Design and operation of a UK based community energy scheme

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Introduction

• DH covers < 2% of UK heat market
• DECC (BEIS) forecasts estimate that 43% of building stock can be connected in a cost effective way by 2050
• 320m£ budget to increase DH penetration
• Regeneration of ex-industrial area
Trent Basin development

- 33 new low-energy houses
- Creation of an “Energy Service Company” ESCO
- Low-temperature Heat network
- Thermal Storage
- PV Field
- Battery Bank
SCENe Energy System
SCENe Model: Electricity network

• EnergyPro to simulate operation of the heat and electricity network
• 450 kW PV field
• 2.1 MWh Battery Bank: charge/discharge rate 0.5 MW, η=89%
• Wholesale Electricity price from 2016 UK Spot Market
• Retail electricity price: 47% wholesale price, 53% grid costs, taxes, commodities
• Energy system can exchange electricity with main grid
• Domestic electricity demand was disregarded
• Nottingham CIBSE weather file
SCENe Model: Heat Network

- SH demand: underfloor heating and/or low-temp radiators
- DHW demand: flat-station with electric heater on the secondary side. Total water volume ≤ 3l. DHW Comfort Temperature 50 °C
- ΔT of 5 °C at the heat exchanger
- Reference scenario: 55/25 °C supply/return temperatures
- Heat tariff: 95 £/MWh
- Heat demand profiles obtained from stochastic predictions
- 20 m³ Thermal Storage
- Temperature in/out ground source: 10/8 °C
Research Strategy

**Aim:** to predict the optimal operation of the community energy networks

- To maximise the use of local energy generation
- To optimise the use of the energy storages
- To compared different operation strategies
EnergyPRO: summer operation
EnergyPRO: winter operation
## Scenarios Comparison

<table>
<thead>
<tr>
<th>SCENARIOS</th>
<th>Operation Income (£)</th>
<th>Heat Losses (%)</th>
<th>COP</th>
<th>GSHP from generation (%)</th>
<th>Export from Battery (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCENe_55</td>
<td>55,739</td>
<td>19.1%</td>
<td>4.1</td>
<td>27</td>
<td>70</td>
</tr>
<tr>
<td>SCENe_50</td>
<td>56,925</td>
<td>18.4%</td>
<td>4.5</td>
<td>28</td>
<td>69</td>
</tr>
<tr>
<td>SCENe_45</td>
<td>58,135</td>
<td>17.5%</td>
<td>4.9</td>
<td>29</td>
<td>68</td>
</tr>
</tbody>
</table>
Heat network: electric heater

- Heat network operation at different supply temperatures
- Danfoss report illustrates use of electric heater for DHW

<table>
<thead>
<tr>
<th>Share of Electricity for heated DHW (%)</th>
<th>ΔT= 7°C</th>
<th>ΔT= 12°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Danfoss</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td>EnergyPro</td>
<td>18.6</td>
<td>30.9</td>
</tr>
</tbody>
</table>
Focus of future investigation

• To validate the stochastic predictions for heat demand profiles
• To validate the operation of the community energy scheme
• To assess new scenarios
• To complete a detailed financial model considering the project lifetime
Thank you!

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