RESTMAC

Applications for Cogeneration

Hotels and Leisure Facilities

Offices

Apartments

Industry

“Creating Markets for Renewable Energy Technologies EU
RES Technology Marketing Campaign“

CREATING MARKETS FOR RES

Cogeneration at Small Scale

Simultaneous Production of Electricity and Heat

EUBIA

SIXTH FRAMEWORK PROGRAMME

Supported by the European Commission - FP6

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Project Coordinator

EREC - European Renewable Energy Council

Project Partners

EWEA - European Wind Energy Association
EPIA - European Photovoltaic Industry Association
ESHA - European Small Hydropower Association
AEBIOM - European Biomass Association
EUBIA - European Biomass Industry Association
EGEC - European Geothermal Energy Council
ADEME - Agence de l'Environnement et de la Maîtrise de l'Energie
NTUA - National Technical University of Athens
ECB - Energy Centre Bratislava
GAIA - Consultores en gestion ambiental
ESTIF - European Solar Thermal Industry Federation

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Images on front cover: COGEN Europe, COGEN Challenge website on small scale CHP.

1. INTRODUCTION

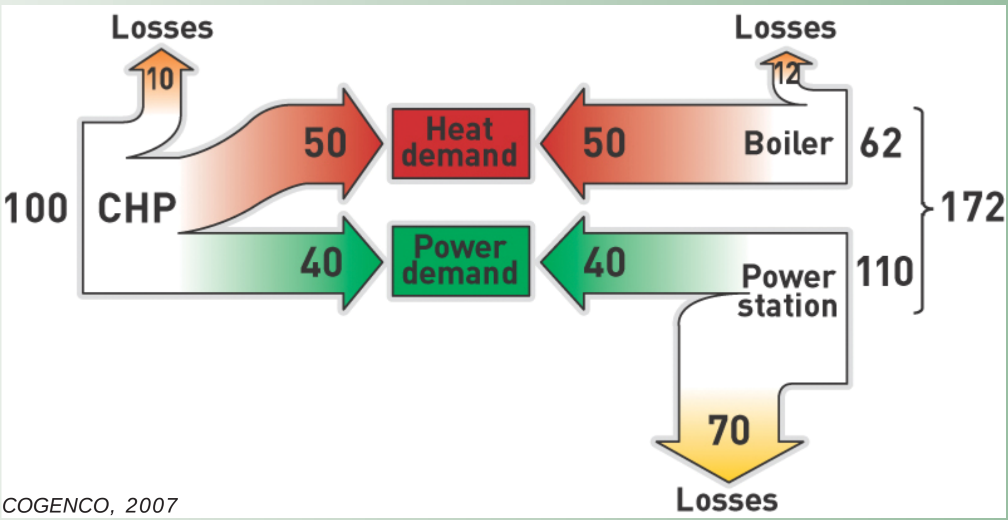
Cogeneration is the simultaneous production of electricity and heat. Cogeneration is also known as CHP (Combined Heat & Power). Cogeneration using biomass is one of the best means of converting a renewable energy source into heat and power coupled with the CO_2 reduction potential when compared with fossil fuels. Higher fuel consumption efficiencies are gained from producing electricity and importantly - utilising the by-product, heat, for use in district heating systems or for individual homes. Other uses include the use of heat or steam for industry such as the paper or steel industry for steam and laundry or hotels for heat. The focus of the brochure is on small-scale cogeneration, which is less than 1 MWe (1 Megawatt electrical power).

Biomass, provided it is used in a sustainable way, has the advantage of being carbon neutral, which contributes to curbing CO_2 emissions in line with the Kyoto protocol targets. It achieves this because in the growing phase of the plant or tree as it takes CO_2 from the atmosphere and releases oxygen during photosynthesis. This is the reverse of standard combustion and energy production. Of particular interest to possible cogeneration operators is the existence of governmental measures such as subsidies and green certificates - which is outlined later in the brochure. In addition to using the heat for cold climates, the energy can also be used for cooling in what is known as trigeneration or Combined Cooling, Heat and Power (CCHP), which will be discussed in the Demand and Potential for Cogeneration or Trigeneration section.

The diagram below shows the advantages of CHP over traditional heat and power production. The use of electricity from power stations is inefficient by nature as the stations are only 25-40% efficient (because they do not use the heat by-product) and there are other losses due transmission of electricity to homes over long distances. The decentralisation of at least part of our electricity needs, along with the heat, depending on the conditions, can be very advantageous in terms of cost and emission reduction. Any unused electricity can be sold back to the national electricity grid and heat can also be sold to neighbouring buildings. There are various issues that complicate selling electricity which will be discussed on the following page.

The RESTMAC project ("Creating Markets for Renewable Energy Technologies EU - RES Technology Marketing Campaign"),aims to develop and employ a comprehensive and well thought-out thematic approach to encourage the uptake of selected RES technologies in the market. In the framework of RESTMAC, this brochure will present information about the current state of the art of biomass compatible small scale cogeneration systems in Europe. It will also discuss the current level in development of small scale CHP and the obstacles.

Glossary:
kW - Kilowatt
MW - Megawatt
kWe - Kilowatt electrical power
kWth - kilowatt thermal power (heat energy)
MWe - Megawatt electrical power
€/kWh - Euros per kilowatt hour (measure of cost for 1 hour of 1 kilowatt of energy)
ppm - part per million (measure of concentration of a gas or liquid)
Nm^3 - Normal metre cubed (average per cubic metre)
NOx - Nitrous Oxides
ICE - Internal Combustion Engine



COGENCO, 2007

2. BIOMASS COGENERATION TODAY

Political situation

The EU Directive 2004/8/EC "on the promotion of cogeneration based on a useful heat demand in the internal energy market" obliges member states to conduct analysis of the potential of high efficiency cogeneration in their country and to establish a support system to encourage cogeneration. It is of obvious relevance to the development of cogeneration, however, it is still in the initial stages of implementation. Whether it be small-scale <1 MWe or micro-scale below <50kWe, the directive states it is necessary to ensure high efficiency for any new capacity. The directive clarifies high efficiency in such that it "must provide primary energy savings of at least 10 % compared with the references for separate production of heat and electricity."

Connection to the grid

Connection to the national electricity grid can be costly and difficult, which substantially determines the expansion of small scale cogeneration facilities selling electricity back to the grid. Off-grid systems are obviously not affected by connection logistics. There are three main types of charging involved in grid connection: Shallow Charging, Deep Charging and Mixed Charging.

- Shallow Charging - the generator (the person or company that owns the CHP unit) has to pay for reaching the nearest point on the grid and for the appliances to meter incoming and outgoing electricity but the utility operator has to pay for additional upgrades to the grid to accommodate the generator if required.

- Deep Charging means the generator pays for all initial connection costs as well as upgrade and any subsequent reinforcing afterwards.

- Mixed Charging is an option as well where the generator pays for the connection cost and a proportion of upgrades and reinforcement work. It varies country by country but it is an important element to clarify before installing a CHP system.

The COGEN Challenge project (www.cogen.org/cogen-challenge/) which aims at promoting, mapping and supporting small scale CHP in Europe provides support for those interested in installing a CHP unit from 6 experts in the field, each from a different region of Europe (Belgium, France, Slovenia, Spain, Austria, Germany). Also on the website is a catalogue of CHP technology suppliers, detailing their product specifications, they also provide a catalogue of cogeneration developers who perform, case-studies; the engineering works required for installation; or contractual and construction management. COGEN Europe, coordinating the project, is a leader in representing and promoting cogeneration at the European level.

Applications for CHP

Building & Services:
Houses, residential buildings, police stations, prisons, schools, universities, community centres, government offices, banks, food processing.

Agriculture & Industry:
Horticulture, greenhouses, drying crops or wood, animal shelters, textiles, brewing, distilling, timber processing, motor industry, sewage treatment works.

Depending on the situation the level of initial investment can be an obstacle for installing CHP units. To help in this respect, third party financing is possible for cogeneration systems from special companies called Energy Service Companies (ESCOs). ESCOs take on the construction, running, fuelling and maintenance of the cogeneration unit which releases the customer from high risk and capital intensive investment. The ESCO and the customer will sign a contract, laying down the duration and particular client requirements and charging will be agreed upon. The ESCO combines all necessary hiring and contracting of plumbers, electricians, planners and builders.

A number of CHP technology suppliers offer a calculator on their website or a spreadsheet document upon request where you can see if the unit will be economical or not based on the annual kWh usage, electricity and gas price, thus giving a good indicator to see if deeper analysis is worthwhile.

3. DEMAND AND POTENTIAL FOR COGENERATION OR TRIGENERATION

The map below shows the proportion of electricity produced by cogeneration in 2004 (Eurostat). In most of Western Europe there is substantial potential for applications in homes and businesses. Due to the warmer climate, the Southern part of Europe requires less heating in general during the year therefore potential is less than in the north.

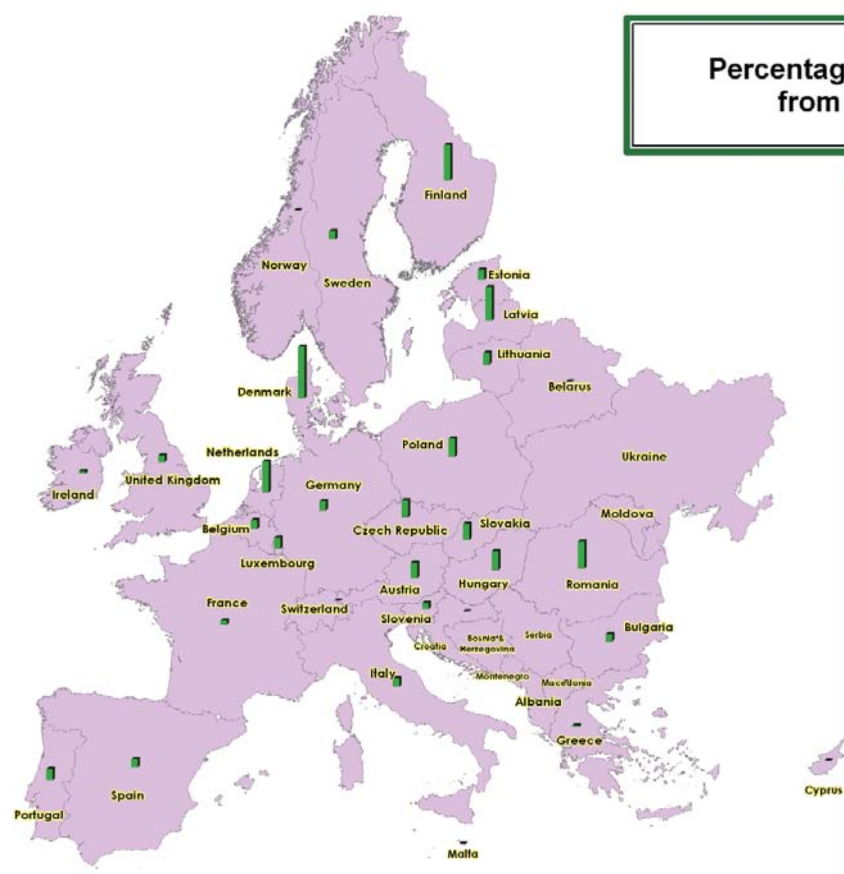
However, there is potential in these hotter climates such as Southern Europe for trigeneration - combined cooling, heat and power (CCHP). It is like cogeneration with the addition of an absorption chiller which converts heat into cooling. It is useful in these regions where there is a frequent or reliable demand for cooling.

The absorption chiller uses the heat from the CHP system to chill water which can then be distributed around a cooling network.

If there is a surplus of cheap heat energy during the summer months, it may be worthwhile analysing the possibility of adding a cooling system. The principle is based on a cooling circuit which uses a working liquid (often ammonia) that has a low boiling point and when it comes into contact with hot water, it then evaporates, releasing heat. The evaporated liquid reforms, now in a cooler state, and it then comes into contact with the water for the cooling network, which can then be distributed to cool buildings.

There are already District Heating systems in place such as some countries in Central and Eastern Europe. A large proportion of Dutch and British homes are heated individually and additionally they have access to natural gas networks. This indicates a large market for cogeneration units in family homes.

Percentage of Electricity Production from Cogeneration - EU27

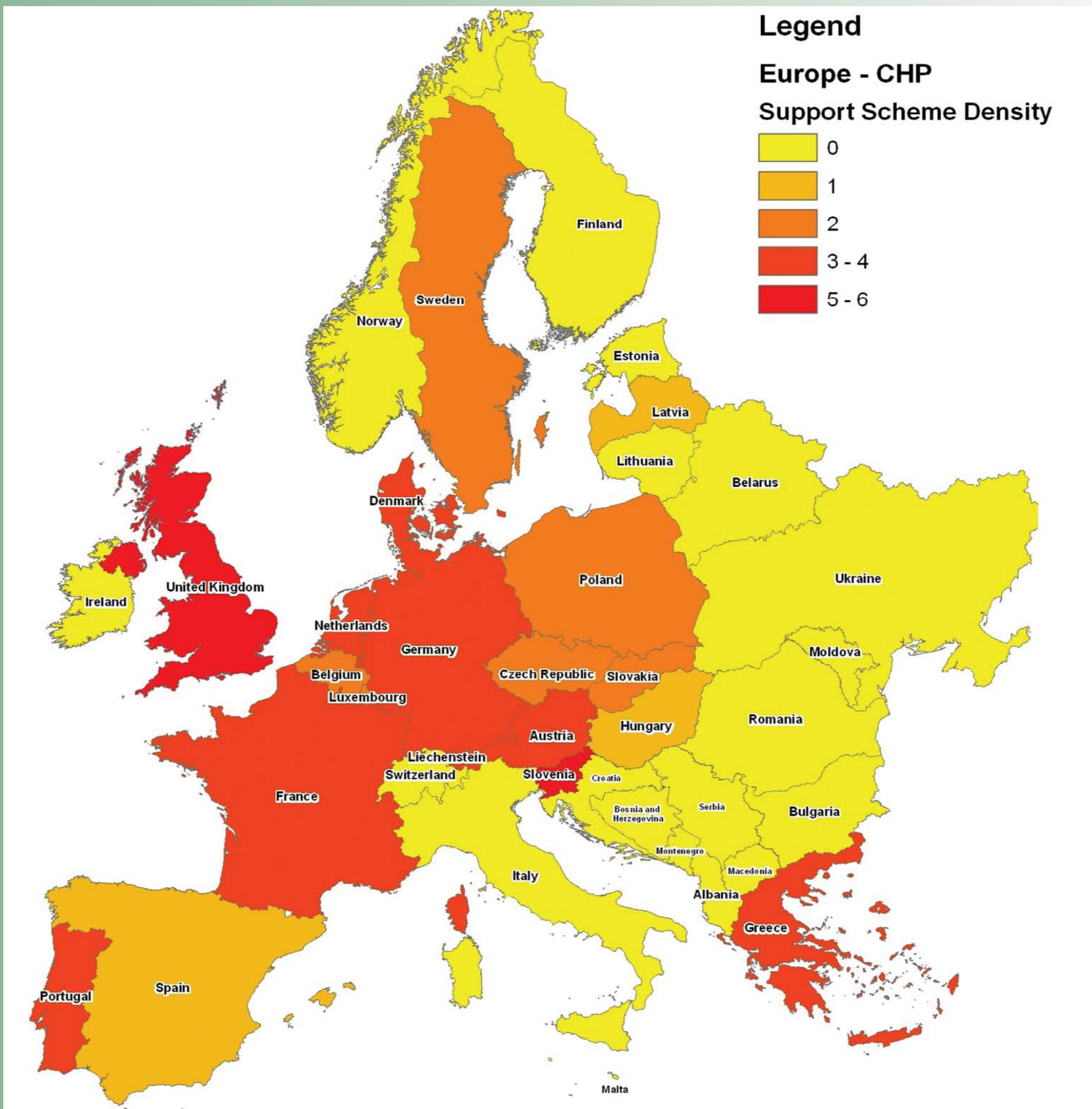


Percentage of Electricity Produced from CHP

	2002	2004
Austria	13,6	15,2
Belgium	7,5	8,4
Bulgaria	-	7,3
Cyprus	0	0
Czech Republic	17,1	16,4
Denmark	49,1	50
Estonia	11	9,9
Finland	38	34
France	4	4,1
Germany	9,8	9,3
Greece	7,8	1,5
Hungary	21,5	18,2
Ireland	2,5	2,6
Italy	7,4	8,1
Latvia	37,5	32
Lithuania	9,7	11,6
Luxembourg	7,9	10,6
Malta	0	0
Netherlands	29,9	29,5
Poland	16	17
Portugal	10	11
Romania	-	26,4
Slovakia	17,5	15,3
Slovenia	5,9	6,4
Spain	7,8	7,9
Sweden	6,8	8,1
United Kingdom	5,4	6,7

EUBIA, EUROSTAT, 2006

4. MAP OF CHP SUPPORT LEVEL DENSITY



The map above indicates the support measures present in Europe. The following table gives a brief list of the incentives in each European Union country. Cogeneration has the potential to reduce CO_2 production from 15 to 40% compared to traditional separate power and heat production (European Cogeneration Review, July 1999). The figure depends on the efficiency of the system and the nature of the fuel and its chemical composition, etc.

The Communities Strategy, outlined in the Commission's cogeneration strategy of 1997, sets an overall indicative target of doubling the share of electricity production from cogeneration to 18% by 2010. Projections show that meeting this target is expected to lead to avoided CO_2 emissions of over 65 Mt CO_2/year by 2010 (DG TREN). In order to meet this target government incentives are very important to see the development of biomass CHP.

5. GOVERNMENT SUPPORT SCHEMES FOR CHP (2005/2006)

Government Incentives and other Support Mechanisms for Cogeneration in Europe

Country	Criteria	Incentive
Austria	< 2 MWe Solid biomass	16 cents/ kWh
	< 200 kWh Liquid biomass	13 cents/ kWh
	> 200 kWh Liquid biomass	10 cents/ kWh
Belgium	Any CHP project	50-75% study cost grant and 20-30% investment grant
Wallonia Region	456 kg of CO_2 emissions avoided gets 1 Green Certificate	92€ when sold to utility
Belgium	Any CHP project	10-20% investment grant
Flanders Region	CHP 1 MWh gets 1 CHP certificate	~38€
	Renewable fuel gets 1 Green Certificate	~113€
Belgium	Any CHP project	50% Study Cost Grant, 20% Investment cost
Brussels Capital Region	217 kg CO2 emissions avoided gets 1 GC	which is ~90€
Cyprus	CHP project support	30% investment cost
	Incentives linked to Fuel price	E.g. £50/tonne = 1.71 cent/kWh between 7h-23h And 1.5 cent/kWh for night time
	CHP Electricity sold to a Utility guaranteed by EAC	At going rate for RES electricity, starting level: 3.7 cents/kWh
Czech Republic	Contribution from Network operator	~20 €/MWh
	In addition: Sale of electricity	~31€/MWh
	Additional profits are possible by selling electricity at peak time ~60€/MWh	
Denmark	Subsidy for CHP	10 ore/kWh
	Electricity sales	~20, 45, 60 ore/kWh for low, high and peak load resp.
	Biogas CHP	0.6 DKK/ kWh for 1st 10 years, after 0.4 DKK
	Tax burden change	Reduces cost for average home using CHP of 1000-1500 DKK/year
Finland	No specific support measures as district heating CHP has gone on for a long time without subsidies, no small CHP market potential, grants for environmentally friendly energy developments/study	
France	Average feed in tariff	6,10 to 9,15 c€/kWh
	12 months tax exemption on Natural gas consumption, reduction of	
	Some grant support from ADEME and regional governments, e.g.	
Germany	Feed-in Tariff for 2007 (changes year on year)	10.99 to 8.51 ct kWh for small biomass CHP up to 5 MW
	Additional support for innovative technologies, for using CHP heat and	
	Small CHP project	Grants for study feasibility/investment
Greece	Within Competetiveness Programme	CHP developments can get up to 35% funding
	Within Development Law	Up to 40% for investment, interest, tax reduction
	Guaranteed purchase of surplus electricity by utility - PPC	57.3 to 59.5 €/MWh from renewable sources
Hungary	Small CHP Feed-in Tariff	9-29 HUF/kWh (4 to 12 ct €/kWh)
Ireland	Future plans to provide a support system	
Italy	Support dropped in 1997, plans to reinstate it, only fiscal incentive is for natural gas	Tax exemption for Natural gas used for CHP depending on electrical efficiency at 80 to 95 €/MWh
Latvia	Feed-in Tariff for CHP systems but need to be 80% efficient and sell 75% thermal heat to DH network	36 €/MWh for fossil fuels, higher for RE sources and for small units <500 kWe
Lithuania	No specific support for CHP but government support for renewables such as biofuels and biogas	

Government Incentives and other Support Mechanisms for Cogeneration in Europe (continued)

Country	Criteria	Incentive
Luxembourg	Very Pro biomass and biogas CHP Feed-in Tariff	2.5 ct €/kWh up to 3 MWe for 10 years
	Investment grant	Up to 25 % of costs – up to 62,000 €
Netherlands	MEP (Milieukwaliteit Elektriciteits Productie) System provides grants	
	Tax Exemption from Green electricity	
	Tax break for energy saving equipement	44% of tax from annual investment costs
Malta	No support measures for CHP – some discussion of support for biofuels	
Poland	Purchase Obligation for Electricity from CHP if Efficiency is over 70%	
	Requirement for utilities to buy CHP electricity	Energy and Regulatory Authority is to set heat and electricity tariffs
Portugal	High feed-in tariffs for electricity from CHP last for 10years indexed on the price of oil	Directly linked to avoided costs from central el. production
	Bonus prices for Micro-CHP and for innovative technologies	Otto cycle engines 1.0 ct €/kWh
		Micro-turbines 1.5
		Stirling engines 2.0
		Fuel cells 20.0
	MAPE Programme	Provides financial support for energy efficiency projects
	SIME Programme	Grants and interest free loans for projects that demonstrate competitiveness
Slovakia	Feed-in Tariff for electricity from CHP depending on technology	~78€ /MWh for Stirling Engines
		~53€ /MWh from Internal Combustion Engines
	Power Distribution License holders are obliged to purchase CHP electricity where feasible	
Slovenia	Qualified Electricity Producer (QP) Programme supports micro-CHP awarded to producers for high efficiency >78%	
	Feed-in Tariffs for technology < 1MW	Biogas 12.1 ct€/kWh
		Wood Biomass 7.0
		Landfill gas 5.3
	AURE programme	Co-financing up to 50% for feasibility studies
	Up to 1MWe units do not require an electricity supply license	
	Low interest loans for CHP and other energy efficiency projects	
Spain	Royal Decree 436/2004 provides a bonus for the sale of electricity	2 systems available, sell el. To wholesaler based on a fixed rate or sell el. to an energy market, both receive a bonus for reactive energy.
Sweden	Certificate based system	Benefits to RE producers
	Tax relief to CHP and biomass depending on production type	Heat production exempt from energy tax and 79% CO2 tax. No tax for biomass/peat
United Kingdom	Good CHP schemes are exempt from Climate Change Levy	Levy Exemption certificates given to CHP schemes that export electricity
	Enhanced Capital Allowance for good CHP scheme	100% first year capital allowance on investment –can write-off cost of investment on taxable profits
	Grant support – Community Energy Programme	Small scale projects aimed at heating and cogeneration with budget of 10m GBP
	License Exemption	El. production < 2.5 MW does not require a license
	Carbon Trust's Action Energy offer:	Feasibilty studies, interest free loans, guidelines
	Energy Saving Trust	Free advice, information and development grants for feasibility

COGEN Europe

COGEN Europe reviews the changes in support mechanisms for CHP.
It is worthwhile to check their website for updates.

6. BIOMASS FUELLING OPTIONS

Although **biogas**, 40-65% methane (CH4), is the most popular renewable cogeneration fuel for small scale cogeneration, the market uptake of biogas CHP units in single homes or small businesses is unlikely to take off without a substantial increase in biogas fuel production and supply. Currently most biogas CHP units are sited on farms and landfill sites with a direct source of biogas feed stocks (e.g. sewage and manure) which are anaerobically digested. The supply of biogas to residential areas in cities is a necessary prerequisite to increased gaseous biomass CHP energy production. Germany has led the way in biogas production in Europe and in establishing the first biogas supply to existing natural gas infrastructure. As it is, natural gas will continue as the dominant small scale CHP fuel.

Solid biofuels such as wood, wood chips or wood pellets are the next step for small scale CHP either by direct combustion in a pellet burner or in a gasification system. Progress in this area has been quite slow and only now, commercially available units are starting to become available.

Wood gas, also known as producer gas, is another fuelling option for CHP. It is created from the gasification of biomass, usually wood chips and other residues. The product, wood gas, is essentially a mix of hydrogen, methane, nitrogen and carbon monoxide where it is then cleaned in a filter and combusted in a generator. It's energy content is much lower than most gaseous fuels therefore larger scale CHP units are more common.

Vegetable oil has, especially in the last 5 years, become more and more popular as a CHP fuel. These units are fuelled by the used filtered vegetable oil from restaurants and other parts of the food industry. The oil is generally cheap or even free as one is taking away the burden of disposal from the original user. The combustion works on the same premise as the diesel engine.

There are a number of **diesel** CHP fuelled units but you need to check with the manufacturer if it will accept biodiesel because there are problems over corrosion of components due to the chemical composition and viscosity of biodiesel. In recent years, in Austria for example, the price of biodiesel has increased whenever fossil diesel increases which creates an unfortunate market dynamic and it makes it more difficult to convince the consumer to switch to greener fuels.

Some major heating companies and CHP technology suppliers do not wish to invest in biomass fuelled units just yet, however there do appear to be a good number of companies interested to serve the current market demand. The important issues for biomass fuelling are based around the obvious logistical requirements to collect and distribute and also concerning the chemical composition of biomass feed stocks. The feedstocks often require pre-treatment due to contaminants which affect the operational efficiency of the combustion. For biomass fuels, problem compounds include chlorine, sulphur, organic acids and silicon. These compounds can stick to heat exchangers preventing heat transfer and in some cases the chlorine or hydrogen sulphide compounds corrode the components making maintenance more frequent and hence more expensive.

7. COMMERCIAL COGENERATION TECHNOLOGIES

Gas Engine/Reciprocated Internal Combustion Engine

In the COGEN Challenge CHP supplier directory there were approximately 160 suppliers of small scale CHP technology. Of this 160, 61 (38%) of them were biogas compatible mostly using the standard combustion gas engine. Only 14 (9%) of these companies manufactured gas-turbines compatible with biogas and only 8 (5%) companies had a technology compatible with vegetable oil, mostly from Germany.

In a reciprocated internal combustion engine, the fuel is ignited for petrol and compressed for diesel, which creates hot gases and thus pressure to push the piston. The mechanical work is either used (as it is in a car) or connected to a generator to convert it to electricity. The heat from this combustion is captured from the exhaust gases, cooling water and engine oil, producing the thermal energy for the building. The internal combustion engine is also known as the gas engine when it is fuelled by a gas. It is dominant over other CHP technologies due to it's long history and large service infrastructure and because it is generally cheaper in terms of energy production per €/kWh. For a typical 250 kWe unit it costs ~ 800 € /kWe from fossil sources and a biogas engine, a slightly modified gas engine costs around 700 €/kWe (COGEN Europe).

Examples of commercially available CHP units today:

The Czech company TEDOM produces a number of small and micro CHP units which normally use natural gas as a fuel but some have been modified to accept biogas. There are eight models available for biogas under the 1MWe definition, from a range of 23 kWe (with 42 kWth) to 300 kWe (with 370 kWth). These units have between 76 and 85% efficiency when both electricity and heat are used together. These figures are based on biogas with 65% methane content. The units are designed to operate with a methane content of between 55-65% but the absolute minimum is 50%. The images opposite are examples of the TEDOM CHP units in operation today.

It is reported that a 22 kWe TEDOM PREMI unit running for 4000 hours a year will save around 18 tonnes of carbon per year compared to separate heat and electricity production. This model is stated to make annual savings of 4,775 Euros and a payback period of 6.3 years at an install cost of 30,000 Euros (COGEN Europe).

Modlany Land fill, CZ, TEDOM
Cento 150 SP BIO
150 kWe, 192 kWth

Petruvky, Land fill, CZ, TEDOM
Cento T 300 SP
300 kWe, 370 kWth

SenerTec DACHS, from the Netherlands, installed around one hundred 5 kWe gas engine micro-CHP units by the end of 2004. The unit provides 5.5 kW of electricity and 12.5 kW of heat and is build around a gas engine (see the image on the following page). SenerTec is a subsidiary of Baxi. Sales of the unit are reported to be good with 985 units in 2001 and 3000 units sold in 2006. Customers have largely been from small hotels, swimming pools, apartment blocks and nursing homes. At a cost of 14,000 Euros it is estimated to save 1,341 Euros per year with a payback period of eight years. As with all gas engine CHP units it is primarily designed to take natural gas but it can also take biogas as well as LPG, fuel oil and biodiesel.

DACHS, Baxi-Sénaire

BODERUS, from Belgium, manufactures micro-CHP units fuelled by biogas as well as natural gas models. They sell a range of capacities from 10 to 383 kWe units using natural gas and biogas (see image below for example). For the biogas unit, they provide a biogas checklist which sets minimum criteria for the chemical composition of the biogas, most notably an 80% methane content. The units are rated as 94% efficient and are designed for an annual running time of 8000 hours.

BODERUS

Limburg, Germany - LOGANOVA model DN 40 - 40 kWe - 72 kWth - Use: hospital / convent (Kloster Marienboren facility)

The Italian Company, ENERGIA NOVA, manufactures a small gas engine CHP unit 20 kWe, 47 kWth which is based around the FIAT FIRE 1200 cc engine. It is rated to have an impressive 97% overall efficiency (29% electrical, 68% thermal). Maintenance is recommended every after 1500 hours of operation.

One of the selling points advertised for the unit is the saving of 450gm of CO_2 per kWh as well as lower NOx emissions with a maximum of 60mg/Nm^3 emitted. ENERGIA NOVA reports that customers may save up to 40 % of fuel costs per year with cogeneration.

ENERGIA NOVA

COGENCO, based in the UK, manufacture and sell biogas CHP units from 116 to 1750 kWe and the thermal power ranges from 186 to 1737 kWth (see image below). They offer to do most feasibility studies free of charge. Depending on the situation return of capital investment can be achieved in a payback time of 2 years. The company offer a "cradle to grave" service where they provide support from feasibility, design, installation to commissioning, maintenance and remote monitoring.

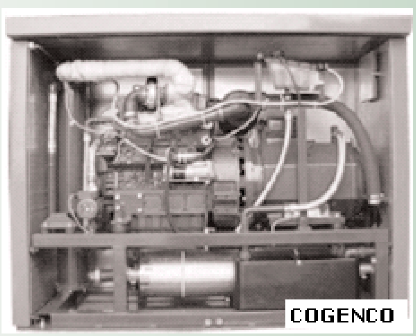
COGENCO
300 kWe unit in Cambridge, UK

TOPEC BV, from the Netherlands, make small scale CHP units from 100 to 1000 kWe fuelled from biogas. The image below is a 340 KWe biogas unit. Topec reports that around 30% of fuel is saved from cogeneration with their units with an overall efficiency of 90%.

TOPEC BV

Vegetable Oil & Biodiesel Reciprocated Engine

The supply of biodiesel or vegetable oil from crops such as rape seed or sunflower is quite limited in Europe for CHP systems as they are largely destinated for transport biofuels. Current production of biodiesel puts Germany in the lead followed by France, Italy and Austria. In order for these units to increase in sales, the supply still needs to increase. Other sources of vegetable oil include the waste cooking oil from restaurants or the catering sector. This oil is filtered to remove impurities and for the moment it is still quite cheap as it is regarded as a waste product.



Cogengreen (Cogenco, Belgium), established in 2004 and in association with the German developers, KW-Energietechnik, sell vegetable oil micro-CHP units (less than 50 kWe - see above) in Belgium. KW-Energietechnik have since 1995 developed diesel and vegetable oil CHP technology. They have units as low as 8 kWe (18 kWth) up to 25 kWe (44 kWth) using vegetable oil or biodiesel interchangeably. Efficiency is rated at ~92%. Smaller 1.8 - 4 kWe units for the family home are being developed at present and commercialisation is anticipated at the beginning of 2009.

Gas Turbine and Microturbines

Another technology suitable for CHP, is the gas turbine and it's smaller brother, the microturbine. It has advantages over the modern internal combustion engine, such as its high power density, fewer moving parts and extremely low emissions. They can be fuelled by liquid and gaseous fuels - fossil or renewable. Gas Turbine capacity is generally between 500 kW and 250 MW and microturbines generally range from 30 to 350 kW. Combustion temperatures are usually considerably higher (800-1300°C) than gas engines, allowing for more complete combustion and lower emissions. The gas turbine works by igniting the fuel with air in the combuster. The combustion gases are directed over the turbine's blades which spin around and it is directly connected to the turbine. A typical 250 kWe unit costs ~ 1500 € /kWe (COGEN Europe).

KAWASAKI Gas Turbine Europe

CAPSTONE Turbines

It is possible to use biogas (landfill, sewage, etc.) and waste gases (flare gases from refineries, industries) as fuels. However, the chemical composition of much of these alternatives requires pre-treatment due to contaminants in the gas which effects the operation of the turbine. KAWASAKI Gas Turbine Europe, a large German/Japanese gas turbine manufacturer, offers a version of their M1A 13X, 0.61 MWe gas turbine (see above left) with a catalytic combustor producing less than 3 ppm NOx guaranteed.

A 65 kW microturbine (above right) is available from CAPSTONE Turbines (USA) which can use biogas as fuel and can achieve 29 % electrical efficiency and 62 % overall efficiency. A COGEN Europe study looked into the financial possibilities for a cogeneration unit in Portugal, where a 30 kW micro-turbine CHP unit would be installed in a hotel. Results showed it would have an install cost of 76,000€ with a payback of less than 7 years. The report said also that it will save 17 tonnes of CO_2 per year as well as over 11,000 Euros in electricity bills with the option to export electricity back to the grid.

TURBEC (Italy & Sweden) also manufacture gas turbines. Since their demonstration biogas CHP turbine in Malmö, Sweden, they have had good results and now biogas fuelled units are available upon request. The T100 model (see below) has a capacity of 100 kWe and 333 kWth with a turbine inlet temperature of 950 °C.

TURBEC

Liquid fuelled Microturbines

A study of liquid fuelled microturbines was conducted by WIP (a German renewable energy company, based in Munich) within the project Bioturbine (www.bioturbine.org) where a variety of fuels were considered: vegetable oil, biodiesel, bioethanol, biomethanol, dimethylether, fischer-tropsch diesel, pyrolysis oil and HTU oil. Combustion temperatures ranged from 700 to 1150 ° C. Trials were done using bio-oil produced from the flash pyrolysis of wood. Results found that small deposits were left in the combustion chamber and on the turbine blades but this did not adversely affect performance. However, if larger deposits were to occur, it could not be tolerated due to the high speeds involved in the turbines operation. To remove the deposits would require taking the turbine apart, thus a costly maintenance procedure. The deposits may be a result of the bio-oil quality. Further testing would be required to confirm this and for development of other fuels. Tests with bioethanol revealed fewer emissions than bio-oil. There is little research into liquid biofuel CHP turbines today, most are focused on gaseous and solid biofuels.

Stirling Engines

The Stirling Engine is still seen as an emergent technology in the realm of CHP systems, thus still expensive, despite the origins coming from the 19th century. It works with heat from an external heat source brought via a heat exchanger. The heat from the heat exchanger is put into contact with the operating gas in the cylinder of the stirling engine, where it expands at high temperature driving the piston up. This system reduces the complexity of the engine compared to an ICE and thus increases reliability and reduces maintenance. The advantage of an external heat source is that it can be powered by biomass, solar, wind, or fossil fuels. This flexibility and the high efficiency of the engine means there is great opportunity ahead. Costs have to be reduced to become commercially competitive with other CHP technologies but there are some models already on the market. Many regard stirling engines as one to watch for the future. A typical 7.5 kWe unit costs ~ 2600 €/kWe.

Prototype 1kWe, ENATEC

Cross section
Microgen Energy Limited

KWB, from Austria (www.kwb.at), has made a name for itself from its pellet burners over the last decade. They have now developed a Stirling engine using a pellet burner as the heat source. The capacity is 1 kWe and is intended to replace the boiler in individual homes. A field test of 40 units started in winter 2006 into 2007. It will be one of the first small scale CHP units using solid biomass to become commercialised.

Dutch based micro-CHP developer, Enatec, are developing a 1 kWe (with 4-35 kWth) Stirling engine (see above left) to replace a conventional boiler for individual homes. They plan to have units available by the end of 2007. ENATEC have concentrated on fossil fuelled burners for the Stirling engine unit, however, the unit is still reported to save 700Kg of CO_2 per year.

Microgen from the United Kingdom has developed one of the first small scale CHP units for individual homes (see previous page on right) to replace the traditional boiler. The unit is reported to be small and quiet enough to be mounted in the kitchen. It has a capacity of 1.1 kWe and 15-36 kWth (which can be modulated down to 5 kW). It is designed to take natural gas as the fuel, and a petroleum version is in the pipeline. Overall efficiency is rated at 90%.

Of particular interest is Solo Stirling (Germany), now part of Stirling Systems AG (Switzerland), (//stirling-systems.ch/) who are developing a solid biomass fuelled Stirling 161 CHP unit. Initial testing of this system started with a biomass burner. A problem which arose during testing was the gradual accumulation of ash and tar deposits on the heat exchanger head thus the biomass burner was abandoned in favour of a gasification system. Wood pellets have been chosen as the fuel as it is a standardised fuel with a predictable composition. In the gasification system, the pellets are gasified, producing wood gas which is then combusted in a burner providing heat via a heat exchanger to the Stirling Engine. Current trials are based on natural gas fuelled units. It is targeted for homes and small businesses. The capacity is based around a modulating unit of 2-9.5 kWe and 8-26 kWth and weighs 460 kg. Overall efficiency is between 92 and 96%. These efficiencies demonstrate the potential for solid biomass fuels.

Steam Engine

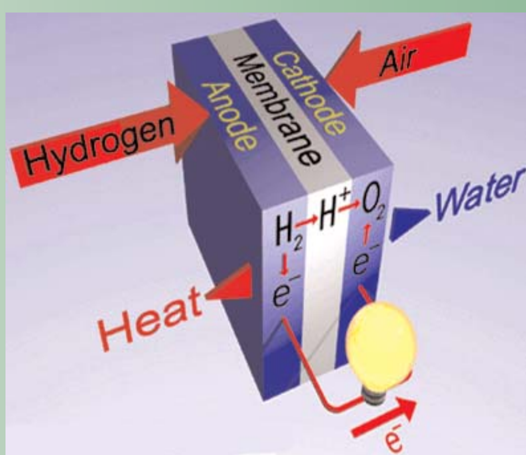
A steam turbine works by the combustion of a fuel in a boiler, which heats up water-injected air that gets pressurised during combustion forming steam. The steam is fed into the steam turbine and the turbine is then fed to the generator. Typically steam turbines have a lower electrical efficiency than gas turbines or a reciprocated engine but overall efficiency can be higher. Applications for steam turbines are those that require a high heat to power ratio and they are more suited to medium to large scale industrial uses such in metal and paper industries which often operate continuously and have a high demand for steam. They are not generally considered for small cogeneration application but are well suited to district heating systems due to the large heat output. There are some steam turbines under 1 MWe, however, an example of which is seen top right.

COGEN Europe

Steam Engine from Spilling, 600kWe, 4200 kWth using solid biomass, heat distributed through District Heating network based in Zelezniki, Slovenia, Investment 2,960,000€

Fuel Cells

Fuel cells are another potential area for the use of ethanol. Fuel cells function by combining hydrogen with oxygen from the air to produce electrical energy, with water vapour and heat as by-products. See the diagram below. Fuel Cells have a typical electrical efficiency of between 30 and 60 % and an overall efficiency, if using the heat by-product, of 70-90 %. The units run with very low noise emissions and pollutant gas emissions are also reduced considerably. It's disadvantages are its relatively high cost, their short life span (regular replacement of components). They are, however, regarded as very reliable for the duration of their lifespan and are often used for emergency power. A number of fuel cells can use bioethanol as well as fossil fuels without the need for a reformer (to convert it to hydrogen). Acumentrics (USA) and Ceramic Fuel Cells (Australia) manufacture such fuel cells. A typical 200 kWe unit costs ~ 5000 € /kWe.



PEMCF energy exchange diagram (Fuel Cell Today, 2007)

Fuel Cells use the chemical energy of hydrogen (or a hydrogen rich fuel such as Natural gas) and in a thermo-chemical reaction where the oxygen rich ions leave the cathode and pass through the electrolyte to the hydrogen ions at the anode. They form together releasing energy, electricity and water vapour. The hydrogen rich fuel is fed to the anode where it is broken down at high temperatures. The oxygen ions movement from the cathode to the anode creates a circuit usually of less than 1 volt, therefore the cells are stacked up together to achieve the required voltage.

Early Fuel Cell use was conducted by NASA as early as the 1960s and was used in outer space as a reliable energy source albeit very expensive to manufacture. New applications include the use of fuel cells in portable electronic devices such as laptops, mobile phones, wheel chairs, medical devices as well as for transport and stationary power generation. The list below shows the different types of fuel cell and the table explains the various differences between them.

Types of Fuel Cell:

- Molten Carbonate Fuel Cells (MCFC)
- Solid Oxide Fuel Cells (SOFC)
- Polymer Electrolyte Fuel Cell (PEFC) aka Proton Exchange Membrane Fuel Cell (PEMFC)
- Phosphoric Acid Fuel Cells (PAFC)
- Alkaline Fuel Cells (AFC)

Acumentrics (www.acumentrics.com/), from the USA, manufacture a fuel cell suitable for residential and other small-scale use with 5 and 10 kWe capacities (see below). They can be set to 120 or 240 volts depending on needs. The start up time is from 10 to 30 minutes, thus creating a disadvantage compared to other CHP power generation unless it is in constant operation all year round. Also as with most units it can be remotely monitored and controlled via the internet. The fuelling options are one of the main advantages as it can take ethanol (thus bioethanol), propane, natural gas, methanol, methane and hydrogen.

Acumentrics

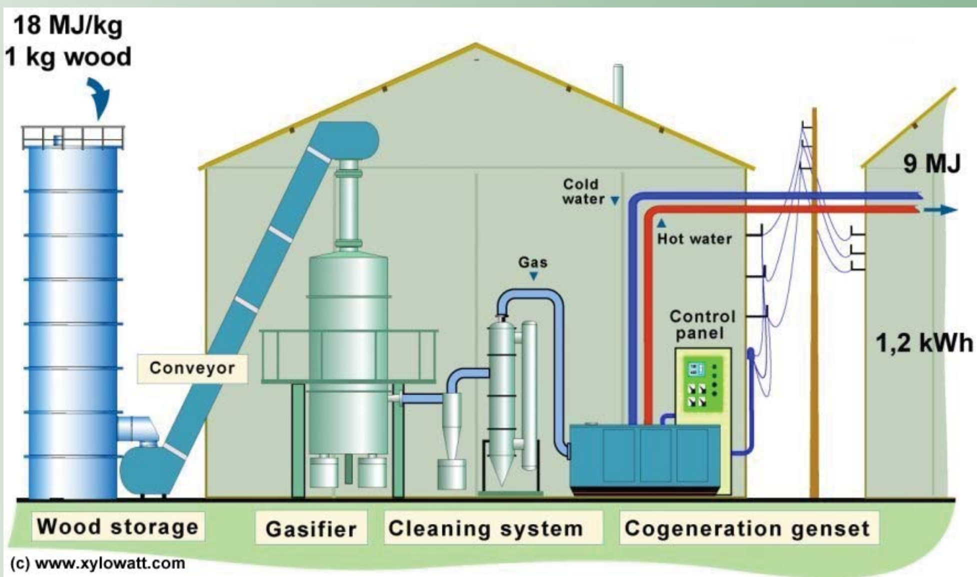
Sulzer Hexis

Sulzer Hexis are responsible for the majority of SOFC CHP installations in the world. They are working on a CHP system, 1 kWe, 2.5 kWth with an additional burner to provide for the heat requirements of the home (see right). At 170 kg it is a lot lighter than R-ICE based CHP units making installation somewhat easier.

Fuel Cell Type	Operating Temperature	Electrical Efficiency	Fuel Type	Applications
MCFC	~ 550 – 700°C	~ 50 to <70 %	Most hydrocarbon based fuels	Large (100's of kW to mW) stationary power generation
SOFC	~ 450 – 1,000°C	~ 45 to <70 %	Most hydrocarbon based fuels	Small (<1kW) to large (mW) stationary power generation
AFC	~ 150 – 200°C	~ 40 %	Pure Hydrogen	Space exploration
PAFC	~ 100 – 220°C	~ 35 to 40 %	Pure Hydrogen	Buses, trucks & large stationary applications
PEFC/PEMFC	~ 80°C	~ 30 to 35 %	Pure Hydrogen	Passenger cars & mobile applications

Ceramic Fuel Cells Limited

8. GASIFICATION OF BIOMASS



The development of small-scale commercialised gasification systems is in its early stages, as generally gasification systems are of capacities 200kWe and above. However, gasification technology has existed for a long time but an all-in-one (gasifier, filter, generator, etc.) unit is difficult to find commercially available as in the past most gasification systems have been designed and built from new. The wood, be it chips or pellets are fed into the gasifier unit where the charred wood reacts with carbon dioxide and air/oxygen/steam to produce carbon monoxide and methane. The image to the right gives a good explanation of the main steps to CHP gasification from Xylowatt (Belgium). The so-called producer gas is then filtered through the cleaning system and can then be burned at higher efficiencies than would have been possible by direct combustion of wood chips.

Ballymena, NI, United Kingdom
An example of a gasification facility is the 55 kWe biomass gasification CHP at the Ballymena ECOS Centre, Northern Ireland. It was tendered by the local council and the contract won by C.A.R.E. Ltd. backed by Shawton Engineering Ltd. who designed and built the system from scratch. It is fuelled by locally available biomass such as the SRC (Short Rotation Coppice) crop - willow. It was commissioned in the year 2000.

Rainford, UK
A pilot biomass fuelled CHP plant was build and tested in the Rainford, UK, by Biomass Engineering Ltd. The project took place from 2003 to 2005 and it has a capacity of 250 kWe with a heat recovery of 100-500 kWth with a 15 minute start-up time. The source fuel is wood, mainly in the form chipped mixed conifer. The system is based on a downdraft gasifier. A ceramic filter cleans the gas of ash and tars before it goes to the engine. Two gas engines were provided by IVECO Aifo (UK).

One major problem for the Rainford project was assuring electricity supply to the national grid. It was neceassry to bring in specialists to design and build a grid supply control room. Additional problems were that significant changes to the gas train had to be made for the producer gas as it was designed for Compressed Natural Gas (CNG). An additional step was purchase a wood chipper to cut the wood to specification on-site. Efficiency was rated at around 34%.

The majority of existing CHP gasification facilities have been built to specification, however Xylowatt, from Belgium, manufactures CHP gasification systems of 300 kWe with 600 kWth. It has a modular design so units can be attached easily to increase capacity. It is designed to take dried wood chips (300kg/hour) but will also take wood waste and agricultural residues. The heat which comes out is at 80-90 °C but the system can be changed to produce steam as well.

IVECO Gas Engine
HMSO, PSI Licence: C2006010726

9. LIST OF BIOMASS FUELLED CHP MANUFACTURERS

This is a list of European small and micro CHP manufacturers that sell biomass fuelled units. All but 1 of the units provided by these manufacturers are designed to take biogas as fuel. There are an increasing number that sell vegetable oil compatible machines. The most popular technology by far for this scale is the standard internal combustion engine/gas engine and the second most popular is the gas turbine. The original list developed, by COGEN Europe for the project COGEN Challenge, contained a list of 160 manufacturers. This abridged list shows around 60 manufacturers offering a biomass alternative to the more common natural gas and diesel powered units.

- ■ (red) Sells **Internal Combustion Engine** CHP units
- ■ (green) Sells **Microturbine or Gas Turbines** CHP units
- ■ (yellow) Sells CHP units designed to take **Vegetable Oil** as a Fuel

Company	Website	Email	Tel	See Above
AUSTRIA				
GE Energy Jenbacher gas engines Austria	www.gejenbacher.com	jenbacher.info@ge.com	+43 52 446 000	■ (red)
BELGIUM				
ABB Zantingh Energiesystemen B.V.	www.abb.be	dpg@be.abb.com	+31 297 354 500	■ (red) ■ (green)
AEC-SMT	www.aecsmt.be	aecsmt@pandora.be	+32 11 871 626	■ (red)
Aspiravi	www.aspiravi.be	rik.vandewalle@aspiravi.be	+32 56 702 736	■ (red)
Bbt Thermotechnology Belgium S.A.	www.buderus.be	mb@buderus.be	+32 16 386 994	■ (red)
Boniver	www.boniver.be	alain@boniver.be	+32 43 882 333	■ (red)
Cogenco	www.cogenco.be	info@cogenco.be	+32 10 618 044	■ (red)
Coretec Engineering S.A.	www.coretec.be	info@coretec.be	+32 43 657 025	■ (red) ■ (green)
Cummins Power Generation	www.cumminspower.com	guido.taymans@cummins.com	+32 475 494 310	■ (red)
Delta Plus Engineering & Consulting Sprl	www.delta-plus.be	delta.plus@skynet.be	+32 43 845 961	■ (red) ■ (green)
Electrabel	www.electrabel.com	guy.dreessen@electrabel.com	+32 25 012 682	■ (red) ■ (green)
Eneas		energy@eneas.be	+32 43 388 953	■ (red)
Eneria (Bergerat Monoyeur N.V. / S.A.)	www.eneria.be	edevis@eneria.be	+32 26 892 244	■ (red)
Made in Power	www.madeinpower.com	e.wolfaardt@madeinpower.com	+32 25 482 901	■ (red) ■ (green)
Technogas N.V.	www.technogas.be	yvb@technogas.be	+32 34 439 790	■ (red) ■ (green)
Vanparijs-Maes	www.vanparijs-maes.be	sebastien.farinotti@vanparijs-maes.be	+32 16 768 040	■ (red) ■ (green)
CZECH REPUBLIC				
Ekol, spol. s.r.o.	www.ekolbrno.cz	jancik@ekolbrno.cz	+42 543 531 701	■ (red) ■ (green)
MOTORGAS s.r.o.	www.motorgas.cz	info@motorgas.cz	+42 283 930 883	■ (red)
TEDOM s.r.o.	www.tedom.com	tedom@tedom.cz	+42 568 837 111	■ (red)

DENMARK				
GE Energy Jenbacher gas engines Denmark	www.gejenbacher.com	jenbacher.scandinavia@ge.com	+45 86 966 788	■ (red)
FINLAND				
Wärtsilä Finland Oy	www.wartsila.com	anders.ahnger@wartsila.com	+358 107 090 000	■ (red) ■ (yellow)
FRANCE				
ABB Zantingh Energie Systèmes	www.abb.com	david.mourre@fr.abb.com	+33 437 032 932	■ (red) ■ (green)
Cogenco SAS	www.nedalogroup.com	info@fr.nedalo.com	+33 130 612 187	
ENERIA	www.eneria.com	nmillet@eneria.com	+33 169 802 100	■ (red)
EURO POWER TECHNOLOGY	www.soffimat.com	pdeveron@soffimat.com	+33 155 374 600	■ (red) ■ (green)
Le groupe JP. Fauché / Electrodiesel	www.fauche.com	info@fauche.com	+33 563 659 860	■ (red)
Pro2 Environnement SARL	www.pro-2.de	info@pro-2.fr	+33 388 181 326	■ (red) ■ (green)
Soffimat Energie / Soffigaz	www.soffimat.com	efarah@ept.homeip.net	+33 155 374 600	■ (red) ■ (green)
GERMANY				
AVS Aggregatebau GmbH	www.avs-aggregatebau.de	s.herrmann@avs-aggregatebau.de	+49 739 395 070	■ (red)
COMUNA-metall Blockheizkraftwerke GmbH	www.comuna-metall.de	bhkw@comuna-metall.de	+49 522 191 510	■ (red)
DEUTZ AG GB DEUTZ ENERGY	www.deutz.de	deutzenergy.v@deutz.de	+49 6213 840	■ (red)
Energietechnik Kuntschar u. Schlüter GmbH	www.kuntschar-schlue-ter.de	info@kuntschar-schlueter.de	+49 569 298 800	■ (red) ■ (green) ■ (yellow)
E-quad Power Systems	www.microturbine.de		+49 2411 689 043	■ (red)
FIMAG Finsterwalder Maschinen- und Anlagenbau GmbH	www.fimag-finsterwal-de.de	vb-leipzig@fimag-finsterwalde.de	+49 3414 426 212	■ (red)
GE Energy Jenbacher gas engines Germany	www.gejenbacher.com	jenbacher.germany@ge.com	+49 621 770940	■ (red)
Höfler Blockheizkraftwerke	www.hoefler-bhkw.de	info@hoefler-bhkw.de	+49 838 225 057	■ (red)
Köhler & Ziegler GmbH	www.koehler-ziegler.de	info@koehler-ziegler.de	+49 640 691 030	■ (red)
KSW Bioenergie GmbH			+49 228 987 700	■ (red) ■ (yellow)
MAN B&W Diesel AG	www.manbw.com	peter.haacke@de.manbw.com	+49 821 3220	■ (yellow)
MDE Dezentrale Energiesysteme GmbH	www.mde-online.com	infomdea@mde-online.com	+49 82 174 800	■ (red)
Öko-Energiesysteme GmbH	www.energie-as.de	BHKW@energie-as.de	+49 3607 651 313	■ (red) ■ (yellow)
Pro2 Anlagentechnik GmbH	www.pro-2.de	info@pro-2.de	+49 21 544 880	■ (red) ■ (yellow)
SOKRATHERM GmbH & Co. KG	www.sokratherm.de	sales@sokratherm.de	+49 522 196 210	■ (red)
SOKRATHERM GmbH + Co. KG Energie- und Wärmetechnik	www.sokratherm.de	info@sokratherm.de	+49 522 196 210	■ (red)
HUNGARY				
GE Energy Jenbacher gas engines Hungary	www.gejenbacher.com	jenbacher.hungary@ge.com	+36 28 587 376	■ (red)

IRELAND				
Deutz Engines Ireland Ltd			+353 14 643 100	■
Temp Technology	www.temptech.ie	temptech@iol.ie	+353 61 413 299	■
ITALY				
CGT S.p.A. - CATERPILLAR DEALER	www.cgt.it	energia@cgt.it	+39 2274 271	■
ENERGIA NOVA S.r.l.	www.energianova.it	g.pilati@energianova.it	+39 112 974 285	■
GE Energy Jenbacher gas engines Italy	www.gejenbacher.com	jenbacher.italy@ge.com	+39 456 760 211	■
TURBEC	www.turbec.com	info@turbec.com	+39 0516835273	■ ■
THE NETHERLANDS				
Deutz Power Systems BV	www.deutz.nl	koster.r@deutz.com	+31 102 992 666	■
Ener-G Nedalo BV	www.energ.co.uk	jurgen.bergman@energ.nl	+31 297 293 200	■
GE Energy Jenbacher gas engines NL	www.gejenbacher.com	jenbacher.netherlands@ge.com	+31 184 495 222	■
MAN ROLLO BV	www.manrollo.nl	sales@manrollo.nl	+31 793 683 683	■ ■
Topec BV	www.topec.nl	hdubbeld@topec.nl	+31 786 417 844	■
POLAND				
BTH Fast	www.bthfast.com.pl	info@bthfast.com.pl	+48 227 110 851	■
PORTUGAL				
GE Energy Jenbacher gas engines ES & PT	www.gejenbacher.com	jenbacher.iberica@ge.com	+34 916 586 800	■
SPAIN				
GE Energy Jenbacher gas engines ES & PT	www.gejenbacher.com	jenbacher.iberica@ge.com	+34 916 586 800	■
TURKEY				
Uzel		UDMinfo@uzel.com.tr	+90 2615 616 820	■
UK				
Cogenco Limited	www.cogenco.co.uk	dudley.mcdonald@cogenco.co.uk	+44 1403 272 270	■
ENER.G Combined Power Ltd	www.energ.co.uk	info@energ.co.uk	+44 1617 457 450	■ ■

Note on Trigeneration:
For CCHP (combined cooling heating and power) there are some companies who provide separate CHP and chilling systems which can be interlinked. An example is TECOGEN (USA). Some companies advertise the possibility of a trigeneration system (TEDOM, CZ; COGENCO, UK; GE Jenbacher, AT) but there is no real commercial, all-in-one unit which is available. The absorption chiller is a physically separate unit to the CHP unit. One also requires a cooling network to be able to distribute the cooling.

The viability depends a lot on the local electricity prices which can be costly for consistent air conditioning needs. If the prices are quite low, then the investment in a CCHP system may not be justified. And conversely high electricity prices make a CCHP system more attractive.

10. CONCLUSION - FUTURE FOR SMALL SCALE BIOMASS COGENERATION

Solid biomass is the main potential fuel for widespread biomass powered CHP systems at small scale. This is due to the fuel supply potential for the consumer being far greater with wood chips and pellets than for biogas, which is produced on farms and on land fill sites or sewage works. The development of a biogas supply system needs to be developed and fed into existing natural gas infrastructure so that it can be supplied to the home or to businesses.

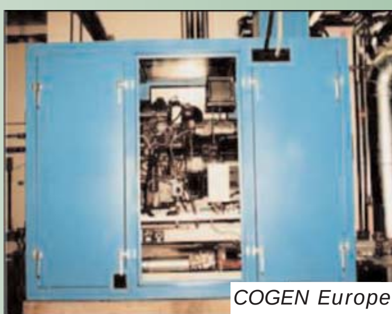
To do this various requirements will need to be met concerning the chemical composition of the biogas and its impurities. Wet biomass such as manure can be used for anaerobic digestion to produce biogas. The separate digester unit is needed to heat and breakdown this biomass into biogas and the facilities will probably remain on farms.

Gasification of biomass using a gas engine or gas turbine presents another area of interest for small to medium scale cogeneration. The Stirling Engine coupled with a pellet burner, or a gasifier, offers a biomass solution which should be available quite soon. For residential, service or public sector cogeneration, the majority of installations will continue to be fuelled by natural gas and other more accessible fossil fuels, therefore much effort needs to be done to lift biomass up to the same level of availability.

11. EXAMPLES OF BIOMASS COGENERATION UNITS IN EUROPE

COGEN Europe

Company	Xylowatt
Technology Type	Gasification CHP
Capacity	300 kWe, 600 kWth
Fuel Type	Wood residues saw-dust, wood chips, briquettes
Investment	2,000,000
Location	Zoning de Mariembourg, Belgium
Additional info	The heat is used to dry chips to be sold around the region



COGEN Europe

Company	AAN
Technology Type	Pressure Ignited Internal Combustion Engine
Capacity	45 kWe, 63 kWth
Fuel Type	Vegetable oil
Investment	166,000
Location	Freiburg, Germany
Additional info	Industrial use

COGEN Europe

Company	Capstone
Technology Type	Gas Turbine
Capacity	30 kWe, 52 kWth
Fuel Type	Biogas
Investment	578,000
Location	Gembloux, Belgium
Additional info	2 gas turbines

COGEN Europe

Company	TEDOM
Technology Type	Biogas International Combustion Engine
Capacity	22 kWe, 45.5 kWth
Fuel Type	Biogas from an onsite digester
Investment	125,000
Location	Migneville, France
Additional info	Agriculture / family home

12. PROJECT OVERVIEW

The project aims at developing and implementing a concise, well-targeted and thematic approach to ensure the uptake of selected RES technologies in the market. In other words the consortium works towards establishing a technology marketing campaign for the different RE technologies involved. So far the market uptake of R&D results does not happen in the best possible way. Lack of information and use of synergies between stakeholders (industries, governments, consumers) is still seen as the critical barrier to large-scale RE technology use in the market place. RESTMAC aims to reverse this trend by:

- A sectoral approach with the objective of promotion and valorization of selected technologies with relevant and strong socio-economic potential;
- A geographical approach with the identification of key market areas where those technologies first selected could be largely deployed.

More specifically the project will look at renewable electricity technologies, renewable heating and cooling technologies and thirdly, the production and distribution of liquid biofuels. A key objective of the project is also to target new member states in the EU and European Islands, along with Asian states and the Mediterranean area where there is significant potential for RES which is as yet un-harnessed. For more information visit the website:

www.erec-renewables.org/47.0.html

The renewable energy sectors to be marketed include:

- PV (photovoltaic)
- SHP (Small Hydro Power)
- Biomass
- Geothermal
- Solar Thermal
- Wind Power

The biomass part of the project focuses on some selected areas that have great potential for the European biomass market and energy sector. EUBIA is responsible for brochures number 4 and 5 while AEBIOM is responsible for the other three:

1. Pellets for Small-scale Domestic Heating Systems
2. New Dedicated Energy Crops for Solid Biofuels
3. Procurement of Forest Residues
4. Co-generation at Small-scale
5. Bioethanol Production and Use