Practical Application of Energy Storage in Social Housing

Dr Jo Patterson, Research Fellow, Welsh School of Architecture, Cardiff University
Summary of presentation

- Low carbon built environment – background;

- Low carbon systems based approach;

- Retrofit and new build case studies;

- Performance analysis and recommendations;

- Future work.
Low Carbon Built Environment - background
Why is low carbon housing so important?

• Condition of existing housing;
• Construction of affordable housing to increase;
• Stimulate economy and create jobs;
• Reduce energy bills;
• Levels of fuel poverty – 25% in UK;
• Carbon emission targets/air pollution;
• Quality of life and well being.
Installation of technologies – case study

Renewable supply
• solar thermal collector;
• ground source heat pump;
• photovoltaic panels.

Demand reduction
• internal wall insulation;
• loft insulation;
• triple glazed windows;
• simple heating controls;
• Mechanical Ventilation and Heat Recovery.

74% reduction in energy use
cost £70,000
Installation of technologies – case study

Electrical Energy kWh

demand met by panel

demand met by grid

export to grid
Need to reduce costs
Low carbon systems based approach

Optimise a **holistic low carbon system** by combining:

- reduced energy demand;
- building integrated renewable energy supply;
- energy storage - thermal and electrical energy.
Low carbon systems based approach

• Provide **affordable, replicable** very low energy buildings;

• **Integrate technologies** into the building rather than ‘bolt on’;

• Provide a **comfortable** environment for occupants.

• Source from **local supply chains**, demonstrate advanced Welsh construction technologies.
Low carbon systems based approach

Use what is generated at source.
Funding

Funding Body - WEFO
LCRI Convergence Energy Programme was launched in September 2009 with funding of £15 million from the European Regional development Fund, through the Welsh Government and matched with £19 million from Welsh Universities and Industry.

SOLCER project – systems based approach demonstrations – 5 retrofits and 1 new build.
Low carbon systems based approach – the process

Model → Monitor → Demonstrate → Monitor

Location
Construction type and layout
Occupancy patterns
Historical Weather Data.

Technical performance
Comfort and quality
Cost

Technical performance
Comfort and quality
Cost
Low carbon systems based approach - retrofits

• Range of ages of properties;
• Demonstrate reduced cost retrofit;
• Demonstrate deep carbon savings;
• Benefit ‘owner’ of property – cost, quality;
• Benefit to ‘householder’ – comfort, cost savings;
• Acceptability – ‘owner’ and ‘householder’;
• No need for planning;
• Allow resident to remain in property.
## Retrofits - demand reduction

<table>
<thead>
<tr>
<th>Retrofit 1</th>
<th>Retrofit 2</th>
<th>Retrofit 3</th>
<th>Retrofit 4</th>
<th>Retrofit 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>• EWI;</td>
<td>• EWI (partial);</td>
<td>• Loft insulation;</td>
<td>• EWI (partial);</td>
<td>• EWI;</td>
</tr>
<tr>
<td>• Loft Insulation;</td>
<td>• Bonded bead cavity wall insulation;</td>
<td>• LED lighting;</td>
<td>• Front Internal Wall insulation;</td>
<td>• Loft insulation;</td>
</tr>
<tr>
<td>• Double Glazed Windows;</td>
<td>• Loft insulation;</td>
<td>• New boiler with hot water tank;</td>
<td>• Loft and floor insulation (extension);</td>
<td>• LED lighting.</td>
</tr>
<tr>
<td>• MVHR;</td>
<td>• Radical radiators;</td>
<td>• positive pressure ventilation from loft.</td>
<td>• LED lighting.</td>
<td></td>
</tr>
<tr>
<td>• System Boiler;</td>
<td>• MVHR;</td>
<td></td>
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<tr>
<td>• Water Tank – using surplus PV;</td>
<td>• LED lighting.</td>
<td></td>
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<tr>
<td>• Wireless Smart Controls;</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>• LED Lighting.</td>
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</tr>
</tbody>
</table>

[Images of retrofits: solar panels, smart control, MVHR system, LED lighting, wall insulation]
Low carbon systems based approach – retrofits

Retrofit 1

Retrofit 2
Low carbon systems based approach - retrofits

Retrofit 3

Retrofit 4

Retrofit 5
Retrofits - Renewable energy supply

Integrated PV roof

<table>
<thead>
<tr>
<th>Retrofit</th>
<th>kWp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retrofit 1</td>
<td>2.5</td>
</tr>
<tr>
<td>Retrofit 2</td>
<td>2.7</td>
</tr>
<tr>
<td>Retrofit 3</td>
<td>4.5</td>
</tr>
<tr>
<td>Retrofit 4</td>
<td>2.5k</td>
</tr>
<tr>
<td>Retrofit 5</td>
<td>4.0</td>
</tr>
</tbody>
</table>
# Retrofits - Energy storage

<table>
<thead>
<tr>
<th>House</th>
<th>Battery Type</th>
<th>Battery Capacity (kWh)</th>
<th>Feeding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retrofit 1</td>
<td>Lead Acid</td>
<td>4.8</td>
<td>LED lights, USB, hot water</td>
</tr>
<tr>
<td>Retrofit 2</td>
<td>Lead Acid</td>
<td>8.5</td>
<td>LED lights, Fridge, USB</td>
</tr>
<tr>
<td>Retrofit 3</td>
<td>Lead Acid</td>
<td>18</td>
<td>House</td>
</tr>
<tr>
<td>Retrofit 4</td>
<td>Lithium</td>
<td>2.0</td>
<td>House</td>
</tr>
<tr>
<td>Retrofit 5</td>
<td>Lithium</td>
<td>10.0</td>
<td>House</td>
</tr>
</tbody>
</table>
New build - Solcer House
Modelling battery size

- Demand and occupancy patterns;
- Supply - How much energy is being generated?
- What will it supply – whole house?
Energy storage – decision making process

• KWh (Battery) – small to just serve house or very large to store energy from grid;
• Cost – capital (materials and installation) and maintenance;
• Maintenance needs;
• Expected lifetime;
• Depth of discharge;
• Claimed efficiency;
• Expandability;

• Max. power in and power out;
• Battery type;
• Physical size and weight;
• DC access;
• kW size PV;
• Connect to other Renewables;
Predicted performance of energy storage

- Power import
- Direct PV supply
- Battery supply
- Power losses
- Power export
Predicted value of energy storage

<table>
<thead>
<tr>
<th>Retrofit</th>
<th>Power import cost</th>
<th>Income from power generation</th>
<th>Income from power export</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Retrofit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>After</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Before retrofit
- After retrofit
- With battery
- Without battery

Cost: £/yr
Retrofit 4 - energy storage
Predicted performance - Solcer House

Monthly energy supply, PV power storage and exportation

Energy: kWh

- Direct from PV
- From Battery
- Heating storage by PV power
- Surplus power to grid
- From grid
Recommendations

Technical
• Software upgrades – not do what expect or want and cost extra;
• Controls/more accurate information – degree of charging/discharging, state of charge, number of cycles complete;
• Maintenance and support – warrantees are essential, need to be clear and need to be honoured;
• Flexibility – modular better – change to suit needs, easier to install as less heavy.

Safety and practicalities
• Guidance to reassure building owners and occupiers;
• Location of battery – access, security.

Cost
• Approx. £1,000 per kWh – still too high to justify for most households. Fuel poverty reduction a big driver in social housing sector.
Stakeholder buy-in

• Occupier – behaviour and care;

• Building owner – full support throughout organisation and responsible for operational costs;

• Technology suppliers –
  • Long term maintenance support;
  • Warrantee;
  • Skill development – quality and confidence.
• Government/policy support.
Low Carbon Built Environment – future
Low Carbon Built Environment – future

- Grid connected batteries – charge from and contribute to grid – AC coupled;
- Balance between cost and need – very small vs excess for grid import. Security of supply is big concern in rural locations;
- Occupancy patterns – modular to fit change of householders;
- Vehicle to interact with house to store energy generated by PV;
- Community scale storage – concerns – how do you balance who uses what?
Key messages

• Cost of a battery system – more costly than an appliance – has to be treated this way by supply chain;

• Domestic level – cost/lifetime, safety, power density and information are key;

• Payback time – approx. 12 years if part of PV system;

• Monitoring to provide relevant information – how much energy do I have available now? How much longer will my battery last?

• Social housing provides an opportunity to speed up market – bring in early/late majority.
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