CIBSE LOW CARBON CONSULTANTS REGISTER – SESSION 6 HIGH EFFICIENCY ALTERNATIVE SYSTEMS

I – Prophets energy services 03012103
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HIGH EFFICIENCY AND ALTERNATIVE SYSTEMS
Consideration of high-efficiency alternative systems for new buildings – Part L Regulation 25A

Before construction of a new building starts, the person who is to carry out the work must analyse and take into account the technical, environmental and economic feasibility of using high-efficiency alternative systems (such as the following systems) in the construction, if available:

(a) decentralised energy supply systems based on energy from renewable sources

(b) Cogeneration (CHP)

(c) district or block heating or cooling, particularly where it is based entirely or partially on energy from renewable sources

(d) heat pumps
The need for renewables
UK Electricity Demand & Generation (MW)
W/C Monday 12th July 2010
Definition of Low and Zero Carbon Technologies

- **Zero Carbon technology**
  
  “A zero carbon technology / development is one that achieves zero net carbon emissions from energy use on site, on an annual basis”

- **Carbon neutral technology**
  
  “Carbon Neutral is defined as a technology that emits the amount of carbon at the point of use as it takes in during its lifetime”

- **Low Carbon technology**
  
  “A low carbon technology / development is one that achieves a reduction in carbon emissions of 50% or more from energy use on site, on an annual basis.”

  Embedded energy is ignored in these definitions
- **Zero Carbon Technologies**
- **Neutral Carbon Technology**
- **Low Carbon Technologies**
- **Centralised systems**

- **Solar – Thermal & PV Wind**
- **Biomass**
- **CHP Biofuels ASHP GSHP**

- **District heating / cooling**
SOLAR THERMAL HOT WATER
Active, Closed Loop Solar Water Heater

- Flat plate collector
- Antifreeze fluid in collector loop only
- Pump
- Solar storage/backup water heater
- Double-wall heat exchanger
- Hot water to house
- Cold water supply
## Solar : Thermal Hot Water

### Installation main components
- Solar panels / collectors
  - Flat plates
  - Evacuated tubes
- Heat transfer system
- Hot water cylinder

### Installation considerations
- Roof area (unshade 2 – 4m²)
- Orientation (south facing)
- Panels inclined 30°-45° from horizontal
- Existing water heating system
- Budget
- Periods of freezing temperatures
- Tank Size

### Maintenance considerations
- Very little maintenance costs (to be checked by a professional installer every 3-5 years)

The figures used are approximate and may vary depending on which source you view.
Solar : Thermal Hot Water

Flat plate collector
Approx 30% efficient

Evacuated Tube Collector
Approx 40% efficient
### Solar: Thermal Hot Water

<table>
<thead>
<tr>
<th>Output</th>
<th>Environmental benefits: CO2 reductions</th>
<th>Financial Support</th>
</tr>
</thead>
<tbody>
<tr>
<td>50-70% of demand which spreads out to approximately 90% in summer, 50% in spring and 20% in winter.</td>
<td>400 - 750 kg per year (average installation)</td>
<td>- Future RHI Technology</td>
</tr>
</tbody>
</table>

The figures used are approximate and may vary depending on which source you view.
Solar photovoltaic (PV) cells generate DC electricity. PV selection depends on peak power, area, and application.
# Solar: Photovoltaic installation

<table>
<thead>
<tr>
<th>Installation main components</th>
<th>Installation considerations</th>
<th>Maintenance considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>PV Array</td>
<td>• Roof area (at least 10 m² unshaded)</td>
<td>Small annual maintenance costs relating to cleaning and inspection</td>
</tr>
<tr>
<td>Inverter DC-AC</td>
<td>• Roof inclined 30°-45° or less.</td>
<td></td>
</tr>
<tr>
<td>Metering</td>
<td>• Orientation (south facing)</td>
<td></td>
</tr>
</tbody>
</table>

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Solar: Photovoltaic efficiencies

Monocrystalline
Approx 14% efficient

Polycrystalline
Approx 11% efficient

Thin Film
Approx 8% efficient
# Solar: Photovoltaic

<table>
<thead>
<tr>
<th>Output</th>
<th>Lifetime &amp; Payback</th>
<th>Environmental benefits: CO2 reductions</th>
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</thead>
<tbody>
<tr>
<td>1 kWp (smallest system available) produces up to 750 KWh of electricity</td>
<td>PV panels ~ 25 years&lt;br&gt;Inverter ~ 10 years&lt;br&gt;Payback: with FIT within life of system</td>
<td>325 kg per year (based on a 1Kwp installation)</td>
<td>Qualifies for FIT</td>
</tr>
</tbody>
</table>

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# Wind Power

<table>
<thead>
<tr>
<th>Installation main components</th>
<th>Installation considerations</th>
<th>Maintenance</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Turbine</td>
<td>• Ideally wind speed greater than 7m/s</td>
<td>• Annual inspection and maintenance</td>
<td>• 1 KW turbine = 1000KWh per year (depending on site conditions)</td>
</tr>
<tr>
<td>• Building Integrated</td>
<td>• Planning issues, visual impact, noise and conservation areas.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Building mounted</td>
<td>• Possible building survey due to increase pressure on fabric of the building.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Stand Alone</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Mast</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Inverter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Battery storage (if off-grid system)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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## Wind Power

<table>
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<tr>
<th>Lifetime &amp; Payback</th>
<th>Environmental benefits: CO2 reductions</th>
<th>Financial Support</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lifetime ~ 20 years</td>
<td>0.5 t/KWe installed per year</td>
<td>Qualifies for FIT</td>
</tr>
<tr>
<td>Payback: with FIT within life of system</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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BIOMASS
Biomass boiler system components

- Biomass Fuel (Feedstocks) Delivery
- Biomass Fuel (Feedstocks) Storage
- Recovery
- Backup and Peaking Boiler
- Hot Water Supply
- Exhaust System and Stack
- Heat Exchanger
- Particulate Collection
- Ash Removal and Storage
- Combustion Chamber
# Biomass

## Installation main components
- Boiler
- Feed Transfer
- Storage
- Heat exchanger

## Installation considerations
- Availability of fuel ([www.logpile.co.uk](http://www.logpile.co.uk))
- Space available for fuel delivery, storage and larger boiler
- Dedicated operators
- Environmental regulations on air quality and ash disposal

## Maintenance considerations
- Significantly higher maintenance requirements than conventional gas boiler
- Quality and consistency of fuel will impact on maintenance

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## Biomass

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<tbody>
<tr>
<td>• Conventional systems</td>
<td>Lifetime: 25 years Payback: 5-10 years dependant upon site and fuel limitations</td>
<td>Arguably a neutral carbon system, at least in terms of achieving a carbon balance</td>
<td>Qualifies for RHI</td>
</tr>
</tbody>
</table>

The figures used are approximate and may vary depending on which source you view.
Ground Source Heat Pumps (GSHP)

- Ground source heat pumps can be used for heating, cooling and water heating
- Summer months this process can be reversed to meet the cooling requirements
- Typical CoPs range between 2.5 to 4
GSHP – Basic principle of operation
# Ground Source Heat Pumps (GSHP)

<table>
<thead>
<tr>
<th>Installation main components</th>
<th>Installation considerations</th>
<th>Maintenance considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Ground loop</td>
<td>• Correct sizing of the heat pumps and the ground loop or bore is crucial</td>
<td>Annual inspection and maintenance required</td>
</tr>
<tr>
<td>• Deep bore drill</td>
<td>• Space available: vertical drill or horizontal loop</td>
<td></td>
</tr>
<tr>
<td>• Heat pump contains:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Evaporator</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Compressor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Condenser</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Heat distribution system (under floor or standard radiators)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Ground Source Heat Pumps (GSHP)

Vertical borehole

Horizontal laid

Ground Water
Ground Source Heat Pumps (GSHP)

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<tr>
<th>Output</th>
<th>Lifetime &amp; Payback</th>
<th>Environmental benefits: CO2 reductions</th>
<th>Financial Support</th>
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<tbody>
<tr>
<td>- Under floor heating more efficient than radiators</td>
<td>Lifetime: 25 years, Payback: 9-10 years in comparison with a gas heating system</td>
<td>600-750 kg CO₂ PA, saving 63% emissions when compared to gas heating system</td>
<td>Future RHI</td>
</tr>
</tbody>
</table>

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COMBINED HEAT AND POWER
Combined Heat & Power (CHP)

• On-site electricity generation with heat recovery
• Best sites have year round heat demand
• In general, can be economic if it runs for more than 5,000 hours/year
• Independent feasibility study is essential, based on reliable demand profiles
## Combined Heat & Power (CHP)

<table>
<thead>
<tr>
<th>Installation main components</th>
<th>Installation considerations</th>
<th>Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Replaces existing gas boiler in system</td>
<td>Machinery can be larger than standard gas boilers</td>
<td>•Approx £1000 per kWe</td>
</tr>
<tr>
<td>Has a combustion engine to run power plant from number of fuels</td>
<td>Too much output for smaller buildings</td>
<td></td>
</tr>
<tr>
<td>On grid or off grid connection possible</td>
<td>Connection agreement required from energy supplier</td>
<td></td>
</tr>
</tbody>
</table>

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# Combined Heat & Power (CHP)

<table>
<thead>
<tr>
<th>Output</th>
<th>Lifetime &amp; Payback</th>
<th>Environmental benefits: CO2 reductions</th>
<th>Available Grants</th>
</tr>
</thead>
</table>
| **Electrical**: AC at 220-240V.  
**Thermal**: Heat output  
Maybe unstable at small scale | **Lifetime**: 15 years  
**Saving**: £150 - £200 per kWe per year (dependant upon size)  
**4 - 7 year payback period** | **30% CO2 reduction per annum when compared with condensing gas boiler** | **Not defined yet under Low Carbon Building Program** |

The figures used are approximate and may vary depending on which source you view.
AIR SOURCE HEAT PUMPS
Air Source Heat Pumps (ASHP)

- Air source heat pumps can be used for heating, cooling and water heating
- Two types Air to Air and Air to Water
- Summer months this process can be reversed to meet the cooling requirements
- Typical installed CoPs range between 2.5 to 4, although manufacturers test figures are generally higher
ASHP – Basic principle of operation
# Air Source Heat Pumps (GSHP)

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<tr>
<th>Installation main components</th>
<th>Installation considerations</th>
<th>Maintenance considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Heat pump contains:</td>
<td>• Best suited to under floor heating when applied to new build</td>
<td>Annual inspection and maintenance required</td>
</tr>
<tr>
<td>- Evaporator</td>
<td>• potential noise issues – location of external components</td>
<td></td>
</tr>
<tr>
<td>- Compressor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Condenser</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Heat distribution system (under floor or air distribution)</td>
<td></td>
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## Air Source Heat Pumps (GSHP)

<table>
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<th>Output</th>
<th>Lifetime</th>
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</table>
| - Under floor heating more efficient than radiators  
- reduced performance in extreme temperatures | Lifetime ~ 20 years | 600-750 kg CO₂ PA, saving 63% emissions when compared to gas heating system | Future RHI        |

The figures used are approximate and may vary depending on which source you view.
Types of Biofuel

• Biofuels may be
  – Solid
  – Granular
  – Gaseous
  – Liquid

• They are derived from
  – Energy rich crops or
  – Processing biological waste products
CENTRALISED SYSTEMS
District Heating / Cooling

- Centralised plant feeding a number of ‘consumers’
- Can use Biomass, PV, GSHP, Solar HW, energy from waste or conventional fuels
- Normally setup as cogeneration (CHP) producing heat and electricity
- Requires heat metering at consumer connection
- High initial costs but lower operating costs (only suitable for long term investment)
- Best suited to ‘high density’ usage areas
Basic principle of operation
## District Heating / Cooling

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<tr>
<th>Installation main components</th>
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</tr>
</thead>
<tbody>
<tr>
<td>• Energy Centre</td>
<td>• Best suited to high density consumption areas</td>
<td>Dedicated energy centre operators</td>
</tr>
<tr>
<td>• Heat distribution system</td>
<td>• high initial investment</td>
<td>Minimal maintenance for the ‘energy consumer’</td>
</tr>
<tr>
<td>• Heat exchangers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Heat meters</td>
<td></td>
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## Air Source Heat Pumps (GSHP)

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</tr>
</thead>
<tbody>
<tr>
<td>- Replaces traditional localised heating and cooling systems</td>
<td>Lifetime &gt; 25 years</td>
<td>System dependant</td>
<td>May qualify for RHI depending upon input fuel</td>
</tr>
</tbody>
</table>

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