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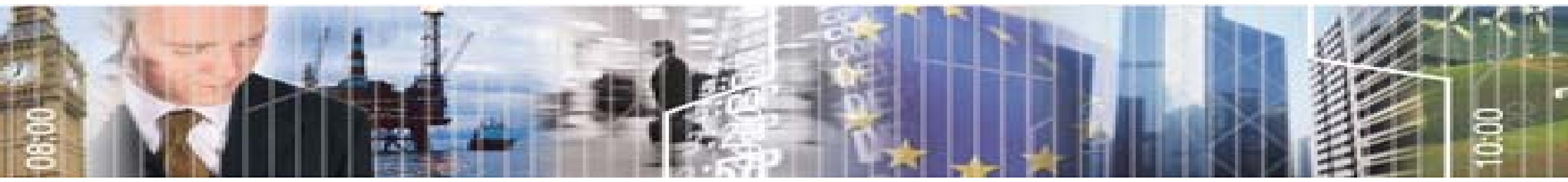
Report



Suitability of renewable energy technologies for the establishment of a new renewable energy policy for Cheshire

Authors: Yvonne Dickson, Andy Beddoes, Chris Wilcox

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Client

Cheshire County Council

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Suitability of renewable energy technologies for the establishment of a new renewable energy policy for Cheshire

by

Yvonne Dickson, Andy Beddoes, Chris Wilcox

Executive Summary

Background

Cheshire County Council (CCC) aims to encourage at least 10% on-site generation of energy for new development from renewable sources. Greater clarification is needed on the types and sizes of development activity for which this aim is practical.

Objectives

The objective is to produce a report which can support land use planning policies within Cheshire requiring the incorporation of renewable energy technology in new development up to 2016. The report is intended for use by the planning community in Cheshire and also for use proactively with developers to encourage greater uptake of renewables.

The work should be summarised by a table which shows the types of renewable technology suitable for different types of development. An opinion on whether the proposed 10% target is realistic for Cheshire is also sought.

Approach

The study has been carried out by Cheshire-based EA Technology, an independent technology services company with extensive experience of technical consultancy related to electricity distribution networks and analysis of technical information.

The two key tasks for the study were identified as:

- Data collection - review CCC documents and locate relevant new information from EA Technology documents and experience and from UK and international sources
- Data analysis - collate the information collected to match CCC requirements

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The period for consideration of available renewable energy technologies was divided into three equal parts: 2004, up to 2010, and up to 2016.

The renewable energy technologies were considered under five main sections: biomass, geothermal, solar/PV, water and wind. Two technologies which may be considered as new and renewable energy were considered under two further main sections: energy from waste and Combined Heat and Power (CHP).

Results

Within each of the technology sections, and within each of their sub-sections, there are tables showing expert opinion on the approximate year of availability (2004, by 2010, or by 2016), the economic viability and, where applicable, the appropriate size and type of development.

While avoiding duplication of the work reported in *Renewable energy in Merseyside & Cheshire: a review* (2004), a few points, particularly in the areas of economic viability and specific allocations to Cheshire are quoted in these technology sections.

Information on costs and economics, from the European Photovoltaic Industry Association and the Energy Saving Trust, and prospects for CHP growth in Europe are reported. Reference is made to a multinational program to promote the implementation of renewable energy in new urban settlements in Europe. A list of quoted references to documents and websites is given, and a table showing the trend for electricity generation from renewable sources in Europe is appended.

The summary tables are presented under the headings: *Expert opinion on renewable energy availability and economic viability for different types of development by 2004, 2010, 2016 (a) domestic, commercial, light industry* and *(b) general industry, agricultural, waste*.

Implications

To clarify the justification for Cheshire County Council to adopt a requirement for a minimum percentage of predicted energy requirements to be generated from on-site renewable sources, the following conclusions were drawn from the study and from experience gained in the renewable energy field:

- In 2004, the current cost of renewables remains a potential barrier with the potential to achieve around 5% on site generation. This figure could increase to 10% if a specific policy is required. The rapid change in the energy market and renewables sector may change the circumstances to enable greater growth in this current figure.

- By 2010, if excluding CHP but including some incentives, then 5% is definitely a realistic figure to target and to expect to achieve. If including micro-CHP, then for domestic properties 10% is entirely realistic.

- By 2016, 10% is definitely achievable and therefore a feasible target.

In addition to the environmental benefits for Cheshire, a more proactive renewable energy policy may encourage local growth and attract new industry to the area.

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Contents

1 Introduction

1.1 Background

A 2004 draft of the Cheshire County Council replacement structure plan aims to stimulate on-site generation of renewable energy from new development in Cheshire. The policy aims to encourage at least 10% on-site generation of energy demand from renewable sources.

In order to implement the aim of 10% on-site generation, greater clarification is needed on the types of development activity and the thresholds of size for development activities in which this aim is practical. Clarity is also needed as to the potential for the various applicable technologies to be utilised within various development activities.

The intended audience for the report is the planning community in Cheshire at both District and County level. However, the report will also be used proactively with developers to encourage greater uptake of renewables.

1.2 Aims of study

The key output of this study is a report which can support land use planning policies within Cheshire requiring the incorporation of renewable energy generating technology in new development.

The study aims to consider:

- thresholds of size at which incorporation becomes feasible for the range of renewable energy generating technologies, within a range of built types.
- barriers to the success of the proposed policy, including perceived financial and other impacts on development

The output should be summarised by a table which shows the types of technology suitable for different types of development. An opinion on whether the proposed 10% target is realistic for Cheshire is also sought.

The period for consideration of available renewable energy technologies is up to 2016.

The report should avoid duplicating the March 2004 report "Renewable energy in Merseyside & Cheshire: a review" [R1] which followed the 2001 North West Regional Assessment [R2].

An ancillary awareness-raising initiative is the Cheshire Renewable Energy Initiative [R3].

1.2.1 Energy efficiency and green energy

Cheshire County Council are separately proactive in the environmental areas of energy efficiency and purchasing of green energy, which are in addition to the 10% of predicted energy requirements from on-site renewable sources. [See R4 for website references.] Chester City Council also procure renewable energy.

1.3 EA Technology

The study is being carried out by Cheshire-based EA Technology, an independent technology services company with extensive experience of technical consultancy related to electricity distribution networks and analysis of technical information, documentation and standards. Within the field of distributed generation, EA Technology provides innovative solutions to consultancy problems encompassing small and large wind projects (eg for Yorkshire Water), photovoltaic and thermo solar (eg Department of Trade and Industry - International Energy Agency), mini- and micro-CHP (e.g. for the European Commission), small scale hydro, fuel cells (eg Baxi Group), biomass and waste energy converters (eg Compass Power Solutions), heat pumps and tidal-wave energy.

2 Approach to study

The two key tasks were:

- Data collection: review Cheshire County Council documents and locate relevant new information, with emphasis on economic and practical issues in built development, from (a) EA Technology documents/experience and (b) UK and international websites
- Data analysis: collate all information to match Cheshire County Council requirements

The period for consideration of available renewable energy technologies was summarised by dividing into three equal parts: 2004, up to 2010, and up to 2016. Given the nature of progress in uptake of renewable technologies, particularly progress in the areas of technology development and grants/funding, a finer division was not felt to be realistic.

Sections 3 to 7 cover renewable energy technologies in alphabetical order:

- Biomass
- Geothermal
- Solar/PV
- Water
- Wind

Section 8 covers a source which may be considered as “renewable energy”:

- Waste

Section 9 covers a source which may be included under “new and renewable energy”:

- Combined Heat and Power (CHP)

Within each of the technology sections, and within each of their sub-sections, there are pairs of tables showing EA Technology expert opinion on the approximate year of availability (2004, by 2010, or by 2016), the economic viability and, where applicable, the appropriate size and type of development. The term “economic viability” is interpreted here as the typical criteria employed commercially to evaluate the worth of a scheme once grants and incentives have been included. Each pair of tables is initially divided into six columns:

The column headings for the "a" tables (eg Table 1a) are:

C3 Houses	A1-A3 Shops, etc, petrol stations B1a Offices C1 Hotels C2 Schools, hospitals D1 Public halls, etc D2 Sports halls, etc	B1b Laboratories, etc B1c Light industry B8 Warehouses, etc

The column headings for the "b" tables (eg Table 1b) are:

B2 Industry, general - Chemical - Minerals	- Agricultural - Horticultural	- Waste sites

While avoiding duplication of the work reported in "Renewable energy in Merseyside & Cheshire: a review" [R1], a few bullet points from that report, particularly in the areas of economic viability and specific allocations to Cheshire were felt to be of direct relevance and are therefore quoted and referenced in these technology sections.

Summary tables of views from all the sources referenced in Sections 3 to 9, ie all the reviewed documents and the expert opinion tables, are given in Section 10.

Finally, Section 11 discusses the validity of the proposed 10% renewable target for Cheshire, and Section 12 lists the quoted references to documents and websites.

2.1 European experience

The installed capacity of renewable electricity plants in the European Union is increasing slowly. Appendix Table A1 shows the trend since 1990 for electricity generation from all renewable sources in the European Union [R5].

EA Technology would like to draw attention to a multi-national project which is nearing completion. RESSET is a multinational program operated by the Group of Building Environmental Research (GRBES) under the frame of the University of Athens [R6, R7]. RESSET aims to develop global strategies, tools and guidelines to promote the implementation of renewable energy in new urban settlements in Europe. One of the project's outputs is:

- A Reference Manual - Design Guidelines Handbook, presenting global design guidelines, performance criteria and methodologies for best practice implementation of renewable energy systems and techniques in new-build settlements. The manual, to be published in London, will be appropriate for building designers, urban experts, utility managers, policy makers and building energy operators.

2.2 Maps of Cheshire

Figure 1: Map of Cheshire

Figure 1 shows the area covered by Cheshire County Council [R8].

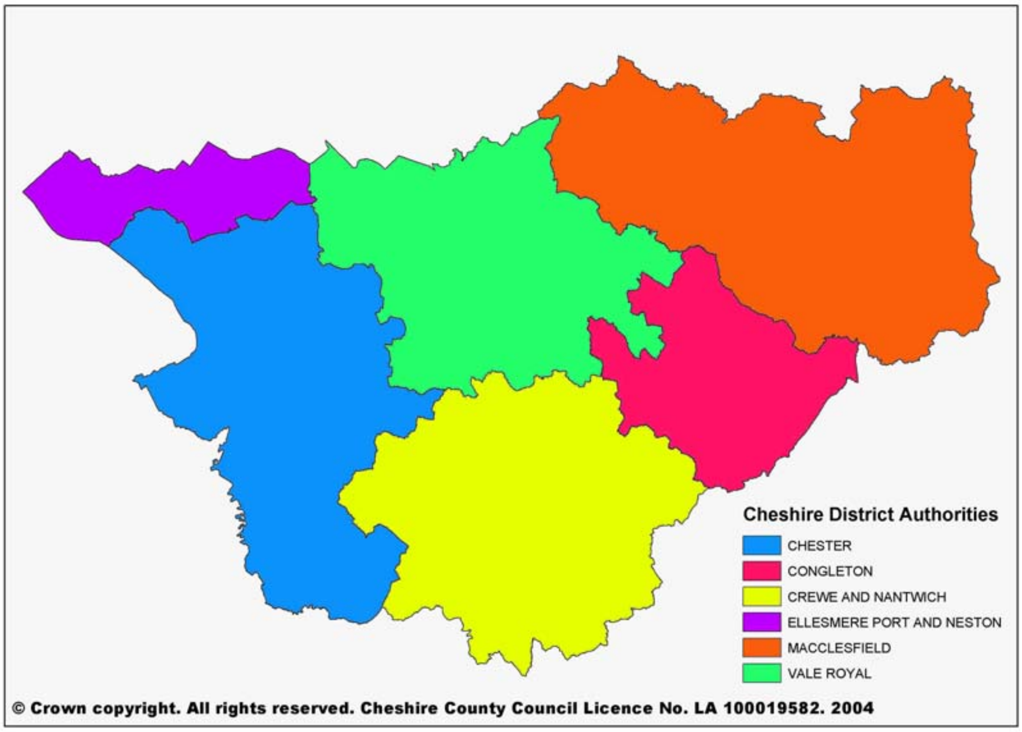

Figure 2: Map of Cheshire County Council district councils

3 Biomass

The following maps are taken from the ‘From Power to Prosperity’ report [R2].

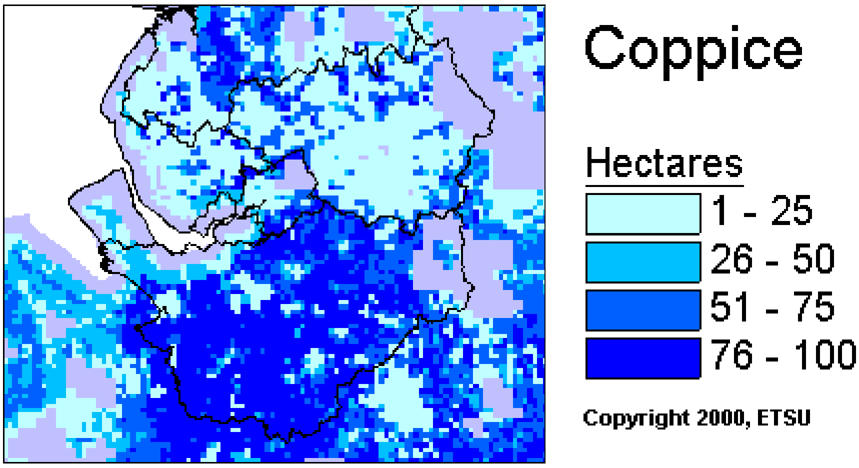

Figure 3: Potential coppice in Cheshire

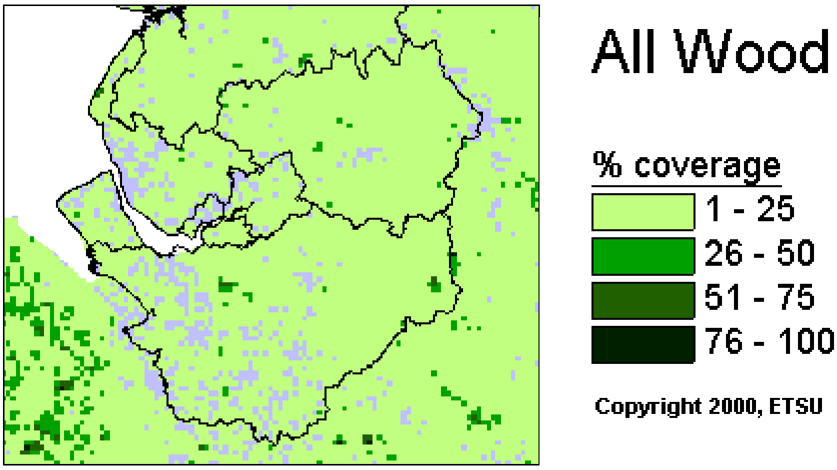

Figure 4: Current tree cover in Cheshire

The 2004 Renewables Review [R1] Appendix H Section 2.2 “Wood-fuelled Biomass Heating" gives background, current status, impacts & barriers, opportunities & benefits for this technology. The section reports:

- There are a number of obvious sites that may have potential for biomass heating in the region. For example, horticultural glass houses require a significant amount of heat and are often in rural areas with high biomass resources, and properties in ‘off gas’ areas will be using more expensive fuels to heat their homes or businesses.

- High capital cost, and long payback times – with available grants, large scale wood chip boilers (e.g. greater than 100kW) are potentially cost-effective, particularly in off-gas areas. However, for smaller scale, domestic-sized boilers and stoves, payback times are typically 10 years or more.

Expert opinion at EA Technology was canvassed to give estimates of whether biomass technology is available and applicable in 2004 or, if not, whether it is likely by 2010 or by 2016 (see Table 1 below). Estimates of economic viability for different types of development are also included in the table, where:

E = economically viable by the stated date
e = marginal economic viability by given date

TABLE 1a: Expert opinion on availability and economic viability of biomass technology for different types of development by 2004, 2010, 2016 (a) domestic, commercial, light industry

	C3 Houses	A1-A3 Shops, etc, petrol stations B1a Offices C1 Hotels C2 Schools, hospitals D1 Public halls, etc D2 Sports halls, etc	B1b Laboratories, etc B1c Light industry B8 Warehouses, etc
Biomass	2004 (wood for fuel) e	2004-2016 dependent upon supply chain developments in biomass fuel 2016 e	2004-2016 dependent upon supply chain developments in biomass fuel 2010 e

TABLE 1b: Expert opinion on availability and economic viability of biomass technology for different types of development by 2004, 2010, 2016 (b) general industry, agricultural, waste

	B2 Industry, general - Chemical - Minerals	- Agricultural - Horticultural	- Waste sites
Biomass	2010 e (eg energy-intensive 24-hour type, or where the fuel is a by-product of the process)	2004 (increasing 2010, increasing again 2016) E	-

4 Geothermal

The 2004 Renewables Review [R1] Appendix H Section 2.3 “Ground Source Heat Pumps" gives background, current status, impacts & barriers, opportunities & benefits for this technology. The section reports:

- The payback time depends on the fossil fuel displaced, but for a system offsetting electrical heating, the payback would be approximately 10 to 15 years. It is important to note that heat pumps are most cost-effective in well-insulated properties with a low heat demand.

Expert opinion at EA Technology was canvassed to give estimates of whether geothermal technology is available and applicable in 2004 or, if not, whether it is likely by 2010 or by

2016 (see Table 2 below). Estimates of economic viability for different types of development are also included in the table, where:

E = economically viable by the stated date
e = marginal economic viability by given date

TABLE 2a: Expert opinion on availability and economic viability of geothermal technology for different types of development by 2004, 2010, 2016 (a) domestic, commercial, light industry

	C3 Houses	A1-A3 Shops, etc, petrol stations B1a Offices C1 Hotels C2 Schools, hospitals D1 Public halls, etc D2 Sports halls, etc	B1b Laboratories, etc B1c Light industry B8 Warehouses, etc
Geothermal	2004 (and increasing gradually) e (or E if no gas supply) (E in 2016)	2004 (and increasing gradually) (for hotels, swim-pools, 24-hour loads) e (or E if no gas supply) (E in 2016)	-

TABLE 2b: Expert opinion on availability and economic viability of geothermal technology for different types of development by 2004, 2010, 2016 (b) general industry, agricultural, waste

	B2 Industry, general - Chemical - Minerals	- Agricultural - Horticultural	- Waste sites
Geothermal	-	2004 e/E (frost-free glasshouses)	-

5 Solar/PV

5.1 Photovoltaics (PV)

The 2004 Renewables Review [R1] Appendix H Section 1.2 “Photovoltaics (PV)" gives background, current status, impacts & barriers, opportunities & benefits for this technology. The section reports:

- In relative terms, PV technology is still a very expensive form of electricity generation. However, the efficiency of solar cells is slowly improving, and as the market grows, mass production is beginning to reduce the price of PV modules.

- The indicative sub-regional allocations for PV as presented in the regional assessment report [R2] suggest that Cheshire could provide 1.43MW_{dnc} (*where dnc = declared net capacity*)

- Niche applications – for local authorities, there are potential stand-alone applications for PV which are more cost-effective, e.g. parking meters & low-power street lighting. These avoid the cost of connecting to the grid.

Local government in North Devon [R9] have reported:

- The use of solar photovoltaics (PV) for electricity generation has a significant potential in the UK, despite at present being one of the more expensive sources of renewable energy.

- The present installations of photovoltaic cells are conducted by integrating them into buildings thereby offsetting some of the costs of the roof construction and saving space. Some of the most likely applications will include:

    - New, high profile commercial office buildings
    - New housing developments (preferably incorporating low energy design features)
    - Schools and other educational buildings
    - Other large high profile developments (such as sports stadiums)

- The technical potential for using these technologies will therefore depend upon the availability of suitable buildings and the number that are constructed up to 2010.

The following statement [R10] on the energy payback for PV is made by the European Photovoltaic Industry Association:

- A popular belief still persists that PV systems cannot 'pay back' their energy investment within the expected lifetime of a typical system – about 20-25 years. This is because the energy used, especially during the production of solar cells, is seen to far outweigh the electricity eventually generated. Data from recent studies demonstrate, however, that present-day systems already have an energy payback time – the time taken for power generation to compensate for the energy used in production – well below their expected lifetime … One way in which efficiency will be increased is through the production of solar-grade silicon specifically designed for the PV market, as opposed to the high quality silicon from the electronics industry currently employed.

Expert opinion at EA Technology was canvassed to give estimates of whether PV technology is available and applicable in 2004 or, if not, whether it is likely by 2010 or by 2016 (see Table 3 below). Estimates of economic viability for different types of development are also included in the table, where:

E = economically viable by the stated date
e = marginal economic viability by given date

TABLE 3a: Expert opinion on availability and economic viability of PV technology for different types of development by 2004, 2010, 2016 (a) domestic, commercial, light industry

	C3 Houses	A1-A3 Shops, etc, petrol stations B1a Offices C1 Hotels C2 Schools, hospitals D1 Public halls, etc D2 Sports halls, etc	B1b Laboratories, etc B1c Light industry B8 Warehouses, etc
- Photovoltaics (PV)	2004 (and increasing) * (e for ten terraced houses with south-facing roofs)	2004 (and increasing) *	2004 (and increasing) * (e in 2010 for large-scale new-build)

* PV is not generally economically viable, but innovators will install PV anyway (and given that Cheshire is the wealthiest county per capita in the UK, this will greatly increase the number of innovators in the county above the national average).

TABLE 3b: Expert opinion on availability and economic viability of PV technology for different types of development by 2004, 2010, 2016 (b) general industry, agricultural, waste

	B2 Industry, general - Chemical - Minerals	- Agricultural - Horticultural	- Waste sites
- Photovoltaics (PV)	2004 (and increasing) * (e in 2010 for large-scale new-build)	2004* (e in 2010 for large-scale new-build)	-

* PV is not generally economically viable, but innovators will install PV anyway (and given that Cheshire is the wealthiest county per capita in the UK, this will greatly increase the number of innovators in the county above the national average).

5.2 Solar water heating

The 2004 Renewables Review [R1] Appendix H Section 2.1 “Solar Water Heating" gives background, current status, impacts & barriers, opportunities & benefits for this technology. The section reports:

- With the exception of households that use electricity to heat their water, it has no financial payback in its operational life time
- This technology is currently not viable in purely commercial terms

Expert opinion at EA Technology was canvassed to give estimates of whether solar water heating is available and applicable in 2004 or, if not, whether it is likely by 2010 or by 2016 (see Table 4 below). Estimates of economic viability for different types of development are also included in the table, where:

E = economically viable by the stated date
e = marginal economic viability by given date

TABLE 4a: Expert opinion on availability and economic viability of solar water heating for different types of development by 2004, 2010, 2016 (a) domestic, commercial, light industry

	C3 Houses	A1-A3 Shops, etc, petrol stations B1a Offices C1 Hotels C2 Schools, hospitals D1 Public halls, etc D2 Sports halls, etc	B1b Laboratories, etc B1c Light industry B8 Warehouses, etc
- Solar water heating	2004 (and increasing) e	2004 (and increasing) e (for hotels, swim-pools, 24-hour loads)	2004 e

TABLE 4b: Expert opinion on availability and economic viability of solar water heating for different types of development by 2004, 2010, 2016 (b) general industry, agricultural, waste

	B2 Industry, general - Chemical - Minerals	- Agricultural - Horticultural	- Waste sites
- Solar water heating	2004 e	2004 e	-

5.3 Passive solar design

Passive solar design, that is designing a building to take maximum advantage of sunlight, can significantly reduce the overall energy consumption of a building [R11]. The 2004 Renewables Review [R1] Appendix H Section 2.4 “Passive Solar Design" gives background, current status, impacts & barriers, opportunities & benefits for passive solar design.

Expert opinion at EA Technology was canvassed to give estimates of whether passive solar design is available and applicable in 2004 or, if not, whether it is likely by 2010 or by 2016 (see Table 5 below).

Estimates of economic viability for different types of development are also included in the table, where:

E = economically viable by the stated date
e = marginal economic viability by given date

TABLE 5a: Expert opinion on availability and economic viability of passive solar design for different types of development by 2004, 2010, 2016 (a) domestic, commercial, light industry

	C3 Houses	A1-A3 Shops, etc, petrol stations B1a Offices C1 Hotels C2 Schools, hospitals D1 Public halls, etc D2 Sports halls, etc	B1b Laboratories, etc B1c Light industry B8 Warehouses, etc
- Passive solar design	2004 E	2004 E	2004 E

TABLE 5b: Expert opinion on availability and economic viability of passive solar design for different types of development by 2004, 2010, 2016 (b) general industry, agricultural, waste

	B2 Industry, general - Chemical - Minerals	- Agricultural - Horticultural	- Waste sites
- Passive solar design	2004 E	2004 E (eg glasshouses)	2004 (eg for heating ground to increase digestion) E

6 Water

6.1 Small-scale hydro

The 2004 Renewables Review [R1] Appendix H Section 1.1 “Small Scale Hydro" gives background, current status, impacts & barriers, opportunities & benefits for this technology. The section reports:

- Assessments have shown potential for small scale hydro on the Dane and at 5 sites along the river Weaver [R8]

Energy Saving Trust [R12] adds the following information on costs and economics:

- Systems have different 'heads' or pressures of water. If the water has to fall further, the volume of water needed to operate it will be less. The lower the head, the larger the turbines need to be, which means the costs are also more.
- An existing mill pond or weir would reduce the cost
- For very small-scale medium head schemes there tends to be a fixed cost regardless of the size of plant
- Installation costs for domestic size systems can be reduced if aspects of the work are carried out on a DIY basis - for example, laying the pipeline.

Expert opinion at EA Technology was canvassed to give estimates of whether small scale hydro technology is available and applicable in 2004 or, if not, whether it is likely by 2010 or by 2016 (see Table 6 below). Estimates of economic viability for different types of development are also included in the table, where:

E = economically viable by the stated date
e = marginal economic viability by given date

TABLE 6a: Expert opinion on availability and economic viability of small scale hydro technology for different types of development by 2004, 2010, 2016 (a) domestic, commercial, light industry

	C3 Houses	A1-A3 Shops, etc, petrol stations B1a Offices C1 Hotels C2 Schools, hospitals D1 Public halls, etc D2 Sports halls, etc	B1b Laboratories, etc B1c Light industry B8 Warehouses, etc
- Small-scale hydro	-	2004 E (if site appropriate)	2004 E (if site appropriate)

TABLE 6b: Expert opinion on availability and economic viability of small scale hydro technology for different types of development by 2004, 2010, 2016 (b) general industry, agricultural, waste

	B2 Industry, general - Chemical - Minerals	- Agricultural - Horticultural	- Waste sites
- Small-scale hydro	2004 E/e (depending on application)	2004 E/e (depending on application)	-

6.2 Tidal/wave

The Renewables Review [R1] Appendix H Section 3.2 “Wave" and Section 3.3 “Tidal" give background, current status, impacts & barriers, opportunities & benefits for wave and tidal technologies.

Expert opinion canvassed at EA Technology was that tidal and wave technology is unlikely to be available and applicable by 2016 to building developments on the river estuaries of the Cheshire coastline (see Figure 1).

7 Wind

The following map, from the ‘From Power to Prosperity’ report [R2], shows that most sites in Cheshire have average wind speeds below 7 m/s (■).

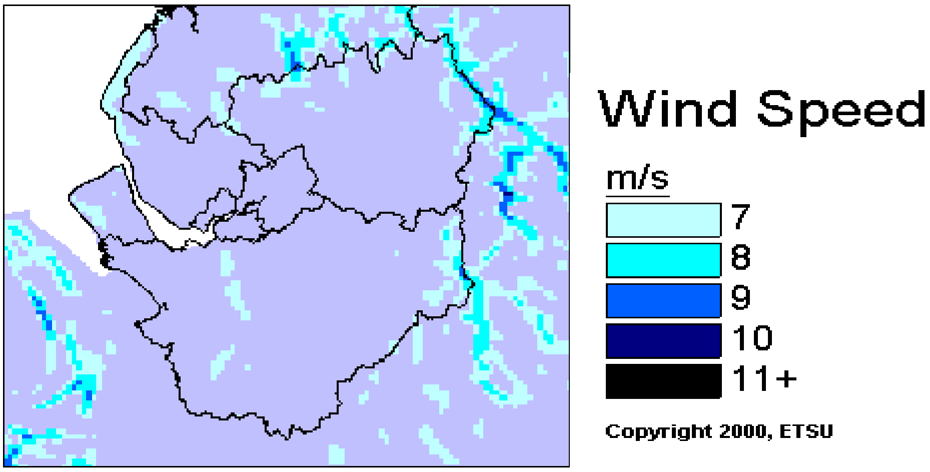

Figure 5: Average wind speeds in Cheshire

The 2004 Renewables Review [R1] Appendix H Section 1.3 “Onshore Wind" and Section 3.1 “Offshore Wind" give background, current status, impacts & barriers, opportunities & benefits, and basic assessment criteria for wind technology.
The onshore wind section reports:

- The 2001 regional assessment identified 1 scheme in the Cheshire area at East Town Farm (Vale Royal BC)
- A commercial-scale wind farm will typically have generated an amount of energy equal to that used during its construction within the first three months [R13]
- The indicative sub-regional allocation for onshore wind as presented in the regional assessment report [R2] suggests that Cheshire could provide 13.3MW_{dnc} (*where dnc = declared net capacity*)
- Urban areas are generally considered less suitable for wind turbines due to lower wind speeds

Energy Saving Trust [R12] adds the following information on wind costs and economics:

- DIY installation for the smaller scale turbines will bring down the costs dramatically
- For the smaller turbines, payback periods are in the region of over 50 years. For grid-connected turbines, simple payback periods can drop to under five years.
- It isn't easy to install a wind generator on your home or business, particularly in an urban environment, but wind turbines are typically four times more effective than solar PV at producing electricity and have an important part to play.

Expert opinion at EA Technology was canvassed to give estimates of whether wind technology is available and applicable in 2004 or, if not, whether it is likely by 2010 or by 2016 (see Table 7 below). Estimates of economic viability for different types of development are also included in the table, where:

E = economically viable by the stated date
e = marginal economic viability by given date

TABLE 7a: Expert opinion on availability and economic viability of wind technology for different types of development by 2004, 2010, 2016 (a) domestic, commercial, light industry

	C3 Houses	A1-A3 Shops, etc, petrol stations B1a Offices C1 Hotels C2 Schools, hospitals D1 Public halls, etc D2 Sports halls, etc	B1b Laboratories, etc B1c Light industry B8 Warehouses, etc
Wind	2004 (and increasing) e	2004 (and increasing) e	2004 (and increasing) e

TABLE 7b: Expert opinion on availability and economic viability of wind technology for different types of development by 2004, 2010, 2016 (b) general industry, agricultural, waste

	B2 Industry, general - Chemical - Minerals	- Agricultural - Horticultural	- Waste sites
Wind	2004 (and increasing) E	2004 (and increasing) E	2004 (and increasing) E

8 Waste

The 2004 Renewables Review [R1] Appendix H Section 1.5 “Energy from Waste" gives background, current status, impacts & barriers, opportunities & benefits for this technology. Sub-section 1.5.1 ”Centralised Anaerobic Digestion (CAD) of Food, Animal and Sewage Waste" reports:

- The economics of CAD are finely balanced. Industry experience suggests that in order for plants to be commercially available, then the following are required:
    - the plant will need to be able to sell its heat as well as electricity. This will mean locating the plant close to a suitable heat load – e.g. industrial process heat, district heating, glasshouses.
    - the use of at least a 20% mix of food waste – this is because food producers will be willing to pay the plant to take food waste, otherwise they have to treat it themselves on site, or pay someone else to dispose of it
- The indicative sub-regional allocation for this technology as presented for Cheshire in the regional assessment report [R2] gives a figure of 0.5MW_{dnc} (*where dnc = declared net capacity*)

Sub-section 1.5.2 “Landfill Gas" reports:

- The indicative sub-regional allocation for this technology as presented for Cheshire in the regional assessment report [R2] gives a figure of 4.5MW_{dnc} (*where dnc = declared net capacity*)

Sub-section 1.5.3 "Advanced Thermal Treatment (ATT) – using Pyrolysis or Gasification" reports:

- Economics - there are also economic benefits associated with minimising the amount of waste sent to landfill. Waste sent to landfill is subject to the Landfill Levy, which was introduced in 1996 to encourage effective waste management. In addition, ATT plants can claim ROCs for the renewable electricity they generate.

Expert opinion at EA Technology was canvassed to give estimates of whether the technology for generating energy from waste is available and applicable in 2004 or, if not, whether it is likely by 2010 or by 2016 (see Table 8 below). Estimates of economic viability for different types of development are also included in the table, where:

E = economically viable by the stated date
e = marginal economic viability by given date

TABLE 8a: Expert opinion on availability and economic viability of energy from waste for different types of development by 2004, 2010, 2016 (a) domestic, commercial, light industry

	C3 Houses	A1-A3 Shops, etc, petrol stations B1a Offices C1 Hotels C2 Schools, hospitals D1 Public halls, etc D2 Sports halls, etc	B1b Laboratories, etc B1c Light industry B8 Warehouses, etc
Waste, eg anaerobic digestion, landfill gas	2016 e	2004 e (eg shops, hotels, schools)	2004 E

TABLE 8b: Expert opinion on availability and economic viability of energy from waste for different types of development by 2004, 2010, 2016 (b) general industry, agricultural, waste

	B2 Industry, general - Chemical - Minerals	- Agricultural - Horticultural	- Waste sites
Waste, eg anaerobic digestion, landfill gas	2004 E/e (eg food waste, tyres, plastics)	2004 E/e	2004 E

9 Combined Heat and Power (CHP)

The 2004 Renewables Review [R1] Appendix H Section 1.4 "Combined Heat and Power, using Energy Crops, Agricultural Waste and/or Forest Residues" gives background, current status, impacts & barriers, opportunities & benefits for this technology. The section reports:

- Economic viability of small-scale biomass CHP plants is very tight, and, in the short term, will rely on capital grants for the construction of power plants, and establishment grants for growing energy crops. Current indications suggest that in order to be economically viable, energy crop CHP plants will need to sell the heat as well as the electricity, which means that they will need to be located close to large heat loads.

In the European Union, four industries (chemical, refining, food, and pulp and paper) account for 80% of industrial CHP, and industry as a whole accounts for 80% of total CHP [R14]. However, most CHP capacity is large and tends to be connected at high voltages (i.e. 110 kV or above).

The prospects for CHP growth in European countries were examined in a 'Future Cogen' project [R15]. Three of the future scenarios modelled were:

(1) *Present policies*, ie current energy policies continue, particularly those affecting CHP, including changes expected. Technology developments are evolutionary, not revolutionary.

(2) *Heightened environmental awareness* based upon present policies, but with extra benefits for 'green' technologies. This involves including the external benefits of CHP through the introduction of a carbon tax and faster technology developments.

(3) A *post-Kyoto world* where CHP benefits are fully included in the technology cost. Micro-CHP becomes technically and economically feasible, and fuel cell CHP becomes possible, with increased investment into 'cleaner' technologies. Flexible mechanisms, such as emissions trading, provide new finance. Economic and energy policies are focused on distributed generation.

Table 9: Forecast CHP capacity (GW_e) under different scenarios

	Scenario 1: Present policies				
	2000	**2005**	**2010**	**2015**	**2020**
EU-15	73.6	76.7	80.6	88.6	94.7
	Scenario 2: Heightened environmental awareness				
	2000	**2005**	**2010**	**2015**	**2020**
EU-15	73.6	80.3	90.7	105.3	124.3
	Scenario 3: Post-Kyoto				
	2000	**2005**	**2010**	**2015**	**2020**
EU-15	73.6	87.9	134.8	166.1	194.8

It is only under the third scenario, the best case scenario, that significant growth occurs and the European Commission's target of 18% electricity generation from CHP by 2010 is achieved.

In the following sub-sections, large–scale CHP plants, typically supplying electricity directly to electricity networks and hot water directly to a district heating scheme have been excluded. Mini-CHP is non-domestic, typically <250kWe; micro-CHP is typically domestic, eg ~1kWe.

9.1 Mini-CHP

Expert opinion at EA Technology was canvassed to give estimates of whether mini-CHP technology is available and applicable in 2004 or, if not, whether it is likely by 2010 or by 2016 (see Table 10 below). Estimates of economic viability for different types of development are also included in the table, where:

E = economically viable by the stated date
e = marginal economic viability by given date

TABLE 10a: Expert opinion on availability and economic viability of mini-CHP technology for different types of development by 2004, 2010, 2016 (a) domestic, commercial, light industry

	C3 Houses	A1-A3 Shops, etc, petrol stations B1a Offices C1 Hotels C2 Schools, hospitals D1 Public halls, etc D2 Sports halls, etc	B1b Laboratories, etc B1c Light industry B8 Warehouses, etc
- Mini-CHP	-	2004 (multi-residential, shops, hotels, hospitals, swim-pools *not offices, schools, public halls*) E (24-hour applications) or e (12-hour application)	2004 e (E in 2010)

TABLE 10b: Expert opinion on availability and economic viability of mini-CHP technology for different types of development by 2004, 2010, 2016 (b) general industry, agricultural, waste

	B2 Industry, general - Chemical - Minerals	- Agricultural - Horticultural	- Waste sites
- Mini-CHP	2004 E (24-hour applications) or e (when not 24-hours)	2004 (and increasing) E (24-hour applications) or e (when not 24-hours)	2004 (eg running on biogas for district heating) e

9.2 Micro-CHP

Expert opinion at EA Technology was canvassed to give estimates of whether micro-CHP technology is available and applicable in 2004 or, if not, whether it is likely by 2010 or by 2016 (see Table 11 below). Estimates of economic viability for different types of development are also included in the table, where:

E = economically viable by the stated date
e = marginal economic viability by given date

TABLE 11a: Expert opinion on availability and economic viability of micro-CHP technology for different types of development by 2004, 2010, 2016 (a) domestic, commercial, light industry

	C3 Houses	A1-A3 Shops, etc, petrol stations B1a Offices C1 Hotels C2 Schools, hospitals D1 Public halls, etc D2 Sports halls, etc	B1b Laboratories, etc B1c Light industry B8 Warehouses, etc
- Micro-CHP	2010* (and increasing to 2016) E/e	2010 for shops (and increasing to 2016) E (for 24-hour applications) or e (12-hour applications)	-

*currently at market trial stage (trials of Stirling engine micro-CHP units in houses have been carried out in Chester area by EA Technology)

TABLE 11b: Expert opinion on availability and economic viability of micro-CHP technology for different types of development by 2004, 2010, 2016 (b) general industry, agricultural, waste

	B2 Industry, general - Chemical - Minerals	- Agricultural - Horticultural	- Waste sites
- Micro-CHP	-	-	-

10 Summary tables for renewable energy technologies

Summary tables of views from all the sources referenced in Sections 3 to 9, ie all the reviewed documents and the expert opinion tables, are given in this section .

These summary tables (Tables 12a and 12b below) cover the same categories as the tables in the earlier sections:

- whether the technologies are available and applicable in 2004 or, if not, whether this is likely by 2010 or by 2016)
    - the symbol “-” represents “not available in the time frame” or “not applicable”
- estimates of economic viability for different types of development are included, where: E = economically viable by the stated date
  e = marginal economic viability by given date
    - neither E nor e signifies “not economically viable within the time frame”
- initial division into six types of development (three columns for each table), and, where applicable, appropriate size or type of development within each table cell

TABLE 12a: Expert opinion on renewable energy availability and economic viability for different types of development by 2004, 2010, 2016 (a) domestic, commercial, light industry

	C3 Houses	**A1-A3 Shops, etc, petrol stations** **B1a Offices** **C1 Hotels** **C2 Schools, hospitals** **D1 Public halls, etc** **D2 Sports halls, etc**	**B1b Laboratories, etc** **B1c Light industry** **B8 Warehouses, etc**
Biomass	2004 (wood for fuel) e	2004-2016 dependant upon supply chain developments in biomass fuel 2016 e	2004-2016 dependant upon supply chain developments in biomass fuel 2010 e
Geothermal	2004 (and increasing gradually) (eg well-insulated properties with low heat demand) e (or E if no gas supply) (E in 2016)	2004 (and increasing gradually) (for hotels, swim-pools, 24-hour loads) e (or E if no gas supply) (E in 2016)	-
Solar/PV			
- Photovoltaics (PV)	2004 (and increasing) [1] (e for terraced houses with building-integrated PV on south-facing roofs)	2004 (and increasing) [1] (eg high profile offices and sports stadiums)	2004 (and increasing) [1] (e in 2010 for large-scale new-build)
- Solar water heating	2004 (and increasing) e (eg to replace electric water heating)	2004 (and increasing) e (for hotels, swim-pools, 24-hour loads)	2004 e
- Passive solar design	2004 E	2004 E	2004 E
Water			
- Small-scale hydro	2004 E (site-dependent)	2004 E (if site appropriate)	2004 E (if site appropriate)
- Tidal/wave	-	-	-
Wind	2004 (and increasing) e	2004 (and increasing) e	2004 (and increasing) e
Waste, eg anaerobic digestion, landfill gas	2016 e	2004 e (eg shops, hotels, schools) [2]	2004 E [2]
CHP (mini/micro)			
- Mini-CHP (typically <250kWe)	-	2004 (multi-residential, shops, hotels, hospitals, swim-pools *not offices, schools, public halls*) E (24-hour applications) or e (12-hour application)	2004 e (E in 2010)
- Micro-CHP (typically ~1kWe)	2010* (and increasing to 2016) E/e [3]	2010 for shops (and increasing to 2016) E (for 24-hour applications) or e (12-hour applications)	-

[1] PV is not generally economically viable, but innovators will install PV anyway (and given that Cheshire is the wealthiest county per capita in the UK, this will greatly increase the number of innovators in the county above the national average).
[2] eg where the plant can sell both heat and electricity (eg industrial process heat, district heating, glasshouses)
[3] currently at market trial stage (trials of Stirling engine micro-CHP units in houses have been carried out in Chester area by EA Technology)

TABLE 12b: Expert opinion on renewable energy availability and economic viability for different types of development by 2004, 2010, 2016 (b) general industry, agricultural, waste

	B2 Industry, general - Chemical - Minerals	**- Agricultural - Horticultural**	**- Waste sites**
Biomass	2010 e (eg energy-intensive 24-hour type, or where the fuel is a by-product of the process)	2004 (increasing 2010, increasing again 2016) E (eg glasshouses)	-
Geothermal	-	2004 e/E (frost-free glasshouses)	-
Solar/PV			
- Photovoltaics (PV)	2004 (and increasing) [1] (e in 2010 for large-scale new-build)	2004 [1] (e in 2010 for large-scale new-build)	-
- Solar water heating	2004 e	2004 e	-
- Passive solar design	2004 E	2004 E (eg glasshouses)	2004 (eg for heating ground to increase digestion) E
Water			
- Small-scale hydro	2004 E/e (depending on application)	2004 E/e (depending on application)	-
- Tidal/wave	-	-	-
Wind	2004 (and increasing) E	2004 (and increasing) E	2004 (and increasing) E
Waste, eg anaerobic digestion, landfill gas	2004 E/e (eg waste food, tyres, plastics) [2]	2004 E/e [2]	2004 E [2]
CHP (mini/micro)			
- Mini-CHP (typically <250kWe)	2004 E (24-hour applications) or e (when not 24-hours)	2004 (and increasing) E (24-hour applications) or e (when not 24-hours)	2004 (eg running on biogas for district heating) e
- Micro-CHP (typically ~1kWe)	-	-	-

[1] PV is not generally economically viable, but innovators will install PV anyway (and given that Cheshire is the wealthiest county per capita in the UK, this will greatly increase the number of innovators in the county above the national average).
[2] eg where the plant can sell both heat and electricity (eg industrial process heat, district heating, glasshouses)

11 Renewable energy target for Cheshire

One aim of this study is to put forward the justification for Cheshire County Council to adopt a requirement for a minimum percentage (say 10%) of predicted energy requirements to be generated from on-site renewable sources.

The following conclusions are based on work reported in this study and on experience gained in the renewable energy field:

- In 2004, 10% is at present not realistic because most of the technology still needs to drop further in cost, but if there is a specific requirement (eg like the new requirement for condensing boilers in the Building Regulations) then the 10% target would be achievable. If the 10% figure is not a requirement, then 10% could possibly still be a reasonable figure to state as a target; but an overall average of 5% would be a maximum reasonable figure to expect in practice.

- By 2010, if excluding CHP but including some incentives, then 5% is definitely a realistic figure to target and to expect to achieve. If including micro-CHP as a partly renewable technology, then for domestic properties 10% is entirely realistic.

- By 2016, 10% is definitely achievable and therefore a feasible target.

In addition to the environmental benefits for Cheshire, a more proactive renewable energy policy may encourage local growth and attract new industry to the area.

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– Task 1 Report, January 2001
– Task 2 Report, March 2001
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[R3] www.cheshirerenewables.org.uk

[R4] Energy efficiency: www.actionenergy.org.uk
Green electricity: www.greenenergy.org.uk

[R5] International Energy Agency (IEA) websites: http://library.iea.org/renew/eng and http://library.iea.org/textbase/stats

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[R11] "Oldham replacement unitary development plan – Revised deposit draft", October 2003 [confidential draft]

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[R14] OECD/IEA, "Distributed generation in liberalised electricity markets", 2002, 124pp

[R15] "The future of CHP in the European market - The European cogeneration study"; Future Cogen Project; Report no XVii/4.1031/P/99-169, May 2001

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Appendix I

Table A1: Electricity Generation in the European Union from Renewable Sources

EUROPEAN UNION		1990	2000	2001	2002 Estimated
PRODUCT	FLOW				
Hydro	Total Electricity Output in GWh	276,118	344,771	362,517	305,435
Geothermal	Total Electricity Output in GWh	3,226	4,785	4,612	4,756
Solar Photovoltaics	Total Electricity Output in GWh	12	110	217	259
Tide/Wave	Total Electricity Output in GWh	571	566	543	540
Wind	Total Electricity Output in GWh	778	22,243	27,194	36,624
Industrial Waste (Non-Renewable)	Total Electricity Output in GWh	..	6,561	8,263	7,121
Renewable Municipal Waste	Total Electricity Output in GWh	..	9,192	10,133	10,740
Non-Renewable Municipal Waste	Total Electricity Output in GWh	..	4,263	4,088	4,209
Solid Biomass	Total Electricity Output in GWh	10,207	19,755	20,785	25,296
Gas from Biomass	Total Electricity Output in GWh	..	6,331	7,546	7,789
Other Waste Heat and Heat Pumps	Total Electricity Output in GWh	0	0	0	0
Total Renewable Electricity	Total Electricity Output in GWh	..	418,577	445,898	402,769

Source: International Energy Agency [R5]