the knowledge of key variables which can push the SES across a threshold, produces decision-making which seeks system resilience to achieve environmental sustainability. Exogenous variables are therefore critical because they define what discontinuities and vulnerabilities are faced by Spier at any given time and therefore, how agent-actors respond to external stimuli.

Knowledge of the business cycle is important to resilience-based decision-making because it determines Spier shareholders' capacity for and Spier management's response to risks and uncertainties in each phase. As evidenced through the case of Spier, human intent can maintain an SES in a late conservation phase and suppress transition through a renewal cycle.

The Spier SES interacts dynamically with other SES at multi-scales, each in their own phases of adaptive cycle, generating multiple linkages and unpredictable outcomes. The multi-scale SES include individuals who are employees, customers, farmers, suppliers, vendors, activists, managers or shareholders; institutions for research, training or consulting; affiliations of farmers, businessmen, recyclers, workers or artists; industrial sectors in hospitality, wine, agriculture or renewable energy; and local, provincial, national and global government departments and forums, interacting with physical and natural systems.

The panarchy framework produces another view of the drivers of corporate behaviour which were listed in table 9.2. For example, regulatory and legal pressures exist at municipal and national levels, as do provision of physical services. Market pressures arise locally, nationally and internationally. Ecological vulnerabilities are also spread across the scales: soil fertility is an issue at the local scale; water scarcity is a regional concern, whereas climate change is a global challenge.

Up to this point in Chapter 9, the Spier system has been discussed and analysed through a variety of theoretical constructs including systems analysis, complexity and the SES conception. Furthermore, case findings were integrated with the components of resilience thinking in order to recognise and highlight instances where decisions were made based on implicit knowledge of system thresholds and regimes, the particular adaptive renewal cycle phase in which the business was and dynamic interactions with other adaptive cycles at multiple scales. The next section looks more closely at the broad area of management and governance for sustainability, drawing parallels with recurring themes from resilience-based adaptive management.

9.4 Adaptive management in the context of Spier

Resilience-based thinking with specific reference to adaptive management shows key recurring themes: the use of dynamic modelling techniques, scenario-building and networking as a means of strengthening general resilience in the SES. At the scale of individual institutions, the related theme of adaptive learning for responding to external and organisational change is also encountered. Each of these themes is discussed in the context of Spier's sustainability journey.

9.4.1 Dynamic modelling techniques

Sophisticated IT-based modelling techniques have not been used by Spier managers for their decision-making purposes or in this research. Dynamic modelling of the Spier system was undertaken by staying very close to the constructs encountered in systems thinking and complexity theory, and later resilience thinking (figures 9.2, 9.3, 9.4 and 9.6).

9.4.2 Scenario-building

The specific form of engagement with key stakeholders whereby multiple explanations of system behaviour under different scenarios are identified through a variety of hypothesis, views and opinions was undertaken as part of the empirical research and case analysis. Key sources of risks, possible unforeseen events, innovation potentials and the visions, hopes and fears of stakeholders as drivers of change were identified through semi-structured interviews with senior and operational managers, and important intermediaries. As a result, the researcher could reflect upon the key attributes of the Spier SES, the phase of adaptive cycle which the system is moving through, what is happening above and below the scale of interest and the linkages between scales, in this chapter.

The discussion in this chapter also begins to address the search for slow variables that define the Spier SES and the thresholds beyond which the system starts behaving differently (with respect to the corporate practice areas of energy efficiency and wastewater reuse, Section 9.3.1).

Within scenario-building, ambiguities and uncertainties were seen to arise from:

- Scientific uncertainty pertaining to ecological variables (planetary thresholds),
- Information overload (LCAs, carbon footprints, sustainability reporting),
- Knowledge asymmetry (strategic return on investment in renewable energy options)
- Unforeseeable reactions of people to unfolding change in the SES (based on values, beliefs and norms)
- Political delays – carbon-capping of nations and industrial sectors

Therefore, when Spier responds to global challenges and local threats, it faces interdependent risks. The notion of 'hard facts' and 'soft values' is replaced by 'hard policy decisions' based on 'soft facts' or uncertainties (Van der Sluijs, 2007).

9.4.3 Networking

Based on the role, the origins and different types of collaboration / consensus-building needed for the successful implementation of adaptive management, Westley and Vredenburg (1991) use collaborative theory to differentiate between planning-led, learning-led and vision-led modes of networking. Each collaborative mode is shown to correspond with strategy making within the organisation from which the collaboration originates and impact on the level of institutionalisation of the network (Westley, 1995).

For instance, highly structured government departments are known to work with rigid, planning-led networks, while research institutes and university departments are used to freer association among individuals. Based on the case of Spier's sustainability trajectory and with specific reference to the associations which Spier shareholders and management have initiated and maintained in the last two decades, it is argued that the same SES (Spier in this case) can exhibit a propensity for certain forms of networks during different phases. In order to corroborate this line of argument the following inferences are drawn.

Networks in the growth phase were primarily vision-led: During the first phase of Spier's history, networks were created around the vision of the owner Dick Enthoven. The evolving understanding of sustainable development of external experts such as Mark Swilling, Eve Annecke, Tom Darlington and Ralph Freeze was closely aligned with that of the owner's vision. During interviews with Eve and Mark it was revealed that alliances early in the growth phase (1993-1999) were considerably spontaneous, and that structure was slowly introduced to networking in 1999 with the establishment of the Spier Strategic Planning Team.

Collaborations since the conservation phase tend to be planning-led: As more structure was introduced within the business, affiliations with external experts and service providers became more institutionalised. Formal procurement policies and requirements for a minimum number of bidders for projects such as the wastewater treatment plant, the greening projects and the refurbishment of the wine-tasting centre reflect this trend. In contrast, the Biolytic wastewater treatment technology in the growth phase was not selected through any formal evaluation processes. The association with the Sustainability Institute is well defined through contracts.

Networks in the late conservation phase are increasingly learning-led: As a result of management efforts to revitalise the organisation by encouraging innovation at all levels in at Spier, individuals are seeking various alliances to augment their own capacity for implementing sustainable solutions and lower-carbon options in the business.

Interviews with Christie Kruger, Gerard de Cock, Sherieen Pretorius, Jaco Durand, Frans Smit, Cherie Immelman and Orlando Filander reveal that managers at all levels are establishing links with a range of innovative thought-leaders, manufacturers and suppliers – such as producers of PET bottles, recyclable wine cases, bio-diesel, humidifiers or solar bulbs; growers of organic food or developers of carbon calculators and cutting-edge reporting methods. Spier's relationship with the SI has also evolved to underscore the learning partnership between the two organisations.

Cycles at lower scales also adopt dominant network modes in different phases: For example, the separate structure of renewable energy exploration and innovation follows its own cycle and also exhibits a transition from utilising vision-led networks in the beginning (partnerships for the experimental bio-fuel and bio-diesel plants explored by the Director for Sustainable Development, Tanner Methvin); through planning dominated processes and technical evaluations for the greening projects; to a learning-led phase which is taking place simultaneously through collaborations with the SI and the CRSES and through the multi-level search for innovative solutions by Spier managers.

The relationship with the CRSES is markedly altered in the different collaborative modes. From an initial role of technical guidance to assist Spier in choosing different renewable energy options, CRSES now funds students (at graduate and post-graduate levels) who co-learn with Spier, ways of traversing a new scientific terrain.

9.4.4 Adaptive learning

Institutions in different stages of the cycle of revitalisation practice adaptive management in slightly different ways (Westley, 1995). The resilience of an organisational SES relies on the adaptive capacity of agent-actors. Organisations that have learnt to learn differently during different stages of their life-cycle (or practice adaptive learning) are more adept at responding to change, and are therefore more resilient than those who have not.

The previous discussion reflected on the different modes of networking which dominate during different phases of Spier's cycle of revitalisation (sustainability journey). Adaptive learning requires that through those dominant trends and phases, an organisation continues to learn the less dominant practices. Enterprise resilience incorporates adaptive learning by suggesting that organisations foresee and strategise ahead of renewal cycles in the panarchy, and build the innovative capacity and response diversity to act before change manifests.

Baets (2006) argues that new cycles of individual learning through new experiences and significant collaboration based on these experiences is the only way that change can be introduced at the level of mental models, new routines and shared models. Therefore, a resilient system creates opportunities for learning and revitalisation at the scale of the business, its sub-components and individuals.

Several iterative and inductive learning processes can be found at Spier. These processes prevent the SES from getting locked into efficient and routine exercises of the late conservation phase and at the same time discourage the chaos and disorder of revitalisation to become the norm:

- Even as myriad explorations into lighter and recycled materials; solar bulbs and bio-diesel producers; endogenous species of trees and local varieties of proteas; organic farming techniques and integrated pest management; humidifiers and electric vehicles, occur within business units and environmental programs, Spier management seeks to reflect upon the material issues that hold the different parts together at the scale of the organisation.
- Spier management is interested in charting its sustainability trajectory with the explicit aim of assessing current performance against goals for environmental sustainability.
- Organisational goal-setting serves the purpose of directing diverse efforts towards a common vision, articulated under the themes of climate change and poverty alleviation. Thus climate change goals may not be sufficient drivers of environmentally significant behaviour, but they produce a common language and a knowledge bank, around which innovations can centre.
- Explorations into on-site renewable energy generation may not have resulted in sizeable capital investment for now, but continue to strengthen managers' knowledge in the area.
- Sustainability reporting on a quarterly cycle and the business carbon footprint on an annual basis, similarly serve to create a unified representation of the enterprise.
- Spier's association with the SI for training staff members at all levels on sustainable development initiates a cycle of change at the level of each individual within the system.

9.4.5 Concluding remarks

Aspects of adaptive management can be found in the different components of Spier's sustainability journey, especially in the corporate practice areas of environmental sustainability:

- The business responds to ambiguities and uncertainties arising from scientific uncertainty, information overload, knowledge asymmetry and political delays when formulating strategies for capital investment
- Spier exhibits a propensity for certain forms of network during different phases.
- Cycles at lower scales also adopt dominant network modes in different phases.
- The business is creating opportunities for learning and revitalisation at the scale of the business, its sub-components and individuals, in order to avoid the efficient and routine exercises of the late conservation phase.
- At the same time, the business is creating ways of consolidating and integrating organisation-wide sustainability-oriented activities to prevent the chaos of revitalisation to become the norm.

9.5 Applying the framework for corporate resilience

In Chapter 6, corporate resilience was proposed by the researcher as a bridging concept which retains the essence of SES resilience but is also informed by the fact that human agents, especially in a private sector context, use networks, explore alternative futures (scenarios) and technological solutions, as adaptive management responses to shocks from the larger SES, interdependency risks and gaps in scientific knowledge (Section 6.6.2).

A framework for corporate resilience was further proposed, which draws on the core principles of resilience thinking, as they are understood in the parallel discourses of ecosystem, SES and enterprise resilience (Section 6.6.3). This framework is a tool for mapping corporate strategies which respond to interconnected (external and internal) risks faced by the business, and at the same time, to contribute towards increased resilience in the SES.

This section revisits the development of the proposed resilience framework and applies it to Spier's search for a lower carbon future and environmental sustainability. The framework is applied by plotting Spier management's strategies in the six corporate performance areas of lower carbon emissions, water sustainability, wastewater treatment, solid waste recycling and ecological custodianship, based on the type of asset or potentiality building investment they represent. Related risks whether they are network or ecological based are also listed for each corporate performance area.

9.5.1 Revisiting the development of the corporate resilience framework

The corporate resilience framework is premised on the need for businesses to act ahead of the cycles of change across different scales in the panarchy (source of potential, external risks) by generating renewal cycles at the scale of sub-systems and thus avoiding the dangers of late conservation and extreme release (internal systemic risk).

Based on the finding that rebirth and early consolidation phases are characterised by capital accumulation or investment in growing the potential of products, ideas and species, the framework suggests investing in different types of assets (whether technological, ecosystem-based, infrastructure-based or knowledge networks) in order to build system potentiality and therefore, resilience.

The corporate resilience framework is inspired by the synthesis frameworks based on the review of corporate citizenship, industrial ecology and ecological economics literatures in Chapters 3 and 4. The corporate practice areas for environmental sustainability are drawn from the systems ecology discussion, presented in Chapter 4 as a framework for assessing a business against best environmental practices (table 4.2). The CC framework (table 3.3) exhibits, as does the corporate resilience framework, that corporate practice spans multiple areas such as infrastructure investments, knowledge networks and biodiversity management.

The framework is an instrument which represents investments made within different corporate practice areas (which build enterprise resilience and SES sustainability) to be linked to risks faced by a business at a certain time, the information contained in it changes depending upon when in the life cycle of the business it is populated.

Table 9.4 Proposed corporate framework for enterprise resilience and ecological sustainability

Corporate practice area	Asset and potentiality building categories for different adaptive cycle phases				
SES sustainability components	Capital Investment (natural and technological)	Supply chain aspects	Knowledge networks and partnerships	Infrastructure networks	Related risks
Lower carbon emissions					
Water sustainability					
Wastewater treatment					
Waste recycling					
Environmental custodianship					

The framework is populated with various ‘stratlets’ (small but strategically powerful interventions) generated at different levels of the business. Stratlets are initiatives and ideas to establish how a particular intervention creates agility in the over-all enterprise and at the same time delivers on the corporate practice areas for ecological sustainability.

The populated framework in table 9.5 is slightly different to the framework proposed in Chapter 6 (table 6.2), repeated as table 9.4 below. The comprehension and delineation of risks in the populated framework incorporates ambiguities and potential threats arising from the supply chain, human-designed infrastructure and physiological networks.

The proposed and reconfigured frameworks do not incorporate legal, market-based and cultural pressures as such. Managers and practitioners using it are encouraged to enhance the framework in order to include determinants and drivers from policy imperatives, societal expectations and ethical and cultural considerations.

9.5.2 Application of the framework to Spier's search for a lower carbon future and environmental sustainability

The populated corporate resilience framework is used to map Spier's business strategies for environmental sustainability, and create another layer of resilience-based analysis of corporate drivers. The framework reflects consistent underlying factors across all corporate areas which support a resilience-based approach to decision-making at Spier. These factors include:

- Increasing reliance on internal and network intelligence
- Reducing risk-exposure, to unreliable service provision from the state, vendors or suppliers
- Adapting to the type of resources available in different phases of the adaptive renewal cycle
- Building resilience in the business at the same time as responding to ecological vulnerabilities

Table 9.5 is populated with corporate strategies aimed at building different categories of assets in five key areas of corporate practice targeting environmental sustainability. Each of these practice areas also represents key components of SES sustainability: lower carbon emissions, water sustainability, wastewater treatment, waste recycling and environmental custodianship, and are discussed individually in the following sections.

Table 9.5 Integrated corporate framework for resilience populated with Spier strategies and SES risks

Corporate practice areas	Asset and potentiality building categories			Related Risks
Environmental sustainability components	Capital investment (natural, manmade)	Networks, partnerships	Knowledge accumulation	Network-based and ecological
Lower carbon emissions	Bio fuel and biodiesel projects Trigger matrix system Light-savers LPG forklifts Heat pumps	GCX CRSES SI students SAFWI RE vendors Biodiesel suppliers	Carbon footprint Carbon offsetting Ongoing explorations into solar technologies (CSP, CV)	Technical info asymmetry Reliance on Eskom grid Climate change
Water sustainability	Water saving showerheads and flushes Water meters	Suppliers of devices Water suppliers	Exploring rain harvesting Water footprint	Municipal supply Industrial supply Water scarcity
Wastewater treatment	Biolytix plant Bioreactor, irrigation system Reed-bed/yin-yang pool	Dowmas (Pty) Lt HWT Engineering DWAF officials	Exploration of alternatives Sustainability reporting	Municipal sewage system New technologies
Solid waste recycling	New shed Compactor Filter pump Compost site	Nov Waste Waste Plan Suppliers of recycled products	SI training Visits to land-fill sites PET bottles	Landfill capacity SAPPI and Nampak networks
Environmental custodianship	25% Land conservation Protea Walk Alien tree clearing river cleansing Vermi-composting	Farmer Angus: biodynamic farming Eric Swarts: Land Reform Project	Research into indigenous trees Organic farming	Biodiversity loss Ecosystem services Loss of natural beauty on estate

9.5.2.1 Lower carbon emissions

Spier has invested over the last two decades in energy efficiency and renewable energy technology solutions along all three asset– and potentiality–building categories. Within the renewable energy cycle, capital investment was pursued aggressively when experimentation was begun in 2007, under the leadership of the Director for Sustainable Development. These investments were driven by a cognisance of the ecological threat of global climate change, and a business imperative to generate clean energy as an alternative to coal-based grid electricity. Unfortunately, these investments in the form of the biodiesel and bio-fuel projects (section 9.3.2) were sunk costs to the business since the projects were never implemented. However, the business did benefit from the immense learning that resulted from the experimentation.

Recent capital investments of trigger matrix system and light savers were predominantly in response to the perceived threat to the business from the discontinuity of Eskom electricity in 2008 (as detailed in section 9.3.2). Heat pumps are under investigation as the next capital investment for increasing energy efficiency and result in both lower emissions (for the global SES) and lower financial costs (for the business SES).

Meanwhile, network-building and knowledge accumulation are consistently invested in, owing in part to the huge knowledge asymmetry between vendors of renewable energy technologies and users or buyers of the technological solutions such as Spier. The networks range from consultancies such as GCX and Trialogue, renewable energy vendors and suppliers such as Emergent Energy, Zingaro and Skoon Diesel, regional farmers' affiliations such as SAFWI, to educational and research institutions such as SI and CRSES.

Alongside the exploration of technologies and investment in knowledge and supplier networks, are the initiatives aimed at building internal knowledge through environmental reporting, carbon footprint assessments and review of international standards for emissions measurement and reporting. A shift towards increased activities in knowledge gathering related to carbon emissions and environmental reporting is observed, driven by the need to understand what is required in order to meet the organisational goals under climate change. Therefore, a carbon-neutral status may not drive the quest for a lower carbon future directly but it does result in the collection of emissions-related information on the business processes, which creates the potentiality of acting on such knowledge when resources for capital investment are available.

Representative of a system in conservation phase, capital investments and niche experiments requiring major financial spend are fewer in 2010, compared to in 2006. Response diversity is built by encouraging organisation-wide sustainability-oriented behaviours. Therefore, senior managers, whose performance is linked to financial and non-financial indicators, are motivated to lower carbon emissions in the operations for which they are responsible by building knowledge capital, investing in networks and implementing lower cost technological solutions. However, in the absence of external risks to the business such as carbon taxes or regulations, significant capital resources are not being allocated to this area. The risk of knowledge asymmetry between Spier and vendors of technological solutions, and past failed investments discourage the business from making large capital investments towards a lower carbon future.

9.5.2.2 Water sustainability

Water sustainability is defined as one of the key aspects of environmental sustainability, and forms an important thread of the narrative in Chapter 7, but was not included as one of the key environmental performance areas interrogated in detail in Chapters 8 and 9.

However, it is possible to plot strategies and initiatives discussed under section 7.3 Wine and water on the corporate resilience framework and reflect upon their determinants from the perspective of building corporate resilience.

Spier is supplied through municipal and industrial water supply streams and farm operations are managed under the paradigm of regional water scarcity and high water rates, despite a high water table in the wetlands which defines the natural topography of the estate. Recent decisions at the level of the shareholders leading to a division of the estate and attached water rights meant that access to certain water sources was diverted to operations which are not part of the Spier Group. In addition, the building of the wastewater treatment plant on the site of two natural dams meant that these could no longer be used for irrigation purposes.

Water is therefore perceived by operational management as an essential, scarce and expensive resource, with direct impacts on all components of Spier business operations: farming, wine production and leisure. Water saving showerheads and flushing systems, as well as ongoing education of staff to conserve water on the estate are part of management's response to this ecological and enterprise level risk.

Water meters were installed on the estate in order to encourage more responsible use of this resource, by holding buildings and the business units which use those buildings accountable for water accounts. The installation of water meters led to the discovery of discrepancies between water usage and water accounts. These were linked to possible leaks in the distribution network, which were located and fixed over a few months, resulting in greatly reduced water wastage.

Water usage contributes to the carbon footprint of the business which also encouraged measurement of actual water consumption through installation of water meters along the distribution network. Investment in maintenance of the physical water supply system therefore also resulted in a reduced carbon footprint for the business.

Recent interest in water footprint calculations of the estate and a bottle of wine, as well as attention to possibilities for rain harvesting are aimed at both conserving an environmental resource as well as reducing business costs of buying water which is in abundance on the estate during certain months of the year. The fact that water is a real, physical resource with measurable costs to the business means that investments result in immediate savings, both in terms of an environmental resource and finances.

9.5.2.3 Wastewater treatment

This area of environmental sustainability is discussed in great detail in Chapters 7, 8 and 9. It is an integral and successful component of the sustainability trajectory followed by Spier in the quest for a zero wastewater profile.

Investments in this corporate practice area are first tracked as experiments with wastewater treatment in section 7.7, which are analysed in section 8.3.3 drawing on sustainability reports, strategic business documents and interviews with relevant staff members and intermediaries, and using frameworks from systems ecology and corporate citizenship (in Part 3 of Chapter 8). In Chapter 9, decision-making in this area of corporate practice is further integrated with systems thinking, complexity and components of resilience-thinking. In particular section 9.3.1 expands upon the malfunctioning Biolytix system, a risk to the business from an environmental and operational level, providing a window of opportunity for further capital investments in wastewater treatment.

The mapping of past and recent asset-building in this arena of environmental sustainability indicates that niche experiments were continuously explored and implemented as a result of the estate never being connected to the municipal sewage system and therefore, always operating in a space of vulnerability and therefore, innovation. The risk of untreated sewage on the estate is real and pertinent to business continuity, in particular the leisure component.

The need for suitable partners to design and execute innovative wastewater treatment solutions means that there has also been an ongoing investment in building valuable knowledge networks, while at the same time retaining critical links with public sector counterparts (DWAF officials) in order to maintain operational standards.

This particular area of corporate practice represents an example of the business system responding to interdependent risks in the larger SES. Potential discontinuity in the wastewater treatment service manifested as risk emanating from new technologies for on-site cleansing of wastewater, compounded by uncertainty with regards to the capacity of the municipal network to offer a long-term solution. Enterprise risk was further accentuated with the involvement of government officials and knowledge of minimum standards for water cleansing, with the potential of tainting business reputation, and negatively affecting working and living conditions on the estate.

Since the environmental goal of zero wastewater is achieved by using the cleansed water for irrigating gardens on the estate, Spier avoids new risks from a system breakdown through monthly testing of water quality in relation to DWAF regulations.

9.5.2.4 Solid waste recycling

This area of environmental sustainability is covered in great detail in Chapter 7 and in Chapter 8 (section 8.3.3) where events and trends were analysed based on case evidence collected through desk-top review of strategic documents, interviews and site visits.

In this chapter, solid waste recycling is studied under section 9.3.5 whereby the cycle of innovation in this corporate area is seen to intersect with a mature recycling industry, thus changing the risk profile and increasing the chances of successful outcomes.

Populating the corporate resilience framework with strategies and investments made towards waste recycling consolidates several informants to business decisions in different phases of the business cycle. Minor capital investments in the form of a recycling depot, a compactor and filter pump are noted. The compost site represents investment in a form of natural capital in the recycling practice area, generating a resource from organic waste which can be used by farmers in the larger SES and not only on the Spier estate.

The particular characteristics of this corporate practice area demand greater investment in linking up with networks of service providers; be they recycling units of large paper-producing companies or suppliers of recycled products. In the growth part of this cycle Spier connected with a local, small-scale operator and carried a relatively larger responsibility (and therefore risk) for increasing recycling rates in the business. In the current conservation phase, Spier is connected to a better established recycling service provider Waste Plan, who reports regularly, and is in turn connected to larger recycling companies, resulting in improved recycling levels.

However, similar networks are yet to be established in the area of buying recycled products. As was noted in section 9.4.3 on networking, managers are establishing links with a range of innovative manufacturers and suppliers – such as producers of PET bottles and recyclable wine cases, in order to test which networks can yield outcomes that help achieve organisational goals for using recycled materials and products.

An important risk associated with this area is lack of awareness among consumers on the estate in the form of guests and staff members. Therefore, substantial investment is made in raising ecological awareness in these two groups through labelling of bins to encourage waste separation at source, training of new staff members on basic sustainability principles at the Sustainability Institute and visits to landfill sites in order to encourage less wasteful behaviour.

Further improvements in this practice area will require radical innovation by Spier, either in terms of capital investment (such as a methane-to-electricity plant for landfill waste emissions or improvements to the waste depot and site), complete redesign of products (such as a recyclable plastic wine bottle range) or changing consumption patterns of clients and employees (such as banning plastic packaging for food items).

9.5.2.5 Environmental custodianship

Aspects of environmental custodianship include endeavours such as wetland conservation and biodynamic farming, which are hard to quantify and are mentioned under the discussion on carbon footprint as a composite measure for climate change in section 7.9 of the narrative in

Chapter 7. It was noted in Chapter 7 and concluded in Chapter 8 (section 8.3.4 and table 8.7) that it is a substantial gap in current footprint assessment methods that efforts towards on-site nature conservation are not incorporated to reduce an entity's carbon footprint.

However, it is possible to plot strategies and initiatives towards nature conservation on the corporate resilience framework and reflect upon their determinants from the perspective of risk perceptions and building corporate resilience.

Allocating 25% of estate for land conservation and planting of indigenous trees and a protea walk are recent initiatives (since 2009) aimed at restoring natural capital on the estate in keeping with the regional biodiversity profile. Clearing of alien vegetation and river cleansing are activities which were initiated when the estate was acquired by Dick Enthoven in 1993 and represent a response inspired by an appreciation for the ecosystem services offered by nature.

The vermi-composting business was absorbed by the business as captured in Chapter 7 (section 7.6) when Spier Green Capital was closed in May 2010, based on the understanding that vermi-composting is an integral part of the business' organic and biodynamic farming operations. Farmers in the region buy compost from the SI estate.

Networks and partnerships in this area of corporate practice include the presence of Farmer Angus (with his pasture reared chickens and cattle and biodynamic farming practices) and Eric Swarts, the only farmer who planted for the first time in September 1999 and twelve years later, still produces organic vegetables and supplies them locally. He is the manager of the Land Reform Project and is supported by Spier to this day through free electricity, water and fuel.

At the time of collecting case evidence, research and knowledge accumulation was focused around what constitutes organic farming and ways of planting and sustaining indigenous trees in surrounding communities. The farming methods of Farmer Angus using biodynamic techniques prove an important source of practical knowledge and have determined the supply chains of Spier's flagship restaurant 8.

Biodiversity loss, loss of natural assets on the estate and ecosystem services are the risks which drive strategic response within this practice area, especially since most of the above investments are not linked to downward trending goals for carbon emissions, zero solid waste or zero wastewater. Neither are there any legislative requirements for Spier management to explore or implement initiatives which result in conservation of natural capital.

There is great potential for Spier's methods to be adopted by more farmers in the region to create corridors as reserves, providing pathways for organisms to utilise and shift along in response to climate change (Ehrlich and Ehrlich, 2008).

9.6 Conclusions

In the introduction of ‘Barriers and Bridges to the Renewal of Ecosystems and Institutions’ C.S Holling (1995) proposes a testable hypothesis: ‘The world is too confusing and there is loss in the belief that any of the ground rules work anymore. To seek understanding is a response to the loss of certitude. A new class of complex issues is sufficiently novel that the science is incomplete and the future unpredictable. Therefore, conflicting modes of inquiry and criteria are utilised for establishing the credibility of a line of argument.’

In application of the above hypothesis, the search for a vision which underpins Spier’s sustainability trajectory was undertaken through several frameworks or modes of enquiry. The intention was that the different modes of enquiry will yield results which will corroborate each other and reveal a common inner logic of Spier’s trajectory. To conceptualise and analyse the full significance of all of Spier’s sustainability activities, the researcher went beyond ‘carbonology’ and ended up with ‘resilience’.

9.6.1 Insights into corporate drivers through alternative, resilience-based constructs

The different constructs from the sustainability sciences have each generated unique insights into Spier’s journey towards environmental sustainability, which establish a credible line of argument articulated as follows:

1. Spier’s journey verifies that the path from current practices to sustainable goals is not one of continuous process optimisation, as portrayed by eco-efficiency thinking and carbon-related goal-setting, but rather a leap as signified by systems change and achieved through sustainability-oriented innovation.
2. Spier’s sustainability journey is underpinned by a quest for corporate resilience which includes:
    - Resilience of Spier as a business and (enterprise resilience)
    - Resilience of the social-ecological system within which Spier resides (SES resilience)

   In other words, Spier’s commitment to sustainability (ecological or social) is not separate from its obligation to its own endurance and longevity.

3. Spier’s sustainability transition follows the path of an adaptive renewal cycle, displaying management paradigms, response strategies and networks which correspond with distinct phases of the cycle.
    - Spier participates in planning-led, learning-led and vision-led networks, with some modes of collaboration more dominant than others during specific phases.
    - Spier displays adaptive learning through its efforts at maintaining a balance between the extreme states of late conservation and disordered renewal.

- Spier invests adaptively across the categories of capital (manmade and natural), partnerships and knowledge in accordance with resource availability

4. Spier's sustainability trajectory along a cycle of change is not driven by its environmental goals including carbon neutral, zero wastewater and zero solid waste. In fact, organisational goal-setting is one of the environmental performance areas, along with sustainability reporting. The areas of goal setting and reporting serve to generate and support a unified, strategic vision, and contribute towards knowledge accumulation in select areas of corporate environmental performance.
5. Real drivers of Spier's future are key variables which can push the SES or components across critical thresholds, such as external shocks and disturbances; visions, hopes and fears of agent-actors and possible policies that might be imposed.

Therefore, this thesis critiques the research question posed by Spier, which was driven by a corporate vision of carbon neutrality, by constructing a line of argument which presents Spier's past and current decisions and behaviours as driven by an underlying logic of resilience-building. Within this resilience-based understanding, carbon-related goals currently serve organisational, knowledge-building purposes but are too narrowly-focused to underpin substantial capital investments.

Large capital investments, as evidenced in the case of Spier (across the practice areas of wastewater treatment, energy efficiency, waste recycling, water sustainability and environmental custodianship), are made by a business either when the continuity of the enterprise is at stake, or that of the larger SES. The continuity in turn is determined by key variables linked to thresholds and by perceptions of risks and opportunities by decision-makers.

9.6.2 Challenging Spier's position on corporate sustainability

Spier's initial position with regards to corporate citizenship and sustainable development are articulated by the following inter-linked assumptions, which also provided the starting points for the case study:

- Sustainability is pursued by Spier as an over-arching vision for activities across social, environmental and economic performance areas
- Charting investments and initiatives across the three areas of sustainable development over two decades should reveal progress along a sustainability trajectory
- Knowledge of how carbon-neutrality can be achieved by a business will assist in achieving this macro-organisational goal for environmental sustainability

Each of the above assumptions is challenged by a resilience-based analysis of case evidence in the following ways:

- It is the search for building resilience in the business as an SES and the larger SES which drives activities across social, economic and environmental performance areas.

- The charting of investments and initiatives across the three areas over two decades reveals a common logic of system behaviour where business strategies (including carbon reduction strategies and investments) respond to risks and uncertainties in the larger SES (as articulated in section 9.6.1).
    - Therefore, progress along a sustainability trajectory cannot be ascertained through case evidence collected and analysed.
    - However, path along a business cycle of change, comprising of birth, growth and consolidation phases for the entire business, and components within it, can be substantiated by applying systems, complexity and resilience thinking to case evidence (sections 9.2 and 9.3).
- Knowledge of how carbon-neutrality can be achieved by a business is not utilised by Spier in achieving this macro-organisational goal for environmental sustainability because as a social-ecological system, the business is responding to risks.
    - Interrogation and presentation of Carbonology reveals that carbon footprint is not a comprehensive measure of climate change impact, ambiguities related to carbon auditing tools and technologies exist, and biases in carbon reduction strategies are found so that a carbon focus translates into a fossil fuel consumption focus (section 5.6).
    - However, search for a lower carbon future is an appropriate business response to the ecological risk of global climate change.
    - Application of Carbonology to Spier's practices reveals that knowledge exists within the system with regards to significant capital investments needed to shift to energy efficiency and renewable sources of energy, and thus reduced carbon emissions. This knowledge is not complete and Carbonology addressed this gap.
    - However, absence of non-ecological risks to the business such as carbon taxes or regulations, as well as the current business phase of late conservation means that significant capital resources are not made available towards this area.
    - Additionally, knowledge asymmetry between Spier management and the industry or vendors of renewable energy and energy efficiency solutions is a risk which business managers are factoring in. This asymmetry also resulted in past failed investments in renewable energy generation, and impacts current decisions with regards to asset-building.

Chapter 10: Conclusions and Recommendations

10.1 Introduction

This doctoral thesis interrogates drivers and informants of business decisions aimed towards a lower carbon future, as well as additional aspects of environmental sustainability. The initial research objectives were focused on investigating appropriate corporate responses to ecological threats such as climate change, including the organisational goal of carbon neutral. Through the research process these objectives were re-formulated into purposeful research problems which required not only a thorough investigation of normative discourses from various sustainable development discourses, but also relied upon pragmatic and applied knowledge, in order to be addressed.

The core research objectives of the thesis are stated below:

- To understand the corporate drivers which underlie the search for a lower carbon future;
- To propose a conceptual framework that should encourage and assist businesses in building corporate resilience, in response to environmental and resource uncertainties.
- To situate the goal of carbon reduction, as well as additional aspects of environmental sustainability within a larger corporate resilience framework.

Conclusions towards each of the above research objectives are presented in sections 10.2 to 10.5, which draw upon both literature review and empirical work chapters (see figures 1.3 and 1.4); followed by methodological aspects of the thesis in section 10.6; and recommendations for future research and practice are offered in section 10.7.

10.2 Corporate drivers for a lower carbon future and environmental sustainability

The thesis contributes to ongoing collaborative engagement between the business sector and the research community, by unearthing deep, ecological drivers for corporate environmental sustainability. The core argument developed and tested by the thesis is that **the search for a lower carbon future, and additional aspects of environmental sustainability, is driven by the need to build corporate resilience.**

Firstly, an investigation into corporate drivers for sustainability-oriented behaviour is conducted from a corporate citizenship perspective (Part 2 of Chapter 3). The moral imperative (Crane and Matten, 2004; Birch, 2001; Henderson, 2005; Hamann et al, 2003), sustainability (or enlightened self-interest), license-to-operate and reputation are unpacked and their primary weakness are exposed by Porter and Kramer (2006), in order to build the strategic benefit argument for corporate sustainability.

In the South African context, corporate drivers for sustainability discussed in the literature include legislative reform, international and local market pressures and quite often, community pressures (Section 3.3.5). However the international and SA writings on corporate drivers fail to grasp the complexity of evolving internal and external contexts within which business practice is carried out and investments towards environmental sustainability are made. This context includes risks arising from legislation, local and global markets and societal expectations related to environmental performance. However, it also incorporates real, ecological risks (such as climate change, food insecurity and eco-system pollution) from greenhouse gas emissions, poor agricultural practices and global production and consumption chains.

Secondly, a review of ecological economics and industrial ecology literatures is undertaken (in Chapter 4) to identify the intellectual roots for several terms used in corporate citizenship frameworks such as eco-efficiency, natural capital and life cycle management. However, the concepts and tools studied in Chapter 4 also do not assist in understanding corporate behaviour, especially when principles such as eco-efficiency and life cycle management fail to produce the expected results. EE and IE do not offer any theories to identify organisational or external drivers of sustainability-oriented corporate behaviour.

The attempts at integrating natural and social sciences within IE especially points to the hitherto engineering focus of IE, underpinned by metaphors from biology and ecology, with insufficient attention paid to the behavioural and human components of industrial systems. This gap is in fact addressed by new thinking around social-ecological systems, exhibiting features of complex adaptive systems, which led to the birth and launch of a new discipline called sustainability science.

Finally, constructs from sustainability sciences are studied to build the core argument put forth by the thesis and to develop a corporate resilience framework (in Chapter 6). The complexity framework acknowledges the existence of non-linear interactions between system components, such as the sudden and far-reaching changes experienced by organisations, with the potential to push them from one stable regime into another with completely unpredictable system definition and behaviours, as opposed to gradual changes for which optimisation and efficiency oriented policies are devised (Section 6.3).

The framing of a business as a social-ecological system and at the same time, as part of larger SES, allows for a systems analysis of a business to be undertaken in terms of co-existing and interacting physical/ecological and social/cultural spheres (Section 6.3.2). The noosphere conception of SES aids in the visualisation of a business as made up of flows of matter, energy, water, waste and information.

A resilience-based perspective, drawing on the extension of resilience thinking into adaptive management (Westley, 1995; Gunderson et al, 1995; Walker et al, 2002) and enterprise resilience (Hamel and Valikangas, 2003; Starr et al, 2002) is able to explain corporate behaviour beyond the best practice matrices synthesised through CC, EE and IE literature bodies (figures 3.3 and 4.2).

The case of Spier provides an excellent testing ground for the argument put forth by the thesis. While some investments made in key areas of environmental performance can be explained through legislative or local market pressures, or reputational risk; there are many decisions which cannot be explained through the business ethics, stakeholder theory, corporate accountability, or strategic management discourses adopted within corporate citizenship (conclusions from Chapter 8).

Based on the development (Chapters 3 to 6) and testing of the core argument (Chapters 7 to 9), the thesis concludes that the corporate search for a lower carbon future results from businesses behaving as social-ecological systems, embedded within a panarchy of social-ecological systems at scales above and below the scale of interest.

Risks and uncertainties to which a business responds are generated within this panarchy, and are experienced along key variables. A lower carbon future is sought by businesses as a way of reducing the collective risk of the larger SES to increasing carbon emissions, globally. It is also linked to the manifestation of this ecological risk into an enterprise level risk (legislative or reputational) requiring businesses to declare carbon footprints, cap carbon emissions or seek lower carbon profiles for environmentally-conscious customers or in response to carbon regulations. Lack of investment towards a lower carbon future can be linked to internal or external risks and uncertainties arising from information overload or knowledge asymmetry.

10.3 A theoretical synthesis: the corporate resilience framework and mapping tool

By integrating the different components of resilience thinking for understanding and describing complex system behaviour, with concepts and tools which inform corporate sustainability from the sustainable development discourses of corporate citizenship, ecological economics and industrial ecology, the notion of **corporate resilience** was put forth as a way of embedding new knowledge into the scientific environment (see Section 6.6.2 for the notion of corporate resilience as a bridging concept).

This is not the first time that concepts from resilience thinking are transferred towards understanding and guiding institutional governance or management. The notions of adaptive management (Westley, 1995; Gunderson et al, 1995; Walker et al, 2002) and enterprise resilience (Hamel and Valikangas, 2003; Starr et al, 2002) testify that scholars have made significant progress in integrating components from the resilience discourse to redefine strategic management in the current, global, economic context. The contribution that this thesis makes is by highlighting the hitherto minimal attention paid to the non-market based drivers of action, such as vulnerabilities arising from ecosystem services and infrastructure service discontinuity.

Figure 10.1 captures how each of the resilience concepts relates to one another, with parent knowledge categories and terms that build the vocabulary in each of the literatures.

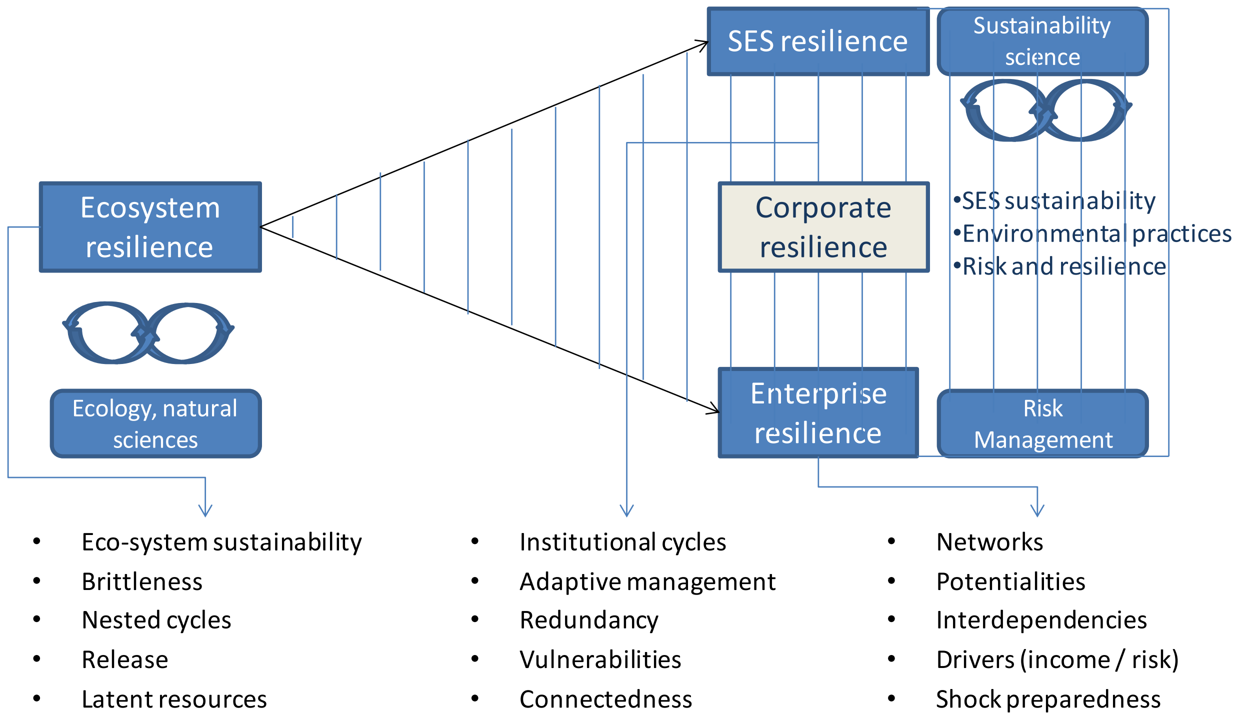

Figure 10.1 Ecosystem, SES and enterprise resilience concepts and Corporate Resilience as a bridging concept

To this end, a mapping tool was proposed which attempts to ground both scholarly recommendations as well as regulatory requirements for businesses by drawing on the core principles of resilience thinking. The framework (table 10.1) is designed with the dual aim of assisting businesses and other organisations to prepare for and respond to interconnected (external and internal) risks, and at the same time, to contribute towards increased resilience in the SES. The framework can also be used to asses the performance of businesses with regards to corporate environmental sustainability, and examine the drivers which inform investments.

Table 10.1 Integrated corporate framework for enterprise resilience and ecological sustainability

Corporate practice areas for ecological sustainability	Asset and potentiality building categories for different adaptive cycle phases				Related Risks (ecological, economic or social)
	Capital investment (natural and technological)	Knowledge networks and partnerships	Supply Chain aspects	Infrastructure networks	
Lower carbon emissions					
Water sustainability					
Wastewater treatment					
Waste recycling					
Environmental custodianship					

The framework is premised on an adaptive management approach which supports the need for businesses to act ahead of cycles of change across different scales in the panarchy (source of potential, external risks) by generating renewal cycles at the scale of sub-systems and thus avoiding the dangers of late conservation and extreme release (internal systemic risk). Based on the adaptive renewal cycle, where rebirth and early consolidation phases are characterised by capital accumulation or investment in growing the potential of products, ideas and species, the framework suggests investing in different types of assets (whether technological, ecosystem-based, infrastructure-based or knowledge networks) in order to build system potentiality and therefore, resilience.

The framework can be populated with various 'stratlets', proposed initiatives and ideas to establish how a particular intervention creates agility in the over-all enterprise and at the same time delivers on the corporate practice areas for ecological sustainability (see section 6.6.3 on the detailed development of the framework).

The proposed framework for corporate resilience is an interdisciplinary tool for addressing the multi-faceted challenge of corporate environmental sustainability, enabled through a resilience-based approach.

The common ideological paradigm for the proposed framework is that of concurrent enterprise and SES resilience-building. In other words, managers may not uphold enterprise resilience over SES resilience or vice versa. Therefore, several seemingly disconnected business strategies and management decisions may present a common inner logic when analysed from a resilience-based governance perspective.

However, the populated framework evolves and changes with the business. Since the framework is an instrument which represents investments made within different corporate practice areas (which build enterprise resilience and SES sustainability) to be linked to risks faced by a business at a certain time, the information contained in it changes depending upon when in the life cycle of the business it is populated (as seen in the next section).

10.4 Application of the corporate resilience framework to the case study

A preliminary analysis of case evidence (Chapter 8) drove the use of complexity theory and resilience thinking for interrogating Spier's sustainability journey, by exposing complex, dynamic and interconnected linkages between system components (informants as barriers or drivers and responses of actors). It became obvious that the business under study constantly evolves, as it responds to drivers, receives feedbacks on its responses and learns through these feedbacks.

The search for an alternate vision which underpins Spier's sustainability journey was undertaken through several frameworks from sustainability science which corroborated each other and revealed a common inner logic of Spier's trajectory (in Chapter 9). The first element of this logic was that Spier's current sustainability practices do not illustrate a trend towards continuous optimisation, but rather display efficiency increasing patterns in some areas of business practice and leaps through radical innovation in others (Section 9.3.1). What is consistent through these two typologies is a quest for sustainability; at a visionary, ecological level but also at a pragmatic, business survival level.

The merging of these two quests is termed corporate resilience, whereby Spier's commitment to sustainability (ecological or social) is not separate from its obligation to its own endurance and longevity.

One of the crucial transferences of abstract knowledge towards understanding Spier's sustainability transition was the successful application of the adaptive renewal cycle. There is evidence of cyclical patterns in the transitions of ecological and economic systems following the work of Wallace (1996); Holling (1973) and Gunderson and Holling (2002), and scholars have proposed the extension of this construct for understanding sustainability transitions within institutions (Walker et al, 2004; Janssen, 2002). While maintaining that all models and constructs are limited in their representation of complex reality (Cilliers, 2001), the application of the adaptive renewal cycle to Spier's case (Section 9.3.3) was a natural progression from the initial delineation of the three phases of revolutionary beginnings, organisational maturity and internalising sustainability (in Chapter 7). Furthermore, various determinants of corporate behaviour and sources of shocks and risks to the Spier system were seen to arise in a panarchy of adaptive renewal cycles at different temporal / spatial scales (figure 9.6).

A resilience-based perspective of Spier's sustainability trajectory along a cycle of change, allowed organisational goal-setting, including carbon-related goals, and sustainability reporting to be viewed as management responses within particular phases of the business cycle, as opposed to drivers of environmental behaviour across all phases. Real drivers of Spier's sustainability trajectory were found to be key variables which can push the SES or components of the SES across critical thresholds, such as external shocks and disturbances from different scales in the panarchy; and visions, leadership qualities and hopes held by agent-actors at the scale of the business (Sections 9.3.4 and 9.3.5).

Each of the phases was found to display dominant management paradigms, response strategies, type of investments and networks which corresponded with particular levels of connectedness, potentiality and experimentation expected in that phase (Section 9.4).

Finally, the environmental performance of Spier in key corporate practice areas of lower carbon emissions, water sustainability, wastewater treatment, solid waste recycling and environmental custodianship were interrogated by plotting different strategies, initiatives and investments onto the corporate resilience mapping tool (Section 9.5, and table 10.2 below). This detailed investigation of each area of performance from an asset-building perspective, in response to real and perceived risks in the SES, allowed business decisions taken at Spier towards achieving environmental performance targets, to be challenged.

In particular, investments made towards lower carbon emissions through energy efficiency and generating own renewable energy, were found to respond to different uncertainties in different phases of the business cycle and of the energy efficiency / renewable energy cycle. These risks or drivers changed from an ecological threat in the form of climate change in the early phase of the renewable energy cycle (resulting in niche experiments), to discontinuity in grid electricity (conservation phase of the business cycle and renewable energy cycle).

Application of the resilience-based mapping tool warns that the long-term resilience of the business and the larger SES is threatened due to lack of investment in this corporate area. The risk generated through knowledge asymmetry between senior managers at Spier and vendors of renewable energy solutions was found to act against the business making large capital investments towards a lower carbon future (section 9.5.2.1). The application of the framework and mapping tool to the case of Spier allowed an insight into deep drivers of corporate decisions in the areas of environmental performance, including lower carbon emissions.

In conclusion, the corporate resilience framework, and the accompanying mapping tool are shown to pinpoint deep, ecological drivers for strategic decisions in corporate practice areas of environmental performance and expose the strategic weakness of some strategies in terms of building long-term corporate resilience.

Table 10.2 An integrated framework for resilience populated with Spier strategies and SES risks

Corporate practice areas	Asset and potentiality building categories			Related Risks
Environmental sustainability components	Capital investment (natural, manmade)	Networks, partnerships	Knowledge accumulation	Network-based and ecological
Lower carbon emissions	Bio fuel and biodiesel projects Trigger matrix system Light-savers LPG forklifts Heat pumps	GCX CRSES SI students SAFWI RE vendors Biodiesel suppliers	Carbon footprint Carbon offsetting Ongoing explorations into solar technologies (CSP, CV)	Technical info asymmetry Reliance on Eskom grid Climate change
Water sustainability	Water saving showerheads and flushes Water meters	Suppliers of devices Water suppliers	Exploring rain harvesting Water footprint	Municipal supply Industrial supply Water scarcity
Wastewater treatment	Biolytix plant Bioreactor, irrigation system Reed-bed/yin-yang pool	Dowmas (Pty) Lt HWT Engineering DWAF officials	Exploration of alternatives Sustainability reporting	Municipal sewage system New technologies
Solid waste recycling	New shed Compactor Filter pump Compost site	Nov Waste Waste Plan Suppliers of recycled products	SI training Visits to land-fill sites PET bottles	Landfill capacity SAPPI and Nampak networks
Environmental custodianship	25% Land conservation Protea Walk Alien tree clearing river cleansing Vermi-composting	Farmer Angus: biodynamic farming Eric Swarts: Land Reform Project	Research into indigenous trees Organic farming	Biodiversity loss Ecosystem services Loss of natural beauty on estate

10.5 Investigation of Carbonology and incorporation into the resilience-based corporate framework

This thesis interrogates a range of definitions, standards and corporate strategies surrounding the concepts of carbon footprint and carbon neutral to establish ‘Carbonology’ (Chapter 5). An examination of industry-related practices in the area of carbon management is grounded in the scientific roots of ecological footprint and industrial ecology, undertaken in Chapter 4 (specifically, sections 4.2.5: ecological footprint; 4.2.6: EF methodologies; 4.3.3.1: mapping global nutrient cycles; 4.3.5.1: LCA as a system tool; and 4.4.2: Intellectual roots for CF).

Despite the articulation of scientific underpinnings, a thorough understanding of carbon-reduction practices required linkage of scientific knowledge with case-specific knowledge. This was gained through information gathering on the Backsberg Wine Cellars' carbon neutral strategy and implementation; and on Spier's renewable energy and energy efficiency exploration efforts (Box 5.1 and 5.2). The resulting body of knowledge (Chapter 5) is a synthesis of abstract, scientific concepts (such as life cycle analysis) as they are incorporated by industry practices for developing carbon assessment tools; with case-specific knowledge of how these tools are interpreted by actual businesses in developing their strategies.

Only through the merging of scientific roots, social praxis and context-specific knowledge it was possible to highlight the limited role of carbon-related goals and multiple informants of corporate carbon management (Section 5.5). Thereafter, the legitimacy of the carbon footprint as a composite measure of climate change was challenged; by highlighting methodological ambiguities related to carbon auditing techniques and observed biases in the choice of carbon reduction strategies (Section 5.6).

However, irrespective of the disputed position of carbon footprint and carbon neutrality as credible indicators for measuring corporate commitment to environmental sustainability, a lower carbon future beyond footprint management, was seen to hold the potential for unlocking innovation and learning (section 5.7).

It was therefore concluded at the end of Chapter 5, that an optimisation-based approach to Carbonology with an emphasis on carbon footprint as a measure of climate change and on carbon neutrality as a driver for sustainability-oriented innovations, driven by market and industry pressure, obfuscates an informed and learning-based pursuit of environmental sustainability in a private enterprise.

The thesis also examines corporate carbon reduction through the different lenses of corporate citizenship, systems ecology and resilience thinking. The core argument of the thesis is that strategies aimed at carbon reduction are linked to the search for corporate resilience. The case study approach provided a unique opportunity for linking theory with practice, and extending the application of Carbonology from a resilience-based perspective.

Management strategies aimed at carbon reduction were reviewed in Chapter 5: Carbonology. It was concluded that ambiguities exist in relation to carbon assessment techniques, in particular because of choice of boundary and scope definitions, and scientific uncertainties with regards to global warming potentials of included gases. The treatment of boundaries from a complexity-based perspective is very different to an accounting-based procedural approach, used by carbon assessment tools. When viewed from a complexity perspective, boundaries become components of a complex system and their interactions with other system components are critical to system analysis (Cilliers, 2001).

This thesis offers a role for carbon-related goals in the practice areas of environmental sustainability from the perspective of building corporate resilience through a lower carbon future. Thus lower carbon emissions are re-incorporated into the integrated framework for building ecological sustainability through strategic investments towards building assets across the three categories of capital (man-made and natural), networks and knowledge (table 10.1). From an SES sustainability perspective, lower carbon emissions engender a climate change mitigation benefit, encourage environmental performance measurement and reporting, and may also result in reduced energy consumption through efficiency measures or renewable energy options (Section 6.6.4).

The format of the framework allows for both ecological and non-ecological drivers of investments to be identified and highlighted. This means that whether carbon reduction strategies are set into motion in response to environmental, social or economic reasons, they can be reflected as such on the framework and are regarded as being underpinned by a search for corporate resilience.

The application of the integrated corporate resilience framework to the case of Spier, allows a full picture to emerge incorporating different types of assets (capital, knowledge and network-based) which have been built towards a lower carbon future by Spier over the years; the different risks (ecological, knowledge and infrastructure network related) to which strategies have responded in different phases of the business cycle and renewable energy cycle; as well as the possible conflicting informants which deter the current lack of sizeable capital investment in this performance area (knowledge-related risks) (Section 9.5.2.1).

In conclusion, the successful plotting of Spier’s strategies towards energy efficiency and renewable energy generation, emissions measurement and reporting, and development of carbon-knowledge networks, in relation to different risks, clearly demonstrates the incorporation of a lower carbon future as a key variable within the integrated corporate resilience framework.

10.6 Methodological aspects

There are two noteworthy aspects of the methodology adopted for this thesis, which are mentioned in the conclusions: a modified transdisciplinary approach and unique access to the case study. These have also been highlighted under the original contributions of the thesis (Section 1.8).

10.6.1 A modified transdisciplinary approach

Transdisciplinary research and knowledge production combines learning, research and application to learn competencies and skills necessary for understanding and facilitating sustainability transitions (Van Breda, 2008). An ideal-typical model of a transdisciplinary research process promotes ‘joint’ or collaborative visioning, problem framing, analysis, integration, whereby each of the three phases of the research process require the coming together and collaboration among the scientific community and societal stakeholders (Bergmann et al., 2005; Jahn, 2008; Scholz et al, 2006, Scholz, 2011).

However, Pohl and Hirsch Hadorn (2007) clarify that the participatory nature of the research process and integrative collaboration among researchers towards solving a life-world problem is not sufficient to make research transdisciplinary. ‘Research is only truly transdisciplinary if it develops knowledge and practices that promote what is perceived to be the common good, if it takes into account the complexity of a problem and the diversity of perceptions of a problem, and if it links abstract and concrete case-specific knowledge’ (Pohl and Hirsch Hadorn, 2007). This thesis follows a transdisciplinary or Mode 2 research approach (Gibbons, 1999) whereby actors from science and business leave their primary processes (research and decision-making processes in this case) and join in a collaborative effort, to solve a complex, socially-relevant problem (Scholz, 2011).

The research process of this thesis grasped the complexity of the research problem, took into account the diversity of perceptions of the problem and made new links between abstract, scientific and concrete, case-specific knowledge streams to yield transformative knowledge for broader application, than the case study.

The problem posed by the management of Spier Holdings: how a business can become carbon neutral, provided the starting point for the case study and guided the structure and process of the empirical work. However, as the meaning and significance of this question was explored with managers and staff members at Spier, it became clear that the business was in fact posing much more profound and deeper questions about building resilience, both in the business as well as the ecological system on which it relies for ecosystem services. The research problem was reframed and redefined to capture the progression from Carbonology to resilience, as a corporate driver of seeking a lower carbon future.

The need for transdisciplinarity arises when our knowledge about problems under investigation is uncertain, when the concrete nature of these problems is disputed, and when there is a great deal at stake for those involved in these problems (Pohl and Hirsch Hadorn, 2007). When this thesis was commenced, there was high uncertainty with regards to the scientific basis for calculating and communicating carbon footprints (beyond an accounting exercise) and the goal of carbon neutrality. Therefore, one of the early products of the research was a study of definitions, standards and corporate strategies surrounding the concepts of carbon footprint and carbon neutral, also termed Carbonology. As a result of integrating the systems knowledge of Carbonology with information about Spier’s sustainability journey, corporate drivers of a lower carbon future became unclear. Therefore, the next research objective addressed by this research was to gain an understanding of deep, ecological drivers of the search for environmental sustainability, and a lower carbon future.

Principles of transdisciplinary research methodology (Pohl and Hirsch Hadorn, 2007) were maintained by reducing complexity through early identification of involved stakeholders (tables 2.1, 2.3, 2.4 and 2.5); achieving integration through open encounters during data collection; contextualising case-knowledge with systems knowledge and vice versa; and adopting a recursive, iterative research process through-out. These principles allowed problem reformulation to continue long into the data collection phase, so that research objectives were continuously honed through the testing of case evidence against abstract knowledge.

In the problem analysis phase of the research, empirical data was deciphered by following an iterative process whereby aspects of case-specific knowledge was analysed using a series of theoretical constructs. Adaptive learning was adopted during the analysis phase by engaging with complexity and components of resilience thinking, once the discourses of corporate citizenship and tools from systems ecology proved inadequate for understanding corporate drivers.

The researcher performed the role of facilitator or knowledge-builder by integrating different categories of systems, target and transformation knowledge through the course of the research. This knowledge was regularly embedded in the domains of society and the scientific environment, as required of a transdisciplinary approach (Pohl and Hirsch Hadorn, 2007).

Research knowledge (including Carbonology and the ‘Sustainability Story of Spier’) was produced through integration of empirical work with theory, and shared with Spier management. As the research questions were revised to arrive at the core research objectives of the thesis, the assumptions held by actors within the case system were challenged. A deep interrogation of the Spier system and the drivers and informants of its sustainability journey took the research into a direction, which at that time was of little interest to the management. On a positive note, the industry-generated goal of carbon neutral was abandoned by Spier management, to be replaced with the more technologically achievable vision of a lower carbon future.

Research knowledge was also embedded in the scientific community through conferences and symposia and contributions to journal articles, while staying open to additional frameworks to be investigated and applied. The primary methodological and conceptual challenge for transdisciplinary research is to transcend disciplinary boundaries in the stages of both problem structuring and knowledge integration (Rosenblum, 1997). Development of scientific insight takes place through the verification of methods, findings and results through different methods such as communicating with relevant knowledge networks, presenting at conferences and publication of journal articles (Pohl and Hirsch Hadorn, 2007). Thus the interaction with members of the international research communities in life cycle management, industrial ecology, renewable and sustainable energy studies, building design and sustainability transitions at various fori was crucial for adaptation of results.

The knowledge production phase or implementation phase represents the culmination of efforts through-out the research process to assimilate heterogeneous research interests and management philosophies among the research group (Loibl, 2005 in Pohl and Hirsch Hadorn, 2007). Moreover, transdisciplinary research requires that solutions for socially relevant problems be related back to practical frameworks for adoption by research and management communities (Scholz, 2011). Therefore, a research opportunity in the application of sustainability science tools such as resilience and risk frameworks to the analysis of corporate sustainability was explored to produce an in-depth review of resilience thinking and its components.

This review provided the basis for a detailed systems analysis of Spier and in essence constitutes transformation knowledge, allowing the business to view itself as part of a local, regional and global social-ecological system, facing risks and vulnerabilities arising at different scales in the panarchy. As the literature review progressed from SES and complexity; past the principles of resilience thinking; to recent writings in enterprise resilience and risk management, intellectual space was created for concepts from corporate citizenship and systems ecology to re-enter the theoretical framework.

Therefore, the resilience-based framework for corporate sustainability incorporates elements from the tools and concepts of industrial ecology, ecological economics and corporate social responsibility; in addition to the fundamentals from risk perception and adaptive learning. The framework was refined further after Spier’s case evidence was reviewed from systems, complexity and resilience perspectives and strategies in different areas of environmental sustainability were transferred to the mapping tool.

Thus the corporate resilience framework, and the mapping tool, is an amalgamation of case-specific and abstract knowledge streams, with the view to transforming current business practices shaped by disconnected responses to market pressures, financial risks and ecological discontinuities towards an integrated approach for building corporate resilience. And it is hoped that the analytical framework and transformation frameworks can be utilised by researchers, managers and other practitioners, thereby enhancing its usefulness and breadth of application.

In conclusion, it is argued that this thesis successfully utilised a modified transdisciplinary research methodology in a global South context, where multi-disciplinary research teams are not always available to collaborate on the three phases of the research process.

A modified transdisciplinary approach for addressing a sustainability problem relied on the researcher's ability to grasp the complexity of a problem through contextualisation; embed research knowledge in society and the scientific community through seminars, conferences and papers; incorporate diverse perceptions of a problem by engaging openly with decision-makers, researchers from international research networks and experts representing multiple disciplines; and produce transformative knowledge and practices that promote the common good, by integrating abstract and context-specific knowledge.

10.6.2 Unique access to case study

The researcher was allowed rare access to the business operations and management philosophies pertaining to sustainability at Spier Holdings. The in-depth analysis was made possible through open access to individuals, processes and practices within and connected to the business.

In the process of tracking Spier's sustainability trajectory which extended much further than the duration of the thesis, the researcher became part of their story. As a student, interacting with agent-actors who were part of Spier's extended knowledge network, the researcher became a node on that network. The interactions with Spier staff members and intermediaries and making sense of their collective stories by using multiple disciplinary constructs was an immense learning experience. Flyvberg (2011) corroborates this development by arguing that cases are important for a researcher's learning processes.

In the absence of predictive theory in social science, the case study methodology is argued as the most suitable for producing context-dependent knowledge (Flyvberg, 2011). Strong links between case study and theory development have also been demonstrated recently as in the work of George and Bennet (2005). For example, by employing process-tracking that links drivers and outcomes; exploring hypothesised underlying means in detail; verifying historical explanations of behaviour and forming new hypotheses and new questions while studying the case (George and Bennet, 2005), fundamental questions specific to Spier's sustainability journey could be addressed. The answers, in the form of the core argument and the integrated corporate resilience framework, are applicable to a larger community of businesses who are keen to reconfigure their relationship with natural resources.

Furthermore, the assumption that decisions at Spier are continually informed by an ongoing commitment to sustainability activated more agents and causal feedbacks than would have been possible in the case of a business not using sustainability as a distinctive brand. The expression of well-defined organisational goals aimed at environmental sustainability shaped the research questions and ultimately allowed for alternative theories to be tested through historical case evidence.

It is concluded that scientific learning was strengthened through close investigation and in-depth analysis of a case that explicitly pursues a vision of sustainability through the articulation of sustainability-oriented performance goals, such as Spier Holdings.

10.7 Recommendations for future practice and research

The following sections suggest opportunities for advancing the utilisation of the corporate resilience framework and methodological aspects for future research; and for enhanced business practices towards a lower carbon future, and environmental sustainability.

10.7.1 Research opportunities

Of the many research opportunities for scholars based on the work presented in this thesis, the first direct opportunity is to extend the corporate resilience framework developed in Chapter 6 and modified in Chapter 9 by applying it to other cases and finding gaps and limitations.

A second opportunity is to continue on the trend of conducting thorough case studies of businesses to develop parallel research in the area of sustainability transitions from alternative perspectives which have not been addressed by this thesis. This would rely greatly upon scholarly access to business practices.

A third opportunity is to build upon the tools used in this research as working alternatives in a resource-constrained, developing country context. These tools would replace or find creative methods for utilising the collaborative research tools recommended in an ideal-typical transdisciplinary research methodology.

And a last opportunity is to generate other examples of integrated knowledge within which practice and theory come together, especially in the field of ecological design and environmental innovations practice (such as in the areas of renewable energy, wastewater treatment, solid waste recycling and food production). Most ecological solutions are underpinned by underlying scientific explanations which may yield interesting results when transferred to actual practices and implementation of such solutions.

10.7.2 Principles for building Corporate Resilience

The following principles for building business resilience are appropriate when devising strategies to populate the framework (based on the vision of Walker and Salt (2006) of a resilient world):

- Promote and sustain diversity in all forms (landscape, culture, values, ideologies and knowledge).
- Accept and promote ecological variability (rather than trying to control and optimise it for efficiency gains).
- Build and sustain modular components since over-connected systems are susceptible to shocks which are rapidly transmitted through the organisation.

- Focus on the few slow, controlling variables associated with key thresholds; so as to increase the size (or space) of the desirable regime and absorb more disturbances, without shifting into an undesirable regime.
- Possess and generate tight feedbacks, allowing thresholds to be detected before they are crossed (as opposed to feedbacks along current globalised production and consumption chains which generate interdependent risks but possess weak feedback signals)
- Promote trusted and strong knowledge networks and leadership to respond collectively and effectively to unforeseen change and risks
- Emphasise learning, experimentation, locally developed rules and embrace change
- Create governance institutions that include redundancy in their structures, so as to possess overlapping ways of responding to change

10.7.3 Recommendations towards building corporate resilience

Finally, it is argued that the corporate resilience framework, which has emerged out the Spier case, may be relevant to similar businesses with a broad scope of sustainability activities and engagements, in particular initiatives aimed a lower carbon future. It is important to note that the mapping tool is one aspect of this framework, and that previously applied elements resilience-thinking build up to the application of this tool.

Based on the above conclusions and with the aim of offering a resilience-based approach towards environmental sustainability to businesses, the following recommendations are made, as a way of generating transformative knowledge:

1. Businesses need to approach the meeting of organisational goals with the understanding that maximising expected utility or minimising losses is different to increasing the adaptive capacity of a resilient system.
2. Goal-setting needs to be viewed as an environmental performance area, with the understanding that macro and business unit goals can change and evolve.
3. Managers at all levels must recognise that a business is an SES and part of larger SESs, simultaneously.
4. Based on the knowledge that a business represents the interaction between social and ecological system components, managers can undertake a detailed scenario-building exercise and include all relevant stakeholders. Such an exercise will augment networking and build general resilience in the system.
5. Management must also acknowledge the particular phase of renewal cycle the business is currently in, to appreciate its own response strategies to external stimuli, and dominant collaboration modes during a particular phase.
6. Once the business cycle phase and external sources of risk are identified, business management can begin populating the proposed corporate resilience framework. This

means supporting appropriate strategies which emerge in a particular phase, through pre-assigned capital (manmade and/or natural capital) and labour commitments in order to ensure the business' strategic resilience.

7. Finally, carbon reduction strategies need to be re-incorporated from a risk and resilience-based perspective as a business response to the ecological uncertainties arising from global climate change. This means viewing a quest for lower carbon future towards building long-term SES and enterprise resilience, beyond short-term responses to discontinuities in national grid-electricity supply.

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Addendum A: Interview Protocol

A.1 Record of semi-structured interviews in early problem definition phase – November 2008

Involved person / Designation / Time of interview	Aspects of the sustainability story investigated
Eve Annecke and Mark Swilling Ex-members of the Spier Strategic Planning team (1999-2002) 13 November 2008 (10h00-12h00)	• Period of Spier's history from 1999-2002 • Dick Enthoven's leadership and sustainability-oriented experiments • Orientation of the research process and problem field • Information on other relevant intermediaries to be interviewed
Tanner Methvin Ex-Director for Sustainable Development (2002-2004) 13 November 2008 (12h00-13h00)	• Intimate knowledge of Spier's operations from 2002-2004 • Adrian Enthoven's leadership and consolidation of sustainability efforts • Commencement of sustainability reporting • Renewable energy projects exploration and implementation
Gareth Haysom Ex- Director of Spier Resort Management 13 November 2008 (14h00-16h00)	• Intimate knowledge of Spier Leisure's operations from 1999-2003 • Sustainability reporting at Spier (2004-2006)

A.2 Record of interviews, meetings, site visits and emails during the data collection phase (February – November 2010)

Date	Subject	Interview/ site visit/email Location	Informant / expert	Aspects of sustainability journey / research process covered (recursive problem-framing)
8 February 2010	Problem-framing	Meeting SI	Heidi Newton-King, COO	Discussed future meeting with senior managers to share technical knowledge and raise issues of academic concerns with respect to CN goal
9 February 2010	Report back on meeting with Heidi	Email to	Mark Swilling and Eve Annecke, cc Prof Alan Brent	Update on empirical work
16 February 2010	PhD and case study update	Meeting SI	Mark Swilling	Discussed possible direction for the research to take, given literature review covered and lvl of engagement with case
16 February 2010	Environmental reporting assignments	First meeting Admin block, Spier estate	Christie Kruger, Group Accountant	Gained information on: • Consolidation of Group Environmental reporting • Spier's carbon footprint for 2009 • LCA of a bottle of wine
24 February 2010	Report back on first meeting with Christie	Email to	Mark Swilling and Eve Annecke, cc Heidi Newton King and Alan Brent	Update on empirical work
23 February 2010	Interviews with book-keepers and accountants	Second meeting	Christie Kruger, Group Accountant	Set up interviews with book-keepers Christie's guidance for GHG reporting data verification (record of interviews attached as A.3)
24 February 2010	International standards	Email to	Sumetee Pahwa, Mark	Sharing of technical standards on LCA

	on LCA	(From Alan Brent)	Swilling and Eve Annecke, cc Heidi Newton-King, Christie Kruger	
28 February 2010	Report back on second meeting with Christie	Email to	Mark Swilling, cc Eve Annecke and Alan Brent	Update on empirical work
2 March 2010	Notes: cellar operations	Cellar walk Wine Cellar, Anandale Road, Spier estate	Marina De Wit	Guided tour with information on: • Wine production process: heating, cooling requirements • Wine production capacity • Sourcing of grapes • Environmental issues: chemicals • Examples of industrial symbiosis
11 March 2010	Notes: lay-out of the estate, location of buildings, structures	Drive through Spier estate and meeting	Orlando Filanders, Farm Manager	Guided tour with discussion on: • Water sources on the estate • Understanding of sustainability as it is implemented at Spier • Septic Tank, sewage treatment plant • Spier reserve / conservation area • Composting site • Complexity at Spier
16 March 2010	Environmental reporting and supply chains (with repercussions for sustainability branding)	Third meeting Admin block, Spier estate	Christie Kruger, Group Accountant	Clarity sought on following issues: • Ownership of business units • Labelling arrangements between Spier and Distel • Bulk wine production (external sourcing of grapes)

				• Unit-level goals for CN • Treatment of tenants • Design of wastewater treatment plant, incorporation in CF or EF
16 March 2010	Re MFA and LCA and analysis of Spier flows	Meeting SI	Alan Brent	Expert opinion sought on the two methods of conducting an environmental impact assessment on Spier's products
30 March 2010	Notes of update to and feedback from senior managers	Meeting and presentation Admin block Spier estate	Executive Committee, Spier CEO, CFO, COO, Director for IT, Procurement Manager and Cellar Master	Update given to ExCo on empirical work and literature review Senior management's concerns wrt drivers for and environmental performance, sustainability reporting, tracking progress
29 April 2010	Water and energy projects	Interview Cherie's office, Spier estate	Cherie Immelman, Facilities Manager, Spier	Operational mgmnt of following areas: • Water consumption on main estate • Electricity consumption and RE options
29 April 2010	More detail on water consumption and recycling on estate	Interview Admin block, Spier estate	Orlando Filander, Farm Manager, Spier	Status of operations: • Municipal water meters • Water usage and rights • Usage of natural water on site • Implementation of organic farming
11 May 2010	Questions and notes re sustainability reporting, pro-poor initiative	Interview SI	Gareth Haysom	Expert opinion and past relationship with Spier to share views on: • Sustainability reporting at Spier • Sustainability indicators • Backsberg and the CN goal
11 May 2010	Backsberg: Carbon	Interview	Jess Schulschenk, Ex-	Aspects of the journey covered:

	Neutral journey	SI	environmental manager at Backsberg Estate Cellars	• Jess' relationship with Spier • Carbon footprint calculation and off-setting mechanisms • Engagements with consultants, university departments • Drivers for CN and challenges
14 June 2010	Environmental reporting and carbon reduction	Interview Admin block, Spier estate	Gerhard de Cock, CFO, Spier	The following issues were raised to the senior manager responsible for environmental reporting: • Likelihood of achieving CN • Reasons for bringing CF exercise in-house • Logic for not including tenants in CF and environmental reporting • Carbon reduction possibilities
14 June 2010	Sustainability strategy, Renewable energy projects, CN focus	Interview, De Rus, Spier estate	Andrew Milne, CEO, Spier	The following matters were discussed: • The role of suppliers in carbon reduction • Details of Bio-diesel project • How and why of carbon reduction • Status of SR 2010 • Organic farming
14 June 2010	Sustainability Reports, Sustainability strategy	Interview De Rus, Spier estate	Annebelle Schreuders Marketing Director, Spier	The following matters were discussed: • Responsibility for Spier SR • Trialogue process and contact • The goal of CN – unlikely unless business model is changed

21 June 2010	Electricity requirements at Cellar	Tour of Cellar, Spier estate with Matti Lubkol	Frans Smit (Cellar Master)	• Energy requirements at cellar • Innovations wrt reducing energy consumption
13 July 2010	Environmental projects	Tour of compost site and packing shed	Orlando Filander, Farm Manager	The farm manager described environmental challenges at the packing shed and the composting site
20 July 2010	Waste recycling	Meeting Waste depot, Spier estate	Cherie Immelman, Facilities Manager	The facilities manager described the following issues: • Separation of organic waste • Maintenance of waste depot • Health and safety concerns • Performance measurement
23 July 2010	Sustainability reporting	Interview Trialogue offices, Kenilworth	Trialogue: Rob Worthington, MD and Denise Bester, Project manager	The following matters were discussed: • Spier's sustainability efforts • Possible drivers for sustainability orientations • Writing of Spier's 2009 and 2010 sustainability reports
28 July 2010	Sustainability reporting	Follow on interview Trialogue offices, Kenilworth	Trialogue: Denise Bester	Detailed information was asked for wrt: • Progress with writing sustainability reports • Process of engagement with Spier management
27 July 2010	Status of environmental reporting and LCA	Closing interview De Rus, Spier estate	Christie Kruger, Group Accountant	Status on following processes was discussed: • Group environmental reporting, quality of information • Status of LCA of a bottle of wine

				• Method for reporting on water footprint • Engagement with Trialogue • GRI indicators
27 July 2010	Greening project	Interview Engineering library, main campus	Riaan Meyer, CRSES	Technical information regarding the following matters was sought: • Feasibility study: bio-mass project • Evaluation of bids for the greening project • How a business can become CN
28 July 2010	Detail on wastewater treatment plant	Second interview Aspen hotel Constantia, Cape Town	Tanner Methvin – first follow up since November 2008.	The following projects and initiatives were discussed: • South Bank development project • Details on wastewater treatment plant • Bio-diesel project • Reporting at Spier • Drivers of sustainability
2 November 2010	Spier's sustainability journey	Last meeting Admin Block, Spier estate	Heidi Newton-King and Andrew Milne (COO and CEO)	Sought verification of information in the Sustainability Story of Spier Discussed value of Trialogue conducting SR for 2010

A.3 Interview Record: GHG reporting and data collection at Spier

Interviewee / Designation	Business Unit/ Entity	Key sources of information	Continuity in reporting-handover	Time spent/ preferred reporting frequency	Current SR knowledge / interest in more
Zizi Oliphant Assistant Accountant	Spier Wines	• Management drive (general ledgers transaction listings): travel, … • Accounting system: expenses, turnover, quantity of bulk wine purchased (Abigail) etc • Production deptt: liters of wine crushed to calculate electricity and water used per liter	Previously reported by production department; shift to reporting by financial director; no handover; briefing by group accountant	20% of working time/ Quarterly reporting works for now, monthly may be too often	Basic concept, interested in more. Would like to see proper descriptions for what is included in fuel consumption for different scopes
Monica Bailey Bookkeeper	Spier home farms, Spier vineyards	• Diesel: 9K liter tank, the farm workshop keeps a log book (consumed by vineyards and other entities) • Municipal water: meter readings at certain points all along the pipes, info sent to Dawie who invoices other entities on estate, Monica reports on water consumed by the farms • Agricultural/industrial water: supplied by Helderberg Irrigation Scheme sourced from Theewaterskloof dam (Wynland Waterusers Association). Frances invoices different entities, Monica reports on usage by farms [Note: Spier estate draws at 7 points with designated areas and allocated liters of water] • Gases: some cylinders at farm workshop for welding	Financial and non-financial data was collected by Monica since she joined in 1997 for Spier home farms (cellar and farms; cellar included orchards, grapes, fruit, veg); 2000: spilt into Spier vineyards and spier wines (cellar) with Monica focusing on vineyards	Sustainability reporting is part of regular reporting; no significant additional time spent / Quarterly reporting works for now, monthly on the same day every month will require juggling because of other duties	Basic concept, can do with a refresher on scope definitions
Crystal Creditor	Spier Resort Management (S.R. focus on fuel consumption)	• Main source: General ledgers transactions listing • Focus on fuel consumption: gas for heating rooms; gas for cooking in kitchens; petrol and diesel usage by company own vehicles for hotel,	Gareth Haysom was handling in 2008; no handover	Half a day per quarter / Own preference not relevant since will furnish info as and when required	Has basic concept, does not need more info or a guide

		conference centre, restaurants; and air travel • Actual invoices to obtain info such as weight or volume of substance purchased			
Frances Bookkeeper	Spier Properties (S.R. focus on energy, waste, water	Reporting is on an outlet / tenant basis • Electricity: facilities staff read the various meters installed, fill in a spreadsheet, this data is used for sustainability reporting and invoicing each tenant • Municipal water: similar procedure, original data from facilities staff, used for invoicing each tenant • Industrial water: not allocated to entities yet, lump sum billing • Waste: info from contractor – Wasteplan: organic, paper, plastic (3 categories for plastics) Spier aggregates to 1 category • Refrigerant and air-con gases: print out of consumption reports from purchasing department	Gareth Haysom was handling in 2008; no handover	One day per month/ Quarterly reporting seems sufficient, although can report monthly	Has basic concept, would appreciate more time to critically analyse the data, would definitely appreciate a better understanding of current sustainability reporting task
Orlando Farm manager	Spier home farms	Chemicals: stock room with all chemicals in, reports directly to Christie on environmental impact			

Addendum B: A detailed map[28] of the Spier estate

[28] Interactive version available on the Spier website: http://www.spier.co.za/index.php

Addendum C: Spier's location among the wine growing areas of South Africa