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Welsh Government

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Case Study 06

Lerwick District Heating

Owner of District Heating:
Shetland Charitable Trust

Owner and Operator of ERP:
Shetland Islands Council

Operator of District Heating:
Shetland Heat Energy and Power (SHEaP)

CHP Consultant:
COWI
(Aarhus, Denmark)

Location:
Lerwick, Shetland, Scotland

Building Types:
Domestic
Public Buildings
Community Buildings
Commercial
Industrial

Renewable Technologies:

Waste to energy
District heating

Project Description

Lerwick is the capital of the Shetland Islands and is home to around 8,000 people.
A district heating scheme utilising an energy–from–waste plant has been successfully installed, providing heating and hot water to the residents of Lerwick for the last decade, and there are now plans to expand the scheme to serve more customers.

Key Drivers

In 1991, the existing Shetland Island incinerators were decommissioned due to non compliance with EU legislation. This presented a waste disposal issue for the area and the use of waste incineration has the benefit of diverting waste from landfill.

Shetland was not connected to the UK electricity grid and was without mains gas. Consequently, fuel costs were among the highest in the UK and the fragile economy was susceptible to energy costs.

The Shetland islands are exposed to the North Atlantic and North Sea winds, which result in high heating demands. This presented a good opportunity for district heating, the feasibility of which is dependant on a high heating density.

Key Features

- Energy recovery plant (waste–to–energy).
- District heating system.
- 300 m^3 peak–load thermal store
- Peak load oil fired boiler station.

Peak load boiler station and thermal store
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Procurement

During the early stages of the project, discussion with Scottish and Southern Energy (SSE) was undertaken by the Shetland Isles Council (SIC) to investigate the potential of a joint venture to establish a district heating scheme for Lerwick, firstly using waste heat from the Lerwick power station operated by SSE, and subsequently from an energy–from–waste plant. However, SSE later withdrew from the project and The SIC approached The Shetland Charitable Trust.
A limited company, Shetland Heat Energy and Power (SHEaP), was then set up by the Trust to operate

'Residents find that they can heat their whole property quickly, and can heat areas which were always cold with previous oil fired heating systems'
Neville Martin, SHEaP

the scheme. Heat generated by the ERP is sold to SHEaP, who then distribute and sell it to customers.

A waste study undertaken identified that in order to successfully implement an Energy–from–Waste scheme, waste would need to be obtained from a number of sources.

Waste Stream	Quantity (t/yr)
Shetland municipal waste	~ 15,000
Orkney municipal waste	~ 8,000
Waste from offshore oil industry	~ 3,000

Summary table of waste sources and approximate quantities for ERP
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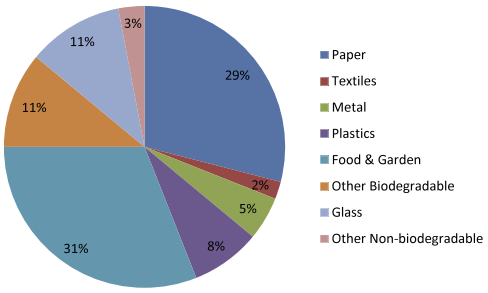
Procurement of waste from Orkney was facilitated through the Orkney and Shetland Waste Plan (SEPA, 2003). Offshore waste generated by Shell, who operated a 'zero offshore waste to landfill' policy, was also sent to the plant. Changes in waste composition have occurred since commencement of the scheme due to increased levels of recycling and a greater quantity of waste plastic packaging. Consequently, waste is now also sent to the ERP by the Highland Council.



Composition of Shetland municipal solid waste
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Despite promotion of the scheme via local media, public presentations and set up of a "shop", low oil prices in the late 1990s meant that sign up by large customers was very slow. However, early sign up by domestic customers (who had some prior experience of district heating in Scandinavia) and a street of council owned property which was then undergoing refurbishment began to promote the scheme through word of mouth.

To incentivise customers for early sign up, EU Thermie funding was made available. The funding provided a 30% grant towards the conversion cost (with a free connection) to any customer who signed up to the scheme before the distribution pipe network was laid past their property.

A high level of customer sign up was also important to minimise waste heat 'dumping' when heat demand dropped significantly. Heat 'dumping' is a mechanism of removing excess of surplus heat production. Initially, air coolers were frequently used to dump surplus heat. This has now reduced somewhat with the scheme now producing around 50,000 MWh per annum with annual customer sales at around 35,000 MWh (i.e. a surplus of 15,000 MWh, a significant proportion of which is lost through the distribution system.)

Dumping of surplus heat is now only undertaken during summer months when the average heat demand drops below a set level. Further reduction of summer dumping cannot currently be achieved without significantly more connections. This in turn would require an additional cheap heat source for the winter.

Back up oil fired boilers in boiler station
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Scheme costs

The initial construction of the ERP cost in the region of £11 million in 1999. As of the end of 2010, the cost of the district heating was approximately £13 million, including the cost of all plant and infrastructure serving a total of around 1100 properties, 110 of which are non domestic but take approximately 60% of the heat.

Maintenance costs of the main network are covered by SHEaP, with customers responsible only for maintenance of plant within their property boundary. A notable proportion of annual maintenance costs, at around £150,000, are associated with alarm systems and mechanical muff joint issues in the pipe network. However, these issues could now be resolved with technological advances in pipe design made since installation of the scheme.

There are a number of economic benefits of the scheme. Approximately £3 million/year is retained in the local Shetland economy which would have otherwise been spent on oil or electricity for heating. Additionally, around £500,000 of local employment is generated every year due to distribution pipe laying and plumbing requirements.

A significant sum is saved by large customers, and the need to install localised expensive heating plant is removed for new large customers.

Technology selection process

The lack of mains gas meant that conventional energy sources available to Shetland were limited. Consequently, the use of waste as an energy source, via district heating, was a desirable alternative for the Shetland Islands Council (SIC) when it was first considered in the 1990s, with the additional benefit of diversion of waste from landfill. An energy recovery plant, for heat only rather than combined heat and power, was decided upon due to the significant cost increase associated with electricity generation for only marginal efficiency improvement.

The energy recovery plant (ERP) is located in an industrial area to the north of Lerwick, near the dock to minimise the transport distance required for offshore waste deliveries. A peak–load boiler station (PLBS) and thermal store were constructed on land adjacent to the Lerwick power station, approximately 1.6 km south of the ERP. The thermal store has a storage capacity of approximately 12 MWh and is used in preference to the oil fired boilers whenever possible. The main distribution and return pipelines connecting the ERP and PLBS to customers run underground to Lerwick. The plant operates at around 80% thermal efficiency and serves approximately a third of the buildings in Lerwick.

Monitoring and operation

A contentious issue with energy from waste is the production of potentially harmful flue gases and precipitates. Flue gases are cleaned in compliance with the waste incineration directive, with contaminant concentrations continuously monitored and spot sampled. It has been argued that as a high proportion of dioxins generated in the UK originate from unmonitored domestic fires and stoves, by replacing individual heating systems with district heating, the Lerwick scheme has actually reduced dioxin emissions in the area.

A study was undertaken to calculate estimated annual savings in greenhouse gas emissions and fossil fuel imports. Data was collated on the individual customer heating systems used prior to installation of the district heating scheme, in addition to operational efficiencies of energy production. For the purposes of the study, the ERP was considered as carbon neutral on the assumption that the biodegradable waste 85% burnt in the ERP would have otherwise been sent to landfill and eventually degraded to methane.

The original study estimated that utilising waste as an energy source saves approximately 4000 tonnes a year of fossil fuel imports. This saving is now estimated at approximately 6000 tonnes. Carbon dioxide savings were originally calculated at approximately 12,000 tonnes a year although this is now closer to 15,500 tonnes.

The annual carbon dioxide savings of 15,500 tonnes a year equate to approximately 1.9 tonnes for each resident of Lerwick.

Connection branch pipes to customer properties
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SHEaP hold responsibility for all plant and distribution pipes up to the valves located just inside the customer property. Customers are responsible for the installation of heat exchangers and valve connection within their properties, by approved plumbers only. SHEaP provides the meters for the approved plumbers to install.

Monitoring of customer consumption is achieved via ultrasonic meters, which report temperature and flow conditions in addition to heat demand in kWh. Meter readings are relayed back to the office on a quarterly basis via a system installed in 2007, although approximately 10% of meters are still read by a handheld receiver for location reasons.

The ERP is now almost operating at capacity and consequently no further connection applications are being considered until an additional heat source is identified. Potential options to provide this heat include:

- generation of off–grid electricity by wind turbines, used to create heat using large scale immersion heaters and a thermal store. The benefit of this option is that the windiest conditions tend to coincide with higher heating demands (due to wind–chill) therefore load matching may be more easily achieved;

'District heating systems are well suited to areas which are not served by mains gas'
Neville Martin, SHEaP

- collaboration with other schemes to take advantage of economies of scale for the import of biomass such as wood pellets, in conjunction with other renewable energy sources such as heat pumps, thermal stores and wind turbines; or
- use of waste heat from a new power station proposed by SSE in the ERP.

Lessons learnt

Technological supply issues:

- Meter all properties and use a remote metering system.
- Keep the organisation small and source specialist services externally.
- Use twin steel pipes with electrofusion joints for distribution system.

Occupant involvement:

- Create incentives for customers to sign up to the scheme from the outset.
- Utilise the local community and workforce as far as possible for effective implementation of scheme (e.g. use of local, approved plumbers for heat exchanger installation).
- Maintain a high level of customer contact.

Financial lessons:

- The type of pipe system installed can have a significant effect on maintenance requirements and so should be considered from the early design stage.
- Share trenching with services for new build developments and build additional capacity into trenches/ducts (this may provide an additional source of rental income).

ERP operated by Shetland Islands Council
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Awards and Achievements

- Environmental Award for Engineers (Engineering Council, 2000); and
- ICE James Watt Medal awarded for a technical paper written about the district heating scheme (2011).

References and Acknowledgements

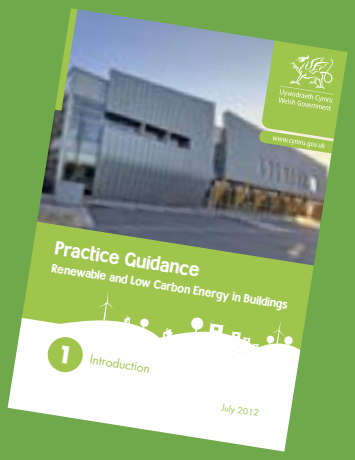
N Martin and W. Spence., 2009, Lerwick district heating scheme Shetland Islands, UK, Energy (163, issue EN3), pages 131–138, ICE

Neville Martin,
Shetland Isles Council

Further information

Shetland Heat Energy and Power Limited
www.sheap–ltd.co.uk

These case studies are presented to show examples of how buildings can be designed and built to be low carbon and incorporate renewable and low carbon technologies. This case study is part of a series of case studies supporting a separate practice guidance document on low carbon buildings. **For further information see www.wales.gov.uk/planning**



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