



## BIOMASS TECHNOLOGY

### SYSTEM OVERVIEW

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## EXECUTIVE SUMMARY

The scope of the report is to investigate the possibility of biomass fuel use in Combined Heat and Power generation (CHP) systems for large-scale projects in the London area.

The study shows that currently biomass CHP is not economically feasible and widely available for the London area. The technology is still under development and the fuel supply and quality cannot be guaranteed.

The main obstacles to the application of biomass CHP in London projects are:

- a. Very high capital cost for CHP package plant which will need to be manufactured and sized depending on the energy needs of each specific project
- b. Biomass CHP technology for mid-scale application is still under development (no reliable systems are being used at the moment)
- c. Although biomass fuel is available in the London area, its sourcing, transportation and storage may be problematic. Woodchip or wood pellets either need large storage spaces and/or continuous deliveries from the suppliers. Additionally, biodiesel oil requires large areas to grow sunflower seeds or alternatively the oil needs to be imported from France. A plant which produces biogas from landfill and other waste is under development and therefore not yet available.
- d. Certification of the quality of biomass fuel is not widely available (the woodchips and pellets need to be of a specific quality and there needs to be an intermediate party to check the quality before using it in the CHP)
- e. Planning permission may be required, as combustion gases require an external flue of the height of a conventional chimney.
- f. A biomass CHP system that has been installed by Bioregional for BedZED in South London has encountered all the above difficulties is still not operational.

However it is envisaged that application of biomass CHP systems will be feasible in London in the near future, when CHP systems are developed for mid-scale projects and when the fuel's quality can be guaranteed for use on the specific systems.

Although UK legislation on Clean Air Act is not updated for many years, there are no concerns on pollutant emissions in to the air from burning clean biomass in CHP and boilers of latest technology and certification (CEN or DIN). Small domestic scale

woodchip or pellet burning may cause air pollution, however this is outside of the scope of this study.<sup>1</sup>

Given the above conclusions on biomass CHP, alternative low carbon technologies have been explored for this report:

- a. Biomass boilers, with the use of pellets or woodchips, where suitable fuel and storage space can be provided
- b. CHP using a percentage of the fuel from bio-diesel or biogas blended with normal fossil fuel



Straw bale  
(Source: European Biomass Association)

<sup>1</sup> Information received from Renewable Energy Association in London

## INTRODUCTION

The report investigates the possibility to use biomass fuel in Combined Heat and Power generation (CHP) systems and boilers for large-scale projects in the London area.

Biomass CHP is one of the low carbon solutions for heat and power supply for buildings and their users' activities. Both biomass heating (i.e. boilers) and biomass CHP are recognised in the (London) Mayor's Energy Strategy called the London Plan as low and zero carbon (LZC) technologies.

Biomass can be used as an alternative to fossil fuel with no or very low carbon emissions, depending on its transportation distance and energy used for processing. Therefore, a biomass CHP system matching the heating and electricity needs of a large-scale building project can be an ideal solution towards a zero or low carbon development.

The report starts with an overview on biomass CHP systems and biomass boilers and continues with various biomass fuel options in London in terms of availability, advantages and disadvantages.

The appendix gives information and references on biomass system suppliers and biomass fuel suppliers for London and the UK and an overview on emerging technologies in the biomass industry.

It is envisaged that London new low-carbon developments will soon need to be heated and powered using locally produced biomass fuel, such as wood products and waste or vegetable oil. It is assumed that biomass such as municipal solid waste and sewage sludge is better to be processed and reused by the local authorities<sup>2</sup>, as it may be difficult to be collected and delivered to a specific site.

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<sup>2</sup> According to CHPA (Combined Heat and Power Association), REA and GLA studies, London has a vast capacity to switch its energy sources from mainly fossil fuel to mainly biomass. Biomass sources for community (or large-scale) electricity and heating needs will include existing and new waste-to-energy plant. Existing plant includes South East London Combined Heat and Power Station (that will switch from only electricity to both electricity and heat power), while new opportunities include GLA's *London Waste Strategy*, which will apply mechanical biological treatment of municipal solid waste produced in London.

## OVERVIEW ON BIOMASS CHP AND BOILERS

### BIOMASS CHP

Biomass CHP units burn biomass fuel to produce both heat and electrical energy.

Currently there are no standard biomass CHP units available in the market.

However there are several manufactures and importers in the UK, who would build a package plant to suit specific project needs. CHP suppliers will be able to propose a suitable CHP package plant, the size of which will depend on the project's specific heat and energy needs.

Further investigation needs to be undertaken, as biomass heating is becoming popular and there may be more companies developing CHP systems for biomass in the future.

### BIOMASS BOILERS

Although biomass CHP is emerging technology in the UK, biomass boilers can be proposed as an alternative biomass solution for now.

Biomass boilers burn biomass fuel to produce heat. They are available in a wide range of sizes.

Biomass heating is currently being applied to a 180-dwelling residential project in North London, where the fuel is wood pellets and the boiler used was by the Danish manufacturer LIN-KA ENERGY. It covers 10% of the energy needs, matching the new requirements for the use of renewables in London (implemented by VITAL ENERGY).

Biomass CHP and boilers manufacturers and suppliers can be found in Appendix A.

## OVERVIEW ON BIOMASS FUELS IN LONDON

### INTRODUCTION

Available biomass in and around London for use in CHP and boilers can be wood waste products and vegetable oil.

The parameters that need to be considered when choosing a biomass fuel for a specific project are:

- CHP or boiler availability for the biomass chosen (see previous chapter)
- Quality guarantee from supplier
- Transportation distance from supplier
- Storage space on site
- Relative cost according to energy output

The following overview discusses the advantages and disadvantages that have been found for the biomass available in London. It begins with a presentation of the available biomass for London and then explores the above parameters needed to be considered when choosing biomass as burning fuel.

For the purposes of this report, a lot from the information has been collected from the European Biomass Association and from the BedZED project published literature and information given by the Bioregional Forestry Manager, as this project's energy needs and sustainability goals are similar to the ones of this investigation.

### WASTE WOOD PRODUCTS

Generally there is a great abundance of wood biomass in London from woodlands nearby, waste wood discarded in landfill along with residual waste, woodland residues, sawmill residues, woodworking and joinery residues, coppice and clean wood waste (prunings, etc). However these waste wood products need to be processed into pellets or woodchips in order to be usable for CHP and boilers.

General advantages:

- there are large amounts of waste wood available near London
- 90% less carbon emissions than oil

General disadvantages:

- high capital investment for CHP plant
- The process between waste wood collection and supply to CHP is not always straightforward and might involve intermediate processes, knowledge of which is not widely available
- large storage space for biomass fuel

#### Woodchip, chopped straw

Advantages:

- More environmentally friendly solution than pellets
- 1/3 cost of pellets (£50/tonne woodchip of 30% moisture)

Disadvantages:

- The process between waste wood collection and supply to CHP is not always straightforward and might involve intermediate processes, knowledge of which is not widely available.

#### Pellets

Advantages:

- ready to burn in CHP, already processed and ready to use
- 50% more energy efficient than other wood products or waste
- 1/4 storage space needed in relation to woodchip

Disadvantages:

- less environmentally friendly than wood waste, as it involves intermediate processing
- 3 times the cost of woodchip (£150/tonne of pellets of 5% moisture)

Local suppliers of wood products for the Canary Wharf and Kew areas in London can be found in Appendix B.

## OVERVIEW ON BIOMASS FUELS IN LONDON

### BIODIESEL

Biodiesel comes from vegetable oil (soy bean, rape seed, sunflower seed, palm oil, peanut oil, canola oil), used frying oil or animal fat. It can be used directly in diesel engines replacing part of the fossil fuel.

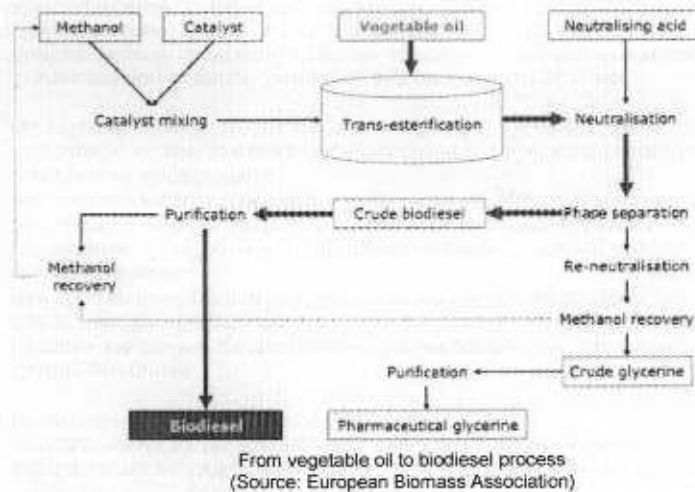
#### Advantages:

- higher energy output per volume, compared to wood biomass
- 60% less carbon emissions than oil deriving from fossil fuel
- low capital investment, as it can be used in an ordinary boiler
- emissions in to the air can be as clean or even cleaner than fossil fuel's

#### Disadvantages:

- needs a large area to grow the sunflower seeds
- Palm oil is imported from abroad
- Biodiesel closest production is done in France
- 2-3 times more expensive to produce than fossil fuel

Further investigation needs to be undertaken in order to safely specify a CHP or boiler with diesel engine for specific project needs.



### BIOETHANOL

Bioethanol is another biomass fuel that comes from sugar cane or corn and mainly replaces automotive petrol.

It is not very widely used in Europe and even less in the UK, as the sugar cane production is not very high.

Further investigation needs to be undertaken in order to safely specify a CHP or boiler that can burn this fuel for specific project needs.



A rapeseed field  
(Source: European Biomass Association)

## OVERVIEW ON BIOMASS FUELS IN LONDON

### ADDITIONAL PARAMETERS WHEN CHOOSING A BIOMASS FUEL

Apart from the availability of the right biomass CHP and boilers for the available biomass options for the specific needs of a project, the following parameters need to be considered before choosing a biomass fuel.

#### Quality guarantee

Biomass has several characteristics that make combustion much more difficult than that of fossil fuel. It is important to assure the biomass quality from the supplier, as lack in some quality characteristics may cause operational problems and more carbon emissions.

For example, wood biomass quality guarantees should be given on shape, size distribution, moisture content, ash content and ash melting behaviour.

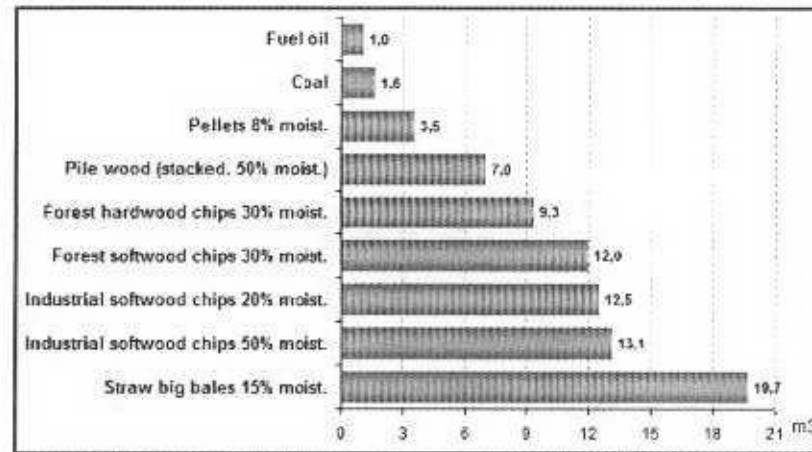
Being factory produced, pellets are easily found with quality guarantees, than unprocessed wood biomass.

Additionally, in order to assure that emissions in to the air from burning biomass are not pollutant, biomass fuel needs to be certified that it is clean.

#### Transportation distance, frequency and on site storage space

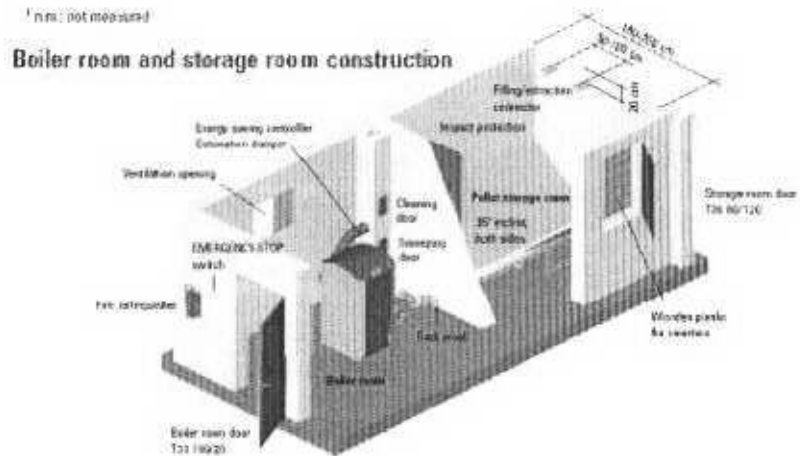
Transportation of burning fuels from the source to the site and on site storage space play an important role when choosing the biomass fuel for a project.

The graph below compares the biomass fuels in terms of volume, which affects transportation and storage space needed on site. As previously mentioned, transportation means and distance affect the embodied energy of a burning fuel and, hence, the project's level of sustainability.



Volume (m³) required to substitute one cubic meter of oil by some other fuels  
(Source: European Biomass Association)

Storage space can be hard to find in urban projects, like the 22 Marsh Wall project in London, and therefore bulky biomass fuels might be inappropriate for urban locations. The sketch and chart below give a rule of thumb for sizing storage space for pellets biomass, the lowest storage demanding wood biomass.



Fuel	Pellets, 10% water content, 6 mm diameter
Storage room for 1 year	→ 0.7 m³ × heating load in kW
Consumption for 1 year	→ 400 kg × heating load in kW

storage sizing example: Pellets biomass  
(Source: KWB Pellet Boilers)



## OVERVIEW ON BIOMASS FUELS IN LONDON

### Relative cost in terms of energy output

The economical parameter needs to be correlated with the energy output of the biomass fuel and with the parameters discussed previously.

It is not possible to rank biomass fuels from cheap to expensive, as there are many different parameters that affect its cost. A rule of thumb for cost of tradable biomass in Europe is listed below.

	EU-15	
	€/GJ	€/t <sub>dry</sub>
<b>Tradables</b>		
Forestry by-products	2.4	100
Wood fuels	4.3	180
Dry agricultural residues	3.0	126
Solid industrial residues	1.6	67
Solid energy crops	5.4	228
Imported biofuels	6	251
<b>Transport fuels</b>		
Biodiesel	23	= 960
Bio-ethanol	29	= 1200

Average supply costs of tradable biomass and crops for transport fuels (EUR/GJ).<sup>3</sup>

Source: BTG, 2004

(Source: European Biomass Association)

### Examples in London

It is worth giving two London examples, where biomass was chosen as a burning fuel, in order to illustrate common issues that may be encountered.

In BedZED, a 100-dwelling low carbon development in South London, woodchips was chosen as the preferable biomass for cost and availability reasons. The Forestry Manager of the Bioregional (developing company) has suggested that woodchip of 30% moisture content is found easily and costs generally four times cheaper than pellets.

On the other hand, a 180-dwelling new development in North London, that aims to meet the new London requirement of 10% energy from renewables, has chosen to burn wood pellets, as for the project they the more cost effective solution to cover the 10% of the energy needs. Both energy output and storage space played a significant role in choosing pellets as the biomass fuel, as explained by the project's energy consultants (Vital Energy).

<sup>3</sup> On average, supply costs of tradable biomass fuels in the EU-15 vary from 1.6 EUR/GJ (solid industrial residues) to 5.4 EUR/GJ (solid energy crops). On average, the supply costs of solid energy crops are close to those of imported biomass, which was taken at a standard level of 6 EUR/GJ. Single average supply costs of 23-29 EUR/GJ were determined for the refined bio-transport fuels bio-ethanol (from sugar beet and wheat) and biodiesel (from rape and sunflower seed). (Source: European Biomass Association)

# APPENDIX



## APPENDIX A - BIOMASS CHP AND BOILERS UK SUPPLIERS

The following boiler and CHP suppliers listed below can provide with systems that burn biomass fuel.

- Talbott's Ltd
- Biomass Engineering
- Tuma Turbomach S.A.
- Baxi boilers
- Air Cogen
- Clarke Energy
- PB Power (Biodiesel CHP)
- Bioenergy Ltd
- LIN-KA (Danish manufacturer)
- Mercia Energy
- Kvaerner

#### SOME BIOMASS BOILERS AND CHP PROVIDERS DETAILS

Source: National Energy Foundation (The log pile website)

##### Talbott's Ltd

Drummond Road, Astonfields Ind. Estate, Stafford ST16 3HJ  
Tel: 01785 213366 Fax: 01785 256418  
Email: [sales@talbotts.co.uk](mailto:sales@talbotts.co.uk)  
Website: <http://www.talbotts.co.uk>

Description: UK Manufacturers of Biomass Energy Systems up to 12000kW. Can supply automatic or hand fed systems to utilise logs, pellets, sawdust, shavings, wood chips, etc to produce Hot Air, Hot Water, Steam or Electricity.

##### Energy Innovations

Meadow View Studios, Church Road, Martlesford Woodbridge 43 IP13 0AT  
Tel: 01728 747874 Fax:  
Email: [info@energyinnovations.com](mailto:info@energyinnovations.com)  
Website: <http://energyinnovations.com>

Description: Supply and install two ranges of boilers. The Gilles fully automated woodchip and pellet boilers made in Austria. The pellet boilers are available in 10kW -145kW outputs and the woodchip boilers are available in 10kW to 6,000kW outputs. Prices from £7,000 upwards. Their other range is P & H boilers, manufactured in Denmark. They also run on woodchip and pellets but can also run on grian and offer outputs of 12 to 300kW. Prices from £4,500 to £15,000. Also offer a wide range of equipment, including fuel storage options and delivery systems.

##### Econergy LTD

Unit 12, St Georges Tower, St Georges Tower, Hatley St George Sandy 1 SG19 3SH  
Tel: 0870 054 5554 Fax: 0870 054 5553  
Email: [sales@econergy.ltd.uk](mailto:sales@econergy.ltd.uk)  
Website: <http://www.econergy.ltd.uk>

Description: Offer contract mechanised whole-tree chipping services. Supply wood fuelled heat and Combined Heat and Power, a full range of products from complete contract energy management services to turnkey boiler installations and arrangement of fuel supplies.

##### EGNI Energy

Tan y Bryn, 10a Tany Bryn St, Abergynolwyn Tywyn 61 LL36 9YA  
Tel: 01248 725600 Fax:  
Email: [info@egni.net](mailto:info@egni.net)  
Website: <http://www.egni.net>

Description: Suppliers of wood pellets. Also supply biomass heat contracts multifuel briquettes fuel logs pellet stoves wood chip boilers district heating schemes

## APPENDIX A - BIOMASS CHP AND BOILERS UK SUPPLIERS

*Turboden are at the forefront of bringing forward new technology to provide for the increasing demand for biomass CHP applications in mainland Europe. The ORC concept offers exceptional performance and reliability, with very low running costs, and is rapidly becoming established as the leading product in its size range. Econergy can now provide its UK customers with a complete turnkey package of thermal oil boiler, fuel handling and OCR turbine - please enquire for further information.*

*'Cutting-edge Organic Rankine Cycle turbine technology for biomass CHP applications 400kWe - 1,500kWe*

<http://www.econergy.ltd.uk/Turboden.html>

*Peter Brotherhood Ltd are one of the world's leading suppliers of steam turbines (turbo-alternator sets) for renewable & sustainable energy, waste-to-energy and combined heat and power plants. We have built a huge level of experience in providing steam turbines to plants dealing with fuels as diverse as:*

- Biomass
- Landfill gas
- Sewage digester gas
- Mines gas
- Coke oven gas
- Refinery flare gas
- Bagasse and other agrifibres
- Clinical waste
- Sewage sludge
- Coppiced wood
- Sawmill/wood processing waste
- Forest residues
- Munciple solid waste (MSW)
- Refuse-derived fuel (RDF)
- Meat and bone meal (MBM)
- Used vehicle tyres
- Olive waste

<http://www.peterbrotherhood.co.uk/default.asp?page=11520&area=0&type=p>

## APPENDIX B – WOOD BIOMASS SUPPLIERS

### SOME LONDON WOOD BIOMASS SUPPLIERS

Source: <http://www.bigbarn.co.uk>

#### Special Branch Tree Care

27 St Johns Park, Blackheath,  
London  
Greater London  
SE3 7TD  
0800 037 9383  
Logs, Chips,

#### Connick Tree Care

Grove Park Cemetery, Marvels Lane,  
London  
Greater London  
SE12 9PU  
0208 680 0500  
Logs, Chips,

#### PSF Division, St Croix Power Systems Ltd.

140 Ashley Crescent, Wandsworth,  
London  
Greater London  
SW11 5QZ  
0845 056 8545  
Pellets,

#### WoodExport

29 Foral St., Covent Garden,  
London  
Greater London  
WC2E 9DP  
0208 229 6416  
Chips, Briquettes,

#### Biomass UK Ltd

7 Savoy Court, Strand,  
London  
Greater London  
WC2R 0ER  
020 7539 7272  
Logs, Chips, Pellets,

#### Complete Tree Care Ltd

Wyke Green Golf Club, Syon Lane,  
Isleworth  
Greater London  
TW7 5PT  
0870 240 8856  
Logs, Chips,

The closest to London large pellet producing company is found in Oxford:

#### Biojoule Ltd

Fred Dumbleton  
Technical Director  
115 Magdalen Rd  
Oxford  
OX4 1RQ  
tel: 01865 207014  
fax: 01865 201900

Solid and liquid biomass with high standard guarantees can be shipped to London from Stockholm by **Talioil AB** biomass Swedish company:

#### Talioil AB

Klarabergsviadukten 70, D7  
S-111 64 Stockholm  
Sweden  
Tel: +46 (0)8 53524600  
Fax: +46 (0)8 109923

## APPENDIX C –FUTURE TECHNOLOGIES

The information in this Appendix has been taken from the European Biomass Association web page.

In order to foster the development of sustainable biomass-based energy technologies, different fields of research must be integrated.



Stage	Emerging technologies	Future technologies
Biomass resources	<ul style="list-style-type: none"> <li>• New energy crops</li> <li>• New oilseed crops</li> <li>• Bio-waste management</li> </ul>	<ul style="list-style-type: none"> <li>• Bio-engineering of new energy plants</li> <li>• Development of low-energy agricultural production systems</li> <li>• Aquatic biomass (algae)</li> <li>• IT methods in land and biological systems management</li> </ul>
Supply systems	<ul style="list-style-type: none"> <li>• Use of new agro-machinery</li> <li>• Biomass densification</li> <li>• Other simple pretreatments (e.g. leaching)</li> <li>• Logistics of supply chains</li> </ul>	<ul style="list-style-type: none"> <li>• Biorefining</li> <li>• Biotech-based quality monitoring throughout the whole procurement chain</li> <li>• IT tools for supply chain modelling and optimal management</li> </ul>
Conversion	<ul style="list-style-type: none"> <li>• Advanced combustion</li> <li>• Co-combustion</li> <li>• Gasification</li> <li>• Pyrolysis</li> <li>• Bioethanol from sugar and starch</li> <li>• Bioethanol from lignocellulosic material</li> <li>• Biodiesel from vegetable oils</li> <li>• Advanced anaerobic digestion</li> </ul>	<ul style="list-style-type: none"> <li>• Biohydrogen (hydrogen from bioconversion of biomass)</li> <li>• Plasma-based conversions</li> <li>• Advanced bioconversion schemes</li> <li>• Other novel conversion pathways (e.g. electrochemical)</li> <li>• Novel schemes for down-stream processing (e.g. of pyrolytic liquids or synthetic FT-biofuels)</li> </ul>
End products	<ul style="list-style-type: none"> <li>• Bioheat</li> <li>• Bioelectricity</li> <li>• Transport biofuels</li> <li>• Upgraded solid biofuels (pellets)</li> </ul>	<ul style="list-style-type: none"> <li>• Use of hydrogen in fuel cells</li> <li>• Use of FT-biofuels in new motor-concepts e.g. CCS (Combined Combustion Systems)</li> <li>• New bio-products (biotech)</li> <li>• Complex, multi-product systems (IT)</li> <li>• CO<sub>2</sub> sequestration: other new end-use "cultures" (e.g., user-friendliness, "closed cycle")</li> </ul>
System integration	<ul style="list-style-type: none"> <li>• Normalisation and standards</li> <li>• Best practices</li> <li>• Economic/ecological modelling and optimisation</li> </ul>	<ul style="list-style-type: none"> <li>• IT-based management</li> <li>• Socio-technical and cultural design of applications</li> <li>• Sustainability based on global as well as local effects</li> </ul>

Source: *Risoe energy report 2, 2003*

## APPENDIX D – RELATED REFERENCES AND CONTACTS

### **Renewable Energy Association**

tel: 020 7747 1830

Peter Billins (Head of Biomass) tel: 077 7164 2075, [pbillins@r-e-a.net](mailto:pbillins@r-e-a.net)

Graham Meeks tel:020 7747 1842, 078 0224 2498

### **Bioregional**

Andrew Tolfts (Forestry manager) tel:020 8404 4891, [at@bioregional.com](mailto:at@bioregional.com)

### **Combined Heat and Power Association**

Syed Ahmed, Head of Research tel 020 7802 0184

Judith tel: 020 7802 0183

### **Biojoule Ltd**

Fred Dumbleton

Technical Director

115 Magdalen Rd

Oxford

OX4 1RQ

tel: 01865 207014

fax: 01865 201900

### **EUBIA European Biomass Industry Association**

Rue d'Arlon 63-65

B-1040 Brussels

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