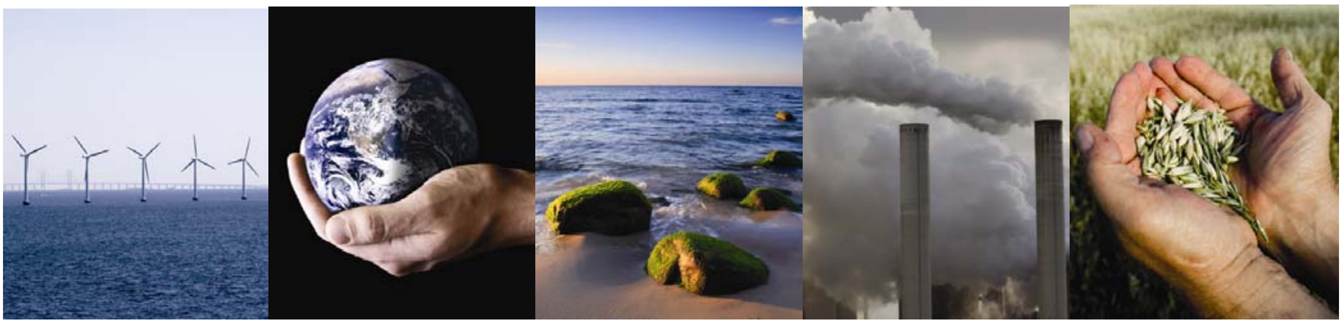

Energy Perspectives of the Baltic Sea Region

Interim Report

Study on the
enhanced regional energy cooperation

Baltic Development Forum

Energianalyse a/s

Sponsored by: norden Nordic Council of Ministers; norden Nordic Council; Danfoss Fabrikant Mads Clausens Fond

Study on
Enhanced regional energy cooperation in the Baltic Sea Region

The energy sector of the Baltic Sea Region will be in special focus in 2009 with the EU Strategy for the Baltic Sea Region and the Baltic Interconnection Plan, both scheduled for June 2009. Also the COP15 in Copenhagen in December 2009 will put spotlight on the region.

In this context The Nordic Council of Ministers is co-sponsoring a study, Enhanced regional energy cooperation in the Baltic Sea Region, carried out by the Baltic Development Forum and Ea Energy Analyses.

Phase I of the project, which was concluded by the end 2008, provided an overview of the present energy situation in the Baltic Sea Region and outlined two scenarios for the energy and transport sectors in the region in 2030. The scenarios aim at achieving two concrete goals for 2030: a reduction of CO2 emissions by 50 per cent compared to the 1990 level and a reduction of oil consumption by 50 per cent compared to the present level (2005).

On 20 October at a Dinner debate hosted by the Baltic Sea Parliamentary Committee valuable feed-back was provided to the scenarios by parliamentarians from the Baltic Sea Region. Further, on 22 October 2008 a presentation was made at the meeting of Joint Platform on Energy and Climate, representing 11 organisations in the region. Finally, the results from the first phase were presented at the Baltic Development Forum Summit 2 December and on 3 December 2008 an input was received from the Group of Senior Energy Officials of BASREC. At the Baltic Sea Region Energy Cooperation (BASREC) Energy Ministers conference where also Commissioner Andris Piebalgs participated, held 17 - 18 February 2009 in Copenhagen Secretary General of the Nordic Council of Ministers, Mr. Halldor Asgrimsson, informed about the ongoing study.

The meetings pointed out the need for a combination of the two scenarios, taking into consideration the policies of the different countries around the region. By including existing measures the scenarios could contribute to showing what additional measure may be needed. Furthermore the importance in showing possible benefits of closer regional cooperation within areas such as wind power planning, interconnectors, demonstration of new technologies and energy markets was underlined. Hence, phase II of the study looks at the region as a whole and sets up a number of more detailed scenarios for the electricity and district heating sector for a number of years, hence it is also possible to examine how EU's 20 -20 -20 targets may be compiled. Phase II is running from January to June this year.

Phase III will explore the opportunities for industries and energy companies in the region to be frontrunners in development of new energy technologies and provide a platform for regional knowledge sharing between public and private stakeholders. A workshop in Kaliningrad is scheduled for May/June 2009 focusing on the role of cities in the promotion of energy savings, district heating and renewable energy technologies.

Energy perspectives of the Baltic Sea Region

Europe is facing a serious energy challenge: fuel supplies must be secured and greenhouse gas emissions reduced significantly, while maintaining a high level of economic growth.

The Baltic Sea Region has a significant potential for developing regional projects to benefit the region as a showcase for sustainable energy development and becoming frontrunners in innovative solutions through regional cooperation

The Baltic Development Forum and Ea Energy Analyses are conducting a study on 'Enhanced regional energy cooperation in the Baltic Sea Region[1]. This project report gives a brief overview of the energy situation in the Baltic Sea Region and presents two general scenarios for the energy and transport sectors, which are developed to comply with the strategic energy and climate goals. In June 2009 a final report, together with a public modelling tool and data, will be presented.

Initiatives for cooperation

Since the early 1990's, several initiatives have been taken to stimulate cooperation between energy stakeholders in the countries surrounding the Baltic Sea. These include among others Baltic 21, Basrec, Baltrel and the Union of the Baltic Cities[2].

The region as a showcase

The Baltic Sea Region has a significant potential for further developing regional projects, which could benefit both the region and the entire EU as a showcase for comprehensive sustainable energy systems. The region holds key industrial competences for producing energy efficient end-use equipment as well as components of energy production facilities and many cities. Several metropolises in the region also have experience with energy efficient building and sustainable heating systems, including district heating and combined heat and power generation.

[1] The study is multi-client study, financed by the Nordic Council of Minister, the Nordic Council, the Baltic Development Forum and Fabrikant Mads Clausens Fond, Danfoss.

[2] Baltic 21 is a regional multi-stakeholder process for sustainable development initiated in 1996 by the Prime Ministers from the eleven member states of the (CBSS).

BASREC is the Baltic Sea Region Energy Co-operation. All governments in the region participate in BASREC as well the European Commission.

BALTREL, the Baltic Ring Electricity Co-operation Committee, represents 15 electricity power supply organizations with operations in 11 countries in the Baltic Sea Region.

Input to EU's Baltic strategy

The key purpose of the present study is to facilitate closer regional cooperation and identify specific opportunities for projects and cooperation within the energy and climate sector in the Baltic Sea Region. The study further aims to examine the best use of the energy resources in the region, for example biomass. Specifically the study aims at providing input to the current strategy work at the EU level.

Renewed focus on the region

The stakeholders in the energy sector in the Baltic Sea Region have for a long time cooperated through organisations such as Baltrel, Baltic Gas, Basrec, Baltic 21 and the Baltic Sea Parliamentary Committee[3].

EU strategy for the Baltic Sea Region

Recently the European Union has renewed its focus on the Baltic Sea Region. In December 2007, the European Council invited the Commission to present an EU strategy for the Baltic Sea Region by June 2009. The strategy will be one of the key objectives for the Swedish EU presidency in the second half of 2009. According to the Swedish prime minister, the strategy should be a concrete, action-oriented instrument which helps the EU and the EU members in the Baltic Sea region to set joint priorities, for instance concerning investments in infrastructure. The aim is to speed up joint implementation of EU decisions, and to better harmonize national regulations so as to create a genuinely single and thus bigger regional market.

Baltic Interconnection Plan

At the meeting of the European Council 15-16 October 2008, the council called for the establishment of a plan of action to speed up interconnections in the Baltic Sea region to enhance the security of supply for all countries in the region and for "wider security of supply and solidarity in the EU" as expressed by the EU Commission in its recent green paper 'Towards a secure, sustainable and competitive European energy network'. The Baltic Interconnection Plan will be developed by the Commission together with the Member States concerned as part of the Baltic Sea Regional Strategy. According to the Commission "the efficient development of the market as well as the contribution of energy efficiency and renewables to increased security of supply will need to be duly taken into account in developing the Plan".

[3] Baltic Gas is an association for cooperation between the natural gas transmission companies in the Baltic Sea Area.
Baltic Sea Parliamentary Committee - forum for debate and information exchange between Parliaments and other organizations in the region both on international and interregional levels.

The Baltic Interconnection Plan will be developed in the first half of 2009 in order for the implementation of the plan to start in the second half of 2009

European coordinators

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”. Their first annual reports were published by the end of September this year.

Best practice at Kriegers Flak

Mr. Adamowitsch recognises the dual function of an off-shore grid, namely to connect the wind farms to the grid and to facilitate cross-border trading in the region and between regions. Moreover Mr. Adamowitsch calls for increased cooperation across the region stating that a fragmented national approach to off-shore wind will be “very costly to consumers and governments and also lead to an unnecessary burden on the environment”. The first action point in Mr. Adamowitsch work-plan for the coming year will be to promote Krieger’s Flak[4] in the Baltic Sea – shared by Denmark, Germany and Sweden – as 'best practice case' for the integration of off-shore wind farms for three countries.

Energy consumption

Energy consumption in the Baltic Sea Region has been fairly stable during the last 15 years. Today, the most important sources of energy are oil, coal and natural gas in the aforementioned order.

Historic view

Since 1990, the role of coal has declined whereas particularly natural gas and renewables have come to play a greater role. In the new democracies in the region, the reduction in coal consumption has mainly taken place in the industrial sectors.

[4] Kriegers Flak is located in the Baltic Sea and is divided between Germany, Denmark and Sweden. The location has been identified as an optimal, shallow area for wind power production, and offshore wind parks have been planned or discussed in the German, Swedish and Danish part of the marine area.

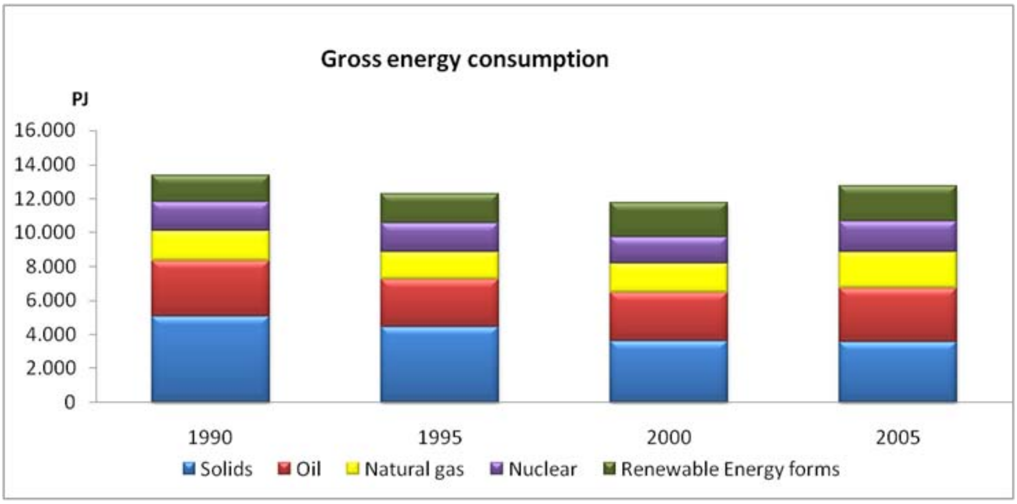

Figure 1: Gross Energy Consumption in the Baltic Sea Region (Denmark, Estonia, Finland, North East Germany, North West Russia, Latvia, Lithuania, Poland, Norway and Sweden). Source: European Commission (DG Tren) and IEA[5].

Reduced energy intensity

The decrease in energy consumption since 1990 has taken place in spite of significant increase in GDP for the region (almost 40 per cent increase since 1990). This reflects a reduction in the energy intensity of the economy, i.e. the amount of energy used per economy output. As indicated in Figure 2 this development is particularly noticeable in the new democracies, which have succeeded in almost halving the energy intensity since the transition to market-based economies.

This change is due to decreasing production from energy intensive industries as well as to energy efficiency improvement in all parts of the economy.

Decreasing CO_2-emissions

CO_2-emissions from the energy and transport sectors have decreased by approximately 18 per cent from 840 Mt in 1990 to 690 Mt in 2005. This reflects the shift in energy consumption towards natural gas and renewables – as indicated in Figure 1 – as well as slightly decreasing total energy consumption.

[5] Data for North East Germany and North West Russia are based on regional shares of national values.

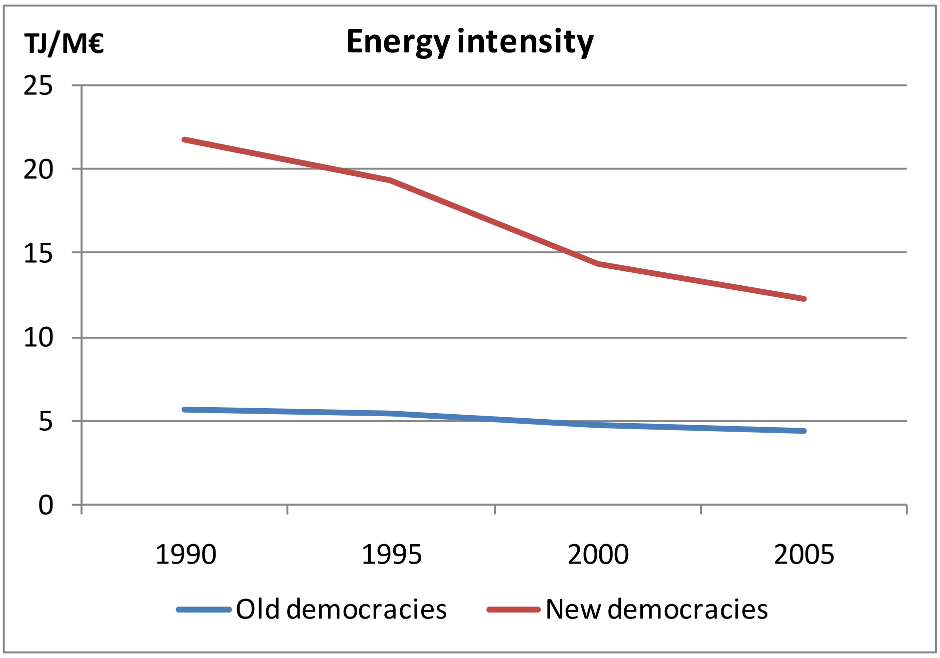

Figure 2: Energy intensity - measured as Final Energy Demand per GDP - in the Baltic Sea Region (Old democracies: Denmark, Norway, Finland, North East Germany and Sweden, New democracies: Estonia Latvia Lithuania, Poland and North West Russia). Source: European Commission (DG Tren), IEA and the World Bank.

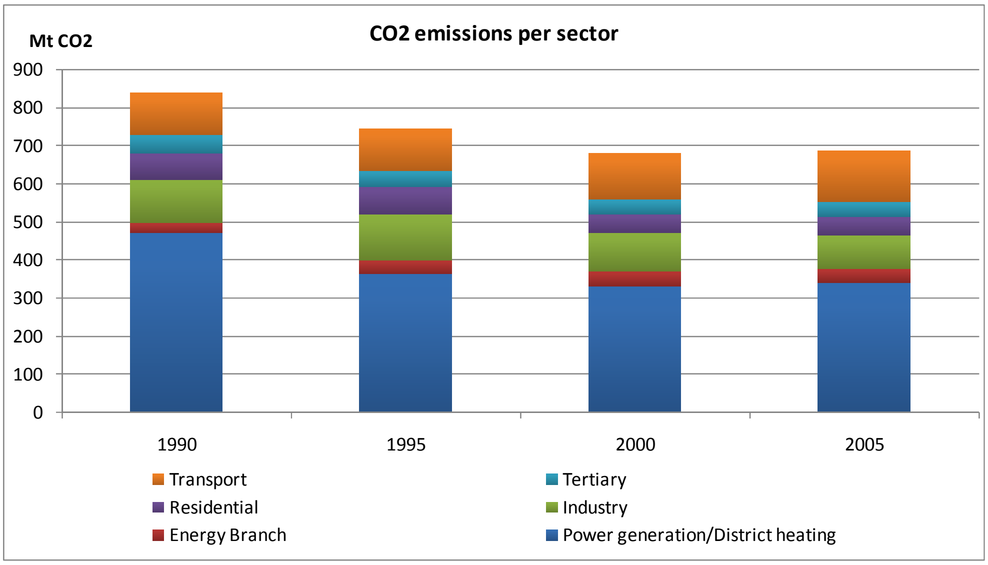

Figure 3: CO_2 emissions in the Baltic Sea Region by sector (Denmark, Estonia, Finland, North East Germany, North West Russia, Latvia, Lithuania, Poland, Norway and Sweden). Source: European Commission (DG Tren) and IEA.

Infrastructure and market integration

Some 45 per cent of the total final energy consumption in the region is supplied through grids (electricity, gas or district heating).

The physical infrastructure is well developed in the Baltic Sea Region. Members of the EU are required to implement the deregulation of the electricity and gas sectors as stated in EU regulation. This includes minimum requirements for accounting and legal separation of transmission and distribution system operators. In the EU's third legislative package on electricity and gas markets put forward in September 2007, the EU Commission proposes to go even further by requiring ownership unbundling of electricity and gas transmission.

The deregulation of the energy sector is likely to bring economic efficiency gains as new entrants are allowed to compete in the markets. On the other hand the government control of generation facilities is reduced causing some concern about security of supply and misuse of market power.

Electricity

All countries surrounding the Baltic Sea are electrically connected directly or indirectly. Still, power is primarily traded on a country level or within smaller regions, though this may change in the future.

The Nordic countries form a common power exchange (Nord Pool) jointly owned by the transmission system operators; in Germany power is exchanged through the European Energy Exchange and in Poland through the Polish Power Exchange. The three Baltic countries still have separate exchanges. Recently, however, negotiations have been launched between Nord Pool and electricity companies in the Baltic Countries to establish a joint spot market in one or more of the Baltic countries. This would allow for a more market-oriented utilisation of the Estlink cable between Finland and Estonia.

Soon the exchanges at Nord Pool and the European Power Exchange will be linked through so-called market coupling to ensure efficient use of existing cross-border interconnections[6].

In the future, as the electricity grids around the region are further integrated, it is not unlikely that we will see a fully integrated electricity market covering the Baltic Sea Region.

[6] http://www.marketcoupling.eu/market-info-and-press/news/news-archive/date/2009-1, 2009-02-17

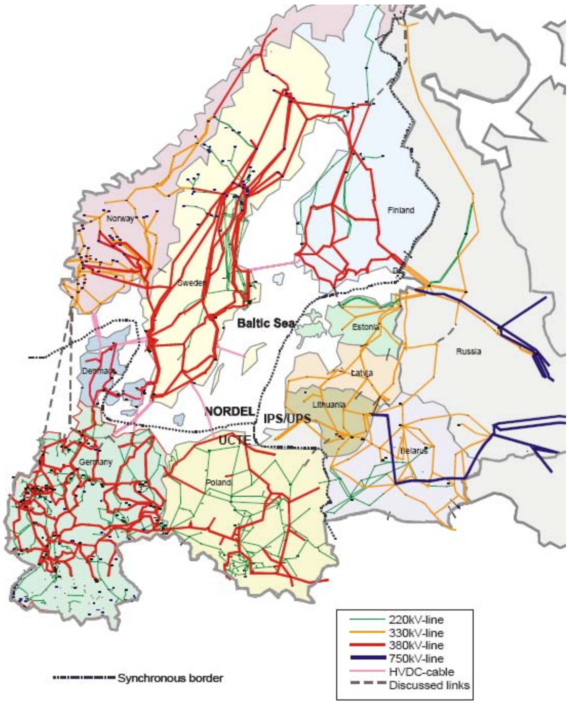

Figure 4: The electricity infrastructure of the Baltic Sea Region. A number of new interconnectors a being discussed, including a cable connecting Sweden and Lithuania, a reinforcement of the grid between Poland and Lithuania and a link between Germany, Sweden and Denmark in connection with the deployment of large-scale off-shore wind farms at Kriegers Flak.

Gas

As indicated on the map below, Northern Europe and large parts of the Baltic Sea Region are equipped with an extensive gas transmission infrastructure. Moreover, important extensions of the infrastructure are being planned, focusing mainly on linking the gas reserves in the North Sea and in Russia with the large consumption centres in Central Europe.

Figure 5: Map of the gas infrastructure in Northern Europe. Dotted lines show pipes which are being planned or are under construction. The Nord Stream pipe connecting Russia and Germany is highlighted in blue. Source: Energi & Økonomi, April 2007.

District heating

Compared to other regions of Europe, the Baltic Sea Region has a well developed district heating system. From an energy resource point of view, this implies huge benefits as combined heat and power generation may increase the fuel efficiency of power plants from 40-50 per cent (electricity only) to approx. 90 per cent (electricity and heat). For example, the district heating systems will allow for a very efficient utilisation of the bioenergy resource in the regions.

Moreover, district heating systems can provide a valuable storage medium for wind power by using possible surplus electricity for heating purposes in electric boilers and heat pumps. Finally, district heating gives consumers a high level of security of supply as multiple fuels may be used for the production.

Energy resources

The countries surrounding the Baltic Sea are rich in resources for energy production – both fossil fuels and renewables. Significant gas reserves are available in Norway and Russia; Germany and particularly Poland have substantial coal resources; Norway has large oil reserves.

As for renewable energy, hydropower and biomass cover the largest part of the economic potential. In the Baltic Sea Region bioenergy will be able to cover about 30 per cent of the gross energy demand of the region as opposed to 16 percent for the EU27. Moreover, wind power already plays an important role in Denmark and Germany, and could play a much greater role in the region in the years to come. In the longer term, solar power, wave power and heating and geothermal energy may also provide notable contributions to the overall energy supply.

Energy scenarios for the future

Two essentially different developments have been explored through a so-called Small-tech scenario and a Big-tech scenario in order to shed light on different pathways towards achieving the long term strategic goals of the region Both scenarios aim at achieving two concrete goals for 2030: reducing CO2 emissions by 50 per cent compared to the 1990 level and reducing oil consumption by 50 per cent compared to the present level. Similar terminologies and goals have been applied in a similar scenario study for the EU27 carried out for the European Parliament[7].

Small-tech scenario

The Small-tech scenario focuses on distributed energy generation, energy savings and efficient utilisation of energy through combined heat and power generation. This scenario assumes a high level of interconnection of the electricity grids in the regions to allow for the integration of a high share of non-dispatchable wind power. So-called smart grid technology and improved com-

---

7 More info on the European project can be found on the website of the Danish Board of Technology: http://www.tekno.dk/subpage.php3?article=1442&survey=15&language=uk

munication between the different parts in the energy system are a key to providing an optimal dispatch and efficient utilization of the energy infrastructure.

Big-tech scenario

The Big-tech scenario explores the opportunities of more centralised solutions. In the Big-tech scenario, almost all new coal and natural gas power plants established from 2020 and onwards will be equipped with carbon capture technologies (CCS) - and the nuclear power capacity will be increased by 35 per cent compared to today. New nuclear generation capacity is presumed to be built in Finland, Lithuania and Poland, as well as no phase-outs in Germany, Sweden and North West Russia. In addition, it is assumed that most new large coal power plants commissioned in the period 2010-2020 are prepared for CCS and retrofitted in the subsequent decade.

Transport

In both scenarios the transport sector undergoes fundamental changes in order to comply with the target of 50 per cent oil reduction. In both the Small tech and the Big-tech scenarios it is a critical assumption that the technical potentials for improving the fuel economy of conventional vehicles are partly realised. Moreover, in the Small-tech scenario, electric vehicles and plug-in hybrids displace oil consumption, and information and communication technologies are put in place to decrease the demand for "physical" transportation. In the Big-tech scenario, 2nd generation biofuels and natural gas are important means, in addition to the electrification of the transport sector.

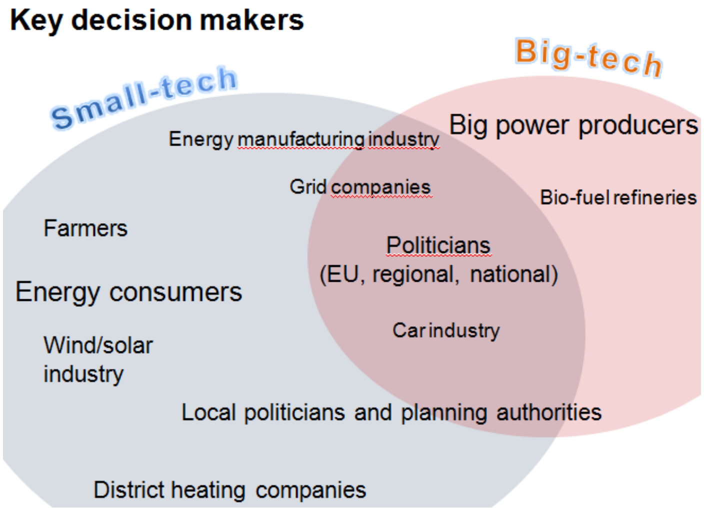

Figure 6 - Key decision makers in the two scenarios

However, the requirements for transformation differ significantly in the two scenarios.

In the Big-tech scenario, the existing structure of the energy supply system remains essentially unchanged, and the large suppliers of electricity become the main actors. Hence, the implementation of the Big-tech scenario depends on relatively few decision-makers. Partnerships for the demonstration of the CCS technology provide an obvious opportunity for regional cooperation in the Big-tech scenario.

In the Small-tech scenario, citizens play an important role as active consumers of energy, changing energy behaviour according to price signals and investing in energy-efficient appliances and buildings; grid owners must develop their systems and the suppliers of energy will have to change sources gradually from large power plants to renewables and to distributed units located closer to the consumers. In the Small-tech scenario the integration of fluctuating energy sources calls for a high level of cooperation on energy markets and new infrastructure projects, particularly concerning off-shore wind. Local authorities and cities are crucial for the facilitation of district heating grids and sustainable transport systems. The need for more efficient supply and demand technologies will provide business opportunities in many industry branches.

Results

To illustrate the consequences of the two scenarios, the key indicators – the development in gross energy consumption and the emission of CO2 – are compared with historic data as well as with a reference for 2030 resembling the most recent projection from the European Commission[8] [Ref. 5].

The scenarios show that resources and technologies are available to achieve the targets set out.

In the Small-tech scenario, it is foreseen that the gross energy consumption is reduced by approx. 20 per cent in 2030 compared to 2005. In the Big-tech scenario, gross energy consumption increases by 13 per cent compared to today. This increase, which is slightly higher than in the 2030 reference projection, is mainly due to increased utilisation of carbon capture and storage technologies which are expected to require a considerable expenditure of energy, particularly for the capture and transportation of CO2. In the Big-tech scenario, compliance with the CO2 reduction target is secured by storing almost 150 Mt of CO_2 underground in 2030.

To realise the scenarios, investments in the energy sector need to be increased considerably. The preliminary calculations show, that the need for additional investments in the scenarios are offset by fuel cost savings and costs of emitting CO_2. In the calculations, an oil price of 122 $/bbl (real term) is applied for 2030 – in accordance with IEA's World Energy Outlook – and a CO_2 price of 45 €/ton.

The average annual economic growth rate is assumed to be just above two and a half per cent in the period until 2030 in both reduction scenarios.

[8] For North-West Russia the reference has been made based on data from the International Energy Agency.

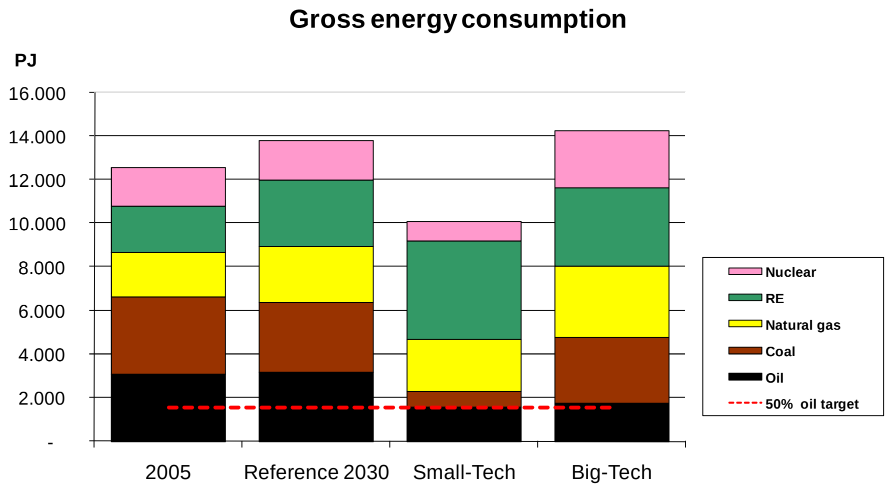

Figure 7: Gross energy consumption in 2005 and projections for 2030 (excluding fuels for non-energy purposes).

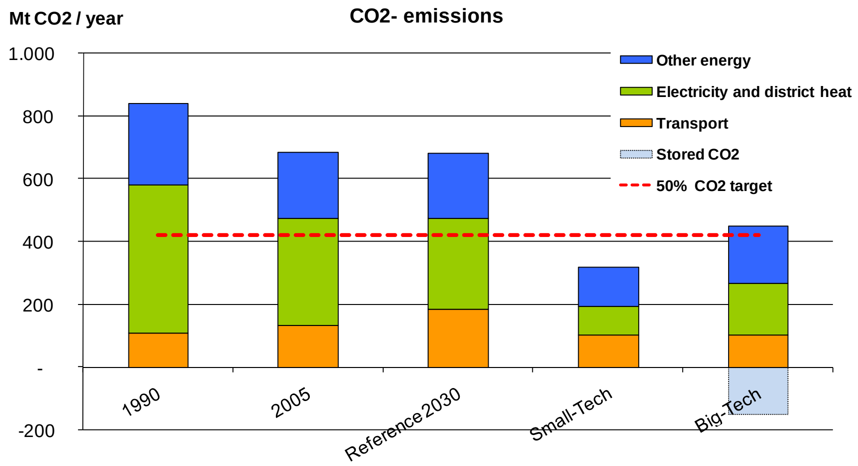

Figure 8: CO_2 emissions from the energy and transport sectors in 1990, 2005 and projections for 2030. “Other energy” includes oil, gas and coal used in households, industry and the trade/service sector.

Critical assumptions

The actual implementation of the scenarios and associated benefits depend on a number of critical assumptions. Most important in the Small-tech scenario is the assumption that it is possible to realise a substantial share of the huge theoretical potential for energy savings, best practice policies at the local level to facilitate district heating and sustainable transport systems.

In the Big-tech scenario, the access to and availability of gas, coal and uranium at reasonable prices is probably the most critical assumption. Moreover, the scenario is dependent on the commercialisation of the CCS technology.

Detailed analyses of the electricity systems

The scenarios described above were developed with STREAM, a bottom up based spread-sheet modelling tool looking at the energy flows of the region at an annual basis. In Phase II of the project – running from January 2009 to June 2009 – detailed scenario analyses will be developed for the power and district heating sectors in the region. Besides showing a pathway towards lower CO2 emissions and an improved security of supply, the scenarios will explore the benefits of closer cooperation around the Baltic Sea on energy policies and specific projects and shed light on the value of establishing new interconnectors in the region.

Whereas the interim report only looks at the target year, 2030, the scenarios for the power and district heating sector in the present report describes the development of the energy system over time by looking at a number of years: 2010, 2015, 2020, 2025 and 2030. Hence, it is also possible to examine how the EU's 20-20-20 targets may be complied with in 2020.

In this analysis one baseline scenario is developed to show how the electricity sector in the Baltic Sea region may develop leading up to 2030. The baseline scenario combines measures from the Small- and Big-tech scenarios and in this sense it is not a business as usual projection.

The scope of the analyses in phase II is to:

- examine how the electricity and district heating systems may develop to comply with medium and long-term policy objectives given different developments in the framework conditions, including a situation with more efficient use of energy
- show the value of establishing new electric interconnectors
- explore the consequences of national vs. regional policy objectives for renewable energy
- assess the costs and benefits of a concerted wind power planning and interconnection at a specific project, Kriegers Flak

The first results will be available by March 2009.

Synthesis scenario

Based on the outcome of the analyses – and subsequent discussions of the results with key stakeholders in the region –a synthesis scenario for the region will be developed. The concrete content of the synthesis scenario will depend on result of the analyses. However, it is expected to include an expansion with interconnectors that are of high value to the electricity system, a level of additional energy efficiency measures compared to the baseline situation and a (partly) regional approach to complying with the policy targets of region.

Appendix: Scenario details

		2005	2030 Small-tech	2030 Big-tech
Annual GDP growth		-	2.6%	
Total final energy demand		8,500 PJ	8,300 PJ	10,200 PJ
Gross energy consumption[9]		12,600 PJ	10,100 PJ	14,200 PJ
System conversion losses[10]		37%	18%	22%
Electricity demand		2,000 PJ	2,200 PJ	3,000 PJ
District heating/cooling (% of final energy demand[11])		14%	25%	18%
Renewable energy (% of gross energy consumption)		16%	45%	25%
Electricity supply (% of electricity production)	Power plants with CCS	0%	0%	20%
	Nuclear	30% (21 GW)	12% (9 GW)	25% (28 GW)
	Wind	1%	17%	5%
	Solar	0%	1%	0%
	Wave	0%	1%	0%
	Bioenergy[12]	4%	16%	8%
Transport[13]	Fuel economy	160 g CO_2/km[14]	100 g CO_2/km	
	Electric vehicles	<1%	15-25%	
	Biofuels	<1%	5-10%	15%

Table 1: Scenario characteristics and key figures

[9] Excluding fuels for non-energy purposes.

[10] Not including losses in the transport sector

[11] Excluding final energy in the transport sector

[12] Including biomass, biogas and municipal waste

[13] The transport figures apply to passenger cars

[14] Average emissions or new cars in the EU