

FINAL TECHNICAL REPORT

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PROJECT CO-ORDINATOR : Centre for Renewable Energy Sources (GR)

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Part 1: Publishable final report (non-confidential)

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1.1 Executive publishable summary

The main objective of the Biomass Cogeneration network (BioCogen) Accompanying Measure was: To provide technical and economic data and deal with the key issues in the implementation of biomass CHP in Europe, aiming to facilitate: (a) the achievement of the White Paper target of 6 Mtoe of biomass fuels being used in cofiring plants by 2010 (Key action 5, specific action 5.1.1), (b) the identification of the best options in terms of resource and technology to reach the cost targets of 1500 Euro/ kWe and 0.05 Euro/kWh investment and electricity production cost (Key action 5, specific action 5.2.1), (c) the achievement of the strategic priority of 26 Mtoe in CHP installations by 2010 (Key action 5, specific action 5.2.1).

To achieve the abovementioned goals, six work packages were scheduled as follows: WP1 detailed the network management, providing the basic infrastructure needed to operate it. WP2 reviewed national and international activities on biomass CHP (ensuring the necessary links with RTD projects, bioenergy networks and IEA activities). In WP3 a market analysis was performed on biomass CHP in the EU and the participating Eastern European countries. WP4 dealt with the formation of a detailed survey of biomass CHP plants. In WP5, factors that hinder or foster biomass CHP were identified thereby facilitating the determination of existing or future flagship projects. Finally, WP6 focused on the dissemination of the results of the network through educational and training activities as well as through the development of an interactive web-site on biomass CHP.

Up to the 24th month, the BioCogen network:

- Achieved all key objectives and deliverables through good working rapport between partners and a shared detailed understanding of the work plan and responsibilities.
- Progressed with WPs and Tasks broadly in line with the original work plan, albeit with some amendments to timings.
- Linked with other initiatives, individuals and organisations.
- Delivered a raft of information with relevant analysis and appropriate presentation. The deliverables provide useful knowledge and insights for external stakeholders. Dissemination is ongoing, through the BioCogen web site and through various initiatives by each of the BioCogen partners.

All reports from the BioCogen network are publicly available, with the exception of the Management Final Report, and the reader is invited to visit www.cres.gr/biocogen. The reports are as follows:

- Publishable Synthesis Report. This provides an overview and assessment of the results of the project and is included within this document.
- Detailed Final Reports as follows:
 - Country energy & cogeneration reports
 - Review of cogeneration plants fuelled with solid biomass
 - Report on link to IEA work on bioenergy & climate change Task 38
 - Biomass cogeneration market analysis including barriers and drivers
 - Strategic marketing plan for biomass cogeneration in Europe including promotion measures
 - 'Flagship' biomass cogeneration projects in selected European countries
- Management Final Report. This details progress and results of the work versus the original description of work.
- Technological Implementation Plan. This describes likely follow-on activities.

1.2 Publishable synthesis report

1.2.1 Objectives and strategic aspects

This section reviews the overall scientific / technological and socio-economic objectives, including contribution to EU policy needs.

Prior to this project, there was no single initiative working for biomass CHP in Europe. There was a clear deficit of uniformly collected and well-structured information on biomass CHP in Europe. The aim of BioCogen was to contribute to specific goals for increased market penetration and cost reduction of bioenergy plus have wider benefits in many scientific / technological and socio-economic areas. It aimed to do this by:

- Gathering and analysing information on existing activities
- Identifying and reviewing ‘flagship’ projects
- Covering many EU states and selected accession countries
- Linking with other relevant initiatives, particularly the International Energy Agency, and trade associations
- Analysing the potential future market for biomass CHP and obstacles and drivers
- Proposing strategies for increasing the market penetration of biomass CHP
- Establishing links and transferring knowledge between European countries including accession countries
- Varied dissemination activities

Biomass CHP offers many varied benefits. It is readily apparent that increased market penetration of biomass CHP would make an important contribution to many EC policies, goals and strategies. The BioCogen team developed a list of these benefits under Work Package 3 and reported these in the ‘strategic marketing plan’. These are reproduced below.

The benefits that biomass cogeneration offers for key sectors in Europe

Industry and other investors. <ul style="list-style-type: none">• energy solutions;• solutions for waste streams;• financial returns that are matched with risk
Environment <ul style="list-style-type: none">• reduce emissions of greenhouse gases: biomass CHP is near CO₂ neutral on life cycle basis.• reduce impacts from waste disposal• local use of biomass has short transport distance compared to fossil fuels
Energy-economic <ul style="list-style-type: none">• help enable decentralization and thus flexibility;• more players in the energy market gives competition;• improve efficiency of energy conversion;• avoid electricity transmission and distribution losses;• achieve greater use of renewable energy;• help improve local energy security;• reduce fuel import needs at national and regional level.
Agriculture and forestry <ul style="list-style-type: none">• enable diversification;• create rural revenue streams;• create/maintain jobs;• help to improve land management practices such as forestry thinning and clearing
Competitiveness <ul style="list-style-type: none">• stimulate development of technologies and services with worldwide applications

1.2.2 Scientific and technical description of the results

The results of the network are contained in a series of independent Detailed Final Reports that are publicly available:

- Country energy & cogeneration reports
- Review of cogeneration plants fuelled with solid biomass
- Report on link to IEA work on bioenergy & climate change Task 38
- Biomass cogeneration market analysis
- Strategic marketing plan for biomass cogeneration in Europe
- 'Flagship' biomass cogeneration projects in selected European countries

A short description of each report is provided below.

Country energy & cogeneration reports

A survey of the current situation of biomass CHP in EU and the participating Eastern European countries was undertaken and a report produced for each country. Each report contains overview information on the country energy sector, the existing policies and support mechanisms for renewables and CHP, plus a detailed consideration of the wider CHP industry and biomass CHP in particular. Short descriptions of existing biomass CHP plants are included in the reports, where possible and appropriate. The compilation of these reports is a large text document.

Review of cogeneration plants fuelled with solid biomass

This presents a detailed analysis of an extensive sample of biomass CHP plants using solid biomass. The analysis is presented in terms of fuel, technologies, plant size, construction time, investment costs etc. The total number of plants included in the survey is 122. The review comprises many graphics plus interpretation.

Report on link to IEA work on bioenergy & climate change Task 38

The International Energy Agency Task 38 considers the role of bioenergy and sequestration in mitigating greenhouse gas emissions, by developing and reviewing computer models of greenhouse gas balances, assessing the life-cycle of different systems etc. This report provides a summary of results that are relevant to biomass CHP including a thorough review of life cycle emissions for CHP plant in Austria. This is a readable scientific-type paper.

Biomass cogeneration market analysis

This report reviews biomass fuel potential, applications of biomass cogeneration, and drivers and barriers to increased market penetration by biomass CHP. These issues are reviewed with reference to the wider fossil fuel cogeneration market. The report determines the main current features, anticipated trends, pan-European similarities and differences between countries. This is a short, text-based report.

Strategic marketing plan for biomass cogeneration in Europe

This presents an overview plan to help grow the biomass cogeneration industry in Europe, drawing on the information presented in all other BioCogen reports plus further input from

discussions and correspondence with the BioCogen team. The report provides: a recommended overall ‘mission statement’; a review of opportunities for expanding biomass CHP; an analysis of strategic objectives; a review of promising target markets; and recommendations for expanding biomass CHP. This is a concise document with matrices and tabulated lists plus interpretation.

‘Flagship’ biomass cogeneration projects in selected European countries

This provides the results of a survey of biomass CHP plants in Europe, selected as ‘good’ examples because of their technical innovation, environmental performance, novelty, and / or public acceptance / participation. Each of 16 plants are summarised in 2-3 pages, covering background, technical information, reasons for selection etc. plus photographs and schematics.

Web based map searching facility

A simple mechanism of searching for the information (biomass CHP plants and country overviews) via a map has been created on the web site. This is publicly available from www.cres.gr/biocogen/plants.htm and www.cres.gr/biocogen/country_profiles.htm

1.2.3 Assessment of results and conclusions

The varied and extensive information and analysis reported by the BioCogen team and made publicly available, as described above, is a valuable resource for the expansion of biomass CHP. The network has thus achieved its core objective, namely the provision of data and engagement with key issues for implementation of biomass CHP. This section presents an assessment of the results of the network.

Country energy & cogeneration reports

The report covers ten participating countries plus further eight countries (see list below).

Austria	Italy
Belgium	Luxembourg
Bulgaria	Netherlands
Denmark	Portugal
France	Slovenia
Finland	Spain
Germany	Sweden
Greece	Turkey
Ireland	United Kingdom

The survey used an extensive number of information sources, including national government statistics and reports (eg. central statistics offices; reports by Ministries; energy regulatory authorities), international reviews by agencies (eg. OECD, International Energy Agency) and trade associations (Euroheat and Power, COGEN Europe); European reports (from networks such as EUBIONET) and statistics (particularly Eurostat); plus the BioCogen partners’ own databases.

Country reports followed a standard format and include:

- Overview of the energy sector

- Review of policies legislation and support mechanisms for renewable energy and CHP
- Details of CHP and biomass CHP activities and plants

The country reports are a thorough and up-to-date review of biomass cogeneration for many countries across Europe (18 countries from the EU25 plus Turkey). The country reports provided valuable background information for other BioCogen tasks. They are a useful deliverable in their own right. The document gives information over a wide geographic area which is useful for promoters of biomass cogeneration and insights to national situations for developers, investors and industry.

Review of cogeneration plants fuelled with solid biomass

The BioCogen partners provided details of a number of plants via the completion of a questionnaire. These were combined with information in an existing database (developed by the University of Graz). The sample size is 122. The sample is quite comprehensive for Germany and Austria but less complete or short of data for some other countries. Compiling this type of data is a difficult task, because information sources are numerous, with different languages, protocols etc. The report provides a quantitative analysis of the plants, using graphs to present aspects such as:

- Construction year
- Technologies
- Installed capacities (electricity/thermal/ratio of electricity to thermal)
- Fuels
- Specific investment costs
- The nature of plants (ie commercial, demonstration etc)

The report is a unique up-to-date reference document that provides insights into the nature and costs of biomass CHP in Europe. Data on these aspects is very scarce so BioCogen makes a useful contribution.

Report on link to IEA work on bioenergy & climate change Task 38

This report reviews the lifecycle greenhouse gas emissions of biomass cogeneration technologies in comparison to fossil fuel energy systems. The basis of the work was IEA Task 25 “Greenhouse gas balances of biomass and bioenergy systems” and the “Global emission model of integrated systems” developed by Öko-Institut Darmstad from Denmark. IEA Task 25 was superseded by IEA Task 38.

This report deals with a key benefit of bioenergy systems, namely their very low level of greenhouse gas emissions compared to conventional fossil fuel systems. The report presents the results of running the model for 34 bioenergy systems and 18 fossil energy systems in Austria. The model includes the full life cycle. The results are presented in readily comparable quantitative tables and graphics.

Overall, biomass fuelled CHP units emit 87-92% less greenhouse gas (CO₂ equivalents) than fossil fuelled CHP units. If biomass is used to replace fossil fuel use, then greenhouse gas emissions can be reduced. Consideration of the whole life cycle and by-products gives some interesting results. For example, the use of animal manures for biogas-fuelled CHP avoids methane emissions so this is found to be a highly beneficial system in terms of net greenhouse gas emissions.

Presentation of these findings in this report is important for raising the knowledge that biomass CHP offers in respect of greenhouse gas mitigation, which is an increasingly important driver in Europe.

Biomass cogeneration market analysis

The biomass CHP industry lies within the wider cogeneration industry mostly based on fossil fuels. The technologies overlap: biomass CHP technology may be the same, adopted or similar to that used in fossil fuel applications. Providers of technology often supply both biomass and fossil fuel applications. Other stakeholders are also common, such as investors and developers. Biomass and fossil fuel cogeneration share some common drivers and many common obstacles.

The starting point for the market survey for biomass CHP was therefore to consider the current and anticipated future for the wider cogeneration industry. A considerable amount of information is available from publications by COGEN Europe and Euro Heat and Power. This information was reviewed. CRES also attended the COGEN Europe annual conference in Brussels in April 2003 and the knowledge gained was valuable input to the market survey.

An important observation is that the cogeneration industry in Europe is currently static or in decline. The wider energy industry is going through large changes - privatisation / deregulation - and costs of energy are being driven down in many cases to levels that are unsustainable in the longer term. This is coupled with the fact that cogeneration does not enjoy easy access to the grid nor recognition of its benefits – there is not an even playing field. However, the report reviews more optimistic scenarios, in which the energy efficiency, security of supply, greenhouse gas emission etc benefits are recognised and rewarded.

The report includes analysis of theoretical biomass fuel availability. Graphics in the report show biomass fuel availability (PJ) in participating countries plus an estimate of how much cogeneration capacity may be installed. The data illustrate the theoretical abundance of biomass fuels. In the nine countries included, there is (very approximately) estimated to be sufficient biomass fuel for 18750 MWe CHP capacity. Estimates of pan-European biomass fuel availability are non-existent, so this rather rough exercise provides some knowledge for debate.

The report considers the potential markets for biomass CHP, such as agro-industry, forestry, district heating etc. Some useful observations are made such as: increasing supply of biomass fuels to existing district heating plants in Europe; potential for landfill and sewage gas in southern and accession states etc. The report reviews drivers in the biomass cogeneration market – from policy maker's and investors viewpoints – and obstacles. Economic, regulatory, institutional, technical, social, environmental factors were considered and the discussion refers to the wider cogeneration market. The web was reviewed for information and BioCogen partners provided their professional opinions and know-how for their national circumstances or from wider international perspectives.

Strategic marketing plan for biomass cogeneration in Europe

The plan includes:

- Consideration of benefits and European policy imperatives
- Future prospects of biomass cogeneration in Europe: Customers; Competitors;

Major external influences (political, legal & regulatory, economic, social, technical)

The above assimilated into a Strengths Weaknesses Opportunities Threats analysis.

- Most promising market segments for growing the installed capacity of biomass cogeneration, by country.
- Competitive advantages and some key observations and trends in target markets
- Bullet point list of key recommendations

The paper is intended primarily for the European Commission. It should also help guide other stakeholders with perspectives and remits for the biomass cogeneration industry, particularly trade associations. The paper offers a common basis for European Commission and other stakeholder's support for and activities with the biomass cogeneration industry.

The overall stated objective for the BioCogen network stated in Annex 1 "Technical Description of Work" to the EC contract was:

"to provide technical and economic data and deal with the key issues in the implementation of biomass CHP in Europe, aiming to facilitate the aim of 26mtoe biomass CHP installations to be reached by 2010".

It was further stated that this will be reached through:

- A review of the national and international activities on biomass CHP (RTD projects, biomass and cogeneration networks, IEA);
- A market analysis on biomass CHP (based on biomass potential in relation to the energy market) in the EU and participating Eastern European countries;
- The provision of information (through country surveys based on uniform questionnaires) on the current situation on biomass CHP in the EU and the participating Eastern European countries;
- The identification of differences between countries or regions within the same country concerning cost efficiencies and environmental performance in comparison to the targets set by the EU;
- The determination of the factors which foster or hinder biomass CHP;
- The identification of 'flagship' projects;
- The dissemination of the results through education and training activities as well as through the development of a web site on biomass.

BioCogen has fully delivered the above.

1.2.4 Acknowledgements

Many individuals were contacted by the BioCogen team while undertaking the work. The BioCogen team is grateful for all support received. The Co-ordinator wishes to thank in particular COGEN Europe and Euroheat and Power for providing contacts and useful material.