Insights from non-domestic BPE studies

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Presentation outline

• Innovate UK Non-domestic case studies
• Energy performance
• Key findings by case study
• Common issues
• Wider lessons
Non-domestic BPE case studies

Angmering Community Centre

Crawley Library

College Lake Wildlife Visitor Centre

Sustainable Construction (SusCon) Academy
Non-domestic BPE case studies

<table>
<thead>
<tr>
<th>Community Centre</th>
<th>Visitor Centre</th>
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</thead>
<tbody>
<tr>
<td>563 m²</td>
<td>362 m²</td>
</tr>
<tr>
<td>Timber frame and brick</td>
<td>Timber frame and brick</td>
</tr>
<tr>
<td>Single storey</td>
<td>Single storey</td>
</tr>
</tbody>
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Angmering CC

College Lake
Non-domestic BPE case studies

Crawley

- Library
  - 4468 m²
  - Concrete, cantilevered facades, limestone and rendered brick cladding with curtain wall
  - 4 storey

SusCon

- Education
  - 2916 m²
  - Steel frame
  - Wooden frame
  - Concrete
  - Exposed Elements
  - 3 storey
## Case studies: physical characteristics

<table>
<thead>
<tr>
<th></th>
<th>Angmering CC</th>
<th>College Lake</th>
<th>Crawley</th>
<th>SusCon</th>
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</thead>
<tbody>
<tr>
<td><strong>Space heating and</strong></td>
<td>Ground Source <strong>Heat Pump</strong> (GSHP), underfloor heating</td>
<td>Air Source <strong>Heat Pumps</strong> (ASHP), Underfloor heating, immersion heater</td>
<td>Biomass lead boiler with buffer vessel to underfloor heating/cooling pipework &amp; radiators</td>
<td>Biomass lead boiler with buffer vessel to underfloor heating; back up gas boilers</td>
</tr>
<tr>
<td><strong>hot water system</strong></td>
<td></td>
<td></td>
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<tr>
<td><strong>Ventilation</strong></td>
<td>Natural Ventilation</td>
<td>Natural Ventilation</td>
<td>Mixed-mode</td>
<td>Natural Ventilation</td>
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<tr>
<td><strong>strategy</strong></td>
<td></td>
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<tr>
<td><strong>Renewables</strong></td>
<td><strong>10.2 kWp PV</strong></td>
<td><strong>3.6 kWp PV</strong></td>
<td>Biomass boiler &amp; solar water heating</td>
<td>Biomass boiler &amp; <strong>4 kWp PV</strong></td>
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<tr>
<td><strong>Sustainability</strong></td>
<td><strong>EPC rating A</strong></td>
<td><strong>EPC rating B</strong></td>
<td><strong>EPC rating A</strong></td>
<td><strong>EPC rating A</strong></td>
</tr>
<tr>
<td><strong>rating</strong></td>
<td></td>
<td></td>
<td><strong>BREEAM Very Good</strong></td>
<td><strong>BREEAM outstanding</strong></td>
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Energy performance
CO₂ emissions

[Bar chart showing CO₂ emissions for different locations, with bars representing modelled, actual, and benchmark (TM46) values for Other fuel, Electricity, and Total.]

- Crawley
  - Modelled (BRUKL - BER)
  - Actual (metered energy use)
  - Typ. Benchmark (TM46)

- Ang. CC
  - Modelled (BRUKL - BER)
  - Actual (metered energy use)
  - Typ. Benchmark (TM46)

- College Lake
  - Modelled (BRUKL - BER)
  - Actual (metered energy use)
  - Typ. Benchmark (TM46)

- SusCon
  - Modelled (BRUKL - BER)
  - Actual (metered energy use)
  - Typ. Benchmark (TM46)
Key findings by case study
Crawley Library

+ Best IAQ indicating good ventilation
  - Problematic biomass boiler decommissioned
  - Regular changes in FM staff with no handover
Angmering Community Centre

+ Most positive BUS results
+ Occupants feel in control of comfort
+ PV gen. higher than expected
- Unacceptably high CO$_2$ levels (>2000 ppm)
College Lake Wildlife Visitor Centre

Weekly CoP of ASHPs and weekly mean external temp. during 4th Nov 2013 – 28th Sep 2014

+ Management very aware of energy use – ensuring no waste by switching off all unused equip

+ Highly efficient and responsive heating system (ASHP)

– BMS not user friendly – created difficulty for management
SusCon Academy

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<tr>
<th>Condition</th>
<th>Description</th>
<th>Notes</th>
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<tr>
<td>Air in summer fresh/stuffy</td>
<td>Fresh :1</td>
<td>7: Stuffy</td>
</tr>
<tr>
<td>Air in summer odourless/smelly</td>
<td>Odourless :1</td>
<td>7: Smelly</td>
</tr>
<tr>
<td>Air in summer still/draughty</td>
<td>Still :1</td>
<td>7: Draughty</td>
</tr>
<tr>
<td>Air in winter fresh/stuffy</td>
<td>Fresh :1</td>
<td>7: Stuffy</td>
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- **Percent of occupied hours at given CO₂ ppm: winter**

- Good IAQ though very underutilised
- Sub-metering never fully commissioned
- Problematic biomass boiler decommissioned
- External noise detracts from use of windows for ventilation
Common issues
Common issues among case studies

Handover
- Facilities manager (FM) not involved during design and planning meetings and/or given insufficient handover
- No log book or user guide provided (2,3)
- FM staff change after handover, no induction for new staff (1,4)

Commissioning and metering
- Sub-meters not connected to BMS / incomplete installation; not commissioned properly.
  - E.g. inaccurate readings and/or no readings
- BMS not able/configured to store monitoring data (1,3)

BUS and environmental analysis
- Occupants satisfied with most overall general features
- Overheating in all buildings / overheating revealed in BUS (1,3,4)
- Buildings over-heated in winter (2,3,4) / resolved during BPE (3)

1 = Crawley Library  2 = Angmering CC  3 = College Lake VC  4 = SusCon Academy
Common issues among case studies

Fabric

- Air permeability on design target or better (2,3,4)
- Thermal imaging identified cold spots at junctions
Common issues among case studies

Energy
• Energy consumption higher than BRUKL BER
• PV performing well (2,3,4)
• Strong correlation with HDD (2,3,4) – strongest with heat pumps
• Energy waste - equipment on standby observed (1,2,4)

Heating Systems
• Biomass boiler failures, fuel procurement issues and eventual decommissioning (1,4)
• Average CoP of heat pumps performing well within range (2,3)

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Wider lessons
Owner / client / developer

Design / construction stages
• Involve FM in all meetings from the beginning – enhances knowledge and sense of ownership

Handover
• Request detailed handover and easy to understand user guide from design team

In-use
• Reach out and provide an atmosphere of openness where occupants can discuss concerns regarding their environment and control.
• In case of a change in FM team, ensure that internal handovers are thorough and induction and training are properly documented through video recordings.
• Set up maintenance contracts and seasonal commissioning for low carbon technology and systems
Building industry

Design stage
• Get to know the site personally, including the smells and sounds.
• Procurement, cost, and method of storage of heating system fuels need to be detailed and discussed with FM and owner in the early stages.

Design, construction and commissioning
• Involve as many stakeholders as possible in meetings to protect the future in-use of the building and expected performance.
• Extra care should be taken to ensure proper commissioning, training and aftercare of un-familiar technology.
• Ensure technicians are knowledgeable about the installation and commissioning processes and documentation. Provide on-site training at all levels to ensure appropriate fitting of materials and systems.
Handover / aftercare

• Design building user guide with needs of users first.
  • Trial building user guide design with laypeople to ensure it is not overly technical (though it should remain technically relevant) and user friendly.
• After a period of operation, check that installation, calibration, and commissioning has been performed correctly.

In-use

• Follow up on installed systems and controls, investigate problems and report back to manufacturers / revise specifications for future projects accordingly.
• Evaluate actual energy consumption to investigate sources of performance gap – inform modelling process.
Building management

Design / construction stages
• Request involvement from the very beginning.

Handover / aftercare
• Ensure that proper documentation of building is provided, e.g. as built drawings, log books, user manuals and supplier contact details.
• Request in-depth handover and training.
• Do not be afraid to ask questions and request additional information or training.

In-use
• Gather occupant feedback on temperature and IAQ in order to fine-tune the building according to their needs.
• Understand installation and commissioning procedures to be equipped with the ability to recognize faults.
• Check commissioning of BMS and sub-meters post-handover.
Thank you to Mariam Kapsali for her involvement in the BPEs

http://architecture.brookes.ac.uk/research/lowcarbonbuilding/