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WASTE TO ENERGY – HOW LOCAL COMMUNITIES CREATE VALUE FROM THEIR OWN WASTE

WASTE TO ENERGY IN DENMARK

Waste-to-energy is the dominating renewable heat energy source in Denmark.

The utilization of heat from waste-to-energy plants has increased by a factor 4 since 1980 and is expected to increase by a factor 1.5 within 20 years. Besides, the share of CHP in the waste-to-energy plants increase to 100%. Therefore waste-to-energy will continue to be an important factor in the Danish energy policy.

This dramatic increase in waste-to-energy is due to several factors:

- the total energy content of waste has increased in spite of more recycling
- the heat markets have been developed and integrated
- the total efficiency has increased, not least due to flue gas condensation
- the old heat only units are gradually being replaced by CHP units
- the electrical efficiency of the CHP units is increasing

At the same time, the optimal size of a waste incinerator has increased to around 30 tons/hour in order to meet the environmental standards in a cost effective way.

Therefore, the challenge for the district heating systems will be to improve the utilization of the available capacity in the summer period in order to reduce the need for deposits (from summer to winter), e.g.:

- by converting consumers from natural gas supply to district heating
- by transmitting heat long distance to other networks
- by utilizing surplus energy in the summer period for cooling

A good showcase of this development is Vestforbrænding situated in a suburb of Copenhagen.

VESTFORBRÆNDING – A GOOD COMBINATION OF WASTE-TO-ENERGY AND DISTRICT HEATING

The waste management company I/S Vestforbrænding owns one of the largest waste incineration CHP plants in Northern Europe and is responsible for around 15% of all waste management in Denmark. Almost all the waste is incinerated in two modern waste-to-energy CHP units, and all the heat is utilized in the district heating system in the Copenhagen region.

In 2006 the Board of Vestforbrænding approved a very profitable heat planning strategy on how to expand the local heat market by gaining market share from large individual natural gas boilers, which will significantly reduce the CO2 emissions. As the plant is owned by the municipality, all the improvements will be to the benefit of the consumers. The fee for waste incineration will be reduced from 20 €/tonne to around 14 €/tonne, and also the heat consumers will benefit.



THE DISTRICT HEATING SYSTEM

The first part of the network was established in concrete ducts with a constant supply temperature of 160 °C to supply the hospital and industries. The second part of the network was established with preinsulated pipes some years later as a low temperature system with supply temperatures from 80 to 120 °C.

After the oil crisis the district heating system was extended and Vestforbrænding took active part in the municipal heat planning process in accordance with the heat supply act from 1979. Consequently, in 1985 Vestforbrænding was interconnected with the Copenhagen heat transmission system with an 80 and later a 70 MW connection in order to utilise all the surplus heat even in the summer period.

Today the maximal supply temperature is 125 °C and it is the aim to reduce it further taking into account the consumers demand for high temperature. Even more important is to reduce the return temperature in order to increase the capacity of the network and to improve the efficiency of the CHP and the flue gas condensation. Therefore Vestforbrænding intends to help and encourage the consumers to reduce the temperature.

THE WASTE INCINERATOR

Due to the Danish energy policy the two newest units, unit 5 and unit 6, were established with combined production of heat and electricity. Vestforbrænding is now one of the largest waste incinerators in Northern Europe incinerating up to 600,000 tonnes/year producing electricity and heat at a total efficiency close to 100%.

In order to increase the profitability, the total efficiency of one unit has been increased by installing fluegas condensation with a steam driven absorption heat pump. With this condensation in operation the unit can produce 15-20 MW heat more, reducing the electricity production by just 2 MW.

The waste-to-energy plant has a triple positive impact on the climate:

1. Waste incineration reduces the emission of methane from landfills which cannot be recaptured
2. Utilization of heat from the incinerator substitutes CO₂ emissions from other heat sources
3. CHP increases the CO₂ emission reduction significantly

MARKET STRATEGY 2015 FOR THE DISTRICT HEATING

Since the municipal heat plans and the zoning between district heating and natural gas were established around 1985 the market conditions have changed significantly:

- CO₂ emission reduction is now an important objective
- The heat density has increased as many large buildings have been constructed
- Industries have to pay fuel taxes for the fuel for heating purposes
- The natural gas network is depreciated and the Danish natural resources will soon dry out
- Natural gas consumers need to replace their boilers
- There is an increasing amount of waste heat, which can not be utilised in the summer period

Consequently there is a huge potential for increasing the district heating market, changing the zoning from natural gas to district heating.

Therefore Vestforbrænding, in collaboration with the neighbouring municipalities, elaborated a district heating market strategy in order to identify the most optimal development of the district heating system. The analysis shows in brief that it is profitable to increase the district heating sale from the present 300,000 MWh to around 600,000 MWh in districts close to the existing supply areas. New networks have to be established but the heat losses will only increase from the existing 50,000 MWh up to around 70,000 MWh as the heat density of the new districts is rather high and as existing pipes are utilised better. Currently 20% of this plan has been implemented successfully and more than 90% of the consumers have been connected the first year. Moreover, a new plan is to establish a transmission line to supply an additional 100,000 MWh base load to another heat transmission system, which is today supplied from a natural gas-fuelled CHP plant.

The analysis shows that the economic rate of return is 10-12% for the whole society of Denmark, and around 25% for Vestforbrænding and the consumers. Thus implementing this plan will significantly increase the profit for the owners – not as profit to an investor nor to the municipal budgets, but directly to the consumers in terms of lower tariffs for the household waste and lower tariffs for heat.

THE HEAT PLANNING PROCESS

The competition between the natural monopolies, which in this case are the district heating and the natural gas infrastructure, is regulated by the heat supply act. The act states that the municipalities in co-operation with the energy utilities shall work with heat planning as an integrated part of the urban planning and that the municipalities shall promote environmentally friendly and energy efficient projects, which are prof-

itable for the Danish society. Accordingly, Vestforbrænding is only allowed to invest in a district heating pipe to supply a consumer in the natural gas zone if it can be justified that the economic internal rate of return for the society for this investment is somewhat larger than 6% (in fixed prices).

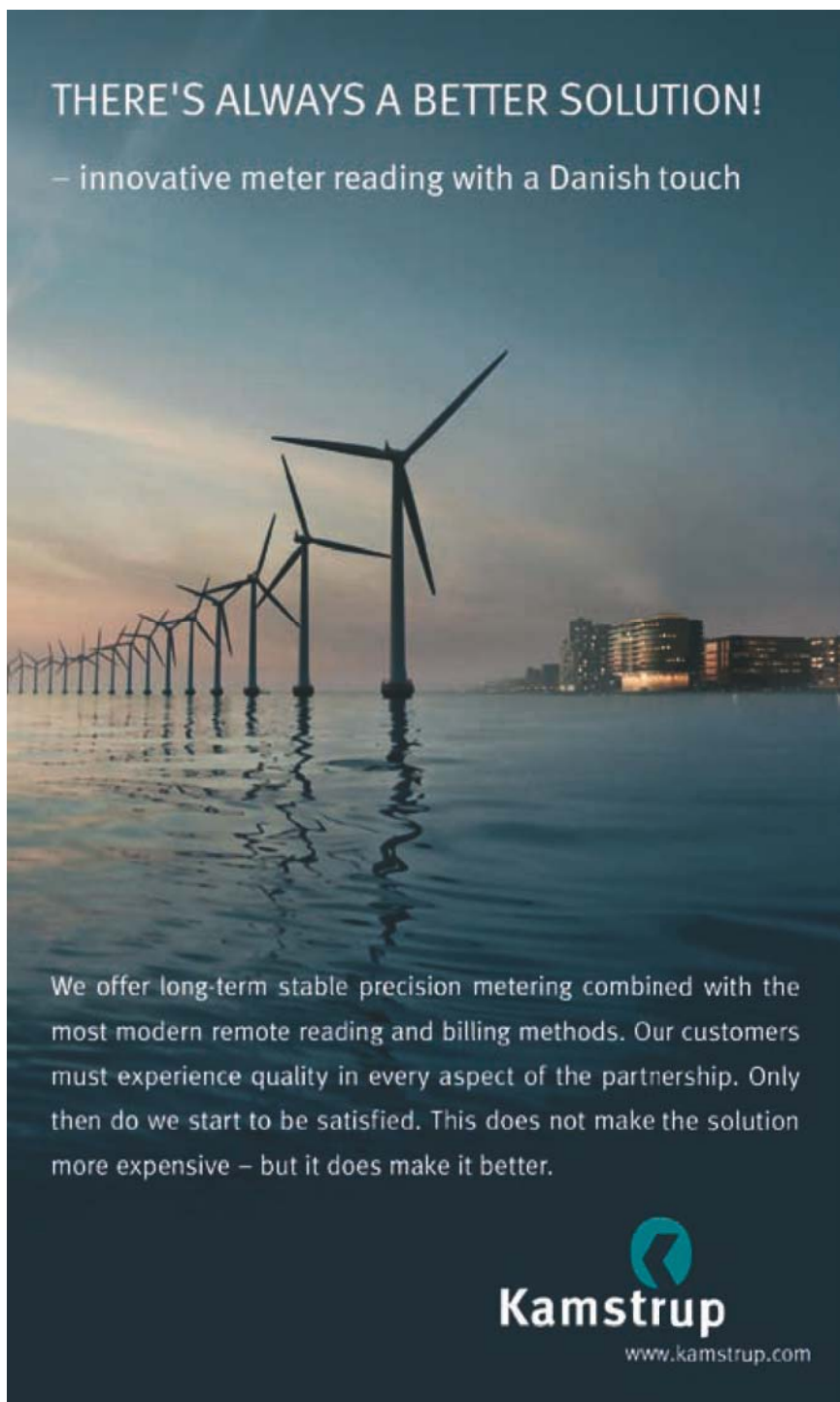
The procedure, which is described in a secondary act and in guidelines issued by the Energy Authority, outlines the requirements to the project proposals and the procedure for the municipal approval. That includes a 4-weeks public hearing in which e.g. the natural gas company can complain and question the analysis, and it includes the possibility that one of the parties after the municipal approval, with a 4-weeks' notice, can appeal the decision of the municipality to The Energy Board of Appeal.

- For further information:
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Waste in Denmark		1980	2000	2005	2010	2020	2030
Status		Statistics			Forecast		
Recycling	1000 t	1,600	8,461	9,454	9,752	10,600	11,753
Incineration	1000 t	1,900	3,064	3,473	3,607	4,047	4,592
Landfill deposit	1000 t	5,000	1,426	981	950	900	900
Waste in total	1000 t	8,500	12,951	13,999	14,309	15,547	17,245
Energy content per ton	MWh/t	2,200	2,917	2,917	3,000	3,000	3,000
Electricity production	GWh	0	849	1,519	1,818	2,792	3,444
Utilized heat	GWh	1,756	5,912	6,640	7,763	9,349	10,608
Cooling of surplus heat	GWh	1,170	657	349	158	0	0
Energy content	GWh	4,180	8,937	10,821	10,821	12,141	13,776



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