Reflections on building up heat networks

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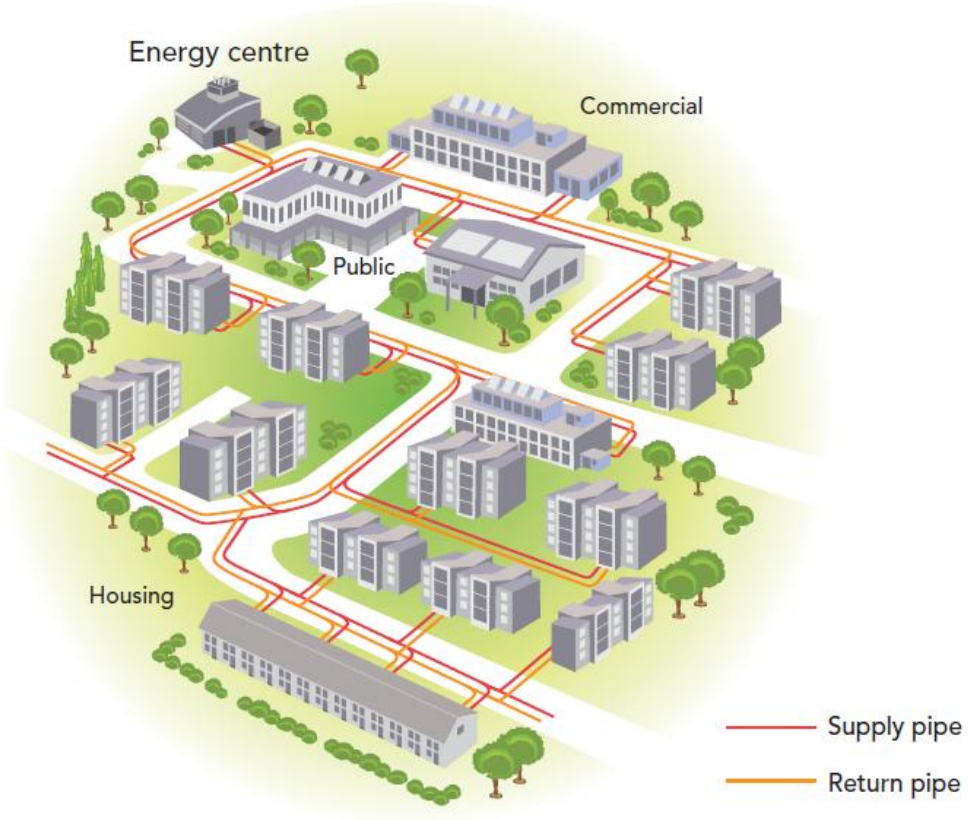
Part of the BRE Trust

What is district heating?



Benefits of district heating

- Environmental – carbon reduction
- Enhanced security of supply
- Affordable warmth
- Efficient use of heat sources (fossil fuel, biomass)
- More straightforward maintenance of heating plant
- Space savings at the building level
- Increased safety of the building occupiers
- Instantly available of any amount of hot water at system pressure

Where to start?

Strategic view; where do we want to get to? (high density diverse heat demands served with local surplus and renewable energy sources)

So-called ‘anchor loads’

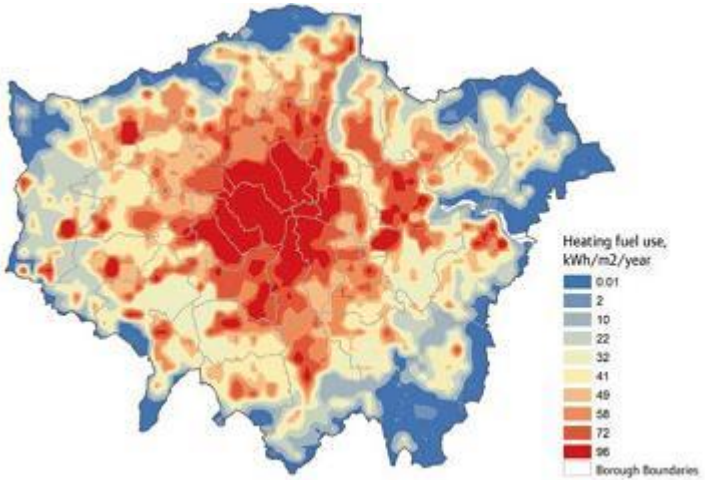
Local authority buildings

Buildings that are major consumers of heat

New build developments/regeneration where services can be installed simultaneously without and serve all buildings/dwellings in the development

But ultimately the true benefit of district heating is realised when a critical mass is reached and connections span different buildings sectors.

London Heat Map



Any building can be connected to a DH scheme,

- e.g. dwellings, commercial and institutional buildings, retail premises and industrial applications, etc

Gothenburg –

- 260 MW elec
- 300 MW heat

Power station in CHP mode

Seaton, Aberdeen –

- 1MW elect
- Circa 1.5MW heat

Dedicated CHP plant

What's the problem?

The true benefit of district heating is realised when a critical mass is reached and connections span different buildings sectors

District heating is major infrastructure – you are not just paying for the in-building system; much other infrastructure was paid from the public purse

Early connections may have difficulties with viability – small early phases may be better served from heat only boilers rather than very small boilers

What's the problem?

- Engineering aspects are different to gas central heating
  - low return temperatures are imperative
  - schemes should be variable flow
- Very peaky and overall low demand in highly energy efficient new-builds
- Pipe runs through communal areas must not be left un-insulated.

Any solutions?

Ensure sound engineering principles adhered to: designers and installers need to be familiar with the concepts of district heating

Look into modern techniques: twin pipe systems; low temperature supply; possibly HIUs with built-in thermal store

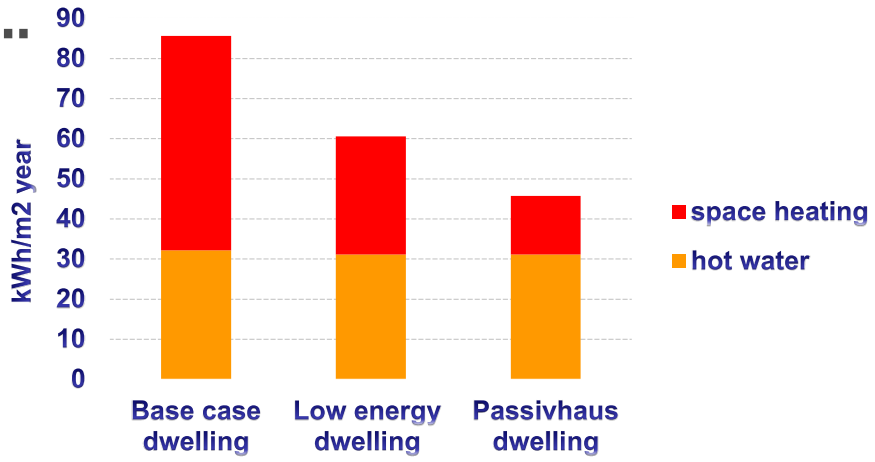
Are there possibilities for connecting to an existing district heating network?

Are there possibilities for cascading supply to new build residential?

Make use of available info: eg IEA-DHC publications at www.iea-dhc.org

And on heat demand density…

- High heat demand densities are typically found at the heart of town and cities, where the building density is highest
- High heat density can also occur in areas of regeneration, although the heat demand of new buildings is usually lower than similar existing buildings of equivalent type and size.



New buildings are generally more energy efficient than existing buildings. This trend will continue into the future due to the increasingly stringent energy efficiency requirements for new buildings.

However, the demand profile for new developments is seasonally smoother because hot water requirements dominate.

New techniques

Twin pipe DH pipe system

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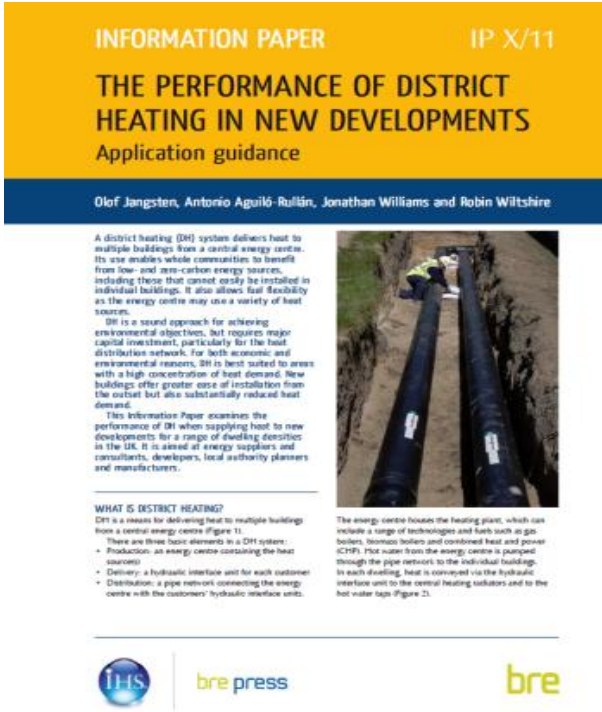
Higher performance systems exist that reduce the heat distribution losses relative to the use of single pipe systems, *e.g. twin pipes*

Research suggests heat distribution losses can be reduced by 20-37% in twin pipe systems relative to single pipe systems.



INFORMATION PAPER IP X/11

THE PERFORMANCE OF DISTRICT HEATING IN NEW DEVELOPMENTS

Application guidance

Olof Jangsten, Antonio Aguiló-Rullán, Jonathan Williams and Robin Wiltshire

A district heating (DH) system delivers heat to multiple buildings from a central energy centre. Its use enables whole communities to benefit from low- and zero-carbon energy sources, including those that cannot easily be installed in individual buildings. It also allows fuel flexibility as the energy centre may use a variety of heat sources.

DH is a sound approach for achieving environmental objectives, but requires major capital investment, particularly for the heat distribution network. For both economic and environmental reasons, DH is best suited to areas with a high concentration of heat demand. New buildings offer greater ease of installation from the outset but also substantially reduced heat demand.

This Information Paper examines the performance of DH when supplying heat to new developments for a range of dwelling densities in the UK. It is aimed at energy suppliers and consultants, developers, local authority planners and manufacturers.

WHAT IS DISTRICT HEATING?

DH is a means for delivering heat to multiple buildings from a central energy centre (Figure 1).

There are three basic elements in a DH system:

- Production: an energy centre containing the heat source(s)
- Delivery: a hydraulic interface unit for each customer
- Distribution: a pipe network connecting the energy centre with the customers' hydraulic interface units.

The energy centre houses the heating plant, which can include a range of technologies and fuels such as gas boilers, biomass boilers and combined heat and power (CHP). Hot water from the energy centre is pumped through the pipe network to the individual buildings. In each dwelling, heat is conveyed via the hydraulic interface unit to the central heating radiators and to the hot water taps (Figure 2).

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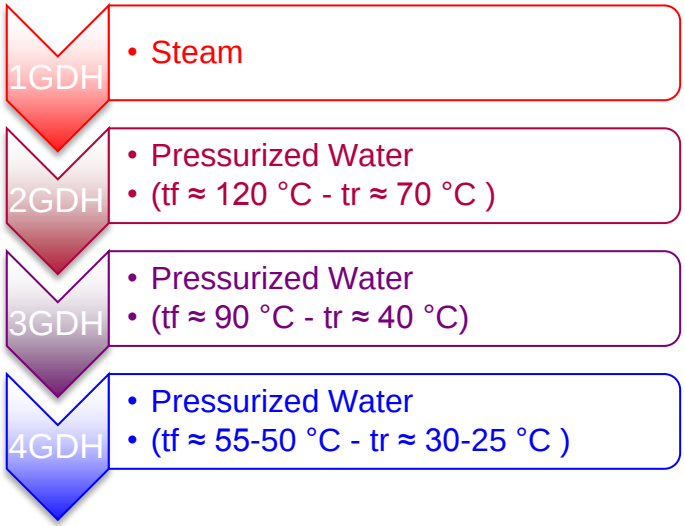
Towards 4th Generation District Heating (4GDH): Experiences with and Potential of Low Temperature District Heating

- Focus is on very low temperature (supply 50° – 55 ° C) systems
- Goal is to bring experience, knowledge and solutions for 4GDH to a level where they are ready for much wider implementation
- Assemble information and analyse lessons from early exemplar schemes, which are mostly high efficiency new-build
- Determine what the practicality is for extending to lowering the supply temperature of existing ‘conventional’ district heating systems
- Legionella issue will be addressed.

District heating development

– Heat carriers and operational temperatures used in DH have evolved:



Current Modern District Heating

- 3G (Conventional) District Heating already offers benefits from demand aggregation and use of residual heat
- Currently low temperature demand is met by relatively high temperature sources.
  - Heat required: ≈20° C
  - Heat supplied: ≈90° C
- It would be more efficient if low temperature demand could be met with low temperature supply.

Low temperature district heating

- 4GDH reduces difference between quality of the supply and demand
  - Heat required: ≈20° C
  - Heat supplied: ≈50 - 70° C
- Extends the scope for using:
  - Low grade surplus (residual) heat
  - Renewable energy sources
- Reduces cost of distribution
  - Heat loss reduced
  - Thermal stress reduced
  - Plastic pipe systems may be used.

Benefits of Low Temperature District Heating

- Extends the scope for locally available useful sources of **residual and renewable heat**
- Reduces heat losses
- Reduces thermal stress
- Reduces operational cost and possibly capital cost.

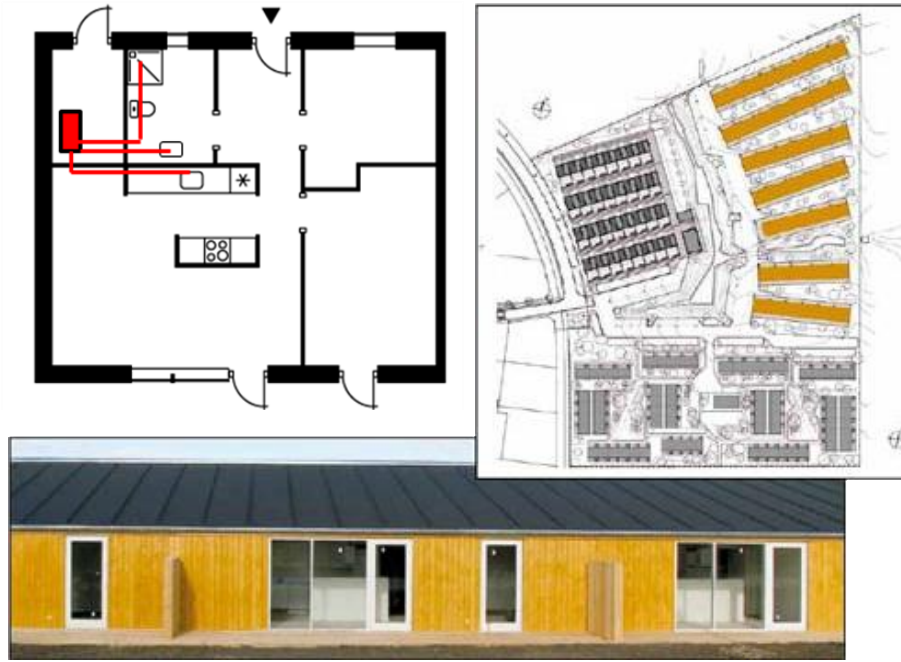
Low temperature district heating: potential future scenario

- Smart Thermal Grids
  - Multiple sources (renewable, residual heat from industry)
  - Virtually any building can be a source or storage of low grade heat
  - Bi-directional energy flows
  - Controls to integrate infrastructure, storage, multiple demand and multiple supply

- Integration with Smart Electric Grids
  - Enhances reliability and stability of power grids.

LTDH Experiences: Lystrup, Denmark

- Monitored throughout 2011
- 40 terraced single family houses
- Combination of radiators and under-floor heating
- 55° C supply, 25° C return
- DHW layout minimises volume of stored water and allows for separate pipes for each fixture.



LTDH Experiences: Lystrup, Denmark

- Heat loss reduction of 75% compared with conventional 80/40° C Danish systems
- Space heating consumption higher than expected: average internal temperature 2° C above design internal temperature
- Customers satisfied with performance of heating and DHW
- Return temperatures have been higher than expected – modification in heat exchanger design may be needed
- Small pipe lengths reduce volume of stored water to address Legionella risk.

LTDH Experiences: Kırşehir, Turkey

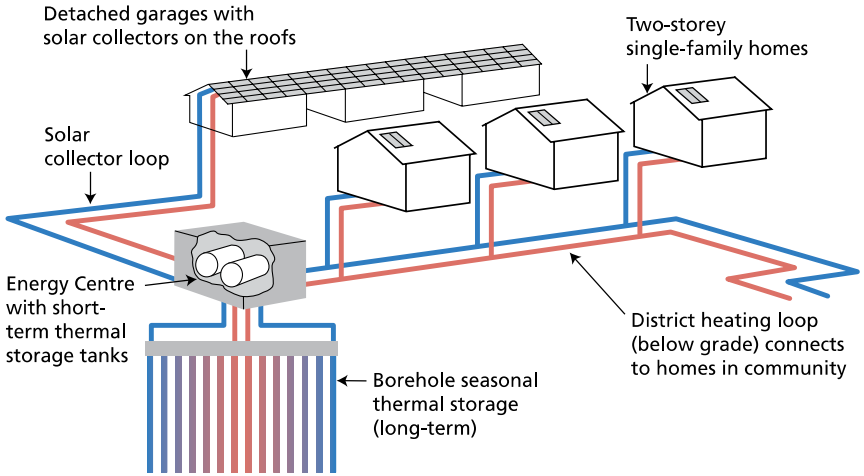
- Availability of geothermal heat at 57° C was the driver for this low temperature system
- It was estimated that this would be sufficient to satisfy the heating requirements of existing housing since the radiators were sufficiently over-dimensioned. Design temperature -12° C same as Denmark
- In operation since 1994 without customer complaint.

LTDH Experiences: Kırşehir, Turkey

- Kırşehir DH supplies heating and DHW to 1800 existing buildings
- Network has fibreglass-reinforced polyester and pre-insulated steel single pipes.

LTDH Experiences: Okotoks, Canada

- Solar thermal district heating project
- 52 detached energy efficient homes
- 90% of space heating demand is met by solar thermal.

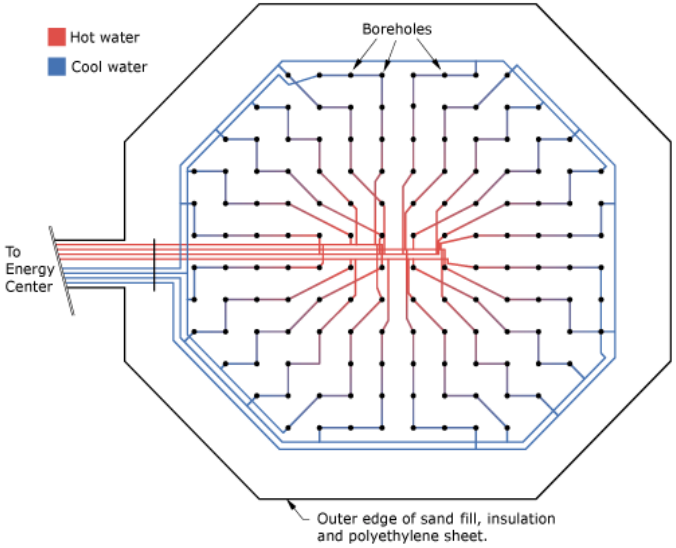


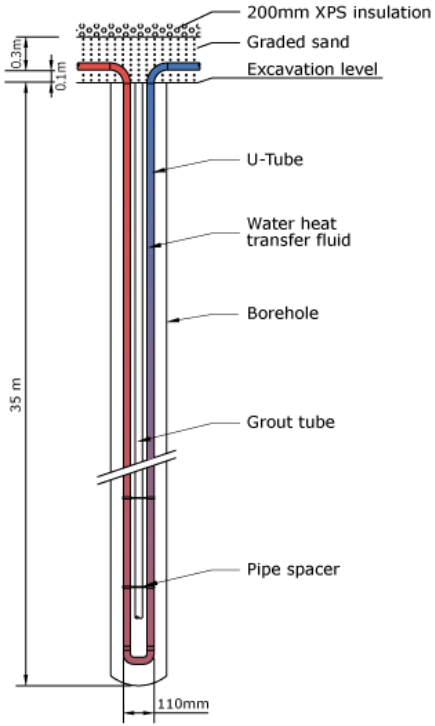
Low temperature, renewables based exemplar DH systems

- Scheme at Lystrup (Denmark) is connected to the **existing district heating** system
- Pilot schemes also include **solar thermal** scheme at Okotoks (Canada)
- and the ‘zero carbon’ development at Greenwatt Way in Slough (UK) using **biomass, heat pumps** and **solar thermal**
- However, there also examples where low temperature systems have been chosen historically due to a particular source supply temperature, eg Kysehir - **geothermal** and Heerlen - **minewater**
- Existing schemes, often over-engineered, may also benefit financially from reducing supply temperatures.

LTDH Experiences: Okotoks, Canada

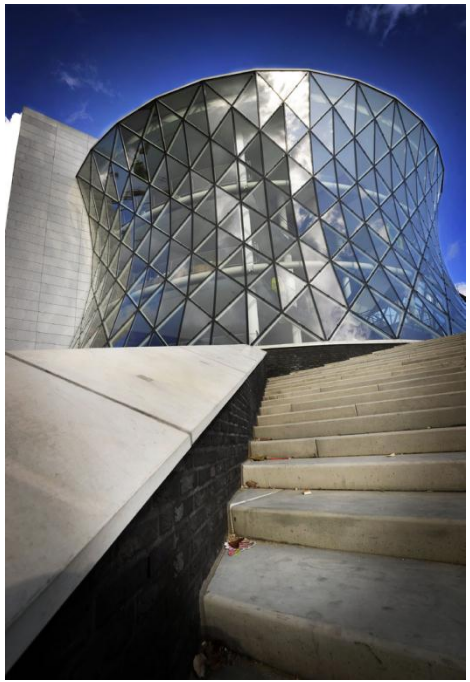
- 55° C supply, 32° C return
- Short-term and seasonal storage used
- Space heating with air-handling unit fed via DH network
- Solar thermal DHW provided by buildings installation.





LTDH Experiences: Heerlen Minewater DHC System

- low temperature district heating and high temperature district cooling
- principal source is water from disused mines then heat pumps
- 28° C from hot wells
- 18° C from cold wells
- common return re-injected at 24° C

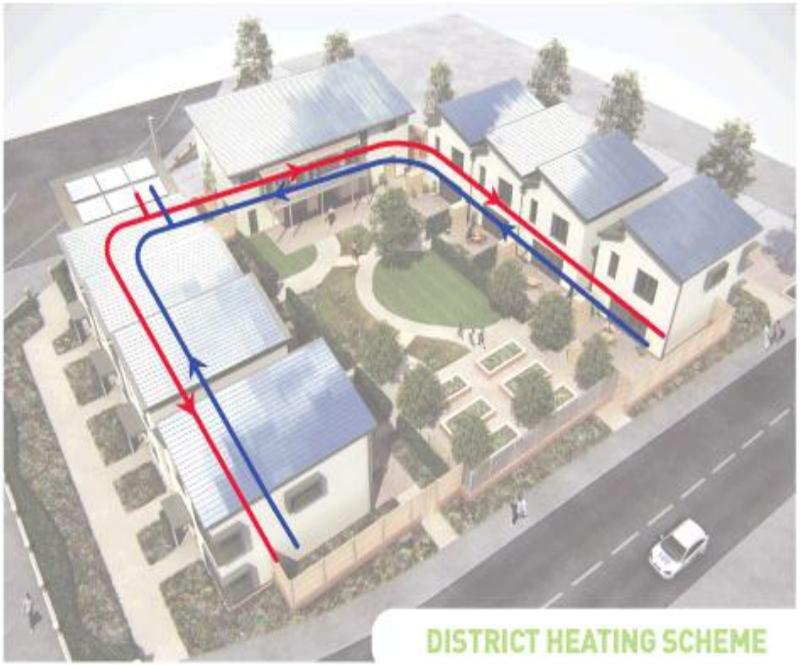


LTDH Experiences: Chalvey (Slough)

- Chalvey Zero Carbon Homes DH system is an experimental development that aims to demonstrate that Zero Carbon can be achieved with district heating
- supplied by biomass pellet boiler, ground source heat pump, air source heat pump, with some solar thermal
- Comprises 10 homes built to very high level of energy efficiency
- Operating supply temperature of 50 ° – 55 ° C.

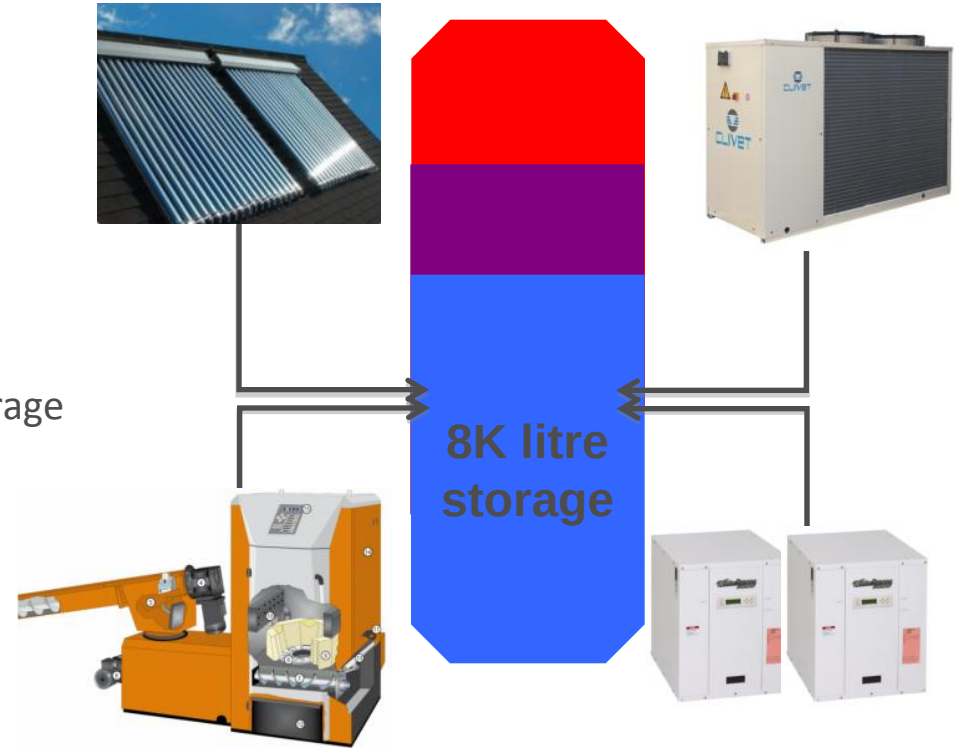
LTDH Experiences: Chalvey, Slough

- Demonstration project aimed to study energy usage in zero carbon houses
- 8 Code 6 single family houses & 2 flats
- Single radiator per house operating at 55° C integrated with MVHR system
- DHW delivered at 43° C at the tap



LTDH Experiences: Chalvey, Slough

- Key points:
  - Heat from stand-alone renewables
  - Integration via 8K litre thermal store
- Challenges:
  - Complex control strategy
  - Achieving low return temperature – average has been about 35° C



Chalvey Case Study

LTDH Experiences: Chalvey (Slough)

- Headline result so far is simple: it works! There are no apparent difficulties with 50 ° – 55 ° C supply for new-build
- Thermal store means plant can run when its most advantageous: solar thermal when its sunny, air source heat pump in the afternoon when the ambient temperature is highest
- Lowering the return temperature crucial to plant efficiency, minimising pipe sizing and pumping energy.

Task-share in planning: Low Temperature District Heating for Future Energy Systems

- Will amplify the work of the existing 4GDH project
- Fundamental link between **low temperature systems**, **integration of renewables**, thermal storage, heat demands of future buildings…
- … all of which together imply the need for research areas on Methods & Planning Tools; DHC Technologies; Communities and Interfaces
- If you are interested in joining please contact me or dietrich.schmidt@ibf.fraunhofer.de

New Call for Proposals - interested in bidding?

- Check out the Call for Proposals documentation at iea-dhc.org
- Ensure your idea is consistent with the Call
- Remember it is essential to partner with organisations from at least one (and preferably two) IEA-DHC participant countries
- It is recommended that you discuss and register your interest in and/or intention to submit a proposal – please contact me
- Deadline for proposals is 30 January 2014.

For more about the IEA-DHC programme, contact:

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