Work Package 3.3
Advanced Heat Pumps & DSR

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Heat Pumps – Retrofit

- Domestic Heat Pumps

Understanding what households use and what they are happy with?

![Graph showing energy usage over time](image-url)
Heat Pumps – Retrofit

- Domestic Heat Pumps
Understanding what households use?
Heat Pumps – Retrofit

- Domestic Small Heat Pumps

What are the electricity network limitations?

Our Work:

1. EST/CT Heat Pump trials, MicroCHP data on home heating – to get an overall picture of UK heating

2. Heat Pump characteristics utilised in PLEXOS electricity market model

3. “Monte Carlo” (?) approach to random “people” effects

4. What can DSR do in market terms?
Heat Pumps – Retrofit

- Domestic Small Heat Pumps

Assessing the Impact of Low Carbon Technologies on Great Britain’s Power Distribution Networks
Heat Pumps – Retrofit

- Domestic Small Heat Pumps

What are the electricity network limitations?
Heat Pumps – Retrofit

- Domestic Heat Pumps – Competing Loads

Diversified profiles for washing machines (WM), dishwashers (DW) and washing machines with tumble dryers (WM+TD)

Understanding the Balancing Challenge For the Department of Energy and Climate Change August 2012
Heat Pumps – Retrofit

- Domestic Heat Pumps

Capacity Management of Compressors

Capacity control of heat pumps, Per Fahlén, REHVA Journal – October 2012
Heat Pumps – Retrofit

- Domestic Small Heat Pumps

Demand Side Response (Modelled)

Heat Pump without Buffering or DSR

Heat Pumps – Retrofit

- Domestic Small Heat Pumps

Demand Side Response (Modelled)

Heat Pump with Buffering and DSR

Heat Pumps – Retrofit

- Domestic Small Heat Pumps

Demand Side Response (Actual)

![Diagram of heat pump system]

Average COP with ambient temperature

![Chart showing COP vs ambient temperature]

30 Minutes

18:00 19:00
Heat Pumps – Retrofit

- Domestic Small Heat Pumps (Demand Side Response (Actual))
Heat Pumps – Retrofit

- Domestic Small Heat Pumps – Options – New Hybrids?

**Existing hybrid heat pumps**
HP & Gas Boiler – Not zero Carbon (ex. bioenergy)

**Heat Pumps and Energy Storage**
Parallel operation – DSR – optimise store to match best HP characteristics

**Heat Pumps and Energy Storage**
Series Option – Lowest electricity costs for highest HP temperatures and lowest COP

**Heat Pumps, Energy Storage and Electric Boiler**
Boiler option an stratified tanks – Role of PCM/TCM?

**Hybrid Cascade Plant**
Using lower stage and upper stages separately
Work Package 4.1: High Temperature Heat Pump

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Heat Pumps – High Temperature

- Industrial/Solar Heat Pumps

Understanding what fluids might be suitable?
Heat Pumps – High Temperature

- Industrial/Solar Heat Pumps

Understanding what fluids might be suitable?

![Coefficient of Performance @ 100°C](chart)

<table>
<thead>
<tr>
<th>Fluid</th>
<th>Coefficient</th>
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<tbody>
<tr>
<td>R134a</td>
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<td>R245fa</td>
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</table>
Heat Pumps – High Temperature

- Industrial/Solar Heat Pumps
Understanding what fluids might be suitable? HDR-14?
Heat Pumps – High Temperature

- Industrial/Solar Heat Pumps
Understanding what equipment might be suitable? R134a equipment?
Heat Pumps – High Temperature

- Industrial/Solar Heat Pumps
Understanding what equipment might be suitable?

Fluids are not common

Is R134a equipment the best choice?

Retain pressure characteristics and temperature tolerances?