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District heating schemes are rare in the UK. Incineration of municipal waste has become controversial despite it being common practice in much of Europe where it is seen as good environmental practice. Currently in the UK many waste to energy recovery plants are being developed which use complex technologies that avoid the word 'incineration'. Many produce only electricity, dumping most of the potential energy as heat. Heat is about 50% of the UK energy demand. Without most of this being met by sustainable sources such as energy recovery plants, the UK will not meet its ambitious carbon reduction commitments. Energy recovery plants have the potential to be the main catalyst to establish district heating networks in the UK. Once the networks are established other heat sources from power stations, industry and renewable sources can join in. The scheme at Lerwick in the Shetland Islands, UK, has been operating for 10 years and has been so successful that new heat sources are required if it is to go forward and eventually serve the whole town. The study looks at how the scheme was conceived, sold to the customers, developed and how it is likely to expand further.

1. INTRODUCTION

Shetland lies about half way between Bergen and the Faeroe Islands and is about the same distance from Aberdeen. Both Bergen and Torshavn have district heating schemes fed by energy recovery plants. The Shetland flag is based on the Scandinavian cross (white cross on a light blue background) showing its cultural and historical ties with these neighbours. Shetland has an area of 1468 km^2. It has over 100 islands of which 15 are inhabited. It has a population of about 22 000 of which over 8000 live in Lerwick (Shetland Islands Council, 2009).

The Shetland climate is relatively mild despite being on the same latitude as the southern tip of Greenland (60°N). While winters are less severe than in the memorable past, summer temperatures rarely reach above 20°C. It has around 2700 degree days compared with 1800 or less in southern England or even 2400 in Aberdeen. This does not take account of the windchill factor, which contributes to Shetlanders having high energy bills and hence a very high carbon footprint.

In 1991 Shetland Islands Council (SIC) was faced with the problem that its existing incinerators were going to have to close down as they did not meet the forthcoming European Union (EU) legislation. A study was commissioned to look at the options. Waste is generally derived from imported goods and has a large energy potential. From an environmental point of view the energy recovery plant (ERP) is considered carbon neutral as, after most of the glass and metals have been removed, around 85% of the material consumed is of a biomass nature (Table 1). This would have biodegraded to mainly methane had it gone to landfill. Methane has about 20 times the greenhouse effect as carbon dioxide. Shetland does not have mains gas despite having large gas (and oil) fields off its west and east coasts. Fuel costs are among the highest in the UK. The economy was fragile and very susceptible to energy costs.

Shetland is not connected to the UK electricity grid. Most of the electricity came from an oil-fuelled power station in Lerwick operated by Scottish and Southern Energy (SSE), formerly Scottish Hydro Electric known locally as 'the Hydro'. This power station, like most in the UK, had to dump most of its energy output as waste heat. A joint study between the Hydro and SIC was undertaken into the possibility of establishing a district heating network in Lerwick initially using heat from the power station and later from an energy-from-waste plant. Visits were made to Denmark to see some schemes in operation. Danish consultants carried out a study which showed that, despite not having the legislative advantages of a scheme in Denmark, the high heating demand of potential customers in Lerwick could make the scheme economically viable.

In January 1997 SIC decided to proceed with the ERP (Figure 1). By this time SSE had withdrawn from the project. The SIC asked the Shetland Charitable Trust if it would invest in a district heating network. The Trust had accumulated funds from the oil industry during the developments of the 1970s and 1980s. Over the previous decade it had invested in improvements for the wellbeing of the population such as leisure centres and care centres. The Trust could invest in Shetland infrastructure that provided an economic benefit even if the financial returns were less certain. It had less than 2 years to get a scheme up and running before the ERP became operational. It had no firm plans and no definite customers. A Trust-owned limited company, Shetland Heat Energy and Power (SHEAP), was set up to operate the scheme.

2. ENERGY RECOVERY PLANT

2.1. Former plant

In the late 1970s Shetland chose incineration as a way to reduce landfill. Six batch incinerators were installed and began

Material	%
Paper	*29*
Putrescibles (food and garden waste)	*31*
Textiles	2
Other biodegradable waste	*11*
Metal	5
Glass	11
Plastics	8
Other non-biodegradable waste	3
Total	100

Figures in italics are primarily biomass and amount to 73%. With most glass removed at bottle banks and metals either removed at battery and can banks or after incineration, the biomass element is around 85%.

Table 1. Composition of Shetland municipal solid waste

operation in 1981. This reduced the waste going to landfill by 75%. These were batch incinerators that were cumbersome to operate and had no flue gas cleaning systems. The introduction of EU emission regulations meant that the incinerators had to be shut down in 1996. Orkney had the same problem, having identical incinerators, and also had to shut them down.

Unfortunately public perception for waste incineration appears to be based on this type of incineration, not the more efficient controlled burning operation and flue gas abatement systems which are available and operated today.

2.2. A new approach

The SIC went to Danish expertise in waste incineration. In Denmark incineration had been used for decades, supplying heat to district heating networks and the electricity into the grid.

A waste study proved there was an insufficient quantity of waste within Shetland for this project. An Orkney and Shetland waste plan (SEPA, 2003) was formed where Orkney waste would be shipped to Shetland where an ERP would be located. The plant decided upon was based on 26 000 t of waste per annum: 15 000 would be local, 8000 from Orkney and 3000 from offshore. Shell operated a zero waste to landfill policy for their offshore waste and decided that it would send its waste to Shetland.

Figure 1. Energy recovery plant

2.3. Design considerations

Following the waste studies, various burning methods were considered including moving grate, fluidised bed and rotary kiln. The moving grate furnace was well established in Denmark and best suited Shetland because of the relatively low throughput of waste quantity. Both electricity and heat energy production were considered for the operation. In the end heat only was decided upon. This would generate up to 6·8 MW of heat. A plant used to generate electricity would increase costs by 50% and was considered not to be cost-effective. The plant generating heat only would have an efficiency of almost 80%. The plant generating only electricity would have an efficiency of about 20%. Combining both electricity and heat together can give an efficiency of over 90% on larger plants but this was not cost-effective at the time for the size of plant proposed. The energy efficiencies were based on thermal efficiencies for different plant types with no consideration of energy used for plant function.

Once the furnace and boiler had been decided, on the flue gas abatement system had to be chosen. It was essential to choose a system that could meet future emission standards.

2.4. Operation

Wastes have different calorific values. In order for the furnace to operate smoothly it is very important to achieve an even calorific value of the waste going to the furnace. This is done by regularly mixing the new waste with the remaining waste in the bunker. The original design was for a waste with a calorific value of 9·6 MJ per kg. Over the 10 years the waste calorific value has increased to about 11 MJ per kg mainly owing to the increase of plastic packaging. Much of the glass is now removed from the waste stream by increased numbers of bottle banks. Similarly various metals are removed from the waste stream with further ferrous metals taken out after incineration by way of magnets for recycling.

Only some of the waste is pre-sorted at the council's sorting shed before it is tipped into the waste bunker. The domestic and commercial waste collected by refuse vehicles is tipped directly into the bunker. There is some separate waste collection in Scalloway and Lerwick but to do so in the rural areas is not considered financially and environmentally worthwhile.

Once the waste is mixed it is fed by the demand of the furnace (Figure 2). The maximum feed rate is 3·3 t per hour but can be reduced to about 2·3 t per hour. The waste is pushed onto the furnace and moved down over the grates at a rate determined by the make-up of the waste. There are three different stages in the furnace: drying, burning and the last section is to ensure complete combustion. Waste that burns slowly will require a feed rate different from waste that burns quickly. Waste layer thickness is also important and can completely change the quality of the burn. Another important factor of the burning is the air being fed into the furnace. The primary air is taken from the waste bunker, reducing odours, and force-fed into the furnace. The amount of air under each grate section is manually set by the operator and then regulated by the oxygen measurement in the furnace. Secondary air fed in the top of the furnace for cooling is also regulated by the oxygen quantity within the furnace. The oxygen level also influences the speed of the grates, which is adjusted to meet the set MW output. The

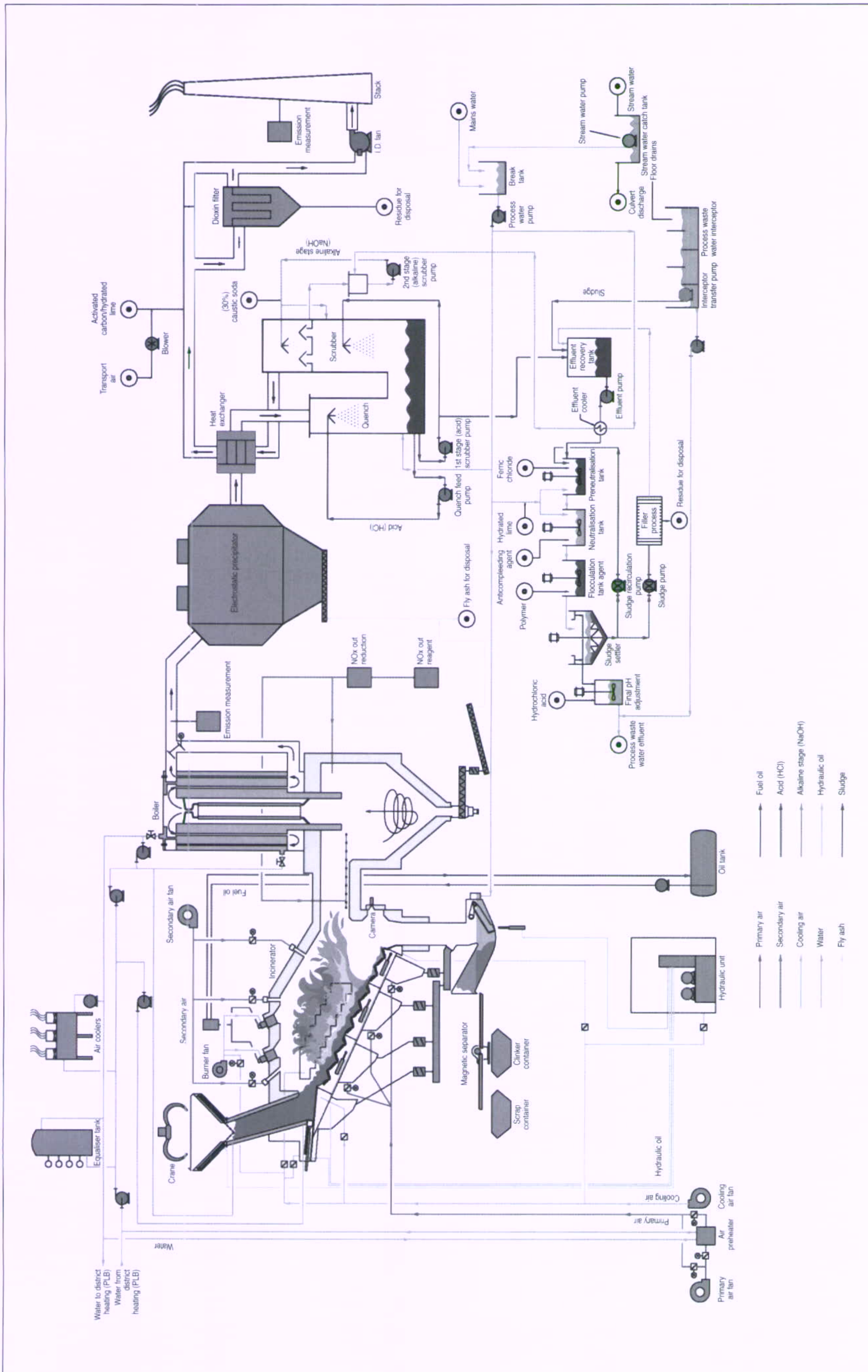

Figure 2. Process flow diagram

temperature within the furnace is maintained around 1150°C. Once the burn is complete the bottom ash falls off the end of the grate, goes through a wet quench for cooling before it passes a magnet to remove ferrous metals and into a container for removal. The ferrous metals are recycled and the wet dust free bottom ash is used for landfill cover. The bottom ash has pozzolanic properties and can be used for construction of road sub-bases.

The after combustion chamber (ACC) is situated directly after the furnace. Temperatures in the ACC have to be maintained above 850°C for at least 2 seconds to ensure that dioxins do not reconstitute. To ensure that temperatures are maintained within the ACC, gas oil burners situated in the roof of the furnace automatically start at a preset temperature. This preset temperature is also critical for carbon monoxide emissions: set too low and the carbon monoxide emissions increase. The preset temperature setting is 945°C.

The ACC is designed to create a vortex of the gases. Centrifugal forces throw the particulate to the outer rim of the chamber where it drops down and is removed. Once the flue gases have left the ACC they pass through a three pass boiler, cooling rapidly to a temperature of 180°C. This temperature is regulated to ensure effective operation of the flue gas abatement system. Fast cooling of flue gases gives less opportunity for dioxins to regenerate.

The gases now enter the electrostatic precipitator for the removal of the small particulate. This system operates by ionising the particulate with very high voltage. The particulate then adheres to the plates of opposite charge. These plates are rapped with hammers and the particulate falls off. The particulate is then conveyed into the same bag container into which the ACC fly ash goes.

The flue gases are then cooled by a heat exchanger before they enter a wet scrubber to have acid gases removed. The scrubber saturates the gases with water to remove hydrogen chloride gas. Sulfur dioxide is then removed using a sodium hydroxide solution; the amount required depends on the pH of the effluent bled off from the second stage of the scrubber. The residual effluent generated in the scrubber is then passed through a water treatment plant for purification and is discharged to the sea.

Once the gases have passed the scrubber they are reheated by the same heat exchanger that cooled them down. Next there is an injection of carbon and lime into the flue gas reactor pipe. The carbon and lime then coats a large number of bags in a bag filter through which subsequently the flue gases pass, removing dioxins and heavy metals.

The flue gases have now been cleaned and taken well within the limits required by the waste incineration directive (European Parliament, 2000) (Table 2).

One of the main objections to plant such as the ERP is the dioxin level. The emissions table shows that these are very small. In the UK, waste plants produce a fraction of 1% of dioxins compared with over 15% coming from domestic coal fires (Porteous, 1996). The district heating scheme is displacing coal fires and therefore actually reducing dioxins overall.

Continuous monitoring			
	Limit		
Parameter: mg/m^3	Half hour	Daily	Actual results
Nitrogen oxides		300	252·0
Hydrogen chlorides	60	10	0·0
Sulfur dioxide	200	50	2·9
Particulate	30	10	0·1
Carbon monoxide	100	50	2·6
Volatile organic compounds	20	10	0·4
Spot sampling			
Parameter: mg/m^3	Limit		
Hydrogen fluoride	1		0·042
Mercury and its compounds	0·05		0·0016
Cadmium and thallium	0·05		0·0016
Ammonia if SNCR	20		0·2
Dioxins and furans: ng/m^3	0·1		0·0053

Table 2. Emissions

When considering schemes such as the present project, the whole concept has to be appraised in order to appreciate the benefits.

3. PHASE 1 OF THE DISTRICT HEATING SCHEME

At the start of 1997 the results of the early study were reviewed with the Danish consultants. The original plan was to serve the whole town. This was reduced to a main pipeline heading to the potential main users. An area of North Lerwick was to be completely redeveloped so the plan was to weave through the town to this area. Any branches would depend on customer demand. The line was designed on the basis that there will eventually be a ring main around the main area of the town.

Land became available alongside the Lerwick power station. This was selected as the site for the peak-load boiler station (PLBS) (Figure 3). It contains the oil-fired boilers that supply the scheme when the ERP is down for maintenance, which is normally for 30 days a year. It also provides additional heat if demand exceeds the ERP output. The feed from the ERP is 115°C which was considered more suited for the industrial area through which the pipes passed. The pipeline would be a size

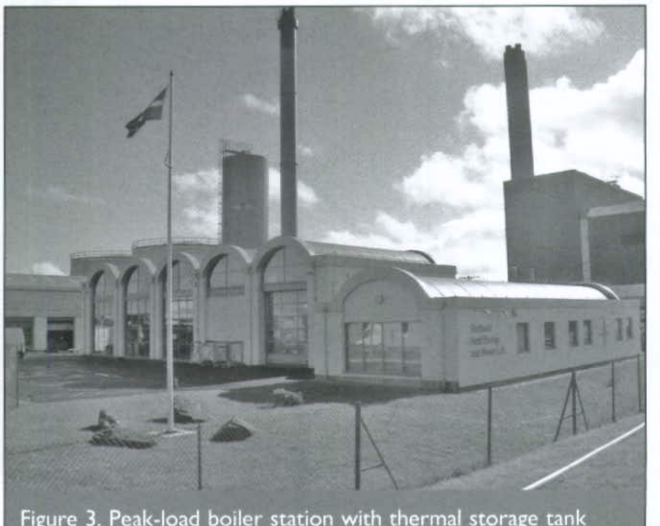

Figure 3. Peak-load boiler station with thermal storage tank

smaller than for 95°C which was planned for the town supply. The PLBS would be where the return water from the town is blended with the supply water to reduce it to 95°C. The pipe size into the town was sized for 20 MW on the basis that the scheme would eventually serve the whole town, assuming that the power station could provide heat once the customer base had been sufficiently built up.

3.1. The operating temperatures

In Denmark the tendency is to build new schemes with lower supply temperatures than in the past. It was decided that 95°C would be the maximum temperature to serve the town. To avoid feeding directly into customer heating systems (normally designed for 82°C), a heat exchanger interface and a higher supply temperature would be required. The initial line from the PLBS would be 4 km long sized for a 20 MW load. It could take many years for this to be reached, resulting in a higher percentage heat loss in the early years; therefore, 95°C was decided on. Once the heatload developed sufficiently the temperature could be lowered as long as the return temperature also came down. It was accepted that with normal UK practice of a return of about 70°C this could be difficult. Lowering their return temperature would cost customers money as they would need to install larger radiators. This, along with exchanger costs, could put them off signing up. It was reluctantly accepted that a good initial result would be if the return were lower than 70°C. It was hoped that with new customers and refurbished properties connecting, the return could be reduced down to 55°C or even lower over the decades. A lower return results in a higher energy being transmitted per unit volume of water with less pumping required and less heat loss. Many service engineers doubted whether this could be achieved. When drawing up the customer specification, existing property systems would be accepted but new properties were requested to have an internal supply temperature of 70°C and a return of only 40°C. In the initial stages a high loss of heat was anticipated from slow-moving water. Ten years later, during the winter there is only about 1°C lost in transmission over the 3·5 km to the Anderson High School.

3.2. Learning from others

Visits to Danish district heating companies were made to find out how they operated. Visits were made to the two largest district heating schemes in the UK at Sheffield and Nottingham to see the problems from a British perspective. A visit was also made to small boiler-fed schemes in Norwich. From these visits it was decided to

(*a*) keep the organisation small and buy in services required
(*b*) meter all properties
(*c*) have no direct feed into customer installations
(*d*) maintain a high customer contact
(*e*) maintain a high level of backup equipment and materials
(*f*) keep as much of the work and expertise as local as practicable.

3.3. Metering

In Denmark metering is now compulsory. In the UK some schemes have avoided metering owing to capital and operational costs, but it was reported that temperature control was often carried out by opening a window. It was decided to use ultrasonic meters as they were expected to last over 10 years and not be susceptible to dirt. They could be read from an outside terminal and were customer friendly, providing temperature and flow conditions along with heat demand in kWh. They could also interface with a prepayment system.

3.4. The customer's installation

The next problem was how far would SHEAP's involvement with a customer's installation go (Figure 4). Owing to lack of staff resources and experience it was decided that the responsibility would stop at the valves just inside the property except for the meter. Supply of heat exchanger units (Figure 5) and other materials was left to the local builder's merchants. Installation of the exchangers, meter and connection to the valves was to be organised by the customer using only approved plumbers. A symposium was organised with local plumbers. Some took straight away to the opportunities while others were very sceptical. In the long term the plumbers became the best salesforce one could wish for. The plumbers had to visit SHEAP regularly for meters. This enabled good relationships to develop where problems experienced could be discussed and information passed on either verbally or by way of newsletters.

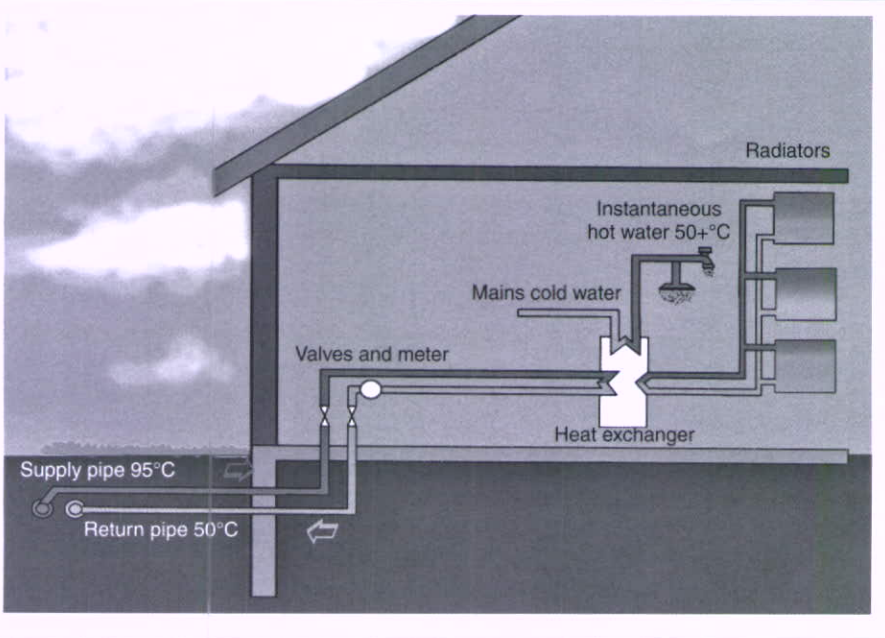

Figure 4. How district heating works

3.5. Selling the scheme

The final part of the jigsaw was how would SHEAP sell a completely new system to potential customers. It had been learnt from schemes visited that it would be difficult to sign up customers before the scheme had been built. It was decided to start promoting the scheme through the local media and giving presentations to such

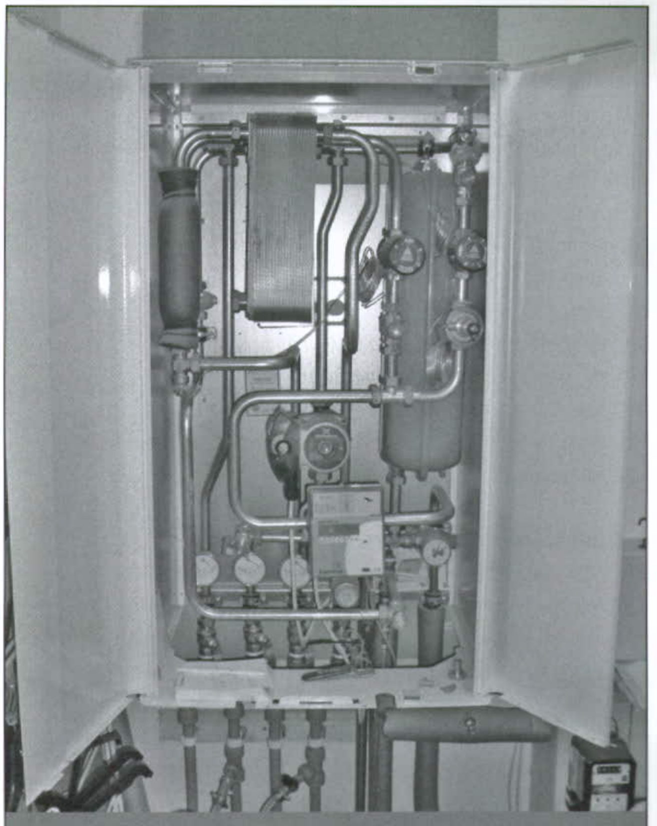

Figure 5. Domestic heat exchanger unit

organisations as the Rotary Club. In Ronne, Bornholm, it had been difficult to sell district heating despite being part of Denmark as it was relatively remote. This had been overcome by setting up a shop where potential customers could come in to discuss issues. It was decided to set up a shop jointly with SIC's energy unit who could give impartial advice and backup for the district heating team. There was no hard-selling approach as the local population was knowledgeable and were willing to find out more on a subject. An informative brochure in a conservative 1950s style was issued that discussed both the pros and cons.

Through EU Thermie funding a grant of 30% towards the conversion cost and a free connection was provided to anyone signing up before the pipes were laid by their property. This provided an inducement during the critical first year.

3.6. Phase I

In January 1998 the contract was awarded with the works, including any connections, to be completed before the next winter. Apart from the main line, branches and connections were provisional quantities. Work commenced in April 1998.

Prior to the contract starting up staff plus local consultants supervising the works were sent to Denmark to be trained in the design and installation of district heating networks. As with most specialist services it would be vital that Shetland should be self-sufficient in operating and maintaining the scheme as help could be days away owing to adverse weather.

A duct was laid alongside the main pipes. The prime purpose was to carry a multi-core cable for the M-Bus system to monitor the largest customers and for transmitting the pressure differential between the supply and return pipes at the extremities. This was to be 0·5 bar. The SIC had offices scattered around Lerwick and was likely to need more communication links, so the duct was laid to more areas than the scheme needed. Over the years most of the duct space has been rented out, bringing in more revenue than anticipated.

Signing up was initially very slow. At the start of 1998 oil was around $20 a barrel but by the end it was under $10. This made signing up the large customers very difficult and was only overcome by offering a price that would change monthly with the price of oil less a discount. Fortunately there was one area where nearly 100% were signing up. The area was primarily of houses about 30 years old and with oil boilers needing to be replaced. Many of the householders had experience of district heating when visiting friends in Scandinavia.

There was also a street of council houses where about 50% had been sold. The remaining 50% were to be refurbished and the SIC gave the tenants a choice of heating, one being district heating. Despite adverse letters in the press saying the scheme would be a white elephant, 70% of the tenants went for district heating plus one of the sold houses. Achieving over 35% in a street was encouraging. It was accepted that elsewhere it was unlikely that more than 5% of households would normally be upgrading the heating in any one year and that if 10–15% would sign at that stage then a branch line would be installed in that street. After that it was anticipated that word of mouth would sell the scheme.

By the beginning of November 1998 the scheme was ready to start operating before the ERP which had fallen behind schedule. Using oil for heat the pipeline was progressively heated up allowing the expansion muffs to be welded up. By Christmas 1998 six houses were receiving heat.

4. EXPANSION

A fire at the ERP delayed its commissioning by a further year. It was decided to continue running on oil and at the same time connecting houses during 1999. Connecting major consumers was delayed. The price of oil remained low, which kept the losses acceptable.

SHEAP staff were now carrying out the design of the extensions and connections. Local firms had developed the expertise to undertake the installation work. About 75% of the cost of the works was of local input.

Once customers started reporting how good the system was, applications for connections increased. Former critics were now applying. The price of oil started rising again.

The ERP came live in December 1999 but there was a long learning curve so it was only operating for about half the time in the first year. Large customers such as the main hospital and the leisure centre connected to the scheme. It was now that it was discovered how little peak demand these buildings required in mid-winter compared with the boiler capacity they had installed, and it was clear that the connection pipes and meters could have been smaller. The connection to the leisure centre is of particular interest as it has a three-pipe connection arrangement. It has a normal high-temperature circuit feeding the heating system designed on the normal UK practice of over 80°C. However, the swimming pool only requires 30°C so the return from the town was used for a low-temperature circuit thus helping cool down the return water. A lower price was charged for the low-temperature circuit.

In 2000 construction of a new care centre in the Sound area gave the opportunity to expand into an area not previously considered. Most of the housing on the way was about 20 years old and required upgrades or replacement heating. Most of these houses had electric storage heating, as there were periods in the 1970s and 1980s when there were large increases in the price of oil. There would be no better time to lay pipes in that area. Signing-up rates for some streets were now approaching 50%, although many would only enquire when the excavations commenced, which made planning programmes very difficult.

Connections were now going into all types of properties. Guesthouses and churches were very numerous. Others included a shopping mall, a fish factory, public houses, schools, the police station including the cells, offices and shops. Strangely, from the UK perspective, far more private houses were being connected than municipal.

In 2003 the UK government brought out the Community Energy Programme of grants. The Lerwick scheme was in a very good position to apply for the grants as the costs were known and long-term aspirations were already assessed. The 3 years of the grants (which averaged 40% of the costs) enabled the scheme to develop far faster than ever envisaged. An extension to the Anderson High School could at last be justified, thus adding the last major customer to the scheme. From the Shetland perspective the programme was a great boost but regretfully it was discontinued.

The ERP operates at a near-constant rate, producing around 50 000 MWh annually. Air coolers were installed at the ERP to dump surplus heat during the early years and now only during the summer months when the average demand drops below 4 MW. The annual sales to customers is now over 35 000 MWh. In a fully developed scheme about 10% is lost in the network, although the current losses will be a higher percentage until almost all properties along the pipe mains are connected. To increase the summer load to reduce dumping will require substantially more connections which cannot be justified until another cheap heat source can be developed for the winter loads which have been increasing rapidly.

By 2004 there was the occasional need to use oil to meet the peak loads. By 2006 the amount being spent on oil justified the construction of a thermal store (Figure 3). This consisted of a 19 m high steel tank, 4·5 m in diameter. The size was such that it could just fit on the ferry operating between Shetland and Denmark. The tank would store surplus heat during the night at 110°C and release it to meet peak loads in the morning instead of burning oil. The tank capacity is 300 m^3. and it can store about 12 MWh. It is expected to pay for itself in under 5 years.

Up to 2005, meter readings had to be done by sending out cards to the customers. These took a long time to be returned and those not returned had to be read from the outside terminal. Sometimes the decimal point was in the wrong place or the customer had put in an electricity meter reading. In 2005 radio modules were inserted in the meters so that they could be read from the road. This still took a week to collect. In 2007 a system

Figure 6. Pipework to Quoys housing scheme

was installed where the meter readings are relayed back to the office overnight. About 10% of the meters have still to be read by way of the handheld receiver for location reasons. As more customers come on board, this percentage is expected to decrease.

In 2005 a new museum was being constructed which enabled the long-term ambition of creating a ring main around Lerwick to come to fruition.

By 2007 there were numerous streets with 100% of properties connected. The new housing scheme built by Hjaltland Housing Association at Quoys consists of 120 houses all of which will be connected to the scheme (Figure 6). Without the scheme most would have been heated by electricity, at under 40% overall efficiency. This helps reduce the load on the power station which is ageing and nearing capacity.

By 2007 it was realised that with the applications in hand the capacity of the scheme using only the ERP was being reached. Except for special cases such as health reasons no more applications are being considered until a new heat source has been determined.

5. STATUS IN 2009

The current number of customers is about 1000 of which 110 are non-domestic. These non-domestic properties take about 60% of the heat demand.

The scheme has proved very reliable over the past 10 years. Power cuts can bring interruptions to the supply but these affect customers' properties at the same time as electricity is required to pump water. The heat exchanger units have had some problems which have required and are still requiring minor alterations to the design to improve their longetivity, which is generally still better than a domestic oil boiler.

The current peak demand in the winter is around 11·5 MW. Interestingly the five largest customers had about 11 MW of boiler capacity but at the peak demand they and around 1000 other customers are being supplied, illustrating the potential of district heating to reduce the amount of plant required by customers.

The estimated annual savings that are achieved are presented in Table 3. The carbon dioxide saving equates to about 0·5 t per Shetlander.

Sulfur dioxide	500 t
Nitrogen oxide	1000 t
Fossil fuel imports	4000 t
Carbon dioxide	12 000 t

Table 3. Estimated annual savings

The scheme was built for the benefit of the Shetland economy and it is in this role that the scheme has done better than originally thought. Keeping the population at its current level of 22 000 and not letting it fall to under 18 000 before the oil came is important. It is estimated that the district heating scheme has brought several economic annual benefits.

(*a*) About £2m stays in Shetland which would otherwise have been spent on oil or electricity and left the economy.
(*b*) New large customers such as the new Anderson High School will save hundreds of thousands of pounds in plant. Existing large customers such as the hospital have gained a large space for other purposes.
(*c*) Large customers save a considerable sum on maintenance.
(*d*) Works both laying pipes and plumbing create over £500 000 of local work.

The cost of the district heating to date is about £13m. The benefits of the above amount to between £2m and £3m annually depending on the price of oil. The cost of the ERP was £11m in 1999.

6. THE FUTURE

The greatest challenge is to find another heat source. Currently several possibilities are being investigated.

(*a*) Installation of wind turbines to provide off-grid electricity to the ERP and create heat by way of immersion heaters to a very large thermal storage tank. This will enable provision of additional heat capacity and reduce the need for the PLBS to burn oil during outages and peak loads. Shetland is a windy place with turbines having a load factor of up to 50% and most of the peak loads are when there is a high windchill. Investigations are ongoing with SSE regarding a potential joint wind energy project. Hydrogen production for transport or electricity generation is another possibility for storing surplus electricity other than as heat. Any heat from the electricity regeneration would go into the district heating scheme, improving the efficiency.
(*b*) Importation of biomass such as wood pellets is being considered for district heating schemes in other townships with a high energy density where houses have been built next to a school and leisure centre. These may be in conjunction with wind turbines, heat pumps and thermal store. If these proceed it could be used in Lerwick to help with the economies of scale.
(*c*) A new power station is being proposed by SSE near to the ERP, possibly as early as 2014. Discussions are being held with SSE to obtain the waste heat. This would be the long-term ideal solution.

Other options are

(*a*) the incineration of 2000 t of waste oils currently exported out of Shetland each year
(*b*) heat pumps that access the heat given off by industrial processes including refrigeration. Large-scale heat pumps are used in Sweden to provide hot water at 80°C by abstracting heat from the Baltic Sea at only 2·5°C (Friotherm, 2005). These could be combined with CHP (combined heat and power) systems.

Despite the many problems encountered, the scheme has thrived. The popularity and reliability of the scheme is beyond question. There are still large areas of Lerwick not served by the scheme. Residents of these areas are lobbying for the scheme to be expanded. The long-term aim is eventually to serve all of Lerwick, making it the 'greenest' town in Britain.

Details of the scheme including brochures and a map can be found on the website www.sheap-ltd.com under Applications.

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