

BIOMASS CHP-WOOD

BORÅS Sweden

If the share of renewable energy in Europe is to be increased to 12% by 2010, one has to consider an increase in the use of biomass, both for heat and electricity production. Wood and wooden waste are anything but rare, but they need rather heavy investments if they are to be fully exploited. That is why the use of wood as a real renewable energy source (keeping the sustainable use and growth in mind!) still is subordinate in comparison to other renewable energy sources. Nevertheless, some cities (many of them in Scandinavia) have had successful experiences, like in Borås in Southern Sweden, where the use of biomass combined with a large drying unit, makes the achievements quite remarkable.

GENERAL ASPECTS

Borås is a city situated in the Southwest of Sweden in the region of Västergötland landskapsnam. The city has 96,100 inhabitants and its history goes back to 1621, when Borås was founded by King Gustav II Adolf. Borås is the centre of the textile industry in Sweden. This was the main source of employment until the sixties, when the production was moved to countries with lower labour costs. Borås is still the centre for textile trading in Sweden. Due to several major fires in the city throughout its history, no really old buildings can be found.

Climatic data:

Degree days (Base 17 °C): 3,600
Annual mean temperature: 6.5 °C



CONTEXT

Since 1959 the Municipality-owned utility in the city of Borås, Borås Energi AB, has delivered electricity and heat via combined heat and power production to the inhabitants in the city. Before 1984 the production was based solely on fossil fuels such as oil and coal, but since then biomass – mainly as surplus wood from the surrounding forests – has been introduced. In 1994, a large drying unit for the wood was installed, thus making it possible to enrich the energy content in the biomass (in terms of energy per volume) and thereby exclude coal completely from normal operating. Previously it was necessary to feed the boilers partly with coal or oil.

Today, fossil fuel is only used for high peaks in heat demand and for the start up of the combined heat and power plants. In addition, the outer areas of Borås - where the district heating network is not fully developed – are partly supplied from small wood chip boilers. Apart from the direct activities through Borås Energi, the Municipality of Borås is active in environmental questions through the establishment of a local Agenda 21 Office. This has been operating since 1995 and offers advice to citizens on appropriate behaviour regarding energy and the environment. Exhibitions and events are organised to inform and influence citizens and energy advice is available free of charge. Finally, a research and development project concerning solar heat at a swimming pool is underway.

EXPERIENCE OF BORÅS

Borås Energi currently produces 25% of the electricity demand in the municipality and supplies approximately 25,000 dwellings and 2,000 private companies with biomass based district heating. In 1999 – which could be considered as a reference year -, the total heat production was 604 GWh, of which 423 GWh was based on biomass. The electricity production was solely biomass based and amounted to 101 GWh. This gives a renewable energy share of approximately 70 %. As a rule of thumb, all the energy produced is based on biomass when the outside temperature is no lower than 2°C.

Due to public opinion, Borås Energi has committed itself to an environmental policy which basically stresses the need for an evaluation of the environmental impact of each decision made by the company. The means of achieving this are, for the most part, centred round continuing education for the employees. Developing contacts with international networks and other actors in the energy market is also a high priority. Via its acquired knowledge and green image the utility hopes to be the citizens' choice in Borås

The plant

The major combined heat and power plant is located quite close to the city centre of Borås. The plant is not, as is usually the case, placed close to water, making it possible to cool prospective surplus heat. Therefore, energy production is planned according to the heat demand in the city. The fuel – wood from forestry in the area – is transported over a maximum distance of 100 kilometres with large trucks. This does not cause a problem



with heavy traffic in the city centre – the plant has its own approach road. The daily wood intake is approximately¹ 3,300 m³. The storage capacity for the wood chips is in total 11,000 m³. The transport of wood chips takes place from Monday to Friday and the wood is delivered by various small associations of forest owners. The ash from the combustion is sent back to the forest, as required by law. In this way, the necessary nutrient recycling takes place and guarantees sustainability in the forests. The effect on the unemployment situation is positive due to increased employment in the forests. The picture above shows the plant with an indication of the heat production (25 MW).

¹ One m³ of wood chips is defined as the amount of wood chips which can be crammed into a one cubic metre box.

The drying unit

The most modern set up is the newly installed drying unit delivered by NIRO A/S. The drying unit has the capacity to reduce the moisture content in the 300 m³/h wood flow from approximately 50 % to 15 %. The "drying energy" is taken from the steam cycle. Steam with a high temperature and pressure level is used – via a special heat exchanger – to heat up the wood pieces and thereby force the water in the wood to evaporate and eventually leave the wood. The problem with non homogeneous pieces of wood (large, small and different shaped pieces) - which require different drying times (it takes longer to dry a big piece of wood than a small one) - has been solved by means of the fluid bed principle, letting the light and small pieces of wood go faster through the drying unit while the heavier pieces stay longer in the unit. Due to the higher energy content per volume in the biomass after passing through the drying unit, it is no longer necessary to feed the boiler partly with coal to ensure sufficient combustion. This means a better environmental record. On the other hand, the drying unit uses electricity (1.3 MW) and steam (250 °C, 3.8 MPa, 20-22 tons/h). Basically, this means that the result of the investment has reduced the electrical capacity of the plant. But the saving on imported coal and the environmental gains have improved the economics and enabled Borås Energi to decrease the unit price of district heating by 1 %. The following table shows the differences before and after the installation of the drying unit. The surplus energy from the water/steam after the drying process is used for district heating. Before discharging the water to the city drains, the pH value is adjusted with Sodium Hydroxide to ensure that the environmental impact is minimised.

	Before	After
Production		
Electricity	126 GWh	109 GWh
Heat	622 GWh	622 GWh
Total	748 GWh	731 GWh
Fuel mix		
Biomass	455 GWh	578 GWh
Coal	126 GWh	0 GWh
Gas-oil	39 GWh	29 GWh
Oil	13 GWh	13 GWh
Electricity	45 GWh	41 GWh
Heat pump	70 GWh	70 GWh
Total	748 GWh	731 GWh
Environment		
SO ₂	90 Tons	30 tons
NO _x	300 Tons	200 tons
Fossil CO ₂	59,000 Tons	7,500 tons
Ash	7,500 Tons	5,000 tons
Surplus water	0 m ³	100,000 m ³

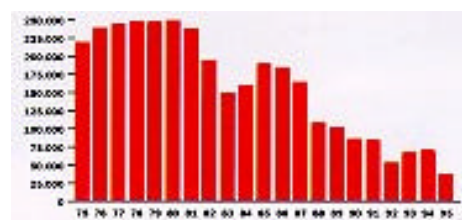
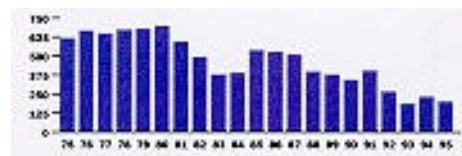
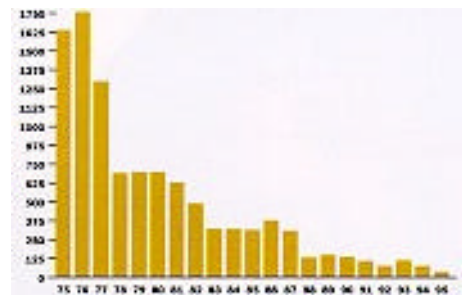


Gas-oil, oil, electricity for heating and heat pumps are all local installations that are mainly used for either specific demands or high peaks in the heat demand. The total investment for the drying unit was Eur 7.7 million² of which Eur 2.5 million were grants from government authorities and research institutes. Due to improved economics based on cheaper fuel (and in addition, no taxes on bio fuels) the investment has meant a yearly gain of Eur 740,000 which – after capital expenses (depreciation time of 15 years) – is reduced to Eur 260,000. This sum equals the 1% reduction in the price of district heating. The picture above shows the transport belt transporting the wood to the drying (blue) process.

² Here one Eur equals 9.488 Swedish Kroner

EVALUATION AND PERSPECTIVES

The main objective for all the initiatives taken by the Municipality is to create a better environment. – In addition, the investments are expected to pay off well for Borås Energi who also have the objective of surviving in the free energy market. During the last 20 years, remarkable results has been achieved. – Borås Energi is currently one of Sweden's largest consumers of bio fuel, and the emissions of SO₂, NO_x and CO₂ have all decreased. In key figures it can be said that after the change to only biomass in 1994, SO₂-emissions have decreased from 80 to 40 tons per year, NO_x-emissions have decreased from 230 to 200 tons yearly and CO₂-emissions have also decreased from 70,000 tons to 37,000 tons per year. The progress in the three "key-emissions" areas is illustrated by the three graphs next to this text.- The yellow shows the falling trends of the SO₂-emissions, the blue the development in the NO_x-emissions, and the red shows the achievements in the CO₂-emissions from fossil fuel. (All in tons per year). The strategy adopted by Borås Energi is, to be the best energy supplier for the inhabitants of Borås. The idea is that concentrating the effort locally will result in better service to the customers and thereby make them choose Borås Energi as their energy supplier which they hope will continue into the future as well. The objective is for all electricity produced by Borås Energi to be green electricity, which will improve the environmental records and also the environmental image of the utility – which is foreseen as important in a free, liberated energy market. Since market liberalisation, Borås Energi has increased its electricity sales from 600 GWh/y to over 1,000 GWh/y.



Plans are currently in progress in Borås Energi to participate in a project concerning the gasification of bio fuels instead of burning them. The current technique is not sufficient for large scale plants, but it is predicted that this will change in 5-10 years. Gasification of the bio fuel combined with the implementation of a gas turbine using the gas produced is the wider perspective which will make it possible to considerably increase the production of power while reducing the environmental impact per energy producing unit.

FOR FURTHER INFORMATION

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