FREED

Funding Resources for Innovation in Energy Enterprise Development

FREED Market Report

WP 3: D3.1.1/D3.1.2

November 2016

Western Development Commission

Northern Periphery and Arctic Programme 2014–2020

EUROPEAN UNION

Investing in your future

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About FREED

FREED (Funding Resources for Innovation in Energy Enterprise Development) is a three year project funded under Interreg's Northern Periphery and Arctic Programme.

The Project will provide SME's in the programme area with the support network required to introduce and develop energy innovations which would otherwise be unavailable to them.

FREED's five step process will:

- Carry out a needs analysis of the types of energy innovations required in the partner region
- Initiate a tender process to generate the necessary technology innovations
- Partner R&D institutions with SME's from the region
- Develop business plans to assist the SME's in delivering the innovation in the region
- Provide a financing service that utilises private investment funds to aid the development of the innovations

The project, which is led by the University of Oulu in Finland, is a collaborative partnership involving private investment firms, R&D institutions, colleges of education and public bodies from Scotland, Northern Ireland, Norway, The United Kingdom, Germany and Ireland.

1 Introduction

Overview

Work Package 3 Activity 3.1 and 3.2.: This work package aim is to engage with stakeholders and undertake a regional analysis for all partner regions energy usage, how this is defined by existing innovation agencies and programmes, regional or local development agencies, how this divides between different sectors, the different characteristics of usage, the barriers and problems they face. The sectors to be considered might be public buildings, hospitals, schools, retail, light industrial, residential. The partners in the NPA GREBE project will also be consulted for their views, so that both projects can be coordinated to increase potential synergies and avoid overlap.

Purpose of report

This report summarises the FREED partner contributions to WP3 Activity 3.1 and 3.2 in a single 'Market Report' document. The regions associated with this market analysis and report are in the Northern Periphery Programme Area. Specifically the regions examined are:

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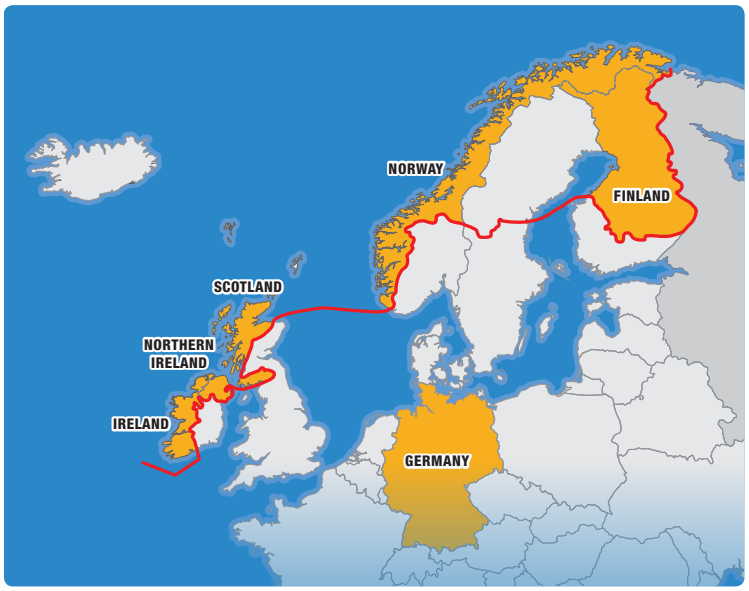
- Ireland
- Finland
- Northern Ireland
- The Highland and Islands of Scotland
- Norway



The FREED project partners are:

- University of Oulu, Finland (UOulu) Lead Partner
- Western Development Commission, Ireland (WDC)
- South West College, Tyrone (SWC)
- Green Angel Syndicate, Scotland (GAS)
- Narvik Science Park, Norway (NSP)
- Limerick Institute of Technology, Ireland (LIT)
- Europäisches Institut für Innovation (European Institute for Innovation, Germany)
- Sustainable Venture Development Partners Ltd (Associate Partner)

NPA programme area and participating countries in the FREED project.

Market Report




2 Ireland: Western Development Commission & Limerick Institute of Technology

The Western Development Commission (WDC) and Limerick Institute of Technology (LIT) consulted with the organisations and stakeholders listed below:

- Local Authorities in Mayo, Sligo, Leitrim, Donegal, Clare and Galway and Tipperary
- Galway Energy Agency, Mayo Energy Agency, The Sustainable Energy Authority of Ireland (SEAI), Tipperary Energy Agency, Kerry Energy Agency, Energy Cork and Aramark
- Enterprise Ireland, Local Enterprise Offices, WDC Investment Fund, and Udaras na Gaeltachta
- Sligo Institute of Technology (IT Sligo) , Galway Mayo Institute of Technology (GMIT) , The National University of Ireland Galway (NUIG), Letterkenny Institute of Technology (LYIT), Cork Institute of Technology (CIT), Limerick Institute of Technology (LIT), Tralee Institute of Technology, Mary Immaculate College Limerick and additional second level colleges in the region
- Claremorris Energy Agency, Tipperary Energy Agency
- Chambers of Commerce representing the retail and business community, Questum Acceleration Centre Clonmel, LIDL, Dunnes Stores and IDA
- Facilities managers in hospitals (including South Tipperary General Hospital, Nenagh General Hospital) & leisure centres (Active Ennis Leisure Complex)
- Clonmel Wastewater Treatment Plant
- Clare County Council Offices Ennis and Ennis Museum
- The Marine Institute, The Office of Public Works, GREBE Project, SECURE Project, Environmental Protection Agency.

Energy Profile of the Region

Table 1: Ireland's total energy requirement per sector – taken from the SEAI report 'Energy in Ireland Key Statistics 2014'

Total Primary Energy Requirement (ktoe)								Shares%	
	1990	2000	2005	2010	2011	2012	2013	1990	2013
Industry	2,524	3,768	3,608	3,264	3,157	3,196	3,142	26.8	23.7
Transport	2,054	4,161	5,179	4,660	4,457	4,204	4,326	21.8	32.7
Residential	2,995	3,522	3,920	4,239	3,660	3,610	3,552	31.8	26.8
Services	1,504	2,228	2,641	2,268	1,974	2,009	1,923	16.0	14.5
Agri/Fishery	331	409	421	333	315	311	279	3.5	2.3

Sources of Energy in Ireland

The main energy suppliers in Ireland are Bord Gáis Energy, Electric Ireland, Energia, Flogas Natural Gas, SSE Airtricity, Panda Power, Pinergy and PrePayPower.

The following key facts on the energy sector in Ireland are taken directly from the SEAI report Energy in Ireland Key Statistics 2014 and relate to the whole country.

- The estimated population of Ireland in 2011 was 4.593 million persons (CSO).
- Gross domestic product in Ireland in 2013 was €174,791m in current prices (CSO).
- Ireland's economy grew by 0.2% in 2013. Primary energy demand fell by 1.2% to 13.3 Mtoe and energy-related CO_2 emissions decreased by 3.8% to 35 Mt.
- Energy-related CO_2 emissions in 2013 were 17% above 1990 levels.
- Since 2007, Ireland's economy has contracted by 6.7%, reaching 2005/2006 levels in 2013. Energy demand has fallen by 18% to 1999 levels and associated CO_2 emissions have fallen by 22% to 1997 levels.
- Ireland's import dependence in 2013 was 89%, down from a peak of 90% in 2006 but up from the 85% recorded in 2012.
- Electricity generated from renewable energy (normalised) reached 20.9% of gross electricity consumption (RES-E) in 2013. Ireland's target for 2020 is 40%.
- Renewable energy contribution to thermal energy (RES-H) was 5.7% in 2013.
- Ireland's RES-H target for 2020 is 12%.
- Renewable energy in transport (RES-T) reached 2.8% in 2012, or 4.9% when weightings are applied to biofuels from waste and second generation biofuels. Ireland's target for 2020 is 10%.
- In 2013, renewable energy grew by 6.9% to 911 ktoe, representing 7.8% of Ireland's gross final energy use. Ireland's target under the EU Renewable Energy Directive is to achieve a 16% renewable energy penetration by 2020.
- Energy-related CO_2 emissions in 2013 in sectors not included in EU emissions trading (non-ETS) were 20% below 2005 levels. Ireland's target is to achieve a 20% reduction in total non-ETS GHG emissions by 2020.
- The average specific emissions from new passenger cars purchased in Ireland in 2013 were 120.9 g CO_2/km, down from 164g CO_2/km in 2007. This has already met the target of 130g CO_2/km set by the EU Directive (443/2009) for 2015.

The Irish Government has set national targets for the provision of renewable energy which include:

- 16% of energy consumption to come from renewable sources by 2020
- 42.5% of electricity consumption to come from renewable sources by 2020
- 12% of energy consumption to come from renewable sources for heating and cooling
- 10% of final energy from renewable sources consumed in transport by 2020.

The energy profile of the NPA region in Ireland (the western starboard) is characterised by a dependency on fossil fuels and grid electricity for most building and industrial energy needs and petrol and diesel for transport and mobile machinery including agriculture. Most counties in the region are not serviced by the natural gas network. Wood fuels are used as fuel for solid fuel stoves but mainly in a supplementary heating context and the uptake of automated wood fuelled heating and power generating systems such as CHP is modest at best. The use of on-site generation (solar and wind) technologies for electricity and heat is also quite low for similar reasons and the recent collapse in oil prices has created a dramatic slow-down in investment in large-scale wind farms. Solar thermal is quite prevalent in new homes as it is seen as the most expedient way of meeting the renewables requirement (10 kwh/m^2/yr) in the current building regulations (2011), however, there has been virtually no new build since the property market collapsed in 2010 with the emphasis to date being on shallow retrofit. Building fabric of BMS upgrade remains the most cost effective method of increasing energy efficiency for most properties.

The lack of incentive to invest in micro-renewables is caused primarily by a lack of feed-in-tariffs and not helped by a scarcity of energy storage options (on macro and micro levels).

The Sustainable Energy Authority Ireland (SEAI) award grants to householders to retrofit domestic dwellings with energy saving technologies as a way for Ireland to meet its 2020 EU Energy Targets, however the take-up has not been as widespread as warranted.

On a more positive note, there are a range of ICT based BMS technologies and products being developed as well and a number of energy efficiency projects based on innovation ongoing in the region however many are reluctant to discuss the innovations until they are market ready. Finally, there is also significant ongoing interaction between indigenous research institutes and both large companies and SMEs which will also lead to the continued development and commercialisation of new energy solutions.

The main innovations identified thus far are wider deployment of:

- Solar PV/Solar Thermal
- Anerobic Digestion
- Biomass CHP and biomass supply chains
- Advanced battery technology
- On and off shore wind
- Innovation in Transport

To support this other actions cover:

- ICT based BMS Smart Metering Technologies / Intelligent Energy Systems
- Energy Management/Distribution & Storage Solutions
- Demand Side Energy Management Solutions
- Internet of Things (IoT) innovations in energy efficiency
- Business & Finance Models for Energy Innovation/ Seed demonstration model capability for renewable energy
- Promotion/awareness raising to support behaviour change
- Clusters of Experitise & Networking opportunities for SME's

Partner Proposals

- **Intelligent Energy Systems (IOT's)**
- **Energy Management Systems**
- **Demand Side Management**
- **Business & Finance Models on Energy Innovation**

3 Oulu Region Finland: University of Oulu

University of Oulu consulted with the organisations and stakeholders listed below:

- Council of Oulu region.
- Tekes – the Finnish Funding Agency for Innovation.
- Oulu Innovation Alliance/ Centre for Energy and Environment. (OIA/CEE)
- Ii Micropolis Ltd. Micropolis Ltd.
- The Northern Ostrobothnia Hospital District. (PPSHP)
- City of Oulu, Oulu Facilities Centre. (Oulun Tilakeskus).
- Ii Micropolis, Vähähiku project

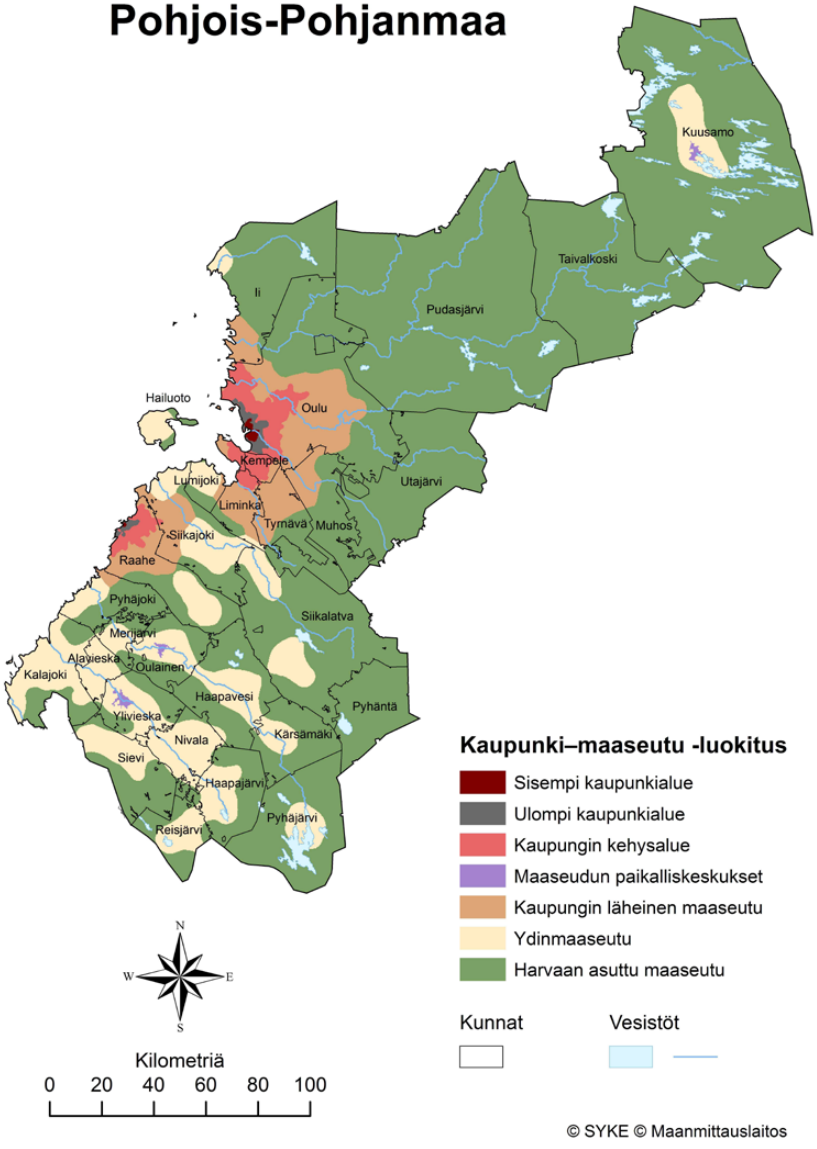


Figure 1. Map of Northern Ostrobothnia community structure and urban-rural classification divided into seven categories using geographical information calculated using 250 x 250 metre statistical squares.

Dark red is "inner urban area", a compact and densely built area with continuous development.

Dark grey is "outer urban area" a dense urban area extending from the boundary of the inner urban area to the outer edgeof the continuous built area.

Red areas are "Peri-urban area" part of the intermediate zone between urban and rural, which is directly linked to an urban area. The above three are the considered urban areas.

Rural areas are divided to four categories: Purple areas are "local centres in rural areas" - population centres located outside urban areas, population density is similar to the "peri-urban areas". Beige and pale yellow are "rural areas close to urban areas" areas with a rural character that are functionally connected and close to urban areas. Rural heartland areas are rural areas with intensive land use, with a relatively dense population and a diverse economic structure at the local level, respectively. Green area is "sparsely populated rural areas" with dispersed small settlements located at a distance from each other. Most of the land areas are forest.

Energy Profile of the Region

The Energy policy in Oulu region is strongly divided to two different streams. The main Oulu city district is the only densely populated area in this region where centralised energy policy is relevant. The other areas are sparsely populated and developing decentralised solutions are the main tasks in these areas.

The main electricity and heat producer "Oulun Energia" produce mainly local energy (99%), it owns the smallest power dam (39MW) in Ouluriver (17% of the whole production) and the Toppila thermal power plants (267 and 315 MW). The main fuels in the plant are local wood and peat and the main city area is almost all district heating. It is difficult to introduce new energy innovations in this energy producing sector and only new development work for the existing systems are found. Instead the need of centralised long term heat storage is noted.

Since Oulu has a target to be carbon neutral by 2050, it is introducing solar wind energy in several new renovation plans. The wind energy solutions are not popular in the dense populated city area, but are built in the rural areas of the region. In those rural areas decentralised solutions are most common, since the population is dispersed. The trend is to change from oil to local fuels (wood chips and peat) and solar/geothermal solutions. Unfortunately major areas in the southern Oulu region lays over very deep clay and sedimentary rock formation, in which geothermal solutions are not possible.

In Ii municipal, (left top corner of the map) energy issues have been outscored to Micropolis Ltd (or Greenpolis). The municipality has a target to be self-sufficient in energy, it owns fifty wind mills and plans to build another fifty one, they are also involved in piloting novel energy inventions like wind poles by the roadside. The Micropolis Ltd is very active in energy innovation having several successful projects in the energy field including an energy capture plan for the renovation of European route E75 passing the Ii town.

Table 2: Use of Fuels for heat production 2011-2015 in Toppila

Fuel %	2011	2012	2013	2014	2015
Peat	70	59	53	53	52
Wood	28	27	33	30	28
Waste	-	10	12	15	16
Oil	2	3	1	2	4
Biogas	0.4	0.4	0.4	0.4	0.5
Electricity	0.01	0.02	0.02	0.01	0.01
Sum GWh	**2 970**	**2 916**	**2 983**	**2 497**	**2 546**

Table 3: Origin for the electricity 2011 - 2015

Origin %	2011	2012	2013	2014	2015
Toppila thermal power plant	42	32	33	25	26
Merikoski dam	9	14	9	11	15
"Osuussähkö"	9	7	11	11	9
Market product	40	47	47	53	50
Sum GWh	**1 952**	**2 072**	**2 034**	**2 036**	**2002**

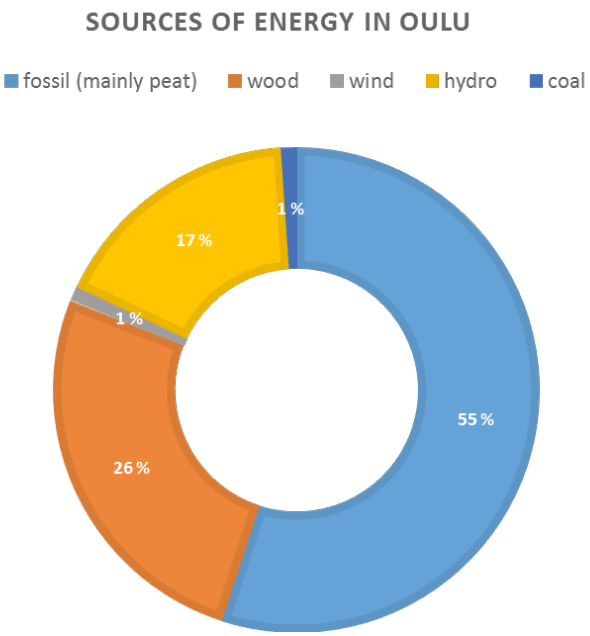


Figure 2. Sources of energy in Oulu

Oulu Region, Energy Innovations

The main innovations occurring or required in the region – as identified by the interviews.

When an innovation can be defined as the successful conversion of *new* concepts and knowledge into new products, services, or processes that deliver *new* customer value in the marketplace.

In Oulu region several development and improving projects in the energy sector are ongoing. Innovations under development are usually not made public until the innovation is ready to market. One specific innovation 'clever electricity distribution system' CleWorks was discussed in detail, CleWorks offer a service called CleBox that automatically controls the usage of electricity consumption by shifting the time of use of electrical devices (e.g. heating) to the cheapest hours, the service reduces customers cost of electricity by 20-35%.

There are several small start-up companies and new SMEs working in this Oulu region and they are going to be identified during the next two months via interviews with local authorities, business angels and official funding providers. E.g smart controlling the lightning and illumination (Valopaa Ltd.), selective glass solutions in windows, novel energy measurement techniques and consumption calculation frames are known to be under investigation in the local technology park.

Energy independent villages are also being investigated, ("Ecovillage" - the shared investments are cheaper to the people living there) and other off grid solutions. In those rural areas there is room for several novel innovations and development work, mostly in the areas of local electricity production solar and wind with storage systems (Teraloop http://teraloop.org/, batteries). Decentralised energy production is a key element and there is also a need for cost effective bioenergy solutions.

The communal solutions like flexibility of the demand (energy efficiency with synergy of real estates with overproduction utilised in other buildings) are calling for different kind of innovations, novel service procedures and behaviour change.

Partner Proposals

- **Smart Illumination.**
- **The role of SME's in the Energy Sector, how small innovative start-ups in the energy sector can have visibility.**
- **Raising the awareness of SMEs of the variety of possibilities in the energy sector.**

4 Northern Ireland: South West College

South West College (SWC) consulted with the organisations and stakeholders listed below:

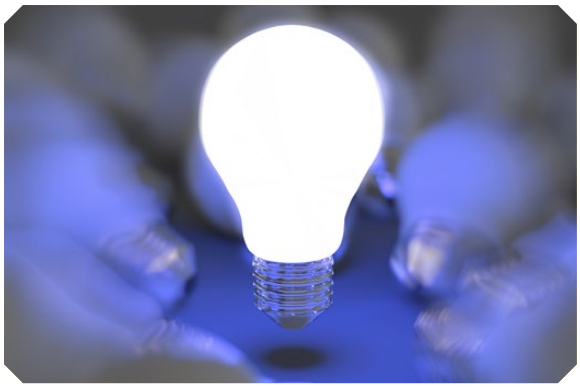
- Fermanagh & Omagh District Council
- Invest NI – Northern Irish Regional Business Development Agency
- Centre for Renewable Energy and Sustainable Technology (CREST).
- Centre for Advanced Sustainable Energy (CASE)
- Lisburn Enterprise Organisation (LEO)
- Omagh Enterprise Centre
- Action Renewables
- Ulster Farmers Union
- CEMES (Community Energy Group)

Energy Profile of the Region

Northern Ireland relies heavily on imported fossil fuels for over 70% of its generation capacity, with three fossil fuel power stations generating about 1.6GW of electricity. Onshore wind is an important part of Northern Ireland's energy mix making up just over 90% of the renewable generation capacity, which currently stands at around 25%. Northern Ireland as a whole has a target to generate 40 % of its electricity from renewable sources by 2020. It is unlikely that this target will be realized and a figure of 30% renewable penetration by 2020 is considered to be more realistic. Thanks to government incentives, a considerable number of small scale generators have also emerged in the last five years. Combined with the fact that Northern Ireland is a largely rural region with good wind resources, there is a fair amount of wind, hydro, solar PV, solar heating, AD and biomass installed amongst domestic and farming communities.

Domestic electricity prices in NI tend to be around 10 per cent higher than those in the rest of the UK and commercial electricity prices are amongst the highest in Europe. Fuel poverty is a big problem in NI and is worse than any other region in the UK, with 42 per cent of the population currently fuel poor. The natural gas network does not extend to many regions in NI so businesses and homes are largely fuelled by oil boilers (68%, rising to over 80% in rural areas). This over-dependence on oil presents a unique set of challenges which do not exist in other regions of the UK.

Connection of renewable generators is becoming an issue for the local DNO (Northern Ireland Electricity) with renewable generation exceeding minimum electricity demand by 200MW at times of low demand. This results in reverse power flowing in the substations that are not designed to operate in this manner. Consequently, large parts of the network can no longer accommodate connection of renewable generators without the need for expensive infrastructure upgrades. The investment is required primarily to alleviate thermal overload and voltage rise on the electricity network. The NIE distribution network is effectively now at saturation point, particularly in the west. When compared to the rest of GB, NIE has connected the highest level of renewables to date, relative to customer numbers, of all the Distribution Network Operators (DNOs), at a rate of c910W per customer as of 2015.



The connection of renewables into the electricity generation market in Northern Ireland is supported by the Renewables Obligation Scheme which came into effect in April 2005 and places an obligation on licensed electricity suppliers to source an increasing proportion of electricity from renewable sources. Unfortunately, this scheme will come to an end in 2017. Whether any subsidies will be available after April 2017 is unclear although some form of Feed-in Tariff may be available. A government Renewable Heat Incentive (RHI) scheme to encourage the production of renewable heat energy was also cut short in February 2016 in light of a decision by the UK Treasury to cease funding. These subsidy cuts and ongoing uncertainty within the market place restrict long-term investment and lead to investors to look to other markets for more certain investment opportunities. That being said, interest is starting to build for large scale investment projects, such as solar PV and wind, that will begin to compete without subsidies. Additionally, the use of intelligent energy systems, managed connections and energy storage have all gained significant attention with their potential to accommodate additional connection and mitigate the need for costly grid upgrades.

Energy Innovations

The main innovations occurring or required in the region – as identified by the interviews.

Results from the feedback on the FREED baseline questionnaire indicate there is a general consensus and recognition that there is a strong regional requirement for a solution or solutions that can address the issue of connecting renewable energy generators onto an electrical grid system that is already performing beyond its original design envelope. Previous work by the MATRIX Sustainable Energy Horizon Panel concluded that such Intelligent Energy Systems will incorporate technologies that can measure, analyse, communicate and control the multi-directional flow of energy at a variety of scales (MATRIX Sustainable Energy Horizon Panel Report, Market Foresight Report 2013 available from www.matrix-ni.org).

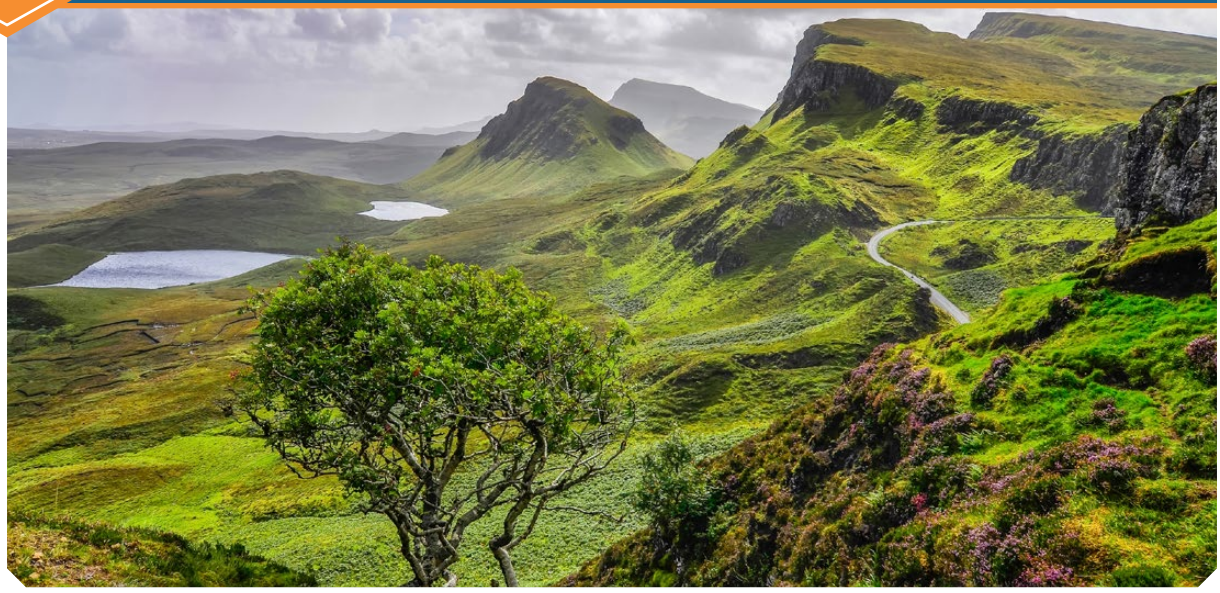
Therefore it is recommended that the full range of technologies and market solutions that can be classified as Intelligent Energy Systems would fall within the scope of interest for the FREED project for the Northern Irish region. Such innovations and technologies would be classified under the following categories:

- Intelligent Energy Systems
- Electrical and heat distribution networks
- Supply chain/network applications
- Incentives to encourage uptake
- Remotely controllable loads
- Support for R&D
- Energy Storage
- Distributed Grid Management
- Power electronics
- "Virtual" power stations
- Demand Side & Control System Management

Partner Proposals

- **Establish Intelligent Energy Solutions**
- **Network to develop a collaborative approach for developing innovative market solutions.**
- **Intelligent Energy IoT Platform focusing on energy monitoring, communications, data analysis and real time control of renewable energy assets, energy storage (electrical and thermal) and controllable loads (industrial, commercial, residential).**

5 The Highlands and Islands of Scotland: Green Angel Syndicate



Green Angel Syndicate (GAS) consulted with the organisations and stakeholders listed below:

- Highlands and Islands Enterprise
- Wave Energy Scotland
- National Health Service Highland
- Scottish Enterprise (Dumfries & Galloway)
- Scottish Enterprise
- Scottish Government (Innovation)
- Scottish Government (Local Energy)
- Scottish Government (Water)
- Local Energy Scotland
- Scottish Water
- Hydro Nation Water Innovation Service

In the private sector, Green Angel Syndicate also consulted with companies based in Scotland working on energy innovations, including:

- Sunamp
- Synaptec
- ACT Blade
- CDC

Energy Profile of the Region

The region can be divided in 6 areas, each with their own energy profile. Shetland Islands electricity grid is made up of 1,650km of lines and cables with subsea cables joining the smaller islands to the mainland. The Islands have 13,600 electricity consumers. There are no mains gas supplies on the islands. There are two main sources of power generation on Shetland: Lerwick Power Station (a diesel powered station) and Sullom Voe Terminal Power (an oil and liquefied gas terminal). These plants are supported by the Burradale wind farm.

This review considers the six distinct areas within the Highlands and Islands region. Areas reviewed are: Shetland; Orkney; The Outer Hebrides; Caithness and Sutherland; Inner Moray Firth; and Lochaber, Skye and Wester Ross. The energy profile of these areas will each be analysed in turn.

Shetland

The Shetland Islands is a 1,466km^2 island group with a total population as of 2012 of about 23,000. Shetland's location and its natural wind, wave and tidal resources make it an ideal location for many renewable energy projects. However, it requires appropriate infrastructure to export potential supplies of electricity. The current electricity profile of Shetland is made up of approximately 1,650km of overhead line and underground cables operating at roughly 33kilovolts distribution voltages. Thirteen subsea cables join the smaller islands to the mainland. The Islands have approximately 13,600 electricity consumers connected to the network, with 85% of those being domestic. There are no mains gas supplies on the islands, meaning electricity is relied on for heating, hot water and cooking, and the average consumption of electricity in the Shetlands is 10,348kW which is twice the Scottish average. Peak demand is 45.5MW, with a low of 11MW in the summer.

There are two main sources of power generation on Shetland: Lerwick PowerStation (a diesel powered station with a heat recovery system producing 67MW, which meets around 52% of Shetland's energy demand) and Sullom Voe Terminal Power (an oil and liquefied gas terminal producing 15MW, which currently meets 41% of Shetland's energy demand). These plants are supported by the Burradale wind farm (3.68MW and one of the most efficient production wind farms in the world, with a reported load factor of 52%), along with numerous small renewable generates and the Northern Isles New Energy Solutions Project which aims at reducing demand, increasing renewable generation output and reducing reliance on fossil fuels. Additionally, the new Viking Wind Farm, will look to generate over 400MW of renewable capacity, co-owned by Shetland Islands council and SSE, it hopes to start feeding power onto the national grid by 2020. It needs a major new interconnector to export that power from Shetland to mainland UK. After reducing its original size to meet environmental concerns, Viking hopes to have a capacity of 370MW but has consents for up to 457MW – enough to power at least 175,000 homes.

The growth of output from wind turbines on Shetland has increased instability in the local grid (which is not connected to the national grid on mainland Scotland) and SSE have installed a 1 MW sodium-sulphur battery in a building close to the Lerwick Power station to ameliorate the peak loads. However, due to safety concerns, the sodium-sulphur battery was removed from the site prior to commissioning. The energy storage building was reconfigured to accommodate 3MWh of advanced lead-acid batteries.

There are proposals to replace the power station at a new greenfield site north of the existing one for which planning permission has already been granted. This decision has been endlessly delayed by the proposed Shetland HVDC Connection which depending on how it were implemented may make such a station redundant, or only required as standby which would affect the type of plant chosen. There is an adjacent District Heating and Energy Recovery Plant. However for a variety of reasons the rejected heat has never been used as

a heat source for the network. This is unlikely to happen with the existing power station as it will be closed soon.

There is however an Energy Recovery Plant in Lerwick which generates hot water by burning waste for the Lerwick District Heating Scheme which is operated by Shetland Heat Energy and Power Ltd (SHEAP). There are over 1200 domestic and commercial properties connected to the district heating scheme. The Plant burns 22,000 tonnes of waste per year and generates 7MW of energy. The waste comes from Shetland, Orkney and Offshore.

The Aegir wave farm was a planned wave farm off the south west of Shetland. The project was developed by Aegir Wave Power, a joint venture of Vattenfall and the wave power technology developer Pelamis Wave Power formed in 2009. The wave farm would have had capacity from 10 MW potentially up to 100 MW. Following the collapse of Pelamis in November 2014, the project was cancelled by Vattenfall in February 2015.

Orkney

The Orkney Islands are an archipelago off the north coast of Scotland. It is comprised of 70 islands, 20 of which are inhabited. The islands have an overall area of 990km^2 and a population as of 2011 of 21,350. The current energy profile of the area allows for Orkney to have abundant wind, wave and tidal power and shows that Orkney can generate 110% of its energy demand via tide and wind power and that Orkney owns 1/8th of the UK's domestic wind turbines. Recently, renewable energy generation has increased significantly in Orkney with 140GWh generated in 2013, while imported energy has fallen to almost zero. Over 48MW of wind energy generators are currently operational in Orkney, with 1.2MW of Photovoltaic panels installed, and 140GWh generated from wind. Currently there are leases held on 550MW and 530MW tidal energy projects in Orkney waters. Additionally, The European Marine Energy Centre (EMEC) is looking to develop the opportunity to test full scale grid connected prototype devices in the intensive wave and tidal conditions.

The Western Isles (Eilean Siar)

The Western Isles or Outer Hebrides are a 3,070km^2 island chain off the west coast of Scotland, with a current population of 27,400. The energy profile for the area shows that roughly 513 GWh were consumed with 226 GWh of that being domestic. The Outer Hebrides has the potential for 6.5GW of renewable energy, with 4.8GW coming from Wave power. Currently, 555MW of this wave power has already been contracted. As of 2014, the Outer Hebrides was served by 22MW Radial Connected from the UK Grid with no export capacity. To allow for the Outer Hebrides to export its energy a 450MW Radial Connector to the UK grid is proposed. Future projects for the Outer Hebrides include the Stornoway Wind Farm with 36 3.6MW Turbines, producing 410 GWh of renewable energy per year and the Beinn Mhor windfarm, with an installed capacity of 140MW, which is expected to be fully operational in 2018. There have also been recent investments in renewable energy manufacturing plants by the Highlands and Islands Enterprise.

Caithness and Sutherland

Caithness and Sutherland are northern highland regions in Scotland, with an area of 7,100km^2 and a population of 39,700. The energy profile of the area shows 17 windfarm schemes generating 436MW, with an additional 10 schemes approved for construction, and 38 schemes under review. Along with wind generation, Caithness and Sutherland has targets to reach between 400MW and 1000MW of installed marine renewable energy by 2020. Additionally, The Lateron, Lybseter and Clyth Community Development Company, has set up a project to develop a community windfarm with a capacity up to 5MW. Finally, the Pentland Firth Tidal Energy scheme has been investigated and could provide the area with 1.6GW of generation by 2020.

Inner Moray Firth

The Inner Moray Firth is an inlet in the northeast Highlands of Scotland with an area of 2,238km^2 and a population of 93,000 including the major city of Inverness. The energy profile for the area shows up until 2015, Inner Moray Firth used largely hydro power plants to generate its electricity.

Recently, The Moray Offshore Renewables Project is due to be started by 2015, with the first Power exportation in 2016, will be able to provide between 4 million MWh and 5.2 million MWh of power each year, which is enough to supply the power needs of roughly 900,000 households. Electricity arrives onshore as a Direct Current and will require to be converted back to Alternating Current to allow it to be supplied to the national grid. Two Direct Current onshore converters with a capacity of up to 750MW will be required in the near future. Along with offshore wind turbines, the Inner Moray Firth has 4 On-shore wind turbine schemes generating 190MW of power. In 2011 construction began on a £60m biomass plant that uses whisky by-products to produce energy. The combined heat and power plant by Helius CoRDE could generate enough electricity to power 9,000 homes.

Partner Proposals

- **Wave and Tidal Opportunities**
- **Internet of Things (IoT)**
- **Demand Side Management**

The role of GAS is to help innovations generated through the FREED project to develop Business Plans and raise the investment funds required to commercialise their technologies. GAS is also in a position to draw in the opportunities represented in the Associated Partner, Sustainable Ventures, based in London, which has three different companies with relevant technology innovations available for development in the NPA region.

Lochaber, Skye and Wester Ross

Lochaber, Skye and Wester Ross is a north-western highland and island area within Scotland, with a total area of 12,000km^2 and a population of 39,100. The energy profile of the areas varies across the three locations. In Skye, The Falck Renewable has a wind farm scheme which can generate 2.3MW of energy, the Storr Lochs hydroelectric scheme generating 2,400 kW and Edinbane which is an 18 turbine wind farm producing the 41.4MW of energy. Lochaber uses hydroelectric to generate 84,000 kW and Wester Ross uses the Cuileig Power Station which generates 3,300 kW of energy, and the Loch Dubh Hydroelectric scheme to generate 1,200 kW. NDS have 48MW of wind, and 1.2MW of PV.

The Western Isles consume 513 GWh of energy were consumed with 226 GWh of that being domestic. As of 2014, the Outer Hebrides was served by 22MW Radial Connected from the UK Grid with no export capacity.

Caithness and Sutherland have 17 windfarm schemes generating 436MW, with an additional 10 schemes approved for construction, and 38 schemes under review. Inner Moray Firth largey uses hydro to generate its electricity. Along with offshore wind turbines, the Inner Moray Firth has 4 on-shore wind turbine schemes generating 190MW of power. In 2011 construction began on a £60m biomass plant that uses whisky by-products to produce energy. Lochaber, Skye and Wester Ross has wind and hydro schemes generating power.

6 Norway: Narvik Science Park

Narvik Science Park consulted with the organisations and stakeholders listed below:

- Statkraft Nordkraft Produksjon
- British Investment Fund
- Statnett
- Nordkraft Vind
- Solbes
- Borealis Enerconsult

Energy Profile of the Region

Energy policy is one of five main priorities in the cooperation between the Norwegian Government and the EU. The main focus in the energy policy is to support EU with renewable energy. Norway enjoys comparative competitive advantages in the future energy market in 6 areas:

- Hydro Power
- Flexible Energy Systems
- Solar Power
- Offshore Wind Power
- Energy Efficiency
- Carbon Capture and Storage

Energy Innovations

The main innovations occurring or required in the region – as identified by the interviews.

The following measures as essential for successful implementation of the energy-strategies:

- Expanding efforts to create an integrated incentive structure along the entire innovation chain
- Strengthening innovation and renewal in the energy sector
- Increasing industry involvement in research and innovation
- Facilitating Norwegian participation in international demonstration projects
- Enhancing research and innovation cooperation in the EU arena
- Strengthen Norway's position as an energy nation
- Developing technology competence groups/ bases
- Govenmental sectorial cooperation to ensure effective implementation

The Norwegian Government and the Research Council has decided that Norway will focus on 8 specific areas in the field of renewable energy, and has granted funding for 8 new centres for Environment-friendly Energy Research and innovation. Each Centre is guaranteed an annual funding for up to eight years. This decision can be looked upon as a policy framework that gives direction and priority to 8 defined energy innovation needs for Norway.

Centre 1: Norwegian CCS Reseach Centre	
Focus Area	Co_2 – capture, transport and storage
Research	SINTEF Energy Research
Industry	25 Partners
Centre 2: Norwegian Research Centre for Hydropower Technology	
Focus Area	› Develop Hydropower technology for the future › New solutions for utilising flexible hydropower
Research	Norwegian University of science and Technology (NTNU)
Industry	31 Partners
Centre 3: Norwegian Centre for Sustainable Bio-based Fuels and Energy	
Focus Area	› Develop technology for second-generation biofuels › Achieve 30 per cent reduction in production cost
Research	Norwegian University of Life Science (UMB)
Industry	40 Partners
Centre 4: Centre for Intelligent Electricity Distribution	
Focus Area	› Modernisation of the electricity grid (Flexibility, Efficiency) › Enable the grid to handle interactions with renewable energy
Research	SINTEF Energy Research
Industry	26 Partners
Centre 5: Centre for an Energy Efficient and Competetive Industry for the future	
Focus Area	Raising energy efficiency in Norwegian Industry
Research	SINTEF Energy Research
Industry	36 Partners
Centre 6: Research Centre for Sustainable Solar Cell Technology	
Focus Area	› Production of silicon-based solar cells › Developing the world's most environment-friendly process
Research	Institute for Energy Technology (IFE)
Industry	15 Partners
Centre 7: Mobility Zero Emission Energy Systems	
Focus Area	› Energy for the transport sector (Hydrogen + Batteries) › Business models for zero-emission transport
Research	Institute for Energy Technology (IFE)
Industry	38 Partners
Centre 8: The Research Centre for Smart Cities	
Focus Area	› Solutions for zero-emission zones in smart cities › Renewable energy benefit for local environment
Research	Norwegian Univercity of Science and Technology (NTNU)
Industry	32 Partners

Figure 3: New Centres for Environment-Friendly Research in Norway

Partner Proposals

- Solar Technology
- Hydrogen
- Small Hydro Power Plants
- Early stage funding/Business Angel Network

Notes:




FREED

Funding Resources for Innovation in Energy Enterprise Development

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