



TEN-YEAR
330 kV and
110 kV
NETWORK
DEVELOPMENT
PLAN
2013–2022 OF
LITHUANIAN
POWER SYSTEM

Abbreviations

BEMIP	Baltic Energy Market Interconnection Plan
ECN	European Continental Network
ENTSO-E	European Network of Transmission System Operators for Electricity
HPP	hydro power plant
IPS/UPS	power system characterized by synchronous operation of power systems of the Baltic states, Russia and CIS, Interconnected Power System/Unified Power System
kV	kilovolts (1 kilovolt = 1 000 volts)
MW	megawatts (1 megawatt = 1 000 kilowatts)
MWh	megawatt hour (1 megawatt hour = 1 000 kilowatt hours)
NEIS	National Energy Independence Strategy
NPP	Nuclear Power Plant
PS	power system
PSPP	pumped storage power plant
RES	renewable energy sources
TL	transmission line
TN	transmission network
TS	transformer substation
TWh	terawatt hours (1 terawatt hour = 1 000 000 000 kilowatt hours)

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Development of the electricity transmission network – for safe and reliable work of Lithuanian electricity system

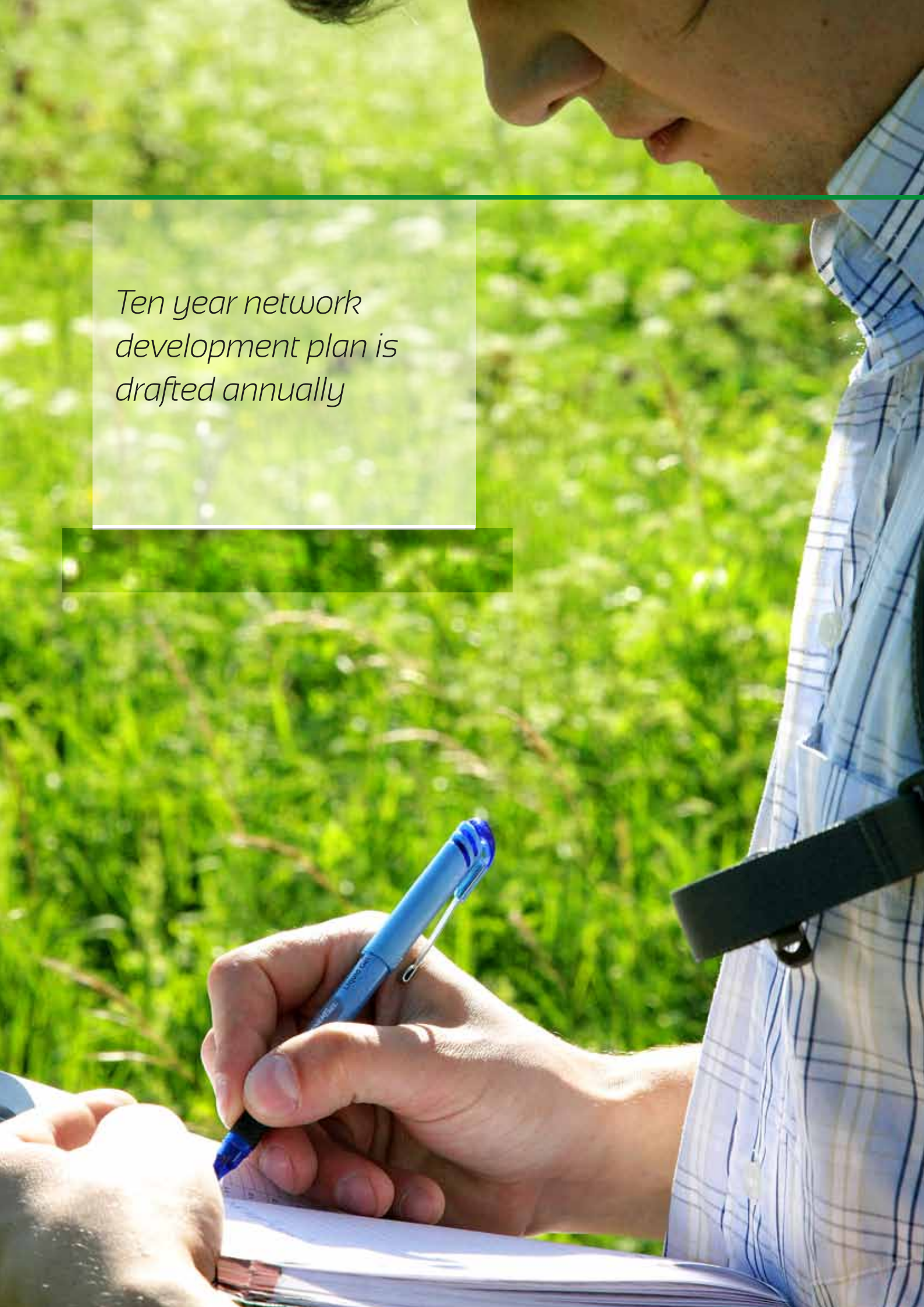
Litgrid, the Lithuanian electricity transmission system operator (hereinafter – TSO), is in charge of the efficient power transfer and balance between power generation and consumption. The Company is responsible for the operation and development of 330 kV and 110 kV transmission networks and ensuring the stability and reliability of the country's electric power system.

The long-term strategic goal of Litgrid is the full-fledged integration of the national power system into the continental Europe power system for synchronous operation in cooperation with the Baltic TSOs. When Lithuania becomes a full-fledged and equal player of the European power system, the country's electricity sector will be managed according to the transparent European standards, the management of electricity flow based on market principles and contribution to the control of system frequency will be ensured.

Ten-year 330 kV and 110 kV network development plan (hereinafter – Plan) has been worked out taking into account the requirements of security of supply, reliability, quality, efficiency, consumption, management, and environment protection as well as the needs of the network users. The Plan was based on the long-term objectives of the National Energy Independence Strategy, the requirements of the European Parliament and Council Directive 2009/72/EC (July 13, 2009), Strategy for 2013–2022 of the Lithuanian electricity transmission system operator Litgrid, guidelines of the European Network of Transmission System Operators for Electricity ENTSO-E and other regulatory provisions, which define activities and principles of the transmission system operators and power systems.

The Plan is drafted annually. Consultations with the players of the electricity market, interested institutions and organizations of the Republic of Lithuania (LR) and other consumers are held as required by legislation in order to ensure that the development of transmission grids are carried out in a transparent way and is approved of by the public.

A distinctive feature of this Plan – four scenarios with certain assumptions considered when analysing the transmission network, calculating power flows and planning investment: the highest attention is paid to scenario A, stipulating that Visaginas nuclear power plant (hereinafter – Visaginas NPP) will be constructed and start operations by 2022, and power systems of the Baltic states will be in synchronous operation with European Continental Network (hereinafter – ECN). The descriptions, assumptions and schemes of the scenario are presented in Chapter 5.



*Ten year network
development plan is
drafted annually*



Key data of the Lithuanian power system

		2012	2022
Electricity consumption (losses of network included)			
Pessimistic	TWh	10,61	12,25
Basic	TWh	10,61	12,84
Optimistic	TWh	10,61	13,88
Peak load			
Pessimistic	MW	1715	2120
Basic	MW	1715	2180
Optimistic	MW	1715	2360
Installed/available generation capacities, total:	MW	4253/3324 (3903)*	5676/5256
Condensing power plants	MW	1955/1304 (1884)*	1055/1020
Nuclear power plant	MW	0/0	1350/1303
Thermal power plants	MW	803/678	1002/864
Hydro power plants	MW	128/117	142/131
Hydro pumped storage power plants	MW	900/760	1125/950
Other power plants	MW	129/129	129/129
Renewable energy sources power plants:	MW	339/336	873/859
Including wind power	MW	274/274	500/500
Transmission lines		6683	7821
400–330 kV overhead line	km	1671,6	2212
110 kV overhead line	km	4966,7	5112
300 kV DC cable	km	-	2x213
110 kV cable	km	44,6	71
400-330 kV substation	unit	13	17
330 kV switchyard	unit	2	2
110 kV substation	unit	218**	229
Compensation devices			
110 kV capacitors	MVAr	112	112***
400 kV shunt reactors	MVAr	-	100***
330 kV shunt reactors	MVAr	180	180***
10 kV shunt reactors	MVAr	300	300

* estimating that operation of 2 x 300 MW units can be resumed within 2 months in case of the need

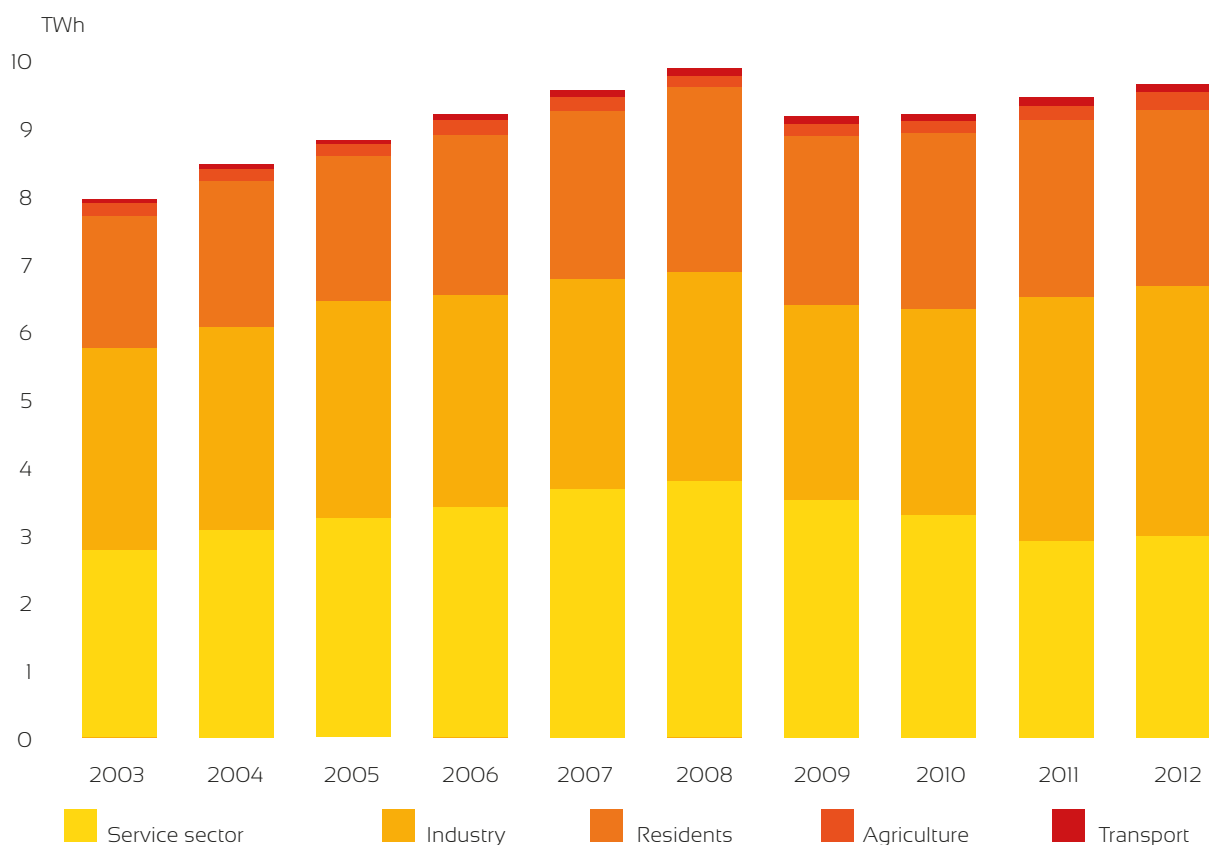
** incl. one switchyard

*** excl. compensation equipment installed in converters

1. Overview of the Lithuanian power system 2012

In 2012 final energy consumption (excluding network losses) in Lithuania reached 9.66 TWh (Figure 1.1). A slight increase in demand as compared with 2011 was noticed in all consumer groups. The highest demand for electricity has been in the industry sector (3.7 TWh), while residents and service sector used more or less the same amount, 2.64 TWh and 2.97 TWh respectively. Transport and agricultural sectors had the lowest demand and amounted respectively to 0.11 TWh and 0.23 TWh. In general, Lithuanian electricity demand after the 2009 economic recession increased insignificantly and was close to 2007 level.

Figure.1.1. 2003–2012, Electricity Consumption by Consumer Groups



In 2012 rapid development of renewable energy continued in Lithuanian power system. Wind farms of approximate total capacity of 86 MW, solar PP - over 7 MW were connected to the grid, and in the middle of 2012 a new 11 MW Šiauliai thermal PP using biofuel was connected to the grid.

A man with a beard, wearing a white shirt, is seated in a black office chair, working at a desk with multiple computer monitors. The background features a large wall covered in complex red circuit diagrams. The scene is illuminated by a circular light fixture on the ceiling.

*In 2012 total energy
consumption in
Lithuania reached
10.61 TWh*

In October, 2012 Lietuvos PP in Elektrėnai started operation of a new 455 MW installed capacity combined cycle unit, which replaced two units by 150 MW each built in the 70's. The new unit is available to satisfy a quarter of the country's electricity needs, if a gas price in the market is competitive.

As of 31 December 2012, the total installed capacity of the power plants (hereinafter – PP) operating in the Lithuanian power system was 4253 MW. Taking into account that part of the capacities are used for the power plants' own needs, have been put into "dead storage", or are limited by the water quantities available at hydro power plants, maximum available capacity in the system (the capacity that can be supplied to the grid by the power plants) amounted to about 3324 MW (*Table 1.1*).

Table 1.1. Capacities of Power Plants, 31/12/2012, MW

Power plants	Installed capacity, MW	Available capacity, MW
Thermal power plants:	2887	2111 (2691)*
Lietuvos PP	1955	1304 (1884)*
Vilnius PP	372	333
Kaunas PP	170	155
Petrašiūnai PP	5	3
Mažeikiai PP	210**	144
Klaipėda PP	11	10
Panevėžys PP	35	33
Other PP	129	129
Hydro and hydro pumped storage power plants:	1027	877
Kaunas HPP	100,8	90
Kruonis HPSPP	900	760
Small HPP	26,5	26,5
Plants using renewable energy resources:	339	336
Wind	274	274
Biofuel	57	54
Solar	8	8
Total:	4253	3324 (3903)*

* estimating that operation of 2 x 300 MW units can be resumed within 2 months in case of the need

** taking into account the information included in the permit to produce electricity (No. LG-0124)

The balance of Lithuanian power system presented here (*Table 1.2*) includes electricity production capacities of power plants, consumption of electricity, exports and imports, the losses of transmission and distribution networks, and the final electricity consumption.

Table 1.2. Electrical energy balance, 2011 and 2012, TWh

	2011	2012
Generation (Net), TWh	4,45	4,71
Thermal power plants:	2,78	3,04
Lietuvos PP	1,10	1,42
Vilnius PP	0,54	0,43
Kaunas PP	0,37	0,32
Panevėžys PP	0,19	0,10
Other PP	0,59	0,76
Hydro and hydro pumped storage power plants:	1,05	0,94
Kaunas HPP	0,39	0,33
Kruonis HPSP	0,57	0,51
Small HPP	0,09	0,10
Wind energy power plants:	0,47	0,54
Connected to the transmission network	0,38	0,44
Connected to the distribution network	0,09	0,10
Plants using other renewable energy resources :	0,15	0,20
Biofuel	0,15	0,20
Solar	0,00	0,00
Commercial system balance (-import/+export):	-6,74	-6,62
Import	-8,71	-8,56
Export	1,97	1,94
Total electricity demand	11,19	11,33
Kruonis HPSP pumping	0,80	0,72
Total electricity consumption	10,39	10,61
Losses in transmission and distribution networks	0,94	0,95
Electricity final consumption	9,46	9,66

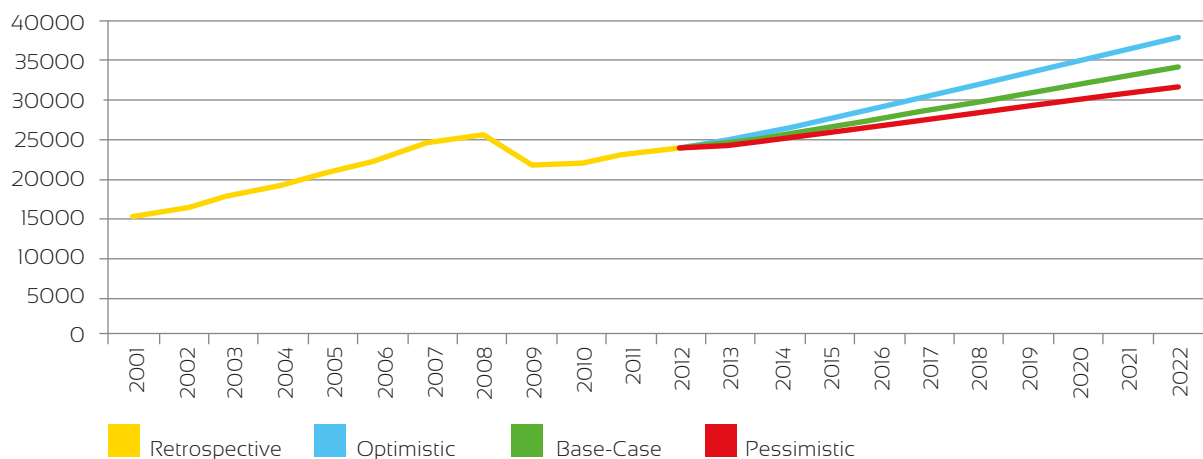
About 32 per cent of electricity consumed in Lithuania in 2012 was produced in thermal power plants burning imported gas and fuel oil. Electricity import accounted for 63 per cent of total demand. Strong dependence on electricity import is determined by not competitive local generation and by cheaper electricity supply from the Nordic and third countries, as well as from Latvia during the spring floods..

In June 2012 Lithuania joined the Nordic power exchange Nord Pool Spot. The average electricity price at Lithuanian power exchange in 2012 was 15.4 cents/kWh; in 2011 the average price was 15.6 cents/kWh.

2. Electricity energy demand and peak load, 2013–2022

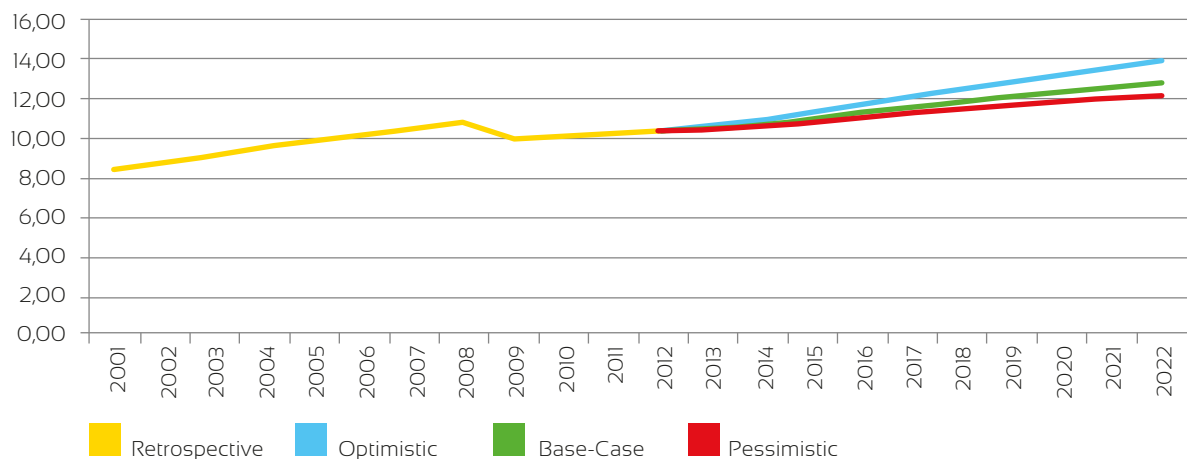
Electricity energy demand (further - energy demand) forecast is done having assessed the gross domestic product (GDP) growth trends (Figure 2.1). GDP growth is the main factor of electricity demand, i.e. energy demand increases with the growth of GDP. The medium-term GDP growth projection is presented by the Ministry of Finance, while the long-term GDP growth forecast is done in accordance with the EU-27 GDP projection till 2050 of the European Commission. By the pessimistic scenario, GDP growth is 0.7 per cent lower than forecasted in the base-case scenario, and by the optimistic scenario – by 2022 the GDP growth is 1 per cent higher than in the base-case scenario. GDP growth is aggregate, and not divided into growth by sector.

Figure 2.1. Lithuanian GDP forecast in prices of 2005, million EUR*.

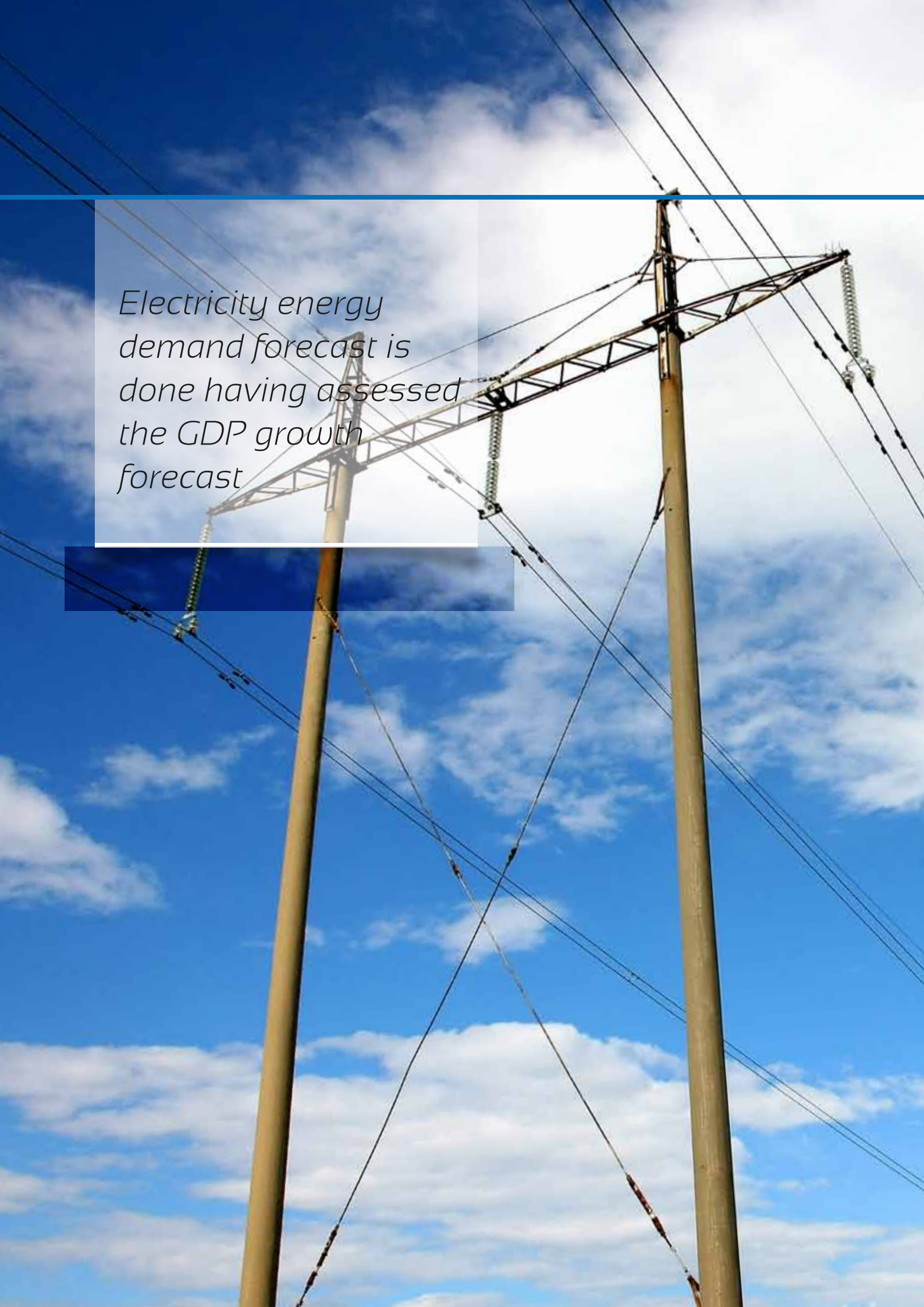


Energy Demand and peak load forecasts are presented in Figures 2.2 and 2.3.

Figure 2.2. Energy demand forecast for Lithuania, TWh



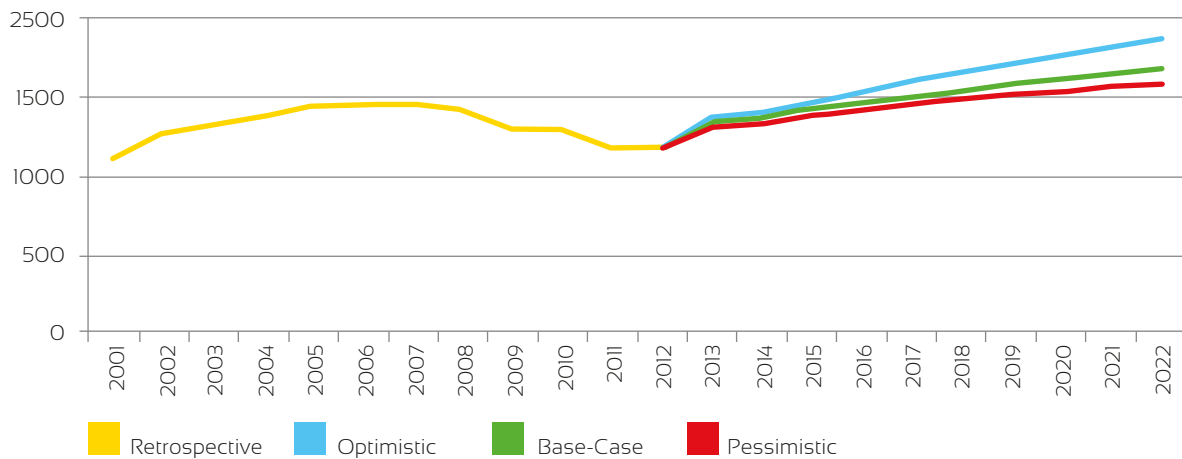
* http://ec.europa.eu/research/social-sciences/pdf/global-europe-2050-report_en.pdf

A low-angle, upward-looking photograph of several high-voltage electrical transmission towers and their associated power lines. The towers are made of metal lattice and are supported by tall, yellowish-brown concrete poles. The power lines are thin and dark, crisscrossing the frame. The background is a bright blue sky filled with soft, white, wispy clouds. The overall composition creates a sense of height and scale.

*Electricity energy
demand forecast is
done having assessed
the GDP growth
forecast*



Figure 2.3. Peak load forecast for Lithuania, MW



It is forecasted that due to the GDP increase in a base-case scenario, the energy demand for Lithuania in 2022 will increase to 12.8 TWh (an average annual growth of 2 per cent), in a pessimistic scenario – up to 12.3 TWh (annual growth about 1.6 per cent), and in an optimistic scenario – up to 13.9 TWh (annual growth about 2.8 per cent).

In 2022, in base-case scenario, the peak load may achieve 2180 MW, by pessimistic – 2120 MW and by optimistic – 2360 MW.

3. Capacities of power plants, 2013–2022

Changes in generating capacities of Lithuanian electricity system for the period 2013–2022 are planned on the basis of the information on prospective plans of the power stations, received at the end of 2012, and generation capacity development trends presented in the National Renewable Energy Development Strategy (approved by the Government Resolution of the Republic of Lithuania No. 789 of 21/06/2010), the National Renewable Energy Action Plan (submitted to the European Commission on 19/07/2010), the National Energy Strategy and Renewable energy Law No. XI-1375.

The plan takes into account generation sources, which are already under construction or preparatory works have started (obtained technical requirements for connection to the network), and which construction may be realistic by the evaluation of the transmission system operator:

- Unit 5 of Kruonis hydro pumped storage power plant – 225 MW (2016)
- New units of Kaunas power plant – 350 MW (2018)
- Second unit of Panevėžys power plant – 35 MW (2018)
- New Visaginas nuclear power plant – 1350 MW (2022)

Planning the future development of power plants using renewable energy sources (hereinafter – RES), not only stipulations of the Renewable Energy Law, but also the current situation is taken into account: applications to get technical requirements for connection to the network, agreed technical projects, signed letters of intent.

Capacities of power plants for 2022 are given in *Table 3.1*.

Table 3.1. Planned capacities of power plants, 31/12/2022, MW

Power plants	Installed capacity, MW	Available capacity, MW
Nuclear power plant:	1350	1303
Thermal power plants:	2186	2013
Lietuvos PP	1055	1020
Vilnius PP	372	333
Kaunas PP	350	320
Mažeikiai PP	210	144
Panevėžys PP	70	67
other PP	129	129
Hydro and hydro pumped storage power plants:	1267	1081
Kaunas HPP	101	90
Kruonis HPSPP	1125	950
small HPP	41	41
Plants using renewable energy resources:	873	859
wind	500	500
biofuel	355	341
solar	18	18
Total:	5676	5256

A photograph of a high-voltage electrical substation. In the foreground, a worker wearing a white hard hat, a yellow long-sleeved shirt, and red overalls stands on a gravel path, looking towards the right. The background is filled with complex electrical equipment, including tall metal structures, insulators, and power lines. A semi-transparent white box with a red border is overlaid on the left side of the image, containing text.

Future electricity generators, the construction or preparatory works of which has already begun are estimated in the plan.

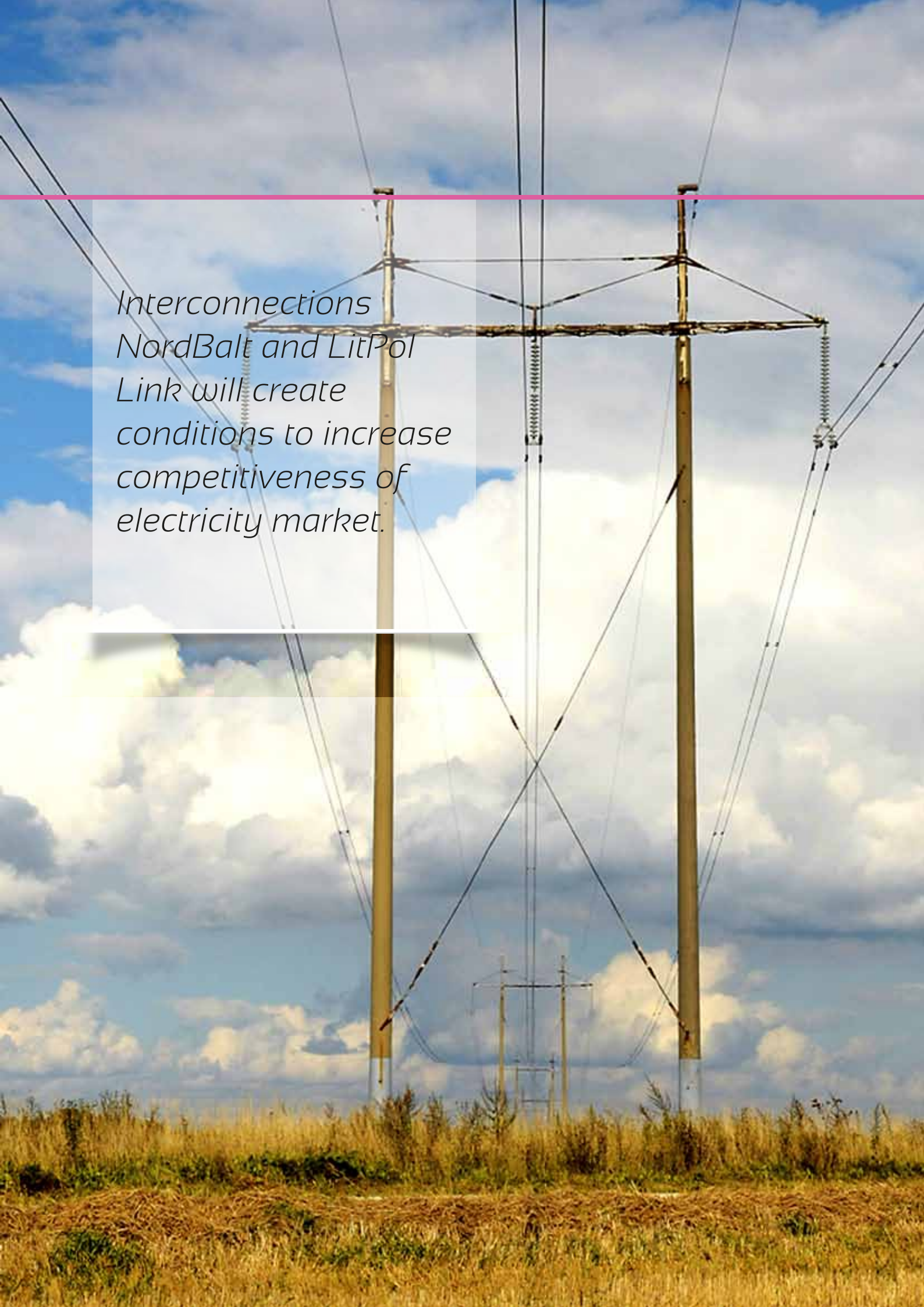
4. Electricity market 2013–2022

Predicted electricity price depends on the choice of assumptions on forecasted electricity demand, fuel prices, the price of carbon permits, subsidies for RES power plants, the production technologies, volumes and prices of electricity import from third-parties, the interconnections and developed scenarios. Start of operation of „NordBalt“ and „LitPol Link“ interconnections will have a significant impact and change the current price of electricity in Lithuania.

The results of electricity market analysis in Lithuania and Baltic States, performed in 2013 by Litgrid, show that in the base-case scenario in 2016 electric energy deficit in Lithuanian may rise to 8.1 TWh (Figure 4.1). Cheaper electricity production in the Nordic countries will determine the flow of electricity in North-South direction. Partly electricity demand in Lithuania will be met by imports from third

Figure 4.1. Energy balance and flows in base-case scenario for 2016



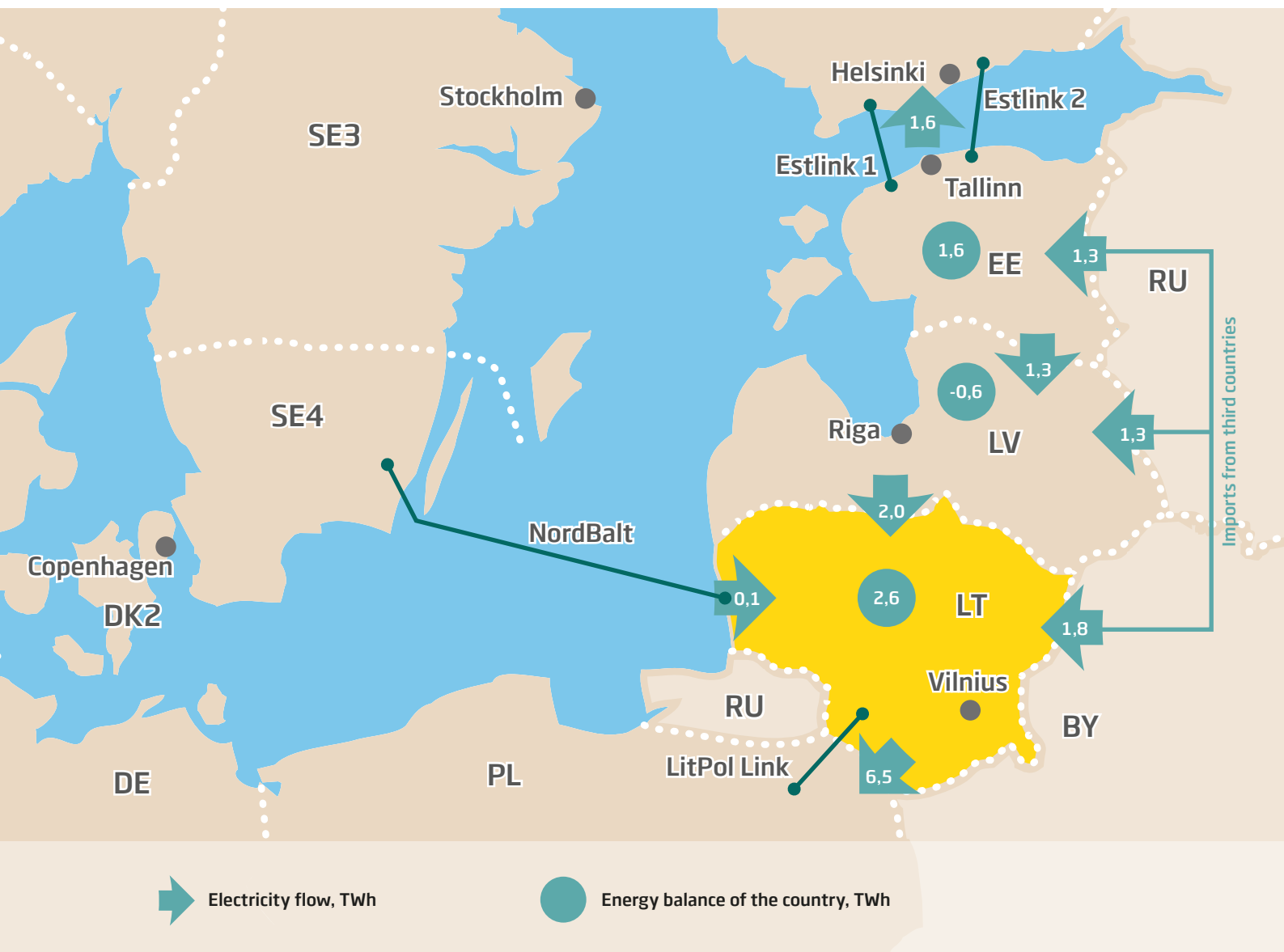
A photograph of high-voltage electrical transmission towers and power lines stretching across a landscape. The towers are made of metal and support multiple high-voltage cables. The sky is filled with large, white, fluffy clouds, and the foreground shows a field of dry, yellowish-brown grass. A semi-transparent white rectangular box is overlaid on the left side of the image, containing text.

*Interconnections
NordBalt and LitPol
Link will create
conditions to increase
competitiveness of
electricity market.*



countries. In 2022, with the launch of Visaginas NPP in Lithuania, the situation would change – Lithuania will become an exporting country (2.6 TWh in net exports) (Fig. 4.2). Due to higher electric energy prices in Poland, electricity exports to this country could reach 6.5 TWh per year. In case of reduction of the difference in electricity prices in Sweden and Lithuania, a decreased imported electricity flow from Scandinavia is foreseen in 2022.

Figure 4.2. Energy balance and flows in base-case scenario for 2022



5. Transmission network development scenarios, 2022

Scenario A (main), ECN + Visaginas NPP: This scenario assumes that the connections to the ECN will be implemented in the Baltic countries and the Visaginas NPP operation (*Figure 5.1*). This scenario requires the following:

- completed construction of interconnection with Sweden („NordBalt“);
- completed construction of interconnection with Poland („LitPol Link“);
- completed preparatory works for the synchronous connection to ECN: additional 110 kV overhead lines constructed in Eastern Lithuania, upgraded electrical control and monitoring systems, necessary number of back-to-back converters on borders with Belarus and Russia constructed, the second 400 kV electricity transmission line for synchronous connection with Poland constructed. The connection point in Poland for the second line is merely indicative and will be adjusted after the completion of “Feasibility study on interconnection variants for the integration of the Baltic States to the EU Internal Electricity Market” (hereinafter – the Feasibility study). This line will be built only after mutual agreement between the parties;
- completed construction of a new Visaginas NPP (1350 MW reactor) and necessary network modifications made;
- completed construction of new 330 kV lines: Klaipėda–Telšiai, Panevėžys–Mūša, Visaginas NPP–Kruonis HPSPP, Kruonis HPSPP – Alytus, Vilnius–Vilnia–Neris;
- completed construction of Mūša switchyard.

Back-to-back converter at Alytus substation will be moved from the direction to Poland to the Belarusian direction.

Figure 5.1. Scenario A (main), ECN + Visaginas NPP



Scenario B, ECN. This scenario assumes that in 2022 synchronous connections of the Baltic countries to the ECN will be implemented, but Visaginas NPP will not be built (Figure 5.2). This scenario requires the following:

- completed construction of interconnection with Sweden („NordBalt“);
- completed construction of interconnection with Poland („LitPol Link“);
- completed preparatory works for the synchronous connection with ECN: additional 110 kV overhead lines constructed in Eastern Lithuania, upgraded electricity control and monitoring system, necessary number of back-to-back converters on borders with Belarus and Russia constructed, second 400 kV electricity transmission line for synchronous connection with Poland is constructed. The connection point of the second line to Poland is merely indicative and will be adjusted after the completion of the Feasibility study. This line will be built only after mutual agreement between the parties;
- completed construction of new 330 kV lines: Klaipėda–Telšiai, Panevėžys–Mūša, Kruonis HPSP–Alytus, Vilnius–Vilnia–Neris;
- completed construction of Mūša switchyard;
- reconstruction of the existing Ignalina 330/110/10 kV substation, and construction of 500 MW DC back-to-back converter.

Back-to-back converter at Alytus substation will be moved from the direction to Poland to the Belarusian direction.

Figure 5.2. Scenario B, ECN



Scenario C, Visaginas NPP. This scenario assumes that in 2022 electricity systems of the Baltic States are in synchronous operation with the IPS/UPS and Visaginas NPP is in operation (Figure 5.3). This scenario requires the following:

- completed construction of interconnection with Sweden („NordBalt”);
- completed construction of interconnection with Poland („LitPol Link”) (back to back converter 2 x 500 MW);
- completed construction of new 330 kV lines: Klaipėda–Telšiai, Panevėžys–Mūša, Kruonis HPSPP–Alytus;
- completed construction of Mūša switchyard;
- new Visaginas NPP (1350 MW unit) built and network modifications made.

Figure 5.3. Scenario C, Visaginas NPP



Scenario D, Current situation (Status Quo). This scenario assumes that the power systems of the Baltic States are in synchronous operation with the IPS/UPS and a new nuclear power plant in Visaginas is not constructed (Figure 5.4). This scenario requires the following

- completed construction of connection with Sweden ("NordBalt");
- completed construction of connection with Poland ("LitPol Link") (back-to-back converter 2 x 500 MW);
- completed construction of new 330 kV lines: Klaipėda–Telšiai, Panevėžys–Mūša, Kruonis HPSPP–Alytus;
- reconstruction of the existing 330/110/10 kV Ignalina substation;
- completed construction of Mūša switchyard.

Figure 5.4. Scenario D, Status Quo



It should be noted that Scenario A is the main one, i.e. by 2022 NPP will operate in Lithuania and power systems of the Baltic countries will operate synchronously with ECN, thus, conclusions and recommendations are made in accordance with the calculations of this scenario. The remaining scenarios are conditional and can be used, when the situation on construction of a new nuclear power plant and / or implementation of synchronous operation with ECN is clarified.

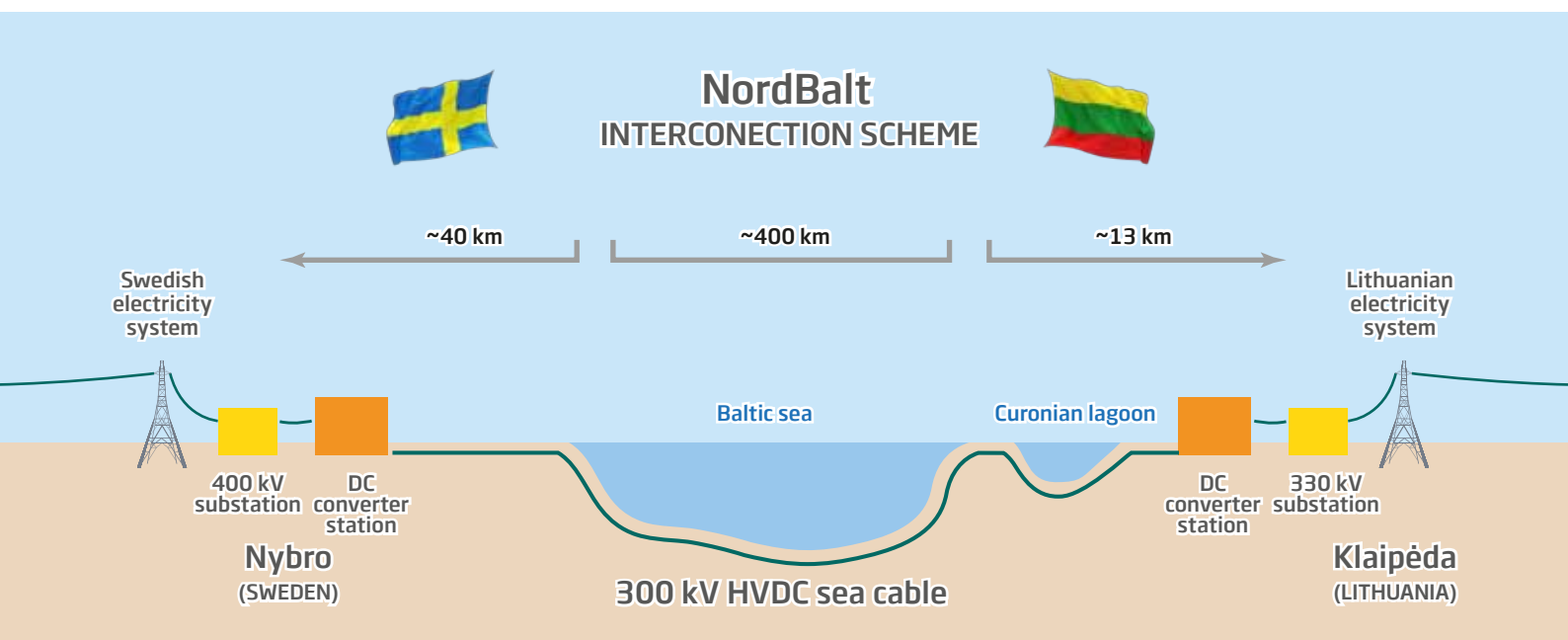
6. Reconstruction and development of transmission networks, 2013–2022

The transmission grid development planning is based on guidelines and assumptions defined in the National Energy Strategy and the company's strategy for 2013–2022. This includes construction of a new nuclear power plant, integration into the Nordic electricity market and the synchronous operation with ECN. If changes are done in the above mentioned documents, present scenarios and assumptions will have to be reviewed and adjusted.

6.1. Interconnection Lithuania–Sweden ("NordBalt")

The aim of the "NordBalt" project is to integrate Baltic energy systems into the Nordic electricity system and market, and to increase the region's energy security and reliability of electricity supply. The project is included in the Baltic Energy Market Interconnection Plan (BEMIP). The „NordBalt” link is a 700 MW capacity, 300 kV DC power cable from the 330/110/10 kV substation in Klaipėda to the 400 kV substation in Nybro (Sweden) and DC converter stations connected to the substations (*Figure 6.1*).

Figure 6.1. Interconnection Lithuania–Sweden



To operate the interconnection at its full capacity a new 330 kV line Klaipėda–Telšiai is under construction and 330 kV line Panevėžys–Mūša is necessary to build. The construction of the earlier mentioned 330 kV line will become very relevant after commissioning of new NPP, to transfer energy to the West direction.

To build a DC converter of a transmission line, 330/110/10 kV transformer substation in Klaipėda is being reconstructed. A new 330 kV overhead line Klaipėda–Telšiai will be connected to aforementioned 330 kV switchyard.

*Interconnection
NordBalt will start
operation by the end
of 2015.*

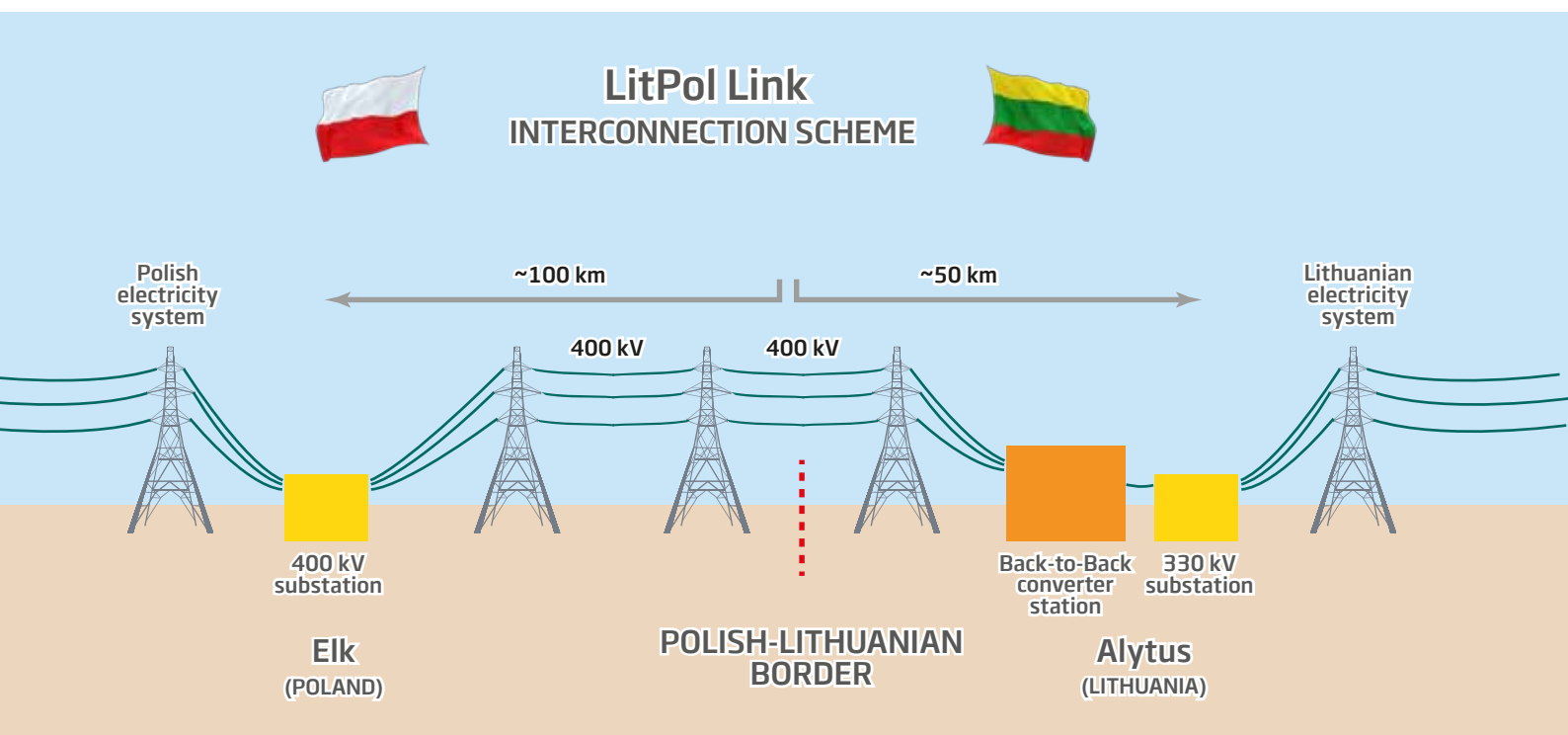




6.2. Interconnection Lithuania–Poland (“LitPol Link”)

In order to ensure the reliability of power supply, system stability and diversification of energy sources, both in Lithuania and in the Baltic region, and to integrate the Baltic electricity market into the EU market, an electricity bridge between Lithuania and Poland is planned to be built. Joint project is given the EU priority project status. To connect power systems a high-voltage (400 kV) double-circuit transmission line from Alytus to Elk (Poland) is going to be built, and 500 MW back-to-back converter at Alytus Substation to be installed in 2015, the second 500 MW back-to-back converter - in 2020* (Fig.6.2).

Figure 6.2. Interconnection Lithuania–Poland



To ensure power exchange via interconnection, a 330 kV double-circuit electricity transmission line Kruonis HPSP–Alytus should be constructed before the start of operation of the “LitPol Link”.

Also it is planned to construct a 330 kV electricity transmission line Visaginas NPP–Kruonis HPSP, which is associated with the power transfer from the Visaginas NPP.

“LitPol Link” is required to connect electricity infrastructure of Lithuania and Poland, as well as Lithuanian and Western European electricity markets. After the construction of this link Lithuania will gain infrastructure required to arrange connection of the Lithuanian electricity system to the ECN for synchronous operation.

* The construction of the second 500 MW DC B2B at Alytus Substation will depend on the start of synchronization with ECN.

6.3. Connection with the European Continental Network for synchronous operation

One of the most important objectives held in the National Energy Independence Strategy is synchronous operation of the Lithuanian power system with ECN as defined in the Law on the Integration of Lithuanian Power System into the European Continental Network adopted by the Parliament of the Republic of Lithuania on June 12, 2012.

According to preliminary results of the feasibility study carried out by the Swedish company Gothia Power, the minimum expansion of transmission network on the territory of Lithuania, which is necessary to ensure the stable and reliable operation of the system and is directly related to the integration of the Lithuanian system for synchronous operation with ECN, was set. As one of the possible second 400 kV double-circuit overhead line between Poland and Lithuania (mutual agreement of the Parties is needed) connection point Gothia Power study proposes a new 400/330 kV Marijampolė Substation. The existing 330 kV line Kruonis HPSP–Sovietisk and a new double-circuit 330 kV line from Marijampolė to 330 kV line Kaunas–Jurbarkas will be connected to the new Marijampolė Substation. The transition to synchronous operation of the Baltic countries with ECN requires installation of DC converters to connect 330 kV interconnection lines between the Baltic countries, Russia and Belarus. Construction of new 330 kV electricity transmission line Vilnius–Vilnia–Neris is necessary for synchronous operation with ECN and for meeting the System (N-I) criteria, also the construction of additional 110 kV lines is necessary to increase reliability of 110 kV network in Eastern Lithuania. In case the decision to synchronize with ECN will be made later, implementation of these lines should be postponed.

Depending on final recommendations of the feasibility study the basic elements of the transmission network development should be reviewed and, if necessary, list of new transmission network facilities as well as parameters foreseen and the Plan should be modified.

6.4. Connection of a new nuclear power plant

When a new nuclear power plant in Visaginas is constructed and the planned connection of the Lithuanian power system for synchronous operation with ECN is assessed, the following development of 330 kV network will be essential for the reliable operation and the transfer of Visaginas NPP power to the system: installation of a new Visaginas NPP 330/110 kV switchyard, the construction of 330 kV lines Visaginas NPP–Kruonis HPSP (this line is only necessary if the Lithuanian power system is in synchronous operation with ECN and Visaginas NPP is in operation) and Visaginas NPP–Likсна (Latvia) (line will be built subject to the approval of both TSOs).



6.5. Development of 330–110 kV transmission network in Lithuania

Litgrid is not planning the construction of new 110 kV substations on its own initiative. Construction of new 110 kV substations often results from appearance of new electricity users (consumers or producers) or quick growth of demand. The following 110 kV substations are planned to be built during 2013–2022 (*Fig. 6.5.1*):

- Šnipiškės substation and Kuprijoniškės substation (since new substations are to be built in urban area, it is planned to connect them to the system by underground cable);
- Lazdėnai substation (to be connected to the existing 110 kV line Vilnius–E3–Vievis);
- Sitkūnai substation (to be connected to the existing 110 kV line Kaunas–Vandžiogala);
- Aleksandrija substation (since substation is planned to be built in densely populated urban area in Šiauliai, to connect this substation to the system cable will be laid);
- Dirvupiai substation (to be connected to the existing 110 kV line Klaipėda–Kretinga);
- Drūkšiai substation (to be connected to Visaginas NPP substation 110 kV switchyard);
- Construction of 110 kV switchyard and installation of power transformer at 330 kV Bitėnai switchgear.

With a progress of the railway Rail Baltica electrification project 4 substations are planned to be built by 2020, which will ensure electrification of the railway line Kaišiadorys–Radviliškis: 110/27,5/10 kV Jonava trauka substation, 110/27,5/10 kV Radviliškis trauka substation, 110/27,5/10 kV Gudžiūnai trauka substation and 110/27,5/10 kV Kėdainiai trauka substation.

Not only electrical facilities of distribution network operator or users must be connected to the transmission grid, but also producers' equipment. New wind farms' connection to the grid requires construction of new 20/110 kV substations. Producers are connected to the transmission network in accordance with the Resolution No. 1-127 of the Order (2012-07-04) of the Minister of Energy of the Republic of Lithuania confirming connection procedure description of the electric energy producers' and consumers' appliances to the electricity network. Construction of 330–110 kV lines is related to reliability increase of the transmission network and the appearance of interconnections, as well as to the synchronous connection with ECN and Visaginas NPP construction plans. 110 kV lines Šilas–Varėna, Neris–Baltupis, Kaunas–Eiguliai 2 (*Figure 6.5.2*) are planned to be built in Central and Eastern Lithuania to ensure required voltage levels and to increase reliability of power supply.

110 kV lines Klaipėda–Marios 3, Kretinga–Benaičiai (also important for transmission of power generated by wind farms to the system) and double-circuit line Pagėgiai–Bitėnai (*Figure 6.5.3*) are necessary to ensure reliability of the transmission grid in Western Lithuania.

Transmission grid of Lithuania for 2022 is given in Appendix I.

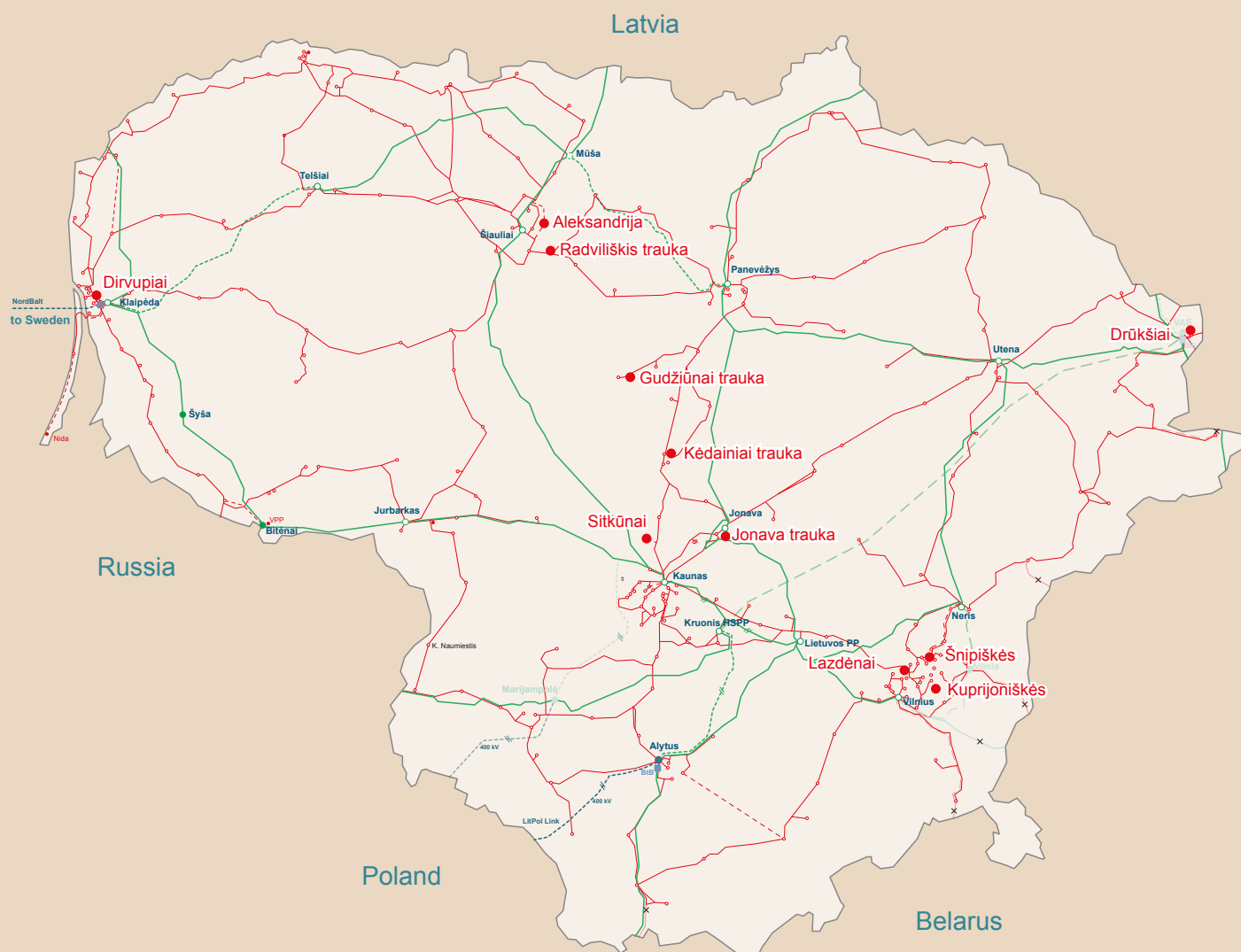


Fig. 6.5.1 Construction of new 110 kV transformer substation.

● New 110 kV transformer substation

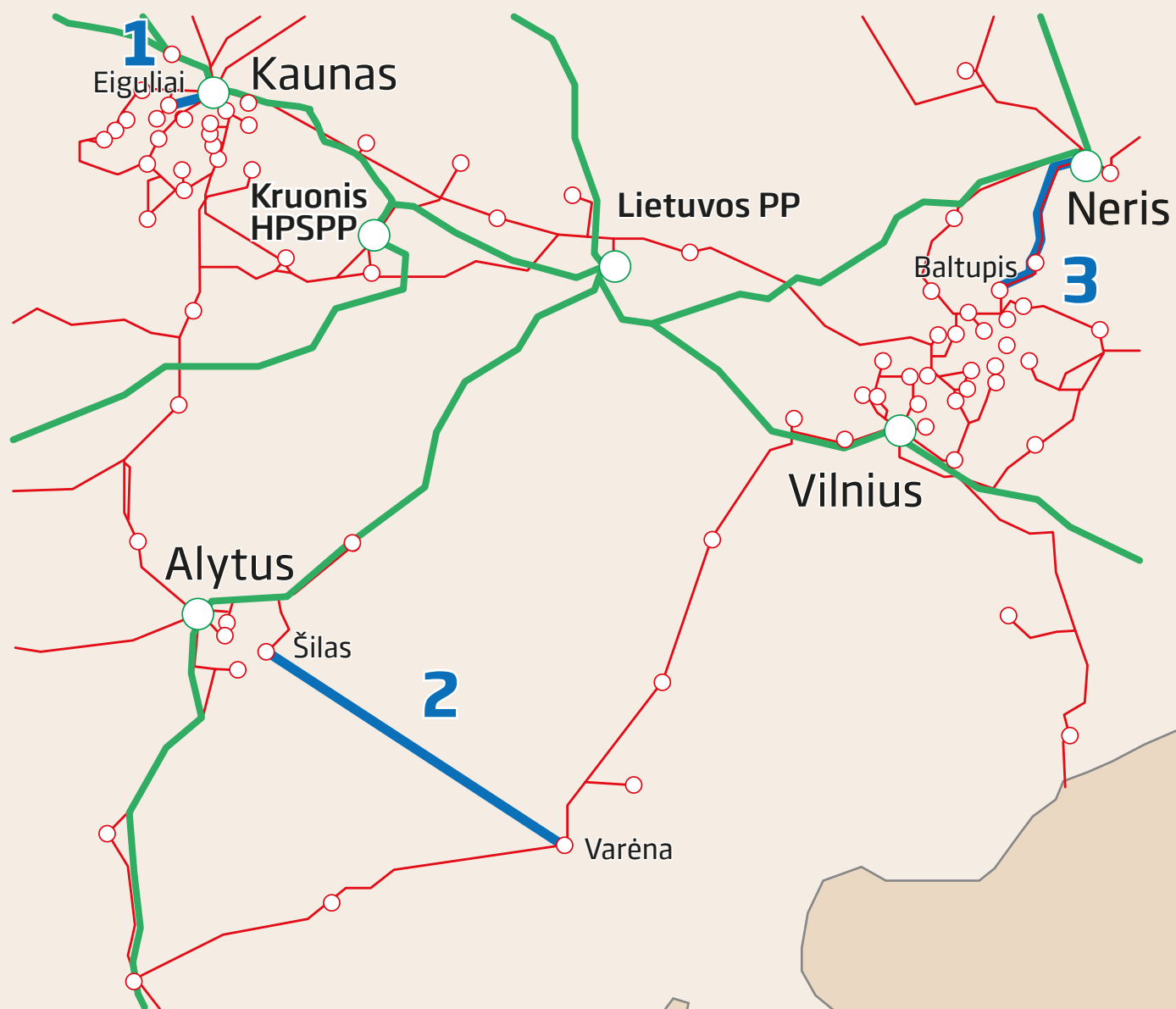
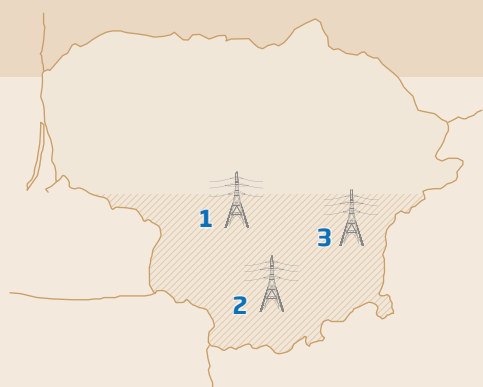


Figure 6.5.2 Construction of new 110 kV electricity transmission lines in Middle and Eastern Lithuania



- 110 kV transmission line
- 330 kV transmission line
- Planned 110 kV transmission lines:
- 1 Kaunas-Eiguliai (second line)
- 2 Šilas-Varėna
- 3 Neris-Baltupis
- 110 kV transformer substation
- 330 kV transformer substation

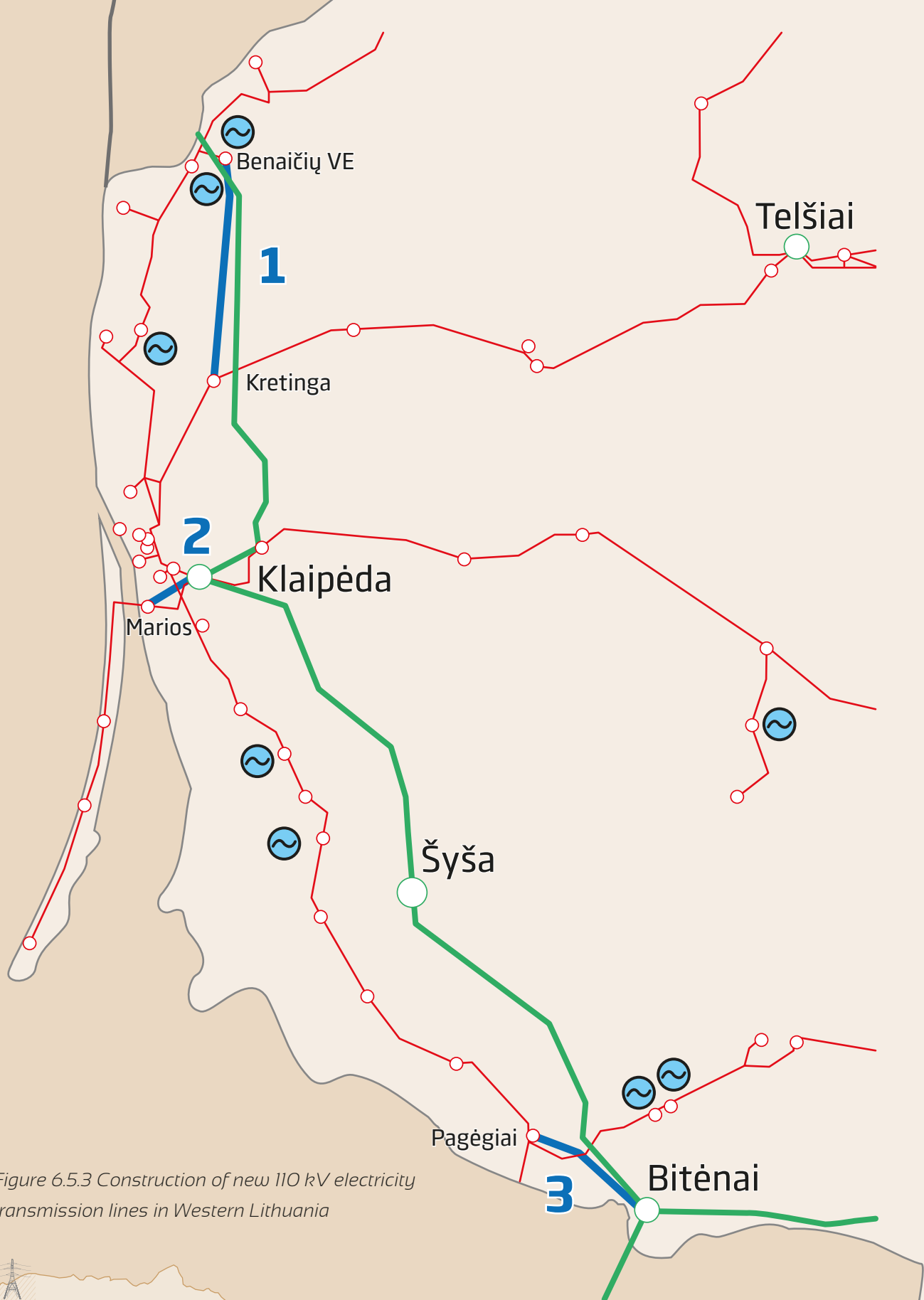
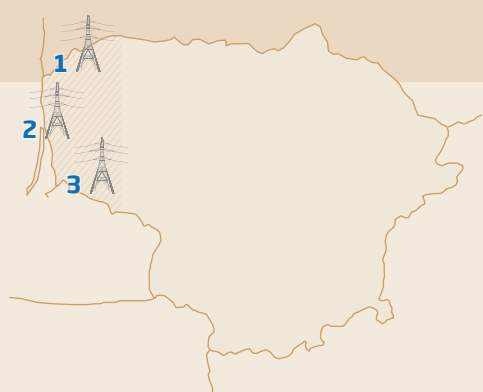


Figure 6.5.3 Construction of new 110 kV electricity transmission lines in Western Lithuania



- 110 kV transmission line
- 330 kV transmission line
- Planned 110 kV transmission lines:
- 1 Kretinga-Benaičiai
- 2 Klaipėda-Marios (third line)
- 3 Pagėgiai-Bitėnai
- 110 kV transformer substation
- 330 kV transformer substation
- ⊙ Wind power plant



6.6. Reconstruction of 330–110 kV transmission grid in Lithuania

It is planned to finish reconstruction of the following 330 kV substations during 2013-2022:

- 330 kV Klaipėda substation – reconstruction project is on-going and scheduled to be finished in 2014.
- 330 kV Šiauliai substation – 330 kV switchyard was reconstructed in 2002. 110 kV switchyard is currently under reconstruction, which is scheduled for completion in 2014.
- 330 kV Panevėžys substation – reconstruction of the substation with the equipment replacement is scheduled for completion in 2014.
- After 2015 reconstructions of 330 kV Neris, Jurbarkas and Jonava substations are planned to be started.

The main objective for planning reconstruction of transmission network is to maintain a sufficient level of reliability for the highest number of users at the lowest cost. Reconstruction of 110 kV substations is carried out under reconstruction volume methodology approved by the company. According to the methodology, 110 kV substation technical condition assessment was carried out and the list of substations that need reconstructions was formed.

330–110 kV electricity transmission lines are reconstructed in accordance with the assessment methodology for technical condition of main elements of 330–110 kV overhead lines and determination of reconstruction volumes approved by the company in 2013. The reconstruction of a section of 330 kV line Šiauliai–Jelgava (continuing to the Lithuanian border), and the replacement of the reinforced concrete pylons of 330 kV Lietuvos PP–Alytus and Jonava–Panevėžys lines are scheduled for 2013–2022. The reconstruction of 110 kV lines Merkinė–Varėna–Valkininkai–Rūdiškės–Trakai and Zarasai–Ignalina NPP is also planned.

When reconstruction or construction new 110 kV lines in cities or residential areas are necessary, the existing infrastructure must be taken into account. If there is not enough space for overhead lines because of existing buildings or other infrastructure then underground cable lines are built. In case the other legal person initiated replacement of overhead lines by cable lines, cost of replacement have to be covered by initiator (according to the „Procedure description of connection to the network of electric appliances belonging to producers and consumers of electric energy“ approved by the Order No I-127 of June 4, 2012 of the Minister of Energy of the Republic of Lithuania).

7. Investment into transmission network, 2013–2022

The total planned investment in transmission grid consists of investment for the implementation of strategic projects, investment for transmission grid reliability, investment for information technology and other projects, and investment initiated by users and producers.

It is expected that for 2013–2022 the total investment for development and reconstruction of transmission grid could amount to about 3084 million LTL. Litgrid investment for development and reconstruction of the transmission network could make around 2908 million LTL (including only investments in strategic, reliability, ITT and etc. projects).

The major part of the planned investment to transmission grid for 2013–2022 will be allocated for the construction of interconnections with Poland and Sweden, and for preparation to synchronous operation with ECN (Table 7.1).

Table 7.1. Planned investment in development and reconstruction of transmission network

Main investment groups	Planned investments, Million LTL 2013–2022
Strategic projects	2150,5
Interconnection Lithuania–Sweden and associated projects (construction of cable and DC converter, 330 kV lines Klaipėda–Telšiai and Panevėžys–Mūša and Mūša switchyard)	789,2
Interconnection Lithuania–Poland and associated projects (construction of 400 kV line Alytus–Elk (to the State border) and back-to-back converter, construction of 400 kV Alytus switchyard, reconstruction of 330 kV and 110 kV Alytus substation, construction of new 330 kV lines Kruonis HPSP–Alytus and Visaginas NPP–Kruonis HPSP*)	594,4
Grid preparation for synchronous operation with ECN* (Feasibility study, construction of additional lines to increase reliability in 110 kV network in Eastern Lithuania, construction of the second interconnection between Lithuania and Poland, construction of 330 kV line Vilnius–Vilnia–Neris and installation of automatic generation control and primary control monitoring systems)	766,9
Projects necessary to ensure network reliability	693,5
ITT and other projects	63,9
Litgrid investment, total	2907,9
Projects initiated by network users and producers	176,2
Investment for network development and reconstruction (scenario A), total:	3084,1
Investment for network development and reconstruction (scenario B), total:	2791,7
Investment for network development and reconstruction (scenario C), total:	2384,3
Investment for network development and reconstruction (scenario D), total:	2230,0

* Implementation of projects will depend on the decision to construct a new nuclear power plant and/or synchronous operation with ECN implementation deadline

The Company estimates that according to the main scenario and taking into account the current regulative policy of the transmission tariff, the forecasted component of electricity price, depending on investment volume in the transmission grid for 2013–2022 could be from 1.85 to 2.05 LTct/kWh, and should not exceed price component in 2013, i.e. 2.05 LTct/kWh.

A close-up, low-angle shot of a high-voltage electrical substation. The image features several large, dark brown ceramic insulators with multiple ridges, mounted on metal frames. A prominent horizontal metal arm with a green and yellow striped safety rail is visible in the foreground. The background shows a complex network of metal ladders and cross-arms against a clear blue sky.

The major part of the planned investment to transmission grid for 2013-2022 will be allocated for the construction of interconnections with Poland and Sweden

CONCLUSIONS AND RECOMMENDATIONS

Lithuanian electric power system, electricity demand, production and market

Nineteen 400/330 kV and two hundred and twenty nine 110 kV substations and switchyards are planned to be in operation in Lithuania in 2022. Total length of 400-110 kV electricity transmission lines will amount to 7821 km.

It is forecasted that electricity demand will increase from 10,61 TWh in 2012 to 13,9 TWh in 2022, i.e. about 2.8% per year, and peak load – from 1715 MW in 2012 to 2360 MW in 2022.

The estimated total installed capacity of power plants in 2022 will be 5676 MW, of which nuclear power plants will account for 1350 MW, thermal power plants – 2186 MW, hydro and hydro pumped storage power plants – 1267 MW and RES power plants – 873 MW.

In 2022 after the launch of Visaginas NPP, Lithuania would become an exporting country, annually exporting about 2.6 TWh of electricity. Re-exports to Poland will amount to almost 6.5 TWh per year.

Development of the transmission grid

The most significant transmission grid development projects in the next few years are construction of interconnection links with Sweden ("NordBalt") and with Poland ("LitPol Link"), which are scheduled to begin operation by the end of 2015. The "NordBalt" project will integrate electricity systems and electricity markets of the Baltic countries to the Nordic. This will improve Lithuania's energy security and reliability of electricity supply. „LitPol Link" project will integrate the infrastructures of the Baltic countries into the common European power system and the European electricity market. The project will form the Baltic electricity ring, which includes the power systems of Lithuania, Latvia, Estonia, Finland, Sweden, Norway, Denmark, Poland and Germany.

The implementation of these projects requires development of internal network:

- to achieve full exploitation of the „NordBalt" interconnection it is necessary to build 330 kV lines Klaipėda–Telšiai and Panevėžys–Mūša, installation of 330 kV Mūša switchyard is required to connect the line;
- to ensure 1000 MW power exchange between Lithuanian and Polish electricity systems it is necessary to construct a 330 kV double-circuit line Kruonis HPSP–Alytus.

To integrate the Baltic power systems into the European Continental Network for synchronous operation, construction of new interconnections and development of internal electricity networks will be required. Specific projects will be identified after the upcoming Feasibility Study, prepared by the company Gothia Power.



*It is forecasted that
Lithuanian electricity
demand will increase
from 10,61 TWh in 2012
to 13,9 TWh in 2022*



Integration of the new nuclear power plant (Visaginas NPP) into the Lithuanian power system requires construction of 330/110 kV switchyard. Construction of 330 kV line Visaginas NPP –Kruonis HPSP is necessary for reliable operation of the transmission network, as well as for power transfer from Visaginas NPP to the system, 1000 MW power flow transfer to Poland, and full use of Kruonis HPSP.

Improvement of 330 kV transmission network in the section between Visaginas NPP and Salaspils (Latvia) is necessary for power transmission northwards from Visaginas NPP. One alternative is the construction of 330 kV line Visaginas NPP –Liksna (consent of both parties needed).

The construction of new 330–110 kV substations is often resulting from emergence of new users and producers, rapid demand growth, development trends of the distribution and transmission networks. About twelve substations, initiated by distribution network operator and consumers, are planned to be built by 2022.

To guarantee the required voltage level and to increase reliability of the electricity supply in the 110 kV network in Lithuania it is recommended to build the following new 110 kV transmission lines: Neris–Baltupis, Kaunas–Eiguliai 2, Šilas–Varėna, Klaipėda–Marios 3, Pagėgiai–Bitėnai.

Investment

It is forecasted that during 2013–2022 total investment in the development and reconstruction of transmission grid can amount to 3084 million LTL:

- major part of planned investments in transmission grid will be required for construction of interconnection lines and network preparation for synchronous operation with ECN projects: 789 million LTL „NordBalt” and related projects, 594 million LTL „LitPol Link” and related projects and 767 million LTL network preparation for operation with ECN respectively, which is about 2151 million LTL in total;
- planned investments for transmission system reliability projects amount to around 693,4 million LTL, of which about 278,2 million LTL for network development, about 391,6 million LTL for network reconstruction and recovery, and about 23,6 million LTL for 330–110 kV substations major repairs;
- approximately 64 million LTL is planned for the information technology, telecommunications and control systems, introduction of technological tools, upgrading of computer hardware and software and other projects of the company.

It is planned that investments for 2013–2022 to projects initiated by producers and users of the network could reach about 176 million LTL.

Under the current transmission tariff regulation policy, the projected price component of electricity, resulting from the investment in electricity transmission grid for 2013–2022, could be from 1.85 to 2.05 LTct/kWh, and should not exceed the price component of 2013.

Annex 1. Lithuanian Electricity Transmission Network Map in 2022

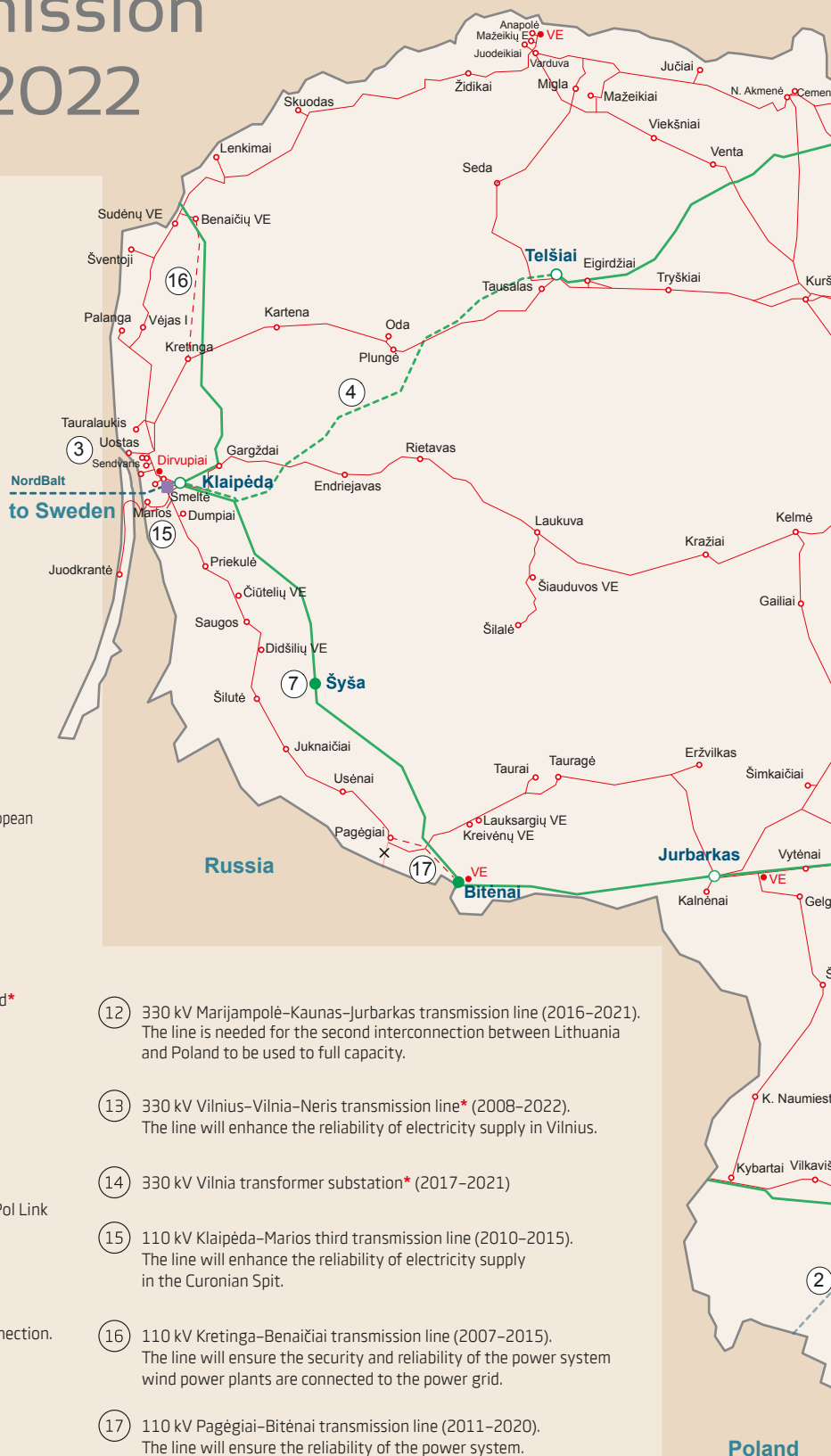
Legends:

- 330 kV transmission line
- - - Planned 330 kV transmission line
- - - Planned interconnection
- 110 kV transmission line
- - - Planned 110 kV transmission line
- // Double-circuit electricity transmission line
- Planned 400 kV transformer substation
- 330 kV transformer substation
- Planned 330 kV transformer substation
- Planned 330 kV switchyard
- 110 kV transformer substation
- Planned 110 kV transformer substation
- DC converter station
- HVDC back-to-back station
- ✱ Wind power plant
- X Disconnected transmission line*
- (- - -) Interconnections which require mutual agreement
- (- - -) Indicative line, the precise location of which will be known upon completion of the Feasibility Study
- (- - -) Planned projects, the terms for construction of which depend on the implementation of the synchronous operation with Continental European Network and the decision on the construction of VNPP

Explanations:

- ① 400 kV LitPol Link interconnection (2008–2015)
- ② Second 400 kV interconnection between Lithuania and Poland* (2016–2021)
- ③ 300 kV NordBalt interconnection (2009–2015)
- ④ 330 kV Klaipėda–Telšiai transmission line (2006–2014)
- ⑤ 330 kV Kruonis HPSP–Alytus transmission line (2011–2016). The line is needed for full utilization of the LitPol Link interconnection.
- ⑥ 330 kV Panevėžys–Mūša transmission line and the Mūša switchyard (2007–2022). The line is needed for full utilization of the NordBalt interconnection.
- ⑦ 330 kV Šyša transformer substation (2015–2018)
- ⑧ 330 kV VNPP transformer substation* (2016–2021)
- ⑨ 330 kV VNPP–Kruonis HPSP transmission line* (2017–2022). The line is necessary for reliable operation of the Lithuanian power grid once the new nuclear power plant begins to operate.
- ⑩ 330 kV VNPP–Liksna transmission line* (only if both parties consent). The line is necessary to strengthen the interconnection between Lithuania and Latvia.
- ⑪ 330 kV Marijampolė transformer substation* (2016–2021)
- ⑫ 330 kV Marijampolė–Kaunas–Jurbarkas transmission line (2016–2021). The line is needed for the second interconnection between Lithuania and Poland to be used to full capacity.
- ⑬ 330 kV Vilnius–Vilnia–Neris transmission line* (2008–2022). The line will enhance the reliability of electricity supply in Vilnius.
- ⑭ 330 kV Vilnia transformer substation* (2017–2021)
- ⑮ 110 kV Klaipėda–Marios third transmission line (2010–2015). The line will enhance the reliability of electricity supply in the Curonian Spit.
- ⑯ 110 kV Kretinga–Benaičiai transmission line (2007–2015). The line will ensure the security and reliability of the power system wind power plants are connected to the power grid.
- ⑰ 110 kV Pagėgiai–Bitėnai transmission line (2011–2020). The line will ensure the reliability of the power system.
- ⑱ 110 kV Kaunas–Eiguliai second transmission line (2016–2020). The line will enhance the reliability of power supply in Kaunas.
- ⑲ 110 kV Neris–Baltupis transmission line (2017–2021). The second circuit of the line will increase the reliability of electricity supply to the northern part of the city of Vilnius.
- ⑳ 110 kV Šilas–Varėna transmission line (2018–2021). The line will enhance the reliability of power supply in southern Lithuania.
- ㉑ Transmission lines needed to increase the reliability of power supply of the 110 kV grid in the eastern part of Lithuania* (2015–2020).

* Implementation of the project depends on the Visaginas Nuclear Power Plant (VNPP) construction decision and/or the project implementation period for synchronous operation with the European Continental Network



Poland



Annex 2. Implementation of investment for Strategic project

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
NordBalt	Construction of DC cable Klaipėda-Nybro and converter station in Klaipėda substation	Construction								
	Construction of 330 kV transmission line Klaipėda-Telšiai	Construction								
	Construction of 330 kV transmission line Panevėžys-Mūša* and 330 kV Mūša switchyard			Preparation works		Technical project design			Construction	
LitPol Link	Construction of 400 kV transmission line Alytus-Eik (Lithuanian crossborder)	Construction								
	Construction of 330 kV transmission line Kruonis HPSPP-Alytus	Technical project design	Construction							
	Reconstruction of 330 kV switchyard in 330/110/10 kV substation Alytus	Construction								
	Reconstruction of 110 kV switchyard in 330/110/10 kV substation Alytus	Construction								
	Construction of 330 kV transmission line Visaginas NPP-Kruonis HPSPP*			Preparation works	Technical project design				Construction	
Network preparation for synchronous interconnection with ECN	Feasibility study on interconnection variants for the integration of the Baltic States to the EU Internal Electricity Market	On-going								
	Construction of new 110 kV line for reliability of transmission network in Eastern part of Lithuania*			Preparation works	Technical project design	Construction				
	New interconnection between Lithuania and Poland*			Preparation works	Technical project design	Construction				
	Interconnection via B2B*					Preparation works	Technical project design	Construction		
	Construction of 330 kV transmission line Vilnius-Vilnia-Neris*			Preparation works	Technical project design				Construction	

■ Preparation works ■ Technical project design ■ Construction

* Implementation of projects will depend on decision to construct a new nuclear power plant and/or synchronous operation with ECN implementation deadline

Annex 3. Implementation of investment for construction of new objects

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Construction of 330/110/10 kV substation Visaginas NPP*			Preparation works	Technical project design	Construction					
Construction of 330 kV switchyard in 110/10 kV substation Vilnia*				Preparation works	Technical project design	Construction				
Construction of 110 kV transmission line Pagėgiai-Bitenai and expansion of 330 kV switchyard Bitėnai		Preparation works	Technical project design	Construction						
Construction of 110 kV transmission line Kretinga-Benaičiai		Technical project design	Construction							
Construction of 110 kV transmission line Klaipėda-Marijos (third line)		Technical project design	Construction							
Construction of 110 kV transmission line Kaunas-Eiguliai (second line)			Preparation works	Technical project design	Construction					
Construction of 110 kV transmission line Neris-Baltupis				Preparation works	Technical project design	Construction				
Construction of 110 kV transmission line Silas-Varėna					Preparation works	Technical project design	Construction			

 Preparation works
  Technical project design
  Construction

* Implementation of projects will depend on decision to construct a new nuclear power plant and/or synchronous operation with ECN implementation deadline

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