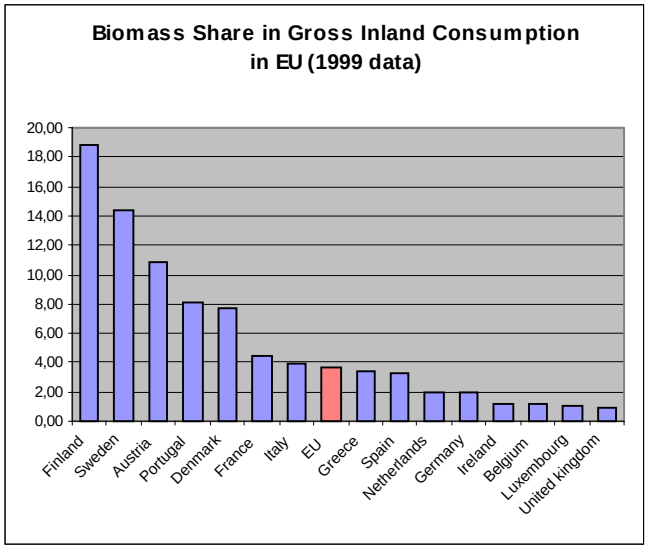
RENEWABLE ENERGY SOURCES - BIOMASS

Main Biomass Facts

Current situation and perspectives in EU

Renewable energy sources are widely recognised within EU as environmentally friendly alternative to conventional energy forms, leading to CO_2 emissions reduction, lowering import dependence, developing new industries and creating jobs. The European Commission adopted a Community Strategy and Action Plan directed towards the goal of achieving a 12 % share of renewables in EU primary energy consumption by 2010. In 1999 this share was 6,1 %.

Biomass is considered the major renewable energy source with about 63 % in the total EU RES consumption. The biomass contribution grew by 3,3 % per year on average over the period 1990-99 both for power generation (mainly in northern countries) and for direct use in the domestic sector. Current trends show a considerable progress in biomass technologies that are fairly competitive and economically viable compared with other decentralised applications that are becoming more strategic in the context of a liberalised energy market.



Environmental benefits

The emissions levels are significantly lower when burning refined biomass (pellets/briquettes). Ash content in 1 tone of refined wood biomass is 88 times lower than in the same quantity of coal, sulphur oxide content - 25 times lower, nitrogen oxides content - 2,6 times lower, and carbon dioxide content - about 40 times lower.

Country overviews

Bulgaria:

Forest covers over 35 % of the territory of Bulgaria and about 33 % of the population live in rural areas where fire-wood together with solid agricultural wastes remains the main energy source in households. The assessments show more than 1 000 000 cub m/annum wood wastes. The use of wood biomass waste quantities can lead to annual savings of 70 000 tones of oil equivalent and to more 350 000 tons CO_2 emissions reduction.

Biomass overall theoretical potential is assessed to about 5 Mtoe. Out of this the economically viable potential is assessed to about 0.7-0,8 Mtoe. Currently the estimates show utilisation of fire-wood of about 4,7 million cubic meters annually which is about 0.4 Mtoe .

Romania:

Forests cover around 28 percent of the total land area of Romania. The most important biomass resource is domestic firewood, which, along with the agricultural wastes, is used as energy source mostly in rural areas where 45% of the Romanian population lives. At the level of year 2000 the total biomass consumption was 118 PJ out of which 105 PJ were used by the population. The use of biomass as energy source can lead to annual savings of 560 000 tons of oil equivalent that means an important emission reduction of CO_2.

Firewood (including other wood biomass) overall potential is assessed to about 3 Mtoe. From the total biomass it is estimated that only a share of 30% is commercial biomass and the share of 70% represents the contribution of the biomass harvested by the owners from the private forests and gardens.

Greece:

The total agricultural land of Greece is about 9 Mha, of which about 4 Mha is arable land and 5 Mha pastures. The amount of agricultural and forest residues produced each year, is estimated to about 4 million toe. The main agricultural residues are cotton stalks, corn stalks and cereal straw. Wheat, cotton and maize corn together occupy more than 40% of the total Greek arable land.

The total biomass contribution, as primary energy, is presently about 1 Mtoe/year. There is a gradual decrease in the use of traditional bioenergy (fuelwood) but also a growth of new bioenergy applications (agro-industrial residues, biofuels) is taking place.

The total installed capacity of biogas electricity generation plants in Greece is 8 MW, in four locations the biggest of which is Psyttaleia power plant (presented as a case-study on page 4).

Here It Works

A Utility Boiler in Finland That Relies on Wood

The Forssa CHP plant produces 48 MW of heat and 17 MW of electricity for Forssa, a town of 19 000 inhabitants located about 100 km northwest of Helsinki in Southern Finland. District heat for the town was generated by burning fuel oil until autumn 1996, when this biofuel fired power plant was commissioned. Main fuels burnt in the plant's BFB (bubbling fluidised bed) boiler include industrial wood residues and forest chips. Also, smaller amounts of recovered fuel (REF) and peat are used.

Annual wood fuel consumption at the plant is about 400 000 bulk m³ {670 TJ). Biowatti Oy, a Finnish wood fuel production and marketing company, has responsibility for the delivery of all wood fuels. Prices are set on the basis of the energy generated and the efficiency of the boiler.

Technical data

Owner	Forssan Energia OY
Commissioned	1996
Electricity output with auxiliary condensing unit	17,2 MWe
Heat output	48 MWth
Annual electricity production	57 GWh
Annual heat production	559 TJ

Fuel data

Annual fuel consumption	760 TJ
Fuel distribution	
Bark	25 %
Sawdust	29 %
Forest chips	34 %
Sod peat	6 %
REF	4 %
Other	2 %

Boiler data

Boiler supplier	Foster Wheeler Energia Oy
Boiler type	Bubbling fluidised bed boiler
Boiler output	66 MW
Steam values	23 kg/s, 61 bar, 510° C

A CHP Boiler in Finland Retrofitted to Increase the Use of Wood Fuels

The Rauhalahti CHP plant of Jyväskylän Energiantuotanto Oy provides energy for the town of Jyväskylä and the M-real Kangas Paper Mill. Jyväskylä, a town of 80 000 inhabitants is located in Central Finland. The boiler at the Rauhalahti CHP plant, originally commissioned in 1986, was converted from pulverised firing to fluidised bed combustion in 1993. The conversion of the boiler significantly improved the profitability, availability and emission control of the plant. Around 50 suppliers are responsible for fuel procurement, mainly of wood and peat. This sets special requirements for the management of the fuel supply chain. As much as 25 per cent of the fuel consumption is covered by wood based fuels and this share will become 50 per cent in the near future. The conversion to fluidised bed technology has made it possible to utilise a wide range of fuels, including moist wood and bark. The increased use of bio-fuels has reduced CO_2 and sulphur emissions.

The plant produces district heat for the town of Jyväskylä, process steam for the Kangas Paper Mill and electricity for the grid. The energy company Jyväskylän Energiantuotanto Oy is a joint venture of Fortum - a Finnish energy company - and the town of Jyväskylä.

Finnish boiler companies, Foster Wheeler Energia Oy and Kvaerner Pulping Oy have retrofitted almost 60 boilers to fluidised bed combustion of biofuels to increase the use of wood fuels in existing plants.

Technical data

Owner	Jyväskylän Energiantuotanto Oy
Commissioned	1986
Conversion	1993
Electricity output	87 MWe
Process steam output	40 MWth
District heat output	140 MWth
Annual electricity production	399 GWh
Annual heat production	3 809 TJ

Fuel data

Annual fuel consumption	6 500 TJ
Fuel distribution	
Peat	67 %
Industrial wood residues and forest chips	25 %
Coal	6 %
Oil	1 %
REF	1 %

Boiler data

Boiler supplier	Kvaerner Pulping Oy
Boiler type	Retrofit to bubbling fluidised bed
Boiler output	295 MWth
Steam values	110 kg/s, 135 bar, 533° C

Pellets used in converted oil boiler heating school and sport centre in Jonkoping, Sweden

Since 1986 the buildings at Flahultsskolan are heated by pellet in a converted oil boiler.

Background

Two oil boilers stand beside each other in the boiler room of Flahultsskolan in Norrahammar outside Jönköping in the south of Sweden. One of the boilers is converted into bio fuel and has a pellet burner. Since 1986 the pellets heat up 4 000 m² school buildings, a swimming hall and a sports hall with four tennis courts.

Local district heating

The heat is transported to the sport hall by culvert with hot water where it supplies the healing system, the showers and the pool. The sports centre has its own mechanics who manage the service there.

The pellet plant manages solely the heating need down to zero degrees outside. When it gets colder the oil boiler automatically supports the pellet boiler. In the winter that means a couple of hours per day, depending on how much activities there are in the sports centre and how much hot water is spent.

Management

Once a week the ashes are removed and drawn to a container which empties twice a year. Every 10th day the mechanic sweeps the boiler and after five weeks the chimney sweeper comes. According to regulations from the government the plant has to be supervised once a day, weekday as holiday.

If power failure the sprinkler system takes care of the glowing remains in the burner, if any alarm goes on the fuel supply is blocked.

Technical facts and function

The burner NT Energi G5, nowadays G6, has an automatic ignition system and a special technique for cleaning of the grate. At the same time the fuel is fed with a movement that stir the fuel. Some of the secondary air passes through the grate staff which gives a jet effect together with a warming up for the combustion air.

The G6 burner has further additions such as an ash rake which removes the ashes from beneath the grate. Also the control system has been further developed where a programming of the PLC of the controlling system can be made through a modem and is prepared for external controlling and supervising from an alarm centre or a central supervising unit.

The results from combustion test in Flahultsskolan are as follows:

CO2	Approx. 13%
CO	Below 200 ppm
NOx	Below 100 ppm
Particles	far below 100 mg/nm³ with a multi cyclone

The average annual efficiency is over 80 %, and the availability at continuous running is better than 95 % not calculating planned stoppages.

Energy consumption

So far the heating system has consumed nearly 4 000 tons of pellets during the years of running. In 1999 the healing system consumed 260 tons pellets and 78,5 m³ oil for support This is in energy terms equivalent to 992 MWh pellets and 785 MWh oil. The boiler that is converted into pellets is from 1963. In 1986 the first pellet burner was installed and it lasted until 1998 when a new more modem burner was installed. The burner is controlled by modem electronics to adapt the combustion to maximum efficiency.

During the summer the plant is down for maintenance. The mechanic looks over the plant before the next heating season. The work takes barely a week to perform.

Costs

The reinvestment cost for the new burner in 1998 was approximately 200 000 SEK (about 22 000 Euro).

Running costs are equally shared by the school and the sports centre. In 1999 the running costs consisted of cost for pellets - 207 500 SEK (about 22 810 Euro), oil - 169 000 SEK (about 18 578) and cost for mechanics - 64 000 SEK (about 7 035 Euro). The cost of maintenance and repairs amounted to 10 000 SEK in the same year (1 100 Euro).

Small wood pellet fired biomass plant substituting electricity heating in a private house in Denmark

The aim of this private project was for the Lambertsen family to decrease the heating costs in their new house. The house was electricity heated and the costs were 32 000 DKK per year. However, by investing in a wood pellet plant and a central heating system in the house instead of the electric heaters, the house has a bill of approx. 7 500 DKK for 6 - 7 tones wood pellets per year substituting 32 000 kWh of electricity.

Description

The house is approx. 160 m² plus 135 m² basement. The company Passat Energi delivered an 11 kW wood pellet boiler with wood pellet storage. It is a compact unit that does not take more room than an oil boiler. Also chimney and brand new radiators were installed. The fuel is wood pellets, which automatically are stoked to the burner. The heat is transferred to the house via water in a central heating system and delivers the heat to the radiators. There are approx. 250 various types approved biomass boilers in Denmark and 30 manufacturers. All the type-approved boilers have a very high efficiency and low emissions. Automatic boilers without accumulation should preferably have as low capacity as the peak heat demand - smaller if it is possible to supply with other heat sources a few days a year when you have the peak load. The boiler has the highest efficiency at high loads.

Results

The family saves approx. 24 000 DKK per year for heating expenses which means a $C0_2$ reduction of approx. 32 000 kg - or 640 tones in a 20 year lifetime. It is easy to use pellets: they are filled into the storage once a week and ash is to be removed 3 times a year. The combustion is automatic and controlled by a sensor measuring temperature and oxygen content in the flue.

Impact on the market

There are still many households using electricity and some with oil, who with advantage could convert into a biomass-fuelled plant with large $C0_2$ reductions as a consequence. The economy could be very good for electricity heated houses, and for oil heated if the oil burner is worn out and they have to change the oil burner anyway. There are subsidies for such plants - and approx. 14 000 biomass fuelled plants have been installed and received the governmental subsidies since they were launched in 1995. The amount of the subsidy has decreased during the years in accordance with the success of the scheme. In 1995 the subsidy was 30% of the total investments whereas in 2001 it is max. 16% - and not for installation costs - and max. 5 000 DKK for a private household (4 000 DKK for a business/industry). The cost savings are generally very good if the plant is installed in larger households, institutions, companies, etc. The environmental impact depends on the fuel being substituted - when it is electricity as in this case it is from 800 g - 1500g $C0_2$/kWh substituted by biomass.

Project costs

Total price: 131 000 DKK (about 17 615 Euro). National subsidy - 37 000 DKK End price: 94 000 DKK. Annual savings: 25 000 DKK. Simple pay back time: 3,76 years.

Conclusions

Approx. 2 600 small boilers have been installed in private households or small institutions and companies per year from 1995 - 1999. A number, which in 2000 rose to 4 600 biomass fuelled boilers, of which approx. 4 000 are for wood pellets. In 2001 6 000 biogas boilers are expected to be established. This systematic testing has thus given a boost to increased efficiency and reduction of emissions.

How It Works in Greece

A successful example of a biomass plant in Greece is that of the BALKAN EXPORT S.A. in Thessaloniki. BALKAN EXPORT S.A. is a wood processing industry with thermal consumption of 5 MW in the form of heat transfer oil at 260 ^{o}C.

The heat is utilized in a chipboard press and several laminating presses. Formerly, the heat was supplied by three boilers using heavy oil. The N.ACH.PHILIPPOPOULOS Co. designed and installed a biomass combustion plant with 5.8 MW nominal capacity. The plant utilizes wood waste from the various processes such as bark, wood chips and wood dust. The new plant has replaced the existing boilers, which led to savings of 2 700 tons annually in heavy oil fuel.

With the replacement of heavy oil fuel with biomass the investor met the following targets:

- Independence of the fuel supply
- Reduction of the production cost
- Protection of the environment
- Reduced fire hazards
- Reduction of the wood waste in the factory premises.

7 MW ELECTRICITY GENERATION FROM BIO-GAS IN PSYTTALEIA, GREECE

AIM OF THE PROJECT

The project aims at maximising the energy use of the biogas produced from treating the whole quantity of the daily wastewater production of the city of Athens (4 000 000 inhabitants). The biogas is being produced from the sludge digesters at a daily rate of 72 000 Nm^3/day and can be used for producing 64 GWh of useful energy per year.

The biogas produced before the instalment of the proposed plant was either being used in burners for hot water production, which was then being used for sludge heating, or it was burnt in 3 specially designed torches, with all associated gaseous emissions being released directly to air. The project includes biogas burning in specially designed turbines for electricity production, and the associated heat coming from the flue gas and the cooling water circuit of the turbines which will be used for sludge heating (inside the digesters) and drying (of the final product).

The unit occupies an area of 400 m^2 and is located on the island of Psyttaleia where is also situated the central wastewater treatment facility of the city of Athens and its surroundings. The produced electrical energy will be consumed for satisfying the site consumption, and any surplus energy will be sold directly to the gird.

PROJECT DESCRIPTION

General Description

The unit is designed with an installed production capacity of 52 800 000 kWh per year. Based on existing situation (since the second stage treatment facility has not yet been completed) the production will be 37 000 000 kWh per year. From the annual production 16 million kWh will be consumed locally for the needs of the sewage treatment plant of Psyttaleia when the remaining quantity will be sold directly to PPC. The environmental benefits arising from the realisation of this project are significant in terms of air emission reduction. The daily methane (CH_4) emissions will be reduced from 20 000 Nm^3 to 0,2 Nm^3, hydrocarbons emissions from 120 Nm^3 to 0,2 Nm^3 when carbon monoxide (CO) will be held below 650 mg/m^3 and NO_x below 500 mg/m^3. In addition to the reduced or avoided air emissions a significant reduction of solid wastes volume will be realised as dewatering and sludge drying will help in reducing its volume by a factor of 0,8. Currently the sludge is being deposited to Athens main landfill at Liosia, which is facing significant capacity problems. The project will also create 20 new jobs on site contributing hence to the acute unemployment problem of the wider area.

Technical description

Biogas is being produced from sludge treatment inside the digesters with a relative constant heating value. The overpressure of the biogas is only 20-30 mbars and hence biogas compressor units must be used in order to raise the gas pressure to 3,5 bars, which is the required pressure for use in gas turbines. Three WAUKESHA 12 cylinder supercharged gas reciprocate machines have been installed each one operating at 1000 rpm. The nominal power output is 2 900 KVA and the output voltage is 3,3 kV. The rejected heat from the turbine cooling water circuit is being used for supplying extra heat to the sludge digesters and hence it is improving the overall system efficiency. In addition the flue-gas leave the gas turbine chambers has a temperature of 400 °C and the heat content of that stream will be used in the near future for sludge dewatering and drying thus reducing humidity content and minimising its volume. When the whole system will become operational an overall system efficiency of 80% will be realised. Nevertheless the heat requirements for sludge heating at the digesters are not constant but follow a seasonal variation. An extra cooling circuit using sea water and a heat exchanger has also been installed in order to remove the heat surplus available at the hot water circuit.

The existing site substation (20KV) is being used for supplying power to the site and also for connecting the plant substation (3,3KV/20KV) to the national grid through a sub-water power cable.

Economic description

The total budget of the scheme is 11 113 720 Euro, with EU funding (Operational Program for Energy, Community Support Framework 1994-1999 for Greece) 5 556 860 Euro and EYDAP S.A. (ΕΥΔΑΠ) 5 556 860 Euro.

The present bulletin is issued by Sofia Energy Centre, Coordinator of Balkan OPET, within the framework of Energy Information Network at Local and Municipal Level

For information and recommendations on the content and layout of the bulletin, please contact:
Ivanka Pandelieva
Sofia Energy Centre
51, James Boucher Blvd.
1407 Sofia
Tel: (02) 96 25 158; 68 35 42
E-mail: ivankap@enpro.bg