

I/S Vestforbrænding – How local communities make value from their own waste



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The waste management company I/S Vestforbrænding owns one of the largest waste incineration CHP plants in Northern Europe. The company treats 2 million tonnes of waste annually - 25 % are incinerated, 68% recycled and 8% deposited. Around one third of the generated heat is utilised in a local district heating system owned by Vestforbrænding, whereas the rest is utilised as base load in the Copenhagen heat transmission system (CTR and VEKS). First half of a flue gas condensation project has been installed increasing the total efficiency from 85% to 93 %. In 2006 Vestforbrænding started implementing a heat supply strategy, which will double the local district heating system by replacing natural gas boilers. Having increased the district heating market and reduced the temperature level, second half of the flue gas condensation will be completed.

In total, these measures are very profitable (a 25% return on invested capital) and will increase the total thermal efficiency of the plant to 100%. As the plant is municipally owned, 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, benefitting the heat consumers again.

History of the site

During the 1960s a number of municipalities in the Copenhagen region found that waste was not managed in an acceptable way and agreed on three basic ideas:

1. Waste management is too difficult for small municipalities
2. Waste incineration is the best solution, minimizing the environmental impact of landfills
3. The surplus energy from waste incineration should not be wasted

As it is a good Danish tradition for municipalities to co-operate when organizing all the municipal services in the most efficient way to the benefit for the residents, it was natural for them to join forces in implementing these ideas.

In 1970 12 municipalities representing 660.000 inhabitants formed the inter-municipal company I/S Vestforbrænding, responsible for the waste management, the landfills and a new waste incineration plant serving all the municipal owners. Accordingly, they established a new waste incineration plant, Vestforbrænding, at the site of an existing landfill. For the neighbours who had suffered from the landfill pollution, this was a major environmental improvement. Since then, the plant has been able to meet the ever increasing environmental requirements and has operated in harmony with its neighbours.

The waste management company, Vestforbrænding.

More municipalities have joined the municipal partnership, which takes care of the main part of the waste managing activities. Vestforbrænding is now serving

Vestforbrænding



29 municipalities and treats household and industrial waste from municipalities with 900.000 inhabitants and 46.000 private companies. The municipalities have appointed 29 politicians to be members of the board, which meets 6 times a year, monitors the company performance and sets out the objectives and the company strategy. The owners have agreed on the following prioritized objectives for the waste management:

1. avoidance
2. recycling
3. incineration
4. landfilling

The amount of recycled waste has increased dramatically. The total amount of waste in the area covered by Vestforbrænding is approximately 2 million tons annually, of which about 68 % is recycled, 25 % is incinerated and less than 8 % is deposited on a landfill.

Besides, a main objective is naturally to minimize the costs of waste treatment for the municipalities and their residents. The most important measures to minimize the costs are:

- to maximize the utilisation of heat and electricity
- to minimize the capital costs of investments by obtaining 100% favourable loans (guaranteed by the municipal owners)
- to focus on cost-effective operation and maintenance of large scale plants

The district heating company, Vestforbrænding

The founders of Vestforbrænding realised from the beginning that it was a very good idea to utilise the waste heat from the incineration. As there was no district heating network near the incinerator, Vestforbrænding decided to establish its own network to supply the new county hospital in Herlev, new apartment buildings and some large industries in the two neighbouring municipalities, Herlev and Ballerup. However, this heat demand of around 300.000 MWh a year could only utilise the surplus heat in the winter period. In the summer, the heat was wasted.

10 years later Vestforbrænding took part in the heat planning process in the Copenhagen region and was connected to the heat transmission systems (CTR and VEKS) for utilisation of all the waste heat. Waste heat from the incineration has priority over the fossil fuelled CHP plants. In summer, the waste incinerators in the system provide the heat, and only on some extra warm days a surplus of waste heat appears; it is transferred to the cooling facilities at Vestforbrænding.

According to the Danish heat supply act, the district heating system has to be operated with its own budget as if it was a separate company. The act regulates the price of heat from the waste incinerator to Vestforbrændings own district heating network and from the waste incinerator to the two transmission companies. Consequently, Vestforbrænding can offer supply of district heating to its own consumers at competitive heat price and the surplus heat is sold to the transmission companies at a price competitive with the alternative production plants in the system.

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 crises the district heating system was extended and Vestforbrænding took active part in the municipal heat planning process, starting in accordance with the heat supply act from 1979. Consequently, Vestforbrænding was in 1985 interconnected with the Copenhagen heat transmission system, with an 80 MW connection to VEKS, in order to utilise all the surplus heat even in the summer period. However, the amount of waste and the calorific value increased. Therefore, 10 years later another 70 MW connection line was established to the grid of CTR.

Today, after implementation of CHP, the maximal supply temperature is 130°C and the aim is 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 (see page 24). Therefore Vestforbrænding intends to help and encourage the consumers to reduce the temperature.

The waste incinerator

Thanks to the strong Danish energy policy which enforces the use of CHP, 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 tons/year and producing electricity and heat at a total efficiency close to 100%.

In order to increase the profitability, the total efficiency of the unit 5 has been increased at the end of 2006 by installing flue gas condensation with a steam driven absorption heat pump. With this condensation in operation the unit can produce 20 MW heat more, reducing the electricity production by only 3 MW. It is also the plan to install condensation at unit 6 within the coming years' implementation of the strategy for increasing the heat market and reducing the temperatures in the network (see the table below).

Market strategy 2015 for the district heating

In order to meet the objectives of improving the performance to the benefit of the residents who deliver waste and receive heat, Vestforbrænding has worked out a strategy for the period up to 2015. The back bone of this strategy is the waste management, with focus on recycling. A heat market strategy has been developed, too.

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

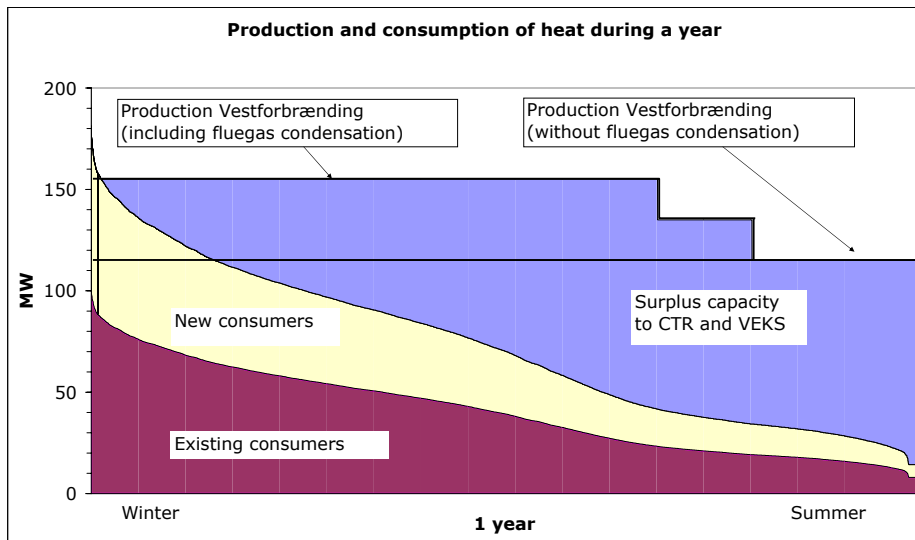
- in the neighbouring zones using natural gas the heat density has increased, as many large buildings were constructed
- industries are now encouraged to save energy; they are obliged to pay fuel taxes for the fuel used for heating purposes

Market strategy development for Vestforbrænding

Vestforbrænding		Strategy for market development			
		2006	2007	2015 min	2015 max
Data for plant and waste					
Total waste collection	ton/a	1.400.000	1.400.000	1.400.000	1.400.000
Waste for incineration	ton/a	500.000	500.000	500.000	500.000
Calorific value	MJ/kg	10,5	10,5	10,5	10,5
Energy content of waste	MWh/a	1.458.333	1.458.333	1.458.333	1.458.333
Heat capacity of CHP	MW	129	129	129	129
Electric capacity of CHP	MW	31	31	31	31
Max load utilisation of CHP	h	7.781	7.781	7.781	7.781
Heat capacity of fluegas condensation	MWh	0	20	40	40
Max load utilisation of fluegas cond.	h	0	6.500	6.500	7.000
Energy balance					
Production of electricity from CHP	MWh/a	235.872	235.872	235.872	235.872
Sale of electricity from CHP	MWh/a	235.872	216.372	196.872	193.872
Sale of heat from CHP turbine	MWh/a	1.003.711	1.003.711	1.003.711	1.003.711
Sale of heat from fluegas condensation	MWh/a	0	130.000	260.000	280.000
Total sale of heat from incinerator	MWh/a	1.003.711	1.133.711	1.263.711	1.283.711
Total energy utilisation of incinerator	MWh/a	1.239.583	1.350.083	1.460.583	1.477.583
Total efficiency of CHP unit excl cond.	%	85%	85%	85%	85%
Total efficiency of CHP incl. cond.	%	85%	93%	100%	101%
Market development					
Sale of heat to own district heating	MWh/a	350.000	350.000	600.000	750.000
Sale of surplus heat to CTR and VEKS	MWh/a	653.711	783.711	663.711	533.711

Flue gas condensation equipment at Vestforbrænding





Schematic duration curve for heat production and consumption for Vestforbrænding.

- the natural gas network has been in operation for 20 years and is, in principle, paid back
- many natural gas consumers have old natural gas boilers, which should be replaced in a few years time
- Vestforbrænding has an increasing production of waste heat, including heat from flue gas condensation, which cannot be utilised in the summer period.

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

In collaboration with the neighbouring municipalities, Vestforbrænding elaborated a district heating market strategy in order to identify the most optimal development of the district heating system. The analysis shows that it is profitable to increase the annual district heating sales from the present 300.000 MWh up to around 500.000 MWh in districts close to the existing supply areas in Herlev and Ballerup, and up to 700.000 MWh if we include districts in 3 neighbouring municipalities. 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 existing pipes are utilised better.

The table shows how the total efficiency of the plant increases in two steps, first from 85% to 93% and later further up to 100%-101% (based on the net calorific value), thanks to installation of flue gas condensation.

The analysis shows that the economic rate of return for the whole society of Denmark (based on the price forecast issued by the Danish Energy Authority) is

10-12 %, which is more than the required 6%. For Vestforbrænding, the economic rate of return is around 25%, which is significantly larger than the real interest on loans, which is less than 3%. Implementing this plan will significantly increase the profit for the owners – not 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.

Thanks to the efficiency and the energy utilisation, the Vestforbrænding fee for waste to be incinerated is today only 150 DKK/ton (20 €/tonne) excluding taxes, and by implementing the strategy it should be possible to reduce this fee to around 100 DKK/ton (14 €/ton).

This comes as a natural task for Vestforbrænding, not only because it is deemed important to go for the very profitable investments in order to meet the objectives of the company, but also because it is its obligation according to the heat supply act.

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 profitable 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 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-week public hearing in which the natural gas company can complain and question the analysis, and it includes the possibility that after the municipal approval one of the parties can appeal the decision of the municipality to The Energy Board of Appeal with a 4 week notice.

The market development plan of Vestforbrænding is very important, as it serves as an overall master plan, giving the overview for all parties and allowing the municipalities to evaluate individual proposals for district heating supply.

The natural gas companies are naturally not happy with this competition; however, the natural gas sales companies can not complain, as the gas market is liberalised.

Only the natural gas network company can complain and has to accept that it will lose income to pay for operation and amortisation of the natural gas infrastructure every time a gas consumer shifts from natural gas to district heating.

In order to speed-up the shift from natural gas to district heating, which is a reasonable move from a political perspective, Vestforbrænding has entered an agreement with the natural gas network company. Until year 2014, Vestforbrænding will be paying a minor compensation to the network company, equal to the lost natural gas network distribution fee. It is stipulated in the agreement that the gas company provides relevant information and shares the obligation of supply in the period of transformation from natural gas to district heating.

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