

BIOMASS

Straw

NAKSKOV

(Denmark)

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 for electricity production. Wood or straw are anything but rare, but they need rather heavy investments if they are to be fully exploited. That is why the use of biomass as a real renewable energy source (keeping the sustainable use and growth in mind!) still is subordinate in comparison to other renewable energy sources. Nonetheless, some cities (many of them in Scandinavia) have carried out useful experiments as in Nakskov in Southern Denmark, where the use of straw used in the city's heat supply is remarkable.

THE CITY

Nakskov is a city situated in the Southern part of Denmark on the Island of Lolland. The municipality has approximately 15,500 inhabitants. The major industries in the area are production of sugar from sugar beets. Recently, the large wind turbine manufacturer, Vestas, installed a factory for production of wings and towers. This has meant quite an improvement in the rate of unemployment, which was among the highest in the country due to the closing of a shipyard in the late eighties.

Climatic data:

Degree days (Basis 17 °C): 3,200
Annual mean temperature: 8.1°C



CONTEXT

The municipality of Nakskov owns and runs 100 % the heat supply system in the city. It is based on district heating from a combination of fossil - and biomass fuelled furnaces, which have been installed since 1957. Originally, the heat supply was owned by an association of citizens, but today the municipality has taken over. Due to the extensive agriculture in this region of Denmark and the general national energy policy of the country, it has been obvious to partly base the heat supply on biomass.

Thus today, the city of Nakskov has a fully municipal owned district heating system with a heat capacity of 44 MW of which 14 MW is purely straw based. This biomass capacity uses a base production, thus, the furnaces burning fossil fuels are only used for peak loads.

There is in Nakskov no other direct municipal involvement in renewable energy which follows good environmental policy, but the municipality has, as it is compulsory for all municipalities in Denmark, developed a plan for prospective wind turbine sites in its region. In addition, energy advice is available free of charge at the technical department in the municipality.

EXPERIENCE OF NAKSKOV

History

As early as 1957, an oil fuelled heat plant was built in Nakskov city centre to supply the citizens with district heating. The plant was initiated, built, and owned by an association of citizens, but the construction was supported by the municipality, which immediately implemented it in the planning schemes. The heat capacity was 20 MW divided between 4 boilers. Later, in 1984, two straw fuelled boilers with a heat capacity of respectively 4 and 3 MW were built in the western part of the city burning pressed straw pellets. These straw pellets were produced/pressed in a building next to the heat plant. The reason for using pellets instead of burning the straw directly is the higher energy content per volume of the pellets. This makes the combustion easier to control and decreases the additional oil co-firing. But after approximately one year it was concluded, that the pressing of these pellets was too expensive, and thus, the boilers were replaced by one furnace for pure coal firing. A few years later this coal furnace was removed - again due to bad economy. By now, the association had a very bad economic results and they were forced to either close or sell the production capacity to the municipality, the latter was done. The coal furnace was replaced by a straw furnace (NordFab) of 6 MW plus 2 new coal furnaces. In 1996, these two coal furnaces were then also removed, and replaced with another straw fuelled furnace (Vdønd), this time with a capacity on 8 MW. In addition, a 20 MW boiler (Vdønd) was installed burning gas oil.



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The production capacity

Today, heat in Nakskov is produced at 2 heat plants, one in the middle of the city, commissioned in 1957 and one in the western part of the city commissioned in 1984. These were later extended:

Commissioned	Capacity	Fuel	Remark
1957	20 MW	Technical grease	No tax paid on this type of fuel
1984	6 MW	Straw	Torn up before feeding
1996	8 MW	Straw	The entire straw bale is feed into the furnace.
1996	10 MW	Gas oil	Used for peak load

Furnaces at present in Nakskov

The plant of 1957 was originally oil fired, but today it is fuelled with technical grease due to its lower price. The district heating network has constantly been increased in the city and today the main connection lines are approximately 35 kilometres in length and the minor connection has a similar length.

Approximately 60 % of the city's heat demand is covered by the district heating network and this figure is foreseen to increase in the future due to the policy of the municipality. – Citizens

living close to main connecting lines were forced to connect to the network for a maximum of 9 years after implementation of the network. This means that 9 years after an extension of the network, all possible households are connected. In Denmark, it is voluntary for the municipalities to use this policy but in Nakskov this has been done. In general, there is in Denmark no available grant for changing to district heating and it is only possible if a consumer has electrical heating. The cost of having district heating is divided into a price per delivered heat and a cost which depends on the heated area in each specific house. The cost of one MWh is 65 Eur and the area cost is 3 Eur/m². This equals approximately the cost of having heat supply with individual oil furnaces. Hot water is delivered at a temperature of 80 °C and returned at 45 °C – no refund is added in case of cooling the water to a lower temperature, and no extra costs is given in case of cooling to, say only 50 °C. Approximately 20% of the energy is lost in the network which is within the normal range. Due to reasons of economy, the furnaces burning technical grease and straw are used for base production. This means that the gas oil fuelled furnace only runs on very cold days, when the heat demand is at its highest or at times of periodic examination of the other installations.



Economy

The production capacity and the network is fully owned by the municipality. There is no general view concerning the investments that have been made in the total system over past years, but the total price for the newest straw fuelled plant commissioned in 1996 was approximately 3.4 million Eur of which 200,000 were granted from the Danish Energy Agency. Today, the total debt bound up in the production capacity, is in the range of 12 million Eur and the yearly profit is 2 million Eur. A part of the yearly profit is used for improvements in the production capacity and extensions of the network. The debt is not from a bank loan, it was taken from available funds in the municipality. Thus, the debt does not cost the municipality money in terms of interest rates.

The straw fuelled furnaces

The two straw fuelled heat plants are different in the way the straw is fed into the furnaces. The older one, built in 1984, works with a tearing system, where the large straw bales are torn up thoroughly before the straw is fed into the furnace. The combustion of the straw is supported by oil in the start-up. The newer furnace, built in 1996, works with another process, whereby the whole bale is stuffed into the furnace and combusts on a grate. The reason for using two different technologies is the state of the art concerning straw burning in 1984 and 1996, respectively. Today, all new straw furnaces use the whole bale input. There is no real difference in economically or technically. The objective and reason for building the straw fuelled heat plants has in general been based on economic evaluations. Due to national Danish energy policy, there is no tax on biomass fuel, thus, it is cheaper to fire with straw than with fossil fuels. In a heat plant, where the restrictions/demands in temperature in the boiler is not as high as in a combined heat and power plant, it is obviously better to install biomass fired boilers, in particular in regions where the biomass resources are as rich as in the area surrounding Nakskov. The yearly heat production from the straw fuelled plant in Nakskov was 64.5 GWh in 1999. This replaces firing with fossil fuel (gas oil). If it is assumed that this amount of energy is to be produced with gas oil instead, the yearly environmental saving impacts can be calculated at:

- Saved CO₂-emission: 17,000 tons

- Saved NO_x- emission: 23 tons
- Saved SO₂-emission: 22 tons

The straw is delivered locally by farmers who normally make contracts with the heat plant for a period of three years. There are strict rules for the quality of the big straw bales which are delivered. They have to have a defined size (2.4*1.2*1.3 m, and a minimum weight of 500 kg) and the straw has to have a water content of less than 19 %. If this is not the case, reductions in the price paid can be expected. In very bad cases the straw is refused. The daily consumption of straw is approximately 200 large bales, which thus equals approximately 100 tons/day. The storage capacity at the plant is only about 1000 big bales which equals 4-5 days at full run. The straw is stored during winter at the farms and delivered continuously by the farmers, who are also obliged to take the surplus ash in return, which is proportional to the amount of straw delivered.

EVALUATION AND PERSPECTIVES

Danish energy policy defines technical grease as renewable, as well – so talking in CO₂-emissions, the Municipality of Nakskov covers the city's requirement for heat with almost no fossil fuel. The process in reaching this goes back to 1984 where expensive, experiments with new technology caused a vary bad economy. Fortunately, the municipality was willing to take over and make the necessary new investment. Today, the heat supply in the city runs with a reasonable yearly gain which means there is a possibility of reducing the debt while at the same time making improvements in the production capacity. The future plan, is to close the two biomass fuelled furnaces in 2003 and 2007, respectively. The municipality will invite private tenders for the building and the running of a new heat capacity, but the distribution network and heat capacity for peak loads will stay in municipal ownership. The municipality prefer in order of priority, first, combined heat and power then surplus heat from large production industries followed by straw fuelled heat plants.

FURTHER INFORMATION

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