



ProEcoPolyNet

ProEcoPolyNet Best practice Sheet

”(1) 40% House
(2) Carbon Vision Buildings Programme”

RTD Project Identification

RTD Project Name: (1) 40% house (2) Carbon Vision Buildings programme

RTD Contract No. T2.23

Programme: (1) UK Tyndall Centre
(2) Carbon Trust

Description of technology

The 40% House project has investigated how the UK Government’s commitment to a 60% cut in carbon emissions from 1997 levels by 2050 can be realised in the residential sector, so that the typical home becomes a “40% House”. A number of technologies have been analysed including micro-CHP.

Under the “40% House scenario”, by 2050, space and water heating requirements (ie useful heat provided) have been substantially reduced from 375 TWh in 1996 to 318 TWh in 2050, through improvements to the building fabric in both existing dwellings and highly efficient new build. Electricity consumption in residential lights and appliances (RLA) has decreased from 73 to 53.4 TWh through the use of more efficient technologies (Chapter 6). Households have, on average, almost two LZCs, equivalent to a total installed capacity of 55.6 GW. This is sufficient by 2050 to generate 82% of total space and water heating demand and meet total residential electricity demand, with around 15 TWh exported back to the grid. By 2050, more than 20% of homes will have very low space heating demand (1,500 kWh pa useful energy) with no need for central heating. All homes are expected to need around 4,000 kWh useful energy for water heating. Around 75% of homes have either community heating (with CHP or biomass), micro combined heat and power (micro-CHP), and other technologies which are out of the scope of this Best Practice Sheet (wind, heat pumps, PV, etc)

Operating principle

Micro-combined heat and power (micro-CHP) units provide sufficient heat for a single dwelling, similar to a conventional boiler. Indeed, units are physically similar to boilers and are designed as

drop-in replacements. However, the heat is provided as the by-product of the generation of electricity in the home – this is more efficient than the generation of heat in a boiler and import of electricity via the electrical network.

The power generation unit can be a Stirling engine, reciprocating engine, or fuel cell, each with different power and heat efficiencies: around 20% for larger Stirling engines (with up to 70% provided as heat) and up to around 35% for fuel cells (net of reformer and DC to AC conversion losses, with up to 55% of fuel converted to heat)

Micro-CHP is capable of operating in condensing mode and thus at a high overall efficiency. In the longer term, fuel cells offer the greatest carbon saving potential, but there are a number of significant issues that need to be addressed first. For example, major cost reductions would be needed for large scale uptake, but the underpinning materials are themselves very expensive.

Technical characteristics of installation

- ▶ *Type: Stirling engine*
- ▶ *Electrical output capacity (kW): 1.1-1.2*
- ▶ *Thermal output capacity (kW): 4.7-6.6*
- ▶ *Proportion of annual electricity met by ICHP system (%): 25-36*
- ▶ *Proportion of annual heat met by ICHP system (%): 66-70*

Location and use

- ▶ *Residential Buildings*

Capital investment and maintenance costs

For unrestricted thermal surplus

- ▶ *Avoided cost of network electricity(£): 112*
- ▶ *Cost of thermal surplus(£): (90)*
- ▶ *Revenue generated from e_{exp} (£): 30*
- ▶ *Total savings (£): 52*

For restricted thermal surplus and part-load capacity:

- ▶ Avoided cost of network electricity (£): 77
- ▶ Cost of thermal surplus (£): (0)
- ▶ Revenue generated from exp (£): 13
- ▶ Total savings (£): 90

Average hours of operation (h/a) 3000-3850

State of Development/Market implementation

- ▶ *Prototypes*
- ▶ *Field tested*

CO2 and primary energy savings

The carbon savings from micro-CHP are strongly dependent on electrical efficiency as well as the operating strategy. As with conventional boilers, micro-CHP units operate to match heat demand, but it is also possible to turn them on at other times, for instance, to generate electricity when prices are high. The heat generated could then be stored in a high pressure water vessel contained within the unit for later supply to the dwelling.

Annual reduction in CO2 emissions, kg CO2 (%)

Stirling engine—unrestricted thermal surplus:
-145 (+3%)

Stirling engine—restricted thermal surplus
and part-load capability: +512(-9%)

Benefits and obstacles

- ▶ It's a low carbon technology.
- ▶ Providing the site energy usage is sufficient, generating electricity locally using a CHP plant will normally be a cheaper than purchasing electricity from a conventional supplier.
- ▶ It increases security of supply, especially in remote locations or where the power supply can be interrupted
- ▶ Micro-CHP only generates a portion of household electricity demand, the balance being imported from the electrical network. At certain times, more electricity may be generated than is required by the home, allowing export back to the network. This represents a significantly different proposition for distribution companies and energy suppliers compared to the current situation, and there are a range of issues about connection, metering and the value of such electricity exports

Contact and further information

Name and contact details

(1) 40% house

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