GREBE

Generating Renewable Energy Business Enterprise

Northern Periphery and Arctic Programme 2014-2020

Advice Notes on Anaerobic Digestion 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:
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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, deep geothermal is deployed on a large scale in Iceland and not as much in Scotland, Finland, 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)*
- ***Anaerobic Digestions (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.

AD Economics Across the NPA

Anaerobic Digestion (AD) is the breakdown of organic material by micro-organisms in the absence of oxygen. The term AD commonly refers to low-temperature biological conversion, with the resulting product (biogas) typically being 60% methane and 40% CO 2. AD technology uses vacuum-packed digesters in which a bacterial culture is sustained in anaerobic environments that stimulate the production of methane. Many forms of feedstock are suitable for AD; including food waste, slurry and manure, as well as crops and crop residues.

AD produces biogas, a methane-rich gas that can be used in different ways:

- In an internal combustion engine or turbine to generate electricity, and heat
- Combustion in a boiler for process steam or hot water
- Combustion in process equipment
- Cleaned, compressed and injected into the natural gas grid
- Cleaned, compressed and used as a road transport fuel

In addition to biogas the AD produces residual solid fibre and, also known as digestate, which can be used as a fertiliser, depending on the nutrient value of the digitate. Thus, it may have additional value in some circumstances.

AD can be classified in a number of different ways

- The number of processing stages - continuous flow or batch system
- The concentration of solids in the material - wet (5-15% dry matter) or dry system (over 15% dry matter)
- The digester temperature level - mesophilic (25-45oc) or thermophilic (50-60oc)
- By number of digesters - single, double or multiple.

The two key costs in AD are the initial capital cost and the cost of feedstock, depending on the system selected and feedstock used.

The main parameters governing hydro power economics include[1]:

- Capital costs (CAPEX) – Every AD plant is different in terms of technology, inputs, outputs, location; thus, accurate costs can only be obtained from a system supplier. Components making up the CAPEX are; feasibility study, project conception and development civil engineering works, system components and installation, the CHP system and grid connection.
- Operational cost (OPEX) – Once the plant is set up, it should have relatively low operating and maintenance costs other than the feedstock. Operating costs include costs associated with recruiting and paying the employees who will run the digester, insurance, transportation, annual licenses, pollution abatement and control, and all maintenance. The budgeted costs of maintaining the plant is often based at about 2 % of its capital value
- Capacity factor - 85% capacity is a fair multiplier and AD technology supply companies suggestions range from 80% to 99% however the volatility of third party wastes (if you are depending on a third party) can make operating an AD plant at full capacity very difficult and bring down the capacity factor to 60 -70%.
- AD lifetime - The life of an AD plant should be in excess of 20 years.

For an AD plant to be profitable a crucial consideration should be given to the supply chain and use of by-products. For example a business with and AD plant must strengthen the relationship with the neighbouring enterprises and business in order to receive their waste and in return provide them with something of value for them – a digestate or heat supply for example. A reliable relationship with feedstock suppliers could make the difference between paying off the capital within 5 years or 15 years.

If you are not yourself creating the feedstock as a by-product of another part of your process, the possession of long-term contracts for the reception of waste (i.e. feedstock) will be essential to give you a “bankable” business plan. Sufficient feedstock material should be ensured at planning stage in order to operate the plant at optimum capacity and to maximise the potential sources of revenue.

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

The use of the heat produced by an AD scheme will add substantially to the economic performance of the project if it can be utilised locally. It is difficult and expensive to transport heat any distance so potential users of the heat would have to be at, or very close to the site.

Another crucial factor for the bankability of an AD plant is to collect income from all available channels. Each output should be considered a co-product rather than by-product and marketed accordingly.

- Sales of biogas or a product from its processing such as electricity.
- Heat from biogas combustion, lowering heating bills and selling to others.
- Claim both Feed in Tariffs and Renewable Heat Incentive
- Sales or own use of fibre and liquid fertiliser in place of mineral fertiliser
- Gate fees are charges made per tonne when the feedstock arrives for processing waste

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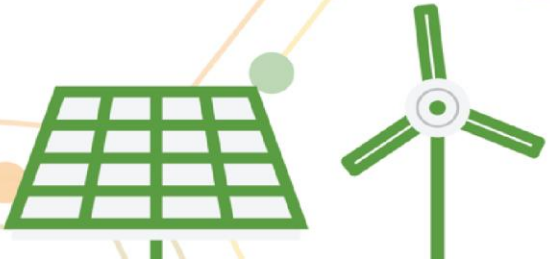
Scotland



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Costs and Economics

Costs and Economics - Costs can differ significantly contingent on the scale and complexity of the plant. In addition to reducing costs to the business itself, an AD plant can generate income from the sale of electricity and heat to other businesses, plus claim FiT and RHI. AD plants may also earn income from gate fees from feedstock providers for collecting and processing wastes. A large proportion of the operating income for CAD plants comes from gate fees (UK studies have assumed £45 or more per tonne) for industrial waste and from the sale of electricity and heat generated. Payback period is around 10 years for 20 years lifetime plant.

- LCOE – the levelized cost of electricity are lower for large-scale plants due to the use of more efficient conversion devices and their lower capital cost per unit of electricity produced. A study found that LCOE was estimated to be 4.3 p/kWhe for AD plants processing the waste of 125 dairy cow sized herds compared to 1.9 p/kWhe for AD plants processing waste of 1000 dairy cow sized herds.[2]
    - A small digester of 10kWe capacity, using residues from 100 cattle, requiring a digester capacity of around 150m3, is likely to cost in the region of £50,000 to £70,000.
    - A large AD plants cost are substantially higher. A plant of 1MWe capacity, requiring a digester of around 10,000m3, is likely to cost between £3 million and £7 million.
- CAPEX - The capital costs for AD plant vary from £3,000 to £7,000 per MWh of electricity generating capacity. Variation in construction costs was reported to be driven by three factors including feedstock type, process configuration and economies of scale. Project development costs, including consultant's fees and planning cost form another significant component of the costs (4-5% of the overall capital investment costs). [3]
- OPEX - Operating costs for an on-site AD project will vary depending on the size of the plant. . Annual operation and maintenance costs for a CAD plant are likely to be in the region of 7-8% of the total capital cost.
    - Staff and labour costs - site, employee, and liability insurance

[2]Potential for Energy Production from Farm Wastes Using Anaerobic Digestion in the UK: An Economic Comparison of Different Size Plants, Gabriel D. Oreggioni, Baboo Lesh Gowreesunker , Savvas A. Tassou.2017
[3]Carbon Trust, Making sense of renewable energy technologies 2012

- Pollution control measures and annual waste management licence fees.
- Training in health, safety, and environmental matters.
- Transport of materials/products to and from the facility is very important factor to consider. A recent study estimated a net cost of the digestate from a particular AD plant to be £12 per tonne; thus deliver should be carefully considered. Despite the fact that digestate is a valuable soil conditioner and fertiliser, its low dry matter content makes it very expensive to move. When estimating the costs of imported feedstock, it is sensible to consider the delivery to site cost.

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. Anaerobic digestion qualifies for FITs.

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.

Incentives are also payable for eligible installations for electricity through the Feed-in Tariff (FIT) arrangement. The FIT rates for AD in Scotland can be found below.

Description	Total Installed Capacity (kW)	Eligible Tariff (pence per kWh)
AD	0-250	6.24
	250-500	5.9
	500-5000	2.24

The Renewable Heat Incentive pays substantial incentives for heat, and methane injected to the natural gas grid. Renewable Heat Incentive[4] - Tariffs can be found below for installations

Description	Total Installed Capacity (kW)	Eligible Tariff (pence per kWh)
Bio-methane Injection	Tier 1	3.2
	Tier 2	1.89
	Tier 3	1.45
Small Biogas Combustion	Less than 200kWth	2.88
Medium Biogas Combustion	200-600kWth	2.26
Large Biogas Combustion	Over 600kWth	0.86

Government Allowances and/or Exemptions

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

The Renewable Transport Fuel Obligation (RTFO) requires suppliers of fossil fuels to ensure that a specified percentage of the road fuels they supply in the UK are made up of renewable fuels. Bio-methane is eligible for Renewable Transport Fuel Certificates provided that it is dutiable and produced wholly from biomass. More information can be found from the Department for Transport, who administer the RTFO.

Levy Exemption Certificates - Combined heat and power (CHP) generated from eligible renewable resources is exempt from the Climate Change Levy (CCL). CHP Levy Exemption Certificates (LECs) are the primary evidence that suppliers use to demonstrate to HM Revenue & Customs the amount of electricity supplied from certified 'Good Quality' CHP sources to non-domestic customers in the UK. For more information on CCL CHP exemption, see the relevant pages of OFGEM's website. For information on getting certification for quality CHP, see the CHP Quality Assurance programme.

Two green gas trading schemes have been established to enable tracking of green gas through the national gas distribution network.

[4] https://www.gov.uk/domestic-renewable-heat-incentive

- The Green Gas Certification Scheme (GGCS) is a simple and reliable way to eliminate double-counting of registered green gas. It provides certainty for consumers who buy the gas, confidence in the green gas sector and an incentive for gas producers to inject green gas into the grid instead of using it to generate electricity.
- The Bio-methane Certification Scheme (BMCS) is an independent certification scheme run by Green Gas Trading Limited. Green Gas Trading was set up to provide both a credible process for certifying bio-methane and a trading platform to facilitate the trading of certificates.

Funding available for Capital Costs

Green Investment Bank (GIB) - The Green Investment Bank was set up by the UK Government as a public company in October 2012. The Bank has £3 billion to invest in sustainable projects, where public capital is used to support private investment. Energy from Waste, which includes anaerobic digestion, is a specific priority area for the bank.

The Scottish Recycling Fund (SRF) is a £3.8M fund established by Zero Waste Scotland and Scottish Enterprise to develop or expand materials reprocessing capacity and remanufacturing facilities in Scotland. Waste materials eligible for the fund include industrial food and drink processing waste.

Technology suppliers, products and services they offer

Supplier	Services	Contact Information
Scaled Biogas	Feasibility, planning and permitting, design, technical due diligence, supply, construction and operation and maintenance of AD solutions. This is ranging from 50kW up to 500kW grid connected systems and larger Gas to Grid solutions custom designed to the requirements of the site and the available feed stocks.	info@scaledenergy.co.uk **Tel:** 0131 510 1401

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Ireland

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AD Economics

Ireland

Costs and economics

Currently in the Rep. of Ireland there are only six anaerobic digestion plants, mostly in the south and south-east of the country; this is compared with 26 in Northern Ireland. Some of the reasons for the low level of plants in the ROI include a complex planning and licensing system with 8 different permissions required, grid connection costs, unattractive electricity tariffs, financing issues and uncertainty in waste policy. This is an area which has potential to grow, with the help of policy development and financial incentives to support the industry.

Costs and Economics - These costs can vary greatly depending upon the scale and complexity of the plant. In addition to reducing costs to the business itself, an AD plant can generate income from the sale of electricity and heat to other businesses. Incentives are also payable for eligible installations for electricity through the Feed-in Tariff arrangement.

- CAPEX – Initial investment of €4,000 per KW, estimate cost to generate 1MW of AD generated electricity is €4m.
- OPEX - Operating costs for an on-site AD project will vary depending on the size of the plant. Feedstock costs for a 1 MW plant would be in the region of €660,000.

Support Schemes

Description	Total Installed Capacity (kW)	Eligible Tariff (pence per kWh)
REFIT 3	Large AD Non CHP (above 500kW)	105.076
	Small AD Non CHP (equal to or less than 500kW)	115.583
	Large AD CHP (above 500kW)	136.598
	Small AD CHP (equal to or less than 500kW)	157.613

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

Financing is one of the key elements of ensuring project viability. In general low interest long-term loans are used for financing biogas plant projects.

A single farmer, a consortium of farmers or a municipality are the most likely to implement successful biogas projects. The success of the project depends on some factors that can be controlled and influenced by strategic decisions concerning investment and operational costs. Choosing the best technology in which to invest and calculate operational costs is very difficult.

If tendering a biogas plant, it is important to outline the following costs:

- Operational cost of CHP including all services and spare parts (amount/kWh)
- Maintenance costs of biogas plant in total (% of investment/year)
- Own electrical energy demand, including demand of CHP (kWh/year)
- Average working hours/day of staff (maintenance and feeding the system)

The success of the project is also influenced by some factors that cannot be controlled such as:

- Interest terms
- Grid access and feed-in tariffs
- World market prices for feedstock (e.g. energy crops)
- Competition for feedstock from other sectors

Quite often, before a bank offers to finance the biogas plant project, the economical long term success of the project must be proven by a study/calculation of profitability. The calculation is normally done within the preliminary planning by an experienced planning / consulting company, but in many cases, especially in the case of single farm based biogas projects, this work can be done by the project developer, as the project developers / partners are forced to have a very close view to the different aspects of the project.

The revenue side of a project is difficult to influence. The feed-in tariffs are set by the government. In case of waste treatment plants, the gate fees are market prices. There are other possibilities on the income side like using/selling the produced heat and selling digestate as a fertilizer.

Technology suppliers, products and services they offer

Developer	Services	Contact Information
Clearpower Ltd.	Installing biomass heating systems is where Clearpower started out 15 years ago. We now have a significant level of experience in delivering and maintaining these systems. We are not an agent for any particular make of biomass boiler – we will install and maintain any biomass boiler.	Unit 18, Claregalway Corporate Park, Claregalway, Co.Galway. Ireland

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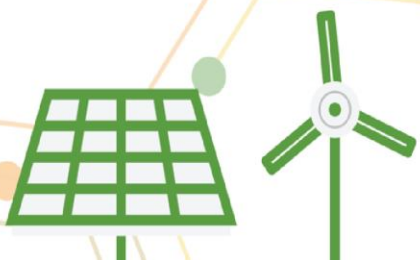
Finland



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Costs and economics

Costs and economics vary depending on the scale and type of the plant (heat and power, or biogas for transportation), and available raw materials. There are only some AD plants in the region so the economic factors are based on national level data.

Average costs of 20 000 t AD plant utilising municipal organic waste and bio waste from agriculture (Government of Finland 2017).

Properties	**AD plant utilising 20 000 tons of bio waste, producing 17 GWh/a energy**		
Revenues	Gate fee for bio-waste	50 €/ton	
	Heat price (70% sold)	30 €/MWh	
CAPEX	Heat	5.2 MEUR	
	CHP	5.5 MEUR	
	Biogas for transportation	6.5 MEUR	
OPEX	Heat	CHP	Biogas for transportation
Operation (€/t)	15	15	20
Service/maintenance (%)	5	5	5+2
Treatment of AD residue (€/t)	10	10	10
Own heat consumption	20%	20%	20%
Own electricity consumption	10%	10%	10%

Currently the profitable production is much based on the gate fees. In addition, the economic supports can raise the profitability of AD schemes over the IRR 8%.

Support Schemes

- Energy support for biogas: 20-30 % (TEM, Ministry of the Employment and the Economy via TEKES Finnish Funding Agency for Innovation).
- Farms can apply investment support from the Rural Development Programme. The support is allocated via local Centre's for Economic Development, Transport and the Environment.
- The feed-in tariff is a financial support and steering mechanism established to increase the RE production. The feed-in tariff is available for wind, biogas (above 100 kVA) and wood fuel power plants. Companies can apply for inclusion to the tariff system. The tariff comprises the target price 83.50 €/MWh less the three-month mean market price of electricity.
- The system for feed-in tariffs is temporary, until the combined capacity of the generators is exceeded. (Biogas 19 MVA).

Projects that have received energy support cannot receive production support.

Government Allowances and/or Exemptions

N/A

Funding available for Capital Costs

N/A

Technology suppliers, products and services they offer

Developer	Services	Contact Information
Envor Protech Ltd.	EPAD (Envor Protech Advanced Digestion) process is proven, reliable and cost effective technology for producing energy and nutrients from organic waste. The product range covers the whole biogas chain from biogas production to biogas utilization. Company offers customers a full turnkey delivery from waste receiving to biogas upgrading, filling stations and vehicle biofuel modifications.	http://www.envorprotech.fi/en
Bio10 Ltd.	Bio10 Ltd. was established in 2007 to treat organic waste and produce biogas based energy and both organic and conventional fertilisers. In addition, the company provides expertise and training services in biogas, waste treatment and recycling.	www.bio10.fi
Envictepolis Ltd.	Expertise / consultancy for renewable energy and material and energy efficiency. Has carried out AD feasibility studies for in North Karelia.	http://envitecpolis.fi/
Metener Ltd.	Biogas technology and expertise / consultancy for new projects. Has carried out AD feasibility studies in North Karelia.	http://www.metener.fi/

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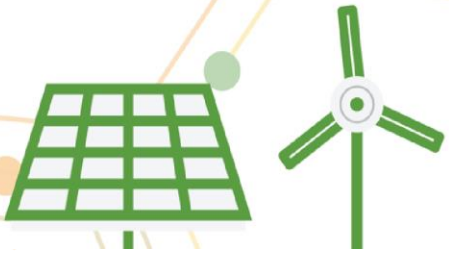
Northern Ireland



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Costs and economics

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Support Schemes

Renewable Energy Guarantees of Origin (REGOs)

The purpose of the REGO scheme is to promote and increase the contribution of renewable energy sources to electricity production across the EU, providing a common platform to facilitate the trade of renewable electricity between member states. The primary use of REGOs in Great Britain and Northern Ireland is for Fuel Mix Disclosure (FMD). FMD requires licensed electricity suppliers to disclose to their customers, and potential customers, the mix of fuels (coal, gas, nuclear, renewable and other) used to generate the electricity supplied annually.

One REGO Certificate is issued for each megawatt hour (MWh) of eligible renewable output generated (with effect from 5 December 2010). For more information on REGO Scheme see the relevant pages of OFGEM's website.

(This is a scheme that coincides with the ROC scheme)

RHI

No longer available.

Green Gas Trading (Certification Schemes)

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Government Allowances and/or Exemptions

Levy Exemption Certificates

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Funding available for Capital Costs

Green Investment Bank:

The Green Investment bank has shown examples of funding they have provided in Northern Ireland in the past. **Foresight**-managed fund commits £10.5m to two on-farm anaerobic digestion plants in Northern Ireland with cornerstone investment from UK Green Investment Bank

Technology suppliers, products and services they offer

£1.8m has been invested in the 0.5 MW Gorthill AD plant in County Derry, which will process agricultural waste to generate renewable electricity.

£8.7m has been invested in the 3 MW Ballymena AD plant, which is expected to be one of the first in the world to be fuelled exclusively by poultry litter.

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Tel: +353 (0)94 986 1441
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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