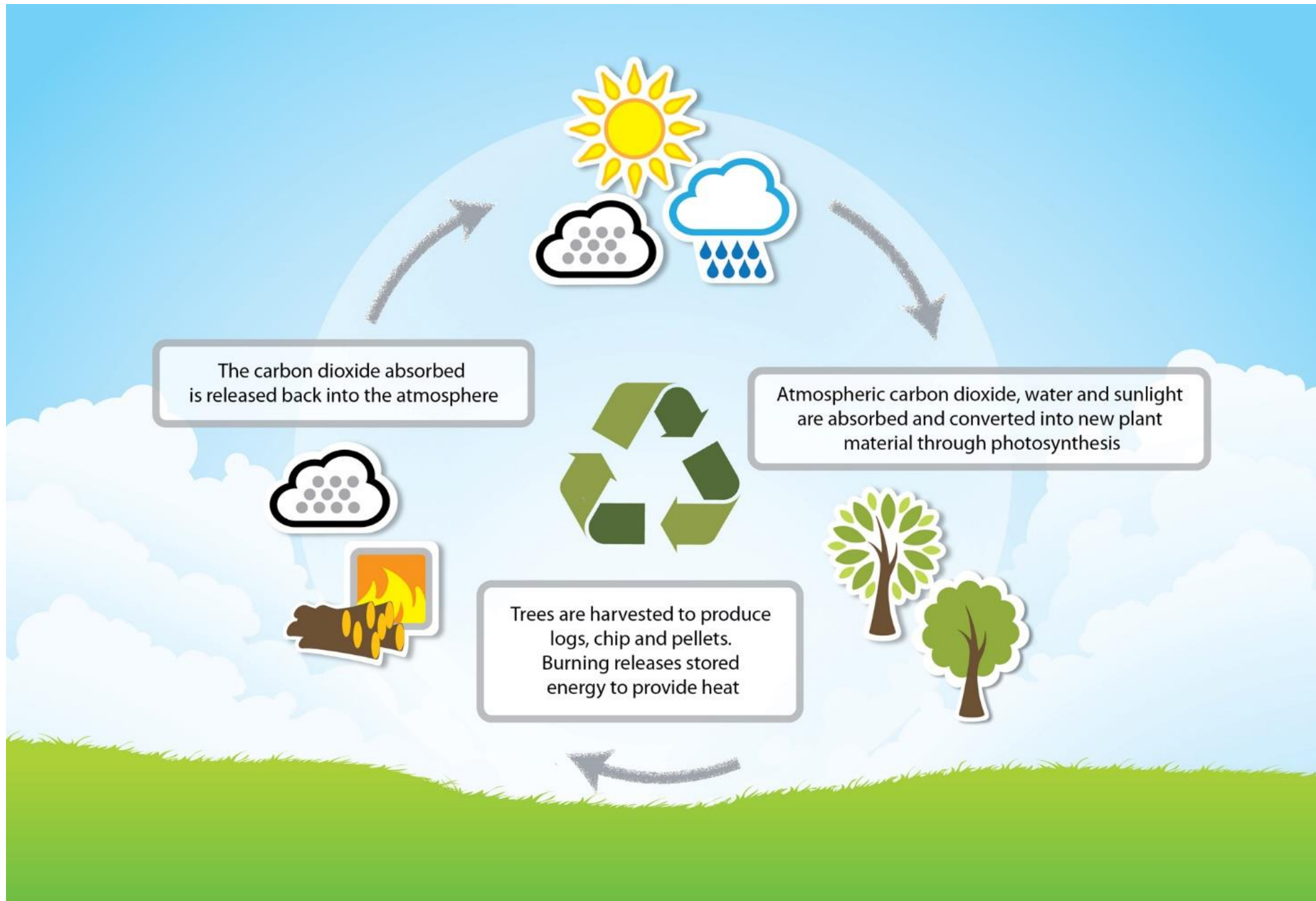


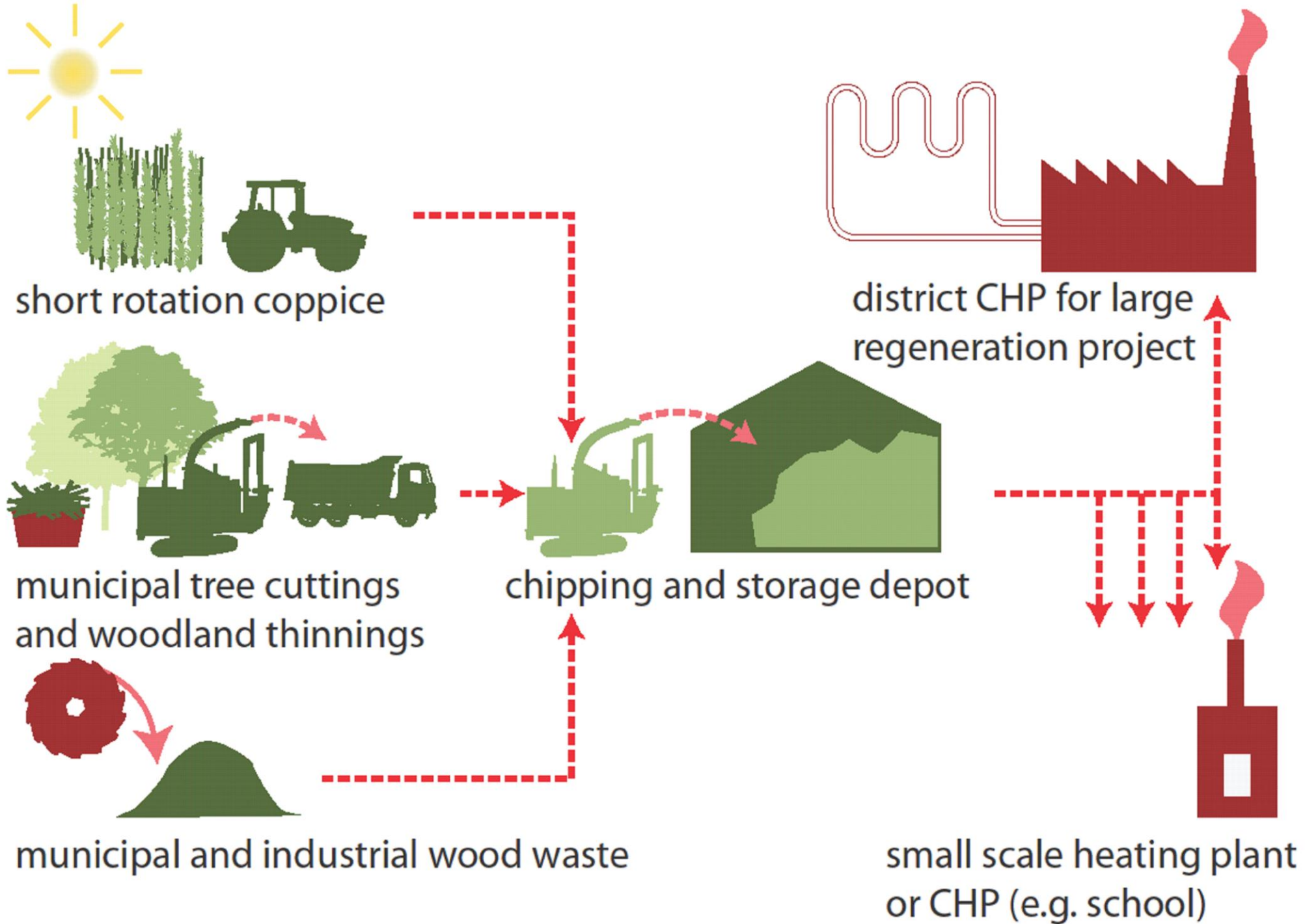
IES

Energy Surveys

Sustainable Heating in Derwenthorpe



- The UK has adopted targets for carbon reduction that will require a change in the energy mix by 2020.
- Burning bio-mass – wood chip which is grown locally and harvested (coppiced) in a continuous cycle – is considered to be low-carbon and renewable - hence the use of the word 'Sustainable'.
- Accordingly, the Government incentivizes the use of bio-mass with a grant (the Renewable Heat Initiative).
- Burning bio-mass is not easy - it is best achieved using industrial boilers.
- In Derwenthorpe, industrial boilers are used to burn locally grown bio-mass.
- District heating – where heat is produced centrally and then distributed to outlying buildings – allows homes to be heated indirectly from industrial boilers.
- **Thus, in Derwenthorpe, the heating is both low-carbon and sustainable.**



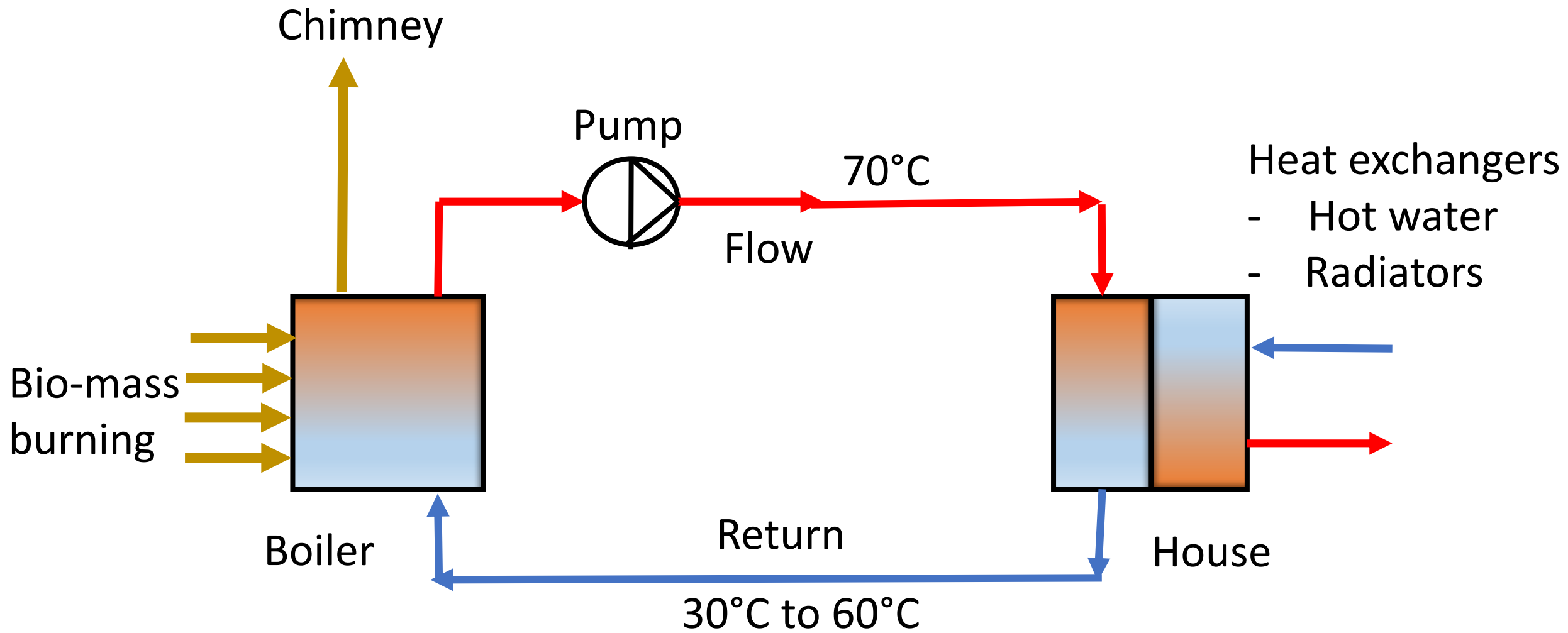
District heating

What is it and why do we have it?

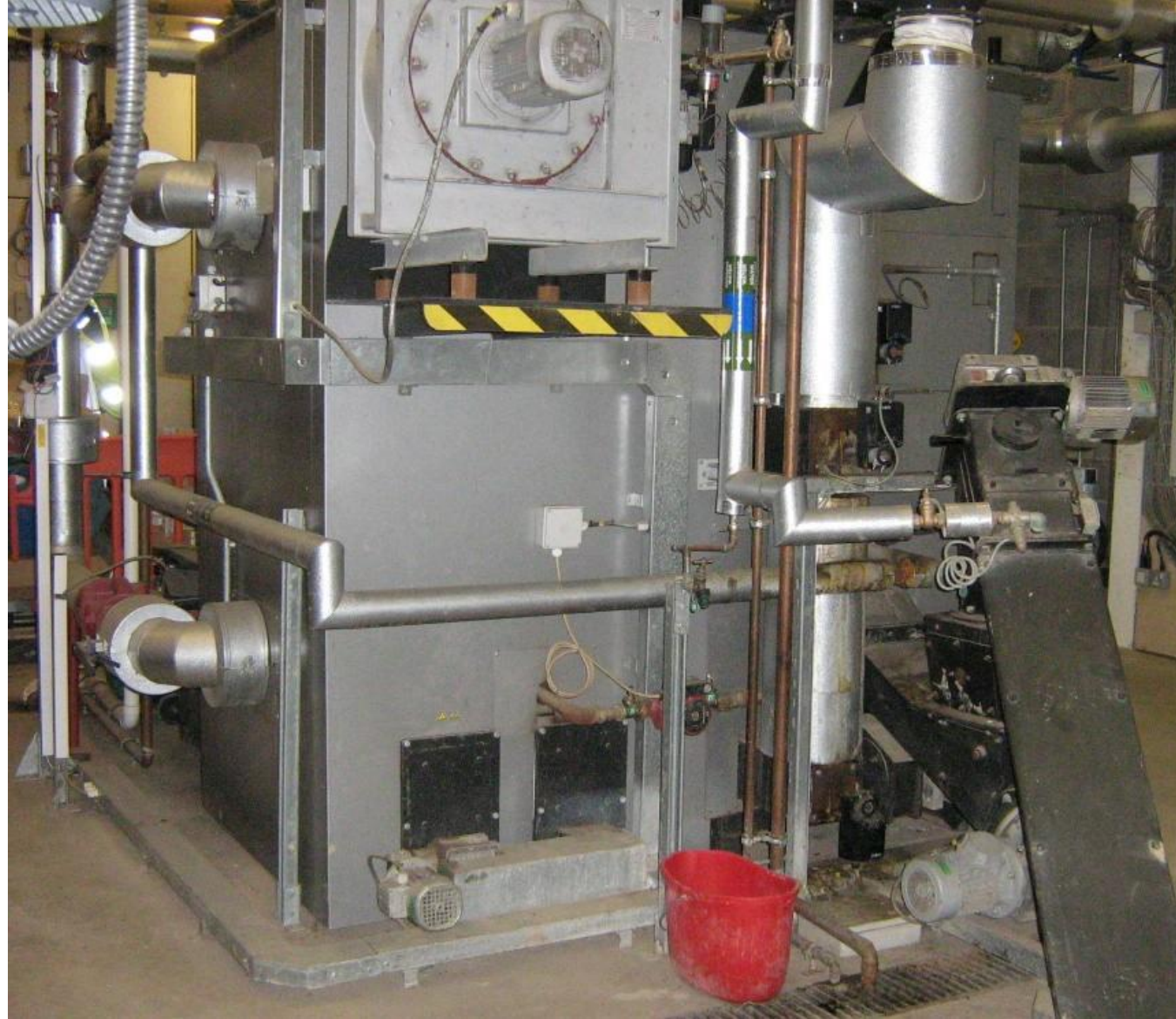
- District heating is not new, it is just uncommon in the UK.
- As specific examples, Finland has 50% of heat delivered by district systems, Denmark 60%, and the UK – less than 2%.
- District heating allows great flexibility in the choice of heat source ranging from waste heat from industry, waste heat from power stations to burning various fuels.
- The economics of operation vary substantially, depending on the heat source, the load and other factors.
- Generally, high density housing using waste heat from a power station will be economically attractive; low density housing using a bought fuel (e.g. bio-mass) will be less attractive.
- Not surprisingly, the cost of heat to the user can be higher or lower than using a standalone gas-fired boiler.
- **At Derwenthorpe, the original design objective of the heating system was for low-carbon 'sustainable' heating – not lowest cost heating.**

District heating

How it works



Bio-mass boiler

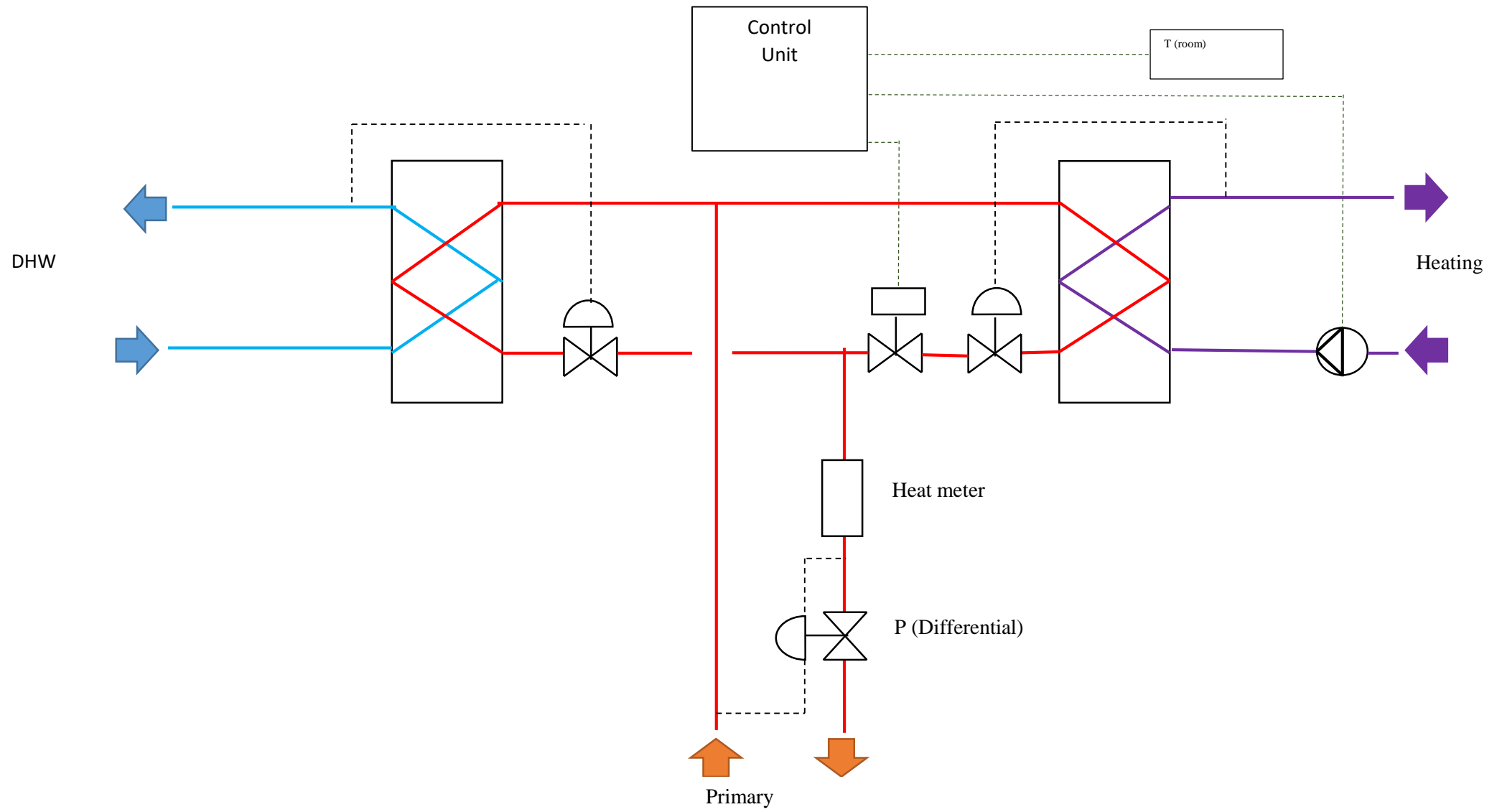




Phase 1 layout - illustrative

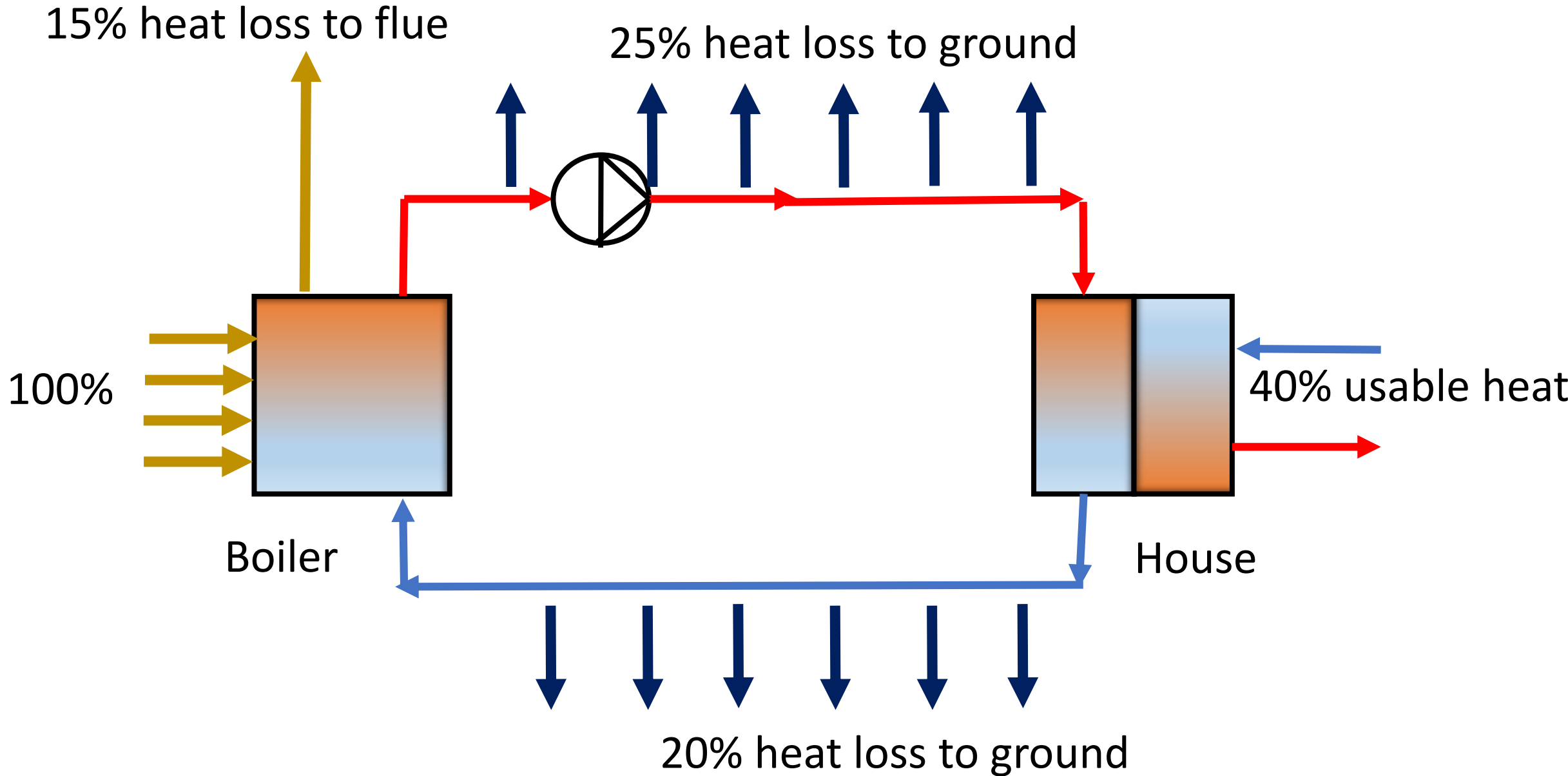






District heating

What are the issues?

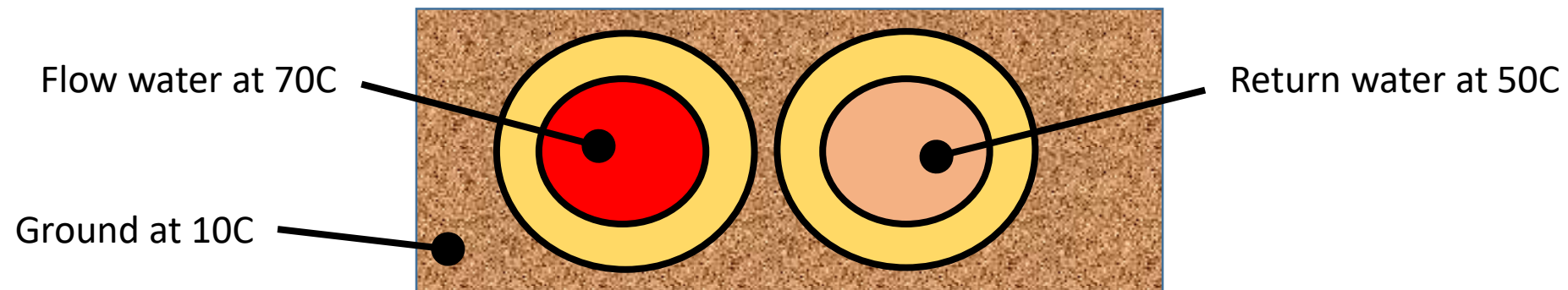


Illustrative annual heat balance



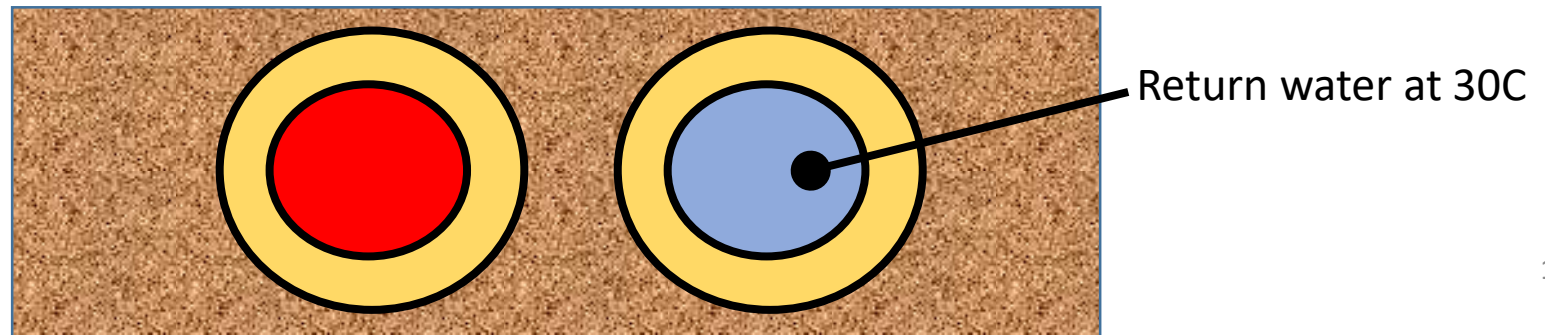
Heat loss

- The underground pipes are insulated but still loose some heat.
- The heat loss is proportional to the difference in temperature between the water and the ground.
- Our system operates at a high return temperature of 50C:
 - The 'flow' pipe losses are proportional to $(70^{\circ}\text{C}-10^{\circ}\text{C})=60^{\circ}\text{C}$
 - The 'return' pipe losses are proportional to $(50^{\circ}\text{C}-10^{\circ}\text{C})=40^{\circ}\text{C}$
- So, the return pipe loses two-thirds as much heat as the flow pipe

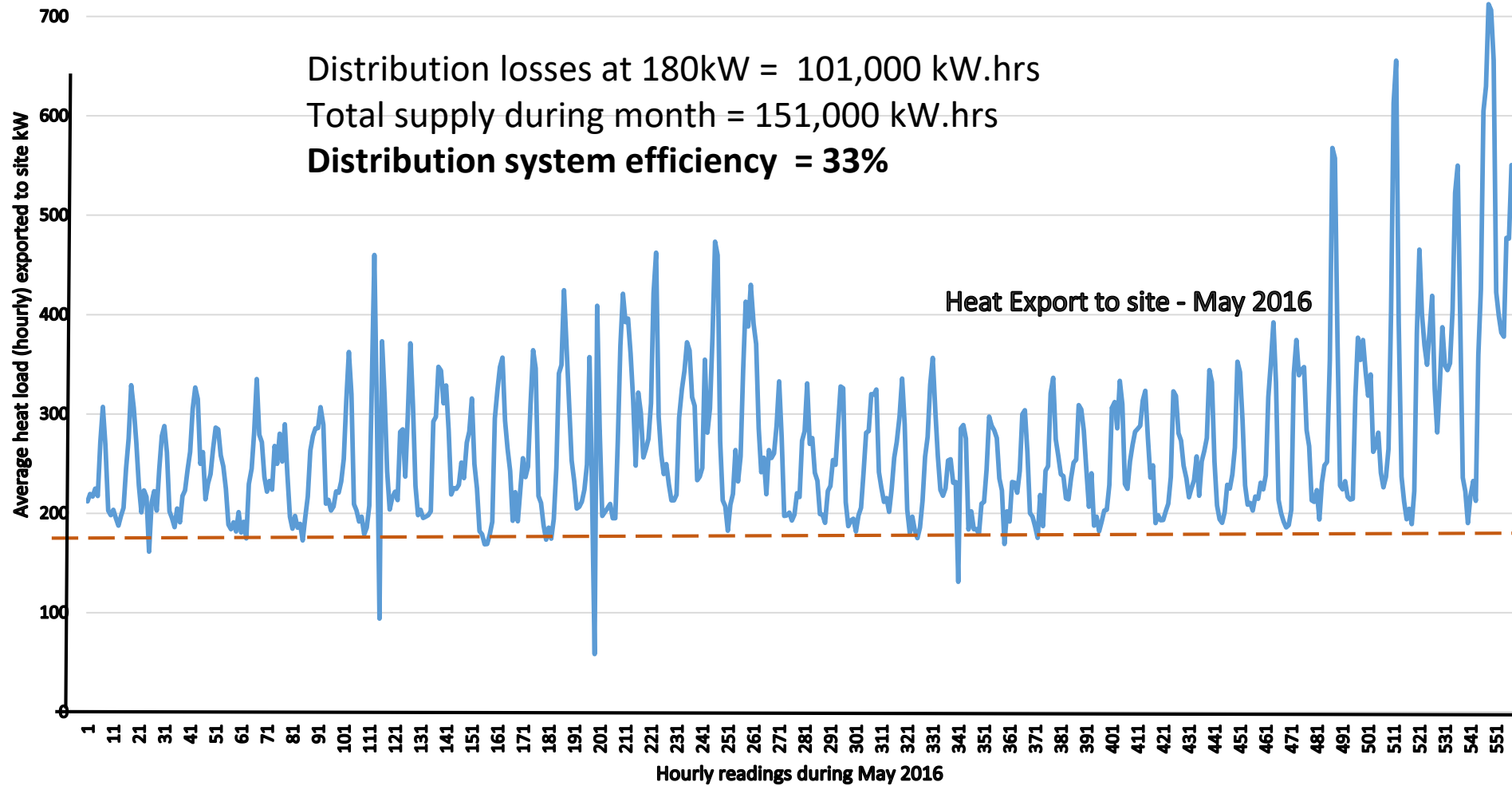


Lower Return Temperatures – Lower Losses

- If the temperature of the return water can be reduced, the heat losses will be reduced.
- Thus, at a return temperature of 30C:
 - The 'flow' pipe losses are proportional to $(70^{\circ}\text{C}-10^{\circ}\text{C})=60^{\circ}\text{C}$
 - The 'return' pipe losses are proportional to $(30^{\circ}\text{C}-10^{\circ}\text{C})=20^{\circ}\text{C}$
- The return pipe losses are now halved to one-third as much heat loss as the flow.
- A big reduction.



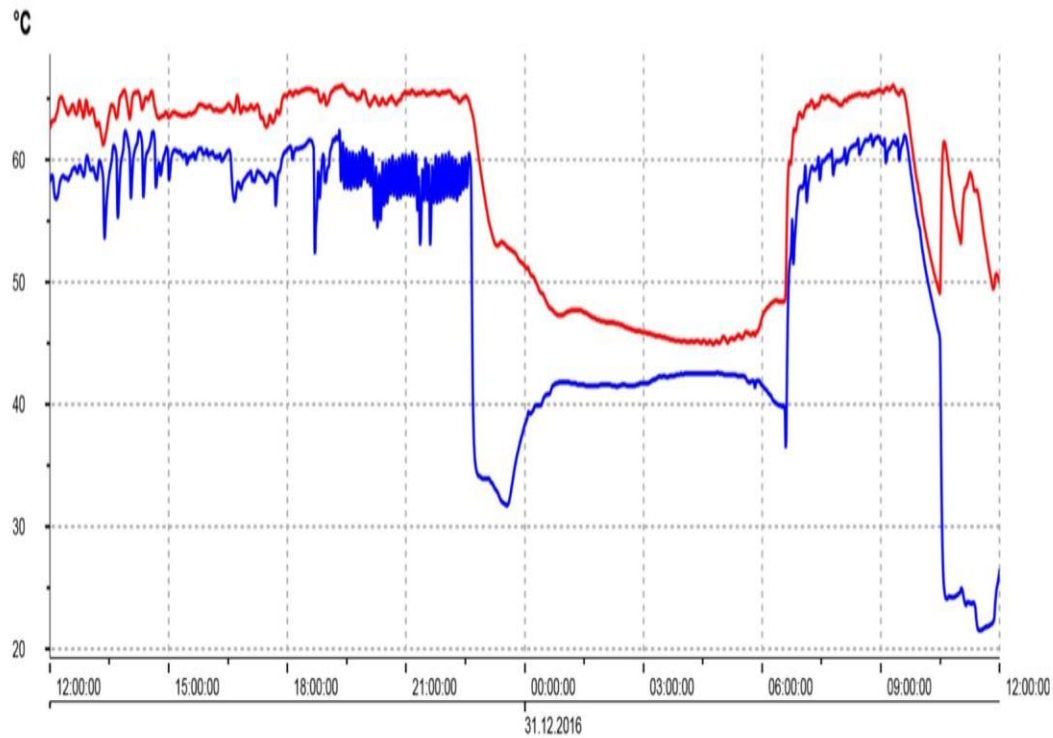
The Importance of Low Return Temperatures



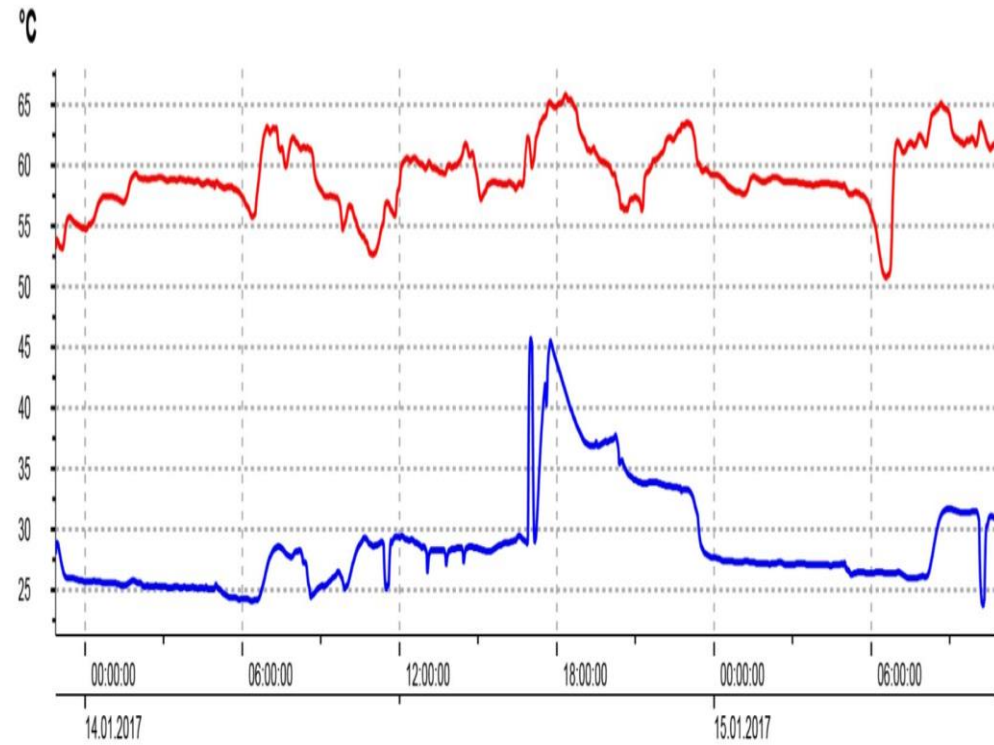
Plot 40 – Flow & Return Temperatures

Phase 1

- Thermostatic control

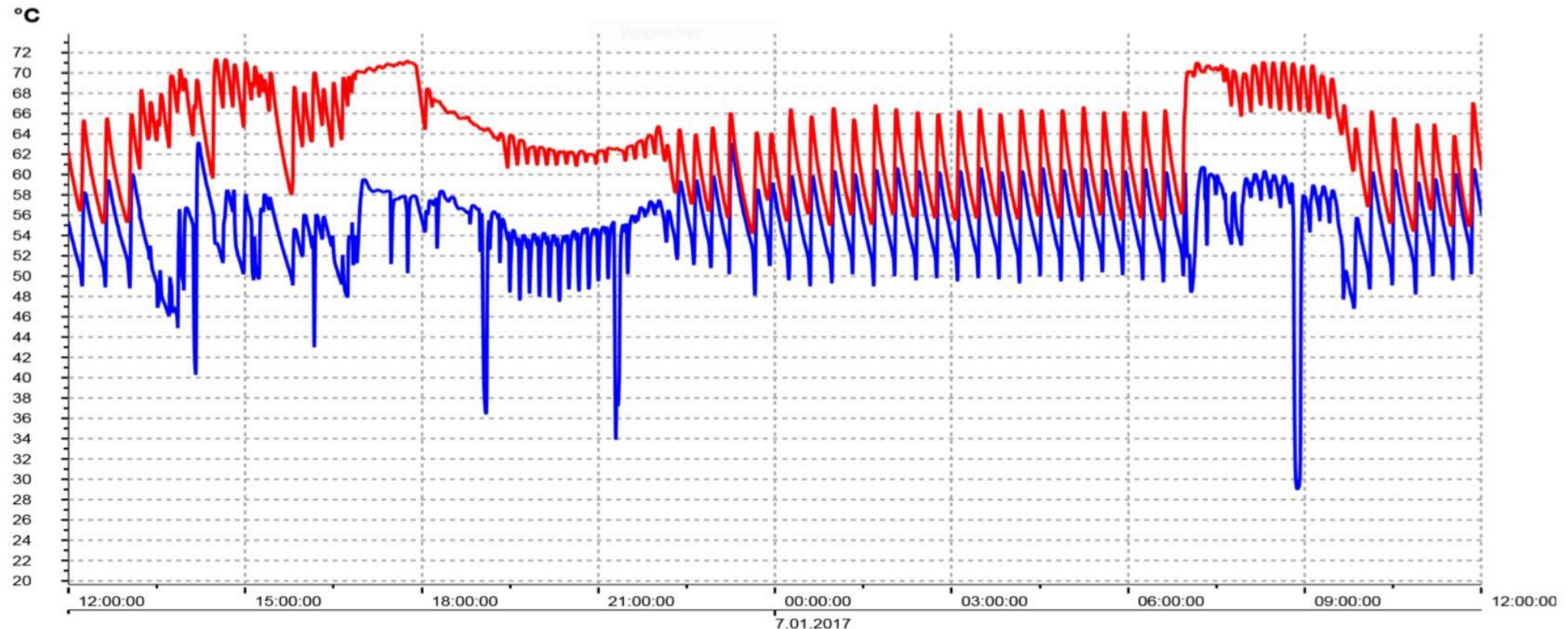


- Weather compensated control



Plot 286 – Flow & Return Temperatures

- Basic control (Phases 2,3 & 4)



District Heating

Costs and charges

- There are many district heating systems in the world and the methods of charging for heat are well established.
- The basis of the method for charging in Derwenthorpe is well established but some of the detail which is specific to Derwenthorpe is unsatisfactory.
- At Derwenthorpe there are two components for charging:
 - A 'dwelling' charge, which is a fixed annual amount to cover the whole cost of the upkeep of the system.
 - A 'utility' charge which is a unit cost proportional to a reference cost known as the gas 'comparator'.
- Our 'utility' charge is based on a comparator of a standalone gas boiler at a discount of 10%.
- In addition, there is a second calculation which represents the lowest utility cost at which the system can be operated, and is known as the 'collar'. In essence, it is the **survival price**.
- The price charged to the resident is the higher of the two prices

The 'Utility' Price

5.1 Subject to clause 5.2 the Utility Charge shall be calculated by multiplying the Market Rate by the Condensing Conversion Rate and applying a 10% reduction.

This is the comparator: a straightforward calculation. The 'market' rate is the average of the cheapest three suppliers of domestic gas times the efficiency of a domestic gas boiler (giving the cost of heat purchased), less a 10% discount.

The 'Collar' Price "A" (survival price)

- *5.2 At each Price Review Date, We and the JRHT will agree the Energy Mix to fuel the plant and equipment in the provision of the Energy Supply at the Derwenthorpe Development in order to minimize the cost of Utility Charge to You.*
- *If the Utility Charge as calculated in clause 5.1 is LOWER than 'A' then cost 'A' shall apply. 'A' is calculated as follows:*
 - $$A = 0.048 \text{ (RPI indexed)} + (((\alpha\% \times \text{Natural Gas Cost}) + (\beta\% \times \text{Biomass Fuel Cost})) \times \text{Conversion Coefficient}) - \text{Expected RHI}$$
- *If the Utility Charge as calculated in clause 5.1 is HIGHER than 'B' then cost 'B' shall apply. 'B' is calculated as follows:*
 - $$B = 0.058 \text{ (RPI indexed)} + (((\alpha\% \times \text{Natural Gas Cost}) + (\beta\% \times \text{Biomass Fuel Cost})) \times \text{Conversion Coefficient}) - \text{Expected RHI}$$

- The 'collar' is the limiter for ensuring economic survival.
- It is a complex calculation based on the **production cost** of supplying heat.
- Factors include:
 - The financial RHI grant is proportional to the amount of bio-mass burned,
 - The financial RHI grant is proportional to system efficiency: the lower the efficiency, the lower the grant,
 - The moisture content of the bio-mass,
 - The constant of £0.048/kW.hr (thermal),
 - The price of commercial gas (not domestic gas),
 - The price of bio-mass.

Unit Price History

	2016	2017	2018
The Utility Price	3.880 p/kw.hr(Th)	4.725 p/kw.hr(Th)	5.043 p/kw.hr(Th)
The Collar Price	4.760 p/kw.hr(Th)	4.406 p/kw.hr(Th)	5.985 p/kw.hr(Th)
The Cap Price	5.800 p/kw.hr(Th)	5.478 p/kw.hr(Th)	7.100 p/kw.hr(Th)
ACTUAL PRICE CHARGED	<u>4.760 p/kw.hr(Th)</u>	<u>4.725 p/kw.hr(Th)</u>	<u>5.985 p/kw.hr(Th)</u>
Bio-mass burn	5%	15%	55%
Market rate, gas	3.662 p/kw.hr(GCV)	5.250 p/kw.hr(GCV)	5.603 p/kw.hr(GCV)

- At Derwenthorpe, on the price review date of March 1st 2018 the 'collar' price was higher than the utility price, hence the 'collar' price applies.
- The reasons for the high charge? A high production cost, caused by a combination of five factors:
 1. An increase in the price of natural gas
 2. A reduction in the basic RHI grant
 3. A further reduction in the RHI grant because of poor system efficiency
 4. An increase in the RPI inflation rate
 5. Poor system efficiency

- Confused by the various prices and their relationship to each other?
- The reason is this:
 - The **utility charge** is based on buying gas on a domestic tariff for burning in a domestic boiler
 - The **collar and cap** charges are based on the cost of producing heat from dual fuels and then distributing it to point-of-use through an inefficient network, less the RHI contribution.
- Chalk and cheese? Yes. Combining two dis-similar methods of calculation doesn't work.

- Our complex, expensive, bio-mass based district heating system was designed to deliver heat from a sustainable source. Starting in 2017 it will increasingly meet this design objective.
- However, from the outset and in all good faith, it was also claimed that the system would be cheaper to operate than standalone boilers.
- The last three years have revealed that the system is not cheaper to run than standalone boilers and it may, or may not be, cheaper to run in the future.
- Accordingly:
 - The original promise/hope/expectation/claim of a Utility Price linked to a domestic 'gas comparator' should be dropped. It cannot be justified.
 - A more realistic calculation for the Utility Price, based on production cost should be considered.

District heating

What of the future?

- Major commitments for the following year, requested by our **Residents' Association** and agreed by Veolia and JRHT are as follows:
 - Selected residents, with the appropriate skills, will be involved in the process of finding a fairer tariff structure for the purchase of heat (Note: at this stage there can be no guarantee that it will be cheaper next year),
 - Selected residents, with the appropriate skills, will be involved with the practicalities of working up the thermal efficiency of the system.
- The working document 'A Constructive Partnership, Method of Working' applies.

More Information, Reports & Articles?

We have a wealth of supporting information in the form of media articles, external reports, internal reports and equipment data.

Available on request from mail@industrialenergy.co.uk or 500271

In prospect: a drop-in evening in the Energy Centre when we can analyse your own consumption of heat using 'Degree-day' analysis.