GREBE

Generating Renewable Energy Business Enterprise

Northern Periphery and Arctic Programme 2014-2020

Advice Notes on Solar PV Technology Economics for the NPA Region

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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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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, Solar PV is not deployed on a large scale in Iceland; however, it is deployed to a certain extent in Scotland, Finland, Ireland and Northern Ireland.

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

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

The selection of the right 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 apt for your business. Those matters will be discussed in depth in the Renewable Energy Resource Assessment Toolkit.

Solar PV Economics Across the NPA

As seen in the in the solar irradiation map below, the NPA Region's average sum of solar irradiation is well below most parts of Europe. However, during the summer period, the countries based in the NPA region get around 17 to 19 hours of daylight and those in the Arctic Circle get 24 hours. Solar PV requires daylight (solar irradiation), rather than sunshine and high temperatures, which makes it a viable technology choice for businesses in the NPA region.

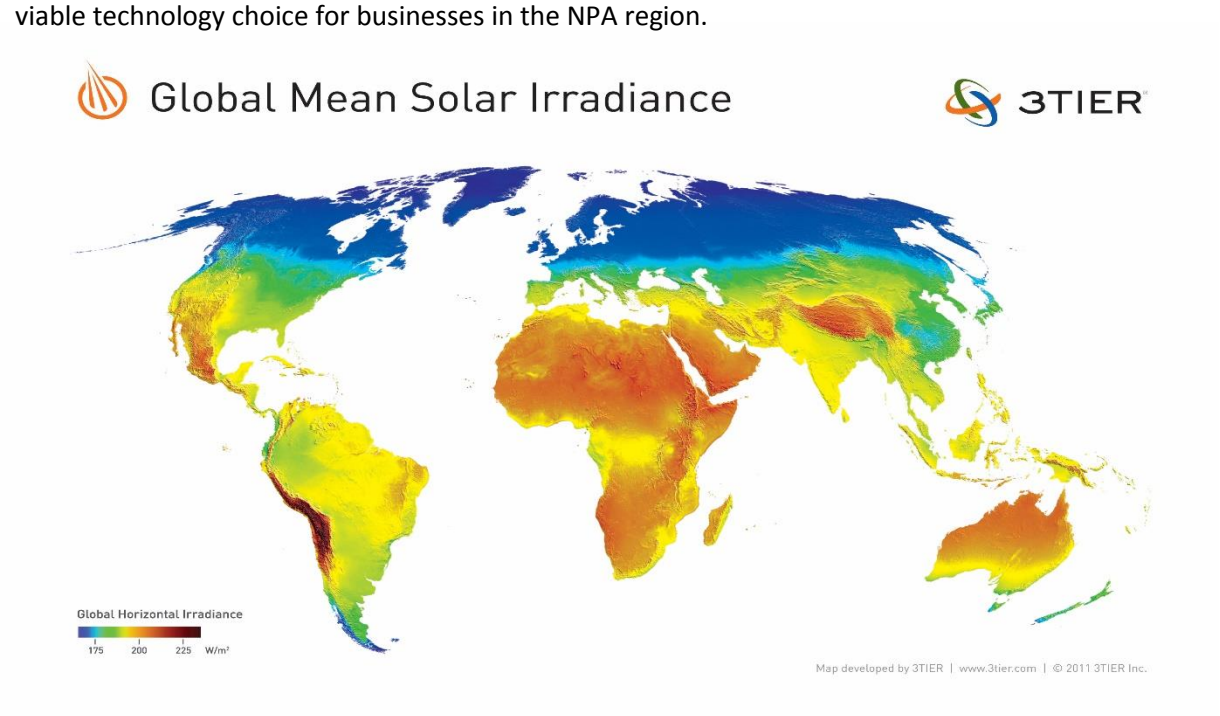

Figure 1. Global mean horizontal irradiation map [1]

[1] https://cleantechnica.com/2013/08/19/germany-breaks-monthly-solar-generation-record/

Financial incentive schemes and massive global deployment and development of solar PV panels has facilitated to address the relatively high capital costs of photovoltaics, by reducing the typical payback period and making it more financially viable investment.

Solar PV technology uses solar cells, which are grouped together in panels, to produce electricity when exposed to sunlight. Solar PV is a highly modular technology that can be incorporated into buildings (roofs and facades) and infrastructure objects such as noise barriers, railways, and roads. This makes PV an apt technology choice for use in urban and industrial areas. At the same time solar PV is appropriate for rural areas as well. This is particularly because solar PV delivers an economical and clean solution for the electrification of remote rural areas where the power from the grid is not available or very expensive. In most cases Solar PV systems may need to be accompanied by energy storage equipment or auxiliary power units, to supply electricity when the sun is not available.

Solar cells and modules come in many different forms that vary greatly in performance and degree of development. Solar PV is characterised by its versatility. Panels can be effectively employed at a very wide range of scales and in different locations and applications range from consumer products (mW) to small-scale systems for rural use (tens or hundreds of watts), to building integrated systems (kW) and large-scale power plants (mW/gW).[2]

The technology costs have dropped tremendously due to economies of scale in production and technological advances in manufacturing. A price decrease of 50% had been achieved in Europe from 2006 to 2011 and there is a potential to lower the generation cost by 50% by 2020. Furthermore, solar PV takes less time to plan and install, compared to other RE technologies.

Solar PV two main types:

- **Crystalline silicon** – the most common type of PV with an average efficiency of about 12-15%. It is typically available in the form of panels, and requires a strong, flat surface for mounting, such as a roof or wall. Groups of PV cells can be added together to form an array, with more cells providing an increasing level of power.

[2] Rogner, H., Aguilera, R., Archer, (2012). *Global Energy Assessment: Toward a Sustainable Future* (pp. 425-512).

- **Thin-film PV** – this is a thin layer of PV applied to a substrate such as glass or metal. Thin film PV is less efficient than crystalline based cells - 6%-10% efficiency. However, it's cheaper and perfect for applications where higher efficiency is not essential and low-cost, light and flexible construction is important

The main parameters governing solar power economics include[3]:

- Capital costs (CAPEX) - investment costs such as solar PV modules and grid connection, also contains labour costs - engineering and installation
- Operational cost (OPEX) - operation and maintenance costs are considered to be low.
- Electricity production – In order to maximise the system's efficiency the panels should be facing south with a pitch angle suited for the location.
- Panels lifetime
- Discount Rate

[3] European, Wind Energy Association, Taylor and Francis, 2009.

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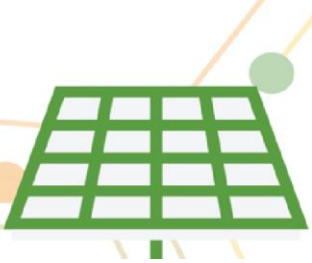
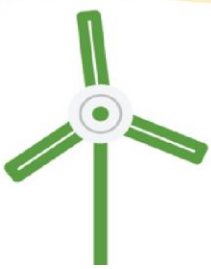
Scotland





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Costs and economics

Solar power in the UK has increased rapidly in recent years as a result of a reduction in the price of photovoltaic cells and the introduction of FiTs. Central to the deployment of PV has been the reduction in component costs at the global level, deployment and improvements in the UK supply chain. Economies of scale mean that the capital cost per kWh will decrease as the size of the system installed increases.

Payback periods for grid-connected PV in the UK are currently between 5 and 10 years, assuming the FIT is claimed. PV energy pay-back time is short and constantly decreasing. This means that the time required for a PV module to produce as much energy as it would need to be manufactured is very short, varying between one and a half to three years. PV costs in the UK have experienced a sharp decline of nearly 70% in the last five years.

- LCOE - Panels form the largest proportion of total construction cost at around 45%, grid connections and racks also represent a significant item – Average LCOE £85/MW
- CAPEX - The majority of the capital expenditure is spent on panels, electrical infrastructure and racking equipment. Economies of scale mean that the capital cost per kWp will decrease as the size of the system installed increases. The range is between £800/kW to £900/kW.
- OPEX – Quite low range from £10k/MW to £20k/MW.

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.

FIT - There are different rates for Solar PV

  - Higher - required to provide an Energy Performance Certificate (EPC) for the property, proving a band D or above in order to be eligible for the higher tariff rate.

- Medium - The system owner has a total of 25 FIT-registered PV installation.
- Lower - The system provides power to a building, and the building does not have an EPC certificate showing its energy efficiency in bands A to D.

The FIT rates as of 1st July 2017 for solar PV power in Scotland can be found below.

Description	Total Installed Capacity (kW)	Eligible Tariff (pence per kWh)
Standard Solar PV - High Rate	0-10	4.14
	10-50	4.36
	50-250	1.99
Standard Solar PV - Middle Rate	0-10	3.73
	10-50	3.92
Standard Solar PV - Lower Rate	0-10	0.48
	10-50	0.48
	50-250	0.48
Standard Large Solar PV	250-1000	1.63
	1000-5000	0.48
Stand Alone Solar PV	0-5000	0.35

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

Home Energy Scotland renewables loan scheme - Interest-free loans

Technology suppliers, products and services they offer

A comprehensive list of suppliers, products and services can be found at the following link:

https://www.solarguide.co.uk/location/scotland/

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Ireland

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Solar PV Economics

Ireland

Costs and economics

Costs – A combination of falling costs, improved technology levels and increased availability of finance means that, with the right level of government support, solar PV could be rapidly deployed in Ireland with the potential to provide between 10% and 20% of Ireland's renewable energy requirements by 2020.

- LCOE –– Average LCOE €118.6/MW
- CAPEX – Estimate of €980,000/MW
- OPEX – Estimate of €148,690 / 5MW installation

Support Schemes

None in place but expected.

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

Irish Solar Energy Association members http://irishsolarenergy.org/members/

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Finland

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Costs and economics

CAPEX is based on both installed systems and forthcoming new investments. It varies depending on the system size and technologies selected. In addition, joint acquisition processes have some price reducing impact.

- OPEX of the solar PV systems is estimated to be approximately 20-22 €/MW (Vartianen 2016).
- LCOE (Levelized Cost of Energy) of Solar PV systems in Finland (Finsolar 2016)

Investment cost €/kWp (2016)	LCOE c/kWh (VAT 0 %)	Exemplar cases	Supports and taxes	LCOE c/kWh (including supports/taxes)
Lowest price 950 €/kWp	4,2 c/kWh	Large-scale industrial solar PV (900 kW), easy roof-assembly.	TEM 25% investment support. 2016 – VAT 0%	3,3 c/kWh
Highest price 2 000 €/kWp	8,6 c/kWh	Small-scale solar PV (3 kW) for a housing association	No support or tax deduction. VAT 24%	11 c/kWh

Average price levels in North Karelia (Karelia UAS 2017, Poveria Biomassasta project case data).

System size, kW	€/kWp (installed) VAT 0%
3	1830
5	1647
7	1482
10	1260
15	1180
20	1145
30	1100
40	1070
50	1050

Average price levels of joint acquisitions of Solar PV systems for households (Regional Council of North Karelia 2016).

System size, kW	€/kWp (installed) VAT 0%
2,65	1460
5	1320
7	1150

Average price levels of joint acquisitions of Solar PV systems for energy enterprises (Karelia UAS, Poveria auringosta project data 2017).

System size, kW	€/kWp (installed) VAT 0%
4,8	1250
5,4	1235
7	1144
8	1122
14,5	1035
21	935

Support Schemes

- Energy supports for Solar PV: 25 % (TEM, Ministry of the Employment and the Economy via TEKS Finnish Funding Agency for Innovation), 35 % (for new innovative technologies, e.g. energy storages and intelligent controls (case specific definition).
- Farms can have investment support of 35-40% from the Rural Development Programme. The funding is allocated via local Centre's for Economic Development, Transport and the Environment. Minimum support amount is 7000 €'s, which means about 20 000 €'s minimum investment with 35% support and 17 500 €'s minimum investment with 40% support.
- Communities can apply LEADER financing (up to 60%) to the renewable energy projects.
- Households can have tax deduction of 50% or maximum of 2400 €'s (2017) of installation costs.

Government Allowances and/or Exemptions

N/A

Funding available for Capital Costs

There are no specific funding options for solar PV systems.

Municipalities in North Karelia have been involved in joint acquisition processes through the HINKU network (Carbon neutral municipalities).

Technology suppliers, products and services they offer

Technology Providers

Supplier	Product	Services	Contact Information
Mirotex Oy, Kitee	Solar PV systems Amerisolar (US/China) TrinaSolar (China) Inverters Fronius and ABB (Austria) Tens of Solar PV plants 3 to 35 kW. (Alava farm at Kitee 35 kW). Off-grid solutions.	-Turn-key solutions -Installations -Service and maintenance -Support -Reselling	www.mirotex.fi
Solarworks Oy, Joensuu, Motiva certified Solar PV installer	Solar PV systems Valoe (Finland), inverters Fronius (Austria), Hybrid solutions (Fronius solar battery) Kuntokeidas Joensuu 50 kW and Lehmo S-market approx. 80 kW (largest Solar PV in North Karelia), also smaller solar PV systems	-Turn-key solutions -Installations -Service and maintenance -Support -Reselling -Intelligent controls -Optimising	https://www.solarworks.fi/
Akkuhuolto Sinkkonen Oy	Solar PV systems Salosolar (Finland), Sma inverters (Germany) Private houses, Off-grid solutions for leisure homes/cottages	-Turn-key solutions -Installations -Service and maintenance -Support -Reselling	http://www.akkusinkkonen.fi

EV-Sähkö	Solar PV systems	-Turn-key solutions -Installations -Service and maintenance -Support -Reselling	http://www.evsahko.fi/
Avot sähkö	Solar PV systems, Green Energy Finland,	-Turn-key solutions -Installations -Service and maintenance -Support -Reselling	http://avotsahko.fi/
Joen Sähköpojat Oy	Solar PV systems, Green Energy Finland (private houses, Off-grid solutions for leisure homes/cottages)	-Turn-key solutions -Installations -Service and maintenance -Support -Reselling	http://elfin.fi/jalleenmyyjat/joen-sahkopojat-oy/
Lieksan sähkö Oy	Solar PV systems (private houses, Off-grid solutions for leisure homes/cottages)	-Turn-key solutions -Installations -Service and maintenance -Support -Reselling	http://lieksansahko.fi/
Sähköasennus Joensuu	Solar PV systems (private houses, Off-grid solutions for leisure homes/cottages)	-Turn-key solutions -Installations -Service and maintenance -Support -Reselling	http://sahkoasennus-joensuu.fi

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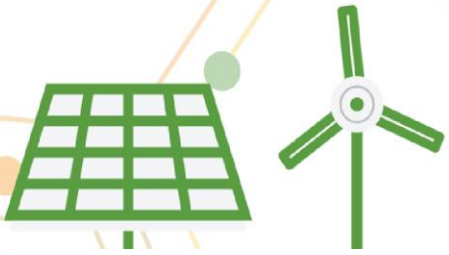
Northern Ireland



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Costs and economics

The solar energy market in Northern Ireland appears to be taking off - the number of installations this year is three times what it was in 2012 according to figures from Ofgem. This popularity is driven by energy prices going up and the price of some renewable technologies coming down. An average solar panel installation for your home will cost you between £4,000 and £9,000 and it should pay for itself in about five to eight years.

Average LCOE: The Levelised Cost of Energy continues to fall for Solar PV. The British Voltaic Association asserts that solar power is creating an energy revolution. Working groups within ISEA have identified those falling costs mean that solar will compete with all other energy sources even without subsidy by 2023. A case study conducted by ISEA concluded that on a 1MWp commercial rooftop; the LCOE on a real basis and excluding incentives was calculated at 9.1c/kWh.

Cost summary for a 5MW solar farm

	2015	2015	2017	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

Support Schemes

The Feed-in Tariff (FiT) is exclusive for Great Britain and therefore does not apply to Northern Ireland. The main mechanism of support for renewable energy generation in Northern Ireland is the Northern Ireland Renewables Obligation (NIRO) (scheme is now closed for new applicants since 31st March), which is led by the Department of Enterprise, Trade and Investment (DETI). The scheme has certain similarities with the FiT; when a business or householder start generating their own energy, they are issued with ROCs based on the technology they are using and the amount of energy produced.

These ROCs can be traded with the energy supplier, like when you sell electricity from your solar panels back to the national grid. You can actually sell the electricity you don't use back to the grid if your energy is supplied by Power NI, and get an additional payment by doing so. You have to keep in mind that the NIRO Scheme is closed to new applicants as from 31st March 2017. However, there is also a proposal to introduce the FiT with some changes in 3 to 4 years and this will displace the NIRO.

Northern Ireland has also incorporated the Renewable Heat Premium Payment (RHPP), a scheme designed to make it easier to households to afford alternative renewable technologies to heat their homes and get hot water. Your property needs to meet certain requirements to apply for funding from the scheme. A value grant for a solar thermal hot water is £320.

Moreover, if you have a privately owned or rented home and need help paying for heating and insulation improvements; you might qualify for the government's Warm Homes Scheme. This is designed for people who receive certain qualifying benefits such as income support, pension credit, and child tax credit, among others. There are two parts of the scheme, Warm Homes and Warm Homes Plus. The first one offers insulation measures and the second also offers heating measures.

Government Allowances and/or Exemptions

A business can claim 100% First-Year Allowances (i.e. you can effectively write off all the capital costs against your trading profit). This allowance can be claimed without using up any of your annual investment allowance limit. And this qualifying enhanced capital allowances include solar thermal, as well as other energy saving equipment.

Funding available for Capital Costs

Solar PV installations accredited before the 31st of March 2017 would have received ROC payments for their energy generation. The ROC bandings have changed over time as the incentive for the solar panels has decreased. Before September 2015 a system would be in the 4 ROC banding meaning that they would receive 16p/kW. Before September 2016 a system would be in the 3 ROC banding meaning they would receive 12p/kW. Then until the incentive closed in March 2017 a person would be in the 2 ROC banding meaning they would receive 8p/kW. The incentive now is closed but a new scheme could be brought in within the next 3-4 years.

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 T : 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 Northern Ireland 02891 468 222 0800 0684 099
Saliis	Solar PV panels.		Unit 1, Greenview Business Park, Edgar Road, Carryduff. BT8 8NB
Altec	Solar PV panels.	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, BT237SZ, Northern Ireland

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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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