District Heating as an Enabling Technology for Biomass in the Western Region

A Report on District Heating as an Enabling Technology for Biomass in Public Sector Buildings and the Wider Community in the Western Region

September 2012
What is Biomass?

Biomass is the biodegradable fraction of products, wastes and residues of biological origin from agriculture (including vegetable and animal substances), forestry and related industries, including fisheries and aquaculture, as well as the biodegradable fraction from industrial and municipal wastes.

Biomass includes a broad variety of raw materials such as wood, agricultural crops, by-products of wood processing, agricultural and forestry industry products, manure and the organic fraction of waste streams.

Forestry and wood-based industries provide a wider range of different fuels including logs, bark, chips, sawdust and pellets. Biodegradable waste covers the organic fraction of municipal solid waste, wood waste, refuse derived fuels, sewage sludge, etc. Agriculture can provide dedicated energy crops as well as by-products in the form of animal manure and straw. Land can be used for growing conventional crops such as rape, wheat, maize etc. for energy purposes, or for cultivating new types of crops such as willow, miscanthus and others.

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What is RASLRES?

RASLRES (Regional Approaches to Stimulating Renewable Energy Solutions) is an EU bioenergy project led by the WDC and funded under the Northern Periphery Programme of INTERREG IVB. The total project budget is €2.8 million over three years. Commencing in September 2009, RASLRES aims to increase the uptake of locally produced bioenergy solutions through the development and implementation of market development models. The project focus is on pilot actions in regard to wood energy, energy crops and marine biomass fuels.

RASLRES is an international partnership which includes:

- Western Development Commission – Ireland
- Action Renewables – Northern Ireland, UK
- Environmental Research Institute, North Highland College – Scotland
- Municipality of Norsjö – Sweden

In the Western Region RASLRES supports the growth of the wood energy sector by delivering practical services to market players and by informing policy development. During 2010 and 2011 RASLRES delivered a range of actions with a focus on selected pilot projects. The project aims to:

- build sustainable local loops of wood fuel supply and demand via new (or existing) wood fueled boilers
- offer best practice approaches to support industry development
- help build critical mass and scale in the wood energy sector of the region
- support investment plans and help secure project finance

RASLRES adopts a full supply chain approach - looking at the energy chain from supply (i.e. fuel producers / processors) to demand (i.e. energy users). The services to the wood energy sector include:

- provision of a range of impartial technical and business advisory support services to selected clients progressing wood energy projects in the region
- generation of market information and intelligence to support the sector e.g. resource forecasting from private sector forestry, assessment of energy crop potential, technical and business case studies
- accessing of international expertise and facilitation of networking with EU markets

Disclaimer: All reasonable measures have been taken to ensure the quality, reliability, and accuracy of the information in this report. This report is intended to provide information and general guidance only. If you are seeking advice on any matters relating to information on this report, you should contact the WDC with your specific query or seek advice from a qualified professional expert.
District Heating (DH) has been successfully used in parts of Europe and the United States for over 100 years and is recognised as an effective means of providing heat to areas with high building density. The heat from a central boiler, or a combined heat and power (CHP) plant, is distributed in the form of hot water through a network of buried pipes to domestic users and often also to communal and commercial buildings.

Renewable energy sources, such as biomass or geothermal plants are commonly exploited by using District Heating for a number of reasons, including:

- The scale that community heat distribution offers
- Decoupling of the heat supply from the fuel - the network delivers hot water leaving flexibility to switch between fuels at centralised boiler(s)
- Policies encouraging energy efficiency and renewable fuels

SEAI commissioned a review of District Heating opportunities in Ireland in 2002[1]. The stark conclusion was that only large CHP (combined heat and power) installations could prove a cost-effective method of supplying District Heating, and that there were many barriers to implementation. The energy policy landscape has changed significantly - energy prices and energy security concerns are much different to 2002, and more aggressive carbon reduction and renewable energy targets are in place in Ireland and other countries. However many of the barriers remain unsolved and to-date District Heating is not in common use in Ireland.

District Heating (DH) is recognised as an effective means of heating areas with high building density. In particular, centralised DH allows flexibility and enables implementation of projects at scale, such as biomass heating or combined heat and power (CHP).

To date in Ireland uptake of DH has been poor, and despite the advantages offered, there are many barriers to implementation. DH infrastructure is expensive and requires long-term financing. There are a number of commercial challenges to operating a DH, such as the novel systems and billing methods required to ensure payment for DH, particularly in social housing projects.

This document outlines the issues for the development of DH in Ireland and uses three case studies of existing DH schemes to highlight the benefits. It also provides case studies of two potential schemes in the Western Region.

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[1] SEAI 2002; Assessment of the Barriers and Opportunities Facing the Deployment of District Heating in Ireland; WS Atkins on behalf of Sustainable Energy Ireland, Dublin.
As part of RASLRES two towns were assessed at outline level by the support services team - Belmullet and Carrick on Shannon. Some details about the economic or technical challenges are highlighted by the case studies of these towns.

Belmullet has a low building density, but a high reliance on LPG. Following background work by RASLRES an application for funding has been made by the Mayo Energy Agency to carry out energy audits on the larger users and carry out a cost-benefit assessment of DH in Belmullet.

Carrick on Shannon provides a useful insight into the different possible approaches to delivering DH to a town – from a remote site or from a central site. The practical benefits from a cluster-based incremental development are also outlined but there are disadvantages to this approach. In particular the smaller users miss out on the public service aspect of DH if the system is planned solely around the quickest payback and the largest energy users.

There is significant potential for DH development in Ireland. This report provides some brief learnings from a variety of case studies. Significantly more work and stimulus would be required to develop a viable DH sector in Ireland.
In order to highlight some of the benefits but also the challenges associated with the development of DH in Ireland three case studies are described here, each highlighting a different aspect of DH development.

2.1 Callan-Nexus District Heating project in Rural Ireland

Callan is a small town just south of Kilkenny with about 1,700 residents. It is typical of rural Ireland, in that there is no natural gas, and heating is predominantly met by traditional solid fuel fireplaces/stoves or by oil-fired central heating. An extensive feasibility on implementing a DH scheme in Callan was carried out in 2009\(^2\) on behalf of CRESCO, a local community-owned renewable energy company.

There is a small District Heating network in place in Callan operated by CRESCO, where a 220kW wood chip biomass boiler serves a number of buildings within a 75m radius. These include a crèche, an arts centre, a friary and 4 small residences. Some other community buildings are already being heated by biomass including the Workhouse which is at the opposite end of town and is heated by a 150kW wood pellet boiler.

To carry out the assessment the town was divided into zones based on activity and an outline design and cost for a wider District Heating network established. Up to 45 potential non-residential customers were identified for a DH network. These comprise mainly educational, religious and commercial premises. There are approximately 800 further residential and smaller commercial buildings.

The whole project would entail a €7.5m investment to meet a peak load of ~ 7MW and require installation of about 5,000m of DH piping. Financial analysis showed a poor return on capital, so a focus was taken on specific areas where a biomass DH could be viable based on reduced chipping costs. Only the original 220kW DH scheme was installed and the project has not progressed further.

A number of learnings have been made during the installation of the existing DH scheme, including:

- Overall the system has worked very well.
- The benefits that could have been achieved using a turnkey contractor and/or a consulting engineer are apparent. Errors occurred where different plumbers’ lines of responsibility crossed, this led to:
  - Extra costs of additional commissioning time and control equipment
  - Design flaws that will diminish the performance of the system and lead to maintenance headaches over the longer term
- Access restrictions means tractor/trailer cannot deliver fuel directly to the boiler and an intermediate smaller delivery vehicle is being used
- Calibration of meters is critical, this took some time to resolve, but eventually lead to improved energy monitoring and savings.
- Individual metering costs and access restrictions (for reading) led to a decision for some residences not to have separate metering. In this case the residences are all owned by the same entity, but where cost allocation is critical metering should be better planned for.

### 2.2 Tralee Town Council District Heating Scheme

A new District Heating network was built as part of the Mitchel’s / Boherbee regeneration project. The decision to use DH in the project came about in response to the high energy costs experienced by businesses in Tralee, especially in manufacturing. The closure of some businesses has been attributed to high energy costs. The regeneration project forms part of an overall strategy to make Tralee an energy-efficient and self-sustaining region.

The project was planned over a number of phases, with the initial phase involving refurbishment of 42 social housing units (built in 1935) and their connection to the new DH network.

Completed at the end of 2011 the District Heating system comprises two 500 kW Hertz wood chip boilers each with an auger feed system from the fuel store. The boilers are linked to two 5,000 litre thermal store buffer tanks. District heat pipes are connected from the plant room to each block of apartments. By the end of 2011 the 1MW District Heating network had been extended to serve in total 100 residential units, a convent day-care centre, a county library, and a primary school.

Heat meters measure the amount of hot water and heat used in kWhs in each apartment enabling Tralee Town Council to bill the tenants. The average annual saving is estimated at 0.5 tonnes of CO₂ or in monetary terms €200 per two-bed apartment. It is too early as yet to ascertain long-term user satisfaction or reveal any maintenance issues that may emerge over the long-run.
The next phase is to expand and create a sustainable energy community through energy efficiency measures and the provision of a heating system to provide a 15MW combined heat and power plant, associated district heat pipe network fuelled by locally produced biomass. Under phase two the centralized heat system will supply heat to over a third of Tralee (population 23,000) and is intended to connect the following facilities:

- 2,000 houses
- Kerry General Hospital / Health Board head office
- Dairy processing unit
- County Buildings / Clash Industrial Estate
- Hotels / Sports Complex / Aquadome
- Primary & Secondary Schools, ITT South Campus

*Figure 2: New Social Housing Units in Boherbee*

*Figure 3: Heat meter at Tralee DH consumer*
An innovative aspect of the scheme was the implementation of a “Pay as you save” scheme, which essentially is a prepayment card system, with the following benefits:

- It addresses the issue of fuel poverty
- It allows control over household budget
- No bulk purchase of fuel is required
- It acts as an energy awareness tool
- Hot water and heating are available on demand
- It provides increased comfort level at reduced cost

A number of learnings can be taken from this case study, including:

- The initial system was sized based on future demand and continues to operate at moderate efficiency until a critical load is connected.
- The council provided the majority of customer base and anchor load, so the issue of private user engagement has not so far arisen.
- The project is designed as part of an overall energy efficiency programme, ensuring that the DH is installed in reasonably insulated homes and buildings.
- New systems and billing methods are required to ensure payment for DH, particularly in social housing projects. The long term success (or otherwise) of the “Pay as you save” scheme in Tralee could present key learnings for the further development of DH in Ireland.

### 2.3 Case Study from Samsoe, Denmark

Samsoe is a Danish island of 114 km² with a population of just 4,300. The island inhabitants embarked on a 10-year plan in 1997 to become energy self-sufficient. This goal has been achieved, mainly through biomass District Heating and the development of wind resources.

Three biomass District Heating networks have been established, mainly based around the use of straw as the predominant local biomass source. Over the 10-years (1997-2007) DH penetration went from 25% to 43%. In addition to this system many individuals and businesses also switched to biomass heating. Wood pellet use grew from zero to 21 TJ.

The island was previously known for agriculture and tourism, but now also has a reputation for renewable energy. A key benefit of community heating was the large employment generated during the project development. There are now skilled craftpersons in DH design and installation in Samsoe. The procurement of biomass has also become an income support for local farmers.

![Figure 4: Samsoe Island Energy Masterplan Diagram]
Key learnings could be summarised as follows:

- Ownership and financial structure of each of the 3 biomass plants is different. This was not planned but just happened that way. One is owned by a large utility, another by a private contractor and the last by the actual energy consumers within the community and all continue to deliver DH to the community.
- Planning legislation in Denmark allows for centralised District Heating as consumers within designated zones are obliged to connect to the DH supply. This removes a very large risk from the project development.
- A strong community initiative and very active public engagement played a large part in the project success
- A supportive national policy environment enabled the project
- The heating energy consumption increased by 10% over the 10-year period, despite energy saving campaigns being run. This is a common problem in conservation and energy economics, and can possibly be attributed to the rebound effect. This refers to a behavioural response to the introduction of new technologies that increase the efficiency of resource use. These responses tend to diminish or offset the beneficial effects of the new technology.

2.4 Other projects in Ireland

There are a number of other DH projects in Ireland including:

- The development of a mixed commercial and residential DH scheme run on biomass at Elm park in South Dublin
- The installation of a 1MW wood pellet boiler at Leinster House to supply the local DH scheme in Dáil Éireann with up to 20% of heat supply from renewable sources
- The implementation of individual apartment heat metering solution from centralised gas CHP engine and boilers at Charlotte quay in Dublin

While there are many lessons to be learnt from the implementation of these systems, they are in metropolitan Dublin. They are all connected to the natural gas network and use gas for some or all of the fuel input. As case studies they are of less relevance to the West of Ireland or other rural regions.
Some of the practical barriers to DH are reviewed here. The two potential schemes reviewed under the RASLRES project (Belmullet and Carrick) are summarised first and then a short discussion of some of the key barriers, namely financing and securing a critical heat load.

### 3.1 Example of Belmullet

#### Background

Mayo County Council was one of the pilot clients of RASLRES, and a number of council buildings were assessed for suitability to switch to renewable biomass heating. This included the public service centre (PSC) in Belmullet.

Although the load in the PSC is small, for a number of reasons the County Council is interested in community energy and potentially biomass District Heating.

These include:

- The remote location of Belmullet to supply mainstream retail energy sources (oil/coal/gas/lpg)
- The high prevalence of LPG in the area
- The County Mayo renewable energy strategy\(^4\) (2011) sets a statutory planning basis for supporting RE in the region
- There is a strong community aspect in Mayo RE strategy through e.g.
  - Community ownership
  - Community benefit contributions
  - Employment & local investment
  - Reduction in fuel/energy costs and alleviation of fuel poverty
- There are significant forest resources available in the region which could be used
- There are already several successful working examples of biomass heating in Mayo

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\(^1\) 2011, RASLRES, Report on Wood Energy Options for Public Sector Buildings in Mayo

Main Energy Users

Figure 5: LPG Deliveries at Broadhaven Bay Hotel

Key energy users identified in Belmullet include:

- Community Hospital (HSE – West)
- Údarás industrial estates (The largest user in the estate is Mayo Mats Ltd which uses Oil for heating)
- Broadhaven Bay Hotel & Leisure
- Talbot Hotel
- Our Lady’s Secondary School
- St Brendan’s College
- Social Housing, Seaside 44 units (many bought out)
- Social housing Atlantic view 22 units (mainly on solid fuel) less have been bought out
- Planned 20 unit residential development by Irish Wheelchair Assoc

Other buildings of interest include the Public Service Centre, the Eurospar, and the Social Welfare Office.

Previous analysis by Bord Gáis Networks has forecast the potential gas consumption in Belmullet, based on standard industry take-up assumptions.

Table 1: 2006 Bord Gáis Networks Energy Projections Belmullet

<table>
<thead>
<tr>
<th>Customer Type</th>
<th>Projected annual consumption (MWh/year) by year 8</th>
<th>Peak day load (kWh/day) by year 8</th>
<th>Peak load author estimate (kW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial/Commercial</td>
<td>6,221</td>
<td>35,752</td>
<td>3000</td>
</tr>
<tr>
<td>New housing</td>
<td>3,048</td>
<td></td>
<td>1500</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td><strong>9,269</strong></td>
<td></td>
<td><strong>4,500</strong></td>
</tr>
</tbody>
</table>

Note: Assumes not all users connected. Ignores all existing housing. Peak load estimates not valid for design purpose. 50% capacity factor used for peak load (i.e. 12 out of 24 hours at full load equivalent).
Outline Solution

Approximately 2.2 km of trunk main would be required to connect the largest energy users via a route along Church Road. The estimated cost of this heat network would be €550,000 excluding secondary lines, spurs and connections. It also excludes the biomass boiler costs.

To incentivise connections to DH a cost saving over the competing fuel, usually LPG and oil, is required. To compete with oil, delivered heat cost should not exceed €80/MWh based on current prices. At present the delivered cost of heat from oil and LPG are €89/MWh and €104/MWh respectively for commercial customers. Using the BGN I/C estimates as a baseline, the potential revenue from a DH is about €500,000/year.

Key challenges faced in developing DH in Belmullet include:

- The low population density – there are about 600 homes only in Belmullet
- New build is likely to be extremely limited in the short to medium term

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5  2012, SEAI. Commercial Fuel Cost Comparison July 2012
The modest size of industrial & commercial loads reduces the potential for a short payback on DH investment.

An initial commitment to and takeup of a scheme over a reasonable period would be required from the largest energy consumers in Belmullet to merit investment (see Bord Gáis assumptions on gas take-up).

Compulsory connection or written undertakings to connect would be required from a high number of end users to progress with a DH scheme.

Measures are being proposed to progress the DH concept in Belmullet. The main aim is to carry out energy audits of the six largest energy consumers and at the same time engage intensively with the local business community to properly consider the merits of a DH scheme for the community.

3.2 Example of Carrick-on-Shannon

Background

Leitrim County Council was one of the pilot project clients of RASLRES. An appraisal was carried out during 2011 of the Aras an Chontae and surrounding buildings in the Dock Area with a view to servicing them from a central District Heating biomass boiler. This initial analysis showed that, including costs for connection of each building, only the Aras and the Dock building have high enough consumption to provide an attractive payback from switching to biomass, 6 and 5 years respectively.

The Council is presently interested in engaging with energy users in the wider community with a view to establishing the viability and potential scale of a DH scheme in Carrick on Shannon.

Main Energy Users

Based on previous Gaslink analysis, there is one large contract consumer in Carrick. There are also 9 large, 47 medium and 213 small I/C loads in the town, as categorized by Gaslink. The contract customer is Masonite, which is at some remove from the town (9km along the N4). Masonite is a biomass processor, so the concept of a biomass boiler and even a CHP plant at Masonite supplying heat to Carrick is of interest.

A preliminary list of large energy users in Carrick was prepared by RASLRES and Leitrim County Council. Some more detailed drawings and spreadsheets were prepared organising energy users into clusters. There are four main zones to consider, and estimations of these zones and energy consumptions are given below.

Table 2: Potential DH Clusters in Carrick Energy profile

<table>
<thead>
<tr>
<th>Potential DH Cluster</th>
<th>MWh/yr heat used</th>
<th>kW load estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dock area cluster</td>
<td>723</td>
<td>615</td>
</tr>
<tr>
<td>Town hotels cluster</td>
<td>5,006</td>
<td>1,921</td>
</tr>
<tr>
<td>Schools cluster</td>
<td>2,853</td>
<td>1,804</td>
</tr>
<tr>
<td>Retail/Office/IDA Cluster</td>
<td>2,214</td>
<td>1,134</td>
</tr>
<tr>
<td><strong>Subtotals</strong></td>
<td><strong>10,796</strong></td>
<td><strong>5,473</strong></td>
</tr>
</tbody>
</table>

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6 2012, RASLRES; Report on Wood Energy Options for Public Sector Buildings in Leitrim

7 2010, Gaslink; New Towns Phase III; [www.gaslink.ie](http://www.gaslink.ie)
Outline Solution

The combined load is approximately 6 MW. There are a number of scenarios for development of the system.

Town DH network

This option involves installing the infrastructure required to service the largest energy users in Carrick. It is based on a provisional location adjacent to the Aura leisure centre and other large users nearby. This is the optimum solution to allow DH to be delivered as a public service through the main parts of Carrick.

Some provisional cost estimates for DH pipe infrastructure have been set out below. The overall cost of the piping would be about €500,000. This excludes heat generator costs and also excludes customer end connection and investments. Boiler capacity of ~6MW would need to be installed.

This analysis has shown that the town hotel cluster is likely to be the cluster with the highest utilisation rates of DH piping, delivering approximately 8.3 MWh/year per m of installed network.

Table 3: DH piping and Cost Estimates per Cluster

<table>
<thead>
<tr>
<th>Potential Cluster</th>
<th>MWh/yr</th>
<th>kW</th>
<th>m pipe</th>
<th>MWh/m</th>
<th>€ DH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dock area cluster</td>
<td>723</td>
<td>615</td>
<td>217</td>
<td>3.3</td>
<td>21,560</td>
</tr>
<tr>
<td>Town hotels cluster</td>
<td>5,006</td>
<td>1,921</td>
<td>602</td>
<td>8.3</td>
<td>226,450</td>
</tr>
<tr>
<td>Schools cluster</td>
<td>2,853</td>
<td>1,804</td>
<td>368</td>
<td>7.8</td>
<td>90,805</td>
</tr>
<tr>
<td>Retail/Office/IDA Cluster</td>
<td>2,214</td>
<td>1,134</td>
<td>803</td>
<td>2.8</td>
<td>135,165</td>
</tr>
<tr>
<td><strong>Subtotals</strong></td>
<td>10,796</td>
<td>5,473</td>
<td>1990</td>
<td>5.4</td>
<td>473,980</td>
</tr>
</tbody>
</table>

Cluster-based development

This approach differs from the town-wide approach in that not all of the heat capacity is installed at once. This would entail initially servicing anchor loads within the identified clusters, which is the most pragmatic approach where capital or other constraints prevent implementing DH on a wide scale.

The main advantage of this approach is that the capital cost is incurred on incremental basis. It is also easier to target anchor loads and obtain their commitment to participate. It can also ultimately reduce DH pipe sizes required and associated costs, as the heat is distributed on a more local basis.

The obvious disadvantage to this approach is that by beginning with the ad hoc addition of boilers, it becomes very difficult to centralise the DH service later. The economies of scale of operating a central unit are not available. The smaller disperse units will incur higher maintenance, fuel and admin costs.

If the network is broken up into smaller projects, it also becomes quite difficult to finance as a utility package. From a public service point of view, the smaller clusters in the town without anchor loads would be deemed unviable as DH not cross supported by the larger clusters with an anchor load.

Masonite option – Remote heat supply

To deliver 6MW of heat from an external plant at a single source 9km distant would require a new transmission line (DN200 insulated steel piping) providing MPHW at 120C. This would have to be stepped down to LPHW (~90C) for local distribution.

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8 Logstor calculator. Flow=120;Rtm=85;P_{ave}=3.4bar;v_{ave}=3.5m/s;P_{ave} criteria 150 Pa/m
9 Medium Pressure Hot Water – at 120C used for distribution over longer distances
10 Low Pressure Hot Water – at 90C used for local heat distribution
11 These calculations are for feasibility only and do not reflect best design practice
The additional cost of this transmission line would be approximately €330/m or ~ €3m. Local main lines and distribution line costs are not included in this. The cost-benefit of such an investment has not been quantified as yet and would depend entirely on the energy cost advantages of the site. In this case preliminary assessment indicates that this approach is not financially viable.

A disadvantage of this approach is that the 9,000m pipe run would also entail additional system losses of up to 360kW (at 40W/m) which must be weighed against the efficiency gains in comparison with more local heat supply.

A further disadvantage is the large piping required for remote heat delivery. A biomass system located close to the larger users would mean that maximum ~ 2,600kW would need to be distributed from the central plant in radial piping rather than having to serve the whole DH network via a single 9km line.

Advantages for Masonite scenario are:

- Already have a large biomass heating plant which would make up a significant part of the overall investment cost.
- Economies of scale possible (in boiler efficiency, maintenance and fuel costs)
- Logistics and transport issues already resolved
- Possibility of combined heat and power or other technologies become technically possible due to scale of operation and space available at the rural location

### 3.3 Financing DH Projects

As in many infrastructure projects, capital is a key barrier to roll out of technology. This is particularly the case for DH where high cost piping is required to deliver a relatively low cost heat product. This barrier can be diminished through the use of long-term financing mechanisms and non-conventional energy procurement models.

The Callan study identified four ownership models for a DH network:

- Full public control by the local authority,
- Full private control,
- Mixed ownership and management – public and private
- Not-for-profit community-owned cooperatives.

Regardless of ownership of the DH assets, it is possible to enter into an agreement with an ESCO (Energy Supply Company) who can potentially provide upfront capital in return for a typical 10 to 15 year energy supply agreement. This ESCO can install and operate just the energy plant or can also finance and install the DH piping.

There can be a philosophical discussion over what society considers is public infrastructure within an energy supply network. For the purposes of this analysis public infrastructure in a DH network is the heat distribution piping. It excludes the energy supply plant and also the customer interface.

In other countries it would be quite unusual for the ESCO to own heat distribution pipes which are regarded as public utility infrastructure, but it is reasonably common for the ESCO to finance the heating plant. The RASLRES project has drafted a model ESCO contracts suitable for biomass applications. These are currently in consultation with industry stakeholders, but provide a workable model for financing biomass plant without upfront capital from the consumer.

The public infrastructure component can be more difficult to finance and is often financed by soft loans to the entity installing the DH infrastructure. The most common way to fund the public infrastructure across Europe has been through direct public spending by a local authority or publicly owned utility. This allows for capital recovery over a longer time horizon than typically associated with private sector investments.
3.4 Critical Mass Heat Load

There is a major challenge to get a critical mass of customers from established residences. This is particularly relevant due to the dramatic slowdown in new constructions in Ireland. The conversion to District Heating cannot be considered to be very attractive for an existing housing estate due to:

- Cost and disruption arising from road openings for pipe installations;
- Cost of piping to an existing house – €3,000; cost is only 10% of this for a new housing estate;
- Low uptake from an existing estate – rely on renovations, ownership changes or other infrequent occurrences.
- Long period for implementation, but capital spend is upfront.

If connections of existing residences are only realized over the long-term, they are generally discounted for financial modeling (Bord Gáis Networks take this approach for gas connection cost-benefit assessment).

This places a priority on new developments and on large commercial/industrial “anchor” loads to provide the impetus for DH networks. A UK study\(^\text{12}\) suggests a density of > 55 dwellings/ha for DH to be viable. Austrian experience has suggested a minimum energy utilization benchmark of 1200 kWh/m of network installed for viable heat distribution. However these benchmarks reflect Austrian energy policies and prices and the viability threshold is likely to be higher in Ireland. In the example in Tralee and others in Ireland and the UK, social housing development has provided the stimulus to develop DH networks.

The Bord Gáis networks appraisal\(^\text{13}\) provide a useful insight into the likely uptake of new energy sources in a town. This is clearly linked to the price and competitiveness of natural gas versus alternatives.

Customers are categorized into the following groups and assigned an estimated take up rate for connecting to the gas network.

<table>
<thead>
<tr>
<th>Customer Category</th>
<th>Gas use MWh/year</th>
<th>Uptake rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contract customers</td>
<td>&gt; 4,395</td>
<td>80% signed up in 3 years</td>
</tr>
<tr>
<td>Large I/C</td>
<td>&gt; 1,172 &amp; &lt; 4,395</td>
<td>80% signed up in 3 years</td>
</tr>
<tr>
<td>Medium I/C</td>
<td>&gt; 200 &amp; &lt; 1,172</td>
<td>50% signed up in 5 years</td>
</tr>
<tr>
<td>Small I/C</td>
<td>&lt; 200</td>
<td>25% signed up in 7 years</td>
</tr>
<tr>
<td>Domestic</td>
<td>average 15 MWh</td>
<td>Established estates, minimal take-up. New build 100% take up.</td>
</tr>
</tbody>
</table>

These take-up levels contrast markedly with the high level of connections for District Heating in Scandinavia. Planning legislation in Scandinavia specifies heating types appropriate for particular regions and customers are obliged to almost unanimously sign up to a local District Heating network.


\(^\text{13}\) Bord Gáis Networks 2006; New Towns Analysis Phase 1
3.5 Moderate Climate

Contrary to popular opinion, the Irish temperate climate is relatively benign. Ireland experiences milder winters than many European countries. This is certainly a factor when considering the economics of District Heating infrastructure and raises the critical customer density and heat load required to make a scheme viable.

For reference a comparison of the heating requirements (measured in standard degree days to 15.5°C) in both Copenhagen and Dublin is given over the years 2009 to 2012.

On average over the sample period of three heating seasons, the theoretical heating requirement would be 18% higher in Copenhagen than Dublin. In practice the differential will be lower, perhaps 10% as the degree day data does not account for minimum heating design temperature.

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14 Degree days are units used by engineers to estimate internal heating requirements. In Ireland for a typical building heat is required when external temperatures are below 15.5°C
15 Data for analysis downloaded from www.degreetdays.net
District Heating (DH) is recognised as an effective means of heating areas with high building density. In particular, centralised DH allows flexibility and enables implementation of projects at scale, such as biomass heating or combined heat and power (CHP).

To date in Ireland uptake of DH has been poor, and despite the advantages offered, there are many barriers to implementation.

As in many infrastructure projects, capital is a key barrier to roll out of technology. This is particularly the case for DH where high cost piping is required to deliver a relatively low cost heat product. This barrier can be diminished through the use of long-term financing mechanisms and non-conventional energy procurement models. The public infrastructure components (i.e. heat transmission pipes) can be more difficult to finance and are often financed by soft loans to the entity installing the DH infrastructure. The most common way to fund the public infrastructure part across Europe has been through direct public spending by a local authority or publicly owned utility. This allows for capital recovery over a longer time horizon than typically associated with private sector investments.

DH is very common in some northern European countries, but a key difference between these countries and Ireland is in the planning legislation as it relates to DH. In Denmark where DH is widely used, customers within DH zones are obliged to connect to the network, which removes the risk for the supplier in relation to the levels of customer uptake to make a scheme viable. In Ireland, a business appraisal of DH would typically ignore residential and small consumers who would not connect in sufficient numbers over a reasonable timeframe to support a business plan.

The shorter heating season and lower demand in Ireland in comparison with other European climates is a factor in the economic viability of District Heating. For example the annual heating requirement in Dublin is approximately 10% lower than in Copenhagen.

The importance of a steady anchor load cannot be overstated in terms of its positive role in economic and operational performance. Some systems are designed based on future load connections, but continue to operate at poor to moderate economic efficiency in the absence of a base load. The unpredictable take-up rate for domestic consumers places a greater emphasis on the large industrial/commercial loads.

To incentivise connections to DH a cost saving over the competing fuel, usually LPG and oil, is required. To compete with oil, delivered heat cost should not exceed €80/MWh based on current prices. At present the delivered cost of heat from oil and LPG are €89/MWh and €104/MWh respectively for commercial customers16.

New systems and billing methods are required to ensure payment for DH, particularly in social housing projects. The long term success (or otherwise) of the “Pay as you save” scheme in Tralee could present key learnings for the further development of DH in Ireland.

Carrick on Shannon provides a useful insight into the different possible approaches to delivering DH to a town – from a remote site or from a central site. The practical benefits from a cluster-based incremental development are also outlined but there are disadvantages to this approach. In particular the smaller users miss out on the public service aspect of DH if the system is planned solely around the quickest payback and the largest energy users.

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16  2012, SEAI. Commercial Fuel Cost Comparison July 2012