Comprehensive policy package for decarbonisation of the Estonian electricity production by 2050

The overall objective of the NORSTRAT project is to build knowledge and understanding among politicians, decision makers and actors in the power industry about possible carbon neutral futures for an integrated Nordic power system in a time perspective up to 2050. By following the direction taken in the Nordic power road map 2050, Estonia's oil shale dominated power production could be fully shifted to the use of domestic renewable fuels and energy sources by 2050. Relevant policies include decarbonisation of the electricity production, development of new transmission grid interconnections and increasing energy efficiency.

Background

This communication is presenting the results of the research carried out by the Stockholm Environment Institute Tallinn Centre, in connection to the preparation of the Nordic power roadmap 2050. Development needs of the Estonian energy sector were assessed in order to prepare policy recommendations for enabling shift from fossil fuel based electricity production to the use of 100% renewable domestic energy sources and fuels on national level. The current communication has a particular focus on the new policy instruments needed to enhance the shift to 100% renewables-based electricity production within the liberalized power market in Estonia. Estonian climate and energy policy goals have been aiming for low-carbon economy since regaining independence in 1991, but until today these goals have not been achieved due to insufficient application of the relevant policy measures. The country's electricity production is 85% based on non-conventional fossil oil shale and all oil-based motor fuels are imported. In 2012, energy intensity of the Estonian GDP was amongst the highest in the EU. The most recent energy sector development strategies until 2030 do foresee maintaining the dependency on oil shale use in power production.

Methodology

A scenario comparison with the LEAP model[1] and Multi criteria analysis[2] was used to analyse the different policy options and choices to reshape the Estonian energy system in order to achieve the most feasible path towards low-carbon power production by 2030 and 2050. Altogether 6 electricity production/consumption scenarios were compared: business as usual (BAU), high- and low-carbon power production. Additionally, these scenarios were complimented with using carbon capture and storage (CCS) technologies. The BAU scenario followed a development path identified in present national electricity strategy. The highCO2 scenario was looking for continuous use of oil shale power plants with co-combustion up to 50% of wood (scenario preferred in national long-term energy scenario under preparation) and a LowW, assumed increased (up to 75%) wood fuel use for co-generation in oil shale plants. As the NORSTRAT project aimed at the region's electricity sector decarbonisation, a LowCO2 scenario was constructed and compared to oil shale based power production scenarios. The LowCO2 scenario assumed a 100% shift to renewable fuels in electricity production in line with the scenario preferred by the Nordic power road-map 2050. Policy measures necessary for a 100% renewable energy future were selected according to their impact, feasibility, cost efficiency, delivery and replicability potential as well as by the level of barriers for use. Both, strengthening of existing policy measures like investment support for construction of new renewable energy capacities or support for renovation of multi-storey dwellings for energy saving, and new measures for promoting RES, successfully implemented in Nordic countries, were proposed.

[1] LEAP, the Long-range Energy Alternatives Planning System, is a widely-used software tool for energy policy analysis and climate change mitigation assessment developed by SEI http://www.energycommunity.org/default.asp?action=47
[2] http://eprints.lse.ac.uk/12761/1/Multi-criteria_Analysis.pdf

Results

Domestic fuels hold a large share in Estonia's total energy resources, thus the current electricity production is mainly based on oil shale. The volume of oil shale production has not changed over last years and has remained under 20 million tons a year – 18.7 million tons was produced in both 2011 and 2012. The majority of oil shale is consumed in power plants and as raw material for shale oil. In 2012, compared to 2011, the consumption by power plants decreased. In 2008, 91% of electricity was produced from oil shale, whereas this share dropped to 85% in 2011 and to 81% in 2012. At the same time, consumption of oil shale in the oil industry increased, together with the growth in shale oil production. The continued demand for shale oil in Estonia and in external markets increased the production of shale oil by about 7% compared to 2011. Nearly 80% of the production was exported.

In the last decade, production of electricity from renewable sources has increased significantly. In 2008 the share of electricity generated from renewable sources was only 2.1% of the total electricity consumption, whereas in 2011 its share was was 12.7% and in 2012 15.2%. New woodfuel-based combined heat and power (CHP) plants have been put into operation, which has increased the share of electricity produced from biomass to two thirds of total renewable electricity production. The production of wind and hydro energy has also increased year by year. In 2012, the production of both wind and hydro energy increased about 20% compared to 2011. The introduction of renewable sources has slightly reduced the importance of waste-intensive oil shale in electricity production.

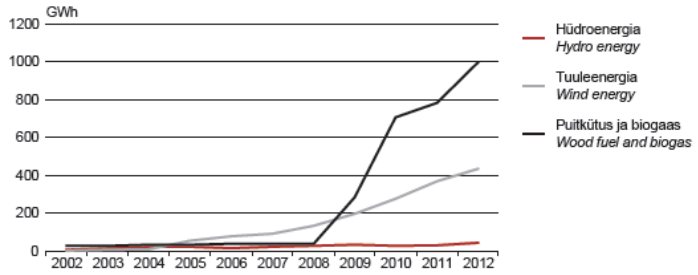

Figure 1. Production of electricity in Estonia 2002-2012, GWh

Despite the significant tempo in increasing renewables share in electricity production, Estonia is far from achieving its goal defined in the Long-term national energy strategy until 2020, to reduce share of oil shale in power production below 50% of the country's total power production mix by 2020.

Table 1. Estonia's electricity production by source in 2013 (GWh)

Source(Fuel)	2013	Share from total
Total Renewables	**1201**	**9.11%**
Incl. Wood	621	4.71%
Incl. Wind	529	4.01%
Incl. Hydro	26	0.20%
Incl. other renewables	25	0.19%
Total Fossil	**11 981**	**90.89%**
Incl. Oil shale	11 388	86.39%
Incl. Oil shale retort gas	299	2.27%
Incl. Oil shale oil	134	1.02%
Incl. Natural gas	89	0.68%
Incl. Peat	71	0.54%
Incl. Heavy fuel oil	0	0%
TOTAL	**13 182**	**100%**

Conversion of the energy sector pays a key role in achieving a low-carbon economy. Both energy security and competitiveness have to be ensured while implementing measures enabling decarbonisation of the electricity production. Electricity demand is growing in all scenarios compared to the current level, co-generation potential is decreasing due to the reduced heat demand after implementation of the energy efficiency measure, therefore the need for new electricity production capacities is increasing. The selection of electricity production technologies in different scenarios is determining how many new capacities have to be installed in the future. Overall production capacity between scenarios may differ almost two times by 2050 depending on the choice.

Electricity demand in the BAU scenario in 2050 is 15,050 GWh, in the HighCO2 scenario 11,550 GWh and in the LowCO2 scenario 9,215 GWh (Figure 2). In the BAU and HighCO2 scenarios electricity demand is growing evenly in all sectors but in the LowCO2 scenario, the demand is decreasing significantly in the residential sector as a result of the implemented energy efficiency measures and by the wider use of heat pumps. In the transport sector electricity consumption will increase in parallel with the increase of electric vehicles.

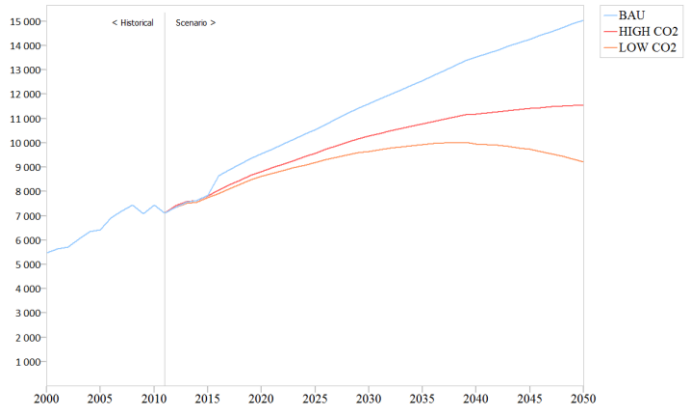

Figure 2. Electricity demand prognosis in Estonia until 2050, GWh

During the period of 2000–2011 electricity production from power plants has been between 8,513–12,964 GWh. If continuing as today (the BAU scenario), in 2050 the electricity production of Estonian power plants will be 17,664 GWh, n the HighCO2 scenario 13,539 GWh, in the LowCO2 scenario 11,114 GWh and in the LowW scenario 13,976 MW.

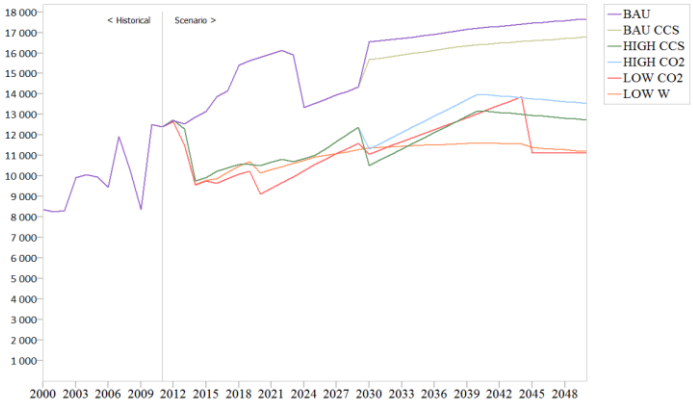

Figure 3. Electricity production in Estonia with different scenarios, GWh

The share of renewable electricity in total domestic electricity consumption in the BAU scenario will increase from 12.7% in 2011 to 31% in 2020, but will decrease after that to 20% by 2050. This is due to the fact that increased

electricity demand will be satisfied mainly by the production using fossil fuels as existing legislation sets a cap to the development of new renewable electricity production capacities.

In the LowCO2 scenario, the share of renewable electricity in end use will increase to 59% by 2020, to 96% by 2040 and from 2045 onwards power production will be almost entirely (98%) based on renewable fuels and sources. A minor share will remain to electricity produced using waste fuel. Scenarios differ a lot on whether oil shale will remain dominant in the fuel mix as primary fuel for power production (BAU), oil shale direct combustion will be phased out (LowCO2) or new CFB boilers of Narva Power Plant will operate with max use of wood biomass mixed with oil shale.

Table 2. Electricity production by selected scenarios in 2050, GWh

Fuels	BAU	LOW CO2	LOW W
Biogas	87	1,107	1,107
Gas-turbine	593	-	-
Hydro	33	33	33
Natural gas	217.	-	204
Waste fuel	134	221	134
Wood	773	1,757	1,581
Wood co-burned w. Oil-shale	313	-	2,630
Solar	-	439	88
Oil-shale CFB	7,114	-	2,630
Shale oil	883	-	-
Peat	70	-	70
Wind	2,688	7,537	5,077
Nuclear	4,743	-	-
Total	17,648	11,094	13,556

The GHG emission reduction potential of the Estonian energy sector is high due to a high share of oil shale in today's energy mix. By implementing appropriate policy measures by following the development path as described in the LowCO2 scenario, emmissions compared to the 1990 level could be reduced by 90% by 2050.

Table 3. Estonia's energy sector's GHG emissions by scenarios and reduction compared to 1990 (%)

				GHG emission, million tCO2eqv			
Scenario	**1990***	**2000***	**2010***	**2020**	**2030**	**2040**	**2050**
BAU	35,76	14,78	18,19	20,31	16,39	17,22	17,49
BAU CCS				20,31	10,80	11,65	11,89
HIGH CO2				13,85	10,33	10,21	10,06
HIGH CCS				13,87	8,18	8,07	7,91
LOW W				8,63	6,53	5,69	4,73
LOW CO2				8,62	6,68	5,73	3,49
				Reduction of GHG emission compared to 1990 level			
BAU	0%	-59%	-49%	-43%	-54%	-52%	-51%
BAU CCS				-43%	-70%	-67%	-67%
HIGH CO2				-61%	-71%	-72%	-72%
HIGH CCS				-61%	-77%	-78%	-78%
LOW W				-76%	-82%	-84%	-87%
LOW CO2				-76%	-81%	-84%	-90%

*data from NIR2012

In order to achieve low-carbon electricity production, the Government has to phase out subsidies and preferential treatment of oil shale users; create conditions for replacement of fossil fuels in existing power plants with renewable fuels; support electricity and heat co-generation in small cities and in industry, as well support distributed and micro generation by individual consumers. In order to mobilise private capital to invest in renewable generation capacities, foundation of the energy cooperatives for small scale power production has to be promoted. New renewable generation capacities on biogas together with gas production have to be supported by the agriculture sector and also wastewater treatment plants in big cities. Solar panels as part of buildings construction have to become standard as well erection of solar parks in rural areas with government support. In order to facilitate large scale replacement of oil shale in the national power mix and concentrated and thus inefficient and vulnerable generation with distributed generation, investment into grid development allowing wider uptake of domestic renewable resources (e.g. wind power in the west coast and islands) and interconnections are necessary. The need for the new interconnections within the Baltic and Nordic region has been studied as part of the NORSTRAT project. Together with enhanced development of renewables-based distributed generation, support to renovation of buildings in the public and private sector has to be doubled from the current support level, in order to achieve energy efficient buildings. Energy audits and ESCO-services have to be mainstreamed together with the strengthening of regulation on energy performance of the buildings, machinery and appliances. Major policy measures which have to be implemented in the coming decade in order to achieve low-carbon electricity production in Estonia are, but not limited to the following:

- Phase out subsidies to fossil oil shale use in electricity production e.g. abolish exemption of large electricity producers from carbon tax, phase out excise tax exemptions to fossil fuels used by the agriculture and fisheries sectors;
- Increase investment support for the construction of the small scale biomass, solar and wind plants;
- Reshape support scheme for renewable electricity production by lifting the tax burden from consumers to the state budget and revenues from emission trade;
- Promote the establishment of energy cooperatives by awareness rising and preferential taxation;
- Increase significantly investment support to energy efficient renovation of housing;
- Support micro energy production in the public and private sector by providing investment support and tax deduction from private investments;
- Prepare a national spatial plan on renewable energy use;
- Use the EU structural Funds for targeted investment into grid aiming for a wider utilisation of the renewable resources for electricity production;
- Invest into new interconnections with Latvia and Sweden in order to benefit from production and balancing capacities of wider power system;
- Apply strictly Green Public Procurements by the purchasing of green electricity and biofuels by the public sector;
- Provide investment support into electric and renewable fuel using public transport;
- Restore investment support and provide tax incentives to replacement of the conventional vehicles with electric and renewable fuel cars;
- Strengthen legislation in support of central heating and provide investment support for shifting heat only boilers to co-generation plants using renewable fuels.

Further Information

Please contact: Valdur Lahtvee, Phone: +372 53285051, e-mail: valdur.lahtvee@seit.ee
Further information on the Estonian Low-carbon roadmap 2050 is available (in Estonian only) http://www.seit.ee/et/projektid?project_id=302.