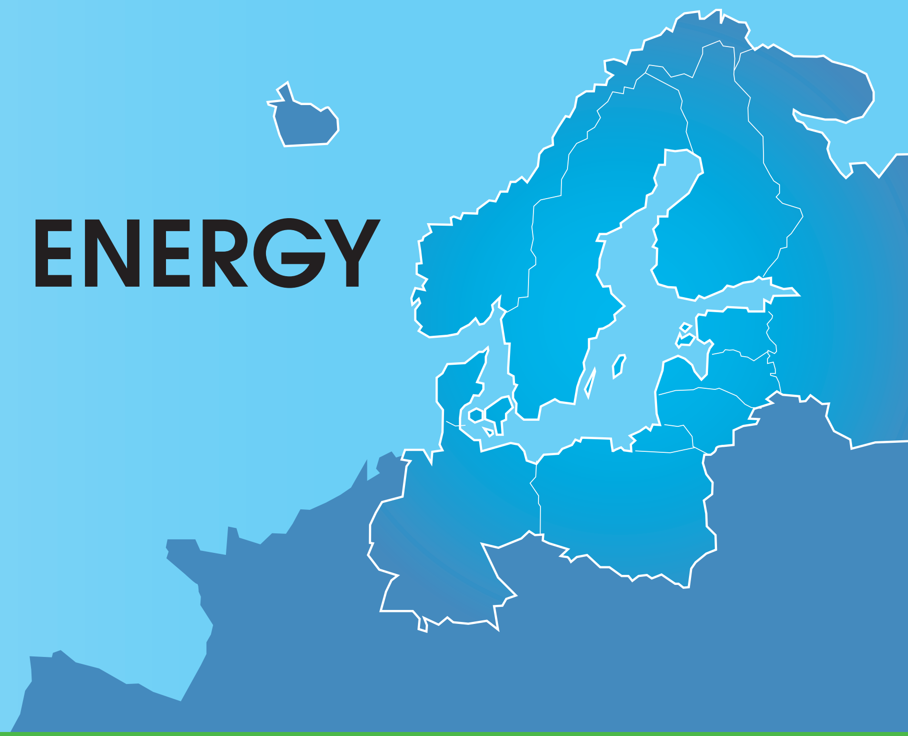
SUSTAINABLE ENERGY SCENARIOS



2010

Energy Perspectives for the Kaliningrad Region as an Integrated Part of the Baltic Sea Region

norden
Nordic Council of Ministers

Ea Energy Analyses

Baltic Development Forum
sustainable growth · innovation · competitiveness

Prepared by:
Ea Energy Analyses
Frederiksholms Kanal 4, 3th floor
DK-1220 København K
Tel: +45 88 70 70 83
Fax: +45 33 32 16 61
E-mail: info@eaea.dk
Web: www.eaea.dk

Initiated by:
Baltic Development Forum
Nygade 3, 5th floor
DK-1220 København K
Tel : +45 70 20 93 94
Fax : + 45 70 20 93 95
E-mail : bdf@bdforum.org
Web: www.bdforum.org

Sponsored by:
The Danish Ministry for Foreign Affairs
The Nordic Council of Ministers' Information Office in Kaliningrad

Table of Contents

Foreword

This report hopes to provide a basis for a better dialogue on energy policy and energy planning in the Baltic Sea region. The report is a continuation of the 2009 study on regional energy scenarios that presented various alternatives for a more integrated energy sector in the Baltic Sea Region. The energy scenarios were discussed at the 2009 BDF Summit in Stockholm and proved to be a very effective way of promoting a dialogue on priorities for the regional energy cooperation. The scenarios offered opportunities rather than fixed solutions. This report looks more closely on Russia and Kaliningrad as an integrated part of the Baltic Sea region.

Russia is a crucial energy supplier for the EU countries in the region. As Russia is the world's largest energy exporter, the EU countries are dependent on Russia as a reliable energy supplier, not least when it comes to natural gas. Hence, Russia is very important in terms of energy security. At the same time, Russia's economy depends on the revenues from the export of oil and natural gas, and this influences many of Russia's policy areas.

Energy policy and security policy are increasingly seen as closely linked in international politics. Therefore, most analyses on Russia's external energy policies take their starting point from a *political* perspective where energy is often seen as Russia's opportunity to influence international relations. This report, however, has chosen a *technical* approach that takes its starting point from an optimal energy planning perspective and explores the different investment strategies by considering Kaliningrad and the neighbouring countries as almost *one integrated area* without borders. In other words, it does not look at politics and the crucial issues regarding security of energy supply but rather focuses on optimal energy investments and energy efficiency. The intention is not to disregard politics but rather to create a dispassionate analytical basis for a better energy dialogue and for closer energy partnerships.

Due to Kaliningrad's geographical position, a balanced energy relationship between Russia and her neighbours in the region seem likely. The strong integration of the electricity systems in this area of the EU also adds to the point that Russia's need to cooperate with her neighbours. This is one of the starting points of this report, which focuses on the *electricity sector* and the plans to build a *nuclear power plant* in Kaliningrad as well as other nuclear power plants in the neighbouring countries. The question that needs to be answered is how these plans impact the region and the wider energy markets, since it seems doubtful at a first glance that there is a market for both the Kaliningrad nuclear power plant and the new Lithuanian nuclear power plant, which is to replace the closed-down Ignalina plant.

The report provides many new and interesting conclusions. It identifies that Russia's main interest in building a nuclear power plant in Kaliningrad might not so much be her interest in the local and regional markets in the Baltic Sea Region but rather the bigger, central European energy markets. A likely future target might be to provide Europe not only with gas but also with electricity.
In line with the previous scenario report, the findings are based on transparent and accessible energy data, open analytical sources and wide policy discussions and consultations on the issue. At the Baltic Development Forum Summit in Vilnius 1-2 June 2010, initiated the debate on the issue and it is our hope that the discussions will continue with this final report. In this sense, the report is in itself a confidence building measure going beyond media statements and press releases on the plans to build new nuclear power plants. Finally, the overall ambition is to promote energy efficiency, which must be the centre of attention for all energy infrastructure developments in order to be able to combat climate change.

Thanking the Danish Foreign Ministry and the Nordic Council of Ministers' Information Office in Kaliningrad for supporting the work on this report, we wish you a good read.

Copenhagen, 1 October 2010

Hans Brask
Director
Baltic Development Forum

About Baltic Development Forum
Baltic Development Forum is an independent and high-level network for decision-makers from business, politics, academia and media in the Baltic Sea Region. Our mission is to create a prosperous Baltic Sea Region through regional integration, sustainable growth, innovation and competiveness. We shape the regional agenda by publishing reports on topics vital to the development of the Region and proposing priorities for action. Our annual high-level Summits offer a unique platform for debating vital matters across borders and sectors. Forum is chaired by the former Minister for Foreign Affairs of Denmark Uffe Ellemann-Jensen.

1 Summary

Baltic Development Forum and Ea Energy Analyses have prepared this report *Sustainable Energy Scenarios – Energy perspectives for the Kaliningrad Region as an integrated part of the Baltic Sea Region.* The report was presented and discussed in a draft version at the Baltic Development Forum Summit, 1-2 June 2010 in Vilnius. The outcome of the discussions as well as comments and corrections from stakeholders is reflected in this final report.

The study is a follow-up to last years' energy report that took a broader look at the mutual advantages of energy co-operation in the Baltic Sea Region. This report focuses on the special situation of Kaliningrad and co-operation between the Baltic countries and Russia.

EU Baltic Energy Market Interconnection Plan

In the EU, effective interconnection of the Baltic Sea region is a high priority. It was identified as one of the six priority energy infrastructure projects in the Second Strategic Energy Review adopted by the Commission in November 2008. The Baltic Energy Market Interconnection Plan (BEMIP) was launched at the 2008 autumn European Council and by June 2009 a final report including an action plan was presented.

A market design for the Baltic countries has been agreed on based on the Nordic energy market model. This should lead to the establishment of common power exchange for physical trade in the Nordic and Baltic area, including the establishment of market based congestion management as well as a common reserves and balancing power market.

Moreover, a number of infrastructure projects have been identified, which are important for the integration of the markets and appear commercially viable. These include NordBalt, linking Sweden to Lithuania, Estlink 2 between Estonia and Finland and LitPol between Poland and Lithuania. Together these links form the so-called "Baltic energy Ring". Several of the proposed BEMIP infrastructure projects – including NordBalt and Estlink 2 – have subsequently been shortlisted to receive financial support from the European Economic Recovery Programme (EERP).

Figure 1: Projects for electricity interconnectors, BEMIP plan, 2009.

The BEMIP plan does not include the Kaliningrad region – since Russia is not a member of the EU or the European Economic Area. However, energy development of Kaliningrad region is impacted by the developments in the surrounding EU countries and vice versa.

Plans for new nuclear

Both in Kaliningrad and in the surrounding EU countries, Belarus and Russia there are plans for establishing new nuclear generation capacity. This will impact electricity market conditions in the region, including profitability of renewable energy and energy efficiency investments.

Scope of study

The scope of the present study is 1) to explore different investment strategies for the Kaliningrad Region and Estonia, Latvia and Lithuania, including an evaluation of the plans for investments in technologies for energy efficiency and in new nuclear power plants 2) as well as an assessment of the possible new interconnectors in the region. The tools and methods developed in the 2009 study provide the foundation for the analyses developed in this report.

Four types scenarios

Four different types of scenarios have been set up for the future energy system of region. All scenarios are for the year 2020:

1) A *Baseline scenario* illustrating a development without new nuclear power plants in the region. In the EU countries in the region the baseline includes a CO_2 price of 25 EUR/ton and a reward to renewable energy of 30 EUR/MWh to mirror the policies of the EU set out in the 20-20-20 targets. In Russia a CO_2 price of 12.5 EUR/ton and a 15 EUR/MWh premium to renewable is estimated for 2020 to

reflect the national energy objectives and Russia's international commitments.

2) Three *Nuclear power scenarios*, assessing the impact of a nuclear power plant in Kaliningrad and/or in Lithuania.

3) A *Higher Efficiency Scenario* illustrating the effect of lower electricity demand than the Baseline scenario.

4) A scenario with *RE subsidy and CO_2 quotas in Russia*, illustrating the consequences of equal RE subsidy and CO_2 quota price in all simulated countries.

In all scenarios for 2020 it is assumed that the aforementioned Baltic Energy Ring is established, including NordBalt (700 MW), Estlink 2 (650 MW) and Lit-Pol (1,000 MW).

The analyses are carried out by the use of the Balmorel model, which is an economic/technical partial equilibrium model that simulates the power and heat markets.

The model optimises the production at existing and planned production units (chosen by the user) and allows new investments in the scenarios, chosen by the model on a cost minimising basis considering the cost of different technologies and the development in fuel and CO_2 prices.

Possible increasing requirements for balancing power in connection with the integration of new nuclear power and wind power capacity in the region has not been subject to analysis in this study.

It should be noted that the study is carried out based on readily available data.

1.1 Findings of the study

The results of the scenario analyses as to electricity generation and CO_2 emissions from power generation in the region are shown in the figures below.

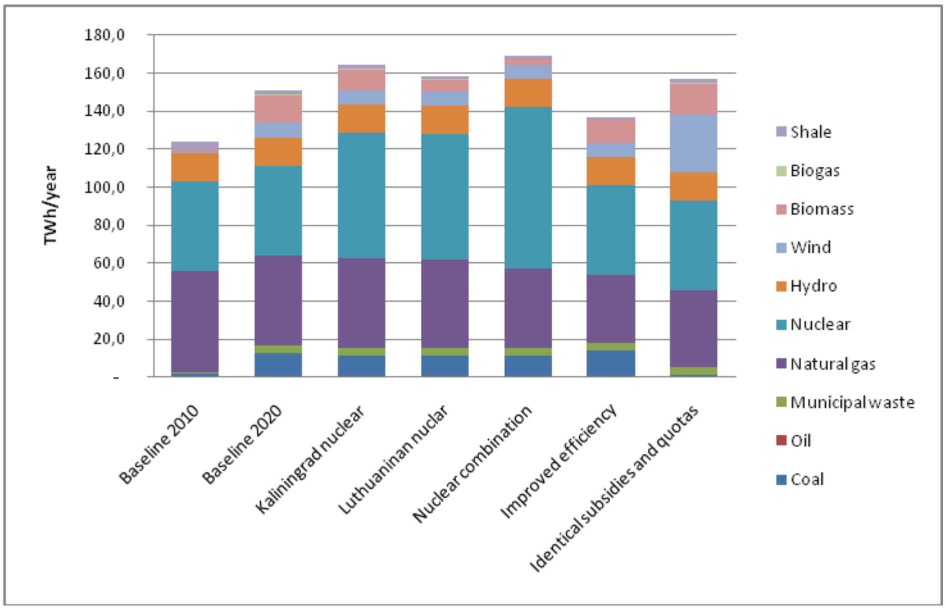


Figure 2: Total electricity generation in Kaliningrad, NW Russia and the Baltic States in all scenarios

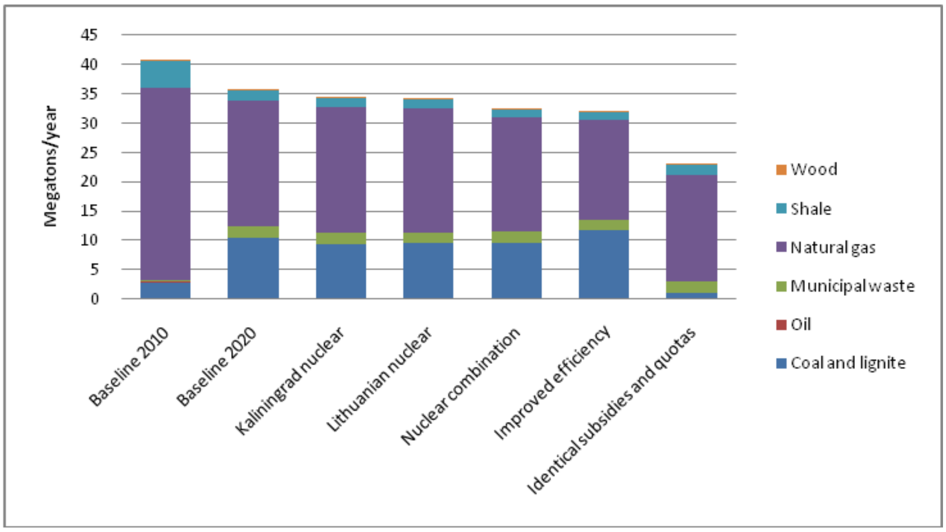


Figure 3: Total CO_2 emissions from power and district heating generation in Kaliningrad, NW Russia and the Baltic States in 2010 simulation compared with scenarios for 2020. The figure includes all emissions including district heating.

Based on the scenario analyses, the following findings can be drawn from the study regarding nuclear power, renewable energy and fossil fuels.

Nuclear power

The development of nuclear power in the Kaliningrad region is mainly motivated by the possibilities of export of electricity from Kaliningrad. With the assumed capacity of the plant of 2,300 MW by 2018 it can be expected to generate more than 18 TWh annually. This should be compared to the electricity consumption of the Kaliningrad region, which is approx. 4 TWh per annum today and is expected to increase to about 6 TWh in 2020. Hence, the large part of the generation from the nuclear power plant will have to be exported to neighbouring regions.

The current interconnection between Kaliningrad and Lithuania, which is operated at approx. 600 MW, is insufficient to cover the demand for export capacity. The investment in a new nuclear power plant in Kaliningrad will therefore have to be supplemented by investments in new transmission capacity. In the simulations with nuclear power in Kaliningrad, a new 1,000 MW interconnector from Kaliningrad to Poland is assumed as well as a reinforcement of the interconnectors to Lithuania (+900 MW). Inter RAO UES is also considering establishing a HVDC cable to Lubmin in Germany. However, this is considered to be a rather costly solution compared to linking closer up with Poland and Lithuania and therefore it has not been subject to analysis in the present project.

It should be stressed that the establishment of new transmission capacity out of Kaliningrad will be subject to agreement with the neighbouring countries. In this respect, it would be very relevant to coordinate any initiatives with the implementation of the BEMIP plan.

Because of the assumption about a new interconnector to Poland, the model simulation shows that the nuclear power plant in Kaliningrad only has moderate influence on power generation in the Baltic States. Approximately two thirds of the power produced at the nuclear power plant in Kaliningrad is exported to Poland and the Nordic countries.

With the implementation of the BEMIP plan, new nuclear power in Lithuania does not have to be followed by additional investments in interconnectors. Establishment of a 2,300 MW nuclear power plant in Lithuania will reduce import of electricity from Sweden through the NordBalt interconnector and reduce the incentive to invest in biomass fired power plants in Lithuania, Latvia and NW Russia.

Exchange of electricity

Table 1 below shows net import/export in the countries in the Eastern part of the Baltic Sea region in the different scenarios. In the 2010 baseline roughly 13 TWh is exported from the region to Finland. This figure increases to 15 TWh in the Baseline 2020 and up to 33 TWh in the nuclear combination scenario, where new nuclear power is commissioned in both Lithuania and Kaliningrad. The numbers indicate that in total approx. 50 % of the generation from the two nuclear power plants will replace generation from other power plants in this part of the region, whereas the other 50 % will be exported to neighbouring countries (Poland and the Nordic countries).

(TWh/year)	Estonia	Lithuania	Latvia	NW Russia	Kaliningrad	Total
Baseline 2010	-2.2	-5.5	-2.4	23.7	-0.2	**13.4**
Baseline 2020	0.4	-0.3	-1.6	18.7	-2.1	**15.2**
Kaliningrad nuclear	-0.2	-2.3	-2.0	17.4	13.8	**26.7**
Lithuanian nuclear	-0.4	11.1	-2.2	16.9	-2.9	**22.5**
Nuclear combination	-0.5	10.0	-2.7	13.1	13.1	**33.0**
Improved efficiency	0.3	-0.2	-1.3	18.1	-2.3	**15.0**
Identical subsidies and quotas	0.4	-0.5	-1.2	29.1	-0.5	**26.1**

Table 1: Net import/export in Kaliningrad, NW Russia and the Baltic States in all scenarios. Positive number is net-import, while negative represent net-export

The simulations show that the Baltic Energy Ring has a high utilization rate in all scenarios, indicating that a decision to establish the interconnectors is robust to different developments in generation capacity in the region.

Renewable energy

The baseline to 2020 implies a considerable expansion with biomass fired capacity and wind power in the region. A large additional potential of biomass and wind power would be commercially feasible to utilize if Russia, including the Kaliningrad Region, introduced the same subsidies and CO_2 quota regulation as the EU countries. The increased use of biomass and wind would primarily replace the use of coal in the system.

Introduction of nuclear power in Lithuania will significantly reduce the use of biomass in the electricity sector, particularly in Lithuania itself.

With the assumed subsidies and CO_2 quotas, wind power is a viable technology. Therefore, according to the simulations, expansion of wind power in the Baltic countries will take place regardless of introduction of new nuclear power capacity in region.

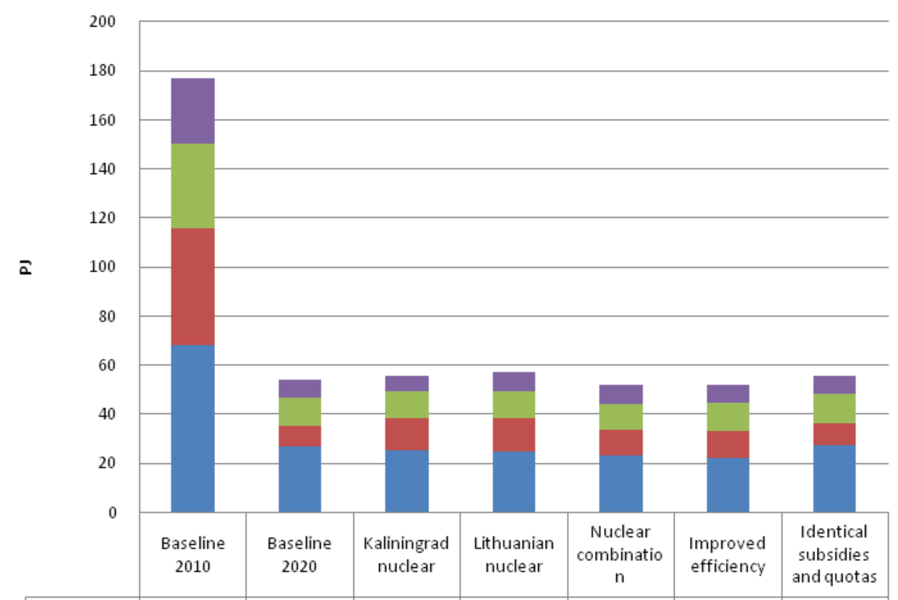
Fossil fuels

It will to some extend become feasible to invest in new efficient coal and gas fired power plants (CHP plants) to replace existing inefficient generation capacity.

If Russia introduces the same subsidies and CO_2 quota regulation as the EU, use of natural gas will decrease somewhat and coal power generation will almost be phased out.

The consumption of natural gas for electricity generation in the Baltic countries and Kaliningrad decreases very considerably in all scenarios for 2020. In the Baltic countries, electricity generation shifts to wind power and biomass or nuclear depending on the scenario in play. This change will require massive investments in new generation capacity, but at the same time improve the fuel security considerably in the Baltic countries.

In the Baseline 2020, the simulations show that it will be attractive to change supply from gas power to new wind power and coal power in Kaliningrad. However, this change is very sensitive to the assumptions about natural gas prices, and the results should be interpreted with caution considering the current expansion with gas fired capacity.



	Baseline 2010	Baseline 2020	Kaliningrad nuclear	Lithuanian nuclear	Nuclear combinatio n	Improved efficiency	Identical subsidies and quotas
Kaliningrad	27	7	6	8	8	7	7
Latvia	34	11	11	11	10	12	12
Lithuania	48	8	13	14	11	11	9
Estonia	68	27	25	25	23	22	28

Figure 4: Consumption of natural gas (PJ) for electricity generation and district heating production in Kaliningrad and the Baltic countries

The average annual marginal electricity market price in Kaliningrad in the simulation for 2010 is just above 40 EUR/MWh increasing to approx. 45 EUR/MWh in the 2020 Baseline[1]. In the 2020 nuclear combination scenario the marginal price of electricity is reduced to approx. 38 EUR/MWh. The moderate difference in electricity prices between the scenarios is an indication that there is a benefit of implementing energy efficiency measures even in a situation with a high level of nuclear base load power with low short run marginal costs. The reason for this is that the electricity market price is defined by the marginal electricity power plant in the market, which is usually a plant with fairly high operation and fuel costs.

1.2 Issues discussed at the Vilnius summit

The preliminary findings of the study were discussed at the BDF Summit in Vilnius in June 2010. The starting point of the discussion was the Nordic

[1] These figures are marginal electricity market prices, which do include tariffs required to financial support for renewable energy technologies or new nuclear power capacity.

electricity market as an integrated and well functioning internal market based on free market principles, transparency and a high level of integration.

The BEMIP action plan is based on similar principles. The plan aims at opening up for integrating the other Baltic Sea countries - the three Baltic republics in particular. This requires a high level of market reforms and of grid interconnections. Decisions are made in order to meet these requirements; Estonia, Latvia and Lithuania are expected to become equal partners in an integrated electricity market.

Well functioning, integrated electricity markets are a prerequisite for efficient use of the power system and interconnectors. The fundamental question is therefore how development of such regional markets can be stimulated, including market-based trading of electricity between Russia, Kaliningrad and the EU countries in the Baltic Sea region.

The summit noted that power suppliers in the market should be competing under environmental conditions at comparable level, for instance meeting the requirements set up in the Espoo convention. Almost all Baltic Sea countries have acceded to the Espoo convention. This prevents distortion of fair competition by "environmental dumping". Competitiveness or supplier status must not be obtained at the expense of the environment.

In addition to this, the summit discussed a number of questions regarding the implementation of a consistent and efficient energy system in the Baltic Sea region:

- Wind power seems to be viable in all scenarios. The utilisation of the full potential for wind power requires close coordination between all countries regarding measures for integrating wind power efficiently. How could the coordination and cooperation be stimulated, and who have the leading role in this?
- Development of new interconnectors seems justified as a means to ensure efficient use of renewable energy and nuclear power. But how are investments in new interconnectors to be financed?
- The development of the electricity system in Poland will have a significant influence on the viability of new nuclear power plants in Kaliningrad and Lithuania. How could the co-operation between the countries on a common understanding of possibilities and challenges be enhanced in the near future?

1.3 Conclusions from the Vilnius summit

Close co-operation is beneficial for all parties

The summit concluded that Kaliningrad Region as well as the rest of the region could benefit from a closer cooperation. This study should be regarded as a basis for – and an invitation to – Russia and Kaliningrad Region to an enhanced dialogue on energy issues.

The regional context and regional planning is of decisive importance. It would benefit co-operation in the Baltic Sea region, if plans for interconnections between Kaliningrad region and the rest of the region could be made public and discussed. If such plans are transparent, it will enable Kaliningrad region together with other parties in the region to assess the prospects for a closer integration.

More and better data needed

The summit also concluded there is a need for more and better data on a number of topics, i.e.:

- Development of electricity demand in the region and in Kaliningrad,
- Potential and incentives for economically viable, enhanced energy efficiency in the region and in Kaliningrad,
- Cost calculations and financial basis for future power production in Kaliningrad,
- Existing and planned infrastructure connecting Kaliningrad with other parts of the region,
- The longer term perspectives of introduction of Smart Grids in the region.

Next steps

After clarification of these issues, a next step could be to establish an energy stakeholder forum with participation of all parties in the region, including Russia and Kaliningrad Region as well as Belarus. The stakeholder forum could contribute to developing a common interconnector strategy for the region.

Secondly, a next step could be to develop regional projects that could benefit the region as showcase for sustainable energy systems.

2 Background

In October 2009 the Baltic Development Forum and Ea Energy Analyses completed the report: Sustainable Energy Scenarios – Energy Perspectives for the Baltic Sea Region. The study looked at the development of the energy systems in the region from the perspective of enhanced regional co-operation in achieving the targets for renewable energy and climate change mitigation in 2020 and with a perspective towards 2030.

The study and its recommendations was prepared and presented at a number of meetings with regional stakeholders (politicians, governments, international organisations and energy companies), and it has been one of the shared platforms for the ongoing discussion about the future energy system in the Baltic Sea Region.

Since the completion of the study, the political agenda has developed further in the region. Many of the countries around the Baltic Sea are in the process of detailing their energy visions - focus is even more on the development of renewable energy - and a number of plans for new electricity and gas interconnectors are being refined.

In the Baltic countries and in the Kaliningrad Region and other parts of Northwest Russia a number of new power generation units, including nuclear power, are at the moment at the planning stage along with ideas for new transmission lines. Unfortunately, these plans are likely to be developed without systematic and coherent regional planning, which could otherwise have provided a better basis for decisions on viable investments.

On the contrary the investment plans have often been strongly politicised, not least in the media, and have given rise to concern in the otherwise strong endeavours to create a spirit of confidence, co-operation and good neighbourly relations.

The model tools developed in the 2009 study offer such a comprehensive planning approach. In the 2009 study, the North West Russia was included in the scenario analyses but only with preliminary data. Since then it has been possible to include official and reliable data for North West Russia including Kaliningrad Region due to the close contacts to regional authorities (Energy Forecasting Agency of North West Russia Region) and to electricity companies in Russia.

The 2010 study reflects the most recent developments in the countries around the Baltic Sea, and it focuses in particular on the different plans for new investments in the energy sector in the Kaliningrad Region, in comparison with the plans for new power generation in the neighbouring Baltic States.

The scope of the present study is to analyse different investment strategies for Kaliningrad Region and the Baltic States, including an evaluation of the plans for investments in technologies for energy efficiency and in new nuclear power plants as well as in new interconnectors in the region. The tools and methods developed in the 2009 study provide the foundation for the analyses developed in this report.

The report is structured in four main chapters:

Chapter 3: A review of key energy policy issues in the Eastern part of the Baltic Sea Region, including an evaluation of the energy markets, energy systems and concrete plans for new generation capacities and expansions of the existing infrastructure.

Chapter 4: Focusing on energy efficiency potentials and opportunities in Kaliningrad. The chapter assesses the energy efficiency policies in the Kaliningrad Region and the possible consequences of the development in the demand for electricity and district heating.

Chapter 5: An energy perspective towards 2020. A Baseline Scenario is developed towards 2020 using the investment model Balmorel. The Baseline scenario assumes that investments in new generation capacity are made on “market terms”, but includes a benefit to renewable energy and a penalty on CO_2 to mirror important cross-national policy objectives in the region. These incentives are assumed to be lower in Russia than in the EU.

Chapter 6: Three alternative 2020 perspectives. A range of alternative 2020 perspectives are developed focusing on nuclear power, wind power, energy efficiency and regional integration of policies.

Chapters 7 and 8 provide additional information on the modelling tool used and the assumptions underlying the calculations.

Kaliningrad has a particular focus in the analyses and results from the Kaliningrad region are therefore highlighted in the report.

3 A review of key energy policy issues

This chapter provides a review of the key energy policy issues in the Eastern part of the Baltic Sea Region, including an overview of the current production, consumption and energy infrastructure in the region, an evaluation of the energy markets and existing energy legislations, and a description of concrete plans for new generation capacities and expansions of the existing infrastructure.

Energy consumption and production

The energy production and consumption in the Eastern part of the Baltic Sea Region differ a lot between the countries. Gross energy consumption has decreased since 1990 in spite of a significant increase in GDP for the region. This reflects a reduction in the energy intensity of the economy, i.e. the amount of energy used per economy output.

Since 1990, the role of coal and oil has declined whereas particularly natural gas has come to play a greater role relatively.

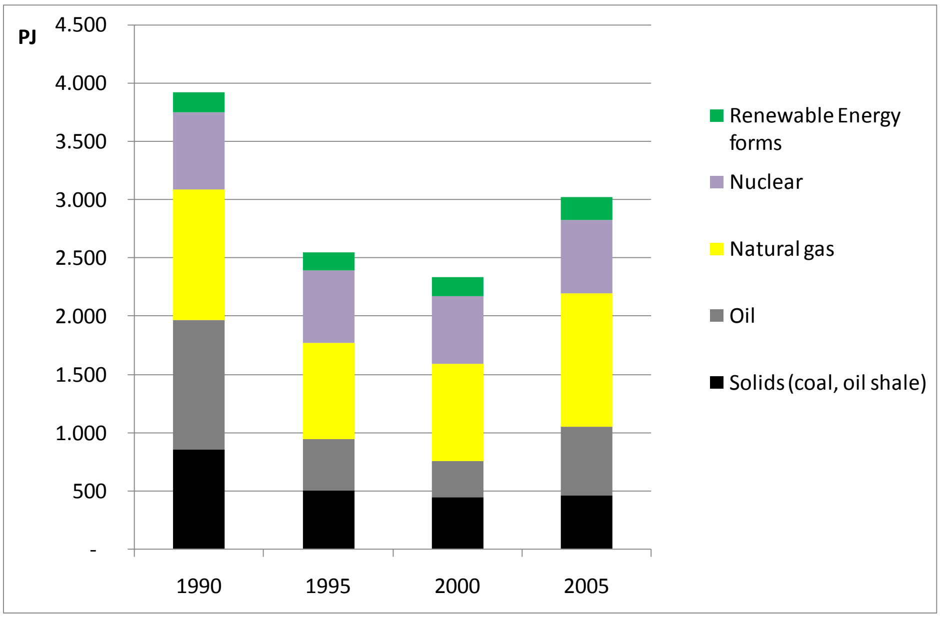


Figure 5: Development in gross energy consumption in the Eastern Baltic Sea region, i.e. Estonia, Latvia, Lithuania and North West Russia, including the Kaliningrad Region (based on data from EU and the IEA).

Russia

Russia in general produces much more energy than what is needed for internal consumption, and therefore a large portion of oil and gas and some electricity is exported, making Russia an international key player on the energy arena. Current energy planning demonstrates that this situation is likely to persist in the future[i].

Kaliningrad

The Kaliningrad region on the other hand has very limited energy resources and the region therefore relies on oil and gas transported from Russia either by tankers through the Baltic Sea or through pipelines going through Belarus or Lithuania, making the region dependent on regional cooperation[ii].

The main elements of the Kaliningrad region power industry is the generating company JSC "Yantarenergo" (which deals with electricity generation, transmission and distribution) and JSC "Kaliningradskaya TETs-2". Both companies are branches of RAO, Russia.

Most of the existing power production facilities owned by JSC "Yantarenergo is more than 20 years old with low capacity. However, in 2006 the gas fired power plant, Kalinigradskaya TETs-2 with a total installed capacity of 450 MW, was put into operation and thereby increased the amount of electricity produced by Kaliningrad power facilities up to 50% of the total power demand[iii]. By the end of 2010 it is expected that a second unit of 450 MW Kalinigradskaya TETs-2 will be put in operation.

Estonia

The Estonian energy sector largely relies on local resources such as oil shale, wood and peat. The reserves are large enough to make the country self sufficient in the near future. The country also exports these resources while importing engine fuels and gas. All natural gas is imported from Russia. In 2007 natural gas share of Estonia's primary energy sources was 15 %[iv].[v].

During the period from 2000-2006 the Estonian gross energy consumption increased by 22 %.

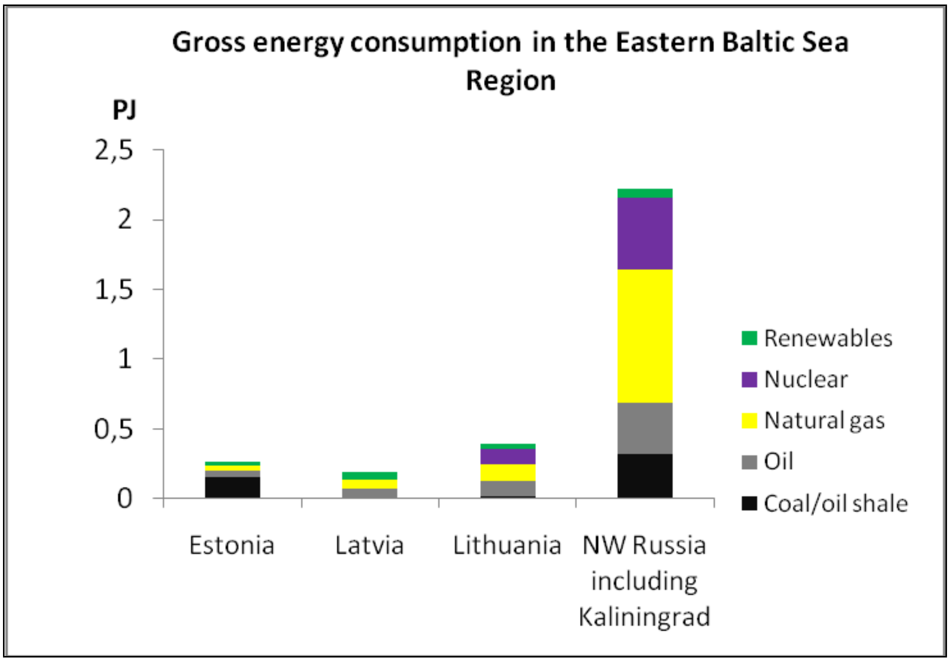


Figure 6: Gross energy consumption in the Eastern Baltic Sea region. Based on data from Eurostat and the IEA (2007 data for Baltic Countries, 2005 data for Russia).

Latvia

Latvia's primary energy consumption is dominated by oil products, gas and wood. The country has a well developed gas supply infrastructure and large underground storage capacity. Around 65 % of Latvia's electricity generation has lately been generated by five large power plants (3 hydro power plants and two thermal power plants), and 3-6 % by more distributed energy resources. The balance is imported from Russia and the other Baltic States.

Russia covers most of the Latvia's energy import, ensuring 100 % of its gas need (almost a third of the country's energy balance), and a large part of its oil need (around 70-80 %).

Lithuania

Lithuania does not possess any hydrocarbon resources and the country can only fulfil a small share of its energy needs through domestic resources. Even though Lithuanian energy policies have been focused on larger energy independency since the country's independence in 1990 it is still mainly relying on Russia for energy import and its system together with the two other Baltic States is more integrated with Russia than with the EU.

With the closure of Ignalina Nuclear Power Plant in December 2009 Lithuanian energy consumption and the dependence on natural gas imported from Russia has further increased.

Electricity infrastructure in the region

The countries surrounding the Baltic Sea operate their generation and transmission systems in three different power systems: NORDEL, UCTE and BALTSO/IPS/UPS.

Germany, Poland and Western Denmark as well as the continental part of the EU are synchronously interconnected within the UCTE system.

Norway, Finland, Sweden and Eastern Denmark are interconnected within NORDEL.

Estonia, Latvia and Lithuania compose the BALTSO pool, which in its turn is synchronously interconnected with the IPS/UPS system of the Federation of Russia, Ukraine, Belarus and the other CIS countries (with the exception of Turkmenistan)[vi].

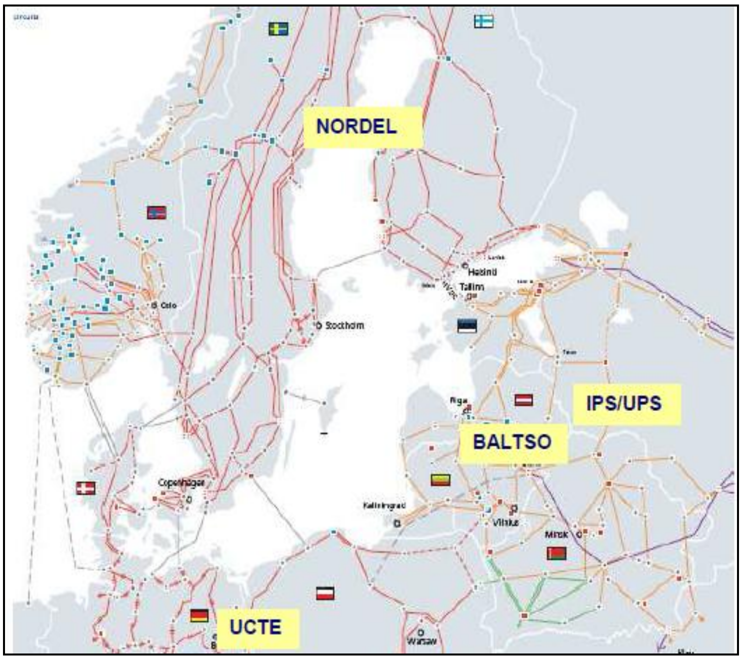


Figure 7: Power Pools in the Baltic Region (CESI report June 2009 nr. A9017214)

Despite a common frequency of 50 Hz these pools are not synchronously interconnected with each other and power exchanges can only take place through HVDC links. Whilst NORDEL and UCTE are presently well interconnected, the three Baltic countries can exchange energy with NORDEL only through one single interconnector between Estonia and Finland (EstLink), commissioned by the end of 2006 and with a capacity of 350 MW. On the other hand, the transmission system of the Baltic countries is strongly meshed with the IPS/UPS pool of the Russian Federation and the other CIS states.

The Kaliningrad region is interconnected only with Lithuania; hence, power transfers to the Kaliningrad region from the rest of the Russian Federation will affect the loading of the Baltic Republics grids, especially in Lithuania and Latvia.

Energy markets

Several of the countries in the region have recently gone through a transformation and liberalisation of their electricity markets.

The reformation of the electricity sector in Russia was completed by July 2008. It included an unbundling by separation of generation capacity from transit and distribution, with transit being controlled by the state and the other two being open for competition. When completed RAO UES, the electricity monopoly of Russia, was officially disbanded. The reforms have lead to the increase electricity prices, removal of most cross-subsidisation and increased competition[vii]. There are currently about 30 different generation companies in Russia[viii].

Deregulation and state control

Since 2006 Russia has also been going through a deregulation of the domestic gas market with the aim of making the domestic gas market for industrial consumers entirely deregulated by 2011, with prices reaching the level of the world market[ix].

The focus on liberalisation of the markets is somewhat in contrast with the policies developed towards increased state control and ownership over the energy sector, with focus on reducing the role of foreign companies within Russia, while also reducing Russia's dependency on transit countries for oil and gas export[x]. The state owned company Gazprom have complete ownership over the Russian gas pipe system[xi]. The oil pipelines (including pipelines for export) are likewise controlled by Transneft, which is a state owned monopoly.

The liberalisation of the energy markets in the Baltic countries has to a large extent been driven by the European Union. However, the electricity market between the Baltic States is not well established yet.

Common Baltic electricity market

In April 2009 the Prime Ministers of the three countries signed an agreement on the creation of an open and transparent common Baltic electricity market and its integration with the Nordic electricity market within the dates foreseen by the EU legislation. The objective is to have a Nord Pool Spot area in 2011 in Estonia, Latvia and Lithuania.

In Lithuania the electricity trading exchange BaltPool was opened the 1st of January 2010. By March 2010 some 60 % of the power consumed in Lithuania was traded at BaltPool. Technically BaltPool is based on the platform of NordPool. The opening of BaltPool was the first big step for Lithuania towards a liberalized and regional integrated energy market. It is expected that the full liberalization process will take less than 5-10 years[xii]. There are some 20 suppliers active on BaltPool so far. However, the Lithuanian energy market is still heavily dominated by the State.

The trading in the Estonian market is carried out by bilateral contracts, and starting from April 2010, via Nordpool Spot Estlink price area for eligible customers. The opening of market is planned to be completed to the full extent by the year 2013. As the only EU member *Estonia* was granted a transit period for the liberalization of its electricity market, as the country needs to undertake large investment to transform its electricity production, which is still heavily relying on oil shale and a single company dominating the market[xiii].

The aforementioned agreement between the Baltic countries also includes a commitment to prepare a joint and common policy regarding import of electricity from third countries in close cooperation with the European Commission and Member States concerned. This relates to the possibilities for exchange of power between Russia and the Baltic States, based on market principles.

Climate change and renewable energy

The large focus on energy and climate change in recent years has added to the prevailing issue of security of supply in the region.

In March 2007, EU leaders agreed on three key targets for 2020: improving the energy efficiency by 20 %, reducing greenhouse gases by at least 20 % and increasing the share of renewable energies in the energy consumption by 20 %. Since then the targets have been transformed into concrete policies and regulation committing the EU countries to act. Most notable is the EU emissions trading scheme and the requirements to develop national renewable energy action plans.

Final energy	Estonia	Lithuania	Latvia
2005 RE share	18%	15%	35%
2020 target	25%	23%	42%

Increase 2005-2020	7%	8%	7%

Table 2: EU renewable target for the Baltic countries

Climate Doctrine

Russian energy policies addressing climate change, renewable and energy efficiency are stipulated in the Climate Doctrine of the Russian Federation, 2009[xiv]**.** Under the Doctrine, Russia will aim to reduce the share of energy generated from natural gas to 46 % or 47 % by 2030 (from more than 50 % currently) while doubling the capacities of nuclear power plants. It will also limit the burning of gas produced from oil wells, and increase the share of electricity produced from renewable energy sources to: 1.5 % by 2010, 2.5 % by 2015 and 4.5 % by 2020.

Besides having ratified the Kyoto Protocol, the Russian Federation is part to the Copenhagen Accord and has pledged to reduce its GHG emissions by 15-25 % in 2020 compared to 1990 level on the following conditions:

- Appropriate accounting of the potential of Russia's forestry in frame of contribution in meeting the obligations of the anthropogenic emissions reduction; and
- Undertaking by all major emitters the legally binding obligations to reduce anthropogenic GHG emissions.

Future power production capacity, including nuclear

A number of new generation units are under construction and plans for even more capacity is under development, both in Russia and in the Baltic States - many of which will have significant impact on the energy systems in the surrounding countries.

The Russian energy strategy is generally based on an assumption of growth in global energy demand. Russia aims at adjusting its production to meet the future market demand, including development of new resources[xv]. Russian Prime Minister, Vladimir Putin, recently announced that if Russia was to continue exporting gas while at the same time meeting the growing domestic demand, it was necessary to turn its domestic fuel consumption to other fuel types such as coal or nuclear [xvi].

In the latest Russian energy strategy from 2010 the domestic coal consumption is therefore expected to rise from 130 million tons per year to 300 million in 2020[xvii]. The strategy foresees development of nuclear capacity in the European part of Russia, coal-fired capacity and hydro power capacity in Siberia and the Far East. If the plans are carried out, by 2020 Russia will generate 62 % of its electricity from thermal plants, 22.5 % from nuclear and 15.5 % from hydropower[xviii]. According to the International Atomic Energy Agency, two new nuclear plants have recently been connected to the grid in Russia while construction has been initiated for five additional nuclear power plants. Kalinin 3 (950 MW) was connected in 2004 and Volgodonsk 2 (950 MW) was connected in March 2010.

In Kaliningrad a draft strategy and program for the development of generation capacity in the Kaliningrad region until 2016 includes a new nuclear power plant ("Baltic Nuclear Power Plant", 2 blocks each 1.150 MW in 2016 and 2018 respectively), as well as a number of combined heat and power plants for cities in the region, which already have district heating networks. These plants should use local biofuels (peat and wood) as substitutes for coal. The program also includes plans for the development of capacity of small hydropower (17 MW) plants and wind power (from 50 to 200 MW)[xix].

On the 25th of February 2010 Prime Minister Putin signed a decree to build the Baltic Nuclear Power Plant. The decree also allocates 53 billion rubles to the construction of new nuclear power plants in Russia. The nuclear power plant in Kaliningrad is expected to become Russia's first nuclear power plant built with the participation of private and foreign capital [xx].

In *Estonia* the National Energy Sector Development Plan prepared in 2008 provides guidelines for developing the energy sector during the next 15 years. A key element in the plan is modernizing of the production of electricity from the burning of oil shale, which should be completed by 2016. Mining oil shale involves a number of environmental impacts. In 2002, about 97 % of air pollution, 86 % of total waste and 23 % of water pollution in Estonia came from the power industry, which uses oil shale as the main resource for its power production[xxi].

Estonia still intends to continue using oil shale out of energy security consideration, but the current capacity of oil shale electricity of around 2,000 MW should be minimized. Estonia's electricity production shall gradually be diversified through building new co-generation plants that are using different fuels, building of new wind power capacity, and maybe construction of a small nuclear power plant[xxii].

Wind power capacity in Estonia is currently below 150 MW, but a large number of projects are in progress, encouraged by a favourable incentive scheme for wind power plants. Approx. 200 MW of new wind power capacity is being constructed and connection points have been completed for an additional approx. 380 MW. Connection proposals have been given for an additional approx. 2,600 MW of wind power. However, it is still uncertain how big a share of this potential will be realised.

On 2nd December 2009*, Latvia* notified a project to subsidise the construction and operation of a new 400 MW power plant. In order to diversify Latvia's energy mix, the plant shall feed on either LNG regasified in Latvia or on solid fuel such as coal, lignite or peat mixed with at least 10% biomass. The aid will be granted in form of a direct grant through a competitive tender, the winner of which would be obliged to operate the plant at least 6,000 hours per year. The European Commission has authorized the aid that Latvia intends to grant for the construction and operation of the power plant.

In *Lithuania* the state-owned Lithuanian Power Plant (Lietuvos Elektrine) is building a combined cycle gas turbine power plant of 450 MW to be operational in 2012 at a cost of EUR 360 million. The European Bank for Reconstruction and Development announced in February 2010 that it would offer a EUR 71 million loan for this project[xxiii]. Upon completion in 2012, the new facility will replace two of the LPP’s outdated generation units, with a combined capacity of 300 MW.

In February 2007, the three Baltic States and Poland agreed to build a new nuclear plant at Ignalina. The Visaginas Nuclear Energy (*Visagino Atominė Elektrinė*, VAE) company was established in August 2008 for the new units. In December 2009, a call for investment in the project was announced. The investor would get a majority stake (probably 51 %) in the proposed new plant, alongside Lithuania's Visagino Anominé Elektriné, Latvia's Latvenergo, Estonia's Eesti Energia and Poland's Polska Grupa Energetyczna (PGE). Five potential partners were chosen to submit proposals in April 2010 and a shortlist of two is expected to be made by mid-2010. The strategic investor – as well as choice of technology and number of units – is expected to be finalized by the end of 2010. The first power would then be generated by 2018-2020[xxiv].

In addition to the Baltic and Russian plans for developing new nuclear power plants in the region, *Finland, Poland* and *Belarus* also plans for building new nuclear power. On the 6 May 2010 the Finnish cabinet decided to grant applications for two new nuclear power stations. Next step is for the Parliament to approve the decision. The suppliers, TVO and newcomer Fennovoima – both non-profit consortiums – believe the new reactors could become operational by 2020. In Poland, the country’s largest power group, Polska Grupa Energetyczna (PGE), has signed a cooperation agreements one possible new nuclear capacity with GE-Hitachi as well as with Electricité de France (Areva technology). The energy security strategy approved by the Polish government in January 2009 aims at one or two nuclear power plants to be built by PGE, the first by 2020.

	Short description	**Target timescale**
Electricity interconnections		
LitPolLink	400 kV, 2x500 MW	2015/2020
Estlink 2	650 MW	2014
NordBalt	HVDC 700 MW	2015
New generation capacity		
OL 3, Finland	Max 1600 MW, nuclear	2012
OL 4, Finland	1450-1650 MW, nuclear	?
Fennovoima, Finland	1500-2500 MW, nuclear	?
Visaginas, Lithuania	Max 3400 MW, nuclear	2018
Bechatow thermal plant, Poland	Max capacity 858 MW, lignite with CCS	2010
Nuclear, Poland	1-2 nuclear power plants	2020
Lithuanian Power Plant, thermal	444 MW, combined cycle, gas turbine	2012
Kurzeme, thermal power plant, Latvia	400 MW, coal and biomass	2016
Riga 2, thermal plant, Latvia	420 MW, gas	2016
Kalinigradskaya TETs-2, Kaliningrad	450 MW, gas	2010
Baltic Power plant, Kaliningrad	2*1150 MW, nuclear	2016/2018
Trade		
Electricity market	Integration of Baltic markets with Nord Pool Spot Exchange	2011

Table 3: Major new Baltic energy projects, including in Kaliningrad. Based in part on www.europeanenergyreview.eu, 19 Feb. 2010

Future interconnectors

In June 2009 the EU endorsed the Baltic Energy Market Interconnection Plan (BEMIP). The EU has also launched the EU Economic Recovery Plan which gives substantial financial support to some of the essential BEMIP infrastructure projects in the region.

The BEMIP plan aims at connecting Estonia, Latvia, and Lithuania to the EU energy networks. The purpose is to integrate the energy markets of the three Baltic countries, followed by the Baltic market merging with the Nordic energy market. The main focus in the BEMIP is the construction of the Baltic Energy Ring and the extension and improvement of the already existing grids in order to strengthen energy security in the Baltic Sea Region[xxv].

The Baltic Interconnection Plan should be seen in relation to the work by the European coordinators that were appointed on the September 2007 by the Commission to monitor and to facilitate the implementation of the most critical identified priority infrastructure projects. Mr. Adamowitsch is responsible for the project concerning "Connection to offshore wind power in

Northern Europe (North Sea – Baltic Sea)" and Prof. Mielczarski for the "Poland-Lithuania link including reinforcement of the Polish electricity network and the Poland-Germany profile".

NordBalt

Preparatory work of the NordBalt link between Sweden and Lithuania is underway. The contract with the selected manufacturers is to be completed by the end of 2010. The length of the connection to be laid is approximately 450 km, 400 km of which is across the bottom of the Baltic Sea. The interconnection is due to for commissioning at the end of 2015. The line capacity will be 700 MW, voltage – 300 kV. The preliminary cost of the power link is estimated at EUR 552 million[xxvi].

Estlink2

The Estlink 2 is expected to be finished by the end of 2013. Fingrid and Elering, who are responsible for the electricity transmission systems in Finland and Estonia, signed a preliminary agreement concerning the construction of EstLink 2 in February 2010. Estlink 2 will have a 650 MW capacity and is expected to cost approx. EUR 300 million[xxvii].

In May 2009 the EU commission launched a call for proposals for energy investments including funding for the Baltic interconnection. In the proposal Estlink 2 receive EUR 100 million[xxviii]. The interconnection between Sweden and Lithuania is to receive EUR 131 million.[xxix]

LitPol
Baltic Energy Ring

The LitPol-link is a double circuit power line with a capacity of 2 x 500 MW. The 1st line of 500 MW is expected to be ready in 2015, the 2nd in 2020. Estimated cost is EUR 237 million. When the construction of the "energy bridge" between Poland and Lithuania is completed, the energy systems of Lithuania, Latvia, Estonia, Finland, Sweden and Poland will be connected in what is referred to as the "Baltic Energy Ring".

The Baltic States have announced plans to separate their energy system from the Russian energy system and shift to parallel operation with the United Western European Energy System UCTE. Lithuania declared these objectives in its National Energy Strategy already in 2007. For the Kaliningrad region the implementation of this project, is likely to make energy supply from (or to) the mainland of Russia increasingly difficult.[xxx].

In the Kaliningrad region RAO UES anticipates two basic cross-border transmission lines to assure energy exchange of Kaliningrad region with neighbouring countries in connection with the establishment of a nuclear power plant in Kaliningrad:

1. AC transmission Kaliningrad – Lithuania (Sovetsk substation). Extension to 1500 MW – subject to agreement with Lithuania.
2. HVDC new transmission. Kaliningrad – Poland up to 1000 MW; Subject to agreement with Poland.

In addition to these RAO UES may look into a potential project of a HVDC submarine cable line (c.a. 600 MW) to Lubmin, Germany.[xxxi]

Natural Gas
Amber PolLit-link

The Baltic Energy Market Interconnection Plan also includes a gas pipeline. The Amber PolLit-link – a gas pipeline connecting Poland with Lithuania has a capacity of 3 billion m^3 per year and an estimated cost of EUR 292 million. The pipeline could be ready by 2014.

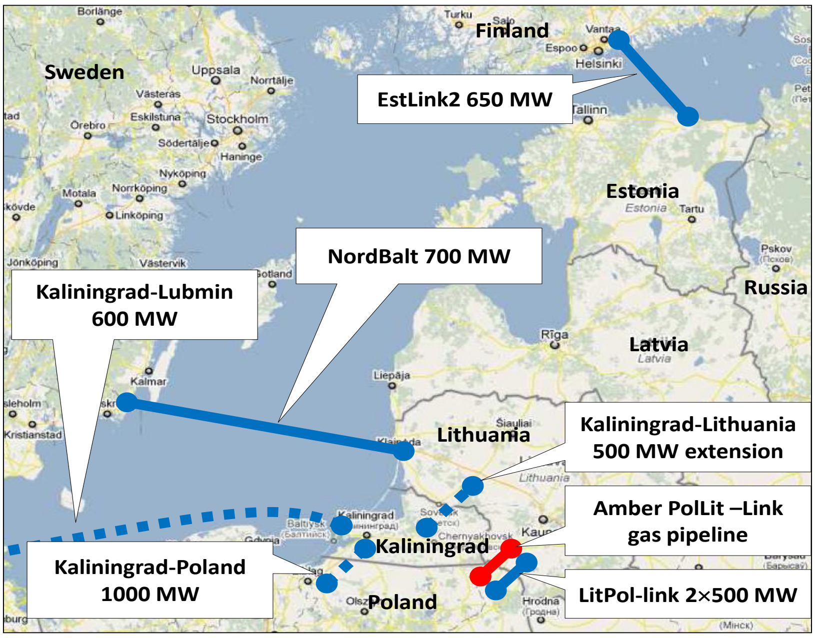


Figure 8: Future energy interconnectors in the Baltic Sea Region (own figure)

4 Theme: energy efficiency potentials and opportunities in Kaliningrad

This chapter briefly assesses the energy efficiency policies in Russia and the possible consequences for the development in the demand for electricity and district heating.

Russia

Russia currently has low energy efficiency and a huge energy saving potential. There is a general lack of modern heating systems in housing, the infrastructure and equipment in energy intensive industrial sectors are outdated, natural gas leaks from pipelines during transmission and distribution, and massive amount of fuel are wasted flaring[xxxii].

In the recent strategy the saving potential is assessed to 360-430 million toe. 20 % of the savings can be implemented at a price of 20 USD/ton standard coal. 2/3 of the savings will cost 20-50 USD and 15 % will cost more than 50 USD. 1/3 of the energy saving potential is within the fuel and energy sector, 1/3 is in other industries and the construction sector, ¼ in the public consumption sector, 6-7 % transport and 3 % in agriculture. Thus the power sector represents an area for massive energy savings at all stages, from power generation to the sale of energy to end consumers. According to ERI RAS estimates from 2000, the Russian energy saving potential may amount to 220–60 billion kWh, i.e. 23–8 % of current electricity consumption.[xxxiii]

In 2006 the Ministry of Industry and Energy, together with RAO UES, proposed a draft law “On the Use of Renewable Energy Sources in the Russian Federation.” The law contains a mechanism for governmental support of development in this sector. The Ministry of Industry and Energy, estimates that the law will increase the share of renewables in the overall energy balance to 3–5 % in 2015, and up to 10 % in 2020.

In July 2007, Russia adopted the Federal Law “On the Basis for Reforming Public Utilities,” which provides efficient mechanisms to manage public utility systems and financial support for the implementation of resource saving technologies. This financial support will benefit both regional and municipal governments.

A law “On Heat Supply” has been past establishing economic and legal incentives for technical upgrade projects[xxxiv] .

It is important to note that in the sphere of the public utilities sector, the individual Russian regions adopt their own laws. A wide range of targeted regional programs for increasing efficiency in the distribution and consumption of electricity already exist, although these projects are mainly aimed at the reconstruction of power supply and power networks, and the installation of electricity meters. Programs to increase information about how to save electricity are still sporadic and experimental and do not have a serious impact on the overall situation in the industry[xxxv].

In the gas sector, Gazprom adopted an Energy Saving Concept in 2001 for the period up to 2010, which includes measures to increase efficiency at every stage, from gas production, to transportation, storage, processing and distribution. The goal with the strategy is to compensate for the lack of new field production while making sure that enough gas will be available for domestic and international customers, to reduce operational expenses by cutting the amount of energy consumed and thereby increasing the competitiveness of Russian gas, and finally, to reduce emissions of greenhouse gases and harmful substances into the air[xxxvi].

According to the International Energy Agency, the following measures for promoting energy efficiency have been put forward in Russia:

Name	Type	Year
Climate doctrine of the Russian Federation	Policy Processes, Multi-sectoral framework policy	2009
Regional Codes for Energy Efficient Buildings	Incentives/Subsidies, Regulatory Instruments	2004
Federal Code of Practice	Regulatory instrument, Education and outreach, Targeted at buildings	2003
Thermal performance of Buildings – Federal Code Revision	Incentives/Subsidies, Regulatory instruments, Targeted at buildings	2003
Programme for Energy Efficient Economy	Policy processes, Framework policy	2001
Enterprise Housing Divestiture Project	RD & D, Education and outreach, Targeted at buildings	2000
Heat Efficiency Leveraging Program (HELP)	Policy processes, RD & D, Regulatory instrument, Targeted at buildings and industry	2000
Microclimate Parameters in Residential and Public Buildings	Regulatory instruments	2000
Model Program of Improving District Heating Efficiency	Public investment, RD & D, Voluntary agreement, Targeted at buildings	2000

Kaliningrad

The Kaliningrad region is currently working on plans for energy saving until 2020 as part of the general energy planning for the region. The concept refers to the experiences from the first program for energy efficiency in the Kaliningrad region from 2001 to 2005 as well as to the order of the President of the Russian Federation "On measures to increase energy and environmental efficiency of the Russian economy, 04.06.2008" and decree of the Government of the Russian Federation “On defining the guidelines of the state policy in increasing energy efficiency by using alternative energy sources, 08.01.2009“.

To improve the program and energy management, the Kaliningrad Regional government is taking active part in “Energy cooperation with NW Russia” program supported by the Nordic Council of Ministers’ Knowledge Building and Networking Program for NW Russia.[xxxvii]

5 An energy perspective towards 2020

In order to analyse different energy strategies for the Kaliningrad Region and the Baltic States, the investment and energy modelling tool Balmorel has been applied on the energy systems of Kaliningrad, NW Russia and the Baltic States. The model also simulates dispatch and investments in the Nordic countries, and Germany and Poland. These countries are however not in focus in this study.

The investment outlooks are explored through a Baseline Scenario and a number of alternative developments.

Four scenarios have been set up to analyse the future energy systems of region. All scenarios are for the year 2020:

1. Baseline: scenario for 2010 representing the current situation and a 2020 simulation.
2. Nuclear power scenarios: Assessing the impact of a new nuclear power plants in Kaliningrad and/or Lithuania.
3. Higher efficiency: Lower electricity demand than in the Baseline scenario.
4. RE subsidy and CO_2 quotas in Russia: Equal RE subsidy and CO_2 quota price in all simulated countries.

In all scenarios for 2020 it is assumed that the Baltic Energy Ring is established, i.e. including NordBalt (700 MW), Estlink 2 (650 MW) and Lit-Pol (1,000 MW).

The scenarios are described in the following sections. The Baseline Scenario is specified with a higher level of detail, while the other scenarios are described in relation to their differences compared to the Baseline Scenario.

5.1 Baseline scenario

The Baseline Scenario has been simulated for 2010 and 2020 representing the current and future situation in the region. The latter includes investments made by the modelling tool.

The baseline assumes that investments in new generation capacity are made on “market terms”, but including a benefit to renewable energy and a penalty on CO_2 to mirror important cross-national policy objectives in the region. These incentives are assumed to be lower in Russian than in the EU.

	RE subsidy to electricity generation	CO_2 cost
EU countries, Norway	30 EUR/MWh	25 EUR/ton
Russia	15 EUR/MWh	12.5 EUR/ton

Table 4: Incentives included in the Baseline

Based on the 2009 study a subsidy level of 30 EUR/MWh has been included for the EU countries included in the study, as an estimate of the level of support required to achieve national renewable targets set out by the EU 20-20-20 agreement. The level of support for renewable energy is therefore not necessarily consistent with existing national subsidy schemes.

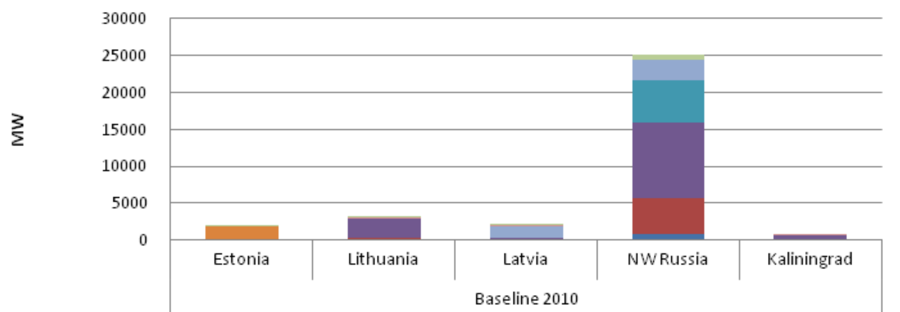
The baseline does not include new nuclear power capacity

As accounted for in the previous chapters a number of nuclear power plants are in the pipeline in the region, including in Kaliningrad, Lithuania, Finland, Poland and Belarus. Moreover, Estonia considers new nuclear power among its longer term options. The decisions on the investments in nuclear power are to some extent interdependent, because they compete for the same market and the utilisation of the same interconnectors.

For the above reasons, and because the specific investments in nuclear power plants are highly influenced by the level of political support, the perspectives of developing new nuclear power plants are explored in separate scenario variations, whereas the baseline does not contain any new nuclear power. Thus, the investment outlooks are explored through a Baseline scenario and a number of alternative developments.

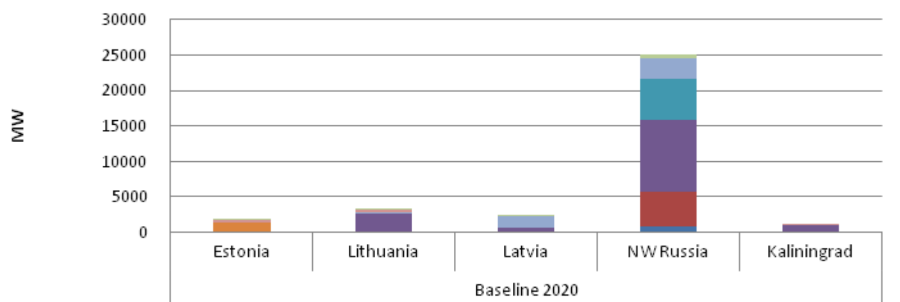
5.2 Baseline scenario results

Figure 9 and Figure 10 show the existing generation capacity in the Baseline Scenario for 2010 and 2020 in the Kaliningrad region, NW Russia and the Baltic States. This is exogenously defined in the model (i.e. assumptions, not model output). For the Baltic States there is assumed a relatively low increase in wind power. In NW Russia no scrapping is assumed for existing capacity, while is should be noticed that the TETs-2 of Kaliningrad is expanded by 450 MW to a total of 900 MW by 2020.



	Estonia	Lithuania	Latvia	NW Russia	Kaliningrad
Biomass	50	38	45	646	
Wind	150	179	28		5
Hydro		90	1560	2860	2
Shale	1698				
Nuclear				5760	
Natural gas	96	2583	357	10138	450
Municipal waste			15		
Oil		248		4917	131
Coal				825	

Figure 9: Existing generation capacity in the Baseline scenario 2010

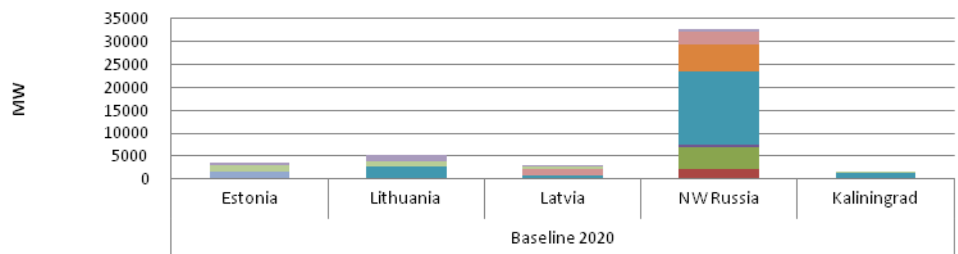


	Estonia	Lithuania	Latvia	NW Russia	Kaliningrad
Biomass	75	87	45	646	
Wind	316	500	117		5
Water		90	1560	2860	2
Shale	1300				
Nuclear				5760	
Natural gas	96	2497	667	10138	900
Municipal waste	17		15		
Oil		148		4917	131
Coal				825	

Figure 10: Existing and planned generation capacity included in the Baseline scenario 2020

New generation capacity

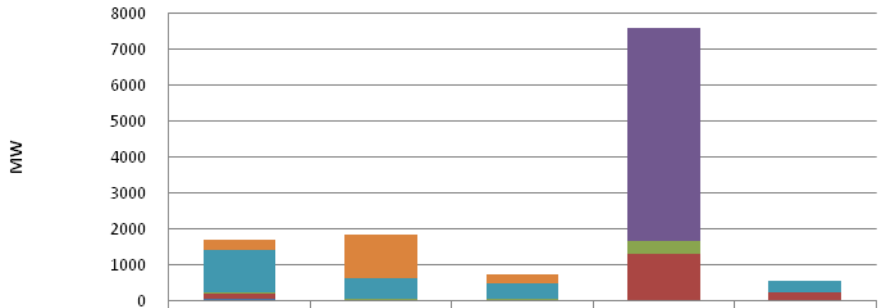
In Figure 11 the cumulated capacity for 2020 is shown. This includes both the existing and planned capacity, as seen in Figure 10, and the new capacity the model has decided to invest in.



	Estonia	Lithuania	Latvia	NW Russia	Kaliningrad
Biomass	378	1312	304	646	
Wind	1500	1050	550		328
Hydro		90	1560	2860	2
Shale	1300				
Nuclear				5760	
Natural gas	96	2497	667	16086	900
Municipal waste	40	60	60	325	
Oil		148		4917	131
Coal	129			2147	229
Biogas	68				

Figure 11: Cumulated generation capacity in the Baseline scenario in 2020

Figure 12 shows only the new generation capacity. In the Baltic States wind power and biomass generation is increased. The model invests to the maximum potential of wind power identified in these countries. In NW Russia the model chooses to invest in natural gas and coal fired capacity, while the result for Kaliningrad is increased wind power and coal power capacity. The investments in coal power in Kaliningrad take place in spite of the recent development of two large gas fired CHP plants, which are sufficient to supply the demand in Kaliningrad. However, this change is very sensitive to the assumptions about natural gas prices, (see chapter 8.1) and the results should be interpreted with caution considering the expansion with gas fired capacity, which is currently being undertaken. For Kaliningrad the coal price is approximate half the price of natural gas per GJ.



	Estonia	Lithuania	Latvia	NW Russia	Kaliningrad
Biomass	303	1225	259		
Wind	1184	550	433		323
Natural gas				5948	
Municipal waste	23	60	45	325	
Coal	129			1322	229
Biogas	68				

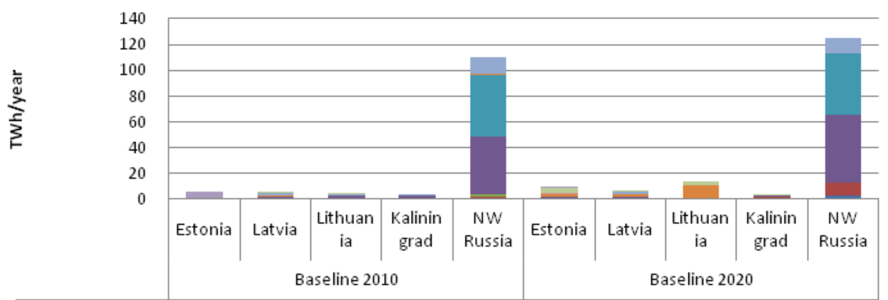
Figure 12: New generation capacity in the Baseline scenario 2020 (made by the model)

Due to the more favourable conditions for wind power in the Baltic countries (higher RE subsidy and cost of CO_2) the model invest there and not in Russia.

Electricity generation

Figure 13 compares the electricity generation mix in 2010 with 2020. The figure shows what could be expected from the results above – there is an increased wind and biomass generation in the Baltic States and coal and natural gas generation in NW Russia and Kaliningrad. There is no oil based generation in 2020.

Generation from the Estonian oil shale power plants is reduced by more than 60 % between 2010 and 2020.



	Baseline 2010 Estonia	Baseline 2010 Latvia	Baseline 2010 Lithuania	Baseline 2010 Kaliningrad	Baseline 2010 NW Russia	Baseline 2020 Estonia	Baseline 2020 Latvia	Baseline 2020 Lithuania	Baseline 2020 Kaliningrad	Baseline 2020 NW Russia
Shale	4,5					1,8				
Wind	0,4	0,1	0,4			3,8	1,2	2,6	0,7	
Biogas						0,5				
Hydro		2,1	0,2	0,0	12,3		2,1	0,2	0,0	12,3
Biomass	0,4	0,3	0,3		1,3	2,6	2,0	9,6		0,0
Nuclear					47,3					47,3
Natural gas	0,5	2,2	2,8	3,2	45,0	0,4	0,9	0,6	0,9	52,8
Oil			0,2		1,7			0,0		0,0
Coal					2,3	0,7			1,7	10,3
Municipal waste		0,1				0,3	0,5	0,5		2,7

Figure 13: Electricity generation in the Baseline scenario 2010 and 2020

CO_2 emissions

Figure 14 illustrates the CO_2 emissions in the Baseline Scenario for 2010 and 2020. In the Baltic Countries the emissions are reduced due to increasing use of biomass and wind power, while the emissions in Kaliningrad are approximately the same. Emissions from natural gas in NW Russia decrease even though gas generation increases. This is due to the investment in natural gas power plants with higher efficiencies.

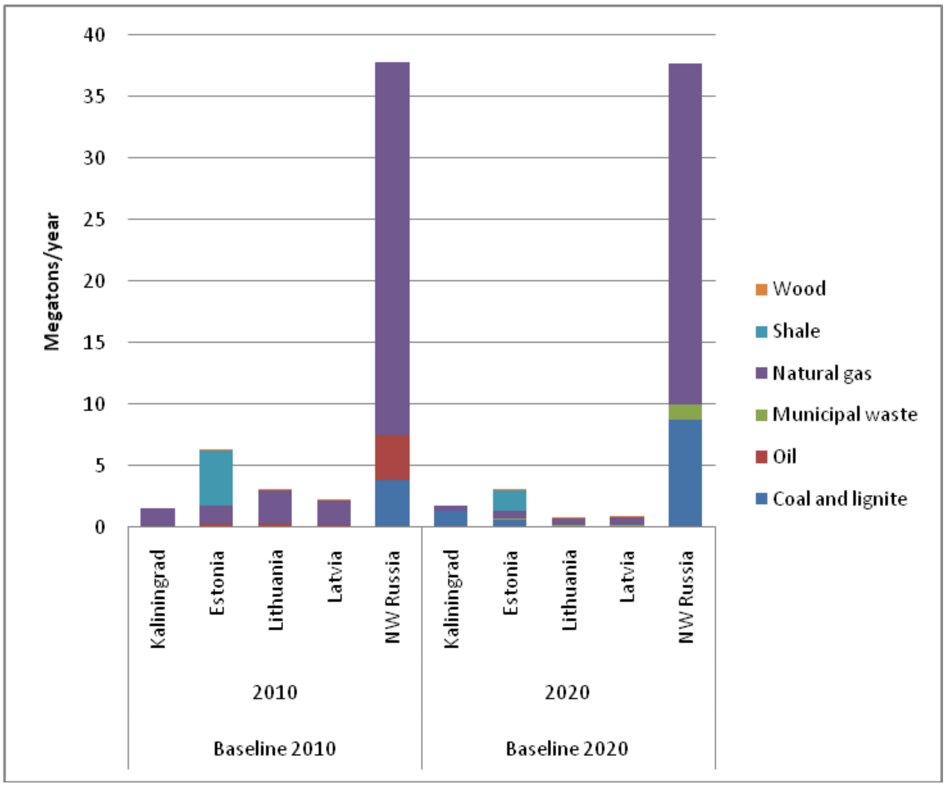


Figure 14: Total CO_2 emissions in the Baseline scenario 2010 and 2020 including electricity and district heating generation

Electricity market prices

The electricity market prices derived from the model are shown in Figure 15 as a yearly average. The prices increase between 2010 and 2020, which is due to raising CO_2 and fuel prices. The investments in new generation capacity contribute to reducing the increase in electricity market prices. Lithuania and NW Russia have relatively higher prices of electricity, which can be explained by their dependency on natural gas.

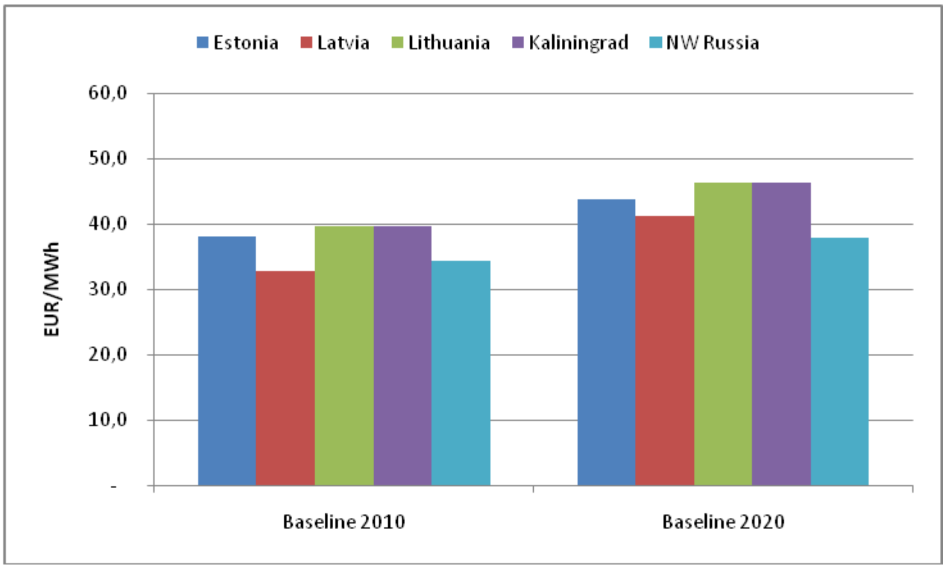


Figure 15: Electricity prices in the Baltic States, NW Russia and Kaliningrad in the Baseline scenario 2010 and 2020

Transmission on the Baltic Energy Ring

In the Baseline Scenario it is assumed that the Baltic Energy Ring is established in 2020. The flows on NordBalt in this situation are shown in Figure 16. Positive numbers represent export from Sweden to Lithuania. In most situations Sweden is exporting to Lithuania, and the connection has a relatively high usage.

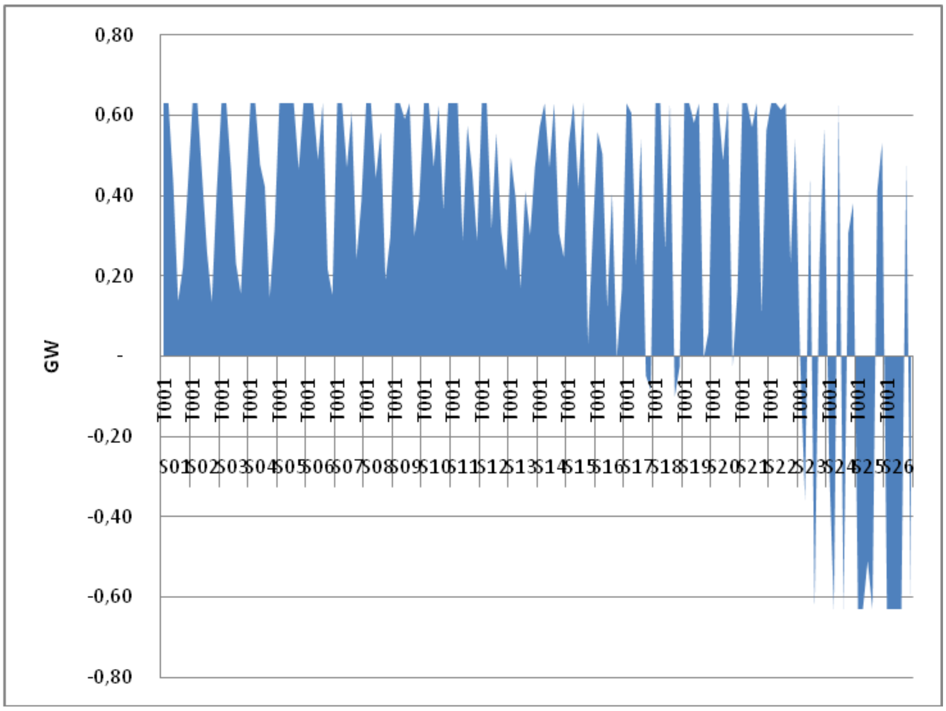


Figure 16: Transmission flow on the NordBalt interconnector between Lithuania and Sweden in 2020 (Capacity on NordBalt is 700 MW, which is derated by 10% to consider outages). Positive numbers are export from Sweden to Lithuania.

The flows on Estlink 1 and 2 are depicted in Figure 17. This transmission line has lower usage than the NordBalt interconnection, but also a higher capacity. In the figure below, positive numbers indicate export from Estonia to Finland. It appears that the connection is mainly used to transmit power from Estonia to Finland.

Lit-Pol (Figure 18) is mainly used to transmit power from Lithuania to Poland. The interconnection has a very high utilisation rate.

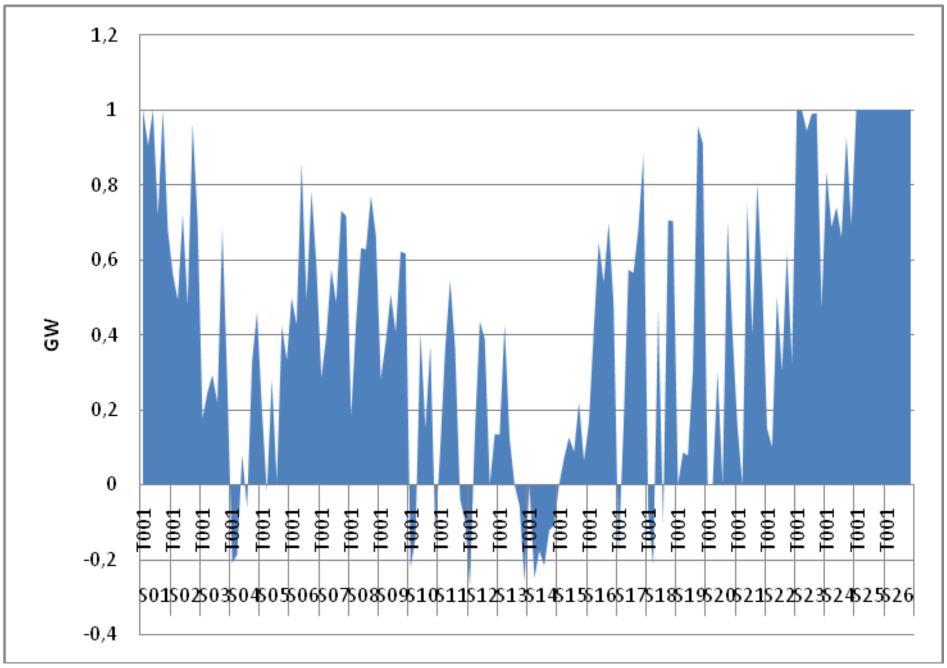


Figure 17: Transmission flow on Estlink 1 and 2 interconnector between Estonia and Finland (total capacity of 1000 MW). Positive numbers are export from Estonia to Finland.

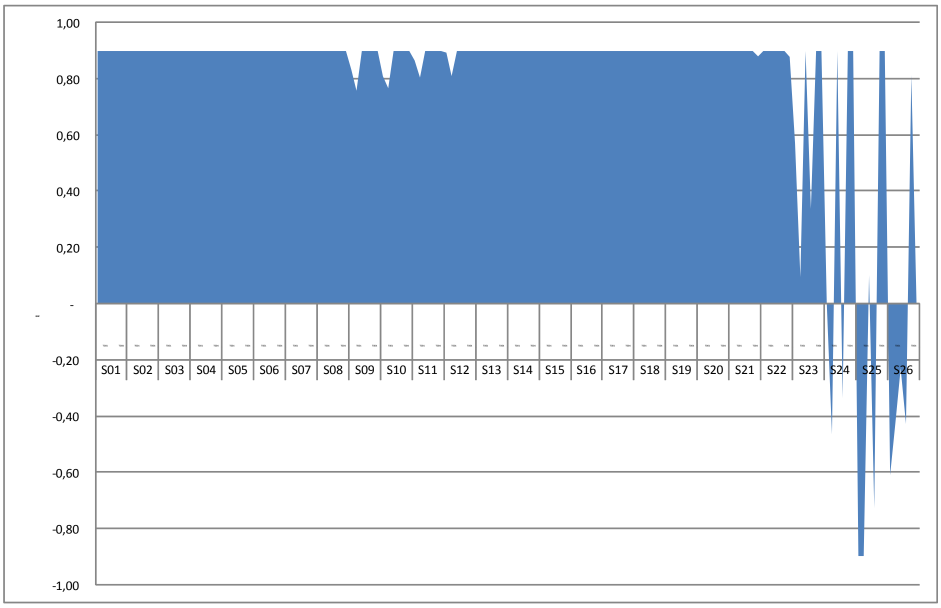


Figure 18: Transmission flow on Lit-Pol between Lithuania and Poland (total capacity of 1,000 MW, derated to 900 MW to consider outages). Positive numbers are export from Lithuania to Poland.

6 Three alternative 2020 scenarios

Three alternative 2020 scenarios have been developed focusing on nuclear power, energy efficiency and regional integration of policies.

1) Nuclear power scenarios: Assessing the impact of a new nuclear power plants in Kaliningrad and/or Lithuania.
2) Higher efficiency: Lower electricity demand than in the Baseline scenario.
3) RE subsidy and CO_2 quotas in Russia: Equal RE subsidy and CO_2 quota price in all simulated countries.

6.1 Nuclear scenarios

Three different nuclear scenarios have been setup to illustrate different future nuclear developments. These scenarios analyse the possibilities for nuclear power plants in Kaliningrad and Lithuania.

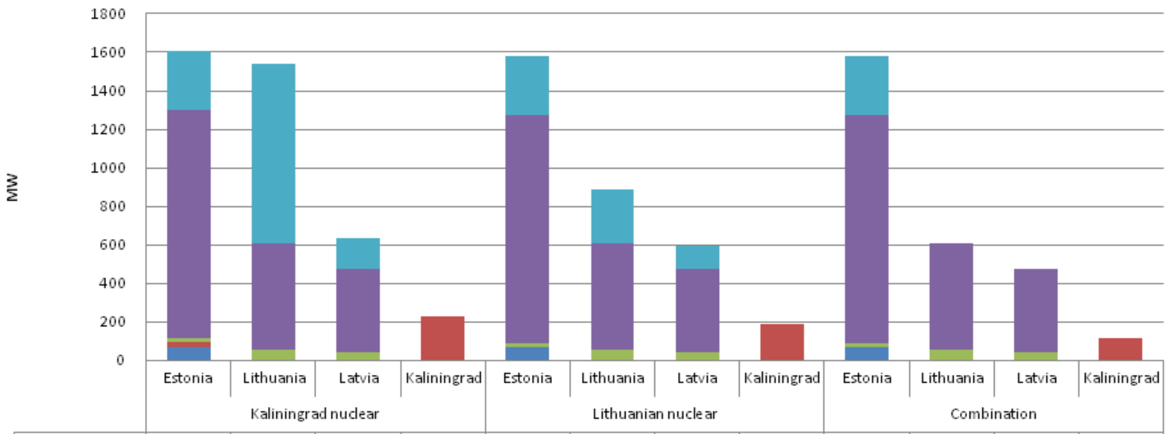
The difference between the Baseline Scenario and these variations are listed below.

1) *Kaliningrad nuclear:* A 2,300 MW nuclear power plant is put into operation in Kaliningrad in 2020. 900 MW of extra capacity on the Kaliningrad-Lithuania interconnector is added to achieve a total capacity 1,500 MW and a new 1,000 MW interconnector between Poland and Kaliningrad is assumed to be established.
2) *Lithuanian nuclear:* A 2,300 MW nuclear power plant is commissioned in Lithuania by 2020. In this scenario no extra interconnectors are put into operation.
3) *Combination:* A combination with nuclear power plants in both Lithuania and Kaliningrad. In both cases the capacity is 2,300 MW and the additional interconnectors from the above scenarios are in operation.

In the following section the above scenarios are analysed in relation to the Baseline Scenario.

New generation capacity

Figure 19 shows investments in generation capacity in the Baltic Countries and Kaliningrad in the three nuclear scenarios.



	Kaliningrad nuclear				Lithuanian nuclear				Combination			
	Estonia	Lithuania	Latvia	Kaliningrad	Estonia	Lithuania	Latvia	Kaliningrad	Estonia	Lithuania	Latvia	Kaliningrad
Biomass	302	927	159		302	276	115		302			
Wind	1184	550	433		1184	550	433		1184	550	433	
Municipal waste	23	60	45		23	60	45		23	60	45	
Coal	29			229				192				120
Biogas	68				68				68			

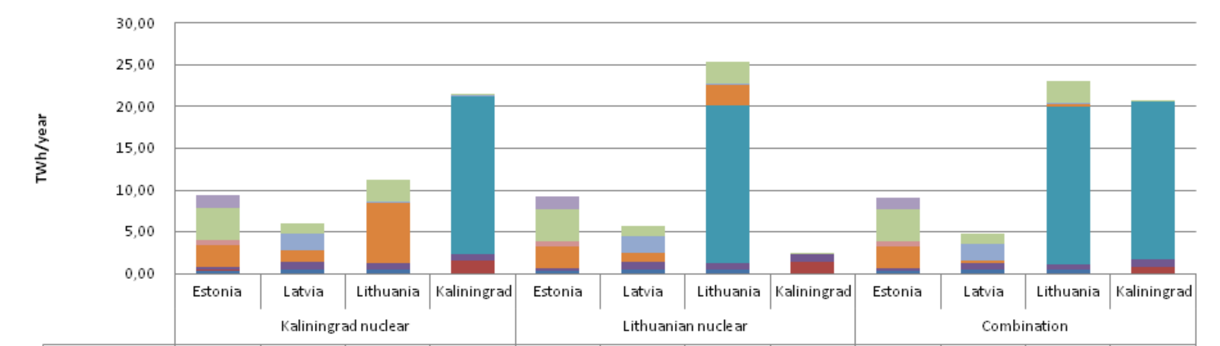
Figure 19: Investments in generation capacity in the Baltic States and Kaliningrad in the three nuclear scenarios.

Development of nuclear power in the Kaliningrad region is mainly motivated by the possibilities of export of electricity from Kaliningrad, and investment in a new nuclear power plant is therefore assumed to be supplemented by investments in a new interconnector from Kaliningrad to Poland and a reinforcement of the interconnectors to Lithuania. As a consequence, the nuclear power plant only has moderate influence on the power generation in the Baltic States.

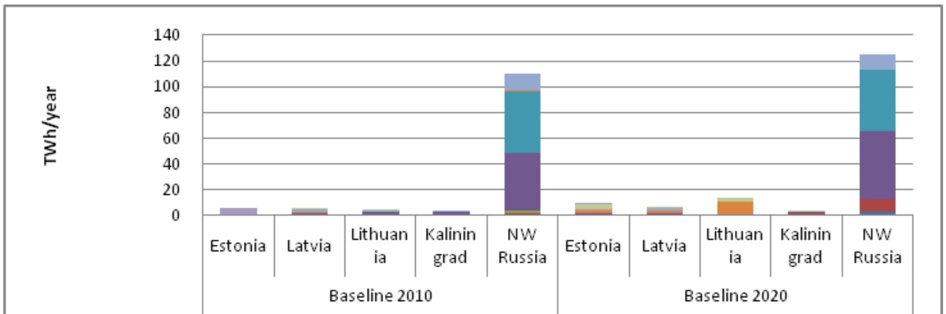
Nuclear power in Lithuania is not followed by additional investments in interconnectors to Poland (1,000 MW interconnector between Lithuania and Poland is assumed in all scenarios as part of the Baltic Energy Ring). The nuclear power plant reduces the import of electricity from Sweden through NordBalt and reduces investments in biomass fired power plants in Lithuania, Latvia and NW Russia.

Electricity generation

Figure 20 depicts the electricity generation in three nuclear scenarios. For comparison the numbers from the Baseline Scenario have also been included.



	Kaliningrad nuclear: Estonia	Kaliningrad nuclear: Latvia	Kaliningrad nuclear: Lithuania	Kaliningrad nuclear: Kaliningrad	Lithuanian nuclear: Estonia	Lithuanian nuclear: Latvia	Lithuanian nuclear: Lithuania	Lithuanian nuclear: Kaliningrad	Combination: Estonia	Combination: Latvia	Combination: Lithuania	Combination: Kaliningrad
Shale	1,60				1,52				1,35			
Wind	3,84	1,19	2,61	0,01	3,84	1,19	2,61	0,01	3,84	1,19	2,61	0,01
Biogas	0,54				0,54				0,54			
Hydro		2,12	0,17	0,01		2,12	0,17	0,01		2,12	0,17	0,01
Biomass	2,60	1,36	7,20		2,59	1,06	2,32		2,59	0,26	0,39	
Nuclear				18,93			18,93				18,93	18,93
Natural gas	0,37	0,86	0,78	0,74	0,37	0,87	0,79	0,93	0,36	0,74	0,55	0,84
Oil			0,00				0,00				0,00	
Coal	0,16			1,62				1,35				0,80
Municipal waste	0,33	0,49	0,49		0,33	0,49	0,49		0,33	0,49	0,49	



	Baseline 2010: Estonia	Baseline 2010: Latvia	Baseline 2010: Lithuania	Baseline 2010: Kaliningrad	Baseline 2010: NW Russia	Baseline 2020: Estonia	Baseline 2020: Latvia	Baseline 2020: Lithuania	Baseline 2020: Kaliningrad	Baseline 2020: NW Russia
Shale	4,5					1,8				
Wind	0,4	0,1	0,4			3,8	1,2	2,6	0,7	
Biogas						0,5				
Hydro		2,1	0,2	0,0	12,3		2,1	0,2	0,0	12,3
Biomass	0,4	0,3	0,3		1,3	2,6	2,0	9,6		0,0
Nuclear					47,3					47,3
Natural gas	0,5	2,2	2,8	3,2	45,0	0,4	0,9	0,6	0,9	52,8
Oil			0,2		1,7			0,0		0,0
Coal					2,3	0,7			1,7	10,3
Municipal waste		0,1				0,3	0,5	0,5		2,7

Figure 20: Electricity generation in the nuclear scenarios and in the Baseline Scenario

CO_2 emissions

Figure 21 shows CO_2 emission in the nuclear scenarios. The location of a new nuclear power plant in Lithuania leads to bigger CO_2 reductions in the Baltic countries and Kaliningrad, because the Kaliningrad location includes a higher level of export of power to Poland.

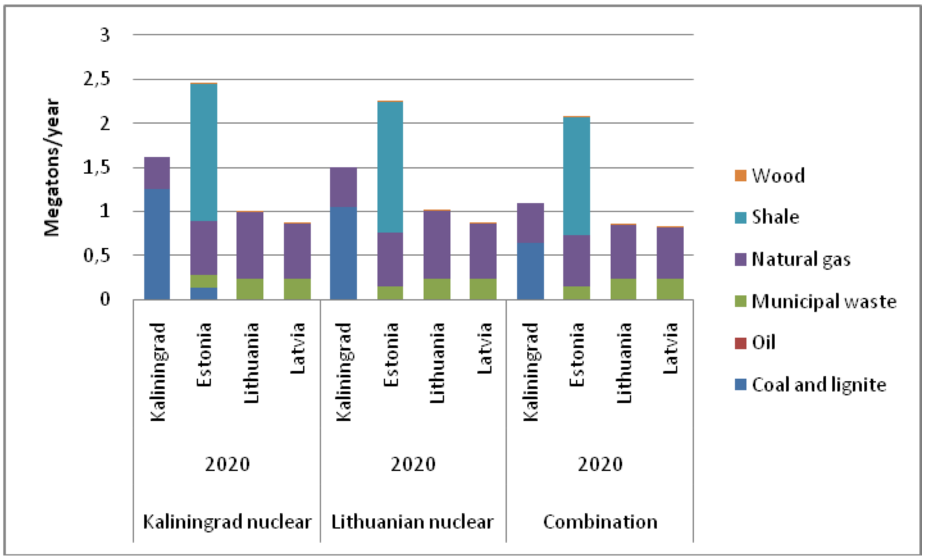


Figure 21: CO_2 emissions in the nuclear scenarios for power and district heating generation

Transmission on new interconnectors

In the Kaliningrad nuclear scenario 900 MW extra capacity is added to the interconnector to Lithuania. The transmission on this line can be seen on Figure 22 below. It is evident, that the transmission capacity is not fully utilised. On the other hand, the line between Kaliningrad and Poland is fully utilised (Figure 23) indicating that there is a greater economic benefit of exporting to Poland than to the Baltic countries.

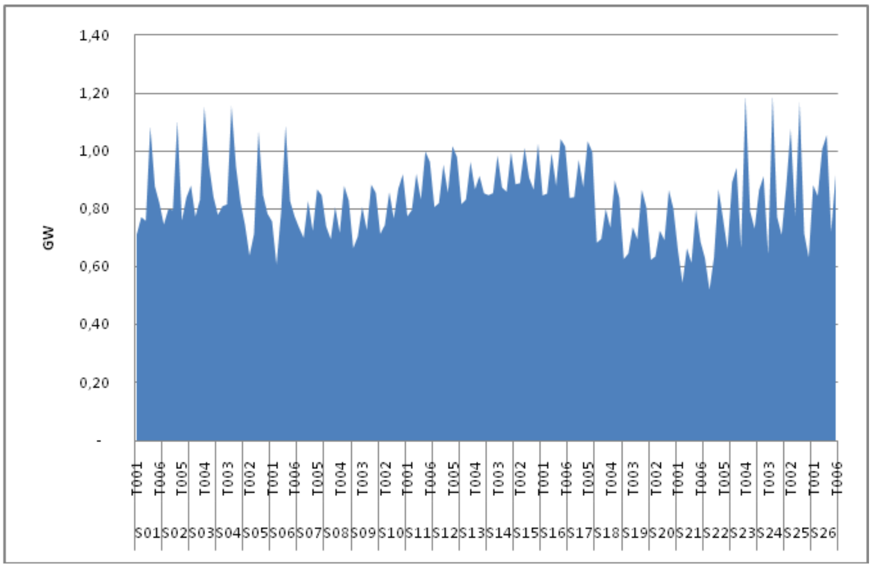


Figure 22: Transmission on the 1500 MW interconnector between Kaliningrad and Lithuania in the Kaliningrad nuclear scenario. Positive numbers are export from Kaliningrad to Lithuania.

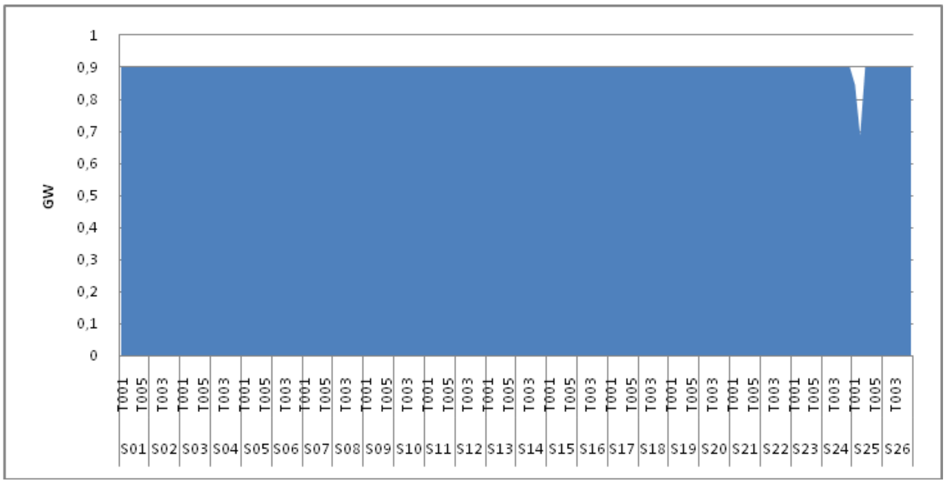


Figure 23: Transmission on 1000 MW interconnection between Kaliningrad and Poland in the Kaliningrad nuclear scenario. Note that the 1000 MW cable is derated by 10% all year to consider outages. Positive numbers are export from Kaliningrad to Poland.

The transmissions flows on the NordBalt interconnector in the Kaliningrad nuclear scenario can be seen in the figure below. Positive values are export from Lithuania to Sweden. The interconnector is used in both directions, but mainly from Lithuania to Sweden. In the Baseline the flow was mainly in the opposite direction.

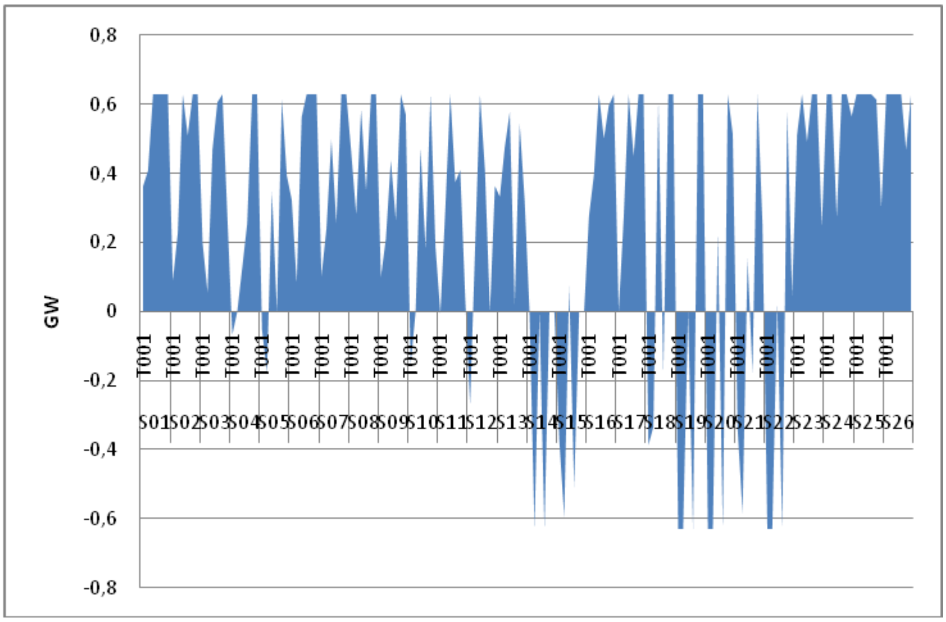


Figure 24: Transmission on the NordBalt interconnector in the Kaliningrad nuclear scenario. Positive numbers are transmission from Lithuania to Sweden

Figure 25 illustrates the transmission on BordBalt in the Lithuanian nuclear scenario. In this scenario the interconnector has a high usage compared to both the Baseline and Kaliningrad nuclear scenario. Positive values are transmission from Lithuania to Sweden. In this scenario the direction of the flow has also changed compared to the Baseline.

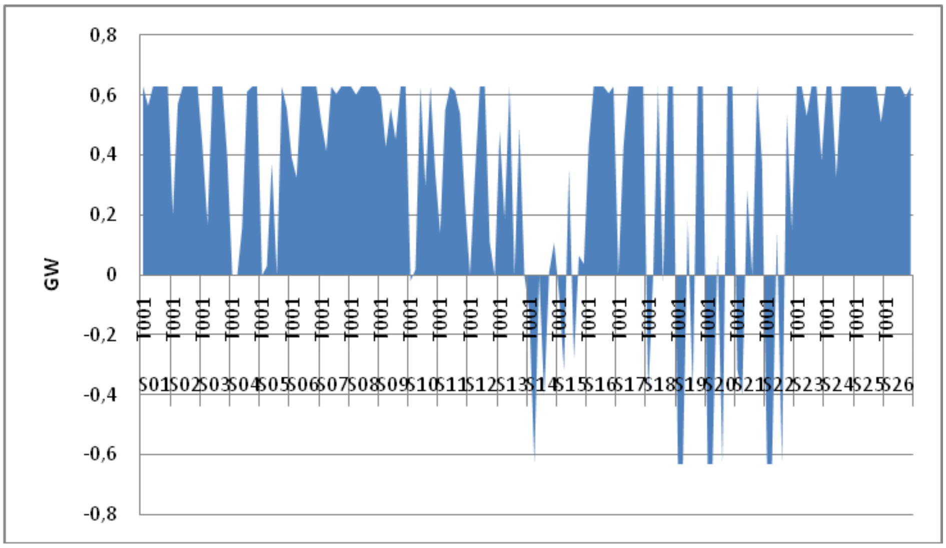


Figure 25: Transmission on the NordBalt interconnector in the Lithuanian nuclear scenario. Positive numbers are transmission from Lithuania to Sweden.

In Figure 26 the use of NordBalt in the Nuclear combination scenario is shown. Compared to the other scenarios this is the scenario with the highest transmission on NordBalt. Again positive numbers indicate flow from Lithuania to Sweden. In this case NordBalt becomes an important transmission line to export the electricity generated on the two new nuclear power plants.

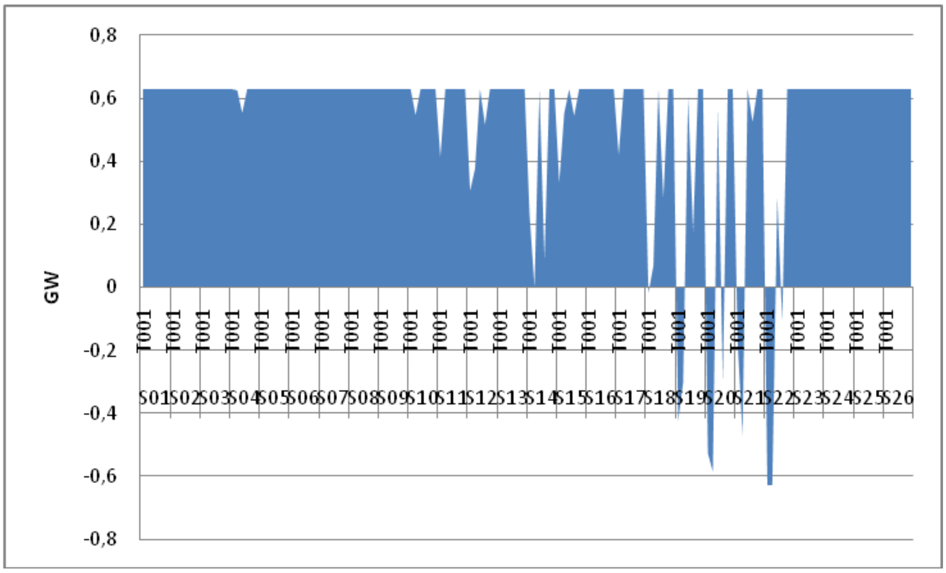


Figure 26: Transmission on the NordBalt interconnector in the Nuclear combination scenario. Positive numbers are transmission from Lithuania to Sweden.

6.2 Russian RE subsidy and energy savings scenarios

Two additional scenarios were analysed.

The scenario *RE subsidy and CO_2 quotas in Russia*, illustrating the consequences of equal RE subsidy and CO_2 quota price in all simulated countries are presented in this section. The subsidies and CO_2 cost in this scenario can be seen in the table below.

	RE subsidy to electricity generation	CO_2 cost
EU countries, Norway	30 EUR/MWh	25 EUR/ton
Russia	30 EUR/MWh	25 EUR/ton

Table 5: Incentives included in the Russian RE subsidy scenario

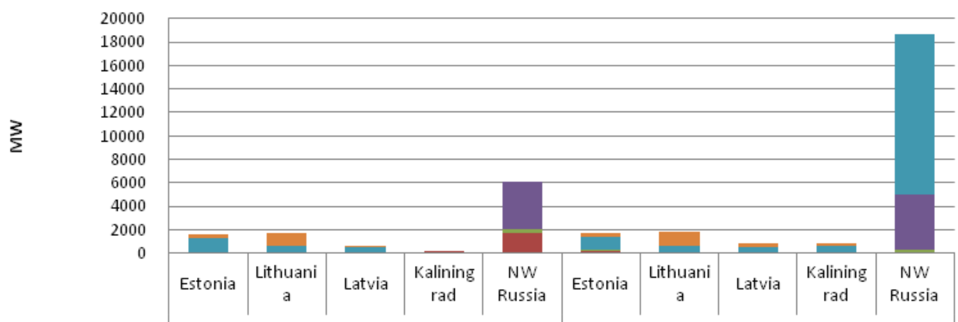
The *Higher Efficiency Scenario* shows the impacts of 10% lower electricity demand than in the Baseline scenario.

New generation capacity

New generation capacity in the Higher Efficiency and Equal subsidies and CO_2 quotas in Russia are shown in Figure 27.

In the Improved Efficiency scenario the electricity demand is 10 % lower than in the Baseline. In the Baltic Countries this results in no new investments in coal generation, as was the case in the Baseline. In Kaliningrad new coal generation also decreases. In NW Russia almost 2000 MW less gas fired capacity is needed, while coal generation becomes slightly more feasible and increases with around 400 MW.

In the Equal RE subsidy and CO_2 quotas scenario the same RE subsidy and CO_2 quota price is applied for NW Russia, Kaliningrad and the EU countries. As it can be seen from the figure below, this results in a massive investment in RE technologies in NW Russia and Kaliningrad. Investments in natural gas and coal generation decrease significantly in NW Russia and Kaliningrad in this scenario. Generation from these plants is replaced by a very significant wind development in NW Russia and Kaliningrad. In Kaliningrad, biomass also becomes attractive.

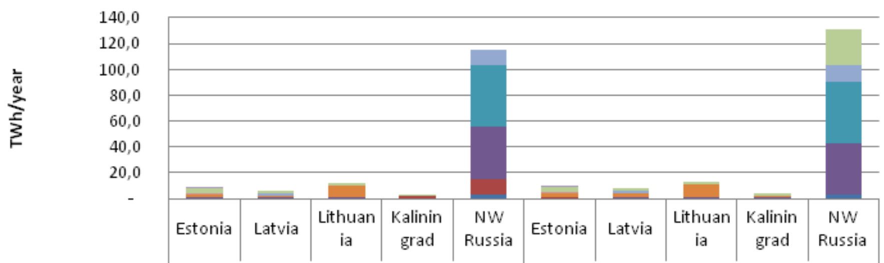


	Improved efficiency					Identical subsidies and quotas				
	Estonia	Lithuania	Latvia	Kaliningrad	NW Russia	Estonia	Lithuania	Latvia	Kaliningrad	NW Russia
Biomass	302	1062	98			303	1213	366	205	
Wind	1184	550	433			1184	550	433	620	13707
Natural gas					4093					4640
Municipal waste	23	60	45		325	23	60	45		325
Coal				219	1679	141				
Biogas	68					68				

Figure 27: New generation capacity in the Higher Efficiency and Equal subsidies and CO_2 quotas scenarios

Electricity generation

As expected, in the Higher Efficiency scenario total generation decreases compared to the Baseline. In the Equal RE subsidy and CO_2 price scenario, the new RE generation in NW Russia and Kaliningrad has a significant impact on the generation mix. Wind generation in NW Russia is close to 30 TWh in this scenario. That is more than 20 % of total generation in this region.



	Improved efficiency					Identical subsidies and quotas				
	Estonia	Latvia	Lithuania	Kaliningrad	NW Russia	Estonia	Latvia	Lithuania	Kaliningrad	NW Russia
Shale	1,2					1,9				
Wind	3,8	1,2	2,6	0,0		3,8	1,2	2,6	1,3	27,6
Biogas	0,5					0,5				
Hydro		2,1	0,2	0,0	12,3		2,1	0,2	0,0	12,3
Biomass	2,6	0,9	8,3		0,0	2,6	2,9	9,5	1,5	0,3
Nuclear					47,3					47,3
Natural gas	0,4	0,9	0,7	0,9	40,4	0,4	0,9	0,6	0,9	40,3
Oil			0,0		0,0			0,0		0,0
Coal				1,5	12,3	0,8				0,2
Municipal waste	0,3	0,5	0,5		2,7	0,3	0,5	0,5		2,7

Figure 28: Electricity generation in the Higher Efficiency and Equal subsidies and CO_2 quotas scenarios

CO_2 emissions

In the Higher Efficiency scenario CO_2 emissions are reduced compared to the Baseline. In the Equal subsidies scenario the emissions are also reduced. In NW Russia alone the emissions are reduced by 15 megatons, which is explained by the large wind development.

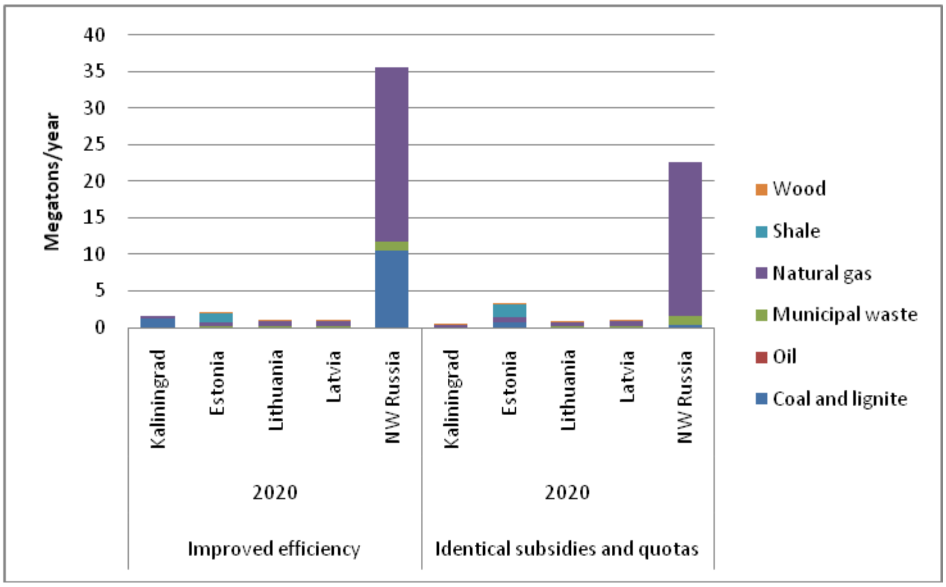


Figure 29: CO_2 emissions in the Higher Efficiency and Equal subsidies and CO_2 quotas scenarios

7 Modelling tool

The Balmorel model

The analyses are carried out by the use of the Balmorel model, which is an economic/technical partial equilibrium model that simulates the power and heat markets.

The model optimises the production at existing and planned production units (chosen by the user) and allows new investments in the scenarios, chosen by the model on a cost minimising basis.

More information about the model can be found on the model's website, www.balmorel.com.

Figure 30: Map of the transmissions grid in the Baltic Sea Region (Source: Nordel)

Geographical scope

The original version of the model contains data for the electricity and Combined Heat and Power (CHP) system in the Nordic countries (Denmark, Finland, Norway and Sweden), the Baltic countries (Estonia, Latvia and Lithuania), Poland and Germany.

The model considers the most important bottlenecks in the electricity systems. Norway consists of four electric areas with capacity constraints between them Sweden consists of three areas, Denmark two and Germany three whereas Poland, Estonia, Latvia, Lithuania and Finland consist of one area each.

Data collected for this study and used in the simulations include data from North West Russia. The following regions were included: Republic of Karelia, Kola Peninsula, Pskov Region, Kaliningrad, Arkhangelsk Region, Leningrad Region incl. St. Petersburg, Novgorod Region and Republic of Komi.[2].

[2] The main sources of information are data obtained directly from InterRAO as well as the reports "Distributed Energy Production in the North-West Region of Russia" (Efimov, A, 2007) and "Scenarios for electricity power sector development in the North-West of Russia" (Abdurafikov R., 2007).

8 Scenario assumptions

The following section describes the most important assumptions underlying the analyses, including:

- Fuel prices
- CO_2 price
- Electricity and heat demand prognoses
- Technology costs and investments
- Renewable energy potentials

8.1 Fuel prices

The development in prices of fossil fuels is based on the latest forecast from International Energy Agency's (IEA) World Energy Outlook 2009 (WEO-2009). According to this projection the real term price of crude oil will increase from an expected 80 $/bbl in 2010 to 100 $/bbl in 2030.

The prices of different types of biomass are based on information from the Danish Energy Agency. The biomass prices represent the marginal prices of biomass delivered at a large power plant. These prices are not necessarily equal to the cost of procurement, because the market price of biomass is defined in competition with other fuels. It is assumed that biomass can be bought on a market like any other fuel.

For municipal waste a negative cost (- 3 EUR per GJ) is used to represent the alternative costs of treatment.

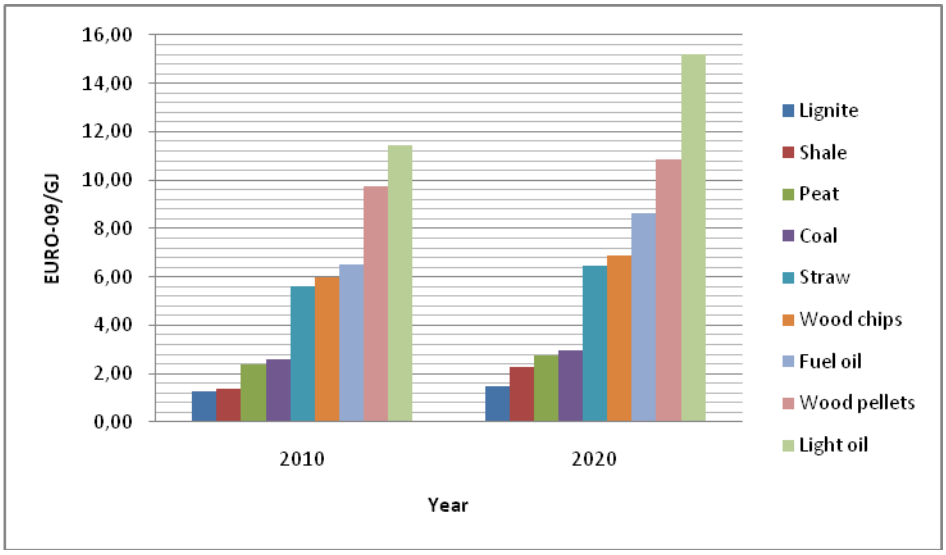


Figure 31: Fuel price assumptions used in the study (real terms) (WEO-09).

Differentiated gas prices

Regional differences are characteristic for natural gas prices. These geographical discrepancies can be a key driver for power flows and are therefore taken explicitly into account in the scenario analyses.

Russia is a key supplier of natural gas for the Baltic Countries, North and Central Europe. The monopoly supplier Gazprom has been adjusting gas prices over the past years with a target of "equal profitability" for gas sales in Russia, exports to FSU countries and Western Europe. From 2007 Russian Federal Tariff Service has been publishing indicative gas prices according to their formula for achieving equal profitability from gas sales in the external and domestic market.

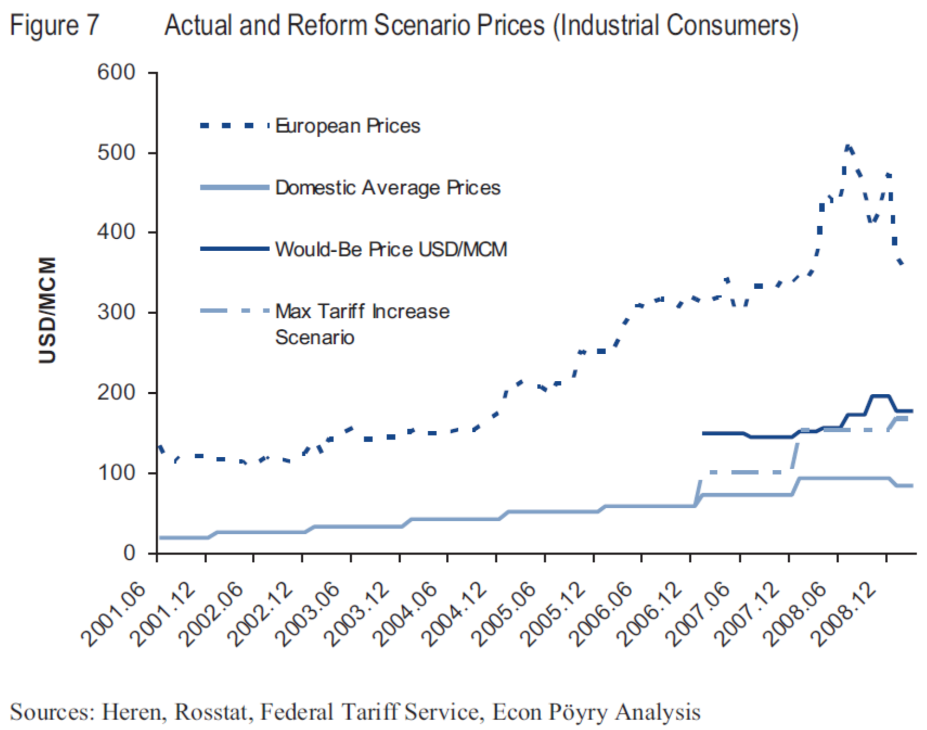


Figure 32: Convergence towards the FTS's "Would-Be-Price" has been slower than the maximum allowed increase by the regulation.

In reality Russia's regulated prices have converged at a pace which indicates that it is unlikely that internal gas prices will reach the would-be price levels published by the FTS by the target year 2011. However, for the purposes of this analysis, this convergence is assumed to have been fully completed by 2020, which is the year in focus.

Based on the FTS price publications, the Russian prices level have been determined in relation to gas prices from World Energy Outlook 2009.

	2010	2020
Karelia	2,93	4,93
Komi	2,54	4,28
Arkhangelsk	2,69	4,53
Kaliningrad	3,54	5,97
Leningrad	2,93	4,93
Novgorod	2,93	4,93
Pskov	3,02	5,09
St. Petersburg	2,93	4,93
Estonia	3,54	5,97
Latvia	3,54	5,97
Lithuania	3,54	5,97
Norway	5,74	6,59
Finland	3,54	5,97
Sweden	7,01	8,05
Denmark	6,37	7,32
Germany	6,37	7,32

Table 6: Price of natural gas used in the scenarios (EUR/GJ)

CO_2 price

A CO_2 price is applied in the calculations. The international price of trading CO_2 emission permits is difficult to predict, but it is expected that the future level will be higher than the level of today. A future level of 25 EUR/ton is considered a realistic level in 2020 while 14 EUR/ton is applied for 2010. In Russia a CO_2 price of 12.5 EUR/ton is implemented in the Baseline Scenario for 2020.

RE subsidies

In the 2020 simulations a subsidy to renewable electricity generation is in force. This subsidy is 30 EUR/MWh for all EU countries in the Baltic Sea Region and 15 EUR/MWh for Russia.

8.2 Transmission capacity

The starting point of the analyses is the existing interconnectors in the region.

In addition, it is assumed that the "Baltic Ring" is established by 2020, including:

Sweden-Lithuania and Estonia-Finland

Sweden and Lithuania are connected by the 700 MW NordBalt connection.

The Estlink 2 connection between Estonia and Finland at 650 MW will be implemented by 2016 increasing the capacity between Finland and Estonia to 1,000 MW.

The PolLit line with 1,000 MW capacity.

Moreover a number of assumptions are made about new interconnectors and reinforcements of the grid in the periphery model area:

Five prioritized Nordic cross sections

1. The five prioritized Nordic cross sections have all been established by 2015. The five prioritized Nordic cross sections are:

   - Fenno - Skan II linking Finland and Sweden (800 MW)
   - Great Belt in Denmark (600 MW)
   - Nea - Järpströmmen between Sweden and Norway (750 MW)
   - South Link in Sweden (600 MW)
   - Skagerrak IV between Denmark and Norway (600 MW)

Reinforcement of German grid

2. Significant reinforcement of the internal grid between the North West and Central parts of Germany will take place (7,000 MW) to accommodate for the planned expansion of wind power in the northern parts of Germany particularly off-shore.

Norway-Norway Norway-Sweden

3. Connections between the central part of Norway and neighbouring areas in South and North Norway and North Sweden are upgraded by 1,200 MW.

No further interconnectors are assumed to be established in the Baseline scenario.

A detailed overview of transmission capacity can be found in Appendix 1.

8.3 Electricity demand

In all scenarios except the scenario called "improved efficiency" the demand for electricity in the EU countries and Norway develops as anticipated in the 2008 projection from the European Commission[3]. For Russia a projection obtained from InterRAO is used while the projection for Kaliningrad is made by the Ministry of Infrastructure Development, Government of the Kaliningrad Region. Table 7 shows the development in electricity demand in the Baseline Scenario.
It should be noted that the electricity demand prognoses contains some uncertainty. For Kaliningrad a moderate projection is used, which has the

[3] EUROPEAN ENERGY AND TRANSPORT
TRENDS TO 2030 — UPDATE 2007, European Commission 2008.

lowest increase among three different projections made by the Ministry of Infrastructure Development.

TWh	Kaliningrad	Lithuania	Estonia	Latvia	NW Russia
2010	3.9	9.1	7.6	6.9	78.1
2020	6.2	11.0	8.3	7.9	82.9

Table 7: The electricity demand in the Baseline Scenario, 2010 and 2020, including grid losses. For the Baltic States no grid losses are included above (net-consumption). In Russia demand is represented in gross consumption.The prognoses for Kaliningrad is based on a moderate projection[4]

According to the EU Baseline projection, the short-term electricity consumption is projected to increase at a rate similar to that observed in the recent past. In the longer term the Baseline scenario “takes the view that energy efficiency improvements in appliance design and the housing stock are exerting a downward pressure on demand which is moderating the growth of electricity consumption in all sectors” (EU Commission, 2008, p. 58).

8.4 Existing generation capacity

The Balmorel model holds an inventory of the existing power plants in the Nordic countries, Baltic States, Germany, Poland and NW Russia (inc. Kaliningrad). In some countries like the Baltic Countries and Denmark all large power plants are modelled individually, whereas a more aggregated representation is used for others, e.g. Germany and Poland.

This inventory forms the starting point for the analyses. However, as time moves forward existing plants are commissioned and new sources of generation will have to be brought online.

A number of assumptions on the rate of decommissioning of existing plants are assumed for the individual countries. These assumptions are based on, among other things, the expected technical life time of power plants, and in certain cases information about the conditions of specific power plants.

8.5 New generation capacity

Apart from investments in new nuclear and hydro power, and a minimum level of investments in wind power and some thermal power plants (power plants that will be commissioned with a very high level of certainty within the

[4] The projection is made by the Ministry of Infrastructure Development,Government of the Kaliningrad Region presented June 2010.

coming years), investments in new generation capacity are decided upon by the model's investment module.

Investment approach

The Balmorel model is myopic in its investment approach, and thereby does not explicitly consider revenues beyond the year of installation. This means that investments are undertaken in a given year if the annual revenue requirement (ARR) in that year is satisfied by the market. A balanced risk and reward characteristic of the market is assumed, which means that the same ARR is applied to all technologies, specifically 11.75%, which is equivalent to 10% internal rate for 20 years. In practice, this rate is contingent on the risks and rewards of the market, which may be different from one technology to the other. For instance, unless there is a possibility to hedge the risk without too high risk premium, capital intensive investments such as wind or nuclear power may be more risk prone. This hedging could be achieved via feed-in tariffs, power purchase agreements or a competitive market for forwards/futures on electricity, etc.

Technology data catalogue

The model has a data catalogue with a set of new power station technologies that it can invest in according to the input data. The investment module allows the model to invest in a range of different technologies including (among others) coal power, gas power (combined cycle plants and gas engines), straw and wood based power plants, power plants with CCS and wind power (on and off-shore). Thermal power plants can be condensing units – producing only electricity or combined and power plants. The model may also invest in heat generation capacity such as coal, biomass and gas boilers, as well as large-scale electric heat pumps and electric boilers.

Wave power and solar power technologies are not considered in the analysis, because – without special subsidies – they are not expected to be competitive with wind power and biomass technologies within the time-frame of the study. However, the technological development may evolve differently than assumed here.

Nuclear power

As opposed to letting the model make "optimal" investments in nuclear power, it has been chosen to describe a fixed development in the baseline complemented by a number of alternative developments.

The reason for this approach is twofold: first of all the direct costs of new nuclear power plants are associated with a high degree of uncertainty. For example, the 5th Finish nuclear reactor of 1600 MW, which is currently under construction, was projected to cost EUR 3.2 billion, but a EUR 2.3 billion cost overrun is reported[5]. Secondly, a number of environmental externalities are related to nuclear power including the risk of nuclear accidents, radio-active emissions from mine-tailings, long-term storage of radioactive waste and the decommissioning of the power plants. These externalities are extremely difficult to monetize and therefore, in reality, decisions on nuclear power are based as much on political assessments and risk assessments as on financial calculations.

The table below shows development of nuclear power in the individual countries in the region in the Baseline Scenario.

Nuclear in the Baseline Scenario

MW	2010	2020
Denmark	-	-
Sweden	9,372	9,782
Finland	2,656	4,256
Norway	-	-
Germany	20,264	20,264
Poland	-	-
Lithuania	-	-
Estonia	-	-
Latvia	-	-
NW Russia	5,760	5,760
Total	**38,052**	**40,062**

Table 8: Nuclear power capacity in the simulated countries. This development is applied in all scenarios except the variations with nuclear power in Kaliningrad and Lithuania.

Hydro power

A number of countries hold a significant potential to increase the generation of electricity from hydro power. To a higher degree than many other sources of electricity generation, the costs of and possible barriers to hydro power projects are site specific. Hence, investments in new hydro power capacity are not decided by the model's investment module.

In the analyses it is assumed that the generation from hydro power is increased somewhat beyond today's production. However, the full technical and economical potential, as identified in various studies, is not utilised.
The table below shows the assumed development in annual generation from hydro power, country by country in 2010 and 2020.

[5] Danish Newspaper "Information" 09 09 05.

TWh	2010	2020
Denmark	0.0	0.0
Sweden	73.0	75.0
Finland	13.8	14.0
Norway	126.8	136.8
Germany	26.9	28.5
Poland	2.1	3.0
Lithuania	0.8	0.8
Estonia	0.0	0.0
Latvia	3.3	3.3
Russia	12.0	12.0

Table 9: Assumed development in annual generation from hydro power, country by country, 2010 and 2020. Note that no division is made between small and large-scale hydro power.

Wind power

A minimum development in investments in wind power is assumed in all scenarios. This mainly reflects wind power plants that are already under construction, and projects where firm decisions have been made.

The model's investment module can choose to invest in additional wind power capacity based on the technical/economical potentials in each country. These are not the theoretical potentials for wind, but an estimate of a possible potential, taking into consideration constraints related to access to sites, the economics of developing different sites and the available wind resources.

These potentials have mainly been deduced from the EU financed project TradeWind, "Wind Power Scenarios"[6]. In some cases however, the data has been supplemented by other sources of information. The values for 2030 are a best estimate of a long-term technical/economical potential. The model is not allowed to invest beyond the long-term potential.

In the Baltic States the long-term potential for wind power has been estimated at 1500 MW for Estonia, 550 MW for Latvia and 1,050 MW for Lithuania.

With respect to Russia and Kaliningrad a crude estimate has been made that the total long-term potential for on-shore wind power in the North West region is 14,500 MW (including 3,000 MW in reach of the areas Karelia, Komi

[6] http://www.trade-wind.eu/fileadmin/documents/publications/D2.1_Scenarios_of_installed_wind_capacity__WITH_ANNEXES.pdf, (2009-02-04)

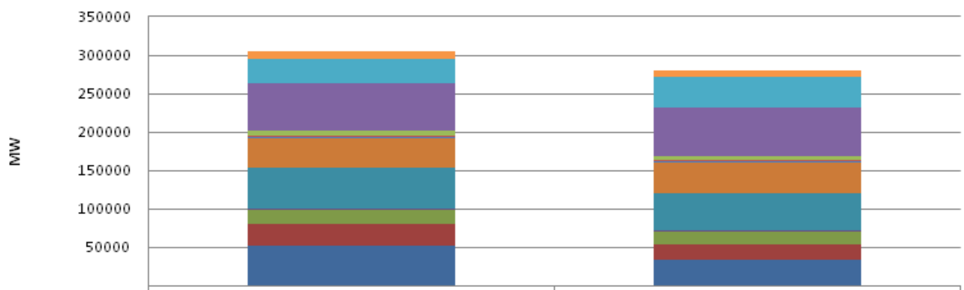
Peninsula, Arkhangelsk and Komi and 625 MW each in Pskov, Kaliningrad, Leningrad Region and Novgorod).

The number of full-load hours for wind turbines are site specific. For the Baltic Countries and Russia it is assumed that onshore turbines will have between 2,000 and 2,200 full-load hours annually corresponding to a capacity factor of approx. 24 %.

Existing and planned capacity by fuel

Figure 33 summarises the so-called exogenously specified power generation capacity for all countries in the years 2010 and 2020, i.e. the existing power plants – which are gradually phased out – as well as planned investments in new nuclear power, wind power and hydro power as described above.

The total existing and planned capacity decreases from approx. 300,000 MW in 2010 to 250,000 MW in 2030. The capacity of the thermal power plants fired with coal, oil, natural gas or biomass is reduced from approx. 150,000 MW in 2010 to 90,000 MW in 2030.



	2010	2020
Biomass	9279	8687
Wind	32977	39184
Hydro	61437	63834
Solar	5310	4355
Shale	1698	1300
Peat	1832	1502
Nuclear	38052	40062
Natural gas	52823	48453
Municipal waste	1872	1687
Oil	18618	16014
Lignite	27628	19973
Coal	53706	35120

Figure 33: Existing and planned capacity by fuel for all countries in 2010 and 2020 [MW]

Biomass resources

Expansion with biomass fired power plants and boilers may to some extent be limited by the availability of resources locally. It is a key assumption that biomass can be bought on a market.

The table below provides an overview of possible biomass resources in 2030 in each of the countries in the region divided into five general categories:

- Energy crops and grass cuttings
- Forestry residues from felling and complementary felling
- Biogas from manure
- Biowaste (mainly agricultural residues)
- Municipal waste

The municipal waste resource also includes the non-renewable energy fraction of the waste.

PJ	Energy crops and grass cuttings	Forestry residues	Biogas from manure	Biowaste (mainly agricultural residues)	Municipal waste	Total
Germany	980	201	190	223	657	2250
Denmark	4	40	39	40	50	173
Finland	54	75	15	234	32	411
Sweden	59	100	22	364	62	607
Estonia	54	8	5	34	9	111
Lithuania	331	17	9	54	11	422
Latvia	63	25	6	2	15	111
Poland	1273	50	93	150	254	1820
Norway	0	160	0	17	40	217
BALTIC SEA	2818	677	379	1117	1130	6121

Table 10: Available bioenergy resources in the Baltic Sea Region. The figures are derived from the report "How much bioenergy can Europe produce without harming the environment?" (EEA 2008), the Green-X database on dynamic cost-resource curves and a projection of the municipal waste resource from RISØ DTU[7]. Data for Russia is lacking. For the purpose of modelling no limitation has been implemented on the access to biomass resources in Russia.

The total identified bioenergy potential will not be at the disposal of the electricity and district heating sector as the bioenergy will also be used in industry, households and the transport sector. Previous long-term scenario studies for the EU suggest that it is reasonable to assume that roughly 60 % of

[7] Norwegian data is based on the following source,
http://www.fornybar.no/imagecache/43.OriginalImageData.20070320085549.jpg
http://www.fornybar.no/sitepageview.aspx?articleID=37
http://www.avfallnorge.no/fagomraader/energiutnyttelse/nyheter/energiutnyttelse_2008 , 22.05.2009

the total bioenergy resource will be available for the power and district heating sectors. This assumes that the share of bioenergy used for transportation is rather low (approx. 5 %).

The table below gives an estimate of the bioenergy resource available for the power and district heating sectors. It is assumed, that 90 % of municipal waste, manure and biowaste is used here – since these fuels are the most difficult to handle and incinerate - whereas only 40 % of energy crops and forestry residues will be used for power and district heating generation. In total, for the Baltic Sea Region, this means that 61 % of the total bioenergy resource is available for the power and district heating sectors.

PJ	Energy crops and grass cuttings	Forestry residues	Biogas from manure	Biowaste (mainly agricultural residues)	Municipal waste	Total
Germany	392	80	171	200	591	1435
Denmark	2	16	35	36	45	133
Finland	22	30	14	211	29	305
Sweden	23	40	20	327	56	467
Estonia	22	3	5	31	8	68
Lithuania	132	7	8	49	10	206
Latvia	25	10	5	1	14	56
Poland	509	20	84	135	229	977
Norway	0	64	0	15	36	115
BALTIC SEA	1127	271	341	1005	1017	3762

Table 11: Available bioenergy resources in the Baltic Sea Region for the electricity sector and for district heating. Data for Russia is lacking. For the purpose of modelling no limitation has been implemented on the access to biomass resources in Russia.

Interpretation of the biomass categories to the model

For the purpose of modelling, the two biomass categories “Energy crops and grass cuttings” and “Forestry residues” are merged into one fuel category termed “Wood”.

The domestic wood resource is limited according to the available resources, whereas there is not assumed any limit on the possibilities for using imported biomass. For domestic wood a price of wood chips is used. For imported biomass a higher price is applied due to higher transportation and handling costs (see previous section). Wood pellets are more expensive than wood chips, but easier to transport and handle.

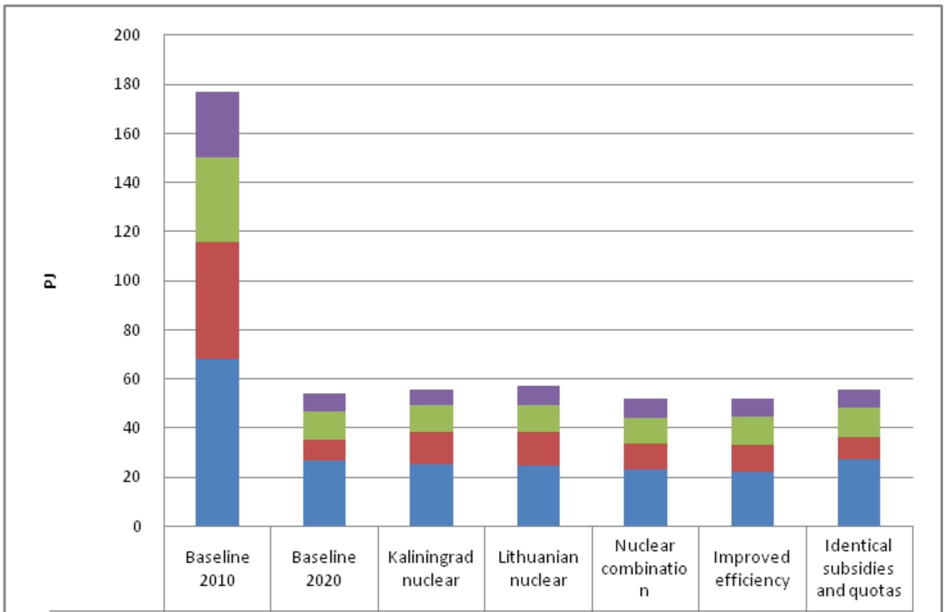
For all other types of biomass only the domestic resources can be used.
The biowaste resource is generally termed “Straw” in the model. It is recognized that part of this resource is cheaper “wood waste” used at existing

power plants in Sweden and Finland. For this fraction a price close to zero is used.

For the purpose of modelling it is assumed that biogas may be used in connection with all local district heating schemes. This is a simplification of the actual possibilities for utilization of biogas. A negative CO_2 factor (-43 kg/GJ) is used for biogas in order to represent the abated fugitive emissions (methane and nitrous-oxide) related to the alternative use of the manure in the agricultural sector.

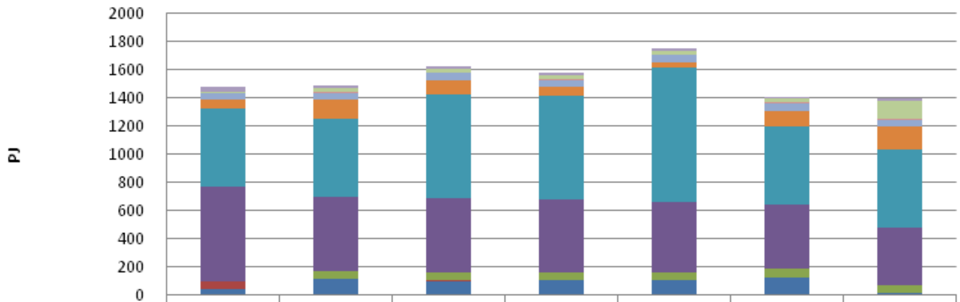
Appendix: Comparison of scenarios

In this appendix, aggregated results for all scenarios are shown for Kaliningrad, NW Russia and the Baltic States, summarising the development in fuel consumption for electricity and CHP production, total generation capacity, total generation, CO_2 emissions, average electricity market prices and exchange of electricity.



	Baseline 2010	Baseline 2020	Kaliningrad nuclear	Lithuanian nuclear	Nuclear combination	Improved efficiency	Identical subsidies and quotas
Kaliningrad	27	7	6	8	8	7	7
Latvia	34	11	11	11	10	12	12
Lithuania	48	8	13	14	11	11	9
Estonia	68	27	25	25	23	22	28

Figure 34: Consumption of natural gas for electricity generation and district heating production in Kaliningrad and the Baltic countries



	Baseline 2010	Baseline 2020	Kaliningrad nuclear	Lithuanian nuclear	Nuclear combinatio n	Improved efficiency	Identical subsidies and quotas
Shale	43	16	15	14	13	12	17
Wind	3	30	28	28	28	28	131
Biogas		5	5	5	5	5	5
Hydro	53	53	53	53	53	53	53
Biomass	62	132	106	60	35	111	157
Nuclear	558	558	735	735	962	558	558
Natural gas	667	524	528	522	496	457	408
Municipal waste	1	59	59	59	59	59	59
Oil	56	0	0	0	0	0	0
Coal	40	111	98	100	101	123	11

Figure 35: Fuel consumption for electricity generation and district heating production in the Baltic countries

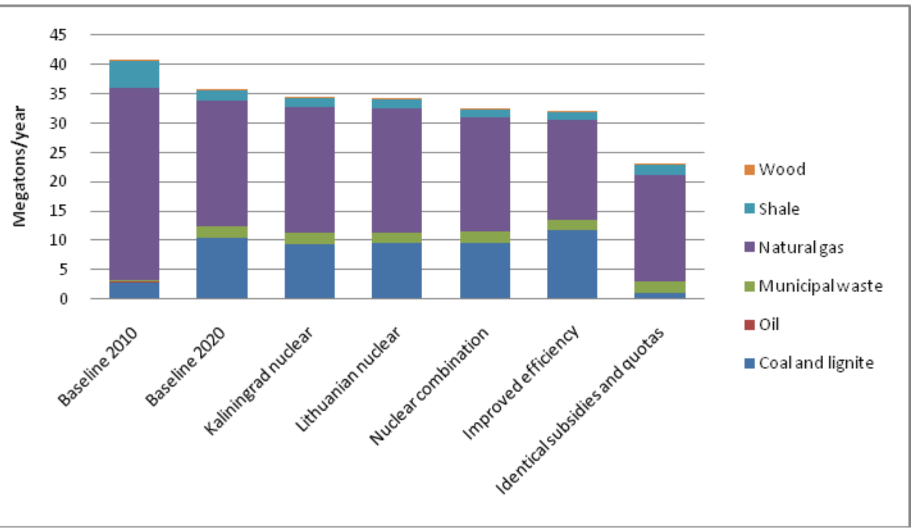
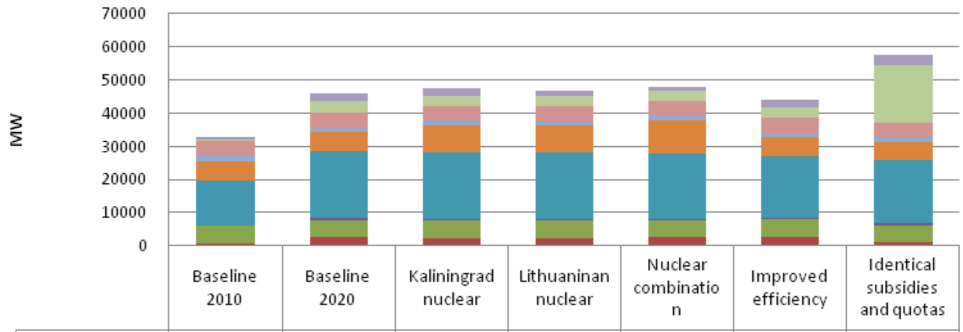


Figure 36: CO_2 emissions from electricity generation and CHP production in North West Russia, including Kaliningrad, and the Baltic countries



	Baseline 2010	Baseline 2020	Kaliningrad nuclear	Lithuaninan nuclear	Nuclear combinatio n	Improved efficiency	Identical subsidies and quotas
Biomass	779	2639	2242	1546	1156	2315	2940
Wind	362	3428	3105	3105	3105	3105	17432
Hydro	4512	4512	4512	4512	4512	4512	4512
Shale	1698	1300	1300	1300	1300	1300	1300
Nuclear	5760	5760	8060	8060	10360	5760	5760
Natural gas	13624	20246	20296	20169	19541	18391	18938
Municipal waste	15	485	485	485	485	485	485
Oil	5296	5196	5196	5196	5196	5196	5196
Coal	825	2505	2296	2332	2352	2724	966
Biogas		68	68	68	68	68	68

Figure 37: Cumulated capacity in Kaliningrad, NW Russia and the Baltic States in all scenarios

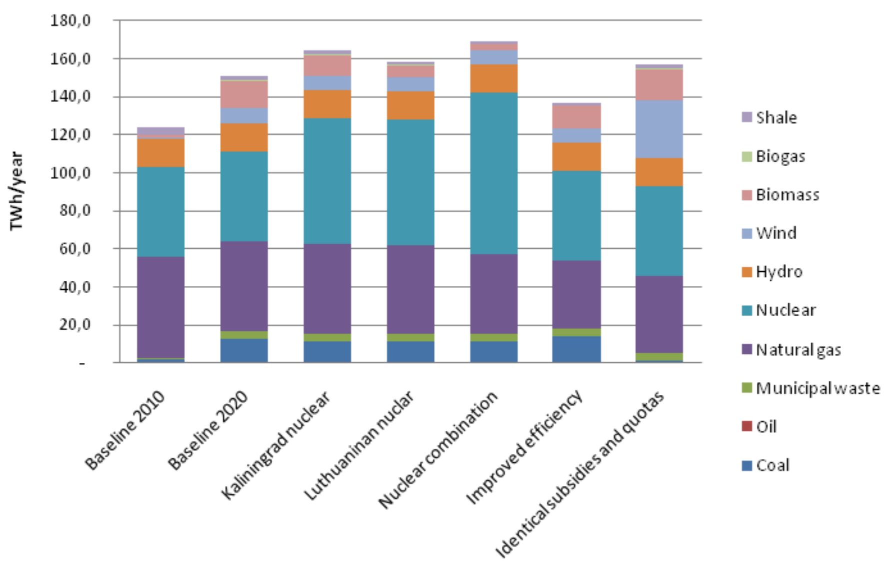


Figure 38: Total electricity generation in Kaliningrad, NW Russia and the Baltic States in all scenarios

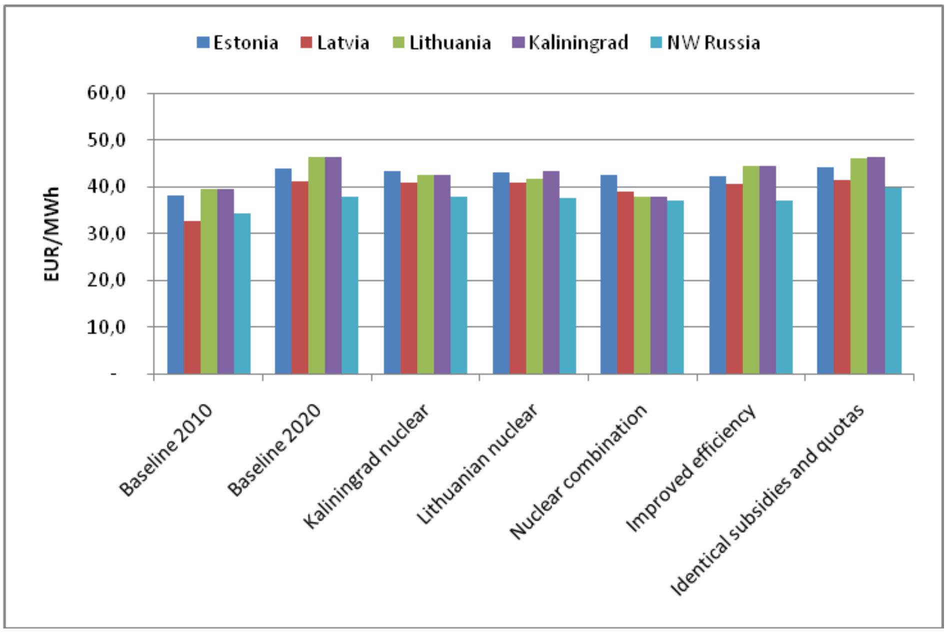


Figure 39: Electricity prices in Kaliningrad, NW Russia and the Baltic States in all scenarios

(TWh/year)	Estonia	Lithuania	Latvia	NW Russia	Kaliningrad	Total
Baseline 2010	-2.2	-5.5	-2.4	23.7	-0.2	**13.4**
Baseline 2020	0.4	-0.3	-1.6	18.7	-2.1	**15.2**
Kaliningrad nuclear	-0.2	-2.3	-2.0	17.4	13.8	**26.7**
Lithuanian nuclear	-0.4	11.1	-2.2	16.9	-2.9	**22.5**
Nuclear combination	-0.5	10.0	-2.7	13.1	13.1	**33.0**
Improved efficiency	0.3	-0.2	-1.3	18.1	-2.3	**15.0**
Identical subsidies and quotas	0.4	-0.5	-1.2	29.1	-0.5	**26.1**

Table 12: Netimport/export in Kaliningrad, NW Russia and the Baltic States in all scenarios. Positive number is net-import, while negative represent net-export.

[i] "ENERGY – Pulling the Baltic Sea Region together or apart?", page 128
[ii] "ENERGY – Pulling the Baltic Sea Region together or apart?", page 133
[iii] "Energy Efficiency at Regional Level in Arkhangelsk, Astrakhan and Kaliningrad Regions - Business Plan Baltisk Wind Farm (Kaliningrad Oblast)".
December 2007. The European Union's Tacis Programme for the Russian Federation. EuropeAid/120746/C/SV/RU
[iv]"ENERGY – Pulling the Baltic Sea Region together or apart?". Page 256
[v]"ENERGY – Pulling the Baltic Sea Region together or apart?". Page 259
[vi]CESI report June 2009 nr. A9017214. Updating T E N-Energy- Invest study. Prepared for the European Commission – Directorate General for Energy and Transport – Directorate C
[vii] "ENERGY – Pulling the Baltic Sea Region together or apart?", page 133
[viii] "ENERGY – Pulling the Baltic Sea Region together or apart?", page 149
[ix]Russian analytical digest. No. 46, 25 September 2008. Produced by the Reseach Centre for East European studies at the University of Bremen and the Center for Security Studies (CSS) at the Swiss Federal Institute for technology Zurich
[x] Russian analytical digest. No. 58, 21 April 2009
[xi] Russian analytical digest. No. 58, 21 April 2009
[xii] Remarks to draft report by Ministry of Energy of the republic of Lithuania
[xiii] Estonian ministry of foreign affairs yearbook from 2008. http://web-static.vm.ee/static/failid/122/Einari_Kisel.pdf

[xiv]"Climate Doctrine of the Russian Federation", Unofficial translation dec. 2009. Found on the president of Russia official web portal: http://eng.kremlin.ru/text/docs/2009/12/223509.shtml
[xv]Article: "Russian energy strategy based on growyh of Global demand – Putin", RIA Novosti 10.02.2010 http://en.rian.ru/russia/20100210/157837247.html
[xvi]Article: "West worries about Russia turning to Coal", EurActiv 10.03.2010 http://www.euractiv.com/en/energy/west-worries-about-russia-turning-coal-news-325434?utm_source=EurActiv+Newsletter&utm_campaign=840b4b57d9-my_google_analytics_key&utm_medium=email
[xvii]Article: "West worries about Russia turning to Coal", EurActiv 10.03.2010 http://www.euractiv.com/en/energy/west-worries-about-russia-turning-coal-news-325434?utm_source=EurActiv+Newsletter&utm_campaign=840b4b57d9-my_google_analytics_key&utm_medium=email
[xviii] "ENERGY – Pulling the Baltic Sea Region together or apart?", page
[xix] "Energy cooperation within the Baltic Sea Region. A Kaliningrad perspective". By Arne Grove. 2009. http://www.tse.fi/FI/yksikot/erillislaitokset/pei/Documents/bre2009/322%202-2009.pdf
[xx]Article: "Private Nuclear Power Plant to be build in Russia", Pravda 25.02.2010 http://english.pravda.ru/russia/economics/25-02-2010/112380-nuclear_power-0
[xxi] Raukas, Anto (2004). "Opening a new decade" (PDF). *Oil Shale. A Scientific-Technical Journal* (Estonian Academy Publishers) **21** (1): 1–2. ISSN 0208-189X. http://www.kirj.ee/public/oilshale/1_ed_page_2004_1.pdf.
[xxii] Estonian ministry of foreign affairs yearbook of 2008. http://web-static.vm.ee/static/failid/122/Einari_Kisel.pdf
[xxiii]Article: "Lithuania trades in Ignalina for BaltPool", European Energy Review 19.05.2010 http://www.europeanenergyreview.eu/site/pagina.php?id=1996&print=1
[xxiv]World Nuclear Assouciation on Nuclear Power in Lithuania http://www.world-nuclear.org/info/inf109.html
[xxv] Press release: The Baltic Sea Region States reach agreement on the Baltic Energy Market Interconnection Plan , IP/09/945. http://europa.eu/rapid/pressReleasesAction.do?reference=IP/09/945
[xxvi] Lithuanian Energy Quarterly, newsletter 2010/2.
[xxvii]Article: NO. 09/2010 NPS – Preliminary agreement signed on EstLink 2 cable connection", Nordpoolspot.com http://www.nordpoolspot.com/Market_Information/Exchange-information/No-092010-NPS---Preliminary-agreement-signed-on-EstLink-2-cable-connection/
[xxviii]Press release: The Commission calls for proposals for €4 billion worth of energy investments, IP/09/804. http://europa.eu/rapid/pressReleasesAction.do?reference=IP/09/804
[xxix] Lithuanian Energy Quarterly, newsletter 2010/2
[xxx] "Energy cooperation within the Baltic Sea Region. A Kaliningrad perspective". ". By Arne Grove. 2009. http://www.tse.fi/FI/yksikot/erillislaitokset/pei/Documents/bre2009/322%202-2009.pdf
[xxxi] *Maxim Kozlov, Inter RAO UES*
[xxxii]Russian analytical digest. No. 46, 25 September 2008.
[xxxiii]Russian analytical digest. No. 46, 25 September 2008
[xxxiv]Russian analytical digest. No. 46, 25 September 2008
[xxxv]Russian analytical digest. No. 46, 25 September 2008
[xxxvi]Russian analytical digest. No. 46, 25 September 2008
[xxxvii]"Energy cooperation within the Baltic Sea Region. A Kaliningrad perspective". By Arne Grove. 2009. http://www.tse.fi/FI/yksikot/erillislaitokset/pei/Documents/bre2009/322%202-2009.pdf

Baltic Development Forum
The leading high-level network for decision-makers from business, politics, academia and media in the Baltic Sea Region.

Nygade 3, 5th floor
P.O. Box 58
DK-1002 Copenhagen K
Denmark
Telephone +45 70 20 93 94
Fax +45 70 20 93 95
bdf@bdforum.org
www.bdforum.org

Baltic Development Forum

sustainable growth · innovation · competitiveness