DISTRICT HEATING & HEAT NETWORK DESIGN
PRESENTATION BY KENNY BOYLE
REHAU WORLDWIDE
THINK GLOBALLY – ACT LOCALLY

6 CONTINENTS  174 LOCATIONS  OVER 17,000 EMPLOYEES
REHAU DIVISIONS
UNLIMITED POLYMER SOLUTIONS

Industry

Automotive

Building Solutions

FURNITURE, HOUSEHOLD APPLIANCES, HOSES AND INDUSTRIAL DEVELOPMENTS

EXTERIOR, WATER MANAGEMENT, AIR MANAGEMENT & SEALING

WINDOW AND CURTAIN WALLING TECHNOLOGY, BUILDING TECHNOLOGY, CIVIL ENGINEERING
District Heating

Definition

Hot water or steam is centrally produced

- Transported via an insulated pipe network
- Connected to individual properties via a heat interface unit
- Heat is metered
- Heat delivered via conventional heating systems
Large carbon savings possible

Economies of scale – increase efficiency

Ideal for technologies not feasible on individual properties (e.g. biomass / energy from waste)

Future proof – easy to change fuel source

Minimise maintenance using one central plant – no individual gas checks required
WHAT IS DISTRICT HEATING?

POTENTIAL BARRIERS

Lack of district heating (DH) experience in UK -> Higher cost to install as perceived as ‘higher risk’

Lack of awareness of DH and historically poorly conceived schemes

Community acceptance required – once installed, closed network, no possibility to switch provider

Control of tariffs for varying usage from end users
“Heat networks can be core to UK’s heat strategy and have potential to play critical role in helping buildings and industry decarbonise”

“Fuel sources for heat networks will need to change over time”

“Networks offer a solution to the problem of limited space in homes and buildings for low carbon technologies”
District heating network design

Heat source
Heat networks
Heat interface unit
BIOMASS

INTRODUCTION

Typically use wood chip or wood pellets for heating.

Most systems installed today are heat only.

Biomass CHP (gasification / pyrolysis) coming to market slowly.
Biomass district heating schemes work well because:

• **Biomass boilers are often bulkier** than traditional boilers, hence typically located in external plant room, not individual houses

• **Require regular wood chip or pellet deliveries** to only one central plant

• **Can be located discreetly on site extremes**

• **Qualifies for Renewable Heat Incentive**
<table>
<thead>
<tr>
<th>Tariff</th>
<th>Eligible Technology</th>
<th>Eligible Sizes</th>
<th>Tier</th>
<th>Tariff (p/kWhth) from 1.4.13</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small biomass</td>
<td>Solid biomass, incl. CHP</td>
<td>&lt; 200 kWth</td>
<td>Tier 1*</td>
<td>8.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Tier 2</td>
</tr>
<tr>
<td>Medium biomass</td>
<td></td>
<td>200-1,000 kWth</td>
<td>Tier 1*</td>
<td>5.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Tier 2</td>
</tr>
<tr>
<td>Large biomass</td>
<td></td>
<td>&gt; 1,000 kWth</td>
<td>N/A</td>
<td>1 (2 from July 2014)</td>
</tr>
<tr>
<td>Biomethane / biogas</td>
<td>Biomethane injection / biogas combustion (not</td>
<td>Biogas combustion &lt; 200 kWth</td>
<td>N/A</td>
<td>7.3</td>
</tr>
<tr>
<td>combustion</td>
<td>landfill)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Tier 1 applicable kWh = kW heat load x 1314

Source: OFGEM, April 2013
District heating network design

Heat source

Heat networks

Heat interface unit
PRE-INSULATED PIPEWORK
OPTIONS FOR PIPE MATERIALS

- Steel pipe with PU foam
  (closed cell - bonded)

- Polymer pipe with PU foam
  (closed cell - bonded)

- Polymer pipe with PEX foam
  (closed cell – non-bonded)
PRE-INSULATED PIPEWORK

STEELPIPES

Advantages:

- Strong material – resistant to impact damage
- Larger diameter sizes available
- Capable of withstanding higher flow temperatures / pressure

Disadvantages:

- Only straight lengths possible
- Joints required every 6-12m
- High installation costs
- Corrosion problems (therefore warning systems are required)
- Specialist welding required

\[ \lambda \approx 0.024 \text{ W/mK} \]
PRE-INSULATED PIPEWORK
TWO TYPES OF PIPE INSULATION – CLOSED CELL BONDED

Bonded insulation:

Advantages:
- Excellent thermal insulation
- No water ingress if outer jacket punctured
- No thermal expansion (self-compensating)
- More flexible compared to steel
- Long coil lengths possible (less joints)

Disadvantages:
- Less flexible compared to open cell

λ = 0.022 W/mK
**PRE-INSULATED PIPEWORK**

**TWO TYPES OF PIPE INSULATION – CLOSED CELL NON-BONDED**

Non-bonded insulation:

**Advantages:**
- Greater flexibility
- Simpler jointing / installation (foam easily removed)
- Ideal for confined spaces
- Long coil lengths possible (less joints)

**Disadvantages:**
- PU closed cell pipes have improved thermal insulation

\[ \lambda = 0.043 \text{ W/mK} \]
PRE-INSULATED PIPEWORK
HYBRID SYSTEM

Possible to combine steel & polymer for large DH schemes, called hybrid systems.

Benefits are:

- High temperature / volume steel mains (e.g. 150-300mm)
- Cost-effective to install flexible polymer house connections
- Can use polymer for smaller ‘spines’ off the mains
Leak detection systems warning systems are required

Steel pipes corrode over time, require additional polymer / galvanised coating

No leak detection required, therefore reduced costs

No corrosion in polymer pipes, no additional layers needed
PRE-INSULATED PIPEWORK
INSTALLATION

- Cover 600mm minimum 800mm with traffic loads
- 100mm of 0.8mm grade sand around the pipe
- Pipe positions:
  - Besides each other
  - On top of each other

Warning tape must be used!
PRE-INSULATED PIPEWORK
PE-Xa COMPRESSION SLEEVES

- Only two components: fitting and sleeve
- Ideal for below ground applications
- Can be used in all weather conditions
- Minimal bore reduction
- Totally secure, permanent fitting
PRE-INSULATED PIPEWORK
PIPE CONNECTIONS

Advantages of shroud system:

- High insulating properties
- No hot works -> improved health & safety
- Fast and simple installation
- Permanent and reliable connection
District heating network design

- Heat source
- Heat networks
- Heat interface unit
Indirect connections:

- Each house needs a heat interface unit (HIU) off the DH network
- Individual house metering monitors & control and then bills based on the amount of heat used
- ‘Smart metering’ – no site readings
- Typically operated by ESCOs (Energy Supply Companies)

Direct connections can also be used (no HIUs required) but each property is not isolated, therefore not normally preferred.
Heat meters are required for RHI compliance as the payments are based on eligible heat used, not heat generated.

MID Class 2 compliant is minimum standard.

2 types of systems:
- Complex (more than 1 meter)
- Simple (1 meter)

Further information on metering can be found on OFGEM website.
OPTIMISING HEAT NETWORK DESIGN

3 AREAS TO FOCUS ON

1) Reducing installation costs

2) Using a smaller pipe diameter

3) Increase the heat density / optimising diversity
REDUCING INSTALLATION COSTS
CONSIDER AT DESIGN STAGE

- Plastic pipes reduce the installation cost due to number of joints and time/cost of connections

- Backfilling costs can be reduced by installing in ‘soft-dig’ areas rather than roads

- Can twin pipe be used?

UNO pipe:
- No heat transfer between flow / return
- Higher cost doing 2 separate pipe runs

DUO pipe:
- Lower cost than 2 x UNO pipes
- But some (minimal) heat transfer between flow & return
Cross-linked polyethylene (PE-Xa) has the following benefits:

- Temperature resistant to +95°C
- High chemical resistance
- Oxygen barrier
- Simple jointing process
PRE-INSULATED PIPE
WRAS APPROVAL

WRAS approval is required by law for any pipes transporting potable water.

Some district heating schemes carry potable water for DHW.

The responsibility lies with the developer and installer on which products they use.
Most flow temperatures are ca. 80°C:

- Extends pipe lifespan
- Makes a safer network (no steam)

Ensure return temperature is as low as possible (high ΔT):

- Reduces pipe size - > reduce capital costs
- Ensures low-grade heat can be used (e.g. Waste heat from CHP)

<table>
<thead>
<tr>
<th>Flow / return temperatures (°C)</th>
<th>Heat load (kW)</th>
<th>Pipe size required</th>
</tr>
</thead>
<tbody>
<tr>
<td>82-71</td>
<td>450</td>
<td>110mm</td>
</tr>
<tr>
<td>80-60</td>
<td>450</td>
<td>90mm</td>
</tr>
<tr>
<td>80-50</td>
<td>450</td>
<td>75mm</td>
</tr>
</tbody>
</table>

Source: EST CE299 report
## USING SMALLER PIPE DIAMETERS

**IMPORTANCE OF OPTIMISING THE FLOW / RETURN TEMPERATURES**

<table>
<thead>
<tr>
<th>Flow / return temperatures (°C)</th>
<th>Pipe size (mm)</th>
<th>Heat losses RAUVITHERM</th>
<th>% heat loss saving</th>
</tr>
</thead>
<tbody>
<tr>
<td>82-71</td>
<td>110</td>
<td>35.2 kW</td>
<td>-</td>
</tr>
<tr>
<td>80-60</td>
<td>90</td>
<td>26.4 kW</td>
<td>25%</td>
</tr>
<tr>
<td>80-50</td>
<td>75</td>
<td>20.3 kW</td>
<td>43%</td>
</tr>
</tbody>
</table>

Increased delta T -> Reduced heat losses -> **operating costs savings**

**Assumptions:**
- 10°C soil temperature
- 1,300m pipe length
- 0.6m installation depth
- 2,400 operating hours
INCREASE THE HEAT DENSITY / OPTIMISE THE DIVERSITY

CIBSE FACTORS

- Some estimates say you need 50 dwellings per hectare (e.g. flats) for economic DH scheme

- But is possible for lower density, e.g. new build housing schemes

Diversity:

- Different buildings require varying diversity factors

- The diversity factor is the multiple of peak demand

- Consider zoning can optimise diversity
DIVERSITY OF HEAT NETWORKS

IMPACT OF DIVERSITY FACTOR

New building
Renovated old building
Old building

Diversity factor
Numbers of connections

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Typically a branch network (with a main distribution pipe) is used. However, a ring main offers some benefits for certain projects:

- Allows multiple heat sources (future connections)
- Flexibility of design
- Reliability
- Redundancy
Lochaber School, Fort William

- Remote energy centre using a 540kW wood pellet biomass boiler

- 400m of RAUTHERMEX, including 160mm UNO
HMP Grampian: Petershead, Scotland

- Originally a steel pipe specification
- Centralised biomass boiler
- Worked with consultant to optimise pipe size and reduce capital costs
- 2,200m of pipework (RAUTHERMEX 40-125mm)
- Large installation time & cost savings (compared to 12m steel lengths)
Sir Chris Hoy Velodrome, Glasgow

- Pipe installed below cycling track, built for 2014 Commonwealth Games

- Original specification was steel – RAUVITHERM chosen for flexibility

- Over 1,000m of pipework in total (25-63 DUO)
DISTRICT HEATING & HEAT NETWORKS

CASE STUDIES

- Link HA – Cornton Road

- West Highland Housing Association - Dunbeg

- Dundee City Council – Kirk Street

- Aberdeenshire Council – Stonehaven Care Village

- City of Edinburgh Council – Greendykes & Wauchope

- Places For People – Madelvic
Low energy windows / curtain walling

Ground-air heat exchanger

Underfloor heating/cooling

Ground-source probes/collectors

District heating pipework

Stormwater management

Outdoor de-icing