

MSc Thesis: Socioeconomic valuation of the Ballen-Brundby district heating plant

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Executive Summary

The Ballen-Brundby district heating plant initiated operations in the winter of 2004 and is the third largest of the four straw-based district heating plants on Samsø. It currently has 250 consumers out of a total number of 290 possible consumers and produces 4900 MWh, relative to a predicted gross demand of 4691 MWh a year. Predicted demand was based on an expected consumer base of 55 percent of total consumers with an average net demand of 16.5 MWh a year, relative to the current consumer base of 86 percent. The reason the actual gross demand is not larger despite the 31 percent increase in consumers is that 82 of the consumers are summerhouse owners, with a lower expected demand. An additional 8 empty properties are currently registered to the district heating plant. A distribution net heating loss of 31.5 percent is included in both gross projections.

The plant was expected to cost 16.8 mil DKr, but ended up costing 17.6 mil DKr, 800,000 DKr over budget (all values deflated to the 2007 price level). The value of the plant over its expected lifetime is summarized by calculating the net present value (NPV), which is the current value of the discounted stream of benefits and costs expected of the plant at the project initiation. The NPV of the expected investment for the 15 year period including scrap value and using a discount rate of 6 percent equals 14.9 mil DKr, relative to the NPV of the actual investment of 14.7 mil DKr, i.e. 200,000 DKr less than initially expected. Initial expectations predicted CO₂ savings equal to 16,754 tons over a 15 year period, but a gross demand of app. 4900 MWh will save 18,290 tons of CO₂ over a 15 year period, i.e. 1,536 tons more than expected. This translates into approximately 4.9 tons of CO₂ saved annually per household. If one applies the CO₂ quota price set by the Danish Energy Authority (DEA 2009), each household would annually save 387 DKr in 2009, 505 DKr in 2010, 662 DKr in 2011, 862 DKr in 2012 and 1,122 DKr from 2013 onwards.

Unfortunately, biomass generators based on straw increase other emissions, specifically methane (CH₄) which is also a greenhouse gas, and sulphur dioxide (SO₂) which can cause acid rain. Summed over the period, the biomass plant increases emissions of CH₄ by 7,352 Kgs (equivalent to app. 154 tons of CO₂) and 26,269 Kgs of SO₂ relative to continued reliance on electrical heating

and individual oil-based furnaces. SO₂ emissions carry costs of 121 DKr/Kg to society, as estimated by the Danish Energy Authority; this sums to app. 3 mil DKr for the emissions over the period at the 2007 price level (not discounted).

Overall the net socioeconomic result from the original project plan sums to a NPV of app. 1 mil DKr in favour of the project, over a 15 year period with a 6 percent discount rate. Total investment costs, scrap value and maintenance and operation costs for both the district heating plant in the project scenario and the required equivalent investments in household oil furnaces, as well as tax differences, fuel price differences and social deadweight loss of the subsidy and loss of taxes are included in the socioeconomic calculations. However, due to the larger than anticipated consumer base, *actual* NPV for the plant sums to 4.8 mil DKr in favour of the plant over the 15 year period – a 3.8 mil DKr improvement over the expected scenario, even after accounting for the increased investment costs.

The benefit for the participating household is calculated based on the socioeconomic prices; however, given that Danish law dictates district heating plants such as the ones on Samsø are not allowed to earn profits above what is needed for reinvestments, maintenance and operation, these prices reflect actual consumer benefits. The NPV with a 6 percent discount rate over the 15 year period sums to 20.8 mil DKr in benefits to the consumer, or app. 83,000 DKr per household over the period. The estimate is composed of *additional* investment, maintenance and operation costs in real prices of 9.5 mil DKr, or app. 38,000 DKr per household; *reduction* in fuel costs equal to 14 mil DKr or 56,000 DKr per household; and a *reduction* in taxes due of 16.3 mil DKr or app. 65,000 DKr per household. All NPV values are at the 2007 price level, summed over the 15 year period and with a discount rate of 6 percent. Since the state must find alternate sources of revenue from the loss in taxes, this value cannot be considered a socioeconomic benefit. If the existing tax legislation which favours renewable energy were to change, then the net benefit for the consumer would drop to a total of 4.5 mil DKr, or app. 18,000 DKr per household.

Multiplier effects from local sourcing of fuel and labour rather than reliance on imported oil have not been estimated. However, the net impact on the straw suppliers has been estimated. Based on local prices (which are significantly lower than expected national prices), NPV earnings from supplying straw to the district heating plant equal 1.8 mil DKr, relative to an expected alternate use value of the straw as fertiliser equal to 3.3 mil DKr. Despite this apparently favouring the use of

straw as fertiliser relative to fuel, additional benefits in the form of multiplier effects in the circulation of money around the island are not included in the estimates. Earnings are calculated as the base price of a ton of straw supplied to the plant minus additional costs of processing and distribution. It should be noted that the actual price paid is generally higher than the base price used in the above calculation, as prices are corrected relative to the moisture content of the straw.

A survey was conducted of the households connected to the district heating plant. Out of 250 consumers, 85 respondents replied, i.e. a response rate of 34 percent. Of the respondents, 87 percent replied that they were satisfied with the district heating plant, and out of those who were dissatisfied, most cited heating costs as the source of contention. Further analysis revealed that at least 24 percent of respondents would be interested in paying for small environmental improvements to the plant. An additional result obtained from the survey is that income has little if any impact on willingness to pay for renewable energy; irrespective of income, those who were most willing to pay were those who had low heating bills relative to house size, indicating a certain level of consumer awareness. This result corresponds to similar surveys conducted abroad. Interestingly, this consumer behaviour could not be predicted from the respondents self-rated energy consumption patterns, which one would expect to be reflective of actual energy behaviour.

Overall, the Ballen-Brundby district heating plant has performed above expectations, resulting in a net positive environmental benefit, cost saving for the consumers and a strengthened local economy. However, some thought into reducing maintenance and operations costs and thus heating prices might be worthwhile, as it is unexpected that a large heating installation should carry higher running costs than numerous individual installations.