Impact Assessment

LIAISE

LIAISE Policy Brief

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Re-assessment of CO_2 and SO_2 emissions in energy sector by using LEAP-model: experiences from Estonian energy sector planning

The LEAP (Long-range Energy Alternatives Planning) model is a software tool for energy policy analysis and climate change mitigation assessment. In 2012, a **re-assessment of LEAP modelling results** on CO_2 and SO_2 emissions in the Strategic Environmental Assessment of the Estonian National Energy Sector Development Plan until 2020 (further referred to as the Energy Plan 2020) was carried out. The aim of this re-assessment was to find out to what extent the LEAP model results for the Energy Plan 2020 were achieved and what were the possible reasons for deviation.

The results highlight the opportunities for policy learning through the re-assessment of modelling results and the need to find out how to include into Impact Assessment the uncertainties that remain outside the scope of models.

LIAISE Policy Brief

This policy brief reports on the results from the LIAISE Network of Excellence.

The *LIAISE test cases* are about acting, participating in, supporting and observing concrete policy processes which use or could use IA tools. *Test cases* enable mutual learning about policy-makers´ and researchers´ needs, as well as learning on opportunities and barriers for interaction on IA tool use and development. Test cases involve researchers, tool developers, IA practitioners and policy-makers.

The *LIAISE test cases* study the use of selected IA tools, user requirements and science-policy interface at various thematic and governance levels. They include seven cases ranging from the EU-level to national and regional levels. They cover several policy areas including climate policy, agricultural policy, resource efficiency policy and land use policy. *Test cases* provide lessons from tool development and from the use or non-use of tools in IA processes. These lessons contribute to increased awareness on IA tools, improved communication between policy and research, and stimulating tool use and IA research.

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Key findings

Periodic re-assessment of modelling results in Impact Assessments enables better policy planning.

The re-assessment of previous modelling results shows that as any other model LEAP is also susceptible to political and economic decisions that cannot be predicted in the long-term. Therefore periodic updates of the impact scenarios are needed in order to account for recent changes in policies, measures and baseline data.

At present, periodical re-assessment of *ex ante* model predictions is not a regular procedure in the policy process in Estonia. Although *ex post* assessment with models may be expensive, compared to other, less complex and data-intensive assessment methods (such as qualitative methods), there is a need for periodic re-assessment of modelling results with the same model to contribute to better informed decision-making and to reduce future uncertainties.

Re-assessment of the CO_2 and SO_2 emissions arising from previously predicted long-term energy scenarios showed some deviation between the modelling results and actual realisation.

The actual CO_2 emissions were 1.5% higher and SO_2 emissions 2.0% higher in 2000–2006 than modelled in LEAP in 2009 largely due to two unassumed factors. Firstly, the statistical data on CO_2 and SO_2 emissions were amended in the national statistical database due to revised methodology, and secondly, the export of electricity was increased to meet the higher demand for electricity in the region. Since the main source of electricity production in Estonia is oil shale, a fossil fuel, CO_2 and SO_2 emissions increased accordingly. Increased external electricity demand was not assumed in 2009 model.

The LEAP modelling assumptions are based on steady growth/reduction forecasts. In reality, the electricity consumption and export depend on political and economic decisions, which are rather difficult to project. Thus, the assumptions work better for supply predictions, and less well for demand forecast, because production capacities are usually more stable parameters than consumption patterns, which are more easily influenced by political and economic decisions.

Future electricity and heat production scenarios in Estonia

The energy-environment modeling tool **LEAP** was developed at the Stockholm Environment Institute (SEI) (Heaps 2012). It was first used for Estonian national level planning in 2008–2009 in the Strategic Environmental Assessment (SEA) of the Energy Plan 2020 to forecast the future trends of **CO_2 and SO_2 emissions** arising from nine electricity and three heat production scenarios.

The level of CO_2 and SO_2 emissions were two of 27 criteria against which the environmental impacts of the electricity and heat production scenarios and proposed measures of the Energy Plan 2020 were assessed.

The electricity production scenarios were constructed on the basis of the scenarios from Estonia's Long-term Electricity Sector Development Plan until 2018 and National Oil Shale Development Plan for 2008–2015 (Kuhi-Thalfeldt *et al.* 2010). In addition, four electricity production scenarios and three heat production scenarios (including baseline scenarios) were added by the authors of the SEA for the Energy Plan 2020 (SEI Tallinn 2009).

The varying scenario parameters were the shares of different sources of electricity and heat production and respective production capacities. Oil shale, a fossil fuel, is one of the energy sources in all scenarios, but to different extent.

Electricity production scenarios:

Scenario	Dominant energy source(s)	Annual oil shale need (mln tonnes)	Use of oil shale for electricity production (%)
0 (baseline)	Oil shale	15	80
A	Nuclear power	15	30
B	Wind power, natural gas	15	30
C	Oil shale	15	50
C2	Oil shale, coal, wind power, natural gas, nuclear power	15	30
D	Oil shale	15	70
E1	Oil shale	15	60
E2	Oil shale	10	80
E3	Oil shale	25	30

Heat production scenarios:

Scenario	Dominant energy source(s)
0 (baseline)	Natural gas
1	Natural gas, liquid fuels derived from oil shale
2	Natural gas, biomass

The CO_2 and SO_2 emissions of the scenarios were based on **2000–2006 data**, and the time period for scenario forecasts was **2007–2030**. In the re-assessment it was possible to extend the LEAP time period: historical period being now **2000–2010** and the model forecast period **2011–2040**.

Main assumptions for the scenarios in 2009 compared to the actual changes observed in 2012

The following changes between the main model assumptions (input parameters) and actual results were observed in 2012.

Population size of the country has decreased less than it was estimated in the model in 2009 (-0.08% vs -0.34% annually).

The actual growth of gross domestic product (**GDP**) was lower than the forecast; the financial crisis resulted in negative GDP growth even in 2008–2009.

Final energy consumption in sectors (industry, transport, agriculture, commercial and public services, households) was assumed to rise according to the GDP forecast, in correlation to the coefficient, which LEAP calculated on the basis of historical data from 2000 to 2006. In 2010, the actual fuel consumption in these sectors was 1.6% higher than assumed.

Electricity generation was assumed to remain at about the same level as in 2006. The actual electricity generation in 2007, 2008 and 2010 has been considerably higher than in the LEAP model projection in 2009. This is caused by the large electricity export that was not assumed in 2009. In 2007–2010, 22–34% of the total electricity production was exported.

Final electricity consumption was linked to GDP; consumption was assumed to change according to the 0.3 coefficient. As the actual GDP growth from 2007 to 2010 was lower than the forecast, the actual electricity consumption should also have been lower than the one presumed. But inspite of the economic crisis the end-use of electricity was still growing – in 2010 it was 2.8% higher than the one modelled because of electricity export.

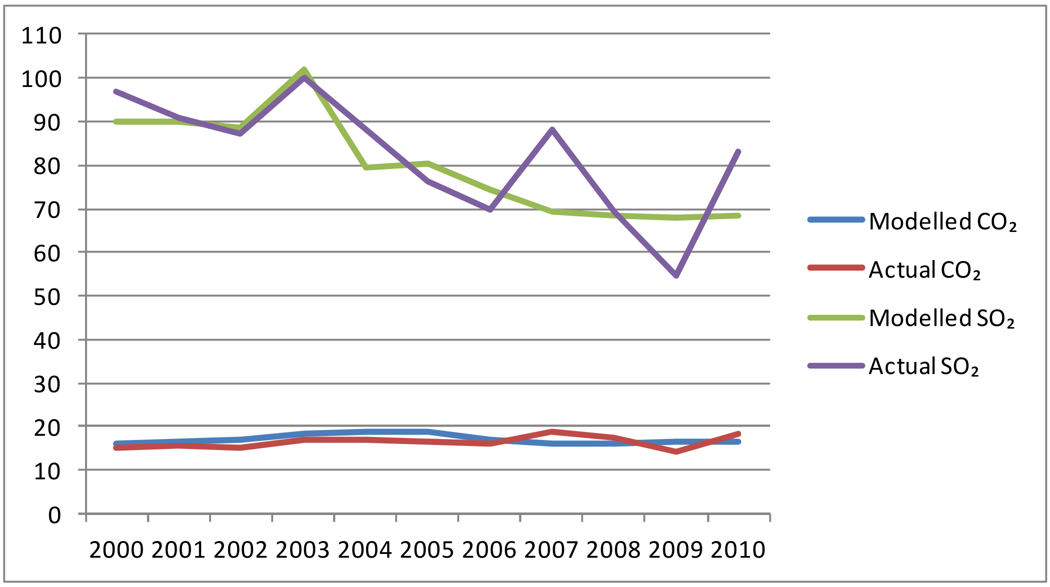
Actual **heat consumption** has been, on the contrary, up to 13% lower than the one assumed. Heat consumption has decreased probably due to better insulation of houses following government supported schemes.

Results of the re-assessment of CO_2 and SO_2 emissions

Due to the revised values in the statistical database of Estonia after 2009 as a result of changes in the emission calculation methodology, the statistical values for CO_2 emissions were about 10% lower and SO_2 emissions 2.0% higher in the period 2000–2006 than those used in the model in 2009. After correcting the emission coefficients in the model, the **actual CO_2 emissions were on average 1.5% higher and SO_2 emissions 2.0% higher** in the **2000–2006** period for all electricity production scenarios than those modelled with LEAP in 2009.

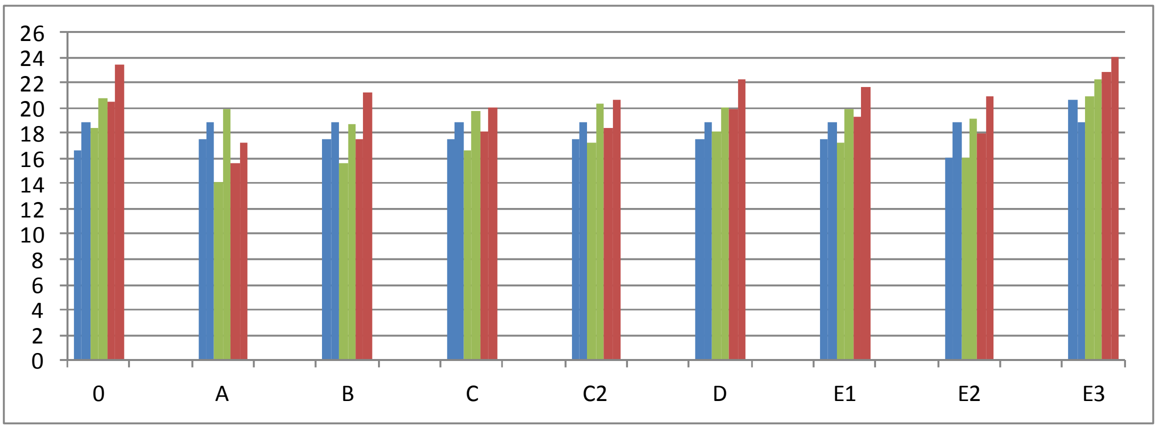
Figure 1 shows the differences between modelled and actual CO_2 and SO_2 emissions for the baseline scenario. The LEAP projections for the years **2007–2010** were much more stable than the actual statistical data, which varied greatly from year to year due to the different outputs of power plants in these years.

Figure 1. Total modelled and actual CO_2 and SO_2 emissions (mln t) for the baseline scenario



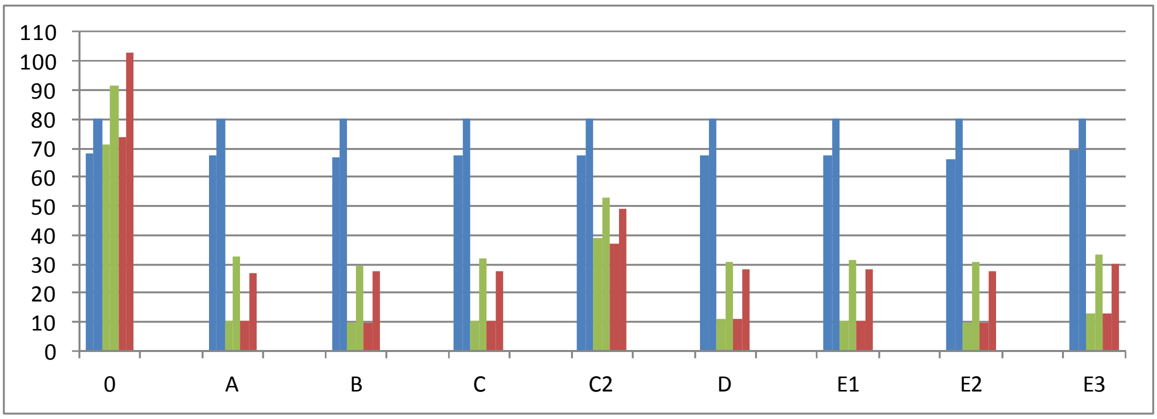
The re-assessment of model projections indicates higher emissions by 2030 than modelled in 2009 due to larger growth in **electricity consumption** (2.2% annually instead of 1.5% used in the model in 2009) and large-scale **electricity export** (4354 GWh annually instead of 1000 GWh) (Fig. 2 and 3). The figures illustrate the total CO_2 and SO_2 emissions in all sectors for each electricity/heat production scenario.

Figure 2. Total CO_2 emissions (mln t) for each of the electricity production scenarios for the years 2010, 2020 and 2030 as modelled in 2009 and in 2012



2010, projected in 2009 (1st column) and actual in 2012 (2nd column)
2020, projected in 2009 (1st column) and in 2012 (2nd column)
2030, projected in 2009 (1st column) and in 2012 (2nd column)

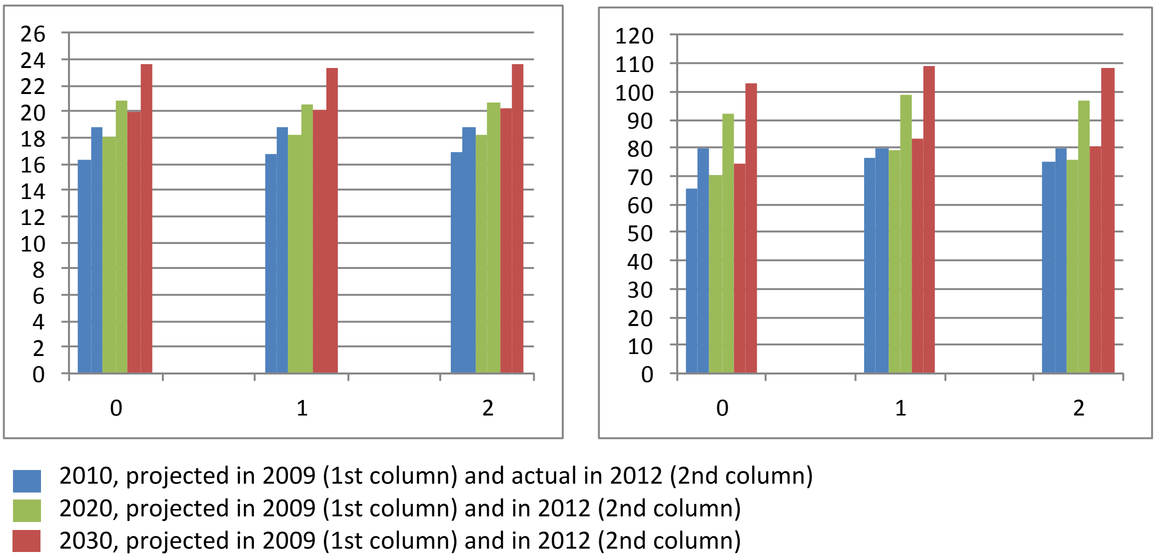
Figure 3. Total SO_2 emissions (mln t) for each of the electricity production scenarios for the years 2010, 2020 and 2030 as modelled in 2009 and in 2012



2010, projected in 2009 (1st column) and actual in 2012 (2nd column)
2020, projected in 2009 (1st column) and in 2012 (2nd column)
2030, projected in 2009 (1st column) and in 2012 (2nd column)

Due to the increase of CO_2 and SO_2 emissions in electricity production, these emissions are also higher in electricity-based heat production scenarios compared to those forecasted in 2009 (Fig. 4).

Figure 4. Total CO_2 (left) and SO_2 (right) emissions (mln t) for each of the heat production scenarios for the years 2010, 2020 and 2030 as modelled in 2009 and in 2012



The differences between LEAP projections made in 2009 and actual CO_2 and SO_2 emissions were caused by the following factors that can be divided into three categories.

Changes in statistics and consumption patterns:

- Statistical data regarding emissions were changed after 2009 due to revised methodology;
- Statistical data were not detailed enough for modelling;
- GDP growth forecast was not accurate;
- Electricity demand has grown faster than assumed, due to economic decisions to increase export of electricity.

Changes in energy production and market:

- Old oil-shale production units were run in full capacity;
- Mining quantities of oil shale and production of shale oil have increased;
- Co-firing of wood chips and oil shale started in new oil shale power units;
- New electricity production units not anticipated in 2009 have started operating after 2009;
- Three new cogeneration heat and power plants on wood chips have started operating in 2009–2010, which has increased the share of wood and decreased the share of natural gas in heat production;
- Net electricity export was started in 2009 with the first phase of opening up of electricity market and has considerably grown since then.

Changes in political arena:

- Shut down date of old oil-shale production units has been postponed;
- Decision to instal sulphur-capturing filters to some oil-shale power units instead of closing these production units down in 2016 as assumed in the Energy Plan 2020;
- The decision to build a new oil shale based power unit was taken in 2011;
- The will-be gas turbines will be used for balancing and emergency reserve, not for normal power production as assumed in the Energy Plan 2020.

These factors were initially not assumed in the modelling. The extent of these changes would have been rather difficult to predict with the model.

The results of the re-assessment of emissions modelled for the Energy Plan 2020 were discussed with the energy policy desk officers and experts in the workshop in February 2012. The workshop participants agreed that the LEAP model is appropriate for calculating emissions and resources of various energy production scenarios and can be used in the updating process of the energy policy; however, periodic re-assessments and adjustments are needed. Re-assessments as part of *ex post* evaluation also contribute to the cyclic process of policy Impact Assessment and policy learning.

References

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The main purpose of the **LIAISE Network of Excellence** is to identify and exploit opportunities to bridge the existing gap between the research and the policy community in the field of Impact Assessment, improving the use of IA tools in policy making. LIAISE combines the multi-disciplinary competence of a core group of European research institutes.

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The Policy Brief Series presents the results of the work carried out in LIAISE to the policy world. It addresses topics of current concern and focuses on those aspects of the issue where the policymaker (and the public opinion) is seeking additional information.

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