GREBE

Generating Renewable Energy Business Enterprise

Northern Periphery and Arctic Programme

Advice Notes on Hydro Technology Economics for the NPA Region

www.grebeproject.eu

The GREBE Project

What is GREBE?

GREBE (Generating Renewable Energy Business Enterprise) is a €1.77m, 3-year (2015-2018) transnational project to support the renewable energy sector. It is co-funded by the EU's Northern Periphery & Arctic (NPA) Programme. It focuses on the challenges of peripheral and arctic regions as places for doing business, and helps develop renewable energy business opportunities in areas with extreme conditions.

The project partnership includes the eight partners from six countries, Western Development Commission (Ireland), Action Renewables (Northern Ireland), Fermanagh & Omagh District Council (Northern Ireland), Environmental Research Institute (Scotland), LUKE (Finland), Karelia University of Applied Sciences (Finland), Narvik Science Park (Norway) and Innovation Iceland (Iceland).

Why is GREBE happening?

Renewable Energy entrepreneurs working in the NPA area face challenges including a lack of critical mass, dispersed settlements, poor accessibility, vulnerability to climate change effects and limited networking opportunities.

GREBE will equip SMEs and start-ups with the skills and confidence to overcome these challenges and use place based natural assets for RE to best sustainable effect. The renewable energy sector contributes to sustainable regional and rural development and has potential for growth.

What does GREBE do?

GREBE supports renewable energy start-ups and SMEs:

- To grow their business, to provide local jobs, and meet energy demands of local communities.
- By supporting diversification of the technological capacity of SMEs and start-ups so that they can exploit the natural conditions of their locations.
- By providing RE tailored expert guidance and mentoring to give SMEs and start-ups the knowledge and expertise to grow and expand their businesses.
- By providing a platform for transnational sharing of knowledge to demonstrate the full potential of the RE sector by showcasing innovations on RE technology and strengthening accessibility to expertise and business support available locally and in other NPA regions.
- To connect with other renewable energy businesses to develop new opportunities locally, regionally and transnationally through the Virtual Energy Ideas Hub.
- By conducting research on the processes operating in the sector to improve understanding of the sector's needs and make the case for public policy to support the sector.

For more information, visit our website:

http://grebeproject.eu/

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https://greberenewableenergyblog.wordpress.com/

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https://twitter.com/GREBE_NPA

The Advice Note aim to provide introductory material for entrepreneurs, startups and SME's, considering to enter into the renewable energy sphere and based in the NPA regions partners to GREBE. The scope of the Advice Note covers regional, trade and industry, renewable energy (RE), technology information from Ireland, Northern Ireland, Scotland, Iceland and Finland. Different partner regions have different level of deployment of the various RE technologies covered by the Advice Notes. Thus, the level of information will vary depending on the level of deployment for each technology. For example, small-scale hydro (SHP) is not deployed on a large scale in Finland; however, it is to a certain extent in Scotland, Iceland, Ireland and Northern Ireland.

The focus of the Advice notes is to provide regional partner information on some of the main economic characteristics, sited as imperative, when making an informed choice, regarding which RE technology may be the optimal choice for the business:

- Costs and economics associated with the relevant technology
- Support schemes available, relevant to the technology
- Government allowance/exemptions, relevant to the technology
- Funding available for capital costs of the relevant technology
- List of the relevant to the technology suppliers/developers, with focus on local/regional suppliers/developers and the products and services they offer.

The technologies that are covered in the Advice Note are the following:

- *Biomass CHP*
- *Wind*
- Solar PV
- ***Small – scale hydro (SHP)***
- AD
- Geothermal
- Air source heat pump
- Ground source heat pump
- Energy storage
    - Electric (batteries)
    - Thermal (heat storage)
    - Chemical (hydrogen – fuel cell and electrolysis).

The selection of RE technology will also be determined by the balance of energy demand of the business, the prospect to exploit local natural resources and the existing supply network. Assessing the energy mix assists in determining which RE technology is right for the business. Those matters will be discussed in depth in the Renewable Energy Resource Assessment Toolkit.

SHP Economics Across the NPA

Approximately 70 per cent of the earth's surface is covered with water, and hydro is a resource that has been exploited for many centuries. As it can be seen in the map below there is an impressive hydropower potential in all of the partners to GREBE.

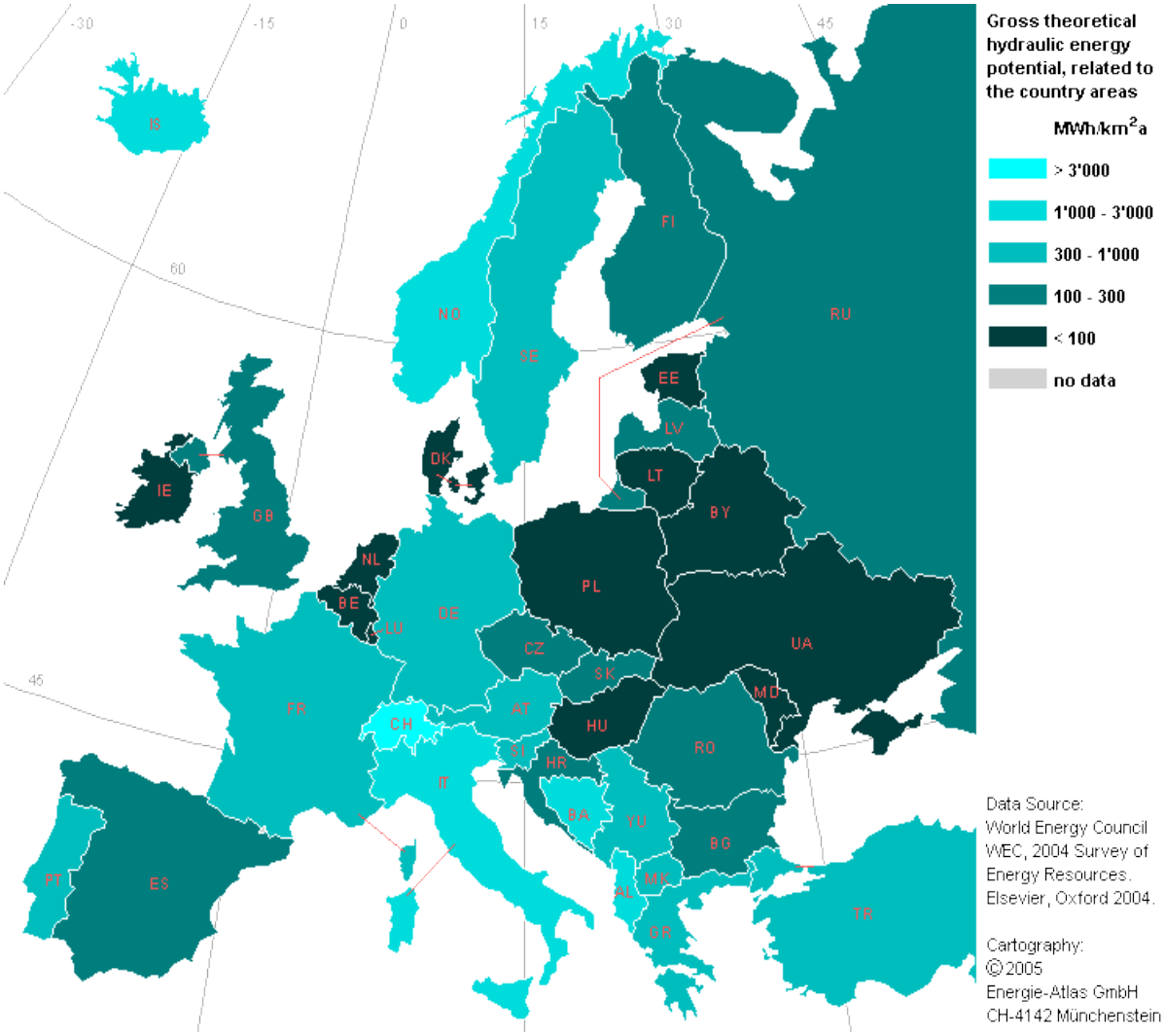

Figure 1. Gross theoretical hydraulic energy potential in Europe.[1]

[1] Global Energy Resource Institute http://www.geni.org/globalenergy/library/renewable-energy-resources/world/europe/hydro-europe/index.shtml

Hydropower is of the most reliable and cost-effective methods to generate electricity, as it can immediately respond to variations in electricity demand meeting both base-load and peak-load demand. The key advantage is that hydro power provides a steady and secure source of electricity supply. Furthermore, it very highly efficient (from 70 to 90%), has a long life span and attractive energy pay-back ratio. Other benefits of hydro are that it is a largely predictable resource of renewable energy (the annual generation can be predicted using historical rainfall data/catchment flow data).When considering the payback period for SHP, account should be taken of the lifespan of the system.

A general SHP project cost level is very difficult to predict as they are very project specific-contingent on the local surroundings, hydro-technical constructions, turbines and electrical equipment.Small-scale hydropower uses water flowing through a turbine to drive a generator that produces electricity. The amount of a hydropower installation's potential power output (kW) is directly related to two key variables:

- Head – The vertical distance between the water level at the intake point and where the water passes through the turbine. Hydro projects can be categorized into three categories according to the existing head.

    - Low head – up to 10m
    - Medium head – 10m to 50m
    - High head – greater than 50m.

- Flow rate – the volume of water flowing through the turbine per second, measured in litres/second (l/s), or cubic metres/second (m3 /s).

There a wide range of different configurations of hydro scheme, two types are relevant:

- Run of river – in these schemes the water is taken directly from the river, passed through the turbine, and then returned to the watercourse. Run of the river hydropower projects have emerged as a viable, low-impact alternative to existing large-scale projects. Such schemes offer long operational life-times in excess of 25 years with minimal maintenance. Payback time for small grid connected systems is a couple of years at the best locations, and under 10 years for the rest. There are several different classifications of run-of-the-river systems, based primarily on their capacity.
    - Pico <5 kW

- Micro < 100 kW
- Mini 100 kW - 1 MW
- Small 1 - 50 MW

- Storage – these schemes use a dam to gather water in a reservoir, which permits electricity generation for prolonged periods (when water flow is at a low level). These schemes are often associated with larger infrastructure projects such as flood control or water abstraction.

The main parameters governing hydro power economics include[2]:

- Capital costs (CAPEX) – A hydro system necessitates considerable initial capital investments but has low operating costs. Location and site conditions determine 75 % of the development cost, while the fixed costs are around 25%. Expenditure for the structural components - 40 to 50 % (i.e. power house, dam, water intake, gates, screen and trash rack cleaner), for the mechanical components -20 to 25 % (i.e. check valves, turbines), for the electrical engineering components - 5 to 10 % (i.e. generator, transformer, energy output) and the other incidental expenses 15 to 35 %(i.e. acquisition of land, planning, authorisation). These costs are very location-dependent but an increase in plant size, however, generally leads to significantly lower investment.
- Operational cost (OPEX) – If the hydro is optimally planned the operation costs tend to be low. Operation and maintenance costs vary again depending on the location. The annual OEPX is around 1 to 4 % of the overall investment. However, the smaller the station the higher the OPEX.
- Capacity factor - Electricity production
- Hydro lifetime - long lifespan up to 100 years

[2] Renewable Energy: Technology, and Environment Economics, 2007.

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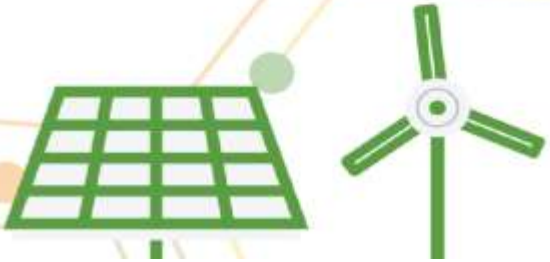
Scotland



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Costs and economics

Total hydro generation capacity in Scotland is about 1,500 MW and more than half of it is the Highlands and Islands area, where most advanced plants achieve energy conversion rates over 90%. Studies suggest that there is 650MW unexploited hydro resource is Scotland.

The cost of a small hydropower scheme is very site specific. The amount of civil engineering work required and ease of grid connection will impact upon the cost of the scheme and varies significantly between sites. The installed cost of a micro or small-scale varies greatly, depending on the size of the scheme, varying from £4,000/ kW and £20,000/kW. With regular maintenance, civil engineering works, and mechanical and electrical plant can last for several decades. Payback periods for a commercial micro and small hydropower system can be anywhere from 6 to over 20 years and are highly dependent on the level of civil engineering works required for a given site. The best returns can be achieved by selling to the grid any electricity that is not used on the site. Electricity generated by small-scale hydropower schemes is eligible for the Feed-in Tariff (FIT).

- LCOE range from £54 to £92 MWh for a system between 5-16 MWh and is around £126 for installations <100kW
- CAPEX – between £1597 to £3378 MWh.
- OPEX - £63/MWh. Annual costs for a small-scale scheme are likely to be in the region of 1-2% of its capital costs.

Support Schemes

In Scotland the Feed-In Tariffs (FITs) scheme is a UK Governments scheme designed to encourage the uptake of a wide range of small scale renewable and low carbon electricity generators.

FITs typically include three key provisions:

- Guaranteed grid access
- Long-term contracts for the electricity produced
- Purchase prices that are supposedly based on the cost of renewable energy generation and move towards grid parity.

The FIT rates for small scale hydro power as of 1st July 2017 can be found below.

Description	Total Installed Capacity (kW)	Eligible Tariff (pence per kWh)
Hydro	0-100	7.8
	100-500	6.26
	500-2000	6.26
	2000-5000	4.54

Government Allowances and/or Exemptions

Earnings from the Feed-in Tariff and energy savings are tax free and index linked

Funding available for Capital Costs

Joint venture with developer.

Rent your land and receive annual fixed income from the developer.

Technology suppliers, products and services they offer

Supplier	Services	Contact Information
Adrian Laycock Ltd	Planning, design and construction of numerous hydropower schemes in the Scottish Highlands. Size ranges from 50kW to 1 MW.	Office : 01631 705088 enquiries@adrianlaycock.com
Gilkes Energy	Along with providing funding packages to help partners finance their hydro project they also manage the project through its five phases: Feasibility, Permitting and Planning, Commercial and Financial close, Construction, Operations and Maintenance. They offer the following: The "Lease Rental Model" – GEL would fund the full project and pay a rental, usually a % of income from the project over the duration of a long term lease – typically 60 years or more. The "Joint Venture Model" –invest alongside GEL in a true Joint Venture. GEL brings their considerable experience to the project and the risks and rewards are shared equally.	T: 01539 720028 info@gilkesenergy.com

Green Highland Renewables	Full project development • Identifying Potential • Design and Licensing • Operation and Maintenance • Financing • Construction and Commissioning	Tel: 01738 493110 info@greenhighland.co.uk

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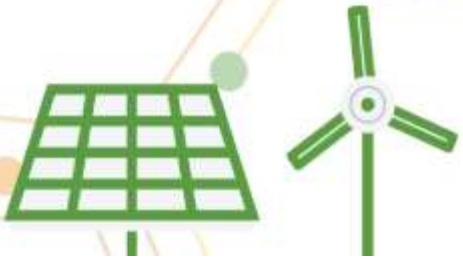
Ireland



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Hydro Technology Economics Ireland

Costs and economics

When designing a hydro plant, the electricity generated may be used directly on site to displace electricity imports to a facility or the electricity may be exported in order to receive a fixed payment from an Electricity Supplier for the output produced from the turbine.

To receive fixed payments, a developer must secure a Power Purchase Agreement (PPA) from either a Government source or a private company. The Department of Communication, Energy and Natural Resources (DCENR) offers PPAs to buy electricity produced from hydro plants. These PPAs are considered to be of sufficient value to allow developers to secure up to 70% of the cost of the project from bank loans.

- LCOE €84.5/MW for a system between 5-16 MW
- CAPEX – In the region of €1,000 to €1,500 per kW installed would be typical in viable projects
- OPEX - €X/MWh

Support Schemes

Description	Total Installed Capacity (kW)	Eligible Tariff (pence per kWh)
REFIT 1		88.068
REFIT 2		88.068

Government Allowances and/or Exemptions

ACCELERATED CAPITAL ALLOWANCE SCHEME (ACA)

The ACA is not a grant, but rather a tax incentive for companies paying corporation tax and aims to encourage investment in energy efficient equipment.

The ACA offers an attractive incentive whereby it allows companies to write off 100% of the purchase value of qualifying energy efficient equipment against their profit in the year of purchase. Eligible equipment can be chosen from the Triple E register (See solar databases – Triple E) and includes solar heating and electricity technologies.

Funding available for Capital Costs

- Debt funding up to 85% of the project costs (recent reports suggest 75% is now more likely).
- ESCOs are in place for some wind energy projects.
- Shared ownership schemes with communities.

Technology suppliers, products and services they offer

Developer	Services	Contact Information
Eco Evolution	Eco Evolution is an appointed agent in Ireland of Mann Power Consulting Ltd (UK) who specialise in the Archimedean Screw hydro turbine. They also design modern water wheels for electricity generation. The Archimedean screw hydro turbines are suited to low-head sites and are fish friendly. They are manufactured by a company who are leaders in the field of mechanical engineering in Germany with a 25 year history of excellence. As pioneers of Archimedean screw	Enniscorthy Co. Wexford www.EcoEvolution.ie

	generating installations in the UK and Ireland, Mann Power believe that they manufacture the best equipment on the market.	
Waterpower Services	Water Power Services has been in business since 1982. Founded by Fiacc O'Brolchain, the company is a hydropower consultancy that can undertake all stages of development of a hydropower site from feasibility to commissioning. The company designs, installs and maintains small hydropower schemes and is responsible for commissioning over 20 small schemes up to 300 kW. All stages of a project can be undertaken including feasibility, licensing, design, specification, preparation of tender documents, project management and commissioning.	Dublin fiaccob@iol.ie www.waterpowerservices.ie

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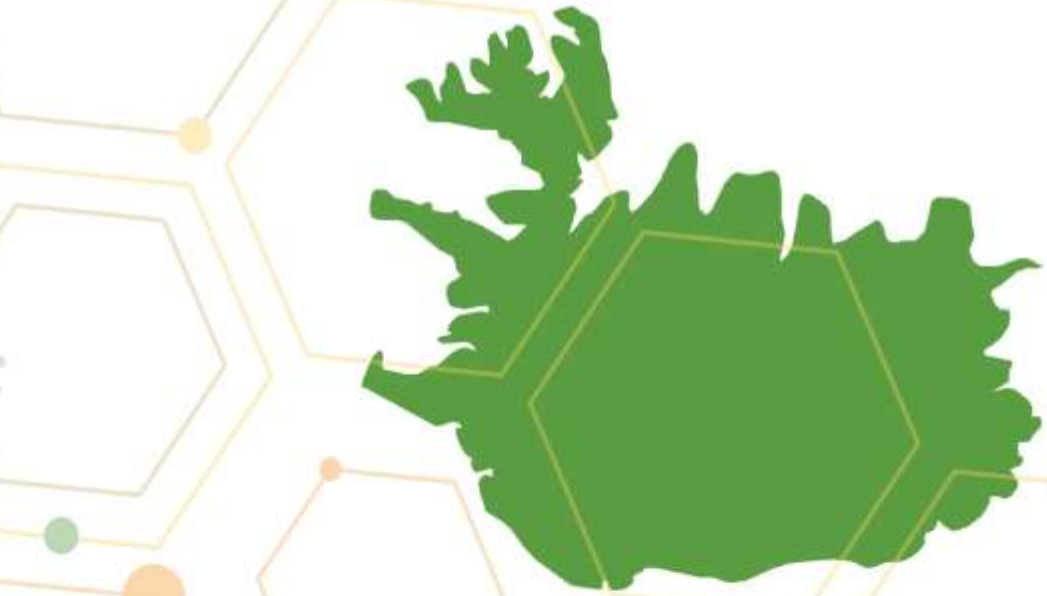
Iceland



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Costs and economics

- LCOE is $34/MWh
- CAPEX – $2.8 MWh
- OPEX – 1.5% of Construction cost

Support Schemes

N/A

Government Allowances and/or Exemptions

N/A

Funding available for Capital Costs

It is possible to apply for funding and loans from:

- Framleiðnisjóður landbúnaðarins - http://www.fl.is/
- Lánasjóður landbúnaðarins
- Byggðastofnun - Icelandic Regional Development Institute
- Orkusjóður - National Energy Authority.

Technology suppliers, products and services they offer

Developer	Services	Contact Information
BMJ energy	Planning, design and construction of hydropower schemes in South of Iceland. The company's focus is on 30kW power plants with average 40l/s pressure pipe. Max Power generation is 5,5 kW @ 7,3 l/s	BMJ energy ehf. Jaðri Suðursveit 781 Höfn í Hornafirði S: 661-4172 Netfang: bmj@bmj.is www.facebook.com/BMJenergy
Artic Hydro	Size 52MW. Power generation is 35,1 GWh/year	Arctic Hydro Höfðatorgi – Katrínartún 2 - 12th stock. 105 Reykjavik. skirnir@artichydro.is Tel. 00354-8985505

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Visit
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Contact
Western Development Commission,
Dillon House, Ballaghaderreen,
Co. Roscommon, F45 WY26, Ireland.

Tel: +353 (0)94 986 1441
Email: paulineleonard@wdc.ie

Project Partners

GREBE will be operated by eight partner organisations across six regions:

WDC

Action Renewables
the future of energy, today

Luke
Natural Resources Institute Finland

FPN
Forskningsparken i Narvik

eri

Fermanagh & Omagh District Council
Comhairle Ceantair Fhear Manach agus na hÓmaí

Innovation Center Iceland

Karelia

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