Future Costs of Heat and Electricity in Belarus

Issue paper from INFORSE-Europe[1], by Gunnar Boye Olesen, May 2009

Background

The present electricity and heat supply of Belarus is mainly based on natural gas, with almost equal power production at power only plants (condensing plants) and CHP plants. Also oil is important as fuel, with the remaining production from biomass and a smaller amount of domestic coal. The production at condensing power plants have a low efficiency (around 38% compared with best available technology (BAT) of about 60%. CHP and heating plants are closer to BAT. With increasing fossil fuel prices this power and heat supply structure is likely to lead to large increases in heat and electricity prices. Therefore it is worthwhile to consider alternatives, in particular alternatives based on indigenous energy resources such as biomass.

Present energy balance of heat and power sector in Belarus:

Present energy system (2005)

Unit: PJ	Oil	Coal	Gas	Biomass	Heat production	Power production	Loss	
Heating st.	19	7	142	16	154		31 =	16,6%
Power (Condens)	2	0	149			58	93=	61,7%
CHP	18	0	236	0	135	54	66=	25,9%
Total	39	7	528	17	289	112	190	

Table 1: Energy input and output of heat and power plants. The table does not include electricity import (about 10% of supply) or network losses. Source: International Energy Agency.

Present and future Fuel Prices

Oil prices have fluctuated substantially in the past, but now they seem to be in a more stable period, raising from a 4-year low of 35 US$/barrel in Jan 2009 to 52.6 US$/barrel at April 3, 2009 and with a slow increasing trend. The present price of oil is set to 55 US$/barrel. Based on limited oil supply and increasingly expensive resources (deep underwater resources, arctic resources, etc.), the IEA in its World Energy Outlook 2008 forecast a future oil price of 100 US$/barrel in 2010 increasing to 110 US$/barrel in 2020 and 122 US$/barrel in 2030. Based on this the medium-term price is set to 100 US$/barrel and the long-term price to 115 US$/barrel.

Gas prices in the spot markets in Western Europe and the USA have followed oil prices up and down in 2008, but Belarus gas supply is bought on long-term contracts from Russia. As a current price is taken 140 US$/1000 m3. As a medium-term price is estimated 450 US$/1000 m3 because Belarus will adjust prices to free market levels in Europe with entrance to the World Trade Organisation(WTO), which we expect that Belarus will enter together with Russia. The long-term price is set to the long-term oil price minus 30%, which gives a price some 20% above the medium-term price.
IEA predicts a long-term Western European gas price of 17 US$/MBtu in 2020 increasing to 24 US$/MBtu in 2030 equal to respectively 13.6 €/GJ and 19 €/GJ, which is equal to future IEA

1 International Network for Sustainable Energy - Europe, a network of 70 European NGOs working for energy efficiency and renewable energy, see www.inforse.org/europe

estimates of oil prices, not 30% lower as is used in this paper.

Coal prices used to be the lowest of all fuel prices, but using world market coal prices, that must be the basis for future coal prices, they are already well above the cost of biomass energy in Belarus, as far as these are recorded. The costs of coal in ports of Rotterdam and Antwerp is currently 67 US$/ton while they in 2008 reached 200 US$/ton. According to IEA World Energy Outlook the long-term price will be 120 US$/ton (2010 - 2015) and a possible price decline after 2015. The IEA estimates were made before the deepness of the current economic crisis, so it is likely that the medium price will be lower, and it is set to 100 US$/ton in this paper. The long-term price is set to 120 US$/ton. The reason for the long-term price above IEA estimate is the limitations of cheap coal resources. The very high prices in 2008 (close to 200 US$/ton) indicates that cheap resources are limited. Because of the limited cheap resources, the decrease in coal prices foreseen by the IEA after 2015 is not so likely.

Biomass price is taken from a quoted price of firewood of 100,000 BLR for a delivery of 8 m3, mid 2008, which is equal to 4.5 €/m3 with an exchange rate of 1 € = 2800 BLR (August 2008). As a short term price is then used 5 €/m3 of firewood, even though large-scale installations typically use wood chips. Wood chip production is typically more expensive than firewood, but wood of lower quality can be used for wood chips, so the energy price difference between firewood and wood-chips should be low for larger amounts.
For medium and long-term is used twice the short-term price because it will be necessary to use more expensive biomass resources, with the large-scale use that is included in the sustainable energy vision. This will probably include energy forestation. The long-term price is some 35% lower than current wood-chip prices in Latvia (2008-prices), indicating this could be a realistic price with a possible opening of the biomass markets in the Baltic area.

This gives the following present and future energy fuel prices:

	Oil price	Coal price	Gas price	Biomass price
	US$/barrel	US$/1000 ton	US$/1000 m3	€/m3@60% density
Present	55	67	140	5
Future 1	100	100	450	10
IEA-future	115	120	oil-30%	10

Table 2: Present and future fuel prices

To compare the prices, they are all converted to €/GJ in the table below, using a €/US$ exchange rate of 1.25:

	Oil price	Coal price	Gas price	Biomass price
	€/GJ	€/GJ	€/GJ	€/GJ
Present	7,9	2,5	2,8	1,3
Future 1	14,3	3,7	9,1	2,5
IEA-future	16,5	4,4	11,5	2,5

Table 3: Present and future fuel prices in €/GJ

Heat and Fuel Prices with Present Energy System

With these fuel prices the "narrow" social costs of heat and electricity are calculated, with the existing energy system. Narrow social costs do not include taxes or external costs such as environmental costs. The heat cost is calculated from heat only plants. The electricity costs are calculated with the assumption that the fuel component of the heat price from CHP plants, is prices the same as that from heating plants. Because no major investments is included, investment costs are set to 0 for the present energy system.

Present energy system (2005)

Present	Total costs	Fuel	O&M	Invest	
Heat costs	4,3	3,8	0,5	0	€/GJ
Power costs	9,5	6,5	2,9	0	€/GJ
Future-medium	Total costs	Fuel	O&M	Invest	
Heat costs	11,1	10,6	0,5	0	€/GJ
Power costs	24,0	21,1	2,9	0	€/GJ
Costs-IEA-future	Total costs	Fuel	O&M	Invest	
Heat costs	13,7	13,2	0,5	0	€/GJ
Power costs	29,8	26,8	2,9	0	€/GJ

Table 4: Present and future heat and electricity prices with present energy structure

O&M costs are set to 0.5 €/GJ for heating stations, reflecting the low O&M costs of gas-fired heating stations. For power plants they are estimated to be set to a fixed sum of 25,000 €/year per MW installed (and 5500 full load operating hours) + a variable of 6 €/MWh, which is about twice the O&M costs of new plants. These O&M cost estimate might be in the high end, but lower O&M costs of existing plants are not crucial for the conclusions of this paper.

Compared with these costs at the plant gate, consumer prices can be expected to be 20% higher because of network losses. Additionally in the consumer price must be included costs of network construction and maintenance, system management, and administrative costs. Also power import will influence consumer prices.

The conclusion is that with the expected fuel price increases, heat and power can be expected to triple on the long-term, and that most of the increase will come in the medium term. In particular the increase of the gas price to 450 US$/1000 m3 is a major driver for that.

Heat and Fuel Prices with a Sustainable Energy System

INFORSE-Europe and others have proposed a sustainable energy system, replacing fossil fuel with energy efficiency and renewable energy. This would give the following energy balance of heat and power plants (similar to table 1)

Sustainable energy vision energy system

PJ	Oil	Coal	Gas	Biomass	Heat production	Power production	Loss	
Heating plants	0	0	0,5	45	41,5		4 =	8,8%
Power (Condens)	0	0	0,5	2,2		1,5	1,2 =	44,4%
CHP	0,5	0	1,5	189	63	89,5	38,5 =	20,2%
Total	0,5	0	2,5	236,2	104,5	91	43,7	

Table 5: Energy energy input and output of heat and power plants with a future sustainable energy supply. The table does not include electricity import (about 10% of supply), windpower, or network losses.

If narrow social costs for heat and electricity is calculated for such a system, it gives quite a different result, as is shown in the table below:

Sustainable energy vision energy system

Present	Total costs	Fuel	O&M	Invest	
Heat costs	4,7	1,4	1,3	1,9	€/GJ
Power costs	12,2	1,8	4,0	6,3	€/GJ
Future-medium	Total costs	Fuel	O&M	Invest	
Heat costs	6,1	2,9	1,3	1,9	€/GJ
Power costs	14,0	3,6	4,0	6,3	€/GJ
Long-term-future	Total costs	Fuel	O&M	Invest	
Heat costs	6,1	2,9	1,3	1,9	€/GJ
Power costs	14,0	3,7	4,0	6,3	€/GJ

Table 6: Present and future heat and electricity prices with proposed sustainable energy structure

For heat is used O&M costs of 19,000 €/MW and 4000 full-load operating hours and investment costs of 320,000 €/MW, 20 year lifetime and 6% interest rate. This is equal to Danish planning data for wood-chip heating stations. For power plants is used an average of 2/3 large CHP plants (about 400 MWe, 30 year lifetime, investment 1.66 mill €/MWe, O&M 31800 €/MW+3 €/MWh) and 1/3 smaller plants (10 MWe, 20 year lifetime investment 3.2 mill. €/MWe, O&M 89000 €/MW+19€/MWh), 5500 full-load operating hours, 6% interest rate. Efficiencies are indirectly included as they are part of the vision.

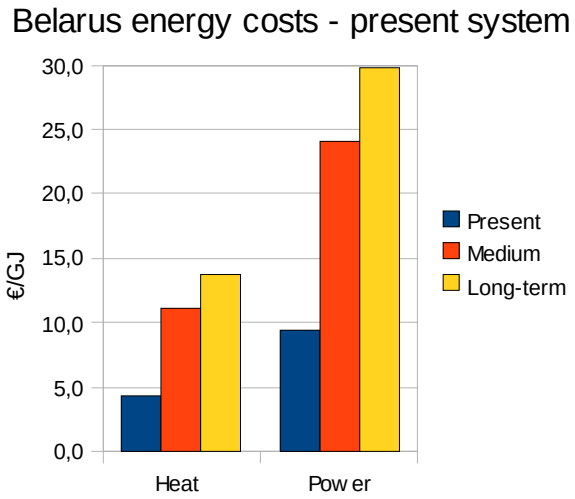
Efficiencies are included here as they are included in the vision. The thermal and total (electric + thermal) are similar to present technology (80-85%) while electric efficiencies are 47% for CHP plants and 55% for power only plants while today's levels for new plants of the proposed sizes fuelled primarily with biomass are 40-42% for CHP plants (combination of smaller plants with lower efficiencies and larger plants with higher efficiencies) and about 50% for power only plants (larger plants). This difference will gives an uncertainty of 2-3% in the results, which is less than other uncertainties.

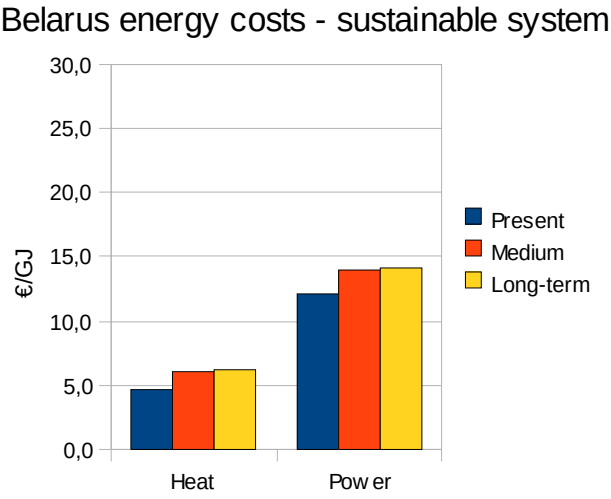
Comparison

Comparing the two systems the conclusion is that with present fuel prices heating is about equal for the present and the sustainable system while the power prices are more expensive with the sustainable system, mainly because of the investment costs. This will, however, change substantially with the medium-term fuel prices, where the heat and electricity prices in the sustainable system are almost half of that of the continued use of the present system. In the long-term the difference is even higher.

Comparing present energy prices with future prices with the sustainable energy system show increase of 50% of heat and electricity costs. This is the lowest possible increases within the solutions analysed. In another analysis that include nuclear power, the cost of nuclear power from new reactors is estimated to 23 €/GJ (81 €/MWh), or 60% higher than the power costs in the sustainable energy system and similar to the costs of the existing power structure with future, high fossil fuel prices.

Both heat and electricity consumption is lower in the sustainable scenario than in the present situation. This is because of the stronger use of energy efficiency, in particular reduction of heat demand with improvements of buildings. The sustainable scenario also includes windpower, solar heating and in the long run also solar PV, all of which are not included in the cost calculation of this paper.





The costs are compared in the following graphs:

Future Work

There are a number of issues that will need further studies for a sustainable energy development. One of them is evaluation of increase of energy forests etc and how to build a biomass energy supply structure. In all the Scandinavia countries such supply structures have existed for several years, but structures will have to be adapted to Belarus.

Sources

This paper is based on INFORSE-Europe's sustainable energy vision for Belarus, November 2008 (available from www.inforse.org/europe), and power plant costs and data from "*Technology Data for Electricity and Heat Generating Plants*"[2] with 27% increase for inflation of investment and O&M costs for the period 2002 - 2008.

2 Report published by the Danish Energy Agency et.al. March 2005, ISBN: 87-7844-503-5