Expensive Electricity from Biomass

Fuel price forecasts are always wrong. Real fuel prices are fluctuating up and down in an unpredictable pattern. Official Danish fuel price forecasts always have a steady and increasing trend. Such forecasts can only be wrong.

Nevertheless, several large Danish energy projects are based on such long-term fuel price forecasts.

From a socioeconomic point of view, the use of biomass for electricity production seems to be particularly expensive. The wrong forecasts and the taxation system seem to make biomass profitable to the power plant owners, but loss making to society.

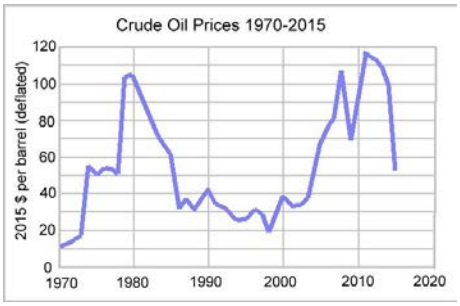

Fig. 1 - Nobody knows if the average crude oil price will be 50 or 100 $ per ton the next 10 or 20 years

Biomass Conversions with Socioeconomic Losses

The cost of biomass is two or three times the cost of coal and at the same level as the gas price. The owners of coal-fired power plants can save fuel taxes by converting to biomass. Several Danish coal and gas fired CHP[1] units are being converted to biomass. The profitability seems to be acceptable to the owners of the power plants. Otherwise, they would not make the investment.

The socioeconomic result seems to be less favourable. The main costs are investments and fuel. The main benefit is the reduced carbon emission.

A case was analysed in a report (in Danish) from Aarhus School of Business, Aarhus University, 2011[2]. The case includes conversion of nine power plants from coal to wood pellets. The present value of the socioeconomic loss would be DKK 116 billion (about €15 billion). This is a huge amount of money. The conversion is loss making in all cases of the sensitivity analysis.

It is debatable if the results are realistic, but the magnitude of the losses should attract attention, because it exceeds other public investments under consideration, such as railways, bridges, tunnels and fighter jets.

The Danish Council on Climate Change seems to be aware of the problem because it recommends an adjustment of the energy taxation in order to establish a more realistic position of biomass compared with other fuels.

Biomass is more Expensive than other Energy Sources

In March 2015, the Danish Energy Agency (DEA) publish the calculated cost of electricity from alternative production technologies[3]. Table 1 shows the main results.

[1] CHP: Combined Heat and Power
[2] "Træpiller vs. kul på de centrale kraftværker – En samfundsøkonomisk analyse af omstillingen i de større danske byer", Aarhus School of Business, Aarhus University, 2011 (pure.au.dk/portal-asb-student/files/37323758/Opgaven.pdf)
[3] Elproduktionsomkostninger for 10 udvalgte teknologier, Danish Energy Agency, J.nr. 4005/4007-0015, March 2015

According to this calculation, biomass is clearly the most expensive source of energy (cost of CO_2 emission has been added to the cost of fossil fuels).

Danish Energy Agency March 2015	DKK/MWh
Wind onshore	316
Wind offshore	586
Solar power	574
Medium CHP - wood chips	829
Medium CHP - straw	910
Medium CHP - natural gas SC	638
Large CHP - wood pellets	751
Large CHP – coal	559
Large CHP - refurb. Wood pellets	783
Large CHP - natural gas CC	591

Table 1 - Calculated electricity costs

The calculation is based on fuel price forecasts from 2014. Fuel prices have changed considerably since 2014. Table 2 indicates the range.

It is remarkable that small CHP system are left out in table 1. Electricity from these units can only be even more expensive.

Fuel oil price 2016	DKK/GJ
Forecast 2011	71.01
Forecast 2014	90.00
Forecast 2016	34.30

Table 2 - Fuel oil prices 2016

The paper includes a sensitivity analysis. The price range is ±25% for natural gas and less for the other fuels. It is far from covering the range in table 2 and demonstrates the inaccuracy of the calculation.

The result was used to state that onshore wind energy is much cheaper than any other source, but the cost of biomass electricity seems to be ignored.

There is nothing wrong in considering a project so important that it must be realized irrespective of the cost, but in such cases, the possible cost should be quantified and discussed publicly. A strong political determination supports the green transition. The question is if the political decision makers have been properly informed about the economic implications.

Very Uncertain Price Forecasts

The profitability of the conversion of CHP units into biomass depends on at least three price forecasts:

- Traditional fuels
- Biomass
- The cost of CO_2 quota

The Danish energy authorities publish every year price forecasts for socioeconomic analyses. It makes sense to have such forecasts as common references for energy analyses, but the forecasts are often accepted without discussion of the possible consequences of the forecast uncertainties. Sensitivity analyses occur, but the range of variation is usually too narrow.

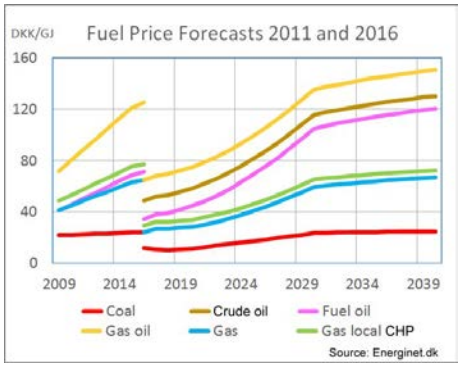

Fig. 2 – The expected fuel price increases have been delayed by 10 to 15 years since the 2011 forecast.

Fig. 2 compares two fuel price forecasts. The 2011 forecasts include the years 2009 to 2030, but in order to keep the chart simple, these forecasts end at 2016. The 2016 forecasts include the years 2016 to 2040.

Steadily increasing prices were expected both in 2011 and in 2016. A possible reason for this trend could be an expected decreasing supply of oil.

Now it is a fact that the fuel price did not increase, but decreased from 2011 to 2016. The 2016 forecast sets the fuel oil price in 2016 at half the value, expected five years earlier.

Predicting the crude oil price level for the next ten years is more difficult than analysing the past. Fig. 1 suggests a level somewhere between $50 and $100 per barrel (about DKK 40 and DKK 80 per GJ). On this background, the expected increase (fig. 2) from DKK 50 in 2016 to DKK 130 in 2040 is strange.

The biomass price forecast is different. The 2011 forecasts link very well with the 2016 forecasts and the price level is expected to stay at the same level until 2040 (fig. 3). This is a reasonable assumption if biomass is supposed to substitute coal, which is expected to have only a moderate price increase (fig. 2).

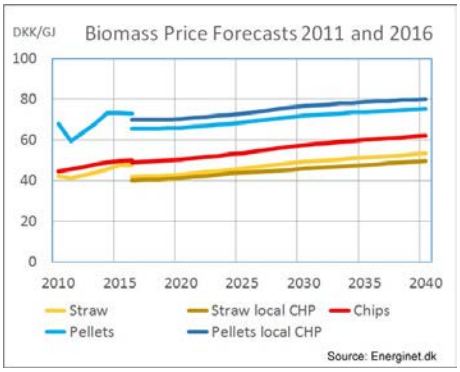

Fig. 3 - Biomass prices are supposed to remain at the same level until 2040

The market price for avoided CO_2 emissions is supposed to be reflected in the cost of CO_2 quota. The market for CO_2 quota did not develop as expected and wanted. The 2011 forecast has been moved six years to the right and the starting point was reduced from DKK 110 per ton to DKK 36. It will probably take a radical redesign of the CO_2 quota market to make the price level increase in accordance with the forecast to DKK 288 per ton in 2040.

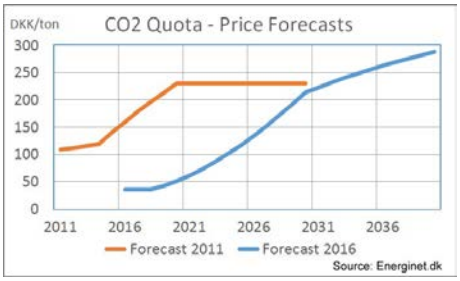

Fig. 4 - High CO_2 prices are necessary for justification of the green transition

Expensive fossil fuel, cheap biomass and expensive CO_2 quota make the best combination for justification of the green transition. Are the three sets of forecasts well-substantiated or just wishful thinking?

Case: The Danish Train Fund

Several public Danish investments have been based on wrong forecasts. In most cases, details on the calculations are not publicly available. The Danish train fund is a particularly interesting case. It has been widely discussed in the media, because it is easy to understand.

The Train Fund DK is a political agreement from 2013. The Danish railway system is obsolete. It needs urgently improvements in order to reach a suitable European level. A national plan for fast trains in Denmark was outlined. The cost would be DKK 28.5 billion, but the money was missing. A majority in the Danish Parliament decided to reserve the yield from an additional tax on the extraction of oil in the Danish part of the North Sea for the purpose. The tax depends on the oil price, which was supposed to be $135 per barrel in average for the years 2015 to 2020.

The crude oil price was never that high in the past (fig. 1). *How could well-informed people find that price level reasonable?* We do not know, but a common trick is to select the data that best serves the purpose (fig. 5).

Now, it is easy to see that the trend from 2000 to 2012 was just a ripple in a longer time series (see fig. 1). In 2015, the crude oil price was back at the $50 level instead of the assumed $121 level.

The oil price drop leaves Train Fund DK without the necessary money for improving the railway system. Some railway lines must be postponed or left out. The case demonstrates the risk of giving the execution of a project vital dependence of future energy prices.

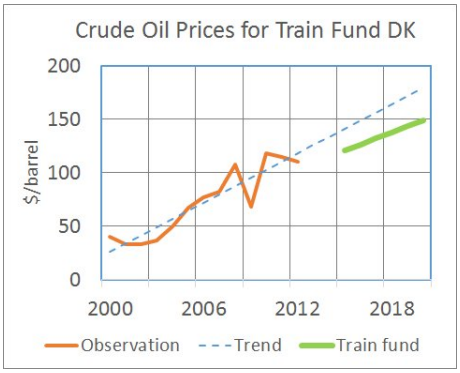

Fig. 5 - The oil price trend 2000-2012 makes $135 per barrel look like a reasonable average from 2015 to 2020

Don't Trust Profitability Calculations

The present value of a time series of positive and negative payments is the traditional indicator for the profitability of a project. However, when the estimated payments depend on uncertainties of the magnitude, described above, the result will be correspondingly inaccurate. Besides, it will be possible to manipulate the data in order to reach a desired conclusion.

Sensitivity analyses is the normal response in such cases, but even sensitivity data can be selected in favour of preferred conclusions. Uncertainty cannot be calculated away.

More advanced procedures, such as *scenario studies*, are required in order to understand opportunities and risks in connection with a possible investment decision. Scenario studies require a concentrated commitment for developing and understanding alternative futures. When a possible future leads to an unacceptable outcome, it depends on the investment strategy if the project should be recommended or rejected.

The crude oil price forecast for the train fund seems to have been based on observations, selected for the purpose. Scenario planning is diametrically opposite. It is about opening your mind for possible and unpredictable new trends.

New projects are traditionally presented publicly as promising. The risk of failure or loss is played down. A multi-faceted result of a scenario study may be less suited for a public debate. It might describe possible, but unlikely, problematic futures, which could cause unnecessary excitement.

A Cheaper Energy Strategy

According to the report from Aarhus School of Business, very large amounts of money could be at stake by continuing the conversions from fossil fuels to biomass. The price calculations from the Danish Energy Agency seem to confirm that risk.

Based on production costs, the DEA report set a priority list for the future production technologies:

1. Onshore wind is cheapest
2. Electricity from offshore wind and large photovoltaic plants is nearly twice as expensive as electricity from onshore wind
3. New large power plants and converted coal fired units using wood pellets
4. Electricity from local CHP units using biomass is most expensive

The current trend is that some large CHP units are being converted to biomass. It may look profitable to the owner, but it will be loss making to society.

All evidence suggests the use of biomass for electricity production reduced in favour of more wind power and photovoltaics.

Operators of local CHP systems are reducing the electricity production and consider producing heat on biomass-fired boilers. In a few years from now, there will only be little local electricity production left if the general framework is unchanged.

According to the calculated production prices, the best option for electricity from local CHP will be to continue using natural gas. It will be helpful that the gas price has fallen since 2014, when the gas price for local CHP in 2016 was expected to be DKK 77 per GJ. In 2016, it is about DKK 30 per GJ. Nobody knows the future price level, but it could very well be so much below the DKK 77 level that local gas fired CHP would be competitive with offshore wind. Changed taxation and support systems could help the local electricity production to survive, and from a socioeconomic point of view, natural gas would be much cheaper than biomass.

A cheaper way to the long-term fossil free future could be

- Less biomass
- Prolonged use of natural gas
- Intensified expansion of wind power and photovoltaics