GREBE

Generating Renewable Energy Business Enterprise

Northern Periphery and Arctic Programme 2014–2020

Advice Notes on Biomass CHP Technology Economics for 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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The Advice Note aim to provide introductory material for entrepreneurs, startups and SME's, considering entering into the renewable energy sphere, based in any of the NPA regions, which are partners to GREBE. The scope of the Advice Note covers regional, renewable energy (RE), technology information, from Ireland, Northern Ireland, Scotland, Iceland, Finland and Norway. 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, Biomass CHP is not deployed on a large scale in Iceland; however, it is widely deployed in Finland, Ireland, Northern Ireland and Scotland.

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.

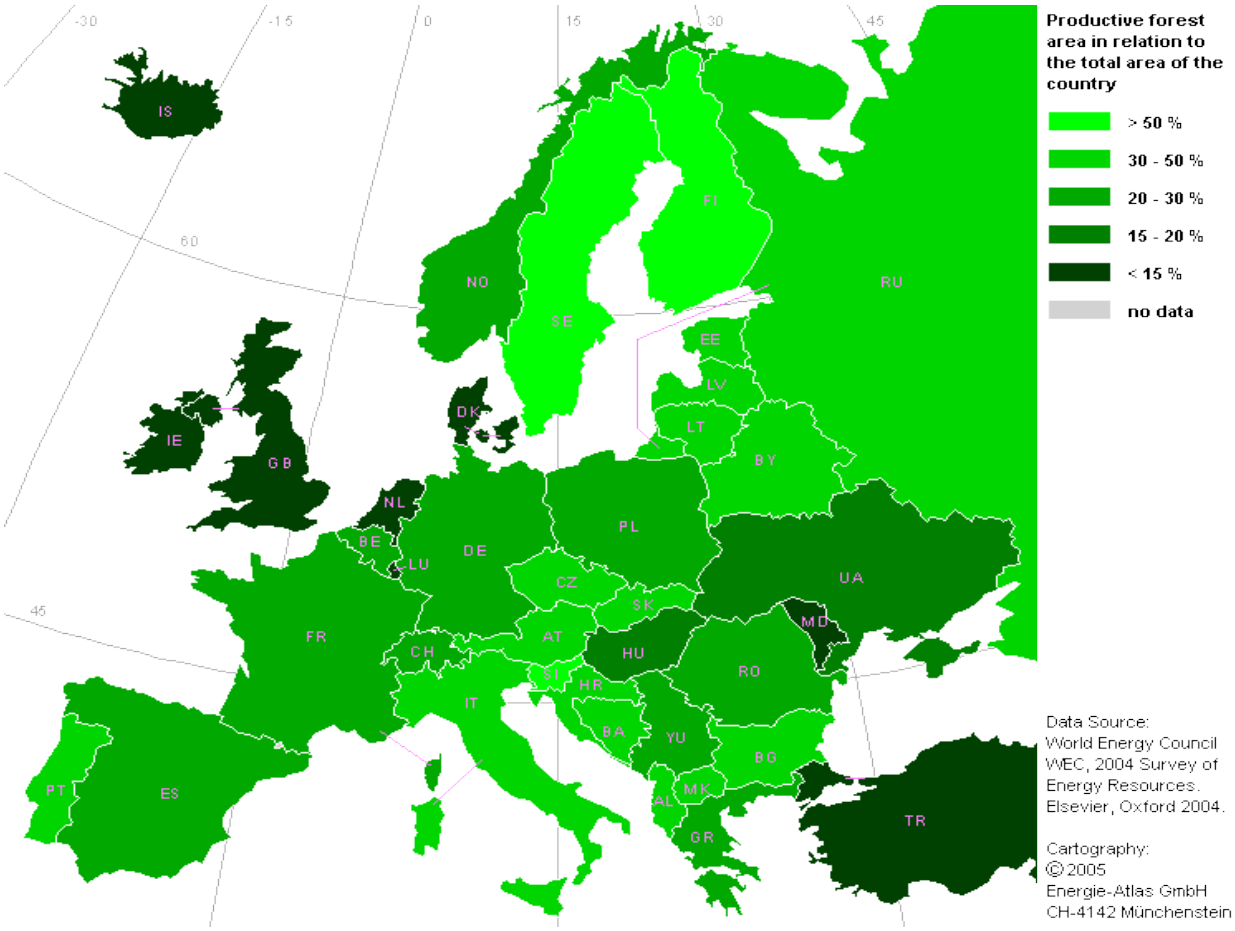
The technologies that are covered in the Advice Note are the following:

- ***Biomass Combined Heat and Power (CHP)***
- *Wind*
- *Solar PV*
- *Small – scale hydro*
- *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.

Biomass CHP Economics Across the NPA

Combined heat and power (CHP) is a method that delivers both heat and power on site in a single, highly efficient process, normally over 80% efficiency. CHP creates electricity and as a by-product of the generation process it produces heat. Wood biomass is fed into the CHP system similar to a normal biomass boiler and the produced gas is then fed to an engine which is connected to a generator generating electricity while the heat produced, can be fed into a heating system. Below is a map showing the productive forest potential in relation to the total area of the country. Biomass is the world's fourth largest energy source, contributing to nearly 14% of the world's primary energy demand.[1]



[1]http://www.geni.org/globalenergy/library/renewable-energy-resources/world/europe/bio-europe/indexbig.shtml

Small scale (<100kW) and micro-scale (<15kW) biomass CHP are particularly suitable for applications in commercial buildings, such as hospitals, schools, industrial premises, office building blocks, and domestic buildings. Optimum system design and implementation is crucial for cost-effective operation and it is established that the best economic performance come about with high load factors when the maximum amount of both electricity and heat sold on-site is maximised.

The main parameters governing CHP economics include[2]:

- Capital costs (CAPEX) – consists of costs for the system (62% to 77% of the CAPEX), engineering and construction costs, and planning. It can also include grid connection, roads and any kind of new infrastructure or improvements to existing infrastructure required for the project.
- Operational cost (OPEX) –The range is from 1% to 6% of the initial CAPEX per year and they consist of labour, scheduled maintenance, routine component/equipment replacement (for boilers, gasifiers, feedstock handling equipment, etc.), insurance and other variables. The bigger the plant, the lower fixed OPEX costs, because of the impact of economies of scale, particularly for the labour required.
- Capacity factor - Electricity production and heat production. CHP tends to be very efficient, over 80%.
- Cost of electricity/heat can be relatively low if local feedstock is available at low cost(no transportation)
- CHP lifetime - lifespan between 20 and 25 years

A reliable feedstock supply chain is vital for the economic viability of a CHP system. Fuel costs are central since when considering the levelled cost of electricity and heat production, ongoing running costs far outweigh capital investment. CHP systems and specifically the ones smaller in scale necessitate fuel of the highest quality and have very low moisture content, wood chip/pellets between 15% and 30% moisture content. Thus, it is imperative before considering investment in a biomass CHP system to ensure that the right fuel can be sourced locally.

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

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Scotland

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Costs and economics

The most common types of fuel choices for biomass CHP systems are chips and pellets.

Average Fuel cost depending on the choice of fuel is represented in the table below:

Typical Properties	Chips	Pellets
Moisture content when used (varies with species of wood)	20-30% (if air dry)	5-12%
Energy content	2.5-3.5MWh/tonne	4.8-5MWh/tonne
Financial		
Typical price	£40-£80/tonne	£140/tonne(bulk) £220-£300/tonne (bags)
Typical energy cost	£10-£22/MWh	£34-£59/MWh
Practicalities		
Suitable boilers	30-10,000kW	8-500kW
Storage facility requirements	Bin, bunker or silo; typically several weeks' to a month supply for small scale.	Vented room or flexible tanks; typically 3 months' supply.
Handling	Front loaders, tippers; automated fuel feed.	Bags - manual; tanker supplies use blowers; fuel feed automatic.
Transport	A 20m³ agricultural trailer will contain about 3.5-5 tonnes of woodchip at 25% moisture content.	A 20m³ trailer/lorry will contain about 12-13 tonnes of wood pellets.

Table 1 – Average Fuel Cost for logs, chips and pellets.

Average LCOE- The economics of a biomass system are governed by the capital cost, the biomass fuel cost, the offset fuel costs and the incentives available. Scotland - £108 £/MWh. The OPEX of many wood-fired boilers is competitive with fossil fuels but CAPEX is much higher:

- Average CAPEX -The capital cost of a biomass boiler is dependent upon the size, fuel type used and level of automation of the system. By combining the predevelopment, construction and infrastructure costs total capital costs for a commercial setting in Scotland are estimated

around £200- £450/kW installed maximum output for a complete turnkey system (up to 2MWth in size)[3].

- Average OPEX- Average operating cost will be from1% to 6% of the capital costs. Availability of fuel from local supply chain and minimization of transport requirement will bring the OPEX costs down.

The introduction of the RHI enhances the viability of Biomass CHP projects.

Support Schemes

Renewable Heat Incentive[4] - Tariffs can be found below for installations with an accreditation date on or after 1st of July 2017.

Technology	Eligible Sizes	Eligible Tariff (pence per kWh)
Solid biomass CHP systems	All capacities	4.29

In order to be sure that the project meets all of the RHI eligibility requirements check **The Carbon Trust's Biomass Assessment Tool** available to help with the economic appraisal:

The FIT rates as of 1st July 2017 for CHP 0 -2 kW power in Scotland can be found below.

Description	Total Installed Capacity (kW)	Eligible Tariff (pence per kWh)
CHP	**0-2**	**13.95**

Government Allowances and/or Exemptions

Installing CHP plants can lead to significant savings in fuel, cost and emissions over conventional power generators and heat only boilers. Capital costs can however be high and payback periods long. The UK Government has therefor introduced a number of fiscal and financial support mechanisms to improve the economics of developing CHP. Details can be found below:

[3] Carbon Trust 2012
[4] https://www.gov.uk/domestic-renewable-heat-incentive

- Carbon Price Support Exemption[5]
- Enhanced Capital Allowances[6]
- Business Rating Exemption [7]
- Contracts for Difference[8]
- Feed in Tariff[9]

Funding available for Capital Costs

Installing Regional/local companies and SME's offer fully financed **ESCo solutions**, where the business receives the cost savings and environmental benefits against other fuels and pays an agreed amount for heat per kWh, billed on a monthly basis. The biomass boiler and associated equipment remains the property of the company which retains the RHI payments.

Regional/local companies and SME's also offer **Shared Ownership option**, where purchase of the plant is shared between the client and company (generally 50/50) and both the annual benefits and costs are shared likewise.

Technology suppliers, products and services they offer

Supplier	Product	Services	Contact Information
Biosus Energy	Spanner HKA 35 (electric power - 35 kWel; heat power 79,5 kWth) Spanner HKA 45 (electric power - 45 kWel; heat power 102,2 kWth) Spanner HKA 49(electric power - 49 kWel; heat power 111,3 kWth)	- Installation - Maintenance	info@biosusenergy.com Tel: 01224 918 192

[5] https://www.gov.uk/guidance/chpqa-guidance-notes
[6] https://www.gov.uk/government/publications/use-of-chpqa-to-obtain-enhanced-capital-allowances
[7] https://www.gov.uk/guidance/chpqa-guidance-notes
[8] https://www.gov.uk/chpqa-guidance-notes
[9] https://www.ofgem.gov.uk/environmental-programmes/feed-tariff-fit-scheme

HW Energy	**Veto Dynamo** in 2 sizes: (A) 88,8 kW (heat 75 kW electricity 10 kW)(B) 53 kW (heat 48 kW electricity 5 kW) **Froling CHP50** (heat: ~110kW ; Electricity: ~49/51 kW 83 % efficiency) **V.E.P Green Steam CHP** (150 kW up to 1,5 MW thermal power and delivers from 30 up to 300 kW electrical power.)Over 90% efficiency; Wood chippings with up to 60% water content; 150kW – 40%.	- Design - Build - Install Wood fuel supply - both in-house wood fuel production business and a high quality network of compliance with the RHI HWEnergy SMART Heat Metering - Remote heat metering service allows keeping an eye on the biomass boiler's performance – at any time of day or night, and wherever you are. ESCo - a fully financed ESCo solution provides a fully managed service by HWEnergy. The business receives the cost savings and environmental benefits against other fuels and pays an agreed amount for heat per kWh, billed on a monthly basis. The biomass boiler and associated equipment remains the property of HWEnergy who retain the RHI payments.	http://www.hwenergy.co.uk support@hwenergy.co.uk 01397 706412
Harpers CHP	**V3.90 gasifier + ECO 165 CHP**(heat - 260 kWth; electricity - 165 kWe) fuel consumption - 110 kg/h **V4.50 gasifier + ECO 50 CHP (**heat - 110 kWth; electricity - 50 kWe) fuel consumption - 40 kg/h.	- Feasibility Studies - Consultation - Advise on RHI - Installation - Maintenance	Harpers CHP Ltd. Unit 2, North Road Industrial Estate INSCH Aberdeenshire AB52 6XP info@harperschp.co.uk 01464 821822.

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Ireland

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Biomass CHP Economics Ireland

Costs and economics

Typical Properties	Chips	Pellets
Moisture content when used (varies with species of wood)	25-35%	5-12%
Energy content	2.5-3.5MWh/tonne	4.8-5MWh/tonne
Financial		
Typical price	€115-125/tonne	>10 tonne: €210/t 3tonne: €230-275/t 1 tonne: € 275/t
Typical energy cost	€3.97/MWh	€5.63-€6.88/MWh
Practicalities		
Suitable boilers	30-10,000kW	8-500kW
Storage facility requirements	Bin, bunker or silo; typically several weeks' to a month supply for small scale	Vented room or flexible tanks; typically 3 months' supply
Handling	Front loaders, tippers; automated fuel feed	Bags - manual; tanker supplies use blowers; fuel feed automatic
Transport	A 20m³ agricultural trailer will contain about 3.5-5 tonnes of woodchip at 25% moisture content	A 20m³ trailer/lorry will contain about 12-13 tonnes of wood pellets

a. Average LCOE for Biomass CHP

There are currently no biomass CHP plants in the North West Region of Ireland and only 2 installed plants in the rest of the country.

Due to lack if installations to date, data relating to LCOE, CAPEX & OPEX is not readily available.

Support Schemes

RESS (Renewable Energy Support Scheme) proposed tariffs due to come into effect in 2018, subject to State Aid clearance from the European Commission. The tariffs are based on a sliding scale depending on MWh/yr usage.

Tier	Lower Limit (MWh/yr)	Upper Limit (MWh/yr)	Biomass Heating Systems Tariff (c/kWh)
1	0	300	5.66
2	300	1,000	3.02
3	1,000	2,400	0.50
4	2,400	10,000	0.50
5	10,000	50,000	0.37
6	50,000	N/A	0.00

REFIT 3 aimed to incentivize the reallocation of up to 310 MW of grid capacity to renewable energy sources with scope for between 100-170 MW of capacity to potentially be attributed to biomass powered CHP. While now closed to applications, some projects exist in the pipeline with deadline for connections extended to September 2019. REFIT will be replaced by the RESS.

Government Allowances and/or Exemptions

For certified High Efficiency CHP (HECHP) plants, they may be eligible for relief from electricity tax for electricity produced from high-efficiency environmentally friendly heat and power generation.

Funding available for Capital Costs

Debt funding up to 85% of the project costs (recent reports suggest 75% is now more likely).

Due to lack of installed capacity (~5.4 MWe spread over 2 CHP plants) there currently doesn't exist a shared ownership or ESCO business model for biomass CHP.

Technology suppliers, products and services they offer

Supplier	Product	Services	Contact Information
Fingleton White	Ireland's leading designer and developer of industrial CHP.		Tel: +353 57 8665400 info@fingleton.ie
HDS Energy	Designers of Industrial Steam Boilers, Biomass Energy Plants, Combined Heat and Power (CHP) Installations and RDF fueled energy plants.		Tel: +353 (0)46 929 3976 info@hds-energy.com
Crowley Energy	Designers and installers of biomass CHP equipment and ancillary equipment.		Tel :+353 (0)21 4396666 sales@crowley.ie
RACKARD STEAM & BIOMASS SERVICES	Technical and mechanical feasibility studies, design and execution of biomass systems.		Tel: +353-872525458 nick@rackard.ie

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Finland

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Costs and economics

Average market prices of biomass fuels:

- Wood pellets: bulk ton delivered 245 €/t (incl. VAT 24%); big bag 500 kg delivered: 124 € (incl. VAT 24%).
- Woodchips at plant, approximate 20 €/MWh. Biomass -based CHP requires higher fuel quality as heat only production, so the price level is above this average price.

There is limited availability of biomass-based CHP suppliers. Basing on the examples of CHP plant supplied by Volter Ltd. for Kuittila Power in Nurmes (40kWe & 100 kWth), and Spanner Re2 in Sukeva (30 kWe & 80 kWth, 110 kW total).

Due to limited operational experiences, OPEX/LCOE is not yet available.

CAPEX varies between 3600-4400 €/kWe.

Support Schemes

Energy support is available for the investments. Biomass based CHP plants in small scale have received investment supports of 30-35% from the regional Centre for Economic Development, Transport and the Environment. Production supports are not available for small-scale biomass.

Government Allowances and/or Exemptions

N/A

Funding available for Capital Costs

N/A

Technology suppliers, products and services they offer

Technology Providers

Supplier	Product	Services	Contact Information
VolterOy (located in Kempele, but has supplied systems to North Karelia)	Volter Indoor model ▪ Fuel: Wood chips ▪ Electric power: 40kW ▪ Heating power: 100kW to water, ca. 20kW hot air from housing ▪ Measurements: Length 4,8m, width 1,2m, height 2,5m, mass ca. 4,5tn ▪ Color: White/Grey/Green ▪ Structure: Steel frame, sheet metal covers with heat and noise insulation ▪ Installation: On a concrete base indoors ▪ Fuel feeding: External spring agitator and chain conveyor ▪ Fuel consumption: ca. 4.5 loose cubic meters/24h ▪ Automation: Schneider electric programmable logic. GSM alarms, remote internet control ▪ Connection requirements: Electricity cable, heat piping (one in, one out), broadband, GSM connection Dryer for bulk solids	Volter Indoor unit is designed for Indoor installation. It is very compact and especially designed for multiple unit installations on one site. Volter units are test ran at the factory before delivery and delivered as turnkey solutions. Customer attaches the heat pipes to the heat grid and electricity cable to the main electrical cabinet on site. Volter offers Lauber dryers that are used for bulk solids in connection with special hook lift drying containers for an efficient and powerful system to dry bulk solids such as wood chips and firewood.	www.volter.fi

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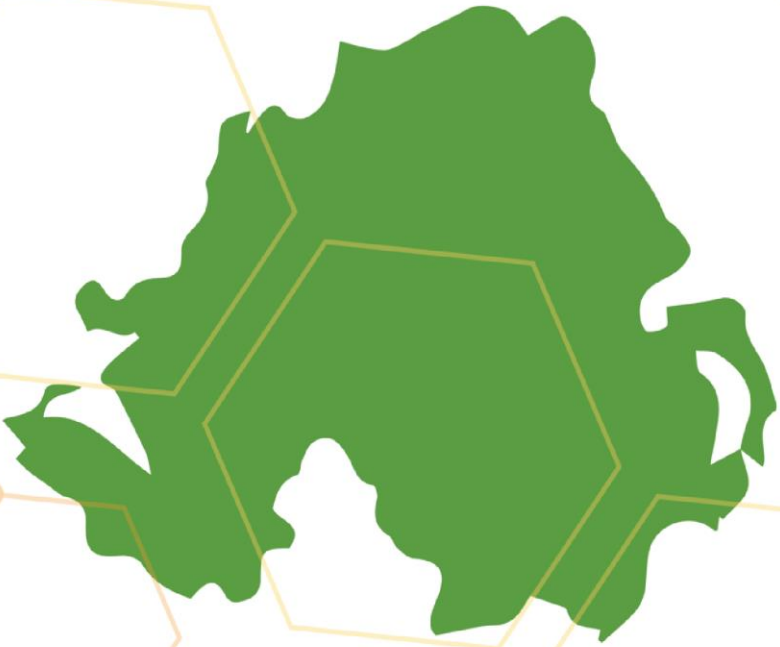
Northern Ireland



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Costs and economics

Cost summary for a 5MW solar farm

	2015		2017	
	Cost/MW	Total(5MW)	Cost/MW	Total(5MW)
EPC Costs	**€1,084,759**	**€5,423,797**	**€916,000**	**€4,580,000**
Grid Connection Costs	**€80,000**	**€400,000**	**€80,000**	**€400,000**
Development/Finance Costs	**€91,600**	**€458,000**	**€91,600**	**€458,000**
TOTAL CONSTRUCTION COSTS	**€1,256,359**	**€6,281,797**	**€1,087,600**	**€5,438,000**
Development Margin	**€100,000**	**€500,000**	**€100,000**	**€500,000**
TOTAL PROJECT COSTS	**€1,356,359**	**€6,781,797**	**€1,187,600**	**€5,948,000**

Technology suppliers, products and services they offer

Supplier	Product	Services	Contact Information
Solmatix	Solar PV panels.		Tully Road, Nutts Corner, Co Antrim, BT29 4SW, Northern Ireland sales@solmatix.com 028 9082 4000
BlueBuild	Solar PV panels.	• Solar Panel 25 year performance warranty • 10 year Product Guarantee • Inverter up to 20 years warranty available • Tigo Harvester Power Optimisers 10 year warranty • Tigo Harvester Management Unit 5 year warranty • BlueBuild 4 years workmanship guarantee • 4 year insurance backed warranty Bluebuild also provide a solar panel cleaning service.	Unit 1 BlueBuild Business Park,N210 Quarry Heights, Newtownards, Co Down, BT23 7SZ 02891 468 222 0800 0684 099

Saliis	Solar PV panels.		Unit 1, Greenview Business Park,nEdgar Road, Carryduff BT8 8NB
Altec	Solar PV panels.	Our Solar PV Panel Warranty: • 25 year performance warranty • 10 year material & workmanship warranty • Inverter 5 or 12 year warranty as standard (Extensions available) • Altec 10 year installation & workmanship insurance-backed warranty • Fixings 10/12 year defects warranty	The ECO Hub, 62 Windyhill Rd Limavady, BT49 0QZ 0044 (0) 28 7777 8177 sales@altecrenewables.com
Bluebuild		Tigo Energy's innovative combination of hardware and software increases the output of solar arrays by up to 20%, enables module-level monitoring and alerts, improves safety with module level deactivation.	Unit 1 BlueBuild BusinessPark, 210 Quarry Heights, BT23 7SZ

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Email: paulineleonard@wdc.ie

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

WDC Western Development Commission

Action Renewables – the future of energy, today

Luke Natural Resources Institute Finland

FPN Forskningsparken i Narvik

eri environmental research institute

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

Innovation Center Iceland

Karelia

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