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Water Asset Utilization for Renewable Energy Generation in the Northern Periphery Region

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ABSTRACT
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Abstract

Water and energy resources are crucial topics on the current European political agenda. At the same time, there is no coherence between the two sectors in terms of legislation: both on EU and national levels, such as Finland. This thesis aims to underline a potential for utilization of renewable energy sources in the Finnish water industry.

In the theoretical part, overview of water services in the Northern Periphery Region (Finland, Norway, Scotland, Northern Ireland and Ireland) is provided. In addition, financial mechanisms for renewable energy support as well as Public-Private Partnerships, as a tool for better implementation of renewable energy solutions in the water industry, are discussed. Renewable energy technologies tend to be utilized according to the countries' geographical conditions and energy polices. Among the common renewable energy solutions are wind, solar, hydropower and bioenergy. As a tendency, the Northern Periphery Region is gradually implementing renewable energy generation in the water industry to a greater degree. At present, water assets are the most utilized in terms of renewable energy generation in Ireland and Scotland. Northern Ireland and Norway can be put second place in this sense. In Finland, heat recovery and anaerobic digestion are employed. But there is still unused potential in the implementation of hydropower, solar and wind energy in the water industry. To utilize it, some improvements in the communication between Finnish water and energy companies should be done. With regards to the economic mechanisms of support, currently, there are six support schemes applied, which are described for each country. These are: subsidies, feed-in tariffs, quota programmes, tax relief schemes, loans and crowdfunding. As to Public-Private Partnerships, they are developing differently in the countries. Scotland, Northern Ireland and Ireland are the most experienced with this tool. Both in Norway and Finland, this model of collaboration is rather new and needs more time to get adopted.

In the experimental part, best practices of renewable energy generation in the water sector are described. In this context, the best practices are examples of *in situ* utilization of unused or hidden opportunities for renewable energy generation. In addition, the Finnish water legislation is analysed in terms of existing legislative and organizational obstacles which hinder communication between the water and energy sectors and, consequently, the implementation of renewable energy sources in the Finnish water industry. Many of the issues stem from EU legislation; both EU and national policies are more focused on environmental issues such as water quality, scarcity, pollution and protection rather than on the water-energy nexus. As an outcome of this thesis, policy recommendations to promote the implementation of renewable energy sources in the Finnish water industry and utilize unused potential of water assets are given. There are three levels of the recommendations considered: European, regional and national.

On a European level, it is recommended to use comprehensive environmental approach, create roadmaps, support research and development; bring awareness, introduce ecolabelling and certification schemes to create visibility; describe economic benefits of renewable energy implementation in the water industry; and enhance the work of the public sector for better integration of the water-energy policies. On a regional level, support regional and transboundary cooperation is suggested. Finally, on a national level, it is proposed to develop a long-term strategy, increase national renewable energy targets; carry out economic analysis, develop new financial support mechanisms, improve pricing schemes; improve communication between public companies and municipalities; regulate intersectoral ownership and bill payment issues; and develop regional, locally oriented solutions within the water-energy nexus.

All these policy recommendations should be consolidated in the legislation and have enough political support. Only if these conditions are met is possible to expect some favorable results with practical implementation in Finland.

This work was done as part of the Water Asset Renewable Energy Solutions (WARES) project financed by the Northern Periphery Programme (NPP) during 2012-2014. NPP is a European Regional Development Funding instrument and it involves remote communities of Northern Europe and aims to facilitate its sustainable development with related social, economic and environmental benefits.

Additional Information

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Tiivistelmä

Euroopan poliittisessa agendassa vesi- ja energiaresurssit ovat ratkaisevan tärkeitä aiheita tänä päivänä. Samaan aikaan nämä kaksi sektoria eivät ole lainsäädännöllisesti yhtenäisiä Euroopan Unionin tasolla, eivätkä myöskään kansallisesti, varsinkaan Suomessa. Tässä diplomityössä pyritään tähdentämään uusiutuvien energialähteiden hyödyntämispotentiaalia suomalaisen vesitoimialan piirissä.

Teoriaosiossa luodaan yleiskatsaus Pohjoisen Periferian alueen (Suomi, Norja, Skotlanti, Pohjois-Irlanti ja Irlanti) vesihuoltoon. Tässä yhteydessä esitellyt parhaat käytännöt ovat esimerkkejä paikan päällä hyödynnettävistä käyttämättömistä tai piilevistä mahdollisuuksista uusiutuvan energian tuotantoon. Lisäksi käsitellään uusiutuvan energian taloustukimekanismeja ja julkis-yksityis-kumppanuuksia työkaluna uusiutuvien energiaratkaisujen paremmassa käyttöönotossa vesitoimialalla. Uusiutuvia energiateknologioita tyypillisesti hyödynnetään eri valtioiden maantieteellisten mahdollisuuksien ja energiapolitiikan mukaisesti. Yleisiin uusiutuvan energian ratkaisuihin kuuluvat tuuli-, aurinko- ja vesivoima, sekä bioenergia. Pohjoisen Periferian alueen vesitoimialalla on suuntauksena asteittain lisätä uusiutuvan energian tuotantoa. Tällä hetkellä uusiutuvan energian potentiaalia hyödynnetään eniten Irlannissa. Skotlanti, Pohjois-Irlanti ja Norja sijoittuvat tässä mielessä toiseksi. Suomella on useita haasteita uusiutuvaa energiaa hyödyntävien teknologioiden käyttöönotossa vesitoimialalla ja se on tällä hetkellä jäänyt kauaksi muista. Tarkastelualueen maissa on tällä hetkellä käytössä kuusi erilaista taloustukimekanismia jotka tässä työssä esitetään jokaiselle maalle. Ne ovat tuet, syöttötariffit, kiintiöohjelmat, verovähennys, lainat ja joukkorahoitus. Julkis-yksityis-kumppanuudet kehittyvät tarkastelluissa maissa eri tavoin. Kokeneimpia näiden kumppanuuksien hyödyntämisessä ovat Skotlanti, Pohjois-Irlanti ja Irlanti. Norjassa ja Suomessa tämä yhteistyömalli on uusi ja vaatii aikaa kehittyäkseen.

Kokeellisessa osassa Suomen vesilainsäädäntöä analysoidaan olemassa olevan lainsäädännön ja organisatoristen esteiden kautta, jotka vaikeuttavat tiedonvälitystä vesi- ja energiasektoreiden välillä ja siten edelleen uusiutuvien energialähteiden hyödyntämistä Suomen vesitoimialalla. Sekä Euroopan Unionin, että eri maiden politiikka keskittyy enemmän ympäristöasioihin, kuten veden laatuun, niukkuuteen, saastumiseen ja suojeluun, kuin vesi-energia-yhteyteen. Tämän diplomityön lopputuloksena annetaan poliittisia suosituksia uusiutuvien energialähteiden käytön edistämiseen Suomen vesitoimialalla ja käyttämättömien uusiutuvan energian potentiaalin hyödyntämiseen. Suosituksia annetaan eurooppalaisella, alueellisella ja kansallisella tasolla.

Euroopan tasolla on suositeltavaa käyttää kokonaisvaltaista ympäristölähestymistapaa, luoda niin kutsuttuja tiekarttoja, tukea tutkimusta ja kehitystä; lisätä tietoisuutta, esitellä ympäristömerkintöjä ja varmentamisjärjestelmiä näkyvyyden parantamiseksi; kuvata uusiutuvan energian käyttöönoton hyötyjä vesitoimialalla taloudellisesta näkökulmasta; sekä tehostaa julkisen sektorin toimintaa vesi-energiapolitiikan integroinnissa. Alueellisella tasolla esitetään tukea alueelliselle ja rajat ylittävälle yhteistyölle. Kansallisella tasolla ehdotetaan pitkän aikavälin strategian kehittämistä, kansallisten uusiutuvan energian tavoitteiden kasvattamista; taloustarkastelujen tekemistä, uusien taloustukimekanismien kehittämistä, hinnoittelujärjestelmien parantamista; julkisten yritysten ja kuntien välisen tiedonvälityksen sekä vertikaalisen kommunikaation ja yhteistyön kehittämistä; intersektoraalisen omistajuuden ja laskunmaksuasioiden säätelyä; sekä alueellisten paikallispainotteisten ratkaisujen kehittämistä vesi-energia-yhteydessä.

Kaikki nämä poliittiset suositukset tulisi vahvistaa lainsäädännässä ja niillä tulee olla riittävä poliittinen tuki. Ainoastaan silloin kun nämä ehdot täyttyvät, on mahdollista odottaa suotuisia tuloksia ja toimivaa toteutusta Suomessa.

Tämä työ on tehty osana “Water Asset Renewable Energy Solutions (WARES)” –projektia, jonka on rahoittanut Pohjoinen Periferia – ohjelma vuosina 2012-2014. Ohjelmaan kuuluu Pohjois-Euroopan syrjäisiä yhteisöjä ja tarkoituksena on edistää näiden aluiden kestävää kehitystä.

Muita tietoja

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PREFACE

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Oulu, July 2014

Victor Pavlov

LIST OF ABBREVIATIONS

CPF	Carbon Price Floor
CCL	Climate Change Levy
CE	*Conformite Europeen*
CER	Commission for Energy Regulation
CFS	Consumer Focus Scotland
CHP	Combined heat and power
DCENR	Department of Communications, Energy and Natural Resources
DWQR	Drinking Water Quality Regulator
EEA	European Environment Agency
EU	European Union
ELY Centre	Centre for Economic Development, Transport and the Environment
GJ	Gigajoule
GWS	Group Water Schemes
HM	Her Majesty's
ICT	Information and communication technologies
IT	Information technology
IWSM	Integrated water resources management
kVA	Kilovolt amperes
kW	Kilowatt
kWh	Kilowatt hour
LEC	Levy Exemption Certificate
MVA	Megavolt amperes
MW	Megawatt
MWh	Megawatt hour
MEE	Ministry of Employment and Economy
NIROC	Northern Ireland Renewables Obligation Certificates
NPR	Northern Periphery Region
NVE	Norwegian Water Resource and Energy Directorate
PPA	Power Purchase Agreement
PPP	Public-Private Partnership
PV	Photovoltaic
REFIT	Renewable Energy Feed-in Tariffs
RED	Renewable Energy Directive
SEPA	Scottish Environment Protection Agency
SWS	Scottish Water Solutions
WFD	Water Framework Directive
W_p	Watt peak

1 INTRODUCTION

Water has become more and more essential issue for the past decades. It brings a lot of challenges both for developed and developing countries. Water supply and wastewater treatment, being part of the water industry, are nowadays as important as never before. Going along with the principles of sustainable development, Europe 2020 Strategy, the European Union Water Framework Directive, and modern environmental standards, this sector needs to have high characteristics of water quality, water supply, pipeline network, water and sewage treatment, and material and energy efficiency. The latter is highlighted in the thesis in the form of finding potential for utilization of renewable energy sources in the water industry.

The focus area of the thesis is the Northern Periphery Region (NPR). Among the geographical list of the NPR countries, it is possible to include Canada, Greenland, Iceland, the United Kingdom of Great Britain and Northern Ireland, Norway, Sweden, Finland and Russia. However, this work considers only those countries presented in Figure 1: Finland, Norway, Scotland, Northern Ireland and Ireland.

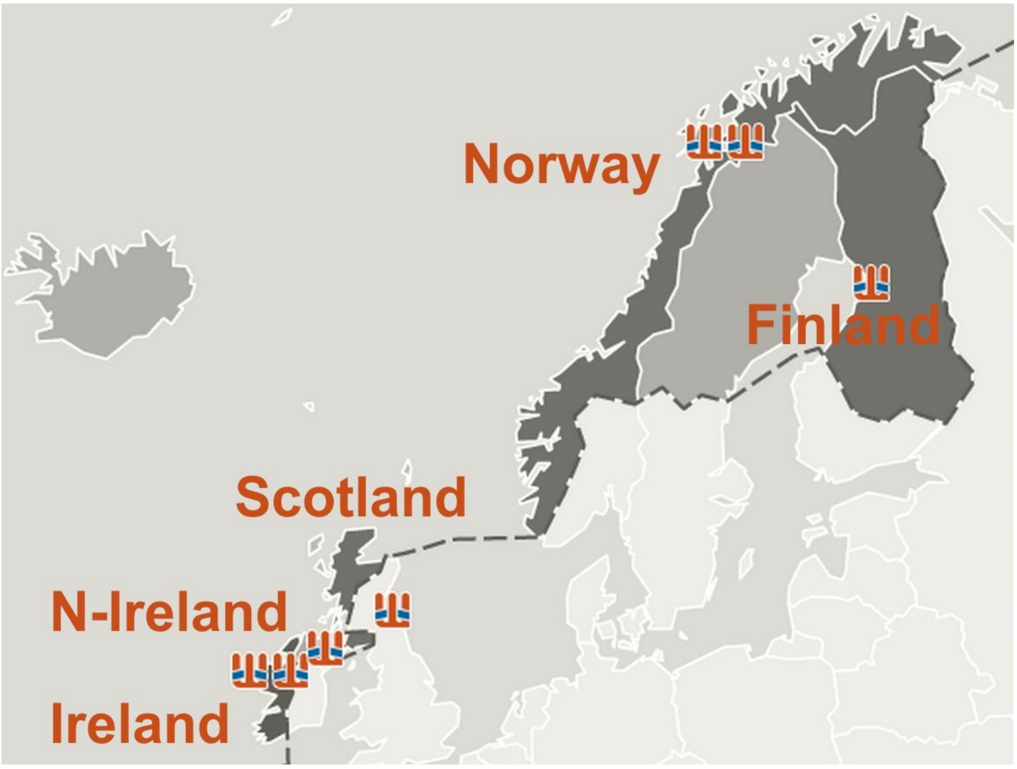

Figure 1 The countries of the Northern Periphery Region considered in the Master's Thesis (modified from WARES, 2014a).

In respect of these countries, the theoretical part of this work discusses water services (Chapter 2). At the end of the chapter a summary of water services of the mentioned countries with related similarities and differences is presented. Within the scope of Chapter 3, financial mechanisms of renewable energy support and Public-Private Partnerships (PPPs) are discussed. The PPP is considered as a possibility to unite the water industry companies, private investors and neighboring communities in remote areas. By means of private sector investments an existing renewable energy potential (e.g. running water, heat losses, wind climate, solar radiation) can be utilized in the most efficient way. (WARES, 2014b) Based on the energy cost savings and respective extra financial returns in the public water utility companies' budgets, it becomes possible to redirect some finances towards municipal social development projects. In addition, new job opportunities, visible livelihood change of people, and political engagement along with renewable energy production appear. (NPP, 2014a) A short summary about the level of development of the economic support mechanisms and the PPPs in five countries is also given within Chapter 3.

The content of the experimental part of the thesis underlines best practices (Chapter 4) in the water industry sector of five countries. In this context, the best practices are good examples of *in situ* utilization of unused or hidden opportunities for renewable energy generation. The natural and community resources are mostly taken into consideration as a potential for water asset utilization. In addition, Chapter 5 considers Finnish water companies in terms of water-energy legislation. The aim is to determine policy issues as well as discuss appropriate policy recommendations and development measures to implement renewable energy sources in the Finnish water industry.

The objectives of the thesis are as listed below:

- Provide an overview of water services in Finland, Norway, Scotland, Northern Ireland and Ireland;
- Show different examples of financial support mechanisms for renewable energy implementation in the countries in question;
- Describe the concept of Public-Private Partnership;
- Illustrate best practices in the water asset utilization for renewable energy generation coming from the considered countries; and
- Give policy recommendations to ease renewable energy implementation in Finnish water utility companies.

This work was done as part of the Water Asset Renewable Energy Solutions (WARES) project that was financed by the Northern Periphery Program for years 2007-2013. The program involves remote communities of Northern Europe and aims to facilitate its sustainable development with related social, economic and environmental benefits. (NPP, 2014) Figure 1 illustrates countries where the represented project partners are from. The list of the partners consists of Action Renewables (Northern Ireland), Clár ICH (Ireland), Mayo County Council (Ireland), Northern Research Institute NORUT (Norway), Narvik Science Park (Norway) and University of Oulu (Finland). The lead partner is International Resources and Recycling Institute (Scotland) (WARES, 2014c).

THEORETICAL PART

2 OVERVIEW OF WATER SERVICES IN THE NORTHERN PERIPHERY REGION

This chapter considers state of the water sectors in Finland, Norway, Scotland, Northern Ireland and Ireland. The main aspects discussed below include, as follows:

- Geographical water coverage;
- Amount of lakes and rivers;
- Availability of water services for each population;
- Ratio of groundwater use for drinking water supply compared to surface water utilization;
- Potability of water;
- Level of each country's expertise within the water sector;
- Organization of water services;
- Ownership issues;
- Water assets: e.g. running water flows, machinery equipment, plants with its heat losses, properties, occupied territories and waste streams with its unused energy potential;
- Water regulation; and
- Financing water services.

Based on these criteria, at the end of Chapter 2 there are two summary tables presented. Using the summarized material the countries in question are compared in terms of water services, ownership, customer fees and some other existing differences in the water sector.

2.1 Water services in Finland

Finland is often called the "land of a thousand lakes". According to the statistical data of the Finnish Water Forum, there are about 188 000 lakes and 650 rivers in Finland. Water bodies cover about 10% of the country's territory and provide essential recreational value for the country. The total area of Finland is about 338 000 km^2 (CIA, 2014b). The volume of fresh water reserves is 21 000 m^3 per person per year. With regards to Finnish water supply system, groundwater reserves play a more important role compared to surface waters. Groundwater share of total water abstraction in Finland is 65%. The main reasons of groundwater use are high water quality, good availability and security of supply. Water supply and wastewater treatment are available for 90% and 81% of the population, respectively, provided by public authorities. The rest of the population also has access to water services but not from public water services providers. The tap water is potable all through Finland. (FWF, 2012 and 2014)

Finland has a globally recognized expertise in integrated water resources management, water construction and services, natural water protection and water research, as well as water-saving technologies and information and communication technologies for measurement, control and monitoring. Among the existing partnerships and the countries where Finland has contributed with the water industry expertise are Russia, Vietnam, Nepal, Kenya and some others. (FWF, 2014)

2.1.1 Water supply and sanitation in Finland

Figure 2 illustrates the system of water supply and wastewater treatment in Finland. There are three levels of stakeholders. At the base are the customers; households, industry, different public institutions and other possible consumers. The most water intensive Finnish industry is pulp and paper production. However, frequently, paper mills have separate water supply and wastewater treatment systems arranged by private companies. On the operational level, there is a difference between Finnish towns and the countryside. In the cities, municipalities own and provide water services. The public sector is in charge of regulation, investments, funding control, maintenance, operation and management. (Mikkonen, 2013; FWF, 2012)

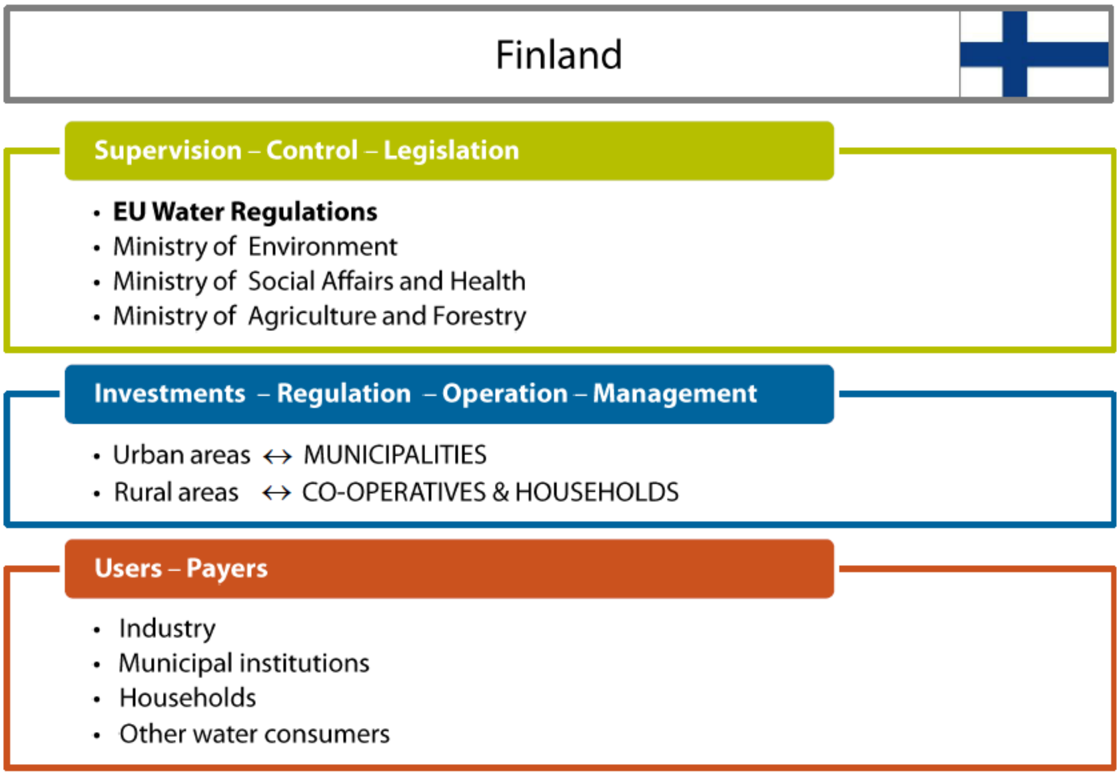

Figure 2 Organization of water supply and wastewater treatment in Finland.

The municipalities are responsible for water services only in population centers and not outside them. As a rule, water supply and wastewater treatment are carried out by municipally owned water enterprises. Ownership for water or land areas belongs to Finnish municipalities (MAF, 2011b). Water enterprises have ownership right on water infrastructure (FINLEX, 2001). Private water companies are not common in Finland. However, there are opportunities according to the Finnish regulations to outsource some services to private companies. Storm water and melt water collection and treatment is also the responsibility of municipal companies. Most storm water is handled via separate pipelines. This decreases the amount of water coming to wastewater treatment facility. In sparsely populated rural areas, water service companies belong to voluntary establishments: households or co-operatives. In detached houses, it is common to drill water wells or boreholes. (Mikkonen, 2013; FWF, 2012, Laitinen, 2012)

The starting point of water supply is very different in built-up areas and in sparsely populated rural areas. In this sense, sparsely populated areas mean those outside the municipal water supply and sewerage system. The law requires such single household areas to manage their wastewater by themselves. They are expected to install certified wastewater treatment systems, for example, commercially available single-household size systems, which scheme is illustrated in Figure 3. As of 1.7.2013, these on-site installations are required to bear the *Conformité Européenne* (CE) mark. (Laitinen, 2012)

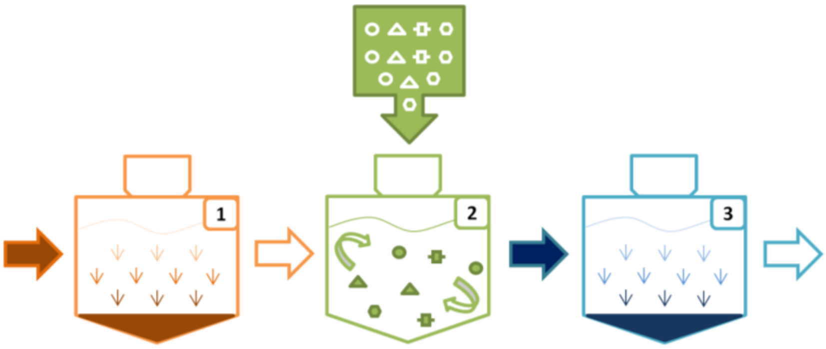

Figure 3 An example of a detached wastewater treatment scheme for rural areas in Finland. The key stages: 1 – first sedimentation; 2 – addition of chemicals, biochemical process; 3 – second sedimentation.

Concerning co-operatives, there can be two sources of water supply: *a)* municipal water network use; *b)* own water source use. In both cases, the co-operatives have to manage related investments, operation and maintenance costs of their water systems. The major difference is that with option *a)* they only need to take care of network and pumping stations, whereas in option *b)* they should also consider water intake and treatment measures. As for wastewater treatment, co-operatives can either rely on municipal sewerage systems or their own wastewater treatment solutions. The latter can be in the form of small-scale *in situ* plants such as illustrated in Figure 4. (Laitinen, 2012)

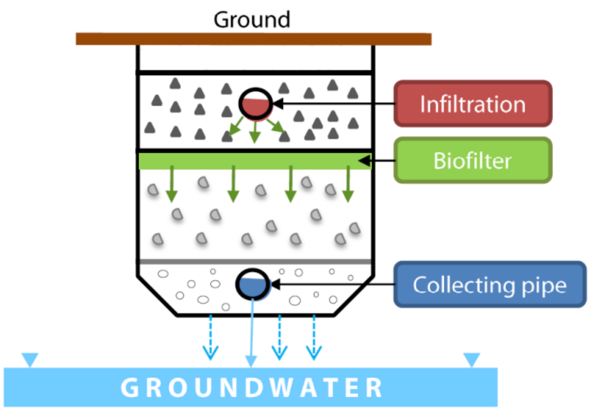

Figure 4 An example of a wastewater treatment scheme often applied in Finnish co-operatives

The plants are simple in terms of design and construction. They are often based on soil filters. Wastewater is sent through a multi-layer ground filter system that outputs clean water for further intake and use. Composting and dry toilet solutions can be also used in the rural areas as a measure to deal with wastewater. In general, co-operatives, as community-based systems allow good water resource management with lower costs to individual water users. When uniting into a co-operative, investment and maintenance costs become lower in comparison to personal *in situ* water systems. Co-operatives may also engage contractors to perform wastewater treatment and maintenance. This solution enables the fulfilment of strict local and EU legal requirements of water quality and supply. (Mikkonen, 2013; FWF, 2012; Laitinen, 2012; FWF, 2014)

These legal requirements are represented by the upmost level in Figure 2: supervision, control and legislation. In Finland, there are four national programs related to natural water protection. They have been in use since the 1970s. In addition, river basin management is of priority and appropriate plans for seven Finnish regions were accepted by the Finnish government. According to these plans, by 2015, 100% of the groundwater reserves, 90% of the lakes and 70% of the rivers there should maintain or reach a good water quality level. The base for the latter was the European Union Water Framework Directive (Directive 2000/60/EC) about sustainable water use and supply in Europe. There are also other water-related Directives, Acts and Laws regulating such areas as (Mikkonen, 2013; FWF, 2014):

- Water services,
- Water quality,
- Wastewater treatment,
- Prevention and control of water contamination,
- Environmental protection,
- Healthcare,
- Sludge utilization and landfill disposal,
- Public work and service contracts,
- Procurement operations,
- Land use and construction works, and
- Sustainable utilization of natural resources.

If there is any industrial or physical activity to be implemented on Finnish territory that influences surface or groundwater bodies, according to the Water Act there is a need to apply for an appropriate permit. The activity is allowed to be started only after approval and permit acquisition. In rural areas, the Act for Water Services and the On-site Wastewater Treatment Decree (for the wastewaters out of municipal sewerage systems) also applies to control pollution and sewage treatment with parameters such as biochemical oxygen demand, total phosphorous content and total nitrogen content. In municipal population centers, decisions for the water industry are taken by the government. It is especially so when it is related to large scale investments. However, water companies can also be responsible for decision-making. What makes the difference is the scale. For instance, certain limits are put for investment costs, profit utilization and material investigation. Only within these limits can the head of a water enterprise make decisions. The same mechanism works with co-operatives in rural areas. The members of co-operatives can discuss problems at their meetings and send proposals to local authorities. The latter afterwards are in charge of the final decision. (Mikkonen, 2013; FWF, 2014; Laitinen, 2012)

According to the Finnish Water Forum, currently there is a tendency to increase inter-municipal cooperation towards joint water and wastewater treatment facilities as well as common sludge disposal. This is already implemented in such Finnish cities as Helsinki, Turku and Tampere with total populations of 750 000, 280 000 and 200 000 people, respectively. These numbers include populations beyond the cities; for example, the Helsinki and Turku wastewater treatment facilities serve five neighboring towns in addition the inhabitants of the two cities. As another trend, water companies are decreasing their dependency on municipal organizations. (FWF, 2012; Pietilä, 2006)

2.1.2 Customer water fees in Finland

The Water Services Act 119/2001 also regulates water fees for users. In municipalities, water fees are the main source of financing water services. The main sources of costs are investments, employee wages, energy supply, chemicals and maintenance operations. The Water Services Act states that all the costs of water supply and wastewater treatment can be covered by customer water fees. The rate of the fees should be mentioned in the water company price list. If there is a need to change the rates, for instance, due to legislation change, authority decision or investment expenses, the company is allowed to do so. It is legitimate under the Water Services Act that if a water company incurs operational, investment or any other expenses, they must be covered by customer water fees. Fees can vary from region to region. Water fees concern and include both potable water and wastewater operations. Thus, water companies invoice customers for water supply and sanitation at once. (FWF, 2012; HSY, 2011; Mikkonen, 2013)

There can be four main types of water fee: connection fee, fixed monthly fee, consumption fee, and other service fee (Figure 5).

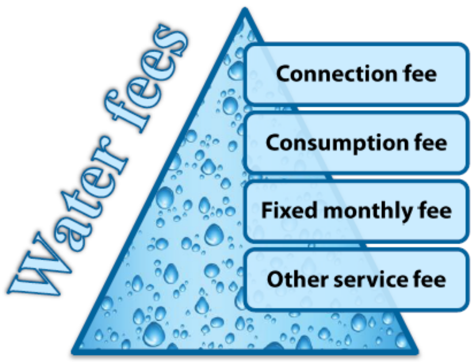

Figure 5 Types of customer water fees in Finland.

The connection fee is paid by a customer to the water company to cover the investment cost to join the water network. The consumption fee is related to the amount of supplied water that is consumed by customer. In this case, water consumption needs to be metered. This is a direct responsibility of the water company. They must install water meters at customer's premises so that the customer can follow the volume of water consumed. The water company needs to specify the meter type and provide the customer with this information. The installed water meter is considered the property of the water company. The consumption fee in Finland is on average about 4,83 euro/m^3

per household in a detached house and 3,96 euro/m^3 per household in an apartment building flat. Based on Finnish Water Forum data, an average Finnish family of four people is assumed to have a monthly water use of 4,5 m^3 per person and, therefore, the monthly water fee costs a family around 2% of their total income. (FWF, 2012) The fixed monthly fee is not tied to the amount of water used by the customer. In this situation, the customer is supposed to pay the fixed fee for water service on a monthly basis. The other service fees are linked to various expenses possible for water company: e.g. water meter installation, storm water collection, pipeline renovation, some other installations or improvements and related expenses. In general, in Finland, up to 80-90% of overall water company expenses do not arise from customer water consumption. They are fixed and included in the customer water fee. In turn, the municipalities and the national government collect from water companies part of their income (5-25%). Towards co-operatives and households obligatory income tax of 26% is applied. With regards to the water fees, in rural areas they are not applied. Rural households and co-operatives make direct payments for water supply and wastewater treatment related investments and costs. (FWF, 2012; HSY, 2011; Mikkonen, 2013)

2.2 Water services in Norway

Norway is a rich country in terms of freshwater resources and has enough supply for industrial and domestic use. Water resources are also considered as recreational objects. The country is especially abundant in waterfalls and rivers. This facilitates the utilization of hydropower in Norway. (EPD, 2007; NMPE, 2013) Norway has a territory of about 324 000 km^2, 5% of which are covered by water. The total amount of lakes is about 455 000, however, most are of very small size. There are also large inland water bodies, with the largest six lakes having a surface area of more than 100 km^2 each. There are 11 river basin regions in Norway. The south-east of the country contains most of the largest rivers and their catchment areas. Along the coast, there are some smaller rivers. In total, there are approximately 4 000 rivers in the country. The total amount of annual fresh water resources in Norway is about 377 000 million m^3. The quality of drinking water is good for most water consumers. (EEA, 1996; Stene-Larsen, 2012; EPD, 2007; Statistics Norway, 2008; Gonzalez, *et al.*, 2011)

Regarding water supply in Norway, surface water sources are utilized more compared to groundwater sources. Their shares are 90% and 10%, respectively. In recent years, the proportion of groundwater use for drinking water supply is slowly increasing. This is explained by the intent to reduce costs and decrease public health risks. In general, public water supply is available for around 90% of the Norwegian population. The other 10% of the population also gets access to potable water but from smaller waterworks. Concerning wastewater treatment, 84% of people have access to this public service. (EPD, 2007; Statistics Norway, 2008; Stene-Larsen, 2012; Berge, *et al.*, 2013)

In terms of water competence, Norway has a strong hydropower expertise. Norway is the largest European producer of hydropower with more than 100 years of experience in all aspects of hydropower implementation: from planning and engineering to equipment installation and management. The Norwegian potential in hydropower is widely utilized; at the present time, Norway is more oriented towards the respective projects abroad: Central and Southeast Europe, Asia and South America. (NMPE, 2013)

2.2.1 Water supply and sanitation in Norway

The organization of the Norwegian water supply and sanitation system is illustrated in Figure 6.

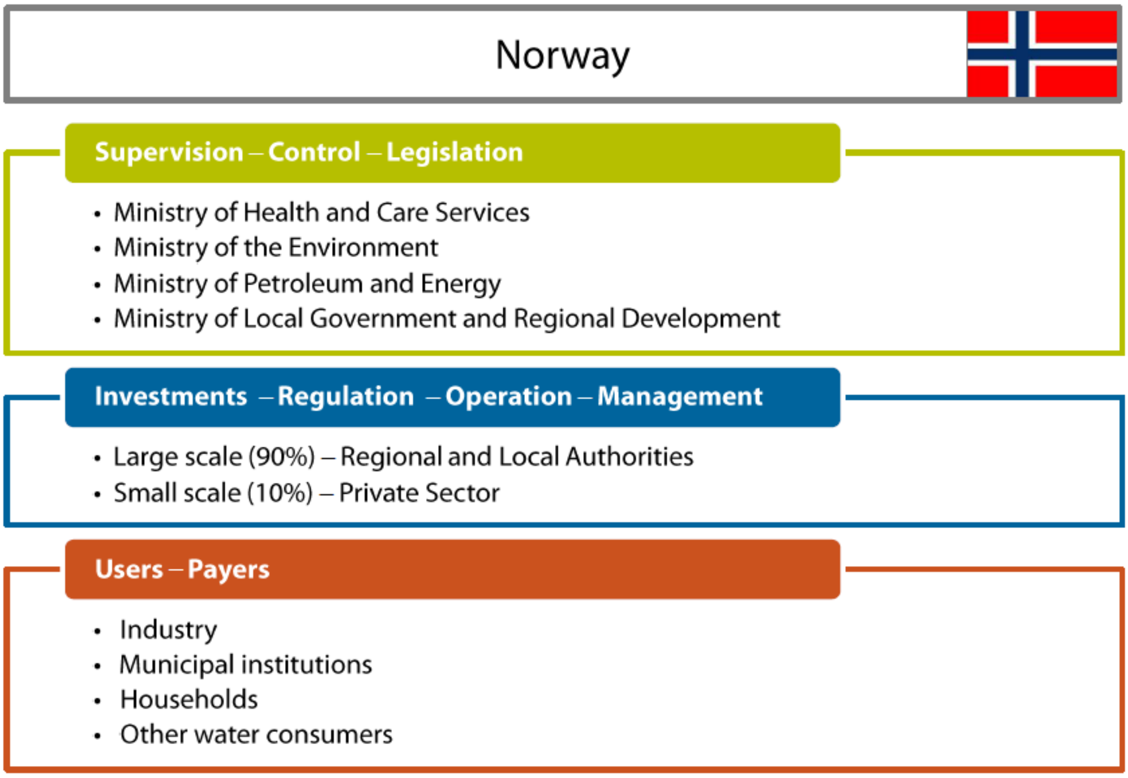

Figure 6 Organization of water supply and wastewater treatment in Norway.

The water consumption rate by users is about 0,7% (approx. 2 700 million m^3) of available annual amount of freshwater resources in the country. The average annual water consumption per capita is 600 m^3 in Norway in comparison with 880 m^3/year of the average in the country-members of the Organisation for Economic Co-operation and Development. The amount of water consumed on an annual basis by the primary industries, the manufacturing industries (especially, metal, chemical, pulp and paper, food industries) and households is 40% (approx. 1000 million m^3), 42% (approx. 1100 million m^3) and 14% (approx. 380 million m^3), respectively. (Statistics Norway, 2008)

In terms of operation and management, in 90% of the cases the public sector owns water companies and is responsible for water services. There is also small share (10%) of private water treatment facilities operating in the Norwegian water sector in rural areas. The state-owned facilities supply water to about 90% of the population and treat wastewater for about 84%. There are 1 570 waterworks registered in waterworks portal of the National Institute of Public Health that are responsible for water treatment. The number includes both public (municipal and inter-municipal) and private organizations, except water supply stations for holiday homes. In 2012, there were about 2 685 wastewater treatment plants in Norway. The most common method of wastewater treatment is chemical or biochemical processing (in 60% of cases) and mechanical treatment (in about 20% of cases). Additionally, 3% of wastewater are untreated and discharged as raw sewage. In rural areas, there are smaller wastewater treatment facilities (16%) that usually consist of sludge separation and filtration. (Berge, *et al*., 2013; Statistics Norway, 2008)

The main sources of water contamination are agriculture, municipal sewage and fish farming. The role of agriculture in Norway is important and interconnected with water in terms of irrigation, drinking water supply and creation of natural boundaries for livestock. (EPD, 2007; Stene-Larsen, 2012)

On the level of supervision, control and legislation, the key organizations are the Ministry of Health and Care Services, the Ministry of the Environment, the Ministry of Petroleum and Energy and the Ministry of Local Government and Regional Development. The Ministry of Health and Care Services (along with the Norwegian Food Safety Authority and the Norwegian Directorate of Health) is in charge of drinking water quality, the Ministry of the Environment (along with the Directorate for Nature Management and the Climate and Pollution Agency) – is responsible for preservation of water resources, the Ministry of Petroleum and Energy (along with the Norwegian Water Resources and Energy Directorate) – is responsible for hydropower and respective regulations, and the Ministry of Local Government and Regional Development (along with the Norwegian Building Authority) – is responsible for the water sector infrastructure. (Stene-Larsen, 2012)

Although not an EU Member State, Norway is also subject to the implementation of requirements of the European Union Water Framework Directive (EU WFD) (Directive 2000/60/EC). The responsibility to coordinate and realize the EU WFD was given to the Ministry of the Environment at the state level and to the county administrations at the regional level. Freshwater use is governed by the Water Resources Act since 2000, which states that river and groundwater reserves should be used in a sustainable manner and take into account the interests of local communities. One of the goals of the Water Resources Act is to ensure the above mentioned water systems are well-preserved, their biodiversity levels are maintained and the vital ecosystem processes are saved. To protect groundwater reserves and avoid overconsumption, the Pollution Control Act is also in force in Norway. (EPD, 2007; NMPE, 2013; Statistics Norway, 2008)

All infrastructures such as railways, car roads, cable cars, ports, as well as plans and programs that deal with water resources should undergo environmental assessment. The requirements are set by the Water Resources Act, and the Planning and Building Act. In addition, the Water Resources Act as well as the Protection Plan for Water Resources state that rivers should be protected from significant negative influence from their energy utilization and other possible works, even though they have high hydropower potential. To start any activity such as water supply, hydropower development, drainage organization and fish farming projects, according to the Water Resources Act, one needs to receive a special license. The obtained license means that no significant influence towards the environment and the community will take place. The administrative guidance regarding the licenses and the application procedure are also described in the Water Resources Act. (EPD, 2007)

Considering renewable energy potential, if a water supply or wastewater treatment company is located nearby a river with hydropower potential or in an area with favourable wind profile, this company needs at first check if it is eligible to use the river or install a windmill to produce energy. In Norway, resources such as land and waterfalls are preferably owned by the public sector. Furthermore, it is established in the goals of the country that hydropower resources should be state-owned. To this end, only the state can use waterfalls, whereas the private sector can own only less than one third of a hydroelectric power plant, for instance. The remaining two thirds should be held in public ownership. If a water company plans to set up a hydropower installation, it should obtain a proper license pursuant with the Industrial Licensing Act. All the fees and basic terms concerning the license application process are mentioned there. Moreover, according to the Industrial Licensing Act, there should be obligatory sales to the municipalities. The latter means that the local authorities have a legitimate right to utilize the power produced at the energy installation. The share of the power at cost given to the public sector should be 10%. Another regulation that is applicable to hydropower production is the Watercourse Regulation Act. This act requires a special permit to use water from a regulation reservoir. The regulation reservoir is a vessel where the water is stored to produce energy depending on a varying demand. (NMPE, 2013)

2.2.2 Customer water fees in Norway

According to Norwegian regulations, customer fees are applied to water supply and wastewater treatment. It is set by municipalities but it should not be more than actual costs spent by municipalities within the water sector for supply and treatment. These costs can include operating, capital and maintenance costs in relation to water supply and wastewater treatment. The principle of full costing should be fulfilled. (Statistics Norway, 2008)

The customer fee types in Norway are usually the following (Statistics Norway, 2008; Berge, *et al.*, 2013):

- Connection fee. It is the fee raised by municipal authorities once when a water user gets connected to the working water distribution system. In 2013, the connection water user fee was about 1 660 euro;
- Annual consumption fee. It is based on calculation of water consumed by the water user measured by water meters. The average annual fee was about 416 euro in 2013 in 37% of municipalities where 71% of the population lives. The fees can vary from county to county, in the range of 80 euro to 695 euro. This substantial difference is stipulated by the location and type of the municipality, and the local geographical conditions: e.g. size of water plant, relief, density of population and other factors;
- Combination of fixed and variable fee. This option includes a fixed fee for the limited initial amount of water determined by water authority, and a variable fee in case this limit is exceeded.

If a property does not have a water meter, the fee is based on water consumption depending on the size of the building in question. The water fee combines both water services: water supply and wastewater treatment. (Statistics Norway, 2008; The Money Converter, 2014a; Berge, *et al*., 2013)

2.3 Water services in Scotland

Scotland is famous in the UK for its abundance and purity of fresh waters; 90% of the British freshwater volume is concentrated in Scotland. Lakes and rivers cover 2% of the Scottish territory, and one of the deepest lakes in Europe, Loch Morar, is situated in the country. In total, there are more than 30 000 lakes and 10 000 rivers in Scotland. The territory of the country is around 78 000 km^2 (Encyclopedia Britannica, 2014a). The tap water in Scotland is potable: 99,91% of water samples taken from customer taps comply with drinking water standards. (Scottish Executive, 2003; SNH, 2001; SNH, 2002; Scottish Water, 2013a)

Concerning water supply, 93% are from surface water versus 7% from groundwater. Water services are provided by a single public company: Scottish Water. Water supply and wastewater treatment are available for about 98% of the population. The rest rely on private water supply sources that do not belong to Scottish Water. (Ó. Dochartaigh, *et al*., 2011; Scottish Water, 2014a; SmithsGore, 2014)

With regards to Scottish expertise, the country has experience in efficient and effective procurement, operation and maintenance of public-owned water facilities which deal with water preparation and wastewater treatment. It exports the know-how, for instance, to India, Qatar, New Zealand and Poland. (Scottish Water, 2013b)

2.3.1 Water supply and sanitation in Scotland

The organization of the water supply and sanitation system in Scotland is illustrated in Figure 7.

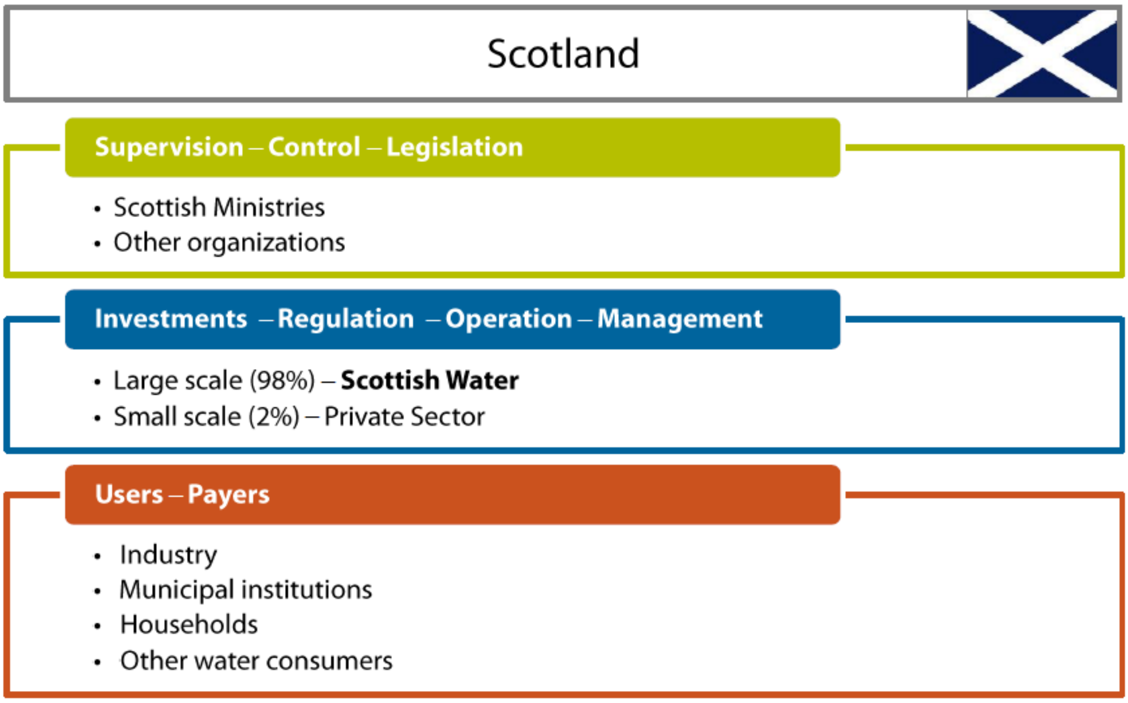

Figure 7 Organization of water supply and wastewater treatment in Scotland.

The water users are connected to water supply and wastewater treatment system operated by Scottish Water. The most important water intensive industries in Scotland are food and drink production and agriculture. (Scottish Government, 2013)

In terms of operation, Scottish Water owns 98% of water facilities and is in charge of water services. A small share, 2% are taken by private water treatment facilities, mainly in rural areas. Scottish Water operates 252 water supply facilities and 1 865 wastewater treatment plants. Scottish Water was formed by the union of the three former regional water authorities; East of Scotland Water, West of Scotland Water, and North of Scotland Water in 2002. This, consequently, helped to improve the efficiency of water services, and reduce costs by 20%. Scottish Water is a state-owned company that is subordinated by the Scottish Parliament. At the same time, its management and structure are similar to private companies. The company owns not only such assets as water preparation and wastewater treatment facilities, pumping stations, pipeline networks and sewers but also land and water. According to Thomson (2013), Scottish Water holds more than 240 km^2 as rural catchment estates. Recently, there has been renewable energy development (mostly wind energy and micro-hydropower) on these estates. This serves as an answer to the current goal of the public company to transform from being one of the largest energy consumers in Scotland towards energy self-sufficiency. In terms of water resources in the country, historically, it was common that land owners had an extended water ownership right. Currently, in Scotland it is not considered as appropriate for water resource management. In practice, the right to manage water resources has shifted from the private sector to a public entity. Water ownership has become a problem of public interest and object of its control. (EC DGRP, 2004; Hendry, 2013; Scottish Water, 2014a; Scottish Water, 2013b; Thomson, 2013; Ramsay, 2014)

The water supply originates mostly from lakes, rivers, reservoirs and partly from boreholes. The drainage system collects storm water and wastewater coming from households and industry. One third of wastewater is composed of storm water from roofs, sidewalks, parking areas and public roads. Scottish Water is responsible for the full cycle for drinking water supply and wastewater treatment including sludge utilization. A larger part of the sludge is recycled whereas a smaller part is disposed at landfills. (Scottish Water, 2014a, b)

On the supervision level, there are number of Scottish Ministers influencing water services, such as water fees strategy, policy and vision of the water sector and other issues related to water services in Scotland: e.g. environmental aspects, drinking water quality and customer service. Public authorities are also responsible for making decisions about the amount of financing available to lend to the water company. (WICS, 2013)

Other regulators, to which Scottish Water is responsible to, are the Water Industry Commissioner for Scotland, the Scottish Environment Protection Agency, the Scottish Executive Water Services Unit (Drinking Water Quality Regulator) and Consumer Futures. The following organizations play important roles and have certain functions in the Scottish water sector (Mohajeri, *et al.*, 2003; Scottish Water, 2014d; WICS, 2013):

- The Water Industry Commission for Scotland (the Commission): deals with the amount of customer fees and acts as an economic regulator;
- The Scottish Environment Protection Agency (SEPA): conducts monitoring of wastewater discharges as well as determines the standards for it. The main role of SEPA is to promote sustainable development and environmental protection as well as to prevent negative influence on human health. It acts as an environmental regulator;
- The Scottish Executive Water Services Unit (Drinking Water Quality Regulator [DWQR]): monitors the quality of supplied drinking water and sets the standards for it;
- Consumer Focus Scotland (CFS): acts as a voice of the water consumers in water issues and water fees;
- The Customer Forum: represents customers interests when working with strategic issues in the water sector: e.g. water charges, customer preferences;
- The Outputs Monitoring Group: is responsible for monitoring the outputs that Scottish Water has to deliver. The main goal is to make it clearer and easier to understand for water consumers. The group consists of representatives from CFS, the DWQR, SEPA, the Commission, the Scottish Government and Scottish Water.

There is a number of water related regulations in Scotland, the most important being (Scottish Government, 2014a):

- The Water Industry Scotland Act 2002;
- The Water Services etc. (Scotland) Act 2005;
- The Water Supply (Water Quality) (Scotland) Regulations 2001;
- The Provision of Water and Sewerage Service (Reasonable Cost) (Scotland) Regulations 2011 (SSO 2011/119).

The EU Water Framework Directive is also implemented in Scotland. (Scottish Government, 2014b)

2.3.2 Customer water fees in Scotland

The main source of funding to maintain water services comes from customer fees. Other possible financial support flows are provided by the Scottish Government. (Scottish Water, 2014d)

There are three general categories of customer water fees in Scotland (Scottish Water, 2014c):

- Water supply fee;
- Wastewater treatment fee;
- Other fees.

The first two categories are applied only if a household or a business property is connected to the water public network. The third one includes such services as connection to the public network, standpipe license issue, septic tank de-sludging, provision of information, inspection and application processes. (Scottish Water, 2014c)

Regarding water supply fees, it depends if the household has a water meter. A water metered household is charged with two fees: an annual fixed fee and a volumetric water fee. The annual fixed fee is paid for operation and maintenance of the pipeline system, wastewater treatment facilities and pumping stations. An approximate value for this fee is about 174 euro (The Money Converter, 2014b). The volumetric water fee is collected for every cubic meter of water consumed. It applies to the first 25 m^3 of fresh water consumption with one rate (approx. 2,7 euro/m^3) and from the 26^{th} m^3 and further with another rate (approx. 0,9 euro/m^3). If a household is not equipped with a water meter, then the water supply fee system is a bit different. For households, the collected fee values can vary from 155 euro to 465 euro. It changes depending on the Council Tax Band system. It consists of 8 levels: from A to H. The lowest fee is charged according to the Tax Band A and, respectively, the highest – according to the Tax Band H. (Scottish Water, 2014a, b, c; The Money Converter, 2014b)

The annual fixed fee and volumetric fee for wastewater treatment have similar grounds to what was described about the water supply fees. However, wastewater generation is considered to be 5% less compared to fresh water consumption. An approximate value for the wastewater treatment fee is around 179 euro. The volumetric fee for the first 23,75 m^3 is about 3,5 euro/m^3 and, for the volumes beyond 23,75 m^3, approximately, 1,7 euro/m^3. In case there is no water meter in a household, based on the Council Tax Band system, the collected wastewater fees vary: from 180 to 540 euro. Therefore, the average combined water service fee in Scotland is about 415 euro (The Money Converter, 2014b). This is lower than in England or Wales. (Scottish Water, 2014b, d; The Money Converter, 2014b)

Apart from the regular wastewater treatment fees, Scottish water consumers pay two other charges: property drainage fee and roads drainage fee (Scottish Water, 2014b). The drainage fees are also related to the Council Tax Band system. The two fees are identical in cost. The lowest fee of Band A is about 36 euro, whereas the Band H value is approximately 108 euro. The property drainage fee is collected for rainwater which goes to the sewer system of the public company. Usually, this water comes from the property roofs, private parking areas and private roads. The roads drainage fee, in turn, concerns storm water from public roads and sidewalks. Both of the fees are levied from households only if applicable. (Scottish Water, 2014b)

The secondary services, which are covered by the other fees, are quite varied. One of the most essential services is connection to the public network. In this respect, there are two types of connection fees: for the connection to the pipeline system providing water supply and for the connection to the wastewater treatment network. Both of the fees are equal and are about 409 euro each. (Scottish Water, 2014c)

2.4 Water services in Northern Ireland

Northern Ireland being surrounded by the waters of the Irish Sea, marine waters have both industrial and recreational importance. Due to the growing energy demand during recent years, there is a tendency of utilizing offshore wind energy, as well as tide and wave power. About 7% of Northern Ireland is covered by surface water bodies.

(Christie, 2011; NIEA, 2013) The total area of the country is about 14 000 km^2 and there are about 3 200 rivers and 1 700 lakes on its territory (Encyclopedia Britannica, 2014b; Mehaffey, 2014). The 1,8 million inhabitants of Northern Ireland receive about 562 000 m^3 of drinking water on a daily basis. In Northern Ireland, the water supply originates mostly from lakes and rivers (55,95%) as well as reservoirs (44%). The largest lake, Lough Neagh, supplies 50% of the country's drinking water. Only 0,05% of water supply comes from groundwater sources. In England and Wales, by comparison, about 35% of the water supply is from boreholes. Water services are provided by Northern Ireland Water, a public authority. Public water supply is available for 99,9% of the population of Northern Ireland. In turn, wastewater treatment is provided for 96,5% of the inhabitants. The water is potable; 99,83% of samples taken comply with the drinking water standards. (Christie, 2011; NIEA, 2013; NIW, 2012; NIW, 2013; Rippey, *et al.*, 2001)

With regards to the specific expertise of Northern Ireland, it is advanced in the promotion of renewable energy in both the public and private sectors. It includes provision of advices about energy efficiency, technological solutions and all the adjacent issues. Apart from recent developments in Northern Ireland, there are also a number of collaborative projects within the European Union in this field. (AR, 2014)

2.4.1 Water supply and sanitation in Northern Ireland

The organization of water supply and wastewater treatment in Northern Ireland is illustrated by Figure 8.

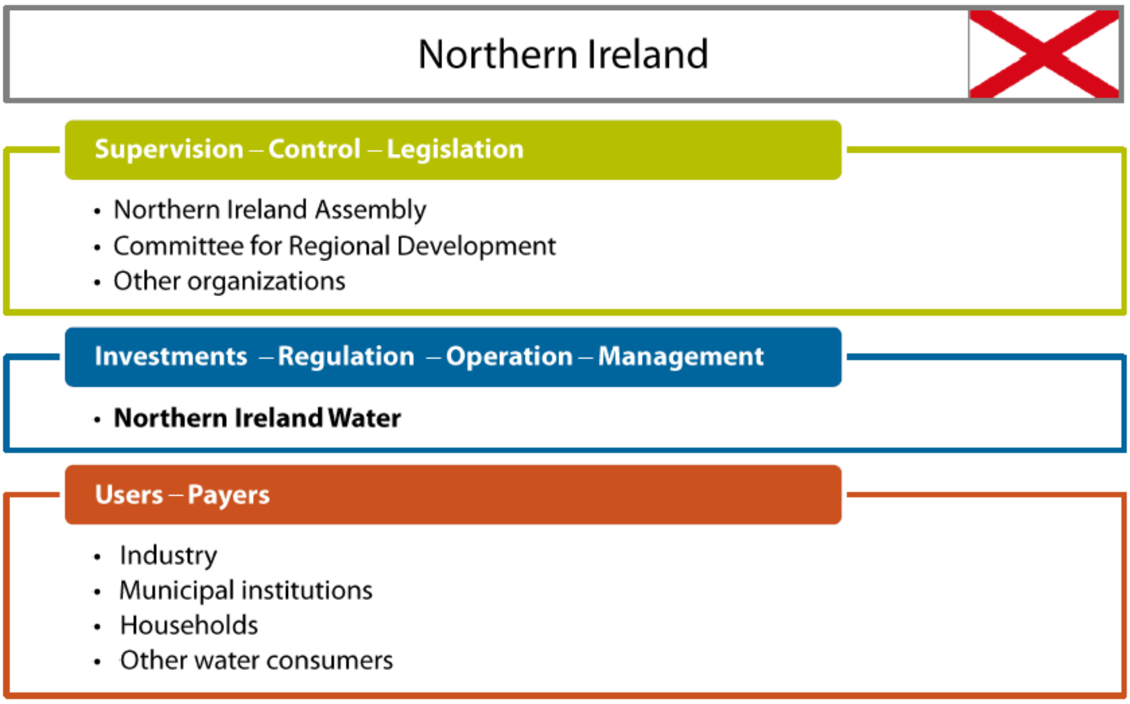

Figure 8 Organization of water supply and wastewater treatment in Northern Ireland.

In Northern Ireland, water consumers receive water supply and wastewater treatment from a government owned company – Northern Ireland Water (NIW). The most water intensive industry in the country is food and drink production. (NIW, 2013; McGuigan, G, 2010) NIW is responsible for investments, operation, regulation and management of water services. Water treatment provided by NIW consists of screening, chemical treatment and clarification, filtration, disinfection and pH adjustment. There are 25 drinking water preparation facilities in operation. NIW also does wastewater collection and treatment to purify the water to the standards that allow discharging it into rivers and the sea. Storm water is also collected via public sewer network. The wastewater treatment process includes 4 stages: preliminary step (screening, grit removal), primary step (sedimentation), secondary step (biological filtration/activated sludge) and final step (sedimentation). There are more than 1 000 wastewater treatment works that the company is in charge of. The operating area of the water company is mainly rural. Concerning ownership, Northern Ireland Water owns 71 impounding reservoir structures, water resources, some land holdings, a network of pipes, pumping stations, sewers, water treatment and wastewater treatment works. (ARNI, 2014; Bookless, 2014; NIA, 2014; NIEA, 2013; NIW, 2012; NIW, 2013; NIW, 2014a; Utility Regulator, 2013)

In terms of supervision and control, the Northern Ireland Assembly and the Committee for Regional Development are in charge of control over the activities of NIW. (NIW, 2013) With regards to legislation, the Ministry for Regional Development under the Northern Ireland Assembly and the Committee for Regional Development are the key legislative bodies. Under the Ministry, the Department for Regional Development creates policy related to water issues as well as deals with funding of the water company and solving problems related to customer subsidies, investments, lending, etc. The other organizations relevant to water services are (NIW, 2013):

- The Northern Ireland Environment Agency: deals with natural environmental heritage and its preservation. It regulates the NIW activity in terms of its compliance with all needed regulations and environmental permits;
  a) The Drinking Water Inspectorate for Northern Ireland: is responsible for drinking water quality control;
  b) The Water Management Unit: is in charge of the water pollution and protection of water bodies;
- The Northern Ireland Authority for Utility Regulation: works for interests of water service customers. It acts as an economic regulator within the fields of water, electricity and gas markets;
- The Consumer Council for Northern Ireland: acts as the water consumers' voice and represents their interests. It also gives advice and provides information to water service users.

The EU WFD is also in use in Northern Ireland. In addition, there are various water related policy drivers and regulations. To illustrate, some of them are listed below (NIEA, 2013):

- The Groundwater Directive (2006/118/EC): regulates and prevents contamination of groundwater reserves;
- The Drinking Water Directive (80/778/EEC): controls pollution of and ensures drinking water quality to protect human health;

- International Decade for Action 'Water for life' 2005-2015: promotes implementation of water related measures as international commitments by 2015;
- The Water Environmental (Water Framework Directive) regulations (Northern Ireland) 2003: controls and sets standards for quality of river waters.

2.4.2 Customer water fees in Northern Ireland

The water service fees in Northern Ireland are (NIW, 2014b):

- Water supply fee;
- Wastewater treatment fee;
- Other fees (e.g. connection fee, septic tank de-sludging).

The system of fees is rather close to that of the Scottish system. However, during 2014-2015, domestic water users are not paying any fees. Instead, the Department for Regional Development is covering the fees. The other fees can be collected from domestic customers when, for example, ordering septic tank de-sludging procedure more than one time per year. Other than that, domestic water users are subsidized by the government, with a 100% water service discount. Water use by default is unmeasured in Northern Ireland on the domestic level. (NIW, 2014b)

Non-domestic water customers, in turn, must cover water services provided by NIW by paying respective annual fees. It varies whether there is a water meter installed or not. (NIW, 2014b) If water consumption is metered, the only variable parameter is a supply pipe diameter. The larger the size of supply pipe, the higher the payment will be. There is a range from less than 20 mm to more than 100 mm. For instance, if it is up to 50 mm, the annual fee for water supply will be 388 euro. If it is over 100 mm, water supply will cost for a non-domestic customer 1 971 euro. The latter fee is called a standing charge for water supply. As an additional fee to a standing charge, there is a variable charge. This fee is collected from water users depending on the volume of water measured by the water meter. For every cubic meter, the charge is 1,25 euro. With regards to wastewater generation and related fees, the situation is similar to water supply; there are standing and variable charges. The standing charge can, in accordance with the size of supply pipe, be from 93 euro for the pipe less than 20 mm in diameter to 2 256 euro for the pipe more than 100 mm diameter. The variable charge for wastewater is set at 2 euro per m^3. (NIW, 2014b; The Money Converter, 2014b)

When water consumption is not metered, there are the same types of fees as in the previous scenario, with a difference in variable charge. This is set in proportion to the non-domestic property valuation. This procedure is done by Land and Property Services on request. For every 1 000 pound sterling (1 228 euro) of the property value, a non-domestic customer should pay about 12 euro as a variable charge for water supply and approximately 17 euro as a variable charge for wastewater. The charge cap is set at the level of 497 euro for water supply and 528 euro for sewerage. The standing charge is respectively 32 euro for water supply and 44 euro for wastewater. Among other possible fees, there may be septic tank de-sludging for around 91 euro, connection fee for about 310 euro. (NIW, 2014b; The Money Converter, 2014b)

2.5 Water services in Ireland

Ireland occupies five-sixths of the territory of the Island of Ireland. The country is rich in water resources; and has coverage by surface water bodies of 2%. The total area of Ireland is about 70 000 km^2 (CIA, 2014a). The availability of fresh water is one of the highest in Europe. (Mohajeri, *et al.*, 2003; CIA, 2014a)

According to Dublin City Council, there are a total of 4 467 lakes and 80 rivers in Ireland. The main source of water supply, around 82% come from lakes and rivers. The share of groundwater usage is about 10%. Approximately 8% of drinking water originates from springs. 99% of the population have access to water supply and 99,5% to wastewater treatment. The numbers include both public and private water services. Public water supply provides water for approximately 80% of the population. The water supplied by public water authorities is potable. The chemical compliance with drinking water standards is 99,5%. The wastewater treatment share provided by public authorities is about 70%. (Mohajeri, *et al.*, 2003; Dublin City Council, 2009; EPA, 2011; ECLG, 2012)

Regarding the expertise area of Ireland within the water sector, it is mostly connected to water and wastewater management. The latter especially concerns local water authorities' level. The main market where this expertise tends to be utilized is European countries. (DJEI, 2013)

2.5.1 Water supply and sanitation in Ireland

In Ireland, the system of water supply and wastewater treatment is currently undergoing some change. Back in 2011, Ireland was the only country-member of the Organization for Economic Co-operation and Development which did not have water fees for domestic water users. To improve drinking water quality, improve cost efficiency of water services and preserve national water reserves, the government made a decision to introduce customer water fees and household water meters. Among other reasons, there were the projected increase of Irish population, large amounts of pipe leaks, requirements of the EU WFD and national water standards, unsustainable funding patterns and high costs of water services provision. The development started in the summer of 2012 and, in 2013, a new company Irish Water Incorporated was established. In the first quarter of 2014, the Irish water assets were transferred to Irish Water. In addition, collaboration was launched with Local Authorities within Service Level Agreements to provide water services. For autumn 2014, there should be already an individual engagement with customers. In the beginning of 2015, the domestic billing system should start. (Tierney, 2013; ECLG, 2012; Bord Gais, 2013; DECLG, 2014)

Figure 9 shows the Irish system of water supply and wastewater treatment.

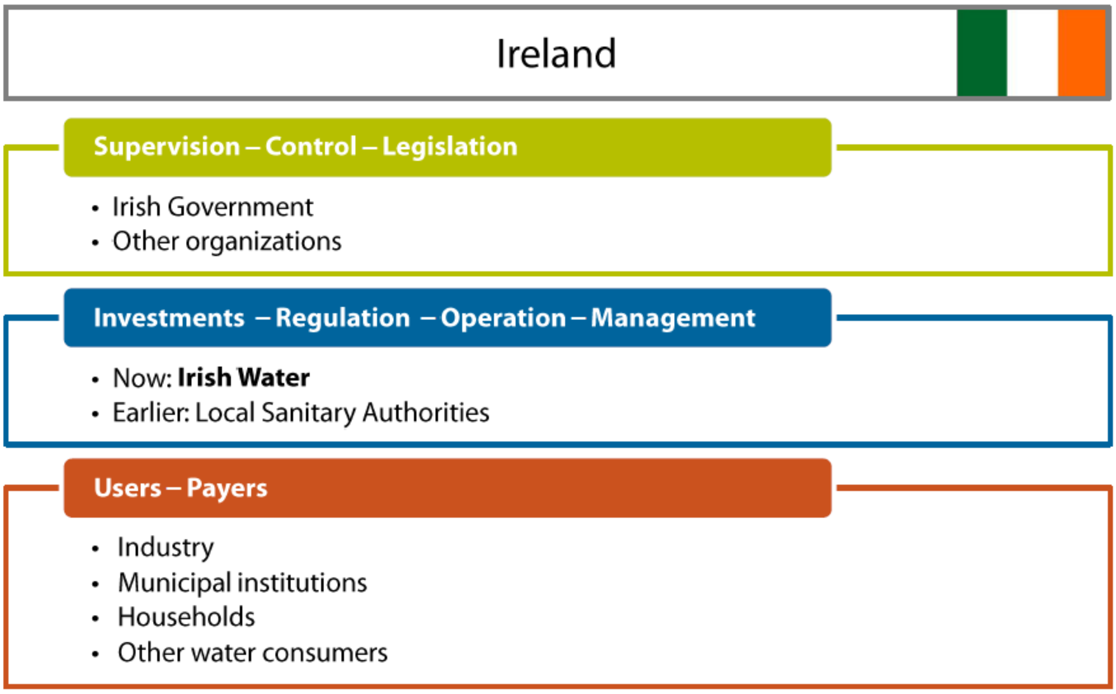

Figure 9 Organization of water supply and wastewater treatment in Ireland.

Water services are provided by the public sector. The most water intensive industries in Ireland are production of chemicals, pharmaceuticals, food, beverages and brewing and information technology sector. The average daily water supply provided by water authorities is 1,6 million m^3. (CIA, 2014a; ECLG, 2012)

As for water service operations, before 2012, water services were provided by 34 local authorities (29 counties and 5 cities). In 80% of cases, the public sector owned water companies and was responsible for water services, infrastructure, pumping stations and water preparation and wastewater treatment plants. Within the local authorities under county or city councils, there were Sanitary Authorities with responsibility for water supply and wastewater treatment. The main source of water supply on public level is surface waters. Apart from the Sanitary Authorities, the population of Ireland has access to drinking water supply and wastewater treatment from private sources (10%) and Group Water Schemes (10%). The last two water suppliers represent about 20% of water supply in the country. (Mohajeri, *et al.*, 2003; NPP, 2014c; ECLG, 2012; Tierney, 2013) The Group Water Schemes (GWS) can be private or semi-private (Mohajeri, *et al.*, 2003). The main difference is the source of water supply. In the semi-private variant, the drinking water originates from public water network. It is metered and paid according to the amount of water consumed by the group. In this case, a group of households usually enters in special purchase agreement with the public authority. In case of private GWS, the water is from group's own water source, such as a well or springs. These schemes function mostly in rural areas. The main reason for the existence of GWSs is that there are some households in Ireland that do not have access to a Sanitary Authority drinking water supply. In 1997, the number of non-connected dwellings was around 200 000. Nowadays it is about 3 000 households. To financially support the operation of GWSs, it is possible to get a grant from the public sector. (Mohajeri, *et al.*, 2003; ECLG, 2012)

Currently, the situation with the Irish water sector is a bit different, especially of water services provided by the public sector. All 34 water authorities are united in one commercial public company – Irish Water. It is a large and complex structural change still ongoing. Irish Water, as a self-financing water authority should be completely formed by 2017. (ECLG, 2012; Bord Gais, 2013; DECLG, 2012; DECLG, 2014)

Irish Water should be in charge of the provision of water services for domestic and non-domestic customers as well as strategic planning and development on national level, investment programs, operations and upgrading current water infrastructure. It should also install water meters in Irish households. Irish Water is supposed to be a single customer service point with all the information related to water services. Basically, the new company should take over all the responsibilities of Sanitary Authorities. (Bord Gais, 2013; ECLG, 2012)

In terms of supervision, control and legislation, the Government of Ireland is in charge of control over the activities of Irish Water. In addition, the Department of the Environment, Community and Local Government, local authorities and Board Gáis Éireann group serve as support in the establishment and operation of Irish Water. (DECLG, 2012)

Other regulators to which Irish Water answers to are (Mohajeri, *et al.*, 2003; Bord Gais, 2013):

- The Environmental Protection Agency: is in charge of pollution control and mitigation of negative environmental influence from the water industry. It also issues licenses for wastewater discharges, thus, supporting the “polluter pays” principle;
- The Commission for Energy Regulation: acts as an economic regulator. It should decide the amounts of the water charges both for domestic and non-domestic customers.

The EU WFD is also applicable in Ireland. In addition, there are many other regulations used in the Irish water industry, in particular, the acts and laws listed below (Mohajeri, *et al.*, 2003; ECLG, 2012):

- The Local Government (Sanitary Services) Act, 1964;
- The Private Water Supplies and Sewerage Facilities Regulations, 1978;
- The Local Government (Water Pollution) Act, 1990;
- The European Communities (Quality of Salmonid Waters) Regulations, 1988;
- The European Communities (Quality of Water Intended for Human Consumption) Regulations, 1988;
- The European Communities (Quality of Surface Water Intended for the Abstraction of Drinking Water) Regulations, 1989;
- The Local Government (Financial Provisions) Act, 1997;
- The Environment Protection Agency Act, 1992;
- The Local Government (Dublin) Act, 1993;

- The Local Government (Water Pollution) (Nutrient Management Planning Consultation) Regulations, 1998;
- The Water Pollution Act, 1990;
- The Water Services Act, 2007.

2.5.2 Customer water fees in Ireland

Before 1997, there were charges for water services. After the Local Government (Financial Provisions) Act was introduced, the water customer fees for domestic users started to be subsidized. In practice, the latter meant that domestic water supply and wastewater treatment became free of charge. Non-domestic customers were and are obliged to pay water fees. As a rule, on industrial, agricultural and commercial enterprises, there are always water meters installed. In addition, non-domestic users have to pay a connection fee when connecting to the public water network. The same is applicable for Group Water Schemes of more than 5 households. For other domestic water users, connection to the public network was free of charge. (Mohajeri, *et al.*, 2003)

Nowadays, in direct connection to the reform in the Irish water sector, water charges are also introduced for domestic customers. The amounts for water fees are not known yet. However, the Minister for the Environment, Community and Local Government declared that it will be about 296 euro per year. The final decision should be taken by the Commission for Energy Regulation. (DECLG, 2014)

There are two possible options of water fees for domestic customers (DECLG, 2014):

- Equipped with water meter:
    a) Water supply fee;
    b) Wastewater treatment fee;
- Unequipped with water meter:
    a) Assessed water supply fee;
    b) Assessed wastewater treatment fee.

In the first case, the water fees are based on household water consumption/wastewater generation. Part of the domestic water usage is subsidized with a free allowance. Free allowance covers on an annual basis 30 m^3 of water supplied to household and corresponding volume of wastewater collected from household. Moreover, there is also a special “water” support for children in Ireland. Every child should have free access to 38 m^3/year of drinking water supply as well as free wastewater treatment service for respective amount of sewage. Hence, if we consider an average Irish family of 4 people and its average water consumption of about 190 m^3 per year, they will have to pay only for 84 m^3 of water supplied and appropriate volume of wastewater collected. These subsidies save more than 50% of the total amount to be paid as water service fees. (DECLG, 2014)

In the case when a household does not have a water meter, then the water fees are based on assessments. The amount of water charges are comparable those in metered households. (DECLG, 2014)

2.6 Summary

Tables 1 summarizes the key figures of water assets of Finland, Norway, Scotland, Northern Ireland and Ireland.

Table 1 Summary of water assets of Finland, Norway, Scotland, Northern Ireland and Ireland.

	Finland	Norway	Scotland	Northern Ireland	Ireland
Territory	338 145 sq km	323 802 sq km	77 925 sq km	14 135 sq km	70 273 sq km
Water coverage	10%	5%	2%	7%	2%
Number of rivers	650	4 000	10 000	3 200	80
Number of lakes	188 000	455 000	30 000	1 700	4 467
Ground water use	65%	10%	7%	0,05%	18% (incl. 8% from springs)
Surface water use	35%	90%	93%	99,95% (incl. 44% from reservoirs)	82%
Public water supply	90%	90%	98%	99,9%	80%
Public wastewater treatment	81%	84%	98%	96,5%	70%
Water expertise	Water-saving; ICT; integrated water resources management; water construction and services; natural water protection; water research	Hydropower: from planning and engineering to equipment installation and management	Efficient and effective procurement, operation and maintenance of the public water services providers	Renewable energy promotion in the public and private sector: energy efficiency, technologies	Water and wastewater management on local authorities' level
Example of water intensive industry	Pulp and paper production	Metal, chemical, pulp and paper, food industry	Food and drink industry, agriculture	Food and drink industry	Food and drink industry; chemical industry; pharmaceutics; IT industry
Ownership	Public	Public	Public (the public company owns infrastructure, water and land resources)		Public (Irish Water owns infrastructure)

Sources: AR, 2014; Berge, *et al.*, 2013; Bookless, 2014; Bord Gais, 2013; CIA, 2014a, b, c; Christie, 2011; DJEI, 2013; Dublin City Council, 2009; ECLG, 2012; EEA, 1996; Encyclopedia Britannica, 2014a, b; EPA, 2011; FWF, 2012; FWF, 2014; Gonzalez, *et al.*, 2011; McGuigan, G, 2010; Mikkonen, 2013; NIA, 2014; NIEA, 2013; NIW, 2012; NIW, 2013; NMPE, 2013; Rippey, *et al.*, 2001; SNH, 2001; Statistics Norway, 2008; Stene-Larsen, 2012; Scottish Government, 2013; Scottish Water, 2013b; Scottish Water, 2014a; Thomson, 2013; Utility Regulator, 2013; Ó. Dochartaigh, *et al.*, 2011

Finland and Northern Ireland have the largest amount of surface water resources. Concerning the amount of lakes and rivers, Norway and Finland have the highest number of lakes, whereas Scotland and Norway have the largest amount of rivers. Note that the definitions of river and lake vary in the considered countries. Consequently, the calculation systems of rivers and lakes may also differ. In Finland, river means "a water body with flowing water whose catchment area covers at least a hundred square kilometres" (MAF, 2011a). In Norway, river is "an accumulation of fresh water that is larger than a brook at least part of the year and which flows naturally with gradual expansion and runs into lakes, seas or other rivers" (Comprehensive Norwegian Encyclopedia, 2014b). In Scotland, Northern Ireland and Ireland, river is defined as "a body of inland water flowing for the most part on the surface of the land but which may flow underground for part of its course" (Scottish Executive, 2002; Department of the Environment, 2003; EPA, 2006). In turn, lake in Finland is usually defined "as a body of standing water larger than 5 acres (500 m^2)" (MMM, 2008). In Norway, lake means "an accumulation of water which is located in a cavity on the ground surface" (Comprehensive Norwegian Encyclopedia, 2014a). In Scotland, Northern Ireland and Ireland, lake is usually "a body of standing inland surface water" (Scottish Parliament, 2003; Department of the Environment, 2003; EPA, 2006). All countries have abundant water supply and safe drinking water resources. The main effort is related to the preservation of natural water reserves and pollution prevention. This is in accordance with the EU Water Framework Directive that applies to all of the considered countries (Statistics Norway, 2008).

In terms of water resource utilization, Norway, has a favorable mountain conditions and an abundance of rivers, and is a leader in hydropower generation. Hydropower is one of the key water expertise fields of Norway. There is also substantial small-scale hydropower potential in Scotland that is increasingly utilized (IRRI, 2014).

Groundwater reserves for drinking water supply are utilized mostly in Finland and Ireland. The other three countries have less than 10% of ground water utilization. One of the main reasons why Finland relies more on groundwater reserves rather than on surface waters is good availability, high drinking water quality and water security.

In all countries, water companies belong to the public sector. The only difference is in ownership. Scottish Water and Northern Ireland Water have ownership both of water and land resources (Bookless, 2014; Ramsay, 2014). In Finland and Norway, water companies do not own neither land nor water resources (FINLEX, 2001; MAF, 2011b). To compare ownership of water companies with some other countries, for instance, in England, water services are organized by private water companies, whereas in Wales, it is done by a not-for-profit water company (NIW, 2013b).

The lowest percentage of public water supply and wastewater treatment is currently in Ireland (80% and 70%). This was one of the reasons to make a radical change in the water sector by the creation of a single public water company – Irish Water. It is expected that this measure will help to solve many problems in the Irish water sector. Scotland and Northern Ireland are in the best position within the water industry, where the coverage of water services is higher than 96%.

The most water intensive industries in all five countries are pulp and paper industry as well as food and drinks production. The first industry is common in Finland and Norway, whereas the second one can be found in Scotland, Northern Ireland and Ireland.

In terms of expertise within the water sector, all of the considered countries are experts in certain areas. Finland is expert at water-saving; use of ICT in measuring, control and monitoring; integrated water resources management; water-related construction and services; natural water protection; and water research. Norway has a leading hydropower expertise, with hydropower share of about 90% of total renewable energy generation (IEA, 2011). In Scotland, expertise lies within efficient and effective procurement, operation and maintenance of the public water services providers. Northern Ireland is an expert in renewables promotion in the public and private sector. Finally, Ireland has strong background in water and wastewater management on local authorities' level.

Customer fees, summarized in Table 2, are a common feature of the water sector in all countries. However, there are no two identical systems of customer fees.

In almost all cases, the fees are different depending on the fact if there is a water meter installed in household or not. In Finland, the fees are paid on monthly basis. It is the only country among the five where this is so. Depending on availability of water meters it can be a metered consumption fee and a non-metered fixed fee. There are some other service fees: e.g. for water meter installation, pipelines renovation, etc.

Table 2 Customer fees in Finland, Norway, Scotland, Northern Ireland and Ireland.

	Customer fees			
	Water metered property	***Non-metered property***	***Other fees***	***Average domestic fee for metered household***
Finland	➢ Monthly metered consumption fee	➢ Monthly fixed fee	➢ Connection fee; ➢ Other service fee	579 euro/year
Norway	➢ Annual metered consumption fee; ➢ Combination of annual fixed and variable fee	➢ Assessed fee	➢ Connection fee	416 euro/year
Scotland	➢ Annual fixed and volumetric water supply fee; ➢ Annual fixed and volumetric wastewater treatment fee	➢ Variable water supply fee (Council Tax Band based); ➢ Variable wastewater treatment fee (Council Tax Band based)	➢ Connection fee; ➢ Property drainage fee; ➢ Roads drainage fee	415 euro/year

Table 2 Continue

<table>
<tr>
<td rowspan="2">Northern Ireland</td>
<td>➢ Annual variable water supply fee;
➢ Annual variable wastewater fee;</td>
<td>➢ Annual variable water supply fee (based on property valuation);
➢ Annual variable wastewater fee (based on property valuation)
<u>Domestic customers</u>:
➢ No meters, no fees*;
➢ But the fee for septic tank de-sludge (if over 1 time per year)</td>
<td rowspan="2">➢ Connection fee;
➢ Septic tank de-sludge</td>
<td rowspan="2">No fees*</td>
</tr>
<tr>
<td colspan="2"><u>Non-domestic customers</u>:
➢ Annual standing charge for water supply (depends on diameter of supply pipe);
➢ Annual standing charge for wastewater (depends on diameter of supply pipe)</td>
</tr>
<tr>
<td>Ireland</td>
<td>➢ Annual water supply fee;
➢ Annual wastewater fee</td>
<td>➢ Assessed water supply fee;
➢ Assessed wastewater fee</td>
<td>➢ Connection fee</td>
<td>296 euro/year</td>
</tr>
</table>

* – during 2014-2015 the water customers of Northern Ireland Water are not paying the fees. The Department for Regional Development is responsible for doing so.

Sources: Berge, *et al*., 2013; DECLG, 2014; FWF, 2012; HSY, 2011; Mikkonen, 2013; Mohajeri, *et al.*, 2003; NIW, 2014b; Official Statistics of Finland, 2010; Scottish Water, 2014a, b, c, d; Statistics Norway, 2008

In Norway, in a water metered household it can be either a consumption fee or both a fixed fee for a fixed amount of water and a variable fee when the limit is exceeded. From non-water metered households, usually, an assessed fee is collected. Both in Finland and Norway, water fee includes both water services: water supply and wastewater treatment. In the case of Scotland, Northern Ireland and Ireland, there are two separate water fees: one for drinking water supply and the other one for wastewater treatment. In Scottish properties with water meters, there is a fixed and a volumetric fee applicable for both water supply and wastewater treatment. In households not equipped with water meters, there is a variable fee for water services in accordance with Council Tax Band. Among other water fees, there may be fees for property and roads drainage. Northern Ireland is an exceptional country in a sense that there are almost no fees for domestic water users (see Table 2). Only non-domestic consumers are obliged to pay fees. Depending on diameter of water supply pipe, there is a standing fee for water supply and wastewater treatment. This fee is paid no matter if there is a water meter installed in property or not. In metered properties, there is a variable fee for both of the services. In properties not equipped with water meters, the variable fee is also collected but based on property evaluation. A septic tank de-sludge fee can also be charged as one of other service fees. In Ireland, there were also no fees for domestic users before. However, there is an ongoing transition of the system and domestic fees are going to be introduced starting from 2015. Water metered households will pay a water supply fee and a wastewater fee. Households without water meters will be obliged to pay assessed fees for both water services. Despite all the differences, there is also something similar. As one example, in every country there is a connection fee that is paid when non-domestic consumers join public water network.

Finally, it is to be reiterated that all five countries are exceptional in terms of richness of water assets, both in terms of water supply, as well as quality of public services, water services coverage, water expertise and also renewable energy potential. This makes these countries ideal for demonstrating efficient water asset utilization.

3 ECONOMIC TOOLS OF RENEWABLE ENERGY SUPPORT

This chapter discusses existing economic mechanisms of support for renewable energy implementation in Finland, Norway, Scotland, Northern Ireland and Ireland. Several financial tools are discussed. Based on these, there is a summary table available to compare the countries in terms of renewable energy support. For a better implementation of renewable energy projects, Public-Private Partnership is presented later in the chapter as one of the best tools for this purpose. The concept of Public-Private Partnership (PPP) was briefly mentioned in Chapter 1. Chapter 3 discusses it in more detail. In addition, some examples of PPP projects of Finland, Norway, Scotland, Northern Ireland and Ireland within the water sector are illustrated.

3.1 Financial mechanisms in the Northern Periphery Region

Currently, there are many options of financial support for the implementation of renewable energy solutions are available in the region. This section provides an overview of the support schemes.

3.1.1 Renewable energy support for water companies in Finland

Financial support for renewable energy implementation is provided by the Energy Authority and the Ministry of Employment and the Economy. The two key categories of financial support are subsidies and the feed-in tariff. (Mikkonen, 2013)

Subsidies, or energy aid, for implementing renewable energy can come up to 15-30% of investment cost. Energy aid is also applicable for research projects dealing with renewable energy solutions. The extent of support varies depending on the renewable energy technologies. In Finland, support is provided for solar photovoltaic and solar thermal energy, anaerobic digestion, bioenergy, wind power, geothermal energy, heat recovery from wastewater and small-scale hydropower. In addition, projects aiming at improving energy efficiency and decreasing environmental impacts from the energy sector can also be eligible for support. The expectation is to implement state-of-art technologies. In case when a research and development project intends to implement a new technology, the financial support can be up to 40% of total costs. Private companies, municipalities or organizations can all be eligible to apply. The applications for subsidy are sent to regional Centres for Economic Development, Transport and the Environment (ELY Centres). The ELY Centres are in charge of funding decisions up to 250 000 euro for research projects or 5 000 000 euro for investment projects, in case the projects deal with the implementation of a new technology. If the budget is higher, the decisions are made by the Ministry of Employment and the Economy. The received energy aid is paid either in several parts or at once depending on the decision of the competent authority. The only limitation for the subsidy holder is that at least 25% of the total project cost should come from non-state financial sources. Subsidies cannot be given to farms, households, co-operatives and construction projects that already have been granted state aid. If a project is done in collaboration of several organizations, the subsidy is given to the lead partner of the project. All the subsidies come from the

Ministry of Employment and the Economy which is the main responsible authority, and provided by the state budget. (Mikkonen, 2013; Brückmann, 2013)

The feed-in tariff (FIT) support became available in Finland in 2010. In 2012, about 100 million euro was provided to subsidize renewable energy. The concept of FIT is illustrated in Figure 10. In general, FIT makes it profitable for a renewable power producer to be present on the power market by receiving a financial support from the government. This support is provided for the difference between the average power market price and a target price. Currently, the target price in Finland is 83,5 euro per MWh.

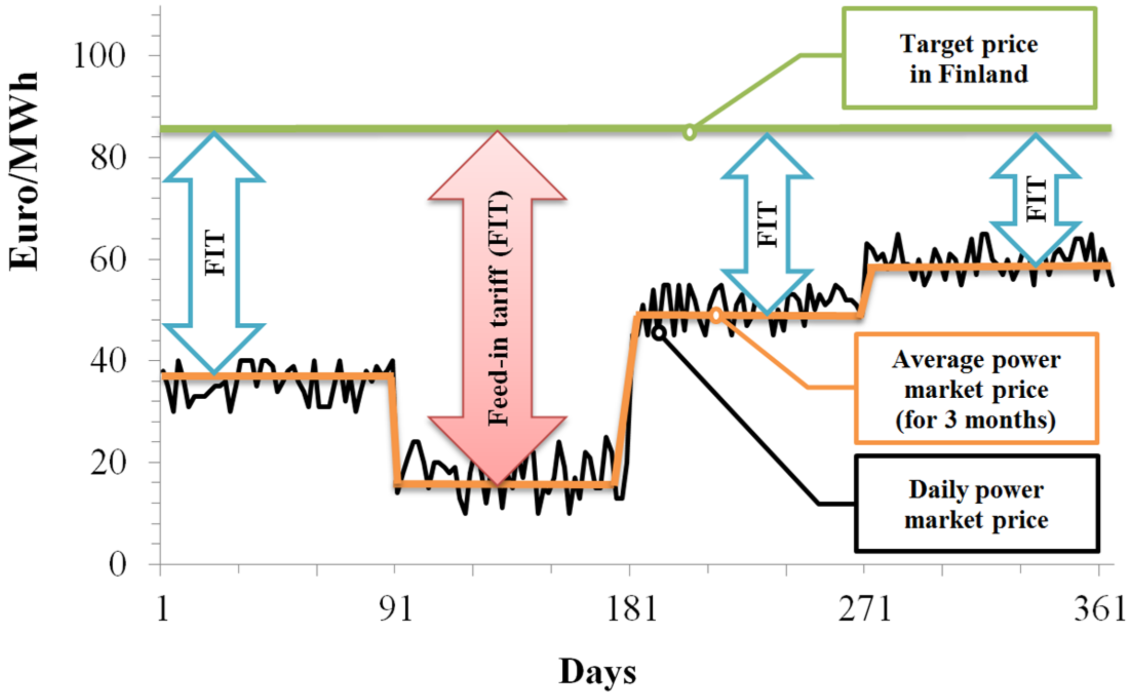

Figure 10 Schematic representation of feed-in tariff support in Finland.
The green line represents target price, the black line – daily power market price, the orange line – average power market price for previous three months.

As can be seen in Figure 10, the power market price varies daily (black line). FIT is the difference between the target price and the average of last three months' market price (blue arrows). If, for instance, a biogas production plant sells power on the power market for an average of 38 euro per MWh, in order to support bioenergy, the Finnish government pays the biogas plant an extra 45,5 euro per MWh. (Mikkonen, 2013; MEE, 2013; Brückmann, 2013) The financial support can relate to different renewable energy sources; however, in focus are especially wind energy, energy production from wood chips or wood fuels and anaerobic digestion. In the case of wind energy, there is a special feed-in tariff of 105,3 €/MWh until the end of 2015, as shown in Table 3. In addition, if a bioenergy or biogas production utility generates also heat, they are allocated extra 20 and 50 euro per MWh. (Mikkonen, 2013; Brückmann, 2013)

Table 3 Amount of feed-in tariff support for renewable energy solutions in Finland (based on Brückmann, 2013).

Energy type	Feed-in tariff, euro/MWh	Special feed-in tariff, euro/MWh	Extra benefits, euro/MWh
Solid biofuel (wood chips or wood fuel)	83,5	-	20 (for heat production)
Anaerobic digestion (biogas production)	83,5	-	50 (for heat production)
Wind energy (onshore and offshore)	83,5	105,3 (until 31.12.2015)	-

The application process starts when energy producer with an already constructed plant lets the Energy Authority know about the intention to start energy production activity. The energy producer informs also about all the technical specifications of the facility. The exception here is a wood chips energy production plant. It can start operation and then apply for the feed-in tariff support. If all the formal requirements are met, the Energy Authority decides about allocation of the financial support. The allocation criteria are as follows (Brückmann, 2013):

- The feed-in support holder should be based on Finnish territory or in Finnish waters, and connected to the electricity grid;
- All the technical and economic requirements related to energy production should be met;
- No grants or state support must have been received before;
- The energy utility should be entirely constructed from new parts;
- The minimal capacity for:
  a) For wind energy – at least 500 kVA,
  b) For anaerobic digestion and bioenergy based on solid biofuel – at least 100 kVA;
- The energy efficiency of anaerobic digestion and bioenergy must be at least 50%;
- There should be both heat and power production with anaerobic digestion;
- If the average power market price for the last three months is lower than 30 euro per MWh, as shown in Figure 10 (red arrow), according to the Finnish regulations the target price should be deducted with 30 euro;
- The feed-in tariff is applicable only until a certain power production limit is achieved, which is:
  a) 2 500 MVA for wind energy;
  b) 19 MVA for anaerobic digestion;
  c) 150 MVA for bioenergy based on solid biofuels.

The Ministry of Employment and the Economy (MEE) and the Energy Authority are in charge of feed-in tariff support decisions. The MEE, as the main competent authority, is responsible for management, supervision and assessments, whereas the Energy Authority deals with practical legal matters and payments of the tariffs and the bonuses. The maximum period a company can hold the support is 12 years. The source of funding comes from the state budget (Brückmann, 2013).

3.1.2 Renewable energy support for water companies in Norway

In Norway, if a water company is motivated to implement renewable energy technology as an on-site installation, the Norwegian authorities can help the company through "Electricity certificates within the quota obligation program". This quota program was established to support the development of a renewable energy market in Norway. The parties under the quota obligation system are electricity suppliers and electricity consumers. The program is based on electricity certificates, which are tradable in the electricity certificates market and function as medium of renewable energy exchange between producers and consumers. Under the program, energy producers are interested to sell the renewable energy certificates, whereas consumers are obliged by the government to buy them in certain proportion or quota. That is why it is called a quota program. (Pobłocka, 2013) The scheme of the quota program is illustrated in Figure 11.

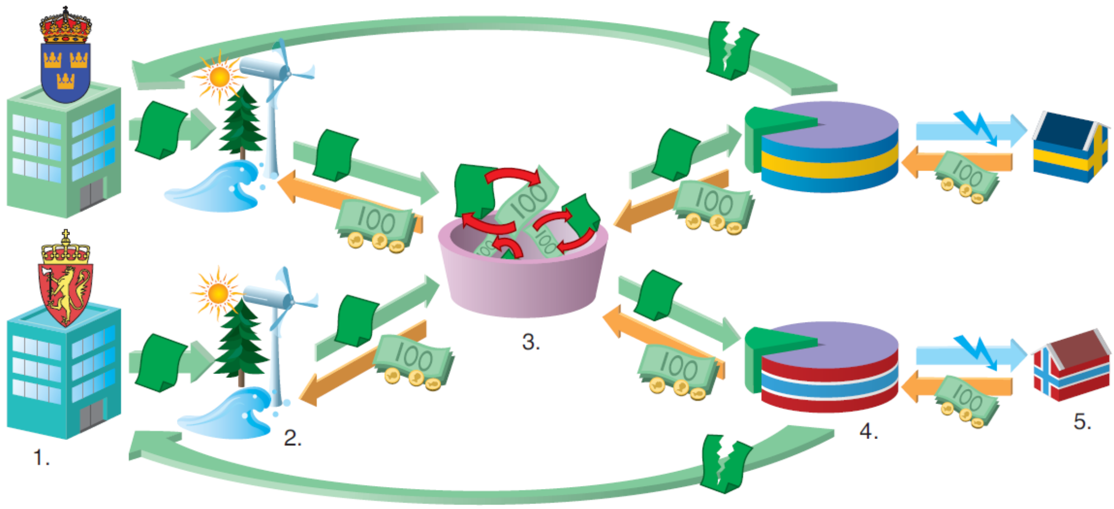

Figure 11 The scheme of joint quota system for electricity market in Norway and Sweden. Key components: 1) authorities, 2) energy producers, 3) certificates market, 4) quota obligation, and 5) consumers (NVE, 2012)

The quota system originates from Sweden where it was established in 2003 and, since 2012, the electricity certificate market works within the scope of Swedish-Norwegian collaboration. The main objective of the energy market union is to meet the requirements of the Europe 2020 Strategy and the Renewable Energy Directive. Among the mutual advantages are more efficient use of renewable resources, more participants on the energy market, good financial support for renewable energy technologies and more cost-efficient renewable energy production. (NVE, 2012)

The quota system applies to all renewable energy solutions: wind, wave, solar, geothermal, hydropower, anaerobic digestion as well as bioenergy. As Figure 11 illustrates, the electricity certificate flow is directed towards electricity end users and the financial support towards the energy producers. The main source of funding is electricity end users. The authorities responsible for electricity certificates in Norway are the Norwegian Water Resource and Energy Directorate (NVE) that is in charge of management and monitoring of the quota system, and the Norwegian transmission grid operator Statnett that produces electricity certificates and supports renewable energy production. Each electricity certificate is worth 1 MWh of production, if, for example, a water company would generate 5 MWh of salable power, they would receive five electricity certificates (or green certificates). (Pobłocka, 2013; NVE, 2012) The water company would also have the right to sell the certificates to energy consumers on the electricity market. The market is open for Norwegian and Swedish electricity consumers. Energy consumers are obliged to buy certificates by law; they must have a certain proportion of electricity usage originating from renewable sources. The quota program is set by the Electricity Certificate Act and the yearly quota obligation coefficients are seen from Table 4. (NVE, 2012)

Table 4 Quota obligation values in Norway 2012-2035 (based on NVE, 2012).

Obligation year	Quota obligation coefficient (proportion of renewable energy)
2012 (first year)	0,030
2016	0,108
2020	0,183
2026	0,164
2030	0,094
2035 (last year)	0,009

The maximum value of quota obligation is in the year 2020: i.e. 0,183. After 2020, it is set to decline. The peak corresponds with the 2020 Strategy and means that, in 2020, electricity end users need to have at least 18,3% of their total energy consumption coming from renewable energy sources. To satisfy this, energy users must buy electricity certificates sold by renewable energy producers. As the energy price with the renewable energy certificates is higher than the regular price of energy, this makes the system attractive for renewable energy producers. (NVE, 2012)

The certificates are cancelled by the end of the year and the consumers need to buy new ones to meet the quota obligation. This creates continuous demand. Failure to meet the quota will result in a fine, which is 150% of the electricity certificates yearly average price. (NVE, 2012)

The price for electricity certificates is included in the customer's electricity invoice and they would only pay for their actual consumption. The system is easy to use for the end-user. For companies to be involved, the conditions are the following (NVE, 2012):

- Renewable energy production should be built within the licensing terms;
- Renewable energy production was started after 2009. The exception is hydropower plants;
- Renewable energy producers that would begin to function after 2020 are not eligible;
- The assignment period is 15 years. However, if company was present on energy market before 2012, the years of presence shall be deducted from the assignment period. For instance, if Norwegian wind park was launched in 2010, the assignment period is 13 years;
- If a renewable energy producer received prior government state grants and it was not repaid before 2012, then this producer is not eligible for the quota program.

3.1.3 Renewable energy support for water companies in Scotland

In Scotland (as well as in Wales and England), a water company as a producer of renewable energy would have access to the following kinds of financial support:

- Loan;
- Feed-in tariff;
- Quota system (Renewables obligation);
- Tax regulation mechanisms; and
- Other economic mechanisms (e.g. crowdfunding).

Loans have been available for renewable energy producers since 2013; however, they apply only to solar energy. It was launched as part of the British Green Deal (Qualifying Energy Improvements) Order 2012. The Green Deal consists of 45 different measures to improve energy efficiency in buildings, including solar energy. Figure 12 illustrates the loan scheme. (Tallat-Kelpšaitė, 2013)

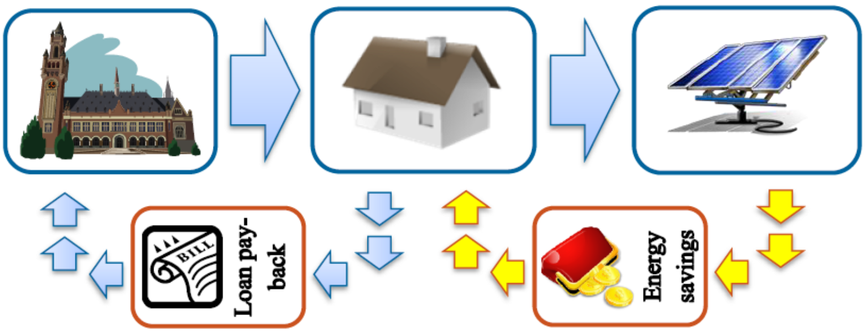

Figure 12 The scheme of loans for solar energy in Scotland.

The target parties are property owners, both business and private. The idea is that the solar installation would reduce the need to buy energy and this would generate savings. The loans can be paid back in two possible ways. The first option is repay during the lifetime of the solar panel investment, whereas the second option is to pay back during a certain repayment period specified in the Green Deal. The specified period can be 25 years at maximum. To receive the loan with the purpose of solar energy production, a property owner should address the Green Deal Oversight and Registration Body which is the main competent authority. In the Green Deal Oversight and Registration Body, the property owner should reach a Green Deal Assessor. The Green Deal Assessor is responsible for assessing the potential and applicability of solar energy technology on the property. The Green Deal Assessor produces a Green Deal Advice Report on the feasibility of solar energy solution, containing recommendations also about potential energy-efficiency measures to take. Furthermore, the report contains estimates of potential savings from a financial point of view if all the recommendations are implemented. After this, the property owner should find an appropriate Green Deal Provider to implement the recommendations. The Green Deal Provider is an entity that will receive the loan. Then the property owner and the Green Deal Provider sign a Green Deal Plan, which is a contract between them. The contract states the amount of loan, specifies that the loan should be repaid by the property owner to the Green Deal provider and sets the period of repayment. When this step is completed, the Green Deal

Provider should find a Green Deal installer that is in charge of solar panels installation. After finishing all the installations and implementations, the loan should be paid back by the property owner to the Green Deal Provider via electricity bills. As estimated, the loan is supposed to be lower than the actual savings from the implemented solar energy solution or any other stated energy efficiency measure. The latter is the so-called "Golden Rule" of the Green Deal. The source of funding originates from the Green Deal Finance Company created by the government. (Tallat-Kelpšaitė, 2013)

The feed-in tariff system has been available since 2010 and applicable for such renewable energy solutions as hydropower, anaerobic digestion, solar photovoltaic energy and wind energy. The main limitation is that the capacity of the technologies has to be fewer than 5 MW. The idea is to support the implementation of renewable energy technologies by providing payments to renewable energy producers extra to the profit made from electricity they sell. This extra support helps them to enter the energy market easier and receive guaranteed pay-back of their investments. The general scheme of the feed-in tariff in Scotland is presented in Figure 13. (Tallat-Kelpšaitė, 2013)

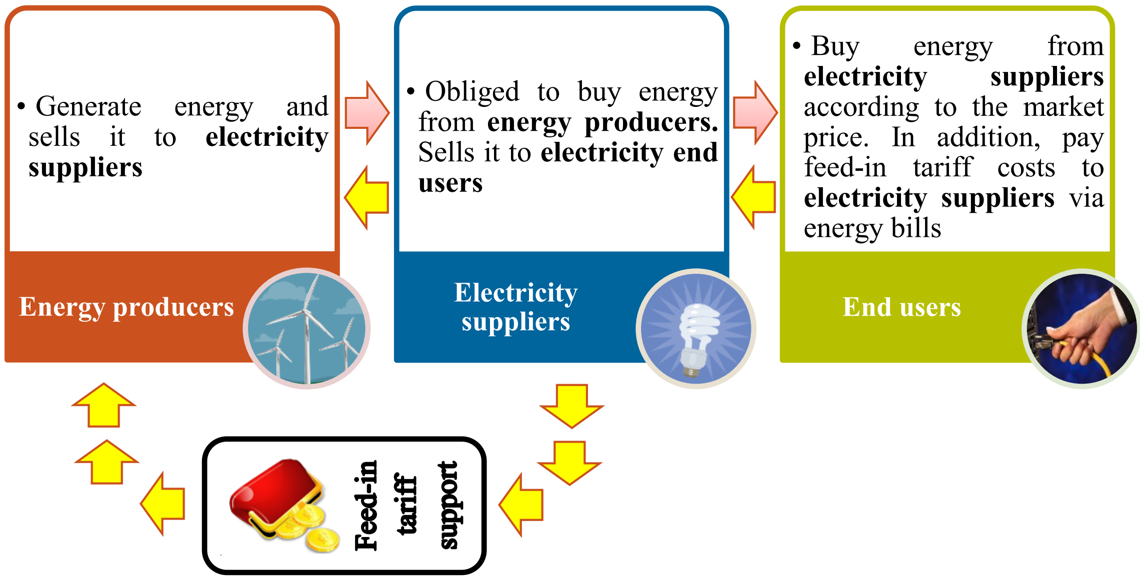

Figure 13 The scheme of feed-in tariff in Scotland

The entitled party is renewable energy producers. After receiving feed-in tariff, they are financially supported by electricity suppliers. This mechanism makes it more attractive for potential renewable energy producers to implement the appropriate technologies.

To become a feed-in tariff support holder, a renewable energy producer first needs to know what the capacity of the energy installation is. If it is less than 50 kW, renewable energy producer should inform the electricity supplier about the energy installation. The electricity supplier should register the installation in a special portal, called the Central Feed-in Tariff Register. If the renewable energy producer generates more than 50 kW, then the application for feed-in tariff support should be directed to the competent authority which is the Gas and Electricity Markets Authority (Ofgem). Ofgem considers the renewable energy producer in an accreditation process. For some technologies, there is a preliminary accreditation available, e.g. for anaerobic digestion, solar energy and wind energy with the capacity of more than 50 kW. After all the requirements are met, the accreditation is issued, and the energy installation is connected to the grid, the renewable energy producer can receive the feed-in tariff support. The support is paid by the electricity supplier, or feed-in tariff licensee, that must purchase it from the energy producers. The feed-in tariff licensees are obliged to take part in the feed-in tariff system and buy electricity from renewable energy producers. Small electricity suppliers covering fewer than 250 000 households can participate in the feed-in tariff support on a voluntary basis. In turn, electricity suppliers include the feed-in tariff payments in energy bills that are paid by electricity end users. (Tallat-Kelpšaitė, 2013)

Ofgem also has a levelisation fund. It was created to ensure that all the costs for feed-in tariff licensees are in the right proportion. The levelisation fund is formed by payments coming from the licensees. When there is need to redistribute finances between electricity suppliers, the fund becomes of use. In case the fund is in shortfall, the licensees need to refill it by making additional payments. (Tallat-Kelpšaitė, 2013)

The amount of feed-in tariff support is published on annual basis by Ofgem, in collaboration with the Secretary of State. The common trend is that small-scale wind energy along with hydropower production is supported the most. With regards to large-scale renewable energy production, the priority is given to solar energy and anaerobic digestion. (Tallat-Kelpšaitė, 2013) Table 5 lists the feed-in-tariff rates for the period of April 2013 to March 2014. The prices are converted from pound sterling to euro based on currency rates of March 27th, 2014. (The Money Converter, 2014b)

Table 5 Feed-in support rates in Scotland (based on Tallat-Kelpšaitė, 2013).

Renewable energy type	Capacity, kW	Feed-in tariff support, euro per kWh
Small-scale		
Solar energy	10 – 50	0,1520
Anaerobic digestion	up to 250	0,1833
Hydropower	15 – 100	0,2443
Wind energy	15 – 100	0,2618
Large scale		
Hydropower	2000 – 5000	0,0391
Wind energy	1500 – 5000	0,0502
Solar energy	250 – 5000	0,0828
Anaerobic digestion	500 – 5000	0,1117

The conditions of the system are as follows (Tallat-Kelpšaitė, 2013):

- For solar energy (up to 250 kW) there are three levels of feed-in tariff support: lower, middle and higher. To get the higher feed-in tariff, solar panel installations (up to 250 kW) should supply electricity with Energy Performance Certificate at Level D or higher. The installations which do not meet this requirement can receive only the lower feed-in tariff. The installations with 25 or more solar panels receive the middle feed-in tariff that is considered a multi-installation tariff;

- The rates of feed-in tariff for solar panel installations decrease every 3 months since November 2012;
- The period of guaranteed feed-in tariff support is 20 years at maximum;
- Renewable energy installations supported by the quota system are not eligible for feed-in tariff.

The Renewables Obligation or quota system, is similar to that of Norway. The difference is that, in Scotland, the idea is to oblige electricity suppliers to have a certain proportion of renewable energy produced and sold, whereas in Norway the obligation was related to electricity end users. In Scotland, within the quota system, an electricity supplier needs to buy Renewables Obligation Certificates to present them to Ofgem. The difference between the Scottish quota system and the feed-in tariff is the capacity of renewable energy. In the Renewables Obligation, preference is given to higher generation capacities, those more than 5 MW. However, also 50 kW to 5 MW capacities can be supported. For an energy producer of the capacity from 50 kW to 5 MW, there is a choice between the feed-in tariff and quota system. (Tallat-Kelpšaitė, 2013) The scheme of the quota system in Scotland is represented in Figure 14.

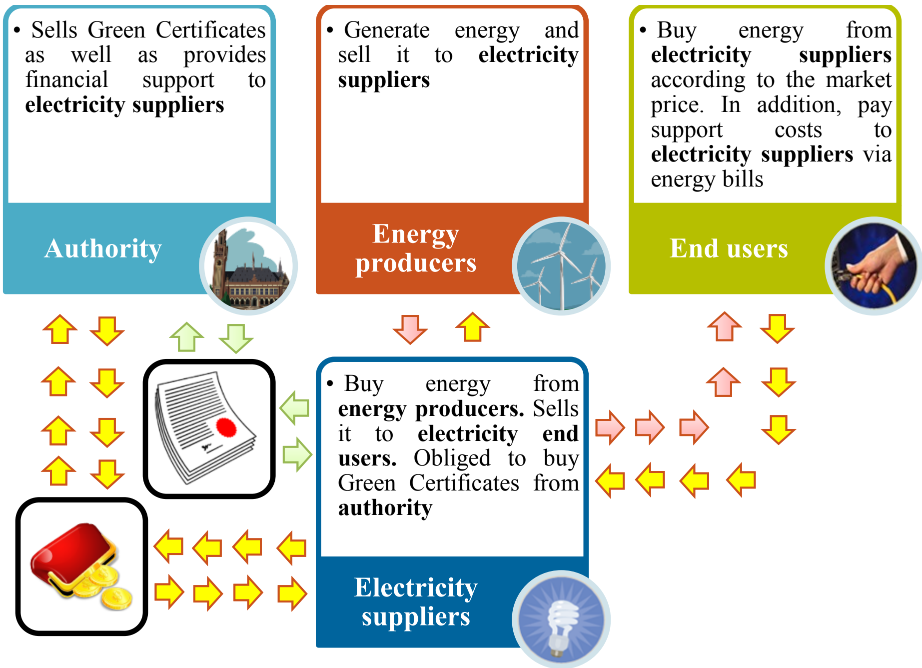

Figure 14 The scheme of the quota system in Scotland.

According to the quota scheme, electricity suppliers should satisfy their obliged proportion of renewable energy supply by presenting Renewables Obligation Certificates, or Green Certificates. A Green Certificate is awarded for every MWh of electricity generated by the energy producer and respectively received by the electricity supplier. The names of the green certificates are different in Scotland and Northern Ireland but the general scheme is the same. To get the Green Certificate, the electricity supplier needs to buy it from the competent authority, Ofgem. The purchase should be done within a certain period during the obligation year: from April of the previous calendar year to March of the next calendar year. All the obligation payments for the Green Certificates are collected into a special fund. When all electricity suppliers provide payments, the financial support is distributed among the electricity suppliers. If the electricity supplier did not buy obligated proportion of the Green Certificates by September, apart from the price of the Green Certificate, there is special penalty of 5% interest per day of the price of the Green Certificate that should be covered by the end of October. In case of shortfall (e.g. due to failure of one electricity supplier to meet an obligation) in the fund, electricity suppliers need to make additional payments. The sources of funding are electricity end users through payments of energy bills. (Tallat-Kelpšaitė, 2013)

Under the quota system, support can be provided to onshore and offshore wind energy, solar photovoltaic energy, geothermal energy, anaerobic digestion, hydropower and bioenergy based on solid biofuels. (Tallat-Kelpšaitė, 2013) The quota obligation for electricity suppliers in Scotland and Northern Ireland is presented in Table 6.

Table 6 Quota system in Scotland and Northern Ireland (based on Tallat-Kelpšaitė, 2013).

Obligation period	Quota obligation coefficient (proportion of renewable energy)	
	Scotland	Northern Ireland
April, 2009 – March, 2010	0,097	0,035
April, 2010 – March, 2011	0,104	0,040
April, 2011 – March, 2012	0,114	0,050
April, 2012 – March, 2013	0,158	0,081
April, 2013 – March, 2014	0,206	0,097

The conditions of funding are as follows (Tallat-Kelpšaitė, 2013):

- The installations completed before 1990 without further renovation, offshore wind mills older than 20 years and large-scale hydropower plants (>20 MW) launched before 2002 are not eligible for the quota system;
- The renewable energy installations supported by the feed-in tariff are ineligible for the quota system;
- The period of the financial support under the quota scheme is 20 years;
- Applications delivered after 2017 are not considered.

Concerning the tax regulation mechanisms, there are two types of the mechanisms (Tallat-Kelpšaitė, 2013):

a) Climate Change Levy. It is a tax created for greenhouse gas reduction and climate change mitigation. It is applied to electricity consumption from sources of energy considered non-renewable. It applies to both industrial and commercial electricity end users as well as households. By the non-renewable energy traditional sources, coal, gas, liquefied petroleum gas are meant. The Climate Change Levy (CCL) is charged from electricity suppliers. The renewable electricity suppliers are supported in this case by being excluded from the CCL obligation. The source of funding is electricity end users as electricity suppliers include the CCL costs in energy bills. To prove that an energy producer generates renewable energy, it should hold a special license. The competent authority, Her Majesty's (HM) Revenue and Customs, is responsible for issuing the licenses. To receive the license, the electricity supplier should enter into an agreement with the electricity end user where it is stipulated that a certain portion of energy originates from renewable sources. The other way is through a Levy Exemption Certificate (LEC) which means that the electricity supplier provides the electricity end users with renewable energy. The amount of renewable energy provided is related to one LEC. Levy Exemption Certificates are issued on a monthly basis by an appropriate regulatory authority. Presence of a LEC at an electricity supplier gives the right to receive the license. If the electricity supplier has either of the options, HM Revenue and Customs can issue the license to free an electricity producer from the Climate Change Levy. In 2013 the CCL was 0,00633 euro per kWh (The Money Converter, 2014b).

b) Carbon Price Floor. It is a tax with a main objective to increase use of renewable energy sources in electricity production. Non-renewable energy producers are charged the Carbon Price Floor (CPF) tax. Approximate rates (converted from pound sterling to euro) are shown in Table 7. Main renewable energy technologies supported by the tax mechanisms which free them from the described taxes are solar energy, geothermal energy, bioenergy based on solid biofuels, wind energy, hydropower and anaerobic digestion. The competent authority is HM Revenue and Customs.

Table 7 Carbon Price Floor (CPF) tax mechanism in Scotland (The Money Converter, 2014b).

Non-renewable source	CPF rates, euro per kWh
Gas from gas utility	0,00404
Hydrocarbon gas	0,06415
Coal	1,9649

The last option of financial support for renewable energy implementation is other variants of funding. This includes different options across the United Kingdom. However, only crowdfunding is briefly considered in this subsection. The concept of crowdfunding usually means a platform based on internet sites where different parties (e.g. individuals, organizations, institutions, companies, public authorities) can support a project of a company seeking extra funding. After raising capital the company spends it all on the project implementation. Thus, the communities where this method was applied or the parties interested in the project get benefits of its realization. Crowdfunding in renewable energy appeared quite recently. And if we consider its development in the UK, it is just in the beginning of becoming popular. Concerning some examples of renewable energy projects, there was funding raised for installation of hydropower generator in the Osney Lock Hydro project. The amount of financial support collected via the crowdfunding mechanism for this project was about 665 000 euro. Another example was in the Gen Community project where approximately 555 000 euro was raised for solar panel implementation in Newport. The largest amount of financial support so far was raised within the Abundance Generation project for renewable energy implementation. According to the latest information from ANRG (2014) the total sum of collected money is around 7 308 000 euro. (NFI, 2013; The Money Converter, 2014b; ANRG, 2014)

3.1.4 Renewable energy support for water companies in Northern Ireland

To implement renewable energy technologies, there are the following mechanisms of financial support in Northern Ireland (Tallat-Kelpšaitė, 2013):

- Loan;
- Quota system (Renewable obligation); and
- Tax regulation mechanisms;
- Other economic mechanisms (e.g. crowdfunding).

The above mentioned four categories of financial support were described before in the work in subsection 3.1.3 (Renewable energy support for water companies in Scotland). This subsection shortly discusses only the loan and the quota system.

The loan support in Northern Ireland is represented by, so-called, free loan scheme. The principle is similar to what was shown in Figure 12 in the case of the Scottish loan scheme. But there are some small differences. The loans in Northern Ireland are available for any business which has an intention to invest in energy efficient, low carbon and environment friendly technologies. To illustrate, the free loan scheme is offered to the projects that include such technological solutions as conditioning of air, heating controls, recovery of heat, building insulation, energy-efficient lighting and renewable energy, for example, solar energy. The exemption from the free loan scheme is only with the case of the public sector. The public organizations are not allowed to get loans with free interest. As regards to the numbers, each 1 500 kg of carbon dioxide saved on annual basis within an eligible project creates an opportunity for business to take an interest free loan of approximately 1 200 euro. In total, business can borrow from Invest Northern Ireland a loan from around 3 700 to 491 500 euro. Business can invest in renewable energy solutions with the use of loan. And the implementation will pay off in the way of energy savings. The loan scheme is in operation in the country. For example, in 2012, Invest Northern Ireland on behalf of the government of Northern Ireland gave about 6 145 500 euro of interest-free loans, as a financial support. As a rule, the loans should be paid back to the government within 4 years after borrowing. (Carbon Trust, 2014a, b; The Money Converter, 2014b)

The quota system under the Renewables Obligation in Northern Ireland is somewhat close to the quota system in Scotland. The general scheme is illustrated in Figure 15.

The key players are, as listed (DETI, 2013):

- The Gas and Electricity Markets Authority (Ofgem) in collaboration with the Northern Ireland Authority for Utility Regulator, as an authority;
- Renewable energy producer;
- Traders and brokers;
- Electricity supplier; and
- Electricity end users.

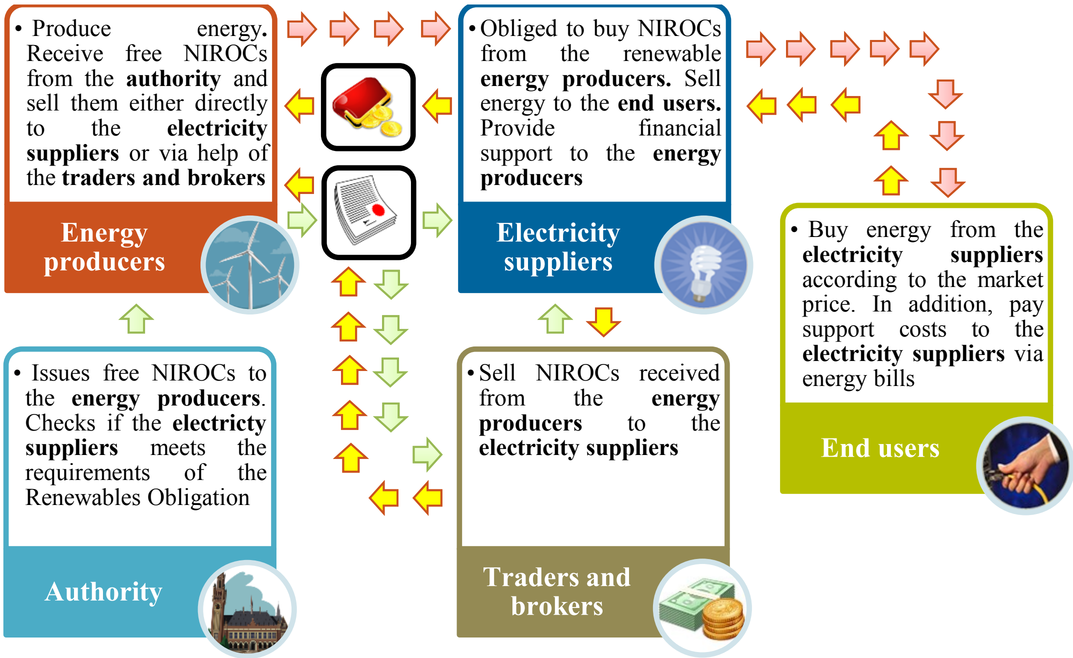

Figure 15 The scheme of the quota system in Northern Ireland.

Essentially, according to the Renewables Obligation the electricity supplier must provide the end users with a certain amount of electricity (i.e. quota) coming from renewable energy sources. To show the authority that this is the case the electricity supplier must purchase Green Certificates. The Green Certificates are also named Northern Ireland Renewables Obligation Certificates (NIROC). The NIROCs can be bought either directly from the energy producer or from the traders and brokers. As it was in the example of Scotland and Norway, every megawatt of power produced from renewables is worth of one certificate. The organization responsible for issuing these Green Certificates is the authority. The NIROCs are provided to the energy producer on free of charge basis. The only thing the renewable energy producer must do is to apply for accreditation from Ofgem. Once it is done, the financial support is available. The latter helps to implement renewable energy solutions with better economic conditions. A large advantage of the NIROCs is that the certificates provide access to a higher price of produced energy on energy market. Thus, it makes it easier and more profitable for the energy producer to invest in renewable energy solutions. The financial support comes directly from the electricity supplier. The source of funding of the quota system originates from electricity end users through payments for energy bills. (DETI, 2013)

As a rule, the electricity supplier cannot present the authority with sufficient Green Certificates to meet the Renewables Obligation. In this situation in Northern Ireland there is an alternative way. The electricity supplier can pay instead a, so-called, “buy-out” fee. The “buy-out” fee is a direct alternative to the Green Certificate. If the electricity supplier, for instance, does not have access to the renewable energy producer, it is possible to comply with the Renewables Obligation by paying the charge. It also works as combination of the two. The electricity supplier can do both: purchase the NIROCs and pay the “buy-out” fee. When the obligation period is over and all the obligations (NIROCs or “buy-out” fees) are met, the “buy-out” fees are redistributed among the electricity suppliers. The redistribution is done according to the proportion of the NIROCs the electricity suppliers have at the end of the obligation period. To illustrate, those suppliers, which carried out the obligation by showing the highest amount of NIROCs, get the highest financial support in the form of the redistributed finances. Nowadays Northern Ireland lacks enough renewable energy producers to generate the needed amount of renewable megawatts to cover completely the Renewables Obligation in the country (Table 6). Hence, the "buy-out" fees are always to be paid and consequently redistributed among the electricity suppliers. The situation makes NIROCs to possess a certain value on the energy market. The latter condition plays a motivating role for renewable energy developers to make appropriate investments. (DETI, 2013)

Among the supported renewable energy technologies within the quota system there are wind energy, solar photovoltaic energy, anaerobic digestion, hydropower and bioenergy based on solid biofuels. (DETI, 2013)

As some examples of the limitations in the quota scheme, there are as follows (DETI, 2013):

- The Green Certificates are in operation only during one Obligation Period;
- The applications coming from energy producers should be delivered no later than 2017;
- The maximum period of the financial support is 20 years or until 2037.

With regards to other economic mechanisms, it is possible that crowdfunding could be used in Northern Ireland. The principle of the financial support is considered in subsection 3.1.3 (Renewable energy support for water companies in Scotland) above. (NFI, 2013)

3.1.5 Renewable energy support for water companies in Ireland

Water companies as renewable energy producers may be supported by the Irish government. There are two mechanisms of financial support (Maroulis, 2013):

- Renewable Energy Feed-in Tariffs (REFITs); and
- Tax relief scheme.

REFITs are available for renewable energy producers. Renewable energy can originate from such technologies as wind energy, anaerobic digestion, hydropower and bioenergy based on solid biofuels. However, there is a requirement to be in a partnership with an electricity supplier. The union between renewable energy producer and electricity supplier is called a Power Purchase Agreement (PPA). Only when the PPA document is present can the renewable energy producer start the application process for financial support. The renewable energy producer does not receive the financial support directly. The electricity supplier does. The renewable energy producer generates and sells energy to the electricity supplier. The latter buys it, sells it to electricity end users and gets the REFIT as financial support. The general scheme is represented in Figure 16 (DCENR, 2012; Maroulis, 2013).

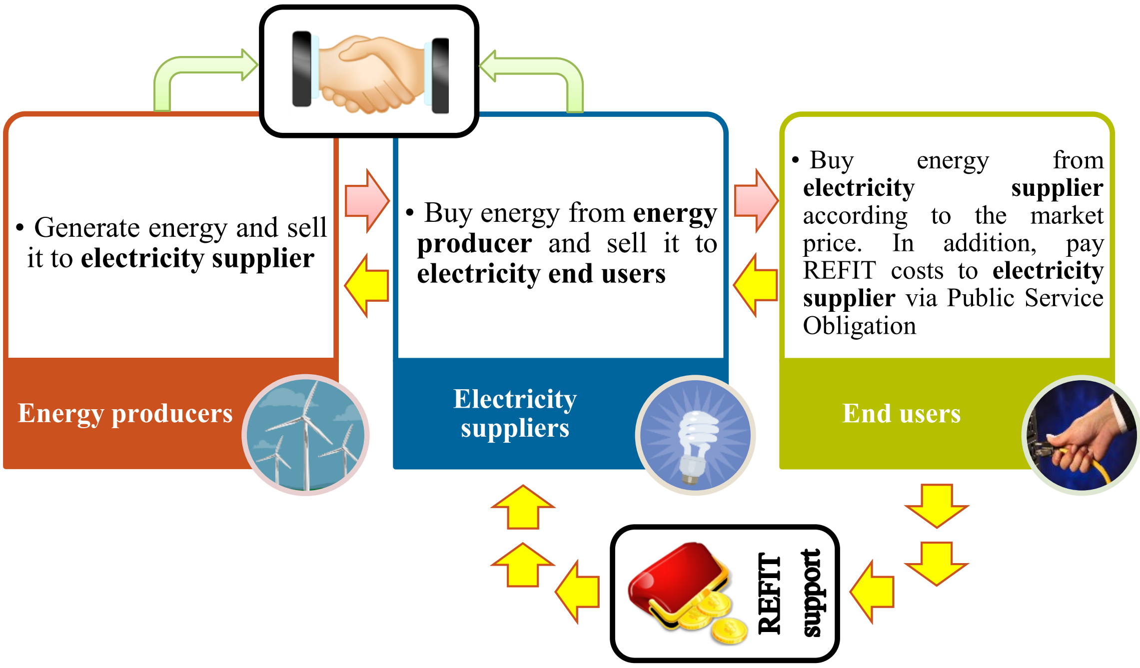

Figure 16 The scheme of the Renewable Energy Feed-in Tariff (REFIT) in Ireland.

There are three types of REFITs in Ireland oriented on various renewable sources, as illustrated in Figure 17. They are REFIT 1, REFIT 2 and REFIT 3. The period of application for the REFIT 1 ended in 2009, whereas the REFIT 2 and the REFIT 3 opened up for applications in 2012 and should be closed in 2015. The financial support for Irish renewable energy implementation should last until 2027 for the REFIT 1 and until 2030 for the REFIT 2 along with the REFIT 3. (DCENR, 2012; Maroulis, 2013)

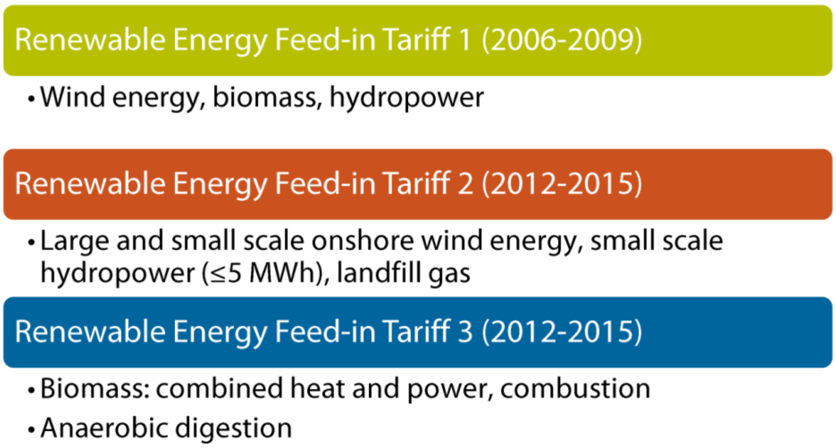

Figure 17 The types of Renewable Energy Feed-in Tariff (REFIT) financial support in Ireland. The respective renewable energy technologies are mentioned below each REFIT scheme. The application periods are given in brackets (based on Maroulis, 2013).

The general scheme for all the REFITs is the same. Every REFIT is created to provide PPA-holders with guaranteed support. Basically, electricity suppliers receive the support via two options. The first one represents percentage (15%) of the reference prices represented in the Table 8. (Maroulis, 2013; Devitt, *et al.* 2011)

Table 8 Financial support in Ireland within Renewable Energy Feed-in Tariff (REFIT) scheme.

Renewable energy source	Reference price, euro cent per kWh	Renewable energy feed-in tariff (REFIT)
Large-scale wind energy (>5 MW)	6.9	REFIT 2
Small-scale wind energy (≤5 MW)	7.1	
Landfill gas	8.5	
Hydropower (≤5 MW)	8.8	
Biomass combustion (other)	8.9	REFIT 3
Biomass combustion (crops)	9.9	
Anaerobic digestion (non-CHP) (>500 kW)	10.4	
Anaerobic digestion (non-CHP) (≤500 kW)	11.5	
Combined heat and power (biomass) (>1,5 MW)	12.5	
Anaerobic digestion (CHP) (>500 kW)	13.6	
Combined heat and power (biomass) (≤1,5 MW)	14.6	
Anaerobic digestion (CHP) (≤500 kW)	15.6	

The latter is fixed and independent on market price. For example, if an electricity supplier gets power from a small-scale wind energy producer, the support would be 15% from 7,1 euro cent which is 1,065 euro cent per every kWh. The second option is when the electricity supplier gets support as a difference between the market price and the reference price if the market price happened to be lower than the reference price. The funding comes from electricity end users. They are obliged to pay the costs within the Public Service Obligation (PSO) and appropriate Irish regulation. (Maroulis, 2013; Devitt, *et al.* 2011)

As mentioned before, there is an application process for a renewable energy producer to get benefits from the REFIT scheme. The renewable energy producer can apply to the Irish Department of Communications, Energy and Natural Resources. The renewable energy producer should have a certain proof of planning permission for the energy production installation; a document about date of construction; and connection offer to the grid from an operator. If it is a combined heat and power (CHP) case, all respective high efficiency standards (Directive 2004/08/EC) should be met in the form of appropriate documents; besides, there should be a certificate from the Commission for Energy Regulation (CER). When the process is completed with a positive answer, the renewable energy producer receives a so-called letter of offer. After that the renewable energy producer should enter in Power Purchase Agreement with a licensed electricity supplier. (DCENR, 2012; Maroulis, 2013)

Competent authorities in the application process are the CER and the Department of Communications, Energy and Natural Resources (DCENR). The CER produces certificates and does the calculations related to the REFIT financial support. In addition, the CER is in charge of Public Service Obligation and amounts of support going to the electricity suppliers. The DCENR is responsible for REFIT administration and processing of REFIT applications. (DCENR, 2012; Maroulis, 2013)

There are several limitations for the renewable energy feed-in tariff scheme. They are as follows (DCENR, 2012; Maroulis, 2013):

- The renewable energy feed-in tariff is limited and dependent on the Power Purchase Agreement duration and its terms: e.g. price and electricity amount to be bought;
- 15 years is the maximum period for the Power Purchase Agreement between a renewable energy producer and a licensed electricity supplier;
- Duration of the REFITs: the REFIT 1 support is due to 2027, the REFIT 2 and the REFIT 3 – due to 2030.

The tax relief scheme, as the other way of financial support for renewable energy implementation, also works in Ireland. It came into use in 1999. There are several renewable energy sources that can be supported under the tax relief scheme: e.g. solar energy, hydropower, ocean, tidal and wave energy, wind energy, and bioenergy. The responsible authority for the tax relief application process is the Irish Revenue Commissioners. To apply for the tax relief, a company should represent an entity which does investments in implementation projects of renewable energy production (i.e. renewable energy producer). Thus, there are two key players here: the investment company and the renewable energy producer. The renewable energy producer must get approval from the DCENR for the renewable energy production technology and obtain an appropriate certificate. Then the renewable energy producer must be certified by the Revenue Commissioners to meet all the legislative requirements. Afterwards, the two players, in particular, the investment company and the renewable energy producer must enter into an agreement about the terms of investment. In the end, the investment company should apply for the tax relief to the Irish Revenue Commissioners that takes the final decision. The tax relief support cannot be more than 50% of the investment cost of the renewable energy project, or 9 525 000 euro. The source of funding in this case comes from the state. (Revenue, 2014; Maroulis, 2013)

3.1.6 Summary

As for renewable energy technologies, according to Table 9, it can be seen that all five countries have interest in renewables. Mostly it includes such solutions as wind energy, hydropower, bioenergy, and solar energy. All these are common for every country in question. Besides, depending on local geographical conditions and energy policies, there is often an orientation prevalent towards certain technological solutions. To illustrate, geothermal energy is financially supported in Finland, Norway, Scotland and Northern Ireland. Wave energy potential is in the focus in Norway and Scotland. Heat pumps are developed in Finland.

Table 9 Renewable energy generation in Finland, Norway, Scotland, Northern Ireland and Ireland.

The colour code reflects the level of development of a renewable energy solution: white – not utilized; yellow – underutilized; orange – somewhat utilized; red – highly utilized. The dots show if a technology is financially supported in the country. The lines mean no support.

	Finland	Norway	Scotland	Northern Ireland	Ireland
Hydropower	•	•	•	•	•
Wind energy	•	•	•	•	•
Biomass energy	•	•	•	•	•
Solar energy	•	•	•	•	•
Geothermal energy	•	•	•	•	-
Wave energy	-	•	•	-	-
Heat pumps	•	-	-	-	-

Sources: Brückmann, 2013; EIRGRID Group, 2013; IEA, 2011; IEA, 2012; Maroulis, 2013; NVE, 2012; Pobłocka, 2013; Scottish Renewables, 2014; Tallat-Kelpšaitė, 2013; Väisänen, 2010

Regarding the current level of development of renewable energy generation, Finland generates most of its renewable energy from bioenergy and hydropower. Some energy savings come from utilization of heat pumps. In Norway, hydropower is the most utilized renewable energy solution. Biomass and wind energy can be second place. Scotland along with Northern Ireland and Ireland has focus on wind energy. Hydropower is also somewhat utilized in Scotland and Ireland. The yellow sectors of Table 9 illustrate that such renewable energy solutions as solar energy, geothermal energy and others are underutilized at the present time. Table 10 gives a summary of economic mechanisms of renewable energy support in Finland, Norway, Scotland, Northern Ireland and Ireland.

Table 10 Economic mechanisms of support for renewable energy in the Northern Periphery Region (Finland, Norway, Scotland, Northern Ireland, Ireland).

Country	Economic support mechanisms
Finland	➢ Energy aid (Subsidy); ➢ Feed-in tariff
Norway	➢ Electricity certificates (Quota obligation)
Scotland	➢ Loan; ➢ Feed-in tariff; ➢ Quota system (Renewables obligation); ➢ Tax regulation mechanisms; ➢ Other economic mechanisms (e.g. crowdfunding)
Northern Ireland	➢ Loan; ➢ Quota system (Renewables obligation); ➢ Tax regulation mechanisms; ➢ Other economic mechanisms (e.g. crowdfunding)
Ireland	➢ Renewable energy feed-in tariffs; ➢ Tax relief scheme

Sources: Brückmann, 2013; Maroulis, 2013; NVE, 2012; Pobłocka, 2013; Tallat-Kelpšaitė, 2013

There are six financial support options considered in this thesis in total. Some of its names are repeated in different countries: e.g. feed-in tariff in Finland, Scotland, Ireland. However, there are differences and special features to be found in each of the countries in relation to economic support mechanisms. Each of them is discussed in detail in subsections 3.1.1-3.1.5, respectively. In Scotland and Northern Ireland the amount of economic mechanisms of renewable energy support is the highest: five and four, respectively. The least number of financial mechanisms is in Norway. There is only one. The latter might be explained by high percentage of share of renewable energy production in the country: 46% of total primary energy supply (IEA, 2011). In Finland and Ireland there are two support schemes each.

3.2 Public-Private Partnership

The concept of Public-Private Partnership (PPP) has already become of high interest, relevancy and popularity in many countries. Nowadays it is not only in Europe where it originally comes from but it is also surely spreading towards Russia, the United States, Australia, Japan, Malaysia, and other countries. In order to compare the countries considered in this thesis (Finland, Norway, Scotland, Northern Ireland, and Ireland) in terms of their PPP experiences and best practices, it is important to set the scene and generate common understanding about the basics of Public-Private Partnership: what the PPP is; the term, how it works, types of partnerships, major focus areas, and pros and cons. (Kappeler, *et al.*, 2010; UNECE, 2008)

From historical point of view the term PPP appeared quite recently. The first PPP use in Europe was initiated in 1990s. Since then the popularity of this kind of public-private collaboration has been increasing, as can be seen from Table 11. (UNECE, 2008; Kappeler, *et al.*, 2010)

Table 11 PPP development in Europe (modified from Kappeler, *et al.*, 2010).

Year	Number of projects	Value of projects, millions euro
1990	2	1 386
1995	12	3 264
1996	26	8 488
…	…	…
2008	115	24 198
2009	118	15 740

In total, during the 1990-2009 period there were more than 1 300 projects in Europe realized with the investments exceeding 250 billion euro. So far, according to the 2009 data, almost 90% of all European PPP projects are represented by five countries. The leading countries are in descending order, as listed (Kappeler, *et al.*, 2010):

- UK (with 67,1% of total PPP projects share in the EU),
- Spain (with 10,1% of total PPP projects share in the EU),
- France (with 5,4% of total PPP projects share in the EU),
- Germany (with 4,9% of total PPP projects share in the EU),
- Portugal (with 3,1% of total PPP projects share in the EU).

The number of the PPP projects continues to grow. The PPP structures, legislative bases, and names are various in different countries. Hereinafter there are some common features represented to describe the PPP concept. (Kappeler, *et al*., 2010)

The Public-Private Partnership can be defined as a model where public facilities and services, as the main object of the partnership, get benefits from the collaboration between public entities and private companies. Within this collaboration the public facilities and services are funded, designed, implemented and operated by the partners. The latter brings a subsequent positive contribution to the community development where the PPP takes place. Among the range of objects of the partnership there can be public transport infrastructure, municipal buildings and facilities (e.g. educational institutes, hospitals), environment (e.g. air pollution prevention, sewage treatment, solid waste management, renewable energy implementation), recreation and culture, and others. At present, the most popular area in the EU for PPP projects is transportation. The only exception is with the case of the UK which is an obvious PPP leader in Europe. The UK's main focus is given towards education and healthcare development. (Kappeler, *et al*., 2010; UNECE, 2008)

The main characteristics of PPP are as follows (UNECE, 2008; Kappeler, *et al*., 2010; AID, 2012):

- Long-term duration of the partnership. It can sometimes last up to 30 years;
- Different funding mechanisms. The PPPs are financially supported by the government budgets. The funding for PPPs also originates from the private sector. Sometimes it can come from the customers of the service (e.g. toll road) and user fees (e.g. water fee, electricity fee, public transport). Besides, the PPP makes it possible for the public sector to avoid borrowing finances from external sources. These are basically a few of the main reasons behind successful development of the PPP model all over the world. These make the Public-Private Partnership scheme attractive to apply;
- Risk sharing. As a rule, the public entity tends to transfer all the PPP-related risks towards the private sector. Thus, all the project risks are taken by the project private company or Special Purpose Vehicle. The latter is considered in the text below;
- Know-how and efficiency contribution. The private sector brings know-how, innovation, and expertise to the projects under PPP concerning funding, designing, construction, implementation, maintenance, and operation. In addition, all the works are done in more efficient ways in terms of time, material, energy, and money use. The construction and labor capacities are also higher.

To get a better understanding of the PPP model, an example of how PPP works is illustrated in Figure 18.

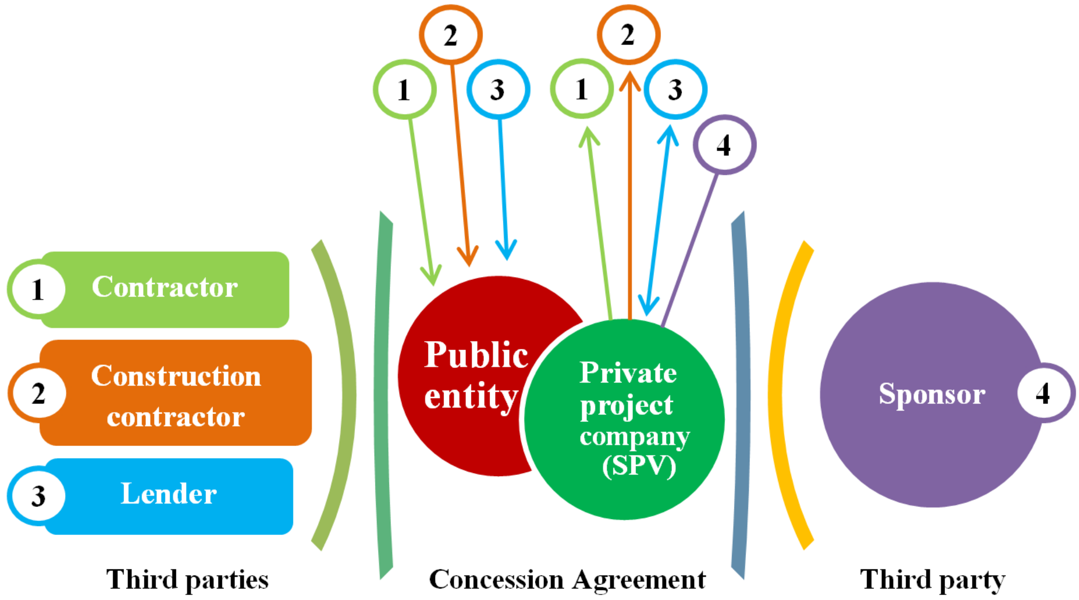

Figure 18 The scheme of Public-Private Partnership and its principle of operation.

To start with, there are two key players that come from the PPP definition: public entity and private company. The public entity is usually represented by a local authority or central government. The public entity is the one in the partnership who initiates the PPP creation and offers the project participation. The reason behind this offer is regularly a need to improve such areas as municipal transport infrastructure, education, healthcare, environment, recreation and culture, defence, etc. The private company is any company from the private sector that fits the purposes of the before mentioned areas of development of the project and can contribute there better than other similar companies. The latter is of importance since usually there is a competition organized by the public entity among different private companies. The competition is held in order to choose the private company with the best expertise and experience suitable for the specifications of the project. The winning private company delivers the project. Once there is a winning company, the public entity gives the private company a concession to realize the project. The next step after the concession is creation of new, separate entity. When the new company (i.e. project company) or so-called Special Purpose Vehicle is formed, the public entity and the project company enter in the Concession Agreement, or the Project Agreement. This serves as an official contract between the two. The Concession Agreement includes the terms and conditions of the project and there is also a paragraph about the risk sharing where all the project related risks are allocated to the new-formed project company. The difference between the private company and the project company is the following. The private company is the one that won the competition to take part in the project offered by the public entity. The project company, in its turn, is a specially created joint venture with the main purpose of the project delivery to the public entity. It is created by the private company to raise the financial support for the project. It consists of the project sponsors and investors to implement the project. They often contribute with a small part of the overall project debt. The project company is created to avoid possible financial risks (e.g. insolvency) for the sponsors in the case the project fails. Thus, the funding for the project, aside from the public entity contribution, also comes from the private sector where the various players are involved. The project company has a strong connection and interdependence with the sponsors, as shown with number 4 and a purple line in Figure 18. It is often a subsidiary of the sponsors. The sponsors usually represent large construction companies or companies responsible for facilities management. In the project the sponsors usually are interested to participate and send their divisions to implement the project. (AID, 2012; Kappeler, *et al*., 2010; UNECE, 2008)

Among other main partners, aside from the public entity as the key partner, the project company actively collaborates with and subordinates (AID, 2012):

- Different contractors which are in charge of the services related to the facilities management, and
- Construction contractors that deal with the construction works.

Sometimes subcontractors can be also invited to deliver some other services. All these various contractors are brought under the project company, as can be seen in Figure 18 with upward arrows. Double-faced blue arrow means interdependent function with the project company. Correspondingly, they all are independent of the public entity (unless it is stated in the Concession Agreement), as shown in the figure with downward arrows. The same goes with the next main player: i.e. lender. The latter is invited to take part in the project as a provider of loans. This is another source of funding for the PPP in addition to the sponsors/investors included in the project company. The lenders (e.g. commercial banks, export credit agencies, other finance institutions) usually enter in the two agreements: Financing Agreement and Security Agreement. The first one is the agreement about providing loans by lenders to the project company. The second one states that there is guaranteed security during the project towards the lenders. The main cash flow in the funding mechanisms, according to the Concession Agreement, originates from the government, or the public sector. This naturally attracts the private sector to get involved in the PPP. (AID, 2012)

With respect to the PPP governance, there are several common key principles related to the collaboration between the public entity and the private sector: transparency and openness, fairness of the created and applied rules, resource (funds, time, material) efficiency, responsibility and involvement of the partners. (UNECE, 2008)

The PPP can be represented by different implementation models. The seven most commonly used models are described in Table 12. The given names of the models are applied worldwide. The differences between the models are explained by the variety of risk sharing and allocation of responsibilities between the public entity and the private sector. (UNECE, 2008)

Table 12 Examples of models of the collaboration between the public entity and the private sector: i.e. Public-Private Partnership models.

Model name	Explanation
Buy-Build-Operate	According to the concession agreement the project company receives the public assets for a certain period of time, improves them and operates until the agreement ends. The public entity can control the public assets during the course of the project
Build-Own-Operate	According to the concession agreement the project company receives and owns the public assets, improves them and operates afterwards. The public entity put some constraints in the concession agreement
Build-Own-Operate-Transfer	According to the concession agreement the project company receives and owns the public assets, improves them and operates with the right to collect user fees for a period of time specified. Then the public entity gets the public assets back to own
Build-Operate-Transfer	Similar to the Build-Own-Operate-Transfer model, except there is no ownership right towards the project company
Build-Lease-Operate-Transfer	According to the concession agreement the project company receives and leases the public assets, improves them and operates with the right to collect user fees for a period of time specified. Then the public entity gets the public assets back to own
Design-Build-Finance-Operate	According to the concession agreement the project company receives and gets the long-term lease of the public assets, designs, finances and improves them and operates within the period of the lease. Then the public entity gets the public assets back to own
Finance Only	According to the concession agreement the project company finances the public assets project

As mentioned before, the advantages of the PPP scheme are long-term duration of the partnership, different funding mechanisms, risk sharing, know-how, and efficiency contribution (AID, 2012; Kappeler, *et al.*, 2010; UNECE, 2008). Besides, the pros are, as listed (AID, 2012):

- Transfer of the project work. The work is directed to the private project company that has expertise to manage it the best and obtain the best value with the least possible expenses;
- Lower costs of the project and higher value for money. All the project costs are as low as possible due to the competitive market pricing process. Besides, the value for money is better because of the promised timings and more certain costing;

- Project incentive. Usually, the payments are made according to the project work progress and performance. It is a motivating factor and a nice stimulus for the private project company to be more active and carry out quality job faster;
- Immunity to political interference. The projects within the PPP are not exposed to political interference.

In countries where the PPP model is currently going to be implemented, for instance, in Russia, they motivate the implementation of the PPP scheme in 2014 for the reasons, as follows (Gagarin, 2013):

- Availability of more funding to the projects and risk sharing;
- Better planning of the projects expenses in time;
- Quality and efficiency of the projects increase;
- Better relationship between the state and the private sector; and
- Corruption decrease.

For the Russian state the most attractive advantages are control over the project, access to more funding, and risk allocation to the private sector. In turn, for the private sector it is 51% share of participation in the project, involvement of the state funding to the project and also control over the project. At present time, a federal law related to the Public-Private Partnership is about to get implemented in Russia. (Gagarin, 2013; Shmeleva, 2014)

Among other possible disadvantages of the PPP in general it is possible to include (AID, 2012):

- Risk of insolvency or large project company profits. If the project company turns insolvent or manages to obtain large profits, it can create political issues for the public entity;
- Higher rates of money borrowing. There are often better offers for the public entities to borrow certain amounts of financial support alone rather than via the PPP with the project private company;
- Sophisticated contracts with complicated negotiations. Due to the long-term orientation of the PPP projects and a great number of key and main partners involved, the legal matters and negotiations can be rather complex. It can also be linked with high transaction and other costs;
- Long-term period of waiting for benefits out of the project. It is coupled with the long-term duration of the project. Quite many years will pass before profit appears after the project realization.

Regarding water supply and wastewater treatment in the considered countries, there are some examples of PPP projects discussed below.

3.2.1 Examples of Public-Private Partnership in Finland

The concept of the Public-Private Partnership described above is rather new in Finland. According to Pietilä, *et al*. (2007) the PPP in the way as it is commonly recognizable in the world does not work in the country. However, the private sector as a partner of municipally owned water companies became involved in water services a long time ago.

As mentioned earlier in section 2.1 (Water services in Finland), water companies are owned by either municipalities or co-operatives and households. Private water companies are allowed to be in operation under the Finnish regulation, but are rarely seen. At the same time, there is a business segment where private companies can come into play and actually have been doing so quite extensively in Finland: i.e. outsourcing. For instance, the municipal water companies can outsource or subcontract some tasks to private companies with a short-term (up to three years) contract. The option of long-term contracts is excluded to create a better environment for business competition among smaller private companies. Usually, the decision of which smaller company to choose is taken by the municipal water company after organized tender. The preferable types of outsourcing to the Finnish water companies are detailed design, construction work, wastewater sludge utilization, material and equipment supply, repair workshop services, laboratory analyses, and other smaller services. The latter listed activities are quite frequently outsourced. The financial flow from the water companies towards private companies can be up to 65% of total expenses. It can be also the case when a smaller company has advanced know-how to offer to a larger municipal company. It goes along with the Finnish legislation. However, so far these collaborations between the smaller and larger companies are not widespread. (Mohajeri, *et al.*, 2003; Pietilä, 2006; Pietilä, *et al*., 2007)

As regards to the PPP projects in the common sense of the concept, one of the Finnish PPP examples deals with the second largest wastewater treatment plant in Northern Finland, Haapavesi. Wastewater treatment capacity of the plant can service 60 000 people. It was actually the first PPP contract established in Finland. The contract was signed in 2002 and was about rehabilitation and operation of a municipally owned sewage treatment facility. The PPP model applied is of the Build-Operate-Transfer type. The contract involves several key players: the Haapavesi municipality with minority of shareholding and the project company (Special Purpose Vehicle between Kemwater Services Ltd and YIT Environment) with majority shareholding. The project company represents an investor in this PPP project. The third party involved is a local dairy (Valio Oy) which entered in agreement with the Haapavesi municipality. The interest of Valio Oy in the project is explained by the following reason: the wastewater treatment plant, apart from municipal sewage, receives also wastewater from the dairy factory. The investment of 2 million euro comes from the YIT Environment whereas Kemwater Services Ltd. which brings to the PPP project know-how in wastewater treatment, is responsible for 12 years of operation after commissioning. The share belonging to the public entity in this case is 49%. The remaining 51% belongs to the project private company. (Mohajeri, *et al.*, 2003; Global Water Intelligence, 2002)

Another PPP case relates to international arena. It was a joint project within the scope of collaboration with Russian partners. The project was related to improvement of a wastewater treatment system in St. Petersburg. The wastewater treatment plant was built in the South West of the city. The Finnish and Russian designers took part in the project development, whereas Nordic contractors did the actual construction work. In the framework of the PPP about 200 million euro was invested in the project. Among the investment mechanisms were, as listed (FWF, 2014):

- International loans,
- Grants,
- Capital investments, and
- Local financing.

The Finnish side was a partner which shared their expertise and skills with Russian partners. The project was under the Northern Dimension Environmental Partnership program which aims to improve environmental state of the Baltic and the Barents Seas. (FWF, 2014)

3.2.2 Examples of Public-Private Partnership in Norway

In Norway the concept of PPP is not well-utilized yet. Some projects started from the 2000s. They are mostly related to road development, transport sector, defence, education, and healthcare. The water sector however still has almost no experience with the PPP. One example of PPP in the water industry is described in subsection 4.2.2 (Best practices of water asset utilization in Norway). The main reason why the Public-Private Partnership is not as developed in Norway compared to the other countries considered in this thesis is that Norway is one of the wealthiest countries in the world. The latter is due to oil industry development in the country. Thus, the public entities have enough funding to finance all the projects they have. There is no need for the Norwegian government to attract the private sector and share risks with it. In addition, Norway does not have enough experience in the PPP matters. There is no official direction towards PPP in the country. (Greve, 2003; Semlitsch, 2005; Wright, 2013; TED, 2013)

3.2.3 Examples of Public-Private Partnership in Scotland

Meanwhile many European and non-EU countries have just started to deal with PPP implementation, the UK is the most experienced state with this matter. In 2009, the share of total European PPP projects for the UK was about 67%. The UK's priorities in public facilities and services within the scope of Public-Private Partnership are: education, health, public services, environment and transportation. The share of the mentioned areas in 2009 was, respectively, about 35%, 34%, 14%, 6% and 4%. Scotland, being part of the United Kingdom, also has a decent amount of PPP projects implementation. In terms of the water sector PPP projects, Scotland had a number of projects related to wastewater treatment: e.g. Aberdeen, Tay, Levenmouth, Highland and others. The normal PPP model used is Design-Build-Finance-Operate. (UNECE, 2008; Kappeler, *et al*., 2010; EBRD, 2005)

To illustrate one of the PPP projects in Scotland, Scottish Water Solutions (SWS) was created in 2002. It was a joint venture organized by Scottish Water Authority. The main objective was to realize investment program starting in 2002 and ending in 2006. The subsidiary company (i.e. Scottish Water Solutions) was established to carry out the program in the best way. This type and large scale of PPP project was the first one in the UK being implemented. The shares in the project were 51% and 49% respectively for Scottish Water Authority and for two consortia under Scottish Water Solutions: Stirling Water (24,5%) (Thames Water, MJ Gleeson, KBR and Alfred McAlpine) and

UUGM (24,5%) (United Utilities, Galliford Try and Morgan Est). The private project company in this case helped to bring in the PPP project experience in engineering, construction, management and investment delivery. Scottish Water was facilitating the development of water quality and wastewater treatment via support for 1 200 related projects. (EC DGRP, 2004)

Another example of PPP projects in Scotland is in wastewater treatment. The project, named Almond Valley and Seafield project, was dealing with an upgrade of five wastewater treatment plants serving about 600 000 water consumers. The goal was to improve sludge treatment, digestion and drying, odor control and ultraviolet light disinfection of effluent. The project was based on a contract via the Private Finance Initiative. The private project company, Stirling Water (Thames Water, MJ Gleeson and Montgomery Watson), was in charge of the project through the Design-Build-Operate PPP model. The period of operation is 30 years. (EC DGRP, 2004)

3.2.4 Examples of Public-Private Partnership in Northern Ireland

Northern Ireland is a part of the United Kingdom. Thus, the concept of Public-Private Partnership is not new in the country. Regarding the examples of PPP projects, it is possible to mention several. However, in this work only one is considered. Project Alpha was started in 2006. It is a strategic PPP project with the objective of improving the drinking water quality to meet the EU Drinking Water Directive requirements. Within the project four existing water treatment facilities and water infrastructure are to be improved. The water system serves about 50% of the population of the country that is around 850 000 people. The partnership is organized between the public entity, Northern Ireland Water, and the private project company, Darliada Water Limited (i.e. Earth Tech Engineering UK, Kelda Group and Farrans Construction). The length of the contract is 25 years, 23 out of which are related to the actual operation of the water treatment facilities by the project company. The used PPP model is Design-Build-Finance-Operate. (Dickinson, *et al*., 2009; UKWP, 2007)

3.2.5 Examples of Public-Private Partnership in Ireland

In Ireland, the implementation of PPP projects started in 1999. The areas of application were public transport, water services, road works, waste management and education. In 2002, the State Authorities (Public Private Partnership) Act 2002 was introduced to provide support for PPP on legislative level and an opportunity for state authorities to participate in PPP. Besides, the same year there was a special agency created to advise authorities about PPP issues, in particular, funding and financial public investment problems. The agency is called National Development Finance Agency. The Irish authorities can address this organization for advice regarding PPP, especially, in the cases when an investment is more than 30 million euro. In addition, there is a network of social partners in Ireland initiated by the government. It includes the Irish Business and Employers Confederation, Congress of Trade Unions, the Construction Industry Federation and other departments interested in the PPP scheme. All these parties are united within a framework agreement. Their task is to act as an informal advisory group concerning different PPP issues. Nowadays Public-Private Partnership is still applied on continuous basis. Currently, there exists a PPP program for projects in such sectors as wastewater treatment, accommodation projects and transport issues. As a part of the PPP scheme implementation support in Ireland, there is a website providing guidance documentation, tools of PPP project proposals evaluation and other useful information. It is organized by Central PPP Unit of Department of Finance. (Robles, 2009)

To support the PPP development in Ireland, there were the following measures taken (Mohajeri, *et al*., 2003):

- Organization of an informal advisory group, Interdepartmental Group and cabinet committee about PPP matters;
- Organization of special units at Department of Finance, Department of the Environment and Local Government, Department of Health and the National Roads Authority;
- Organization of the PPP Fund for the projects non-eligible for the main investment programmes;
- Organization of the Complete Information System and the Local Authority Financial Accounting System;
- State Authorities (PPP Arrangements) Bill 2001, as new PPP related regulation;
- Framework agreement with social partners;
- Training courses and seminars at three levels.

Areas of potential PPP application in the water sector include wastewater treatment, water supply, rural water supply improvement, group drainage wastewater facilities, water treatment development and operation, renovation of water infrastructure and some others. Examples of used PPP models in Ireland are Design-Build and Design-Build-Operate. (Mohajeri, *et al*., 2003)

Among the examples in the Irish PPP in the water sector is the case with the Dublin Region Waste Water Scheme (Treatment plant) estabslished in 1999. The aim of the PPP was to build a new plant according to the best available technologies and expertise. The plant was supposed to provide wastewater treatment from commercial and domestic users in the Greater Dublin Area. The partnership was organized between Dublin Municipality, Water Authority and Private International Consortium on the Design-Build-Operate PPP model. During the 20-year period of operation the contractor can charge fees from non-domestic customers. The latter covers the capital costs and the costs related to operation and maintenance. The source of funding originates from Heritage and Local Government, an EU Grant from the EU Cohesion Fund, the Department of the Environment, Dublin City Council and non-domestic users. Half of the funding was provided by the EU Cohesion Fund. The financing of the project started in 1999. The wastewater treatment plant was completed in 2003. (EC DGRP, 2004; DKM, 2012)

3.2.6 Summary

The current situation in the aspect of the PPP in the countries in question is different. In the UK and Ireland the development is quite high. Scotland, Northern Ireland and Ireland are the most experienced among the countries considered in the thesis with the concept of Public-Private Partnership and its projects implementation within the water industry. (UNECE, 2008; Dickinson, *et al*., 2009; Robles, 2009) Both in Norway and Finland this model of collaboration is rather new and needs more time to get adopted. Finland is on the way to improvement and starting more examples of PPP in the water sector (Pietilä, 2006). Norway, in this context, has almost no valid and motivating reasons yet to attempt more collaborative financial projects between the public sector and private companies. The latter is explained mostly by the availability of state funds to finance the projects that are usually done via the Public-Private Partnership. Notwithstanding the existing differences, the common trend in Europe in terms of PPP use is towards increasing and playing more significant role in the water sector as well as in other areas. (Greve, 2003; Kappeler, *et al*., 2010) Concerning the renewable energy implementation via the PPP mechanism, it has also a potential in the upcoming future.

EXPERIMENTAL PART

This thesis is performed within the Water Asset Renewable Energy Solutions (WARES) project. WARES is a strategic two-year project that aims to find a potential to utilize unused or hidden opportunities for renewable energy generation (WARES, 2014a; WARES, 2014b) within the water services sector. Natural and community resources are mostly taken into consideration, as a potential for water asset renewable energy utilization. As potential water assets, the project explores hydropower, waste heat, biomass, wind energy and solar radiation (WARES, 2014b). The time frame of the WARES project is from October, 10^{th}, 2012 to September, 30^{th}, 2014. Within the scope of the project, Public-Private Partnerships are considered as a possibility to unite water industry companies, private investors and neighboring communities in remote areas and use it as a tool for providing renewable energy investments in the water industry. Based on the energy cost savings and respective extra financial returns in the water utility companies budget, it becomes possible to redirect some finances towards municipal social development projects. In addition, new job opportunities, visible livelihood change of the people, and political engagement along with renewable energy production will appear on the project territories (NPP, 2014a). The expectation is that, within the WARES project, there should be at least nine pilot sites explored and the knowledge and experience in the water industry assets utilization for renewable energy generation disseminated. In addition, the network of project partners should create a mutually supporting platform not only for the purposes of the WARES project but also for further development of the Northern Periphery region and its remote communities. Moreover, the experience and best practices in the partnership establishment and its maintenance between industry, community, policy decision makers, and private investors should become available. Based on these, long-term and self-sustaining business projects with the similar cases could be successfully implemented in future.

The project consists of several work packages illustrated in Figure 19.

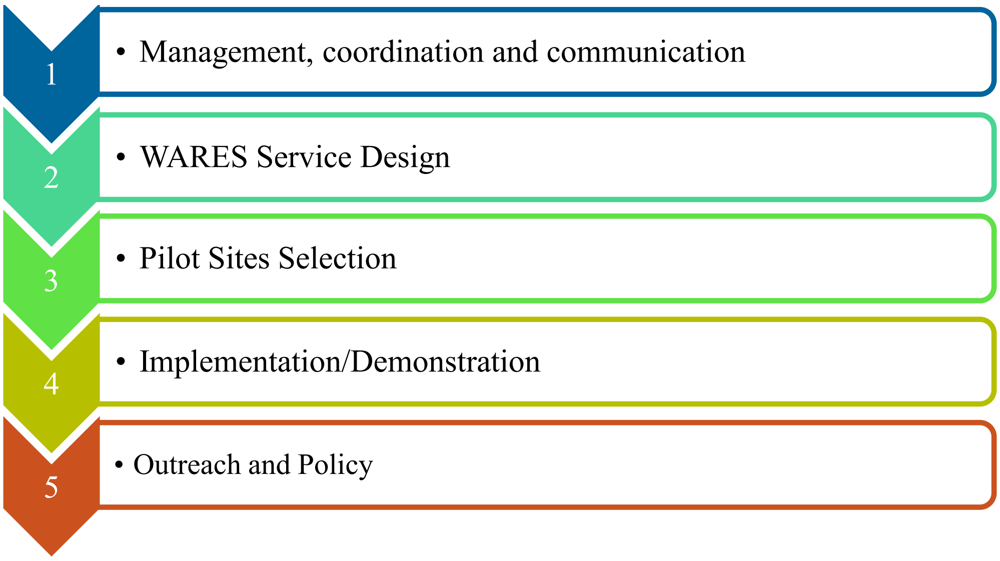

Figure 19 The work packages of the WARES project.

This thesis is related to Work Package (WP) 5 – Outreach and Policy. This WP refers mainly to the social and community benefits of the project as well as to the policy recommendations. Tasks 5.5 of the WP 5 is prioritized in the master's thesis and considered in Chapter 5. Task 5.5, or Policy Recommendations, aims to determine policy issues in the project territories and discuss appropriate policy recommendations and development. The scope of this thesis within WP 5 covers only Finnish water companies and regulations. As an outcome, policy recommendations are provided for better implementation of renewable energy sources via the utilization of unused water asset potential in the Finnish water industry.

4 BEST PRACTICES IN WATER ASSET UTILIZATION FOR RENEWABLE ENERGY

Water services require significant amounts of energy for their operation. The rates of energy consumption are the highest for pumping and energy supply for needs of on-site buildings. In total, up to 30% of general costs for operation of water companies account for electricity consumption. (Liu, *et al*., 2012) Introduction of *in situ* renewable energy solutions can, therefore, enable both energy and financial savings.

This chapter briefly outlines the different renewable energy technologies, which are currently explored in the Northern Periphery Region within the WARES project. In addition, best practices of utilization of water assets for renewable energy generation are discussed.

4.1 Renewable energy solutions for the Northern Periphery Region

According to the EU Renewable Energy Directive, hydropower, wind energy, bioenergy solutions (e.g. anaerobic digestion), solar energy, geothermal energy and ocean energy are defined as renewable energy sources. In case when significant amount of energy is produced by heat pumps via utilization of thermal energy, then they can be also considered as a renewable energy solution. The thermal energy can originate from air, ground or water. (European Parliament, 2009)

All these technologies can potentially contribute to the water industry energy consumption patterns in terms of energy savings. The energy generated via renewable energy solutions can be used for operational needs, when providing water services: e.g. pumping, heating buildings, wastewater treatment processes, etc. (Gopal, 2013)

In this thesis, hydropower, wind energy, solar energy, anaerobic digestion as well as aero-, hydro- and geothermal solutions (heat pumps) are considered suitable for the Northern Periphery Region. The principle of operation of these technologies has been explored in earlier theses (e.g. Kauriinoja 2009, Caló 2011 and Mikkonen 2013). Therefore, only brief explanations, common installation capacities and periods of investment repayment are provided in this thesis:

- Hydropower is the energy utilized from kinetic energy potential, contained in streams of water bodies. It mostly originates from large and small rivers where there is a natural movement of water mass from higher to lower levels of altitude. The kinetic energy of the moving water is converted firstly to mechanical energy via a turbine. Afterwards, the turbine delivers the mechanical energy to a connected electrical generator. The generator, in turn, transforms the mechanical energy into electricity. The technology is highly utilized in the world thanks to its maturity and economic competitiveness. (IPCC 2011) The typical hydropower plant capacity is usually in the range of 0,1 to 100 MW and more. The payback period may be around 10-15 years. (Mikkonen, 2013);
- Wind energy is generated by converting the kinetic energy of moving air into mechanical energy and further to electrical energy. Modern, large wind turbines have the cut-in speed of 3-4 m/s, which means that the wind turbine starts to

extract energy from the wind at these speeds. The power production increases until the wind turbine reaches its rated power level. At wind speeds higher than this, the control systems start to limit the power output in order to avoid overloading the turbine. When wind speeds reach approximately 25 m/s (the cut-out speed), the rotor is stopped to prevent damage. (IPCC 2011) Wind installations have the capacity of up to 3,6 MW. The return of investments can be about 20 years. (Mikkonen, 2013);

- Solar energy can be converted into electricity using photovoltaic (PV) cells. A group of these cells can be mounted together into a solar panel. The PV cells are made out of layers of semiconductor material such as silicon. When sunlight shines on the semiconductor a negative charge is created on one side of the surface and a positive charge on the other. This creates a voltage. The two sides of the cell are connected to a load and as the current flows from one side to the other, electricity is generated. (IPCC 2011) Usually, solar panels have power production values of 20 to 500 W_p. The period of repayment is within 10 to 20 years. (Mikkonen, 2013);
- Bioenergy can be defined as the solar energy stored in biological organic matter, or biomass. It is energy contained in living or recently living organisms, both plants and animals. This sustainable energy type is normally represented in solid (e.g. biomass, wastes), liquid (e.g. ethanol, biodiesel, methanol, synthetic petrol) or gaseous (e.g. biogas, hydrogen, dimethyl ether) states of matter. Each energy type comes from carbon, oxygen and hydrogen atoms that were put into different molecular forms of sugars and which were accumulated in the plants thanks to the reaction of photosynthesis. (IPCC 2011) In the water industry, the most common bioenergy type is production of gaseous biofuels – in particular, biogas via the process of anaerobic digestion. Anaerobic digestion is a biochemical process of organic matter conversion into flammable gas, or biogas, and digestate, occurred in the condition of oxygen absence and microorganisms' presence. These two conditions are considered as a driving force of the process. The technology is normally applied by using of airtight containers, also known as digesters. The chemical composition of generated biogas is about 30-50% carbon dioxide, 50-70% methane and traces gases, mostly represented by nitrogen. A lot of various wet organic feedstocks (e.g. food waste, manure, and wastewater) are utilized to get the final product. Due to minor presence of some other chemical substances biogas usually undergoes appropriate treatment. In addition, it can be upgraded to higher quality gas with only methane composition. Apart from biogas there is digestate as an output product that can be utilized on agricultural field as soil fertilizer. The biogas ranges of application are, for example, local heating, district heating or CHP in small capacity plants in boilers, internal combustion engines and gas turbines. After special treatment and compression it can be also used as a vehicular fuel. (IPCC 2011) Typical scale of anaerobic digesters is from small-scale installations of 0,1 MW to large-scale factories of 20 MW. The payback period of investments is can be up to 25 years. (Mikkonen, 2013);

- Heat pumps are installations that transfer thermal energy from low temperature environment to higher temperature environment. It is a refrigerator from technical perspective that contains such parts as a condenser, a compressor and an evaporator. It is also equipped with an expansion valve. The principle of operations is based on thermodynamic cycles and heat transfer. The heat pumps are a mature technology and can be utilized in space heating or cooling, providing significant amounts of energy derived from air, water or ground. The capacity of heat pumps varies from 0,1 MW to 90 MW. The period of repayment is, by estimation, 2-10 years. (Mikkonen, 2012 and 2013).

4.2 Best practices and WARES pilot sites

The renewable energy technologies described above are often utilized to provide residential and other municipal buildings with energy supply. In the water industry, there are also some best practices currently available. Since the Northern Periphery Region is the focus of this thesis, such countries as Finland, Norway, Scotland, Northern Ireland and Ireland are reviewed and the WARES pilot sites are introduced.

4.2.1 Best practices of water asset utilization in Finland

In Finland, there are some examples of renewable energy implementation in the water sector. Mostly, it is related to heat recovery and anaerobic digestion in wastewater treatment plants. To illustrate, there are around twenty municipal and industrial anaerobic digestion facilities with biogas production from wastewater in the country (Kauriinoja, 2010). Heat recovery from sewage is utilized, for example, in Helsinki (Heinonen, 2013). However, when considering other renewable energy sources, there is still unused potential in the water industry. Currently, the scale of implementation of hydropower, solar and wind energy in water utilities is negligible. One of the main reasons is lack of communication between Finnish water and energy companies (Ministry of the Environment, 2004; MAF, 2001; MAF, 2011a). More explanations with listed barriers of the Finnish legislation are provided in Chapter 5.

4.2.2 Best practices of water asset utilization in Norway

In Norway, anaerobic digestion in wastewater treatment is applied. For example, HIAS plant in Hamar provides wastewater treatment for the city and surrounding towns of 90 000 people. The sludge from the process serves as a feedstock for biogas production. (Cambi, 2008) As regards to hydropower, there is one 1,5 MW hydropower plant working combined with water supply facility in Taraldsvik, Narvik (SHP News, 2003). A WARES pilot project is on the development stage. It deals with renewable energy implementation in the water industry – Sagelva project. The project focuses on a water supply company that delivers water to domestic users in the municipality of Hemnes in the Norwegian county Nordland. The site of the pilot is illustrated in Figure 20.

Figure 20 An example of water asset utilization for renewable energy generation in Norway (NPP, 2014d).

There are plans to implement a micro-scale hydropower plant on the water assets. The project is done within the PPP mechanism. The public entity are the water asset owner (and land owners) and the private sector partner is Fjellkraft AS. The private company is an expert in small-scale hydropower technology. Within the project a new project company is supposed to be established to implement the project. The capacity of the planned micro-scale hydropower plant is 1,5 MW. The capital cost of the project is estimated to be about 2,2 million euro. The source of funding originates from the quota obligation support program and private company investments. (NPP, 2014d)

4.2.3 Best practices of water asset utilization in Scotland

Regarding the renewable energy implementation in the Scottish water industry, there is a list of projects. As described earlier in the theoretical part, Scottish Water is a large energy consumer in the country and aims to become an energy self-sufficient entity. In this context, the water assets such as land, water and community resources are in the focus of attention. There are quite many renewable energy initiatives applied and now Scottish Water produces about 7% of their total energy consumption. To illustrate, there are anaerobic digesters installed in wastewater treatment works. Not only sewage is used to produce biogas but also food waste is utilized in anaerobic co-digestion process. Solar panel installations are set on the Scottish Water assets to generate power. 25 GWh of hydropower potential is projected to be utilized by 2015 via hydro-turbine schemes. At present, there are ten of them in operation. Part of land resources of Scottish Water are used to produce wind energy. There are about sixty large-scale and ten small-scale wind turbines built. (Scottish Water, 2014e)

Within WARES, there are two community pilot projects in Evanton and Roybridge (Inverness-shire). The pilot sites are in the planning stage before implementation. The technological renewable energy solution to be utilized is hydropower. (IRRI, 2014)

4.2.4 Best practices of water asset utilization in Northern Ireland

In Northern Ireland, a WARES pilot is explored in Loughmacrory. There are plans to implement solar and wind energy solutions on the land belonging to Northern Ireland Water. The roof area of 560 m^2 of a club building is planned to be used for solar panel installation. The potential estimated for solar energy is 80 kW, and for wind energy – 225 kW. The possible annual energy savings can be up to 2 750 euro and 7 350 euro, respectively. The capital cost of the solar panels is projected to be about 86 000 euro. For the wind turbine, it is approximately 615 000 euro. The payback period for both is 20 years. (ARNI, 2014; The Money Converter, 2014b)

4.2.5 Best practices of water asset utilization in Ireland

There are numerous renewable energy projects in Ireland within the water sector. Within WARES, two of the projects are related to Group Water Schemes (GWS). One of them, in Killaturley, considers implementation of solar energy. The GWS supplies 400 domestic users. After implementation of the project, it will be possible to gain energy savings. The capital cost of the 25 kW solar panel installation is about 52 000 euro. The payback period is 17 years. The other one, in Kilmeena, serves the same number of households and also plans to install solar photovoltaic panels totaling 8 kW capacity. The estimated capital cost is around 17 000 euro. The time to recover return on investments is 13 years. (NPP, 2014c) In the list of other WARES pilots in Mayo County of Ireland are Achill Island central, Achill Regional, Erris Pumping Station, Lahardaun, Lisglennon, Lough Mask Schem and Mayo Abbey. The prioritized renewable energy technologies are wind energy, solar PV energy and hydropower. To give some examples, in the Achill Island Central project the implementation of solar panels (10 kW) and wind turbine (20 kW) is considered to power a wastewater treatment plant serving 4 000 people. The capital cost for the solar energy solution is 17 000 euro, whereas the wind turbine option investment requirement is 100 000 euro. The projected production of energy is 9 MWh from the solar panels and 76 MWh from the wind turbine. The payback periods are about 12 and 8 years, respectively. In the Archill Island Regional project with a water supply company hydropower and wind energy are used as primary renewable energy solutions. One of the most unique projects is connected with the implementation of in-pipe hydropower technology shown in Figure 21.

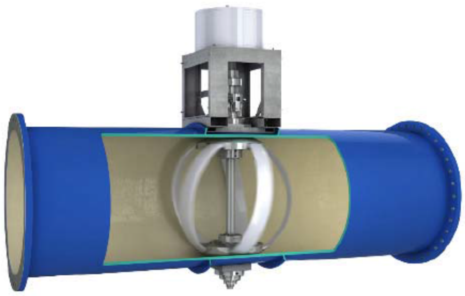

Figure 21 An example of water asset utilization for renewable energy generation in Ireland (MayoCoCo, 2014).

It is planned to be done under the Lough Mask Regional project. The return of the 70 000 euro investment is calculated to be in 5 years. The capacity of the installation is 14 kW. It converts energy of running water inside the pipe (with up to 1,4 m/s flow rate) into electricity. The expected energy production is 120 MWh. The source of funding for all the Mayo projects is based on the PPP model. Irish Water, in particular, also provides some financial support of the projects. (MayoCoCo, 2014)

4.3 Summary

The Northern Periphery Region is gradually including more renewable energy sources in energy supply for the water industry. Hydropower, solar and wind energy are applied in Norway, Scotland, Northern Ireland and Ireland. Anaerobic digestion is common for Finnish, Norwegian and Scottish water service sector. Water assets are the most utilized for renewable energy generation in Scotland and Ireland. These countries have the highest number of water-energy projects. Northern Ireland and Norway can be second place in this sense. In Finland, heat pumps and anaerobic digestion are used. But the scale of implementation of hydropower, solar and wind energy is negligible and there is still unutilized potential. To employ the potential, some improvements in the communication between Finnish water and energy companies should be done. This will help to implement more renewable energy sources in the water industry.

5 WATER POLICY CHALLENGES AND RECOMMENDATIONS

This chapter discusses briefly background of water policy in Europe, its history, development path and tendencies. It also covers existing obstacles in the EU legislation related to water asset utilization for renewable energy production. To overcome the obstacles, a list of policy recommendations is provided to cover water-energy nexus. The main focus in terms of the recommendations is given to Finland.

5.1 EU water policy review

The current global problems include climate change, over-exploitation, overpopulation, urbanization and contamination. All these have negative influence on fresh water reserves, affect water consumption tendency and create challenges for international water management and water industry as a whole. Since fresh water belongs to the group of finite resources and is crucial not only for vital activity of human beings but also for the economy; other sectors like agriculture, energy, industry, transport and recreation are also challenged and in need of finding appropriate solutions. In general, global fresh water withdrawals to supply various economic sectors are projected to increase twice as fast as the rates of the population growth. Based on this, the probability of water shortages and droughts in the future is rather high. Indeed, in Europe, by now, about 11% of population and 17% of territory face issue of water scarcity and droughts. These natural phenomena cost about 100 billion euro for the past three decades. Therefore, the water issues are already taken closely into consideration by the EU. (Europe's World, 2012; EC, 2010b)

Concerning other projections and tendencies, within the next 40 years production of electricity will double. The future support of renewables, in particular, hydropower and bioenergy, will be stronger. All these will consequently result in increase of water utilization for energy generation and energy storage. In agriculture it is expected that there will be intensification boost in the course of time. In addition, the contribution of global warming will be more predominant in years to come. (Europe's World, 2012; EWA, 2012)

With regards to the statistics of water consumption in the EU, the current situation can be described as follows (EEA, 2014):

- Public sector requires about 15% of water,
- Industry and energy branches have the second-largest water usage with 40%,
- The most water intensive area is agriculture with 44%.

The largest water consumers such as agriculture and energy production are very often interconnected. When studying the energy sector, water consumption patterns vary depending on type of energy production, as can be seen from Table 13. (Europe's World, 2012)

Table 13 Water consumption patterns in the energy sector in the European Union

Energy sector	Water consumption, m^3/GJ
Natural gas production	0,11
Crude oil production	1,06
Bioenergy	10-250

If the production of natural gas has rather low water consumption rates, in the bioenergy branch the amounts of water per GJ can be quite massive (up to 250 m^3). This is the reason why there is a debate considering energy versus food: whether it is better to utilize water for growing energy crops to generate power or for cultivating vegetables to supply people with provisions. The food and energy sectors can be rather competitive in this sense: not only in terms of land but also for water. This actually is one of the reasons why water, energy and food should be considered together. All three are essential for population and require certain security. Including the fact that climate change with its extreme weather events makes it harder to predict agricultural yields and, as a result, questions the security of food supply to EU population. The solutions about the policies should be developed as explicit as possible to cover the water-energy-food nexus completely in order to avoid competition between energy sector and food industry. These and other issues related to the sectors of water, food and energy require attention and should be put on international table discussions. (Europe's World, 2012)

This thesis concentrates mainly on water policy and the water-energy. A brief analysis of water and energy legislation is provided below based on examples of the EU Water Framework Directive (2000/60/EC), the EU Renewable Energy Directive (2009/28/EC), the Flagship initiative under the Europe 2020 Strategy about resource efficiency (2011) and A Blueprint to Safeguard Europe's Water Resources (2012). Each document is discussed shortly regarding its content. Water-energy nexus is in the focus of attention, in particular, presence or absence of interconnections between water and energy issues within the text bodies of the legislative papers.

5.1.1 EU Water policy timeline

Currently, the EU Water Framework Directive is one of the most comprehensive water policy legislative documents. The directive illustrates a result of long-term development of EU water policy. It began in 1970s with Environmental Action Programme establishing targets of the environmental policies in the EU. Along with it, water legislation was enacted. In 1975, abstraction of drinking water from rivers and lakes was standardized. In 1980, the first drinking water quality targets were established for surface and ground waters. Control over contamination of water bodies was done via the Dangerous Substances Directive (76/464/EEC). In the beginning of 1990s, when there was an increasing problem of surface water eutrophication, several new directives were adopted. After reviewing the current water legislation and finding gaps, the Urban Waste Water Treatment Directive (91/271/EEC) was formed to support secondary and other advanced methods of wastewater treatment. In addition, the Nitrates Directive (91/676/EEC) and the Directive for Integrated Pollution and Prevention Control (96/61/EC) were introduced to control water pollution sources originating from agriculture and large-scale industry, respectively. In 1998, the Drinking Water Directive came into force to improve quality standards. In 2000, after initiatives coming from the Council of environment ministers and the European Parliament's environment committee, the EU WFD (2000/60/EC) was formed as an answer on increasing fresh water demand and growth of contamination rates of water resources. The main purpose of the directive is to improve efficiency of water protection in Europe on legislative level. (EC, 2010b; EC, 2014; European Parliament, 2006)

Starting from 2000s, there was a launch of simplification process for legislation according to the "Better Regulation" Strategy in the EU. Water policy is part of the process. By simplification, a transformation of the regulations into more easy-readable forms is meant, with less volume and better consistency. (European Parliament, 2006)

In 2006, as a Daughter Directive of the WFD the Groundwater Directive (2006/118/EC) was adopted. Ground water is an essential water supply source for the EU. Based on this reason, the Directive was created separately from the WFD to draw attention to regulation of chemical pollution of ground water reserves from agriculture. The Bathing Water Directive (2006/7/EC) was also introduced the same year to cover bathing water monitoring and classification aspects in order to inform people about status of bathing sites. In 2007, a Communication addressing the challenge of water scarcity and droughts in the EU was accepted to bring forward several policy proposals for water efficiency and water saving. Water-energy correlation is underlined in the document, in particular, by equating water saving and energy saving. It is one of the first signs that water-energy nexus started to be more recognized by the European Commission. In 2008, the Marine Strategy Framework Directive (2008/56/EC) was established to preserve and protect the marine environment. In 2009, a White Paper on Adapting to climate change was issued to address climate change mitigation measures and improvements in water and energy efficiency. In 2012, the Blueprint for Europe's Waters was introduced to improve water management, determine drawbacks in water policy and give recommendations how to improve water quality, water use and make it more sustainable, as well as increase resources efficiency. (EC, 2009; EC, 2010b; EUR-Lex, 2008; European Parliament, 2006; Europe's World, 2012)

All things considered, European waters are covered by the legislation and can be safe from an environmental point of view. The main necessary condition is the water policy framework should be completely implemented in Member States of the EU. To enable this process, the Common Implementation Strategy for the Water Framework Directive was accepted. From development perspective, in recent years, EU water policy has been standing in the transformation phase. It is likely that some more reorganizations might arise in the course of time. (European Parliament, 2006)

5.1.2 Water Framework Directive

The Water Framework Directive (WFD) 2000/60/EC was developed by the European Commission to introduce an operational tool for water protection in Europe. It is based on legislation, economic instruments, monitoring, awareness-rising and research development. It is a single document uniting fragmented water policy (seven directives) in one framework for integrated water management. The water management is organized for European river basins within set natural boundaries rather than political borders. The WFD aims mainly towards achievement of good status of fresh waters in the EU by 2015. Currently, the WFD is under-implemented or implemented unevenly throughout the EU. (EC, 2010b; EWA, 2012; EC, 2014)

A list of main statements from the directive is given below (WFD 2000/60/EC)**:**

- Raise awareness and involve water users;
- Bring together water managers of all levels: from authorities to communities; (EC, 2010b);
- Produce river basin management plans on country level;
- Carry out economic analysis of water utilization to enable cost-effectiveness;
- Improve quality (ecological and chemical status) of surface and ground waters;
- Develop a list of priority chemicals and take measures to avoid them polluting water bodies;
- Use pollution control systems at source;
- Utilize water resources sustainably;
- Introduce water pricing policy for water services with included environmental and resource costs;
- Develop administrative arrangements, research and development; and
- Monitor the progress.

The WFD covers many aspects of surface and ground water protection. However, the main focus in the WFD is given to environmental quality of waters. Only negligible amount of energy issues in relation to water utilization are discussed in the document. One of them is energy flow of rivers as a river characterization. The other aspect is that energy and water policies should be more interconnected. The WFD aims to create a platform for development of further policy integration with adjacent sectors of economy such as agriculture, transport, fisheries, tourism and others. There are no more evidences in the water directive of showing correlation with energy issues. (EUR-Lex, 2000; Europe's World, 2012)

5.1.3 Renewable Energy Directive

The development of the Renewable Energy Directive (RED) 2009/28/EC was triggered by a need to promote renewables in Europe. The main outcome should be reached by 2020. By then, 20% of total energy consumption in the EU should arise from renewable energy sources. In addition, transport sector fuel supply should consist at least of 10% of renewable energy share. The national targets are developed for Member States of the EU. To illustrate, for Finland the renewable energy share of final energy consumption by 2020 should be 38%, for Norway – 67,5%, for Scotland – 30%, for Ireland – 16%. (BEFSCI, 2010; Ministry of Petroleum and Energy, 2012; Scottish Government, 2011) Northern Ireland has set targets for electricity and heat consumption from renewable energy sources of 40% and 10%, respectively (NSIPA, 2013).

The directive covers different areas such as land-use, water availability and quality, food security, biodiversity, greenhouse gas emissions, air quality, socio-economics, governance, etc. The document regulates administrative procedures, access to the electricity grids and its operation, provides information about national energy plans, joint energy projects, support schemes, biofuels and its sustainability. (European Parliament, 2009)

The RED creates a platform for favorable promotion of renewables in the EU. As concerns the interconnection of water and energy issues, water is included in the text body as an energy constituent of water bodies, for example, oceans with its tides and waves. Ground and surface water protection and preservation of water quality are also taken into account as renewable energy generation activities should not contribute to contamination of European waters. In addition, overconsumption of water, especially, in water scarce areas should be prevented. (European Parliament, 2009) Thereby, to conclude, presence of water issues in the directive is rather limited. Opportunities to utilize renewable energy potential within the activities and properties of the water industry are not covered.

5.1.4 A Resource Efficient Europe – Flagship Initiative

Resources Efficient Europe is a flagship initiative under the Europe 2020 Strategy presented in COM(2011)21. In it the European Commission declares that pressure on natural resources such as water, fuels, food, soil and biomass is increasing. Competition between land used for food production and land used for energy production may continue and create pressure on land resources. Water scarcity in the EU may launch implementation of desalination technology. This will consequently reflect on energy footprint of the water industry. Due to population growth, the security of supply of the resources is threatened. To tackle these challenges, one of the key solutions may be improvements in resource efficiency and developing a related framework for long-term strategies in energy, agriculture, industry, transport and climate change policies. The latter is the main contribution of the initiative. This is also seen as crucial measure to achieve the Europe´s vision by 2050 where greenhouse gas emissions are reduced by 80-95%. (EC, 2011)

A list of proposed actions for resource efficiency from the initiative is given below (EC, 2011):

- Take measures in policy areas with political support and visibility as well as provide effective governance;
- Do actions and investments urgently due to long pay-back times;
- Bring awareness on customer and producer level, change consumption patterns, give understanding to businesses about immediate investments, implement new technologies, avoid rebound effect;
- As a medium-term proposal, increase water saving and efficiency in water policy in order to use water in more sustainable manner and enable its secure supply;
- Make true costs of resources transparent and well-understood by consumers, and introduce pricing policies, in particular, for water and energy sectors to support resource efficiency measures;
- Use international cooperation, exchange of knowledge, skills and best practices to solve resource efficiency problems; and

- Create tools for monitoring and measuring of progress on resource efficiency on European level.

Within the Flagship initiative, there was a future 2050 vision developed for the EU. It is based on present tendencies and policies. The reference scenario states that energy efficiency will slightly increase. In addition, there will be also moderate decoupling of energy use and economic growth. In terms of renewable energy sources, there is a projection that there will be more investments in smart grids, along with gradual refusal of subsidies for mature energy solutions. Moreover, energy cost reduction, learning of new technological solutions and improvements in administrative regulations are expected. Concerning water resources, droughts and water stress will become more frequent. As desalination is used more often, larger amounts of energy will be utilized. With regards to the WFD, the good water status is mostly achieved. (EC, 2011)

The initiative takes into consideration water and energy efficiency. However, they are discussed separately. No nexus of the two is mentioned. There is no visible correlation of water and energy sectors in the document.

5.1.5 Blueprint to Safeguard Europe's Water Resources

The Blueprint to Safeguard Europe's Water Resources COM(2012)673 final is focused on Europe's waters and intended to analyze the situation in the water policy in the EU by 2012: river basin management, water scarcity and droughts, climate change and other anthropogenic factors influencing water resources and aquatic environment. As a result, some improvements and actions are suggested to water managers and decision makers. A nexus of agricultural, energy and water policies is one of the recommendations (Europe's World, 2012; EC, 2012).

The preconditions for developing the blueprint were, as follows (EC, 2012):

- An estimation that by 2030 there may be global shortage in water supply for 40% of the world population. In Europe, about 50% of river basins may be under influence of water scarcity;
- Transfrontier character of rivers within the EU, interconnection of hydrological cycles, interlinked (positive or negative) effect of land use in adjacent territories, interdependences in different economic sectors, common policies, etc.;
- The EU WFD with a clear point that water management is a broad field where, apart from supply and treatment, there are also other areas involved such as land use and management;
- Analysis of the EU WFD, Review of the Policy on Water Scarcity and Droughts, the EEA State of Water report, the Fitness Check of EU Freshwater Policy and the Commission assessment of the Member State's River Basin Management Plans which state that the objective of the WFD to achieve good water status by 2015 is not going to be gained completely. The expected level of its fulfilment is for 53% of EU water bodies; and
- Understanding that more measures need to be taken to improve water quality and resource efficiency as well as preserve EU waters. The actions should be connected with green growth; mitigation of climate change; land use

improvement; improvement of communication between energy, industrial, agricultural and recreational sectors; and well-organized development of urban communities.

The blueprint was issued at the end of 2012. The document mainly includes discussion about improvements of such problems as environmental status of waters, water pollution, water efficiency, land use, resilience of water bodies, biodiversity, ecosystem services, adaptation to climate change, vulnerability to floods and droughts, governance, water management and cross-cutting problems. (EC, 2012)

The main barriers for better communication between the water-linked sectors (e.g. renewable energy, agriculture, transport, disaster management) and the water sector which are mentioned in the document are as follows (EC, 2012):

- Problems in water management;
- Lack of awareness;
- Lack of proper definition of water services;
- Low level of governance;
- Absence of appropriate support to improve water management;
- Lack of water metering use;
- Environmentally harmful subsidies: e.g. lack of true prices on resources; and
- Absence of economic instruments.

Among the proposals of the blueprint are as listed (EC, 2012):

- Continue Common Implementation Strategy of the EU WFD to contribute to implementation of the water framework;
- Increase water efficiency with compliance with the Flagship initiative about resource efficiency in the linked sectors (e.g. agriculture, water distribution infrastructure, energy generation, buildings) to save water and energy. Maximize water reuse;
- Implement water metering to support EU WFD pricing policies with included true costs of water resources and provision of cost-recovery of water services;
- Design a guidance document to provide information about cost-effectiveness, water trading, pricing policies in water services and benefits when the pricing policies are applied. This should facilitate implementation of water-related projects due to enough financial support;
- Use water accounts to carry out a better water management at river basin, control water flows and monitor water availability for abstraction;
- Develop water efficiency targets for river basins which are under threat of water stress. The targets should be connected to water-linked sectors of economy;
- Participate in EU Ecolabelling to distinguish between advanced water efficient products on the market and those outdated and low efficient. This measure will enable transition to more water efficient equipment. To illustrate, in building sector not only can it decrease water consumption but also allow energy savings. These savings come from heating of water in households for hot water supply;
- Improve irrigation efficiency in agriculture;

- Reconstruct water distribution networks to decrease amount of water lost via leakages;
- Participate in European Innovation Partnerships about water and agricultural issues to utilize innovative solutions;
- Improve knowledge base: e.g. about water status and policies;
- Improve governance: e.g. reporting system, sustainable water management;
- Utilize computer hydro-economic model by Members States of the EU to understand the economic result of taken measures of River Basin Managements Plans;
- Participate in peer-review system to enable exchange of experience and improve quality of documents: e.g. review of River Basin Managements Plans by Members States;
- Draw attention to use of water for economic growth and water-agriculture-energy-environment nexus;
- Bring awareness of water consumption and water services; and
- Review and revise the EU WFD by 2019.

The Blueprint concentrates mostly on improvement of environmental status of waters in the EU, water efficiency issues, adaptation to global warming and related extreme events, water management and water quality. With regards to the water-energy nexus, the blueprint discusses briefly water in connection with energy. To illustrate, hot water is considered as a carrier of energy. In buildings, water efficient solutions can be combined with energy efficiency. More statements are connected with cost-effectiveness what also may be interlinked with energy savings from water equipment use. Communication improvement between water-linked sectors such as agriculture, industry, recreation and water sector is also positioned as a necessary measure to be taken. Another positive factor underlined from the document is a proposal about knowledge base improvement. This may potentially enable development of water asset utilization for renewable energy generation. Several other proposals may also be considered to have positive influence on water-energy nexus development. But as a whole, there is still lack of solid description of possible asset utilization in water companies to produce energy from existing renewable energy potential and make financial savings.

5.1.6 Summary

Water is a constituent of our life that belongs to all areas: from socioeconomic to environmental sectors. By solving water issues and using a holistic approach it is possible to address many other related global problems. (Europe’s World, 2012) The water policy developed substantially over the last four decades: from simple quality standards on drinking water, water protection measures and wastewater treatment improvements to a complex single framework uniting seven water directives to achieve good environmental status of European waters. (EC, 2014) Due to increase of water utilization within various economic sectors, global warming contribution, threat of water shortages and droughts, water issues have become one of the priority issues in the EU. (Europe’s World, 2012; EC, 2014) Interconnection of water-linked sectors such as water, energy, agriculture, recreation and industry is recognized with a higher extent compared to what it used to be two decades ago. It is especially so with regards to food versus energy dilemma. Now it is clear that the problem is not only related to agricultural land-use but also to water utilization. There is an understanding that issues of water, energy, food sectors need to be addressed on policy level together as it is a nexus. (EC, 2012; Europe's World, 2012) Correlation of water and energy issues can be seen more frequently on the legislative level. Water savings are often equated to energy savings. (EC, 2010b; EC, 2012)

However, although it is clear today that energy production and water consumption are mutually dependent and strongly linked, it is also already a fact that in Europe both of the policies exist in non-cohesion with current lack of coordination and interaction. It is two strongly isolated areas. There is no proper interaction and strategic framework between the water and energy sectors. (EC, 2010a; Europe's World, 2012)

Concerning the examples of legislative documents, the EU Water Framework Directive covers only environmental quality of waters. It states that water management is a broad field and interconnected with other sectors of economy. But the water-energy discussion, in particular, is almost absent in the text body of the directive. (EUR-Lex, 2000) In turn, the EU Renewable Energy Directive, which aims to promote renewables use in Europe, includes only negligible number of water issues. No opportunities to utilize renewable energy potential in water companies are described. Water is seen either as an energy constituent of water bodies (e.g. ocean waves or tides) or as a subject under legislation on water preservation and protection. (European Parliament, 2009) In the Flagship Initiative about resource efficiency under Europe 2020 Strategy, water and energy efficiency are considered. But the consideration of them is done separately. No possible interactions between the sectors are mentioned in the document. (EC, 2011) The Blueprint discusses a need for integration and improvement of communication between water sector, energy production, industry, agriculture and recreation. However, the text body is still mostly concentrated on improvement of environmental status of European waters, water efficiency, adaptation to climate change and water management aspects. (EC, 2012)

Thus, after studying the listed legislative documents, it is possible to summarize that the main focus is given most of all towards environmental issues of water bodies. Although a need for integration of the policies in the areas interconnected with water is recognized by the EU, no strategic framework between the sectors is currently available. (EC, 2010a; EUR-Lex, 2000; Europe's World, 2012) Nowadays, even if discussion goes about water-energy issues, it is primarily related to water utilization and its aspects in energy production. The inverse discussion is so far not included in the EU documents to a considerable degree.

As regards to a list of barriers which prevent integration of water sector with water-linked policies, they are the following (EUR-Lex, 2000; EC, 2012; Europe's World, 2012):

- Lack of awareness;

- Low level of communication of the main water industry players such as consumers, water utility managers and decision-makers;
- Low level of governance;
- Environmentally harmful subsidies: e.g. lack true prices on resources;
- Absence of economic instruments;
- Lack of economic analysis of water utilization to enable cost-effectiveness;
- Absence of appropriate support to improve water management; and
- Lack of water metering use.

5.2 Finnish policy review

Being a Member State of the EU, Finland has a similar situation to what can be seen in the European legislation. All acts regulating the water sector almost do not include any cohesion with the energy sector. In energy legislation, opportunities about water asset utilization are also not considered. There is a strong lack of interaction. (Ministry of the Environment, 2004; MAF, 2001; MAF, 2011a) With regards to concrete examples, the Water Act (587/2011), which aims to cover all water issues, from renewable energy perspective regulates only implementation of hydropower plants, permits procedures and its operation. There is no consideration of renewable energy solutions in the water industry. (MAF, 2011a) The Water Services Act (119/2001) does absolutely not concern any energy issues (MAF, 2001). In the Land Use and Building Act (222/2003), water is considered in terms of environmental protection from building activities. Sustainable water usage is another topic present in the text body. As regards energy issues, they are not mentioned. (Ministry of the Environment, 2003) In the National Energy and Climate Strategy, water protection and water management are the only water issues discussed. The water-energy nexus is out of consideration. (Government of Finland, 2013) In Finnish renewable energy legislative documents, such as Government Decree on Production Subsidy for Electricity Produced from Renewable Energy Sources and Act on Production Subsidy for Electricity Produced from Renewable Energy Sources (1396/2010), which objective is to promote renewable energy use in Finland, there is also no description of correlation between water companies and potential for renewable energy generation. (Government of Finland, 2010; Parliament of Finland, 2010)

Currently, implementation of renewable energy solutions represents also a complex process. For example, to implement hydropower with respective spatial planning and infrastructure development, different administrative procedures according to the Land Use and Building Act, the Nature Conservation Act and the Environmental Protection Act are required. These acts are managed under the Ministry of the Environment. The Water Act, that is also important when the hydropower technology is implemented, is under the responsibility of another ministry – the Ministry of Agriculture and Forestry. (MEE, 2009) Thus, when realizing a renewable energy project with building high-voltage lines as part of network infrastructure, crossing some water bodies, etc. – the project executor must get different permits pursuant to the Land Use and Building Act and the Water Act. Since the implementer needs to address different ministries, the procedure can be rather challenging. Not only is it time-consuming but also the decision process is sophisticated. At present, there is no single organization where it would be possible to do all the needed administrative procedures at once. The length of the period, when decisions about the application, coming from the implementer, are made, varies from case to case. It also depends on the project scale and respective amount of work. If it is a small-scale project, it can take about one month for obtaining the permission decisions. If it is a large-scale renewable energy implementation, where not only permissions but also environmental impact assessment, spatial planning and licensing procedures are required, then it might be much longer. The time necessary for going through all the administrative steps in this case may be estimated in years. (MEE, 2009)

Concerning water companies in Finland as well as other public services providers – they all function in a different manner compared to how public companies usually do. By this, different financial mechanisms of companies, providing water supply and wastewater treatment, waste management and energy supply, are meant. The Finnish public companies have their funding mostly originating from customer fees. In this sense, the public companies are rather independent and self-sustaining. They sell their services and they do not need any financial or other support from the public sector. However, at the same time the companies are still considered as public.

Regularly, the Finnish public companies are small-scale and operate on regional level. No single water, energy or waste management company function on country level, like it is, for instance, in Scotland – Scottish Water, Northern Ireland – Northern Ireland Water and Ireland – Irish Water.

As nowadays the public companies are all-sufficient, the role of municipalities is quite weak. The companies are not well-linked with Finnish ministries. The common decision making process and other possible ways of collaboration are absent. Hence, the vertical communication at the base of the organizational pyramid does not work efficiently. Only horizontal connections between the public companies, in particular, provision of waste management to water companies or water services to energy companies, are present. Otherwise, the public companies among themselves as well as the public sector and the public companies exist separately.

On the other hand, the same pattern can be seen in the public sector with ministries. After introduction of environmental concerns in 1970s, the European legislative base developed substantially and went deep from general issues of environmental protection and sustainable development to very specific aspects. Eventually, at the present time, there is loss of overall picture. There are different ministries dealing with the environment, trade, the economy, agriculture and so forth. They all work within their specific fields without interaction and communication between each other. The problems of one sector are not discussed with specialists from another sector. There are separate fields of energy, water and waste management. Even in one field the division may be rather significant: e.g. professionals in water supply do not communicate with professionals in wastewater treatment, although they belong to one water sector. Thus, if there is an example of intersectoral concern, it is quite difficult to tackle this challenge and deal with practical matters such as permits, financing mechanisms, etc.

From another perspective, there is no motivation for the public companies to do anything else besides providing the services. There is no need for them to go to another sector. To illustrate, for energy company there is no interest of building a wind turbine on the territory of water company. In addition, there are many challenges and questions they can face: starting from ownership of the wind turbine and ending with paying the bill for the produced energy. In the Finnish legislation, so far, it is not clear if either water or energy company is the owner of the renewable energy solution as well as if either water or energy end users have to pay the bill for the received energy. The lack of interest from the public companies is also explained by a fact that both water and energy companies are in their comfort zone. They are self-organized and have stable profits. They are already financed by either water or energy customer fees. The companies receive no support from municipalities. There is clearly no economic sense or a win-win for companies to meet the present challenges of the legislative structure. Something is still missing in the system and needs to be done.

Scale of water companies is also of importance when implementing renewable energy solutions. In Scotland, for instance, Scottish Water has more opportunities and favorable conditions to implement renewables. It is a large-scale public company that is the only one in the country providing water services. It is more organized in comparison with Finnish small-scale companies. Scottish Water is one of the largest energy consumers in Scotland and has rates of energy consumption visible and open to communities (Thomson, 2013). In addition, Scottish government has water on its agenda in the HydroNation initiative (Scottish Government, 2014c). This is also a positive factor for the water industry development. In contrast, in Finland, small water companies have only annual reports. Often, many services are outsourced. The water companies do not follow their energy consumption before they pay for it. The energy values are rather unnoticed. There is lack of awareness in this regard in Finland.

This is a common problem within the Northern Periphery, which is why a panel discussion has been organized within the WARES conference on June 4th, 2014, participated by Karoliina Auvinen of Finnish Local Energy Association, Barry Greig from the Scottish Government, Iarla Moran of Mayo County Council, Brian McDonald from Group Water Schemes and Haflidi Haflidason of Arioni Bank (WARES Panel, 2014). Based on also the discussion of the panelist, the following barriers in the Finnish legislation can be presented:

- Lack of political leadership in climate issues;
- Lack of mutual understanding between politicians and other officials;
- Lack of political will and support;
- Lack of environmental directions;
- Complex and inefficient way of handling proposals. To illustrate, a proposal to unite water and energy sectors can be received by one Ministry where it is discussed. Then it stops there and do not continue going further to other Ministries;
- The energy market is very regulated, market-based price does not exist;
- Fossil fuels are incentivized;

- Profitability problems in terms of renewable energy;
- Administrative barriers: e.g. ownership issues of renewable energy solution, energy or water bill payment;
- Absence of communication between water and energy sectors to utilize potential for renewable energy generation within the activities and properties of the water industry (MAF, 2001; MAF, 2011a; Ministry of the Environment, 2004; Government of Finland, 2013);
- Bureaucracy problems: e.g. complex process of decision making for renewable energy implementation in water industry, contracts and different forms are difficult to fill out;
- Small scale, self-sufficiency and independence of the Finnish public companies;
- Weak role of municipalities, inefficient work of vertical municipality-public company communication in decision making, and poor state of organizational pyramid as a whole;
- Loss of overall picture;
- Lack of motivation, economic interest and need for public companies go to another sectors: e.g. energy company to the water industry;
- Lack of awareness; and
- Lack of research to enhance profitability of implementation of renewables.

5.3 Finnish policy recommendations

The recommendations aim to promote implementation of renewable energy solutions in the Finnish water industry though utilization of hidden or unused potential of water assets (e.g. running water flows, machinery equipment, plants with its heat losses, properties, occupied territories and waste streams with its energy potential). There are three levels of proposed recommendations: EU, regional, and national. Under the national level there are short-term and long-term recommendations.

5.3.1 European Union level

The public sector should be the main driving force. As can be seen from Figure 2, EU regulations are driving Finnish water legislation. Thus, the initiative coming from the EU would be the most effective tool to improve the current lack of water and energy interconnection in Finland. To make proper decisions about the future policies, a common understanding of the problem of water-energy nexus should be achieved on European level. To start the reform, there should be an understanding of overall sustainability concept; comprehensive environmental approach should be utilized. These have a central role. In addition, there should be a coherent analysis done to realize why water assets are not used efficiently at the present time. As an outcome, there should be appropriate intersectoral roadmaps developed. The roadmaps should be directed towards a better communication between the sectors of water and energy. This will help to improve the policies and security on energy and water. On a national level, the government should act as a catalyst in enabling renewable energy implementation in the water industry. The awareness should be brought from the political arena also to the community level. All parties should be involved in the transition process: regional and local decision makers, water companies, water consumers, business sector, agriculture, industry, and other economic and environmental stakeholders. It is important to provide knowledge and training to the parties so that they do not see this development as an obstacle but more like an opportunity to improve water and energy efficiency and gain some financial savings. As proposed in the Water Blueprint, a guidance document should be also developed to support cost-effectiveness of water measures. The document aims to describe costs and benefits of the measures in the water sector. (Europe's World, 2012; EC, 2012; WARES Panel, 2014) The profitability of renewable energy implementation should be shown.

Integration of water policy with other interlinked sector policies should be done. The EU should give high priority the water-energy issue and put it on the discussion table to make appropriate changes. There should be a developed cooperation, coordination, institutional linkage between the involved parties and across the economic sectors to build green economy with resource efficiency and low carbon footprint. There should be chosen a wider perspective about water resource management. Since there are many crossing points, water and renewable energy should be much more integrated. This will help, in particular, to involve renewable energy in the water sector more that it is nowadays. The water-energy integration can also help to increase water and energy efficiency. As a result, it can enhance water and energy security and allow making some financial savings on the EU level. Thus, all these can be beneficial both for the economy and the environment. (Europe's World, 2012; EC, 2012)

Environmentally harmful subsidies should be removed on European and national levels. The subsidies that directly or indirectly facilitate industrial or other economic activities which negatively affect the environment should be eliminated. Among these activities may be put support for production and use of fossil fuels, over-use of water in agriculture for irrigation and other examples. (Europe's World, 2012)

Ecolabelling and certification schemes in water service sector should be launched. This measure should be taken to improve awareness among citizens and various business players. Labels and certificates can help to confirm, for instance, that water and energy were utilized efficiently in the production chain, renewable energy solution was implemented in water utilities and so forth. If this scheme is developed on international level and supported by EU policies, different industrial players and other stakeholders will be more motivated to implement various water-energy solutions. (Europe's World, 2012; EC, 2012)

Support research and development should enable improvements in water and energy efficiency, sustainable water resource management, consumption patterns and technological schemes, water supply and wastewater treatment technologies, renewable energy solutions applicable in the water industry, design and construction of power plants, water energy storage solutions, decentralized energy systems, as well as water network infrastructure development. The research should be supported by international cooperation (Europe's World, 2012; EWA, 2012; EC, 2012).

Implementation of the updated legislation should be done. There should be full implementation of the new legislation on European and national levels. (Europe's World, 2012)

To control the degree of implementation of renewables in the water industry monitoring and measure of progress should be done on EU level.

5.3.2 Regional level

There should be regional and trans-boundary cooperation to support water-energy nexus and have better policy coherence. There should be created different platforms for interaction (e.g. forums, conferences, workshops) between the decision-makers and other involved parties to address these challenges. (Europe's World, 2012) Exchange of knowledge, skills and best practice should be arranged. Collaboration as Norway and Sweden have is a good example to follow. To meet the requirements of the Europe 2020 Strategy and the EU's Renewables Directive, common electricity certificate market was established. There are mutual advantages with more efficient use of renewable resources, more participants on the energy market, good financial support for renewable energy technologies and more cost-efficient renewable energy production. (NVE, 2012) Similar projects within the water-energy nexus should be done in terms of Finnish cooperation with neighboring countries.

5.3.3 National level

Among a list of long-term proposals are:

- Development of a long-term strategy within water-energy nexus should be done to improve water management, water and energy efficiency and tackle the existing challenges hindering implementation of renewable energy in the water industry. (EWA, 2012);
- Increase the objectives for renewable energy promotion on a value higher than in the 2030 framework for climate and energy policies and the EU Renewable Energy Directive. This will enable more efficient promotion of renewable energy implementation. (Auvinen, 2014)

Short-term recommendations are listed as follows:

- Regulate ownership and bill payment issues when there are intersectoral cases of conflict between public water and energy companies;
- As proposed from the EU WFD, there should be done an economic analysis of water utilization to enable cost-effectiveness. (EUR-Lex, 2000);
- The work of ministries when handling proposals to improve policies, in particular, in water and energy sectors, should be enhanced. This will help to make the policies integration in a more efficient manner;
- The public service companies should be more involved in decision making process. Better communication should be arranged. The vertical communication and organizational pyramid should function more efficient;
- The public service companies should not function on country level, as it is the case, for instance, in Scotland with a single public water company – Scottish Water. Although Finland and Scotland belong to the Northern Periphery Region and have a lot of similarities: e.g. in environmental and organizational issues; there are also many differences. The largest difference is geographical parameters such as country size, sparse population, length, etc. The water sector

functions also very differently in Norway and Finland in comparison with Scotland, Northern Ireland and Ireland. The concept of one company for the whole country would not work in Finland. In Finland regional, locally oriented solutions with homogeneous conditions would be more suitable. Among the conditions to define the regions there could be water coverage, population, industry, structure of water abstraction, competing users, land area, stress on water bodies, etc. In addition, there should be some regional organizations in the country which promote communication between energy and water sectors;

- Application processes and implementation of renewable energy solutions in general should be better arranged. By this, easier application forms and faster process of handling applications are meant;
- Development of financial support and pricing schemes should be carried out. Currently, there are only two renewable energy support financial tools available. There should be more economic mechanisms of support for implementation of water-energy solutions created on national level. Best practices with financial support mechanisms for renewable energy implementation of the Northern Periphery Region should be utilized. Finland, for example, could also introduce some new charges, water prices or tax schemes to support development of renewable energy in water companies (EWA, 2012). The introduction of water pricing policies for water services with environmental and resource costs included is also recommended by the EU WFD (EUR-Lex, 2000). The true costs of water and energy resources should be better understood by consumers. Besides, it should help to provide cost-recovery of water services. (EUR-Lex, 2000; EC, 2011; EC, 2012) A favourable market conditions should be created where price mechanisms and financial support schemes are efficient and well-developed. This will help to use water and energy resources more sustainable and raise their value. This is especially important if resources are scarce. Government support in these aspects plays a crucial role. In addition, there should be a single financial intersectoral tool developed in Finland. It should have influence on water and all related sectors: e.g. energy, agriculture, transport, and the environment. (Europe's World, 2012; EWA, 2012);
- Research and development on national level should be supported. It should help to promote renewables in the water sector;
- Training of specialists should be performed. There should be higher educated staff available to support implementation of water related solutions and renewable energy technologies. (EWA, 2012)

Table 14 summarizes all the listed barriers of the Finnish legislation as well as proposed recommendations. The recommendations are classified on either European (E), regional (R), national long-term (NL) or national short-term (NS) levels.

Table 14 The barriers and policy recommendations for the Finnish water and energy sectors.

<table>
<tr><th colspan="2">Finnish legislation and water-energy nexus</th></tr>
<tr><th>Barriers</th><th>Recommendations (NS/NL/R/E)</th></tr>
<tr><td>Lack of political leadership, mutual understanding, will and support in environmental issues, environmental directions</td><td rowspan="2">Bring awareness on all levels, use comprehensive environmental approach, develop a guidance document to describe beneficial points and cost-effectiveness of renewable energy implementation in the water industry, develop intersectoral roadmaps towards a better communication between the water and energy sectors, place the public sector to play a key role in the transition, involve all parties, monitor the progress (E)</td></tr>
<tr><td>Profitability problems of renewable energy solutions</td></tr>
<tr><td>Loss of overall picture</td><td>Develop a long-term strategy, increase the goal of renewable energy share on national level up to 40%, train renewable energy specialists (NL)</td></tr>
<tr><td>Complex and inefficient way of handling proposals</td><td>Enhance the work of ministries when handling proposals about policies improvements (E)</td></tr>
<tr><td>Too regulated energy market with no market-based price</td><td>Support regional and trans-boundary cooperation, especially, with neighboring countries (R)</td></tr>
<tr><td>Fossil fuels are incentivized</td><td>Remove environmentally harmful subsidies (E)</td></tr>
<tr><td>Administrative barriers</td><td>Regulate intersectoral ownership and bill payment issues (NS)</td></tr>
<tr><td>Absence of communication between water and energy sectors</td><td>Integrate water policy with other interlinked sector policies (E)</td></tr>
<tr><td>Bureaucracy problems</td><td>Make easier and faster the process of implementation of renewables (E)</td></tr>
<tr><td>Small scale, self-sufficiency and independence of the Finnish public companies</td><td>Organize regional, locally oriented solutions with homogeneous conditions and involve regional organizations to promote better communication between energy and water sectors (NS)</td></tr>
<tr><td>Weak role of municipalities, inefficient work of vertical municipality-public company communication in decision making, and poor state of organizational pyramid as a whole</td><td>Improve communication and vertical organizational pyramid between public companies and municipalities (NS)</td></tr>
<tr><td>Lack of motivation, economic interest and need for public energy companies go to the water industry</td><td>Carry out economic analysis of water utilization to enable cost-effectiveness, develop more financial support mechanisms based on best practices of the Northern Periphery region, improve pricing schemes (NS)</td></tr>
<tr><td>Lack of research to enhance profitability of implementation of renewables</td><td>Support national and international research and development (E, NS)</td></tr>
<tr><td>Lack of awareness</td><td>Introduce ecolabelling and certification schemes (E)</td></tr>
</table>

Sources: Europe's World, 2012; EC, 2012; EUR-Lex, 2000; EWA, 2012; Government of Finland, 2013; MAF, 2001; MAF, 2011a; Ministry of the Environment, 2004; WARES Panel, 2014.

All these recommendations should be consolidated in the legislation and have enough political support. Only if these main conditions are met, it is possible to expect some favorable results with practical implementation.

6 SUMMARY AND CONCLUSIONS

Whilst Finland, Norway, Scotland, Northern Ireland and Ireland have multiple environmental and organizational analogies, there are also a lot of dissimilarities. The geographical differences, for example would warrant grouping these countries into two groups. The countries of the British Isles, Scotland, Northern Ireland and Ireland could be the first one with the total area under 100 000 km^2. Norway and Finland in Fennoscandia could be the other one with the country's size of about 330 000 km^2. As can be seen, the countries in Fennoscandia are three times larger than the countries from the British Isles. The latter fact has consequences and is likely to have played a significant role in forming the structure of the water industry. In both groups, water services are provided by public water companies. But scale of companies, coverage of public water supply and wastewater treatment, water customer fees and water assets vary. In the British Isles, water services are provided by a single public water company working countrywide. These companies have ownership rights on water infrastructure, land and water resources. The coverage of water services is rather high; sometimes close to 100%. The only exception is Ireland. However, the Irish water industry is in the transition stage towards improvements in the water service sector. In turn, in Fennoscandia water services are organized by small-scale, local companies. Due to the sparse population and the country length, the coverages of public water supply and wastewater treatment constitute about 90% and 82%, respectively. The ownership on land and water resources belongs to municipalities. Thus, the Finnish and Norwegian water companies own only the infrastructure but not land or water assets. With regards to customer water fees, they are present in all five countries but in different forms, types and rates.

Renewable energy technologies are utilized according to the countries' geographical conditions and energy polices. However, among the common energy solutions are wind, solar, hydropower and bioenergy. As concerns the water industry and its energy supply, the Northern Periphery Region is gradually implementing more renewable energy sources. Today, water assets are the most utilized in terms of renewable energy generation in Scotland and Ireland. Northern Ireland and Norway can be put second place in this sense. Finland has already employed such solutions as heat pumps and anaerobic digestion. But there is still unused potential in the implementation of hydropower, solar and wind energy in the water industry. To utilize the potential, some improvements in the communication between Finnish water and energy companies should be done.

With regards to economic mechanisms of support for renewable energy generation in the Northern Periphery Region, currently, there are six support schemes applied in the listed countries in total. Each mechanism in every country has its peculiarities. The statistics tells that, at present, Scotland and Northern Ireland have five and four support tools, respectively. Due to the high percentage of share of renewable energy production in the country, Norway has the least number of financial mechanisms – one. In Finland and Ireland there are two support schemes each.

Public-Private Partnerships, as a tool to implement renewable energy solutions in the water industry, are developing differently in the countries in question. Scotland, Northern Ireland, and Ireland are the most experienced with this tool. Both in Norway and Finland this model of collaboration is rather new and needs more time to get adopted.

As can be seen, water asset utilization for renewable energy generation is organizationally developed and financially supported differently throughout the Northern Periphery Region; the first group of the countries is more successful in this regard compared to the second one. In Finland, currently, there are many obstacles on legislative and organizational levels which hinder communication between the water and energy sectors and, consequently, the implementation of renewables in the water industry. As Finland is a Member State of the EU and is under its water policy, European water legislation is also a key to find solutions to this issue. Although the EU water policy developed substantially over the last four decades, interconnection of water-linked sectors such as water, energy, agriculture, recreation and industry is recognized with a higher extent, strong correlation and interdependence of water and energy issues are found more often in the legislation; it is still true that in Europe both of the policies exist in significant non-cohesion with current lack of coordination and interaction. The main focus is given mostly to environmental issues of water bodies. The laws are primarily related to water utilization in energy production. The inverse train of thought is so far not to be seen in the legislation to a considerable degree. There is no strategic framework available to link the water and energy sectors. On a Finnish national legislative level, the absence of water-energy interaction can also be underlined. Small-scale water and energy companies are rather independent from municipalities, financially self-sufficient and have no economic interest to do intersectoral projects: e.g. implementation of renewable energy solution at water companies. By now, there are more administrative, bureaucracy and organizational obstacles rather than attractive and profitable opportunities visible for the public companies. Lack of awareness and political support are the main barriers.

To promote implementation of renewable energy sources in the Finnish water industry and utilize unused potential of water assets, the following recommendations for the legislation are proposed:

- *On a European level*:
    a) Use comprehensive environmental approach, create roadmaps, support research and development;
    b) Bring awareness, introduce ecolabelling and certification schemes to create visibility;
    c) Describe benefits from economic perspective of renewable energy implementation in the water industry;
    d) Enhance the work of the public sector for better integration of the water-energy policies;
- *On a regional level*, support regional and trans-boundary cooperation;
- *On a national level*:

a) For long term perspective, develop a strategy, increase national renewable energy targets;
b) Carry out economic analysis, develop more financial support mechanisms, improve pricing schemes;
c) Improve communication and vertical organizational pyramid between the public companies and municipalities;
d) Regulate intersectoral ownership and bill payment issues; and
e) Develop regional, locally oriented solutions within the water-energy nexus.

All these policy recommendations should be consolidated in the legislation and have enough political support. Only if these conditions are met, it is possible to expect some favorable results with practical implementation in Finland.

7 REFERENCES

AID, Advocates for International Development. (2012). *Public-Private Partnership (PPP).* Available: http://a4id.org/sites/default/files/files/%5BA4ID%5D%20Public-Private%20Partnership.pdf. Last accessed 13th Mar 2014.

ANRG, Abundance NRG Ltd. (2014). *Investments that build a better world to spend your money in.* Available: https://www.abundancegeneration.com/. Last accessed 30th May 2014.

AR, Action Renewables. (2014). *What We Do?.* Available: http://www.actionrenewables.co.uk/wp-content/uploads/ACTION-RENEWABLES-BROCHURE.pdf. Last accessed 15th May 2014.

ARNI, Action Renewables, Northern Ireland. (2014). *Loughmacrory pilot site.* Available: http://www.waresnpp.eu/assets/documents/WARES%20-%20Northern%20Ireland%20Pilots.pdf. Last accessed 30th May 2014.

Auvinen, K. (2014). *Renewable energy in Finland*. Presentation at the *Renewable Energy at Water Utilities WARES conference*, Oulu, 4 June.

BEFSCI, Bioenergy and Food Security Criteria and Indicators Project. (2010). *EU Renewable Energy Directive (RED).* Available: http://www.fao.org/bioenergy/20638-095e8d8019b42aea550493261a5ec29a6.pdf. Last accessed 11th July 2014.

Berge, G., Mellem, K. B. (2013). *Kommunale avløp.* Available: https://www.ssb.no/en/natur-og-miljo/artikler-og-publikasjoner/_attachment/153599?_ts=142e1befaf8. Last accessed 2nd May 2014.

Bookless, A. (2014) E-mail on Ownership in Water Utilities in the Northern Periphery Region on behalf of Action Renewables. Northern Ireland. Received *07.07.2014*

Bord Gais. (2013). *Transforming water services in Ireland.* Available: http://www.southtippcoco.ie/media/Irish%20Water%20Publications_Public_Notices_Leaflet.pdf. Last accessed 13th May 2014.

Brückmann, R. (2013). *Electricity Promotion in Finland.* Available: http://176.9.160.135/search-by-country/finland/tools-list/c/finland/s/res-e/t/promotion/sum/128/lpid/127/page.pdf?out=pdf. Last accessed 19th Mar 2014.

Caló, A. (2011). *Assessing the potential for smart energy grids in the Northern Periphery.* Available: http://nortech.oulu.fi/MicrE_files/Antonio_Calo_DW.pdf. Last accessed 24th July 2014.

Cambi. (2008). *Hamar, N.* Available: http://www.cambi.no/wip4/plant.epl?cat=10643&id=190990. Last accessed 25th July 2014.

Carbon Trust. (2014a). *Northern Ireland. Reducing Northern Ireland's carbon footprint in business and the public sector.* Available: http://www.carbontrust.com/client-services/northern-ireland. Last accessed 28th May 2014.

Carbon Trust. (2014b). *0% business loans eligibility.* Available: http://www.carbontrust.com/client-services/northern-ireland/loans-eligibility. Last accessed 28th May 2014.

Christie, S. J. (2011). *UK National Ecosystem Assessment Northern Ireland Summary.* Available: http://uknea.unep-wcmc.org/LinkClick.aspx?fileticket=mYewbZ5ifj0%3D&tabid=82. Last accessed 13th May 2014.

CIA, Central Intelligence Agency. (2014a). *The World Factbook. Ireland.* Available: https://www.cia.gov/library/publications/the-world-factbook/geos/print/country/countrypdf_ei.pdf. Last accessed 17th May 2014.

CIA, Central Intelligence Agency. (2014b). *The World Factbook. Finland.* Available: https://www.cia.gov/library/publications/the-world-factbook/geos/fi.html. Last accessed 30th June 2014.

CIA, Central Intelligence Agency. (2014c). *The World Factbook. Norway.* Available: https://www.cia.gov/library/publications/the-world-factbook/geos/no.html. Last accessed 30th June 2014.

Comprehensive Norwegian Encyclopedia. (2014a). *Elv. (River).* Available: http://snl.no/elv. Last accessed 2nd July 2014.

Comprehensive Norwegian Encyclopedia. (2014b). *Innsjø. (Lake).* Available: http://snl.no/innsj%C3%B8. Last accessed 2nd July 2014.

DCENR, Department of Communications, Energy and Natural Resources. (2012). *Electricity Regulation Act 1999 (Public Service Obligations) (Amendment) Order 2012.* Available: http://www.dcenr.gov.ie/NR/rdonlyres/C0276F9F-AD8F-4595-B4DE-FA119448B45C/0/SI_438_2012.pdf. Last accessed 2nd Apr 2014.

DECLG, Department of the Environment, Community and Local Government. (2012). *Water Sector Reform Implementation Strategy.* Available: http://www.environ.ie/en/Publications/Environment/Water/FileDownLoad,32001,en.pdf. Last accessed 2nd May 2014.

DECLG, Department of the Environment, Community and Local Government. (2014). *Frequently Asked Questions on Government decisions on free allowance and water charges.* Available: http://www.environ.ie/en/PublicationsDocuments/FileDownLoad,37945,en.pdf. Last accessed 21st May 2014.

Department of the Environment. (2003). *The Water Environment (Water Framework Directive) Regulations (Northern Ireland) 2003.* Available: http://www.doeni.gov.uk/niea/finalregs.pdf. Last accessed 2nd July 2014.

DETI, Department of Enterprise, Trade and Investment. (2013). *The Northern Ireland Renewables Obligation (NIRO).* Available: http://www.detini.gov.uk/niro_-_how_it_works-2.pdf. Last accessed 28th May 2014.

Devitt, C., Malaguzzi L.V. (2011). *The Effect of REFIT on Irish Electricity Prices.* Available: http://www.tara.tcd.ie/jspui/bitstream/2262/54955/1/WP374.pdf. Last accessed 25th Mar 2014.

DJEI, Department of Jobs, Enterprise and Innovation. (2013). *Progress report on Growth and Employment in the Green Economy in Ireland.* Available: http://www.djei.ie/publications/enterprise/2013/Green_Economy_Progress_Report_2013.pdf. Last accessed 15th May 2014.

Dickinson I., Glover C. (2009). *Project Alpha - Public Private Partnership.* Available: http://www.waterprojectsonline.com/case_studies/2009/NIW_Alpha_2009.pdf. Last accessed 14th Apr 2014.

DKM Economic Consultants, Dublin. (2012). *Dublin Waste Water Treatment.* Available: http://ec.europa.eu/regional_policy/sources/docgener/evaluation/pdf/projects/dublin_wastewater.pdf. Last accessed 11th Apr 2014.

Dublin City Council. (2009). *Revised Risk Assessment Methodology for Surface Water Abstractions from Lakes.* Available: http://www.wfdireland.ie/docs/24_Abstractions/Abstraction%20Lakes%20Final%20Report%20Jan09.pdf. Last accessed 15th May 2014.

DWQRS, Drinking water quality regulator for Scotland. (2012). *Drinking water quality in Scotland 2012.* Available: http://www.dwqr.org.uk/portalbase/pages/download.aspx?locationId=89104205-6cab-45f5-bda5-fe3563d600ea. Last accessed 7th May 2014.

EBRD, European Bank for Reconstruction and Development. (2005). *Update on Best International Practices in Public Private Partnership with Regards to Regional Policy Issues.* Available: http://www.partnershipsforwater.net/tc/TC_Tools/081505_EBRD%20ATKINS%20Update%20on%20Best%20International%20Practices%20in%20Public%20Private%20Partnership%20with%20Regards%20to%20Regional%20Policy%20. Last accessed 8th Apr 2014.

EC, European Commission. (2007). *Addressing the challenge of water scarcity and droughts in the European Union.* Available: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52007DC0414&from=EN. Last accessed 14th July 2014.

EC, European Commission. (2009). *Adapting to climate change: Towards a European framework for action.* Available: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2009:0147:FIN:EN:PDF. Last accessed 14th July 2014.

EC, European Commission. (2010a). *Water Framework Directive.* Available: http://ec.europa.eu/environment/pubs/pdf/factsheets/water-framework-directive.pdf. Last accessed 5th May 2014.

EC, European Commission. (2010b). *Water Scarcity and Drought in the European Union.* Available: http://ec.europa.eu/environment/pubs/pdf/factsheets/water_scarcity/en.pdf. Last accessed 5th May 2014.

EC, European Commission. (2011). COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS. *A resource-efficient Europe – Flagship initiative under the Europe 2020 Strategy.* COM(2011)21. Available: http://ec.europa.eu/resource-efficient-europe/pdf/resource_efficient_europe_en.pdf. Last accessed 11th July 2014.

EC, European Commission. (2012). COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS. *A Blueprint to Safeguard Europe's Water Resources.* COM(2012)673 final. Available: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52012DC0673&from=EN. Last accessed 17th June 2014.

EC, European Commission. (2014). *Introduction to the new EU Water Framework Directive.* Available: http://ec.europa.eu/environment/water/water-framework/info/intro_en.htm. Last accessed 14th July 2014.

ECLG, Environment, Community and Local Government. (2012). *Reform of the water sector in Ireland.* Available: http://www.environ.ie/en/Publications/Environment/Water/FileDownLoad,29192,en.pdf. Last accessed 13th May 2014.

EC DGRP, European Commission. Directorate-General Regional Policy. (2004). *Resource Book on PPP Case Studies.* Available: http://ec.europa.eu/regional_policy/sources/docgener/guides/pppresourcebook.pdf. Last accessed 8th Apr 2014.

EEA, European Environment Agency. (1996). *Surface water quality monitoring.* Available: http://www.eea.europa.eu/publications/92-9167-001-4/at_download/file. Last accessed 2nd May 2014.

EEA, European Environment Agency. (2014). *Water use by sectors.* Available: http://www.eea.europa.eu/themes/water/water-resources/water-use-by-sectors. Last accessed 15th July 2014.

EIRGRID Group. (2013). *Annual Renewable Report 2013.* Available: http://www.eirgrid.com/media/EirGridAnnualRenewableReport2013.pdf. Last accessed 3rd July 2014.

Encyclopedia Britannica. (2014a). *Scotland.* Available: http://www.britannica.com/EBchecked/topic/529440/Scotland. Last accessed 30th June 2014.

Encyclopedia Britannica. (2014b). *Northern Ireland.* Available: http://www.britannica.com/EBchecked/topic/419739/Northern-Ireland. Last accessed 30th June 2014.

EPA, Environmental Protection Agency. (2006). *Water Framework Directive Monitoring Programme.* Available: http://www.epa.ie/pubs/reports/water/other/wfd/EPA_water_WFD_monitoring_programme_main_report.pdf. Last accessed 2nd July 2014.

EPA, Environmental Protection Agency. (2011). *The Provision and Quality of Drinking Water in Ireland.* Available: http://www.epa.ie/pubs/reports/water/drinking/Drinking%20Water_web.pdf. Last accessed 13th May 2014.

EPD, Environmental Protection Department. (2007). Review of the International Water Resources Management Policies and Actions and the Latest Practice in their Environmental Evaluation and Strategic Environmental Assessment. NORWAY. Available: http://www.epd.gov.hk/epd/SEA/eng/file/water_index/norway.pdf. Last accessed 14th Apr 2014.

EUR-Lex. (2000). Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy. Available: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02000L0060-20090625&from=EN. Last accessed 5th May 2014.

EUR-Lex. (2008). *Marine Strategy Framework Directive.* Available: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0056&from=EN. Last accessed 15th July 2014.

European Parliament. (2006). *Simplification of European Water Policies.* Available: http://www.europarl.europa.eu/RegData/etudes/note/join/2007/385630/IPOL-ENVI_NT(2007)385630_EN.pdf. Last accessed 15th July 2014.

European Parliament. (2009). *Directive 2009/28/EC on the Promotion of the Use of Energy from Renewable Sources.* Available: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0016:0062:EN:PDF. Last accessed 11th July 2014.

Europe's World. Issue 21. Summer 2012. (2012). *Water and energy security are two sides of the same coin.* Available: http://www.siwi.org/documents/Resources/news_articles/EW21water.pdf. Last accessed 9th June 2014.

EWA, European Water Association. (2012). *Water Manifesto.* Available: http://www.ewa-online.eu/tl_files/_media/content/documents_pdf/Publications/Water-Manifesto/EWA_Water-Manifesto_3_2012.pdf. Last accessed 17th June 2014.

FINLEX. (2001). *Vesihuoltolaki 119/2001. (Water Supply Act 119/2001).* Available: http://www.finlex.fi/fi/laki/ajantasa/2001/20010119?search%5Btype%5D=pika&search%5Bpika%5D=Vesihuoltolaki. Last accessed 7th July 2014.

FWF, Finnish Water Forum. (2012). *Management of Water Supply Services in Finland.* Available: http://www.finnishwaterforum.fi/binary/file/-/id/9/fid/383/. Last accessed 28th Feb 2014.

FWF, Finnish Water Forum. (2014). *Finnish Water - Best Practices.* Available: http://www.finnishwaterforum.fi/binary/file/-/id/2/fid/78/. Last accessed 28th Feb 2014.

Gagarin, P. (2013). *Государственно-частное партнерство как инструмент реализации масштабных проектов. (Public-Private Partnership as a tool for realization of large-scale projects).* Available: http://www.gradient-alpha.ru/analitika/2013/03/20/gosudarstvenno-chastnoe-partnerstvo-kak-instrument-realizaczii-masshtabnyix-proektov/. Last accessed 7th Apr 2014.

Global Water Intelligence. (2002). *Finnish city to outsource WwTP.* Available: http://www.globalwaterintel.com/archive/3/4/general/finnish-city-to-outsource-wwtp.html. Last accessed 8th Apr 2014.

Gonzalez, D., Kilinc, A., Weidmann, N . (2011). *Renewable Energy Development Hydropower in Norway.* Available: http://www.th-nuernberg.de/fileadmin/Fachbereiche/bw/studienschwerpunkte/international_business/Master/CAIFD/SeminarPapers/HydropowerNorway_SeminarPaper.pdf. Last accessed 3rd Mar 2014.

Gopal, C., Mohanraj, M., Chandramohan, P., Chandrasekar, P. (2013). Renewable energy source water pumping systems — A literature review. *Renewable and Sustainable Energy Reviews*. 25, p351–370.

Government of Finland. (2010). *Government Decree on Production Subsidy for Electricity Produced from Renewable Energy Sources.* Available: http://www.energiavirasto.fi/documents/101091/0/Decree+1397_2010+EN.pdf/6c081c13-6e5d-469d-85ec-00bc35542375. Last accessed 18th July 2014.

Government of Finland. (2013). *National Energy and Climate Strategy.* Available: https://www.tem.fi/files/36292/Energia-

_ja_ilmastostrategia_nettijulkaisu_ENGLANNINKIELINEN.pdf. Last accessed 17th July 2014.

Greve C. (2003). *Public-Private Partnerships in Scandinavia.* Available: http://www1.imp.unisg.ch/org/idt/ipmr.nsf/ac4c1079924cf935c1256c76004ba1a6/4871a3fc8fe0cc87c1256e0400523ebd/$FILE/IPMR_4_2_PUBLIC%20PRIVATE%20PARTNERSHIP%20IN%20SCANDINAVIA.pdf. Last accessed 14th Apr 2014.

Heinonen, M. (2013). *Wastewater Treatment Update FINLAND.* Available: https://www.globalmethane.org/expo-docs/canada13/mww_02_Finland.pdf. Last accessed 24th July 2014.

Hendry, S. (2013). *Private Rights and Public Responsibilities: Recent developments in Scots water law.* Available: http://www.fljs.org/files/publications/Hendry.pdf. Last accessed 13th May 2014.

HSY, Helsinki Region Environmental Services Authority. (2011). *General Supply Conditions.* Available: http://www.hsy.fi/vesi/Documents/Hinnat_sopimusehdot/ENG_materiaali/HSY_vesi_toimitusehdot_eng2011_13826.pdf. Last accessed 3rd Mar 2014.

IEA, International Energy Agency. (2011). *Energy Policies of IEA Countries. Norway.* Available: http://www.iea.org/publications/freepublications/publication/Norway2011_web.pdf. Last accessed 5th May 2014.

IEA, International Energy Agency. (2012). *Finland: Renewables and Waste for 2011.* Available: http://www.iea.org/statistics/statisticssearch/report/?country=FINLAND&product=renewablesandwaste&year=2011. Last accessed 3rd July 2014.

IPCC (2011) IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation. Prepared by Working Group III of the Intergovernmental Panel on Climate Change [O. Edenhofer, R. Pichs-Madruga, Y. Sokona, K. Seyboth, P. Matschoss, S. Kadner, T. Zwickel, P. Eickemeier, G. Hansen, S. Schlömer, C. von Stechow (eds)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1075 pp. Available: http://srren.ipcc-wg3.de/report

IRRI, International Resources and Recycling Institute. (2014). *Scottish Pilots.* Available: http://www.waresnpp.eu/assets/documents/WARES%20-%20Scotland%20Pilots.pdf. Last accessed 30th May 2014.

Kappeler A., Nemoz M. (2010). *Public-Private Partnerships in Europe – Before and During the Recent Financial Crisis*. Available: http://www.bei.europa.eu/attachments/efs/efr_2010_v04_en.pdf. Last accessed 13th Mar 2014.

Kauriinoja, A. (2010). *Small-scale biomass-to-energy solutions for northern periphery areas.* Available: http://nortech.oulu.fi/MicrE_files/Anu_MSc_thesis.pdf. Last accessed 24th July 2014.

Laitinen, J. (2012). *Rural Water Supply and Sanitation in Finland. Waste Management, Legislation and Practices.* Available: http://www.finnishwaterforum.fi/binary/file/-/id/15/fid/395/. Last accessed 4th Mar 2014.

Liu, F., Ouedraogo, A., Manghee, S. and Danilenko, A. (2012). *A Primer on Energy Efficiency for Municipal Water and Wastewater Utilities.* Available: http://water.worldbank.org/sites/water.worldbank.org/files/publication/ESMAP-EECI-WWU.pdf. Last accessed 20th July 2014.

MAF, Ministry of Agriculture and Forestry. (2001). *Water Services Act 119/2001.* Available: http://www.finlex.fi/en/laki/kaannokset/2001/en20010119.pdf. Last accessed 11th June 2014.

MAF, Ministry of Agriculture and Forestry. (2011a). *Water Act 587/2011.*Available: http://www.finlex.fi/en/laki/kaannokset/2011/en20110587.pdf. Last accessed 11th June 2014.

MAF, Ministry of Agriculture and Forestry. (2011b). *Vesilaki 587/2011.* (*Water Act 587/2011).* Available: http://www.finlex.fi/fi/laki/ajantasa/2011/20110587?search%5Btype%5D=pika&search%5Bpika%5D=Vesilaki. Last accessed 7th July 2014.

Maroulis, G. (2013). *Electricity Promotion in Ireland.* Available: http://176.9.160.135/search-by-country/ireland/tools-list/c/ireland/s/res-e/t/promotion/sum/148/lpid/147/page.pdf?out=pdf. Last accessed 20th Mar 2014.

MayoCoCo, Mayo County Council, Ireland. (2014). *Mayo Pilot Sites.* Available: http://www.waresnpp.eu/assets/documents/WARES%20-%20Ireland%20Pilots%202.pdf. Last accessed 30th May 2014.

McGuigan, G. (2010). *Value of Food & Drink Industry to Northern Ireland.* Available: http://www.nifda.co.uk/fs/doc/publications/nifda-goldblatt-mcguigan-report-for-web.pdf. Last accessed 27th May 2014.

MEE, Ministry of Employment and the Economy. (2009). *Finland's national action plan for promoting energy from renewable sources pursuant to Directive 2009/28/EC.* Available: http://www.buildup.eu/sites/default/files/content/resubmitted_nreap_finland_en.pdf. Last accessed 11th June 2014.

MEE, Ministry of Employment and the Economy. (2013). *Feed-in Tariffs.* Available: http://www.motiva.fi/en/energy_in_finland/key_policies/feed-in_tariffs. Last accessed 12th Mar 2014.

Mehaffey, P. (2014) E-mail on the total amount of rivers in Northern Ireland on behalf of the Rivers Agency. Received *19.5.2014, with reference number* DA2-14-8559.

Mikkonen, L. (2013). *The utilization of renewable energy potential in water utilities in Northern Finland*. Oulu, Finland: University of Oulu, Faculty of Technology. 96

Mikkonen, L. (2012). *Heat pumps in municipal buildings and households.* Available: http://nortech.oulu.fi/GREENSETTLE/Heat%20pumps%20in%20municipal%20buildings%20and%20households.pdf. Last accessed 20th July 2014.

Ministry of the Environment. (2003). *Land Use and Building Act (132/1999, amendment 222/2003 included).* Available: http://www.finlex.fi/en/laki/kaannokset/1999/en19990132.pdf. Last accessed 17th July 2014.

Ministry of the Environment. (2004). *Act on Water Resources Management 1299/2004*. Available: http://www.finlex.fi/en/laki/kaannokset/2004/en20041299.pdf. Last accessed 11th June 2014.

Ministry of Petroleum and Energy. (2012). *National Renewable Energy Action Plan under Directive 2009/28/EC. Norway.* Available: http://ec.europa.eu/energy/renewables/transparency_platform/doc/dir_2009_0028_action_plan_norway__nreap.pdf. Last accessed 15th July 2014.

MMM, Ministry for Foreign Affairs, Ministry of the Environment, Ministry of Agriculture and Forestry. (2008). *Finnish Water. Best Practices.* Available: http://www.wise-rtd.info/sites/default/files/d-2008-05-05-report_BMPs_Keski.pdf. Last accessed 2nd July 2014.

Mohajeri S., Knothe B., Lamothe D.N., Faby J.A. (2003). *Aqualibrium. European Water Management between Regulation and Competition.* Available: http://www.wise-rtd.info/sites/default/files/d-2008-07-14-Aqualibrium.pdf. Last accessed 14th Mar 2014.

NFI, New Finance Innovations. (2013). *A Guide to Crowdfunding in the UK.* Available: http://files.meetup.com/2243521/A%20Guide%20to%20Crowdfunding%20in%20the%20UK%20v1.0.pdf. Last accessed 2nd Apr 2014.

NIA, Northern Ireland Assembly. (2014). *Official Report (Hansard): Reservoirs Bill: Northern Ireland Water.* Available: http://www.niassembly.gov.uk/Documents/Official-Reports/Agriculture/2013-2014/140218_ReservoirsBill(NIWater).pdf. Last accessed 20th May 2014.

NIEA, Northern Ireland's Environment Agency. (2013). *From Evidence to Opportunity. A Second Assessment of the State of Northern Ireland's Environment.* Available: http://www.doeni.gov.uk/niea/stateoftheenvironmentreportfornorthernirelandwater.pdf. Last accessed 15th May 2014.

NIW, Northern Ireland Water. (2012). *Drinking Water Quality Annual Report 2012.*Available:

http://www.niwater.com/sitefiles/resources/pdf/leaflets/2012dwqreport.pdf. Last accessed 13th May 2014.

NIW, Northern Ireland Water. (2013). *Annual Report and Accounts 2012/13.* Available: https://www.niwater.com/sitefiles/resources/pdf/reports/march2013annualreport.pdf. Last accessed 19th May 2014.

NIW, Northern Ireland Water. (2014a). *Your water and wastewater.* Available: http://www.niwater.com/sitefiles/resources/pdf/your-water-and-wastewater.pdf. Last accessed 20th May 2014.

NIW, Northern Ireland Water. (2014b). *Scheme of Charges Document 2014/2015.* Available: http://www.niwater.com/sitefiles/resources/pdf/watercharges/201415/final1415/niwater2014-15schemeofcharges.pdf. Last accessed 20th May 2014.

NMPE, Norwegian Ministry of Petroleum and Energy. (2013). *Fact 2013. Energy and Water Resources in Norway.* Available: http://www.regjeringen.no/upload/OED/Faktaheftet/FACTS_energy_water.pdf. Last accessed 2nd May 2014.

NSIPA, North South Inter-Parliamentary Association. (2013). *Energy Security.* Available: http://www.niassembly.gov.uk/Documents/RaISe/Publications/2013/north_south/13213.pdf. Last accessed 15th July 2014.

NPP, Northern Periphery Programme. (2014a). *Main Projects. WARES.* Available: http://www.northernperiphery.eu/en/projects/show/&tid=104. Last accessed 26th Feb 2014.

NPP, Northern Periphery Programme. (2014b). *Programme Info. Short Introduction.* Available: http://www.northernperiphery.eu/en/content/show/&tid=177. Last accessed 26th Feb 2014.

NPP, Northern Periphery Programme. WARES. Ireland. (2014c).*Irish Pilots.* Available: http://www.waresnpp.eu/assets/documents/WARES%20-%20Ireland%20Pilots.pdf. Last accessed 30th May 2014.

NPP, Northern Periphery Programme. WARES. Norway. (2014d). *WARES Water Asset Pilot Selection.* Available: http://www.waresnpp.eu/assets/documents/WARES%20-%20Norwegian%20Pilots.pdf. Last accessed 30th May 2014.

NVE, Norwegian Water Resources and Energy Directorate. (2012). *The Swedish-Norwegian Electricity Certificate Market. Annual report 2012.* Available: http://www.nve.no/Global/Elsertifikater/Elcertifikat2013_Eng_TA%20(2).pdf. Last accessed 21st Mar 2014.

Official Statistics of Finland. (2010). *Total statistics on income distribution [e-publication]*. Available: http://www.stat.fi/til/tjkt/2010/tjkt_2010_2011-12-16_tie_001_en.html. Last accessed 1st July 2014.

Ó. Dochartaigh B. É., Smedley P. L., MacDonald A. M., Darling W. G., Homoncik S. (2011). *Baseline Scotland: groundwater chemistry of the Carboniferous sedimentary aquifers of the Midland Valley.* Available: http://nora.nerc.ac.uk/14314/1/OR11021.pdf. Last accessed 8th May 2014.

Parliament of Finland. (2010). *Act on Production Subsidy for Electricity Produced from Renewable Energy Sources (1396/2010).* Available: http://www.energiavirasto.fi/documents/10179/0/Act_1396_2010+EN+6.5.2014.pdf/eadd751f-b0b3-4063-8eb5-ab69a42b2a6d. Last accessed 18th July 2014.

Pietilä, P. (2006). *Role of Municipalities in Water Services.* Available: https://dspace.cc.tut.fi/dpub/bitstream/handle/123456789/86/pietila.pdf?sequence=1. Last accessed 1st Apr 2014.

Pietilä, P., Katko T.S., Hukka J.J. (2007). *Public-Private Partnership in Finnish Water Services.* Available: http://www.cesifo-group.de/DocCIDL/dicereport207-forum5.pdf. Last accessed 11th Apr 2014.

Pobłocka, A. (2013). *Electricity Promotion in Norway.* Available: http://176.9.160.135/search-by-country/norway/tools-list/c/norway/s/res-e/t/promotion/sum/378/lpid/379/page.pdf?out=pdf. Last accessed 20th Mar 2014.

Ramsay, E. (2014) E-mail on Ownership in Water Utilities in the Northern Periphery Region on behalf of the International Resources and Recycling Institute. Scotland. Received *20.6.2014*

Revenue. (2014). *Relief for Investment in Renewable Energy Generation.* Available: http://www.revenue.ie/en/business/incentives/renewable-energy-generation-taxrelief.html. Last accessed 2nd Apr 2014.

Rippey, B., Doe, S., Girvin, J., Hale, P., McElarney, Y., Neale, M., Preston, J. (2001). *A Preliminary Classification of Lake Types in Northern Ireland.* Available: http://aquaticcommons.org/4643/1/BRippey.pdf. Last accessed 13th May 2014.

Robles, O. A. (2009). *Public private Partnerships (PPP).* Available: http://www.cedr.fr/home/fileadmin/user_upload/Publications/2009/e_Public_private_partnerships_(PPP).pdf. Last accessed 8th Apr 2014.

Scottish Executive. (2002). *A Shadow River Basin Management Plan for the South West of Scotland. Appendices.* Available: http://www.scotland.gov.uk/Resource/Doc/46737/0014809.pdf. Last accessed 2nd July 2014.

Scottish Executive. (2003). *Scotland in short.* Available: http://www.scotland.gov.uk/Resource/Doc/923/0010669.pdf. Last accessed 8th May 2014.

Scottish Government. (2011). *2020 Routemap for Renewable Energy in Scotland.* Available: http://www.scotland.gov.uk/Resource/Doc/917/0118802.pdf. Last accessed 15th July 2014.

Scottish Government. (2013). *Scotland's Future.* Available: http://www.scotland.gov.uk/Resource/0043/00439021.pdf. Last accessed 27th May 2014.

Scottish Government. (2014a). *Legislation.* Available: http://www.scotland.gov.uk/Topics/Business-Industry/waterindustryscot/statgovcon/legislation. Last accessed 20th May 2014.

Scottish Government. (2014b). *Water Framework Directive in Scotland (WFD).* Available: http://www.scotland.gov.uk/Topics/Environment/Water/15561/WFD. Last accessed 20th May 2014.

Scottish Government. (2014c). *Scotland the Hydro Nation.* Available: http://www.scotland.gov.uk/Topics/Business-Industry/waterindustryscot/ScotlandtheHydroNation. Last accessed 18th July 2014.

Scottish Renewables. (2014). *Scotland's Renewable Energy Sector in Numbers.* Available: http://www.scottishrenewables.com/scottish-renewable-energy-statistics-glance/. Last accessed 3rd July 2014.

Scottish Water. (2013a). *Annual Water Quality Report 2013.* Available: http://www.scottishwater.co.uk/assets/about%20us/files/key%20publications/annualwaterqualityreport2013.pdf. Last accessed 7th May 2014.

Scottish Water. (2013b). *Annual Report and Accounts 2012/13.* Available: http://www.scottishwater.co.uk/assets/about%20us/files/key%20publications/swar2013.pdf. Last accessed 7th May 2014.

Scottish Water. (2014a). *Business Plan 2015 to 2021.* Available: http://www.scottishwater.co.uk/assets/about%20us/files/strategic%20projections/swbusinessplan201521march2014.pdf. Last accessed 7th May 2014.

Scottish Water. (2014b). *Your charges explained household metered charges 2014/15.* Available: http://www.scottishwater.co.uk/assets/domestic/files/you%20and%20your%20home/charges/meteredhouseholdcharges201415.pdf. Last accessed 8th May 2014.

Scottish Water. (2014c). *Your charges explained scheme of charges 2014/15.* Available:

http://www.scottishwater.co.uk/assets/domestic/files/you%20and%20your%20home/charges/sofcharge14.pdf. Last accessed 8th May 2014.

Scottish Water. (2014d). *Water and waste water charges 2014/15.* Available: http://www.scottishwater.co.uk/assets/domestic/files/you%20and%20your%20home/charges/unmeteredhouseholdcharges1415.pdf. Last accessed 8th May 2014.

Scottish Water. (2014e). *Energy.* Available: http://www.scottishwater.co.uk/investment-and-communities/investment-programme/energy. Last accessed 20th July 2014.

Semlitsch, K. (2005). *Public Private Partnerships: Norwegian challenges.* Available: http://www.intosaiksc.org/archives/12thmeeting/papers/ppp_norwegian.pdf. Last accessed 14th Apr 2014.

SHP News. (2003). *International Cooperation of SHP in China.* Available: http://www.hrcshp.org/shp/en/pdf/2003/autumndetail.pdf. Last accessed 25th July 2014.

SNH, Scottish Natural Heritage. (2001). *Natural Heritage Trends 2001 Scotland.* Available: http://www.snh.org.uk/pdfs/strategy/trends/snh_trends.pdf. Last accessed 8th May 2014.

SNH, Scottish Natural Heritage. (2002). *Fresh Waters.* Available: http://www.snh.org.uk/futures/Data/pdfdocs/Fresh_waters.pdf. Last accessed 8th May 2014.

Shmeleva, E. (2014). *Культура партнерства. Отраслевые игроки ждут принятия федерального закона о ГЧП. (Partnership culture. Sectoral players are waiting for a law on Public-Private Partnership to be enacted).* Available: http://www.rg.ru/2014/01/14/seleznev.html. Last accessed 7th Apr 2014.

SmithsGore. (2014). *Newscast Smiths Gore in Scotland. The Water Issue.* Available: https://www.smithsgore.co.uk/Pages/Publication/25/169/Issue%206.pdf. Last accessed 8th May 2014.

Statistics Norway. (2008). *Natural Resources and the Environment 2008. Norway.* Available: https://www.ssb.no/a/english/publikasjoner/pdf/sa109/sa109.pdf. Last accessed 2nd May 2014.

Stene-Larsen, G. (2012). *Water management and challenges in Norway.* Available: http://www.unece.org/fileadmin/DAM/env/documents/2012/wat/workshops/Nordic_Baltic_Seminar_Oslo/2.Norway_presentatation_challenges.pdf. Last accessed 2nd May 2014.

Tallat-Kelpšaitė, J. (2013). *Electricity Promotion in United Kingdom.* Available: http://176.9.160.135/search-by-country/united-kingdom/tools-list/c/united-kingdom/s/res-e/t/promotion/sum/204/lpid/203/page.pdf?out=pdf. Last accessed 20th Mar 2014.

TED, Tenders Electronic Daily. (2013). *Norway-Bergen: Renting or leasing services of own property.* Available: http://ted.europa.eu/udl?uri=TED:NOTICE:219162-2013:TEXT:EN:HTML&src=0. Last accessed 14th Apr 2014.

The Money Converter. (2014a). Convert Norwegian Krone to Euro | NOK to EUR. Available: http://themoneyconverter.com/NOK/EUR.aspx. Last accessed 3rd May 2014.

The Money Converter. (2014b). Convert British Pound Sterling to Euro | GBP to EUR. Available: http://themoneyconverter.com/GBP/EUR.aspx. Last accessed 27th Mar 2014.

Thomson, D. (2013). *Land Reform Review Group: Call for Evidence Scottish Water Response.* Available: http://www.scotland.gov.uk/Resource/0043/00432861.pdf. Last accessed 13th May 2014.

Tierney, J. (2013). *Irish Water - Moving Water Services in a New Direction.* Available: http://www.ipa.ie/pdf/LGDA2013-JohnTierney.pdf. Last accessed 8th May 2014.

UKWP, UK Water Projects. (2007). Project Alpha. Available: http://www.waterprojectsonline.com/case_studies/2007/NI%20Project%20Alpha%202007.pdf. Last accessed 14th Apr 2014.

UNECE, United Nations Economic Commission for Europe. (2008). *Guidebook on Promoting Good Governance in Public-Private Partnerships*. Available: http://www.unece.org/fileadmin/DAM/ceci/publications/ppp.pdf. Last accessed 13th Mar 2014.

Utility Regulator. (2013). *Water and sewerage service Price Control 2015-2021 Northern Ireland Water.* Available: http://www.uregni.gov.uk/uploads/publications/W123_40_03_01_PC15_UR_Approach_to_Asset_Maintenance.pdf. Last accessed 20th May 2014.

Väisänen, H. (2010). *Heat Pumps as part of RES and Energy saving goals in Finland.* Available: http://www.heatpumpcentre.org/en/hppactivities/hppworkshops/WSHelsinki/Documents/2.1_Heikki%20V%C3%A4is%C3%A4nen,%20RES%20in%20Finland,%20TEM.pdf. Last accessed 3rd July 2014.

WARES, Water Asset Renewable Energy Solutions project. (2014a). *Project Description.* Available: http://www.waresnpp.eu/index.php. Last accessed 6th May 2014.

WARES, Water Asset Renewable Energy Solutions project. (2014b). *Mid Term Project Update (Oct 2013 – November 2014).* Available: http://www.waresnpp.eu/aims.php. Last accessed 26th Feb 2014.

WARES, Water Asset Renewable Energy Solutions project. (2014c). *Partners....* Available: http://www.waresnpp.eu/partners.php. Last accessed 26th Feb 2014.

WARES Panel (Auvinen, K., Greig, B., Haflidason, B., MacDonald, B., Moran, I) 2014, 'Does legislation promote or hinder the implementation of renewable energy at water utilities?'. Panel discussion at the *Renewable Energy at Water Utilities WARES conference*, Oulu, 4 June.

WICS, Water Industry Commission for Scotland. (2013). *Strategic Review of Charges 2015-21: Innovation and choice.* Available: http://www.watercommission.co.uk/UserFiles/Documents/SRC%20innovation%20and%20choice%20final.pdf. Last accessed 8th May 2014.

Wright, J. (2013). *E18 Hamina – Vaalimaa PPP Project.* Available: http://portal.liikennevirasto.fi/portal/page/portal/e/projects/under_construction/koskekyla_kotka/progress/PPP_project_day/6_Wright.pdf. Last accessed 14th Apr 2014.

8 APPENDICES

Appendix 1. Approval of figure use in the thesis

From: Eliston Anton Jayanand [mailto:ajel@nve.no]
Sent: 20. May, 2014 18:33
To: Victor Pavlov
Cc: Hillestad Kjetil
Subject: SV: Copyright issue. Figure. Annual report

Hello,
With regards to your question on using the figure explaining the electricity certificate market. Please feel free to use the illustration in your thesis. However, please ensure to quote NVE and the Swedish Energy Agency as the source.
By the way if your thesis is in English, we would be happy to have a read after it is made public. So if it is not too much trouble, please send me a link at your convenience.
Have a nice day!
Best regards,

Anton Jayanand Eliston
Advisor
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Section for renewable energy
Norwegian Water Resources and Energy Directorate
Telephone 22 95 95 95 eller direct 22 95 98 81
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From: Victor Pavlov
Sent: 5. May, 2014 16:35
To: 'khi@nve.no'
Subject: Copyright issue. Figure. Annual report

Dear Kjetil Hillestad,

This is a Master’s Degree student, University of Oulu, Finland. I am writing my Master’s Thesis and was wondering if in your opinion it is allowed to use there the figures from the annual report (2012): “The Swedish-Norwegian Electricity Certificate Market”.
(http://www.nve.no/Global/Elsertifikater/Elcertifikat2013_Eng_TA%20(2).pdf)

I am talking about the figure on page 7 (How the electricity certificate market works). My thesis will be officially published. Thus, all the copyright issues should be taken into account.
I rely on your high level expertise and looking forward to hear from your earliest convenience.
Thank you for understanding.

Kind regards,
Victor Pavlov
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NorTech Oulu, Thule Institute
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