

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 successful experiences, like in Nakskov in Southern Denmark, where the utilisation of straw utilised in the city's heat supply is remarkable.

GENERAL ASPECTS

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 1980-ies.

Climatic data:

Degree Days (Base 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 on 44 MW of which 14 MW is purely straw based. This biomass capacity is used as 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 and in good environmental behaviour, but the municipality has, like it is obligatory for all municipalities in Denmark, developed a plan for prospective wind turbine sites in its region. In addition, energy advice are available free of charge at the technical department in the municipality.

EXPERIENCE OF NAKSKOV

History

As early as in 1957, an oil fuelled heat plant was built in Nakskov city centre to supply the citizens with district heating. The plant was initiated, build, and owned by an association of citizens, but the erection was supported by the municipality, which immediately implemented it in the planning schemes. The heat capacity was 20 MW divided in 4 boilers. Later, in 1984, two straw fuelled boilers with a heat capacity on respectively 4 and 3 MW were built in the western part of the city burning pressed straw pellets. These straw pellets where 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 to expensive, and thus, the boilers were replaced with 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 economy and they were forced to either close or sell the production capacity to the municipality, which was done. The coal furnace was replaced by a straw furnace (NordFab) on 6 MW and 2 new coal furnaces. In 1996, these two coal furnaces were removed as well, and replaced with another straw fuelled furnace (Vølund), this time with a capacity on 8 MW. In addition, a 20 MW boiler (Vølund) was installed burning gas oil.



The older plant in the city centre

The production capacity

Today, the production of heat in Nakskov takes place 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 with later extensions:

<i>Commissioned</i>	<i>Capacity</i>	<i>Fuel</i>	<i>Remarks</i>
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 from 1957 was originally oil fired, but today it is fuelled with technical grease due to lower price. The district heating network has constantly been increased in the city and today the main connection lines has a length of approximately 35 kilometres, 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 are forced to connect to the network maximum 9 years after implementation of the network. This means that 9 years after an extensions of the network, all possible households are connected. In Denmark, it is voluntary for the municipalities to use this policy, in Nakskov this is done. There is in Denmark in general no available grant for changing to district heating. Only if a consumer has electrical heating this is possible. The cost of having district heating is divided into a price per delivered heat and a cost which depends on the heated area in the specific house. The cost of one MWh is 65 € and the area cost is 3€/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 refunds is given 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 in the normal range. Due to economy, the furnaces burning technical grease and straw are used for base production. This means that the gas oil fuelled furnace only runs in very cold days, when the heat demand is in its highest or in periods for periodic examination of the other installations.



The newer plant.

Economy

The production capacity and the network is fully owned by the municipality. There is no general view concerning the investments in the total system in the years passed, but the total price for the newest straw fuelled plant commissioned in 1996 was approximately 3.4 million € of which 200,000 were granted from the Danish Energy Agency. Today, the total debt bound in the production capacity, is in a range of 12 million € and the yearly profit is 2 million €. 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 costs 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 feed into the furnaces. The older one, built in 1984, works with a tearing system, where the large straw bales are torn thoroughly up before the straw is feed into the furnace. The combustion of the straw is supported by oil in start-up. The younger furnace, built in 1996, works with another process, where 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 economical or technical concerns. The objective and reason to build 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 quite obvious 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 in 1999 64.5 GWh. This replaces firing with fossil fuel (gas oil). If it is assumed that this amount of energy was to be produced with gas oil instead, the saved yearly environmental impacts can be calculated to:

<i>Saved CO₂-emission:</i>	17,000 tons
<i>Saved NO_x- emission:</i>	23 tons
<i>Saved SO₂-emission:</i>	22 tons

The straw is delivered locally by farmers who normally makes contracts with the heat plant for a period of three years. There are strict rules for the quality of the delivered straw big bales. 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 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 to about 1000 big bales which equals 4-5 days at full run. The straw is stored for the winter at the farms and delivered continuously by the farmers, which as well are obliged to take the surplus ash in return proportional to the delivered amount of straw.

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 new, necessary investment. Today, the heat supply in the city runs with a reasonable yearly gain which means possibilities to reduce the debt and, at the same time, make improvement in the production capacity. Regarding the future is the plan to close the two biomass fuelled furnaces in 2003 and 2007, respectively. The municipality will invite private tenders for the building and running of new heat capacity, but the distribution network and heat capacity for peak loads will stay in municipal ownership. The municipal fixing in order of priority is that combined heat and power is preferred, then surplus heat from large production industries followed by straw fuelled heat plants.

FOR FURTHER INFORMATION

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