Office of the
Deputy Prime Minister
Creating sustainable communities

Low or Zero Carbon Energy Sources – Report 4: Final Report

Building Research Technical Report 3/2005

December 2005

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December 2005
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Executive Summary

1 Low or zero carbon energy sources are increasingly being installed in buildings, e.g. small scale and micro CHP units, photovoltaic panels and building mounted wind generators. The development of performance standards and suitable guidance on satisfactory provisions, on e.g. structural measures, weatherproofing and location is needed, also compliance with ADL and any relevant provisions of the forthcoming Electrical AD. This desk study will also take account of the Energy White Paper and the EU Energy Performance of Buildings Directive (EPBD).

2 The overall aim of this project is to develop suitable performance standards and guidance for the installation of low or zero carbon energy sources in buildings.

3 It is proposed to include a specified list of low or zero carbon energy sources as alternatives to energy conservation and energy efficiency measures in order to achieve target carbon emissions for different building types. The extent to which LZC energy sources can contribute to achieving the carbon emissions target should be limited to a given level or percentage.

4 The potential for each LZC energy source to contribute to carbon emissions reductions in domestic and non-domestic building applications has been assessed. The majority of LZC energy sources can deliver carbon emissions reduction in the range 10-20% and several can deliver much larger reductions.

5 Since the proposal is to include LZC energy sources as an alternative to further energy conservation or energy efficiency measures there is no strict requirement to calculate the cost effectiveness of each for the purposes of regulatory impact assessment. However, an assessment of cost effectiveness has been undertaken to provide ODPM with:

a) an understanding of the comparative cost effectiveness of different LZC energy sources and

b) to determine if any of the LZC energy sources can be deemed to be cost-effective and hence considered for mandatory inclusion in Part L.

6 The assessment of cost effectiveness shows that few LZC technology/application cases achieve a positive NPV and hence none are recommended to be considered for mandatory inclusion.

7 It is recommended that the cost-effectiveness assessments are not made available as part of any consultation exercise since they have served their purpose within this report and could easily be misinterpreted outside the context this purpose.

8 A proposal for ‘reasonable provision’ clauses for certain LZC energy sources and associated technologies is presented.

9 A proposal for measures to prepare buildings for the future introduction of LZC technologies to make them ‘Renewable Ready’ is also presented.

Introduction

BACKGROUND

10 Low or zero carbon energy sources are increasingly being installed in buildings, e.g. small scale and micro CHP units, photovoltaic panels and building mounted wind generators. The development of performance standards and suitable guidance on satisfactory provisions, on e.g. structural measures, weatherproofing and location is needed, also compliance with ADL and any relevant provisions of the forthcoming Electrical AD. This desk study will also take account of the Energy White Paper and the EU Energy Performance of Buildings Directive (EPBD).

OVERALL AIM AND OBJECTIVES

11 The overall aim of this project is to develop suitable performance standards and guidance for the installation of low or zero carbon energy sources in buildings.

12 The specific objectives of this project are:

a) To identify existing published standards for low or zero carbon energy sources in use in buildings,

b) To assess the available performance standards and installation guidance and identify any gaps,

c) To prepare suitable guidance on performance standards and installation practice for inclusion in ADL.

d) Respond to Article 5 in the EPB Directive to ensure that the feasibility of low or zero carbon technologies is properly reviewed in the design process

ISSUES ADDRESSED IN THIS REPORT

13 This report, which is the fourth deliverable of this project, provides:

a) A proposal for the way in which low and zero carbon energy sources could be referenced/included in ADL

b) A confirmation of the LZC energy sources to be considered under the building regulations

c) A review of the potential for different LZC energy supplies to contribute towards carbon emissions reduction

d) A review of the cost effectiveness of different LZC energy sources (It is recommended that the cost-effectiveness assessments are not made available as part of any consultation exercise since they have served their purpose within this report and could easily be misinterpreted outside the context this purpose.)

e) A proposal for ‘reasonable provision’ clauses for certain LZC energy sources and associated technologies

f) A proposal for measures to prepare buildings for the future introduction of LZC technologies to make them 'Renewable Ready'

14 The phrase Low or Zero Carbon Energy Sources is abbreviated to **LZC** for convenience.

Inclusion of LZCs in the Building Regulations

15 Based on the proposal that some form of requirement to consider the inclusion LZC energy sources in new buildings (and refurbishments) may be included in ADL1 and ADL2 the following will be required:

a) An introduction to each of the LZC energy sources

b) A calculation method for each LZC energy source to predict the contribution to carbon emission reduction (or offset)

c) References to appropriate performance standards and guidance documents

d) Additional material drafted to fill gaps in existing performance standards and guidance

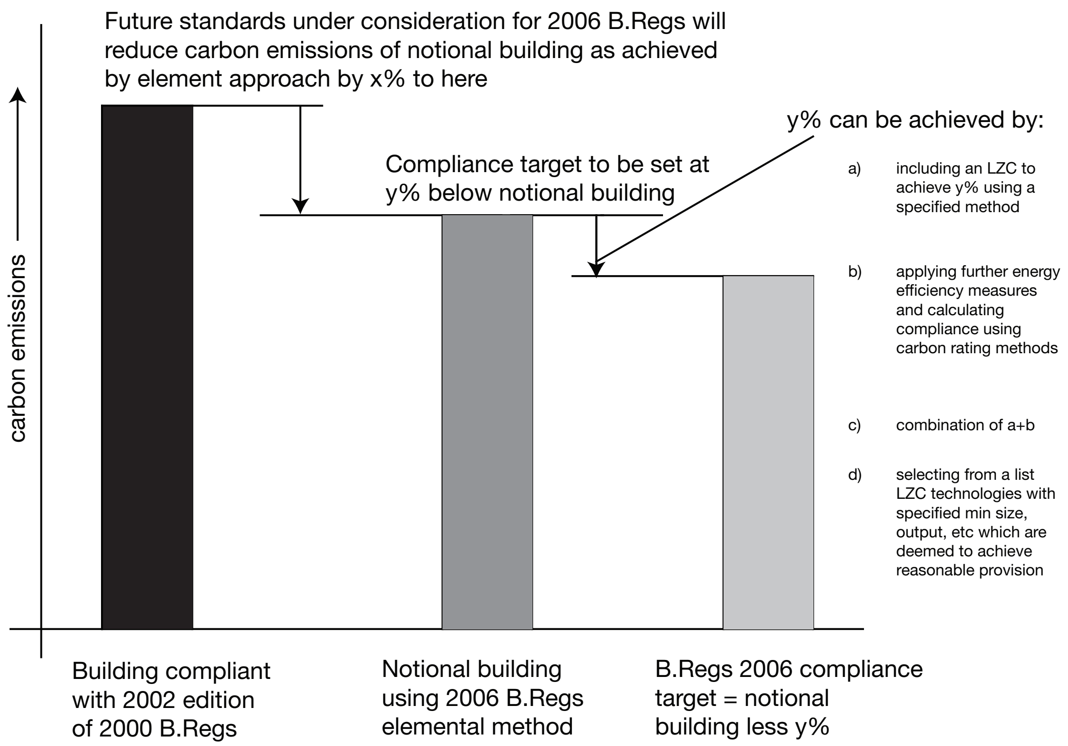
e) A proposal for the quantity (%) of carbon emissions to be reduced or offset for new build and refurbishment in both domestic and non-domestic buildings which must form part of a method to demonstrate compliance with ADL1 and ADL2 (eg: SAP and CPR).

16 Whilst some references to supporting material are provided in the current versions of ADL1 and ADL2, it would not be appropriate to add significantly to these or to include new material describing LZC energy sources. It is therefore proposed to include only item (e) above in the text of ADL1 and ADL2 and to create a new document that would contain the other items listed above. The working title for this new document is “A Strategic Guide to Low and Zero Carbon Energy Sources”. This guide has been presented as the third deliverable from this project.

17 The level at which an LZC energy source can contribute towards a building’s compliance with the minimum standards applicable under ADL1 and ADL2 must be constrained in order that a poor base building is not constructed on the grounds that a high percentage of the energy supplied comes from a LZC source. The diagram below shows how the contribution of an LZC source should be considered under Part L.

18

Principle for Achieving Y% from LZC Engery Sources



19 The level of contribution allowed for a LZC energy source was the subject of considerable discussion at the IAG WP4 meetings and figures considered included 10%, 15% and 20%. With some members proposal higher values. This report does not propose a value for the percentage contribution but instead presents the level at which different LZC technologies can contribute to further inform the discussion.

NEW BUILD VS RETROFIT TO EXISTING

20 The principle for including LZC energy sources presented above applies to new-build and major refurbishment. However, the Building Regulations also apply to certain controlled services and components (eg: boilers and windows) which are replaced from time to time in existing buildings. Since many of the LZC energy sources have applications in existing buildings (some of which may be more cost-effective than new build applications) this raises the question of if, and how, they might be addressed by Part L in this context.

21 The question of inclusion has to be informed by what building services and building components are or might in the future be controlled by the Building Regulations. At present the only controlled service relevant to this question is the heating boiler which must be replaced with a boiler achieving a minimum SEDBUK standard. It would be possible to specify criteria for LZC technologies such as Micro CHP and ground source heat pumps that are at least as good in terms of carbon emissions to allow these to be considered as alternative replacements.

22 Specific proposals for retrofit of LZC technologies could be developed once it is clear what controlled services and components are proposed in the current revisions.

LZCs to be Included

23 The LZC energy sources to be included are:

a) Absorption cooling

b) Biomass heating (and CHP)

c) CHP (Micro-CHP)

d) Ground Source Cooling

e) Ground Source Heat Pumps

f) Photovoltaics (solar electric)

g) Solar thermal water heating

h) Wind turbines

24 The following paragraphs discuss the applicability of the different LZC energy sources and level at which they can contribute to carbon emissions reductions in buildings based on calculations undertaken using the methods set out in the strategic guide. These levels are summarised in a table at the end of the section and the spreadsheet containing the detailed calculations forms a separate deliverable from this project.

25 In each case the total carbon emissions for a building is taken as the carbon emissions resulting from those building services regulated under Part L of the Building Regulations. For dwellings this includes; heating, hot water and fixed lighting, and for non-domestic buildings this includes heating, hot water, lighting, ventilation and cooling.

26 Calculations supporting the following discussion are presented in a separate spreadsheet:

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ABSORPTION COOLING

28 Absorption cooling is most likely to be applicable to prestigious office buildings and highly serviced spaces requiring full air-conditioning.

29 If absorption cooling is delivered from heat that would otherwise be wasted (rejected to atmosphere) then this could be regarded as a zero carbon supply. In this case calculations for example 3,000m² offices (EGC19 Type 3 and Type 4) show a carbon emissions reduction of 12-15% for new build and 14-16% for retrofit in existing buildings.

30 If absorption cooling is delivered from heat supplied by a CHP system then calculations for example 3,000m² offices (EGC19 Type 3 and Type 4) show a carbon emissions reduction of 7-9% for new build and 8-9% for retrofit in existing buildings.

BIOMASS HEATING (AND CHP)

31 For the purposes of this work biomass fuel is taken to be carbon neutral over the lifecycle. In practice, if biomass fuel is obtained from a local source (<25 miles) this is a safe assumption. Even if the biomass fuel comes from further away the extra emissions generated from transporting and processing can be offset by the avoiding the material being disposed to land fill where it would decompose and generate methane which would have significantly higher global warming impact.

32 A biomass plant providing heating and hot water in an individual dwelling will reduce total carbon emissions by >90% in both new build and retrofit applications. In non-domestic buildings such as offices where heating and hot water account for a smaller portion of total carbon emissions biomass heating can deliver a carbon emissions reduction of 37-70% (based on EGC Type 1-4 offices) in new build and 42-83% in retrofit applications.

33 In larger scale, non-domestic, multi-dwelling or mixed use applications, biomass heating may provide only a portion of the annual heating and hot water demand. Using the EGC19 Type 4 3,000m² office as a 'worst case scenario', if the a biomass plant provides 50% of the annual heating and hot water demand it will deliver a carbon emissions reduction of 18% in new build and 21% in retrofit applications.

34 Few successful examples of Biomass CHP in buildings exist in the UK so far. However, if systems can be successfully implemented they should reduce/offset a building's carbon emissions by considerably more than biomass heating installations and in some cases could achieve 100% or more reduction. Installations are likely to by 200kW electric or above and will mainly apply to mixed used developments or those with a significant year-round thermal load.

CHP (MICRO CHP)

35 Mini and large scale CHP is already cited in the ADL1 and ADL2 and hence the discussion here focuses on the emerging Micro-CHP technology.

36 Capacity to deliver carbon emission reductions will vary with technology.

37 Small Stirling engine units will typically produce around 10-20% of their output as electricity (usually around 1-1.5kW). When applied in single dwellings such a unit can deliver a carbon emissions reduction of 11% in new build and 11-12% in retrofit applications.

38 Internal combustion engines produce higher electrical output but are usually larger in size and unlikely to be applicable to new build single dwellings. When applied to groups of dwellings or small non-domestic applications internal combustion units can deliver a carbon emissions reduction of around 16%. In some cases the CHP unit may meet only part of the annual demand for heating and hot water and the carbon emissions reduction will be smaller.

GROUND SOURCE COOLING

39 Ground cooling uses the relatively constant ground temperature to provide summertime cooling through ground heat exchangers. These heat exchangers could either be air-to-ground or water-to-ground (aquifer). As with absorption cooling, it is most likely to be applicable to prestigious office buildings and highly serviced spaces requiring full air-conditioning.

40 If a ground source cooling installation supplies the full cooling demand of a Type 3 or Type 4 3,000m² office (EGC19) then it could deliver carbon emissions reduction of 11-14% in new build and 13-15% in retrofit applications. However, for large buildings with significant cooling demands the area of heat exchange in the ground could be unrealistically large and the system would therefore be sized to meet only a portion of the demand and the resulting carbon emissions reduction would be smaller.

GROUND SOURCE HEAT PUMPS

41 Ground Source Heat Pumps (GSHP) make use of the energy stored in the Earth's crust coming mainly from solar radiation. Essentially, heat pumps take up heat at a certain temperature and release it at a higher temperature. This is achieved by means of ground collectors (coils), in which a heat exchange fluid circulates and transfers heat via a heat exchanger to the heat pump.

42 Assuming a CoP of 3, GSHP applied to single new-build dwellings can deliver carbon emissions reductions of around 20% compared to heating by gas and around 63% compared to heating by electricity. In retrofit applications similar carbon emission reductions can be achieved.

43 For non-domestic applications (based on 3,000m² offices EGC Type 1-4) GSHP providing 100% of the heating demand can deliver carbon emissions reduction of 14-27% in new build and 16-32% in retrofit applications. However, for large buildings with significant heating demands the area of heat exchange in the ground could be unrealistically large and the system would therefore be sized to meet only a portion of the demand and the resulting carbon emissions reduction would be smaller.

PHOTOVOLTAICS (SOLAR ELECTRIC)

44 A PV installation can be sized to generate carbon zero electricity to a level equivalent to any percentage of the total carbon emissions of the building subject to there being sufficient suitable surface area to mount the required area of PV.

45 To deliver a 10% carbon emissions reduction in a new build dwelling would require an installation in 0.3-0.5 kWpeak range occupying no more than 5m² of suitable orientated roof and 20% would require double this size and area.

46 To deliver a 10% carbon emissions reduction in an existing dwelling would require an installation in 0.9-1.5 kWpeak range occupying 8-14m² of suitable orientated roof and 20% would require double this size and area.

47 Hence, providing up to 20% carbon emissions reduction from PV should be technically achievable in most cases for most new build and existing dwellings.

48 To deliver a 10% carbon emissions reduction in a new build 3,000m² office would require an installation in 35-45 kWpeak range occupying 324-415m² of suitable orientated roof. To achieve the same level (10%) of carbon emissions reduction by cladding the south facing façade of a new build prestige office building would require an installation in 49-58kWpeak range occupying 450-526m².

49 To deliver a 10% carbon emissions reduction in an existing 3,000m² office would require an installation in 67-88 kWpeak range occupying 600-800m² of suitable orientated roof. To achieve the same level (10%) of carbon emissions reduction by cladding the south

facing façade of an existing prestige office building would require an installation in 97-111kWpeak range occupying 883-1014m².

50 Hence, providing a 10% carbon emissions reduction by installing PV on an office building should be technically feasible in most cases. Providing a higher percentage emissions reduction would require the available area for PV to be considered in detail.

SOLAR WATER HEATING

51 Solar water heating is a well-established renewable energy system in many countries outside the UK. It is appropriate for both residential and non-residential applications. For a single typical house, for instance, a suitable system would occupy 2.5-4m² of roof space and would cost 1,500-£2,500 for a flat plate system that will provide around 50% of the typical hot water demand and up to £5,000 for an evacuated tube system that will provide around 60%.

52 Solar hot water can be applied in a number of non-domestic building types, such as hospitals, nursing homes and leisure facilities, which have high demands for hot water. Solar hot water systems are rarely installed in commercial buildings, where the demand for hot water is lower.

53 In electrically heated homes a typical flat plate solar hot water system could deliver a carbon emissions reduction of 19-23% for new build and 16-21% in retrofit applications. In gas heated homes a typical flat plate solar hot water system could deliver a carbon emissions reduction of 17-21% for new build and 16-19% in retrofit applications.

54 For applications in commercial buildings a solar hot water system sized to provide the maximum of 50% of the annual hot water demand would deliver carbon emissions reductions of 1-3% in both new build and retrofit applications.

WIND TURBINES

55 A wind turbine installation can be sized to generate carbon zero electricity to a level equivalent to any percentage of the total carbon emissions of an associated building subject to there being a suitable location for a turbine of the appropriate size.

56 To deliver a 10% carbon emissions reduction in a new build dwelling would require a turbine in the range 0.1-0.3 kW and 20% would clearly require double this size. To deliver a 10% carbon emissions reduction in an existing dwelling would require a turbine in the range 0.3-0.5 kW and 20% would require double this size. Turbines up to 1kW are available and some are now available at this scale specifically designed to mounting on buildings.

57 To deliver a 10% carbon emissions reduction in a 3,000m² office would require an installation in 6-32 kW range for new build and 12-62kW for a retrofit application. The location of a turbine in these size ranges would need careful consideration.

Review of Cost Effectiveness

58 Since the proposal is to include LZC energy sources as an alternative to further energy conservation or energy efficiency measures there is no strict requirement to calculate the cost effectiveness of each for the purposes of regulatory impact assessment. However, an assessment of cost effectiveness has been undertaken to provide ODPM with:

a) an understanding of the comparative cost effectiveness of different LZC energy sources and

b) to determine if any of the LZC energy sources can be deemed to be cost-effective and hence considered for mandatory inclusion in Part L.

59 The detailed cost effectiveness calculations are presented in the separate spreadsheet referred to earlier. The key parameters used in determining cost-effectiveness are:

a) Marginal cost of the LZC technology for each building application

b) Cost of energy (all electricity generated by LZCs is assumed to be valued at retail price)

c) Value of carbon (taken to be £95/tonne)

d) Discount rate: 3.5%

e) Lifetime appropriate to the expected life of LZC technology

60 Domestic and non-domestic (primarily office) examples have been examined and the energy prices for each are:

a) Domestic: gas £0.014, oil £0.032, electricity £0.07

b) Non-domestic: gas £0.01, oil £0.025, electricity £0.04

61 The following have been excluded from the cost-effectiveness calculations:

a) Grants and subsidies (eg: enhanced capital allowances)

b) Income due to renewables obligation certificates (ROCs)

c) Any additional cost of maintenance

62 The following output parameters are determined:

a) Simple payback period in years

b) Net present value (NPV): taken to be the present value of the savings over the life of the installation less the capital cost. Where the NPV is positive the installation is said to be cost-effective (ie the value of the savings over the lifetime exceeds the capital investment). Where the NPV is negative a further parameter is calculated:

c) Cost of Carbon: the negative NPV (ie the additional cost invested in an installation over and above the cost savings) divided by the total carbon emissions reduction over the lifetime of the installation (£/tC). This parameter allows LZC technologies that are not cost-effective to be compared on a common footing.

63 It is recommended that the cost-effectiveness assessments are not made available as part of any consultation exercise since they have served their purpose within this report and could easily be misinterpreted outside the context this purpose.

ABSORPTION COOLING

64 Absorption cooling is assessed for Type 3 and Type 4 offices only (EGC19). For both new build and retrofit applications the technology has a positive NPV and payback periods in the range 2-6 years.

65 Applications of absorption cooling to other office types and other non-domestic building types are unlikely to be cost effective.

BIOMASS HEATING (AND CHP)

66 Biomass heating is assessed for domestic and non-domestic applications. No applications are cost-effective since the cost of biomass fuel is similar to the cost of gas and hence there are no energy cost savings. The cost of carbon ranges from £281 to £1,184 /tC.

CHP (MICRO CHP)

67 Micro CHP is assessed for single dwellings (small Stirling engine) and groups of 8, 10 and 12 flats (internal combustion engine). Small Stirling engines are shown to be cost effective in existing single dwellings and larger new-build ones. All other applications do not meet the cost-effectiveness criteria and the cost of carbon ranges from £22 to £2,982 /tC.

GROUND SOURCE COOLING

68 Ground source cooling is assessed for Type 3 and Type 4 offices only (EGC19). The technology does not achieve the cost-effectiveness criteria for any application examined and the cost of carbon ranges from £3,307 to £3,870 /tC

GROUND SOURCE HEAT PUMPS

69 GSHP are assessed for electrically heated and gas heated single dwellings and for full and partial heating for Type 1-4 3,000m^2 office buildings. The technology is shown to be cost effective for electrically heated new build applications and for retrofit in both electrically and gas heated existing dwellings. In other applications the cost of carbon ranges from £314 to £979 /tC

PHOTOVOLTAICS (SOLAR ELECTRIC)

70 PV installations are assessed for roof mounted installations in single dwellings and roof and façade mounted applications in Type 1–4 3,000m^2 offices. Only façade mounted applications in offices are shown to be cost effective and only when the value of carbon at £95/t is included in the cost saving. The reason for this exception is that the capital installation cost of the PV has been offset by high conventional cladding costs (eg marble façade). In other applications the cost of carbon ranges from £17 to £1,522 /tC

SOLAR WATER HEATING

71 Solar hot water installations are assessed for roof mounted installations in electrically heated and gas heated single dwellings and roof mounted applications in Type 1–4 3,000m² offices. Only roof mounted applications in electrically heated dwellings are shown to be cost effective and only when the value of carbon at £95/t is included in the cost saving. In other applications the cost of carbon ranges from £35 to £958 /tC

WIND TURBINES

72 Wind turbine installations are assessed in association with single dwellings and Type 1–4 3,000m² offices. None of the applications are shown to be cost effective and the cost of carbon ranges from £5 to £683 /tC

Reasonable Provision

73 For some LZC technologies in certain broad applications the effect will almost to be a reduction in carbon emissions of at least 10% using the calculation methods set out in the Strategic Guide. If 10% is the level set for LZC energy sources to contribute to building compliance then for these technology/application cases it would be possible to accept that inclusion of the LZC technology is deemed to be ‘reasonable provision’ without the need for calculations. If this approach is to be considered then minimum standards for the technology would need to be satisfied.

74 The cases in which the ‘reasonable provision’ approach might be taken are:

a) Biomass heating (and CHP) in all applications where at least 50% of the annual heat demand is met

b) Micro CHP in new build single houses with a floor area of $75m^2$ or more

c) Ground source heat pumps in new build single houses with a floor area of $75m^2$ or more

d) PV in new build domestic applications where at least 0.5kWpeak is installed for each dwelling within given orientation and tilt constraints

e) A solar hot water installation in new build single houses with a floor area of $75m^2$ or more within given orientation and tilt constraints

f) A wind turbine installation in new build domestic applications where at least 0.5kW is installed for each dwelling

75 An example of how a ‘reasonable provision’ clause could be drafted is provided below for Micro CHP:

76 Installation of a National Grid connected, gas or oil fired CHP system, in a dwelling of minimum floor area $75m^2$, producing a minimum electricity output of 1kW, with a dedicated control system which ensures that the system shuts off when there is no heat demand in the building. The CHP system must have an overall efficiency (combining heat and electricity output) of a minimum of 100% as defined by the SEDBUK CHP method.

77 Justification:

a) The CHP must be electricity grid linked to make sure that the electricity is all useful, even when it exceeds the house demand.

b) The simple payback on a microCHP installed in a 2000 Building Regulations standard $75m^2$ floor area house, is about 15 years which is the life of a microCHP The operation of a microCHP in a smaller unit is likely to be inefficient due to the small heat demand and consequent cycling, and to be not cost effective. MicroCHP is not targeted at small heat demand dwellings.

c) A 1kW minimum electricity generation represents the standard systems available. The performance of smaller systems which may come onto the market is unknown and they are unlikely to make a significant contribution to carbon emission reductions.

d) The requirement for a dedicated control system is to ensure that systems are heat led.

e) The combined efficiency must be superior to that of a Category A boiler.

Renewables Ready

INTRODUCTION

78 It has been suggested that low cost additions could be installed in all new housing, and possibly other buildings, which would enable and even encourage later installation of LZC sources as these became more cost effective. At present, retrofitting of solar water heating for example, requires both a sufficiently strong and appropriate roof location, pipework connections and most likely a supplementary tank. Planning at the initial construction stage for retrofitting could greatly reduce the cost of such an installation. This tablestarts to look at what might be required for different LZC options.

LZC OPTION REQUIREMENTS

LZC Technology	Renewable ready component possible/required
Absorption cooling (non-domestic)	Larger space for absorption chillers Waste heat connection to chilling area
Biomass heating	Chimney in the house Storage for fuel supply Space and location for larger boiler (domestic)
Biomass CHP	Storage for fuel supply
Micro CHP (limited to domestic applications)	Wet central heating system Import/ export meter as standard
Ground Source Heating	None
Ground Source Cooling (non-domestic)	Larger coolth emitters
Heat pumps	None
Photovoltaics (solar electric)	Import/export meter as standard Wiring from roof space to meter area Space for inverter External fixings on south facing roof DC electrical circuits to allow direct use of PV power
Solar thermal water heating	Pipe connections from roof space to DHW cylinder External fixings on south facing roof Second heating coil in DHW storage cylinder
Wind turbines	Import/export meter as standard Wiring from meter location to suitable external point
District heating	If the building is within 50 m of a district heating system a connection should be made, if this is the cheapest heating method.
Other aspects	Reduced temperature wet heating systems (60/40°C) to allow for low temperature heating systems. Central heating systems in housing blocks (with heat metering), to allow for CHP and biomass heating All housing to have south-facing roof +/- 45°

DISCUSSION

79 The additional cost of some “renewable ready” items is small (e.g. cabling for PV) whilst others (e.g. storage for biomass fuel) could be significant. Compared with the cost of retrofitting the items, the cost effectiveness is likely to be high but a costing exercise has not been carried out.

80 Some of the ideas proposed have been thought to be unacceptable as they would limit current choice, for example a requirement to install a wet central heating system, would discriminate against electric, or warm air heating systems.

81 Others could not be installed with enough accuracy to allow for a future and unknown installation, e.g. roof fixings for PV arrays or solar water collectors.

82 Others would require too large an investment to justify up-front installation, e.g. a chimney in every house, bearing in mind future uncertainties.

CONCLUSIONS

83 Due to the uncertainties of future energy supplies, particularly the LZC options, it seems doubtful that many of the above options are worthwhile. The table below give some reasons for or against including them as requirements under Building Regulations:

LZC Technology	Renewable ready component possible/required	Reasons against
Absorption cooling (non-domestic)	Larger space for absorption chillers Waste heat connection to chilling area	Cost and uncertainty of future use Cost and uncertainty of future use
Biomass heating	Chimney in the house Storage for fuel supply Space and location for larger boiler (domestic)	Cost and uncertainty of future use Cost and uncertainty of future use Uncertainty of future use
Biomass CHP	Storage for fuel supply	Cost and uncertainty of future use and successful development of technology
Micro CHP (limited to domestic applications)	Wet central heating system Import/export meter as standard	Reduces choice of heating method Possible, low or zero cost option
Ground Source Heating	None	
Ground Source Cooling (non-domestic)	Larger coolth emitters?	Cost and uncertainty of future use
Heat pumps	None	
Photovoltaics (solar electric)	Import/export meter as standard Wiring from roof space to meter space Space for inverter External fixings on south facing roof DC electrical circuits to allow direct use of PV power	Possible, low or zero cost Possible, low cost Unnecessary, space always available in roof space Location uncertainty Cost and uncertainty of future use
Solar thermal water heating	Pipe connections from roof space to DHW cylinder External fixings on south facing roof Second heating coil in DHW storage cylinder	Possible, some cost Location uncertainty and cost Possible, some cost
Wind turbines	Import/export meter as standard Wiring from meter location to suitable external point	Possible, low or zero cost Possible, low cost
District heating	If the building is within 50 m of a district heating system a connection should be made, if this is the cheapest heating method.	Possible, some extra cost (if not used)

Other aspects	Reduced temperature wet heating systems (60/40°C) to allow for low temperature heating systems. Central heating systems in all housing blocks (with heat metering), to allow for CHP and biomass heating All housing to have south-facing roof +/- 45°	Cost and uncertainty of future use Cost and uncertainty of future supplies Planning and design considerations. Building Regulations cannot control planning issues