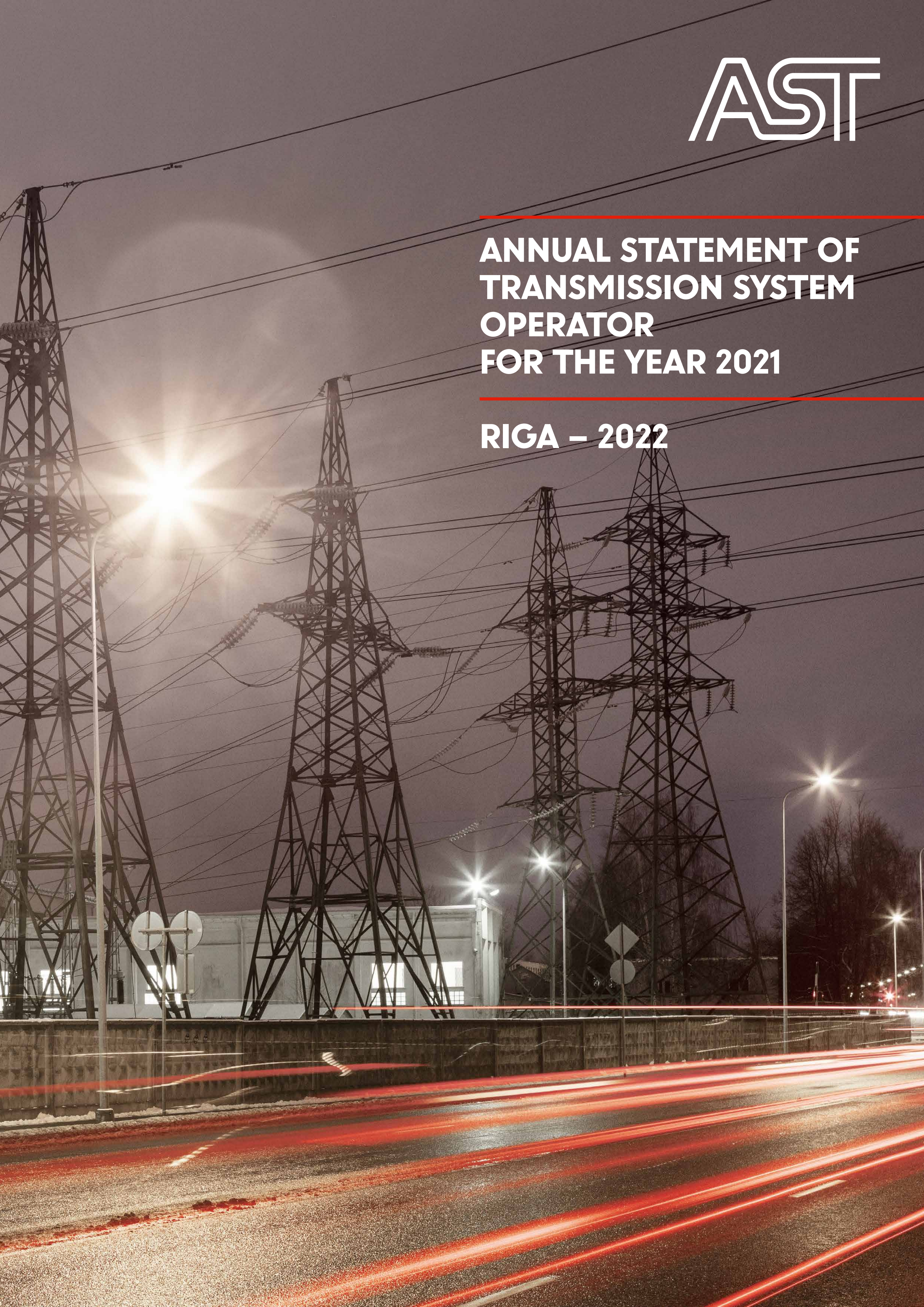
AST

ANNUAL STATEMENT OF TRANSMISSION SYSTEM OPERATOR FOR THE YEAR 2021

RIGA – 2022



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The report has been prepared in accordance with the Regulations No. 322 “Regulations on the TSO’s annual statement” by the Cabinet of Ministers of the Republic of Latvia, in accordance with the informative report on the Latvian Long-Term Energy Strategy for 2030 and the National Energy and Climate Plan 2021–2030 developed by the Ministry of Economics (NECP)

1.

NATIONAL ELECTRICITY AND CAPACITY DEMAND IN THE PREVIOUS YEAR

1.1. Electricity consumption (nett) by week for year 2021

The total annual electric energy consumption, excluding electric energy losses is 7 382 226 MWh.

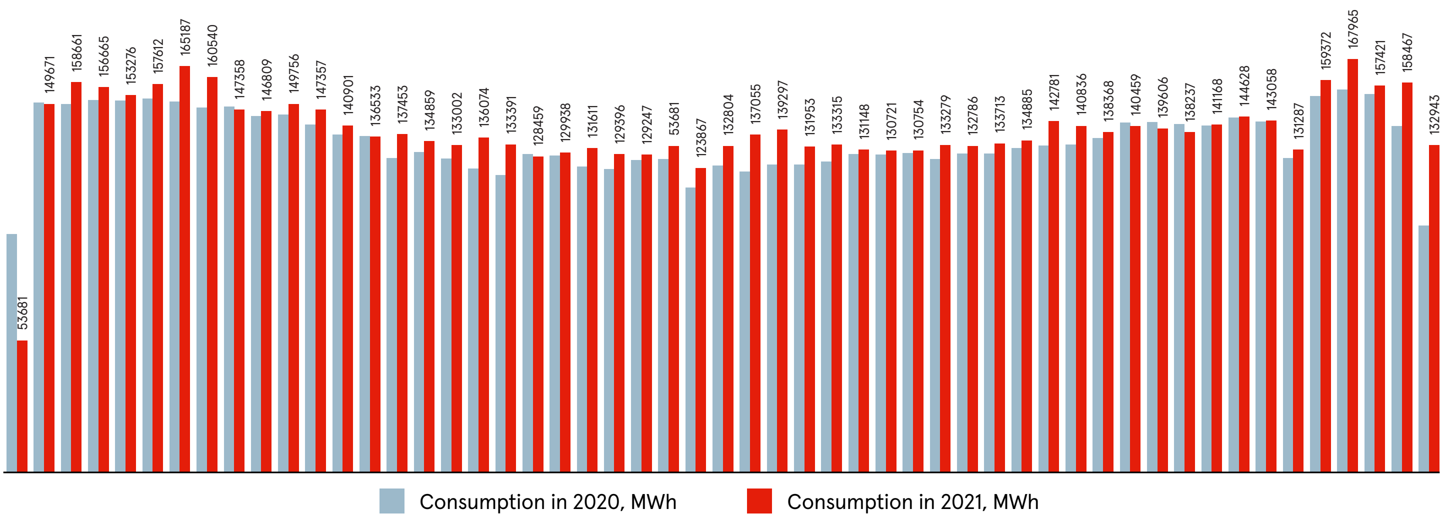
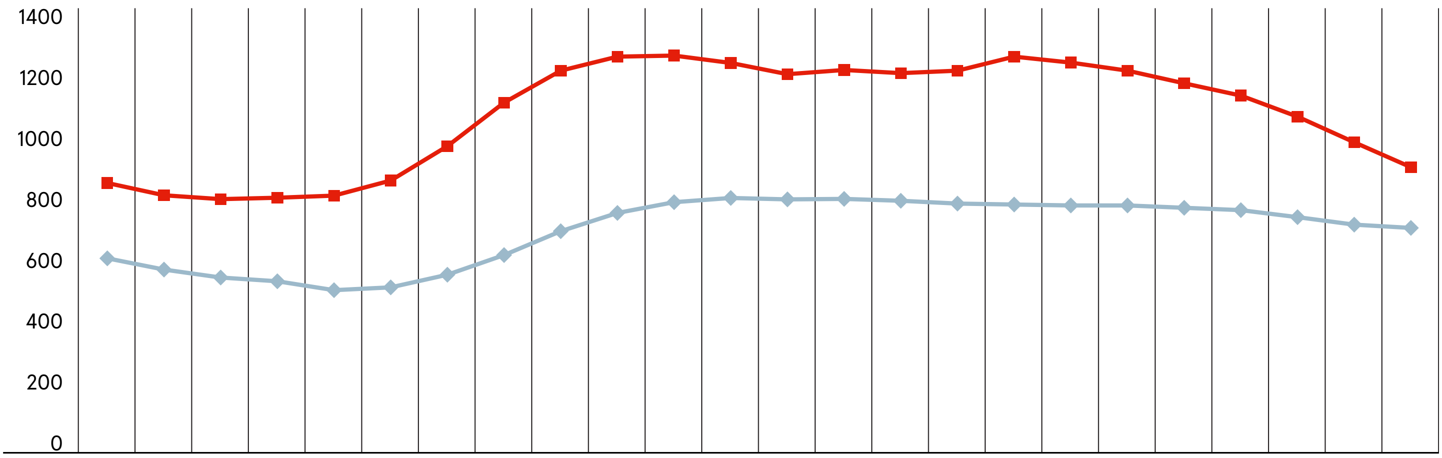


Fig. 1 Weekly electric energy consumption in Latvia (nett), MWh

1.2. Maximum winter peak load and minimum summer load (control-measurement data, MWh/h)

Minimum load:	516 MW	25.06.2021. g.	05.00
Maximum load:	1251 MW	09.12.2021. g.	11.00

1.3. System load in control measurement days (24 hours)



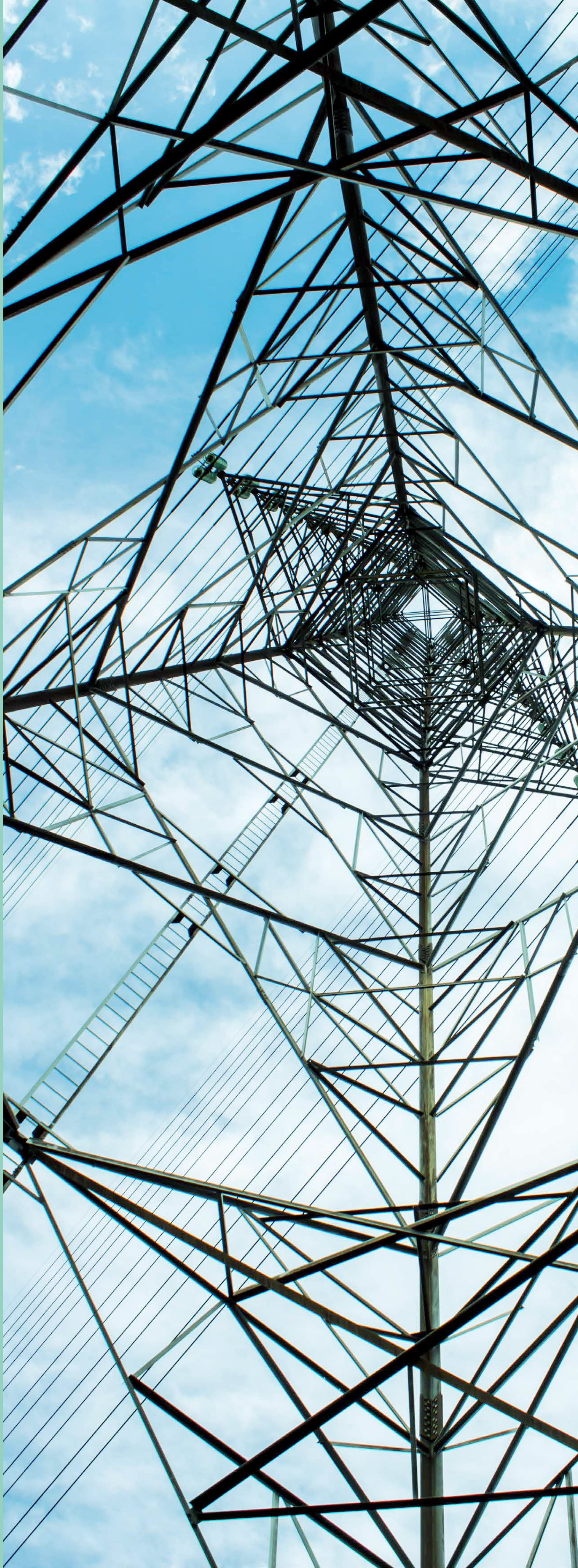
	01:00	02:00	03:00	04:00	05:00	06:00	07:00	08:00	09:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	00:00
9. DEC MWh	850	811	800	804	811	856	967	1105	1204	1249	1251	1230	1196	1204	119	1204	1250	1231	1207	1165	1128	1061	980	902
25. JUN MWh	613	579	555	543	516	522	561	622	699	758	791	802	800	799	795	788	782	779	776	770	762	740	721	707

9th december MWh   25th june MWh

Fig. 2 System load during 24 hours

2.

ELECTRICITY AND POWER DEMAND IN THE COMING YEARS (MINIMUM FORECAST PERIOD - 10 YEARS), INCLUDING THE ANNUAL ELECTRICITY CONSUMPTION AND PEAK LOADS BY SCENARIOS



The maximum load of the electricity system has been calculated (normalized) based on the Latvian GDP growth forecast, submitted by the Ministry of Economy of the Republic of Latvia at the average regulated ambient temperature during winter period (December – February) -3.5 °C (see Table 1). Changes in outdoor temperature also affect changes to the maximum load. Electricity system consumption has been forecasted for three economic development scenarios – Conservative (A), Base (B) and Optimistic (EU2030).

Table 1

Year	Annual consumption for Conservative scenario (A) GWh	Annual consumption for Base scenario (B) GWh	Annual consumption for Optimistic scenario (EU2030) GWh	Peak load MW
2022	7361	7474	7511	1273
2023	7408	7542	7608	1294
2024	7436	7591	7686	1313
2025	7465	7642	7767	1332
2026	7489	7688	7843	1350
2027	7509	7731	7917	1368
2028	7528	7774	7992	1387
2029	7551	7821	8072	1406
2030	7570	7864	8149	1425
2031	7588	7908	8227	1445
2032	7605	7951	8306	1465

3.

ADEQUACY ASSESSMENT OF SUPPLY AND CONSUMPTION IN THE REPORTING PERIOD AND FORECAST FOR THE FOLLOWING YEARS (MINIMUM FORECAST TERM - 10 YEARS)

3.1. Annual electricity demand and possible sources to cover it

The forecast of the electric energy and power balance, as well as the forecast of electricity consumption, have been developed for three scenarios, where all scenarios include the synchronization of the Baltic States with Continental Europe, starting from 2026. This detailed analysis of the scenarios has been selected on the basis of the Political Roadmap set by the Heads of Government of the European Commission, the Baltic States and Poland on June 28, 2018 by European Commission, Baltic States and Poland on the synchronization of the Baltic electricity transmission grids with the electricity grid of Continental Europe, as well as on the basis of agreement on the connection of the Baltic States to the synchronous zone of Continental Europe (CFI Agreement – Agreement on the conditions of the future interconnection of power system of Baltic States and power system of continental Europe), signed on May 27, 2020 by the electricity transmission system operators (hereinafter TSO). According to the development plans approved by Europe and Latvia, the implementation of the Synchronization project is planned until the end of 2025.

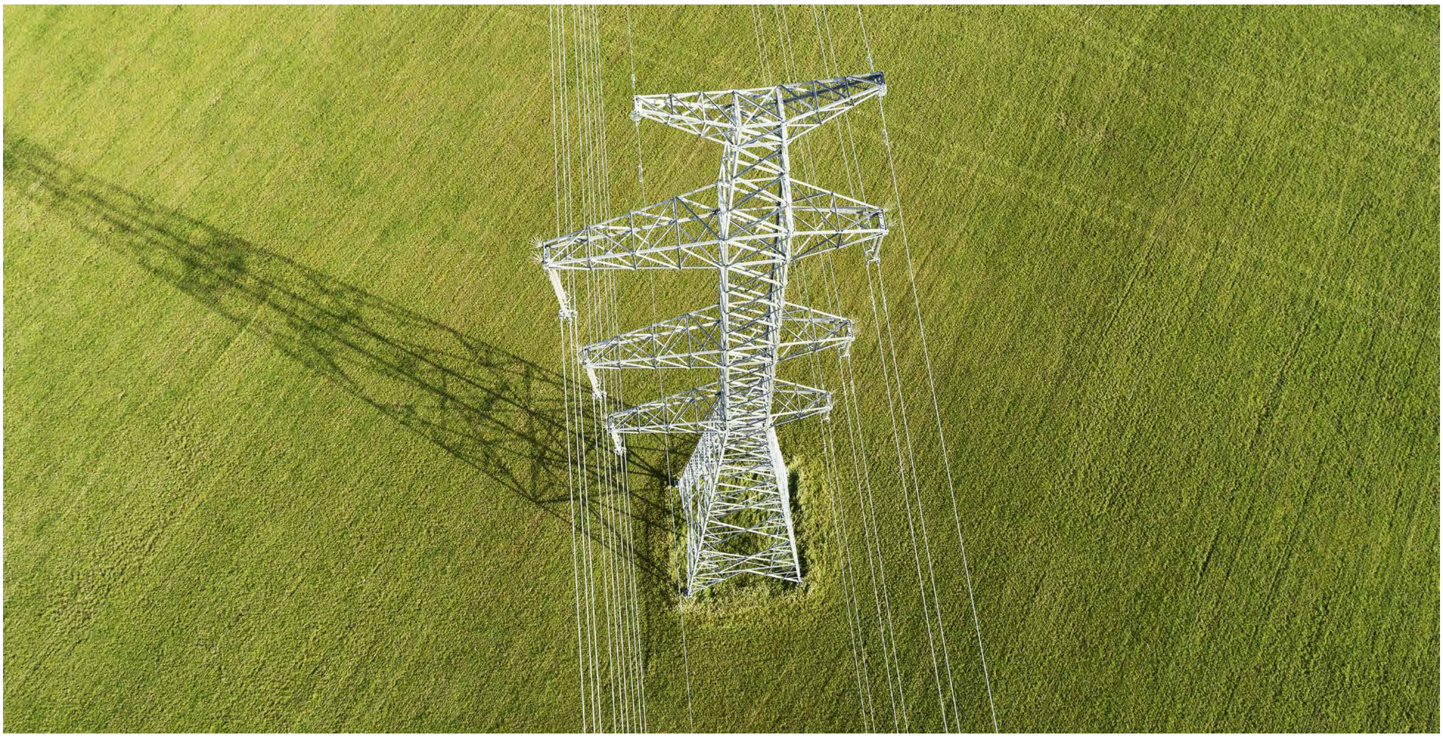
Detailed description of scenarios:

- **Scenario A "Conservative development":** The electricity system load forecast is based on the information submitted by Latvian distribution system operators about the development of load and electricity consumption, which has a stagnant nature, and electricity consumption develops slowly. The forecast for the development of generating capacity is planned, taking into account the operation of natural gas power plants under electricity market conditions, mostly working in cogeneration mode during the winter period only. In the conservative scenario, the development of wind power stations, biomass and biogas stations, small gas cogeneration stations and solar power stations is planned under the condition that the development rates of each generation source in Latvia may be affected by possible changes in the state support scheme. The development of the off-shore wind farms is slow, and TSO assumes that offshore wind farm projects in 2030 will implemented partially, which is planned 350 MW of installed capacity for Latvia. Due to cancel of the state support, the Imanta CHP has been stopped of operation, maintaining its existing capacities, but not participating in provision of the electricity system's adequacy. Due to slow development of the electricity system and the development of new generating capacities is conservative, Riga CHP–1 and Riga CHP–2 remain operational to ensure the balance of capacity throughout the evaluated time period, but the generation of electricity is reduced on an annual basis – gas import restrictions are possible.
- **Scenario B "Base scenario":** The electricity system load and consumption forecast is based on the GDP growth forecast issued by the Ministry of Economic of Latvia, system participants involved in energy sectors, as well as based on the information submitted by Latvian distribution system operators on load and electricity consumption development. The rate of consumption development is moderate. The generation capacity development forecast takes into account the power plants that are planned to be in operation or shut down according to the information received by the electricity system participants. In the Base scenario (B), the production by the Daugava HPP hydroelectric power plants is based on the average annual power plant production levels, and the production of both Riga CHPs is planned according to the electricity market conditions and state support for big power gas cogeneration plants. Riga CHP–1 could be closed in 2030, as it will be possible to replace its capacity with RES, and it is possible that such power plant will not be competitive in 2030. The development of wind power stations, biomass and biogas stations and solar power stations is planned based on the historical development rate of each generation source in Latvia and moderate, stable long-term economic development rates in the country. The development of the offshore wind farms is expected moderately, and TSO assumes that offshore wind farm projects, including ELWIND, are being implemented in full, providing the installed capacity of 500 MW for Latvia by 2030. Rapid development of small natural gas cogeneration stations is not plan-

ned, and in connection with the increase in gas prices and restrictions on gas Import, the volume of small gas cogeneration stations is decreasing. In 2021, the operation of the Imanta CHP has been stopped, due to the expected changes in the national support schemes.

- **Scenario EU2030 "Optimistic Development":** Generation capacity development forecast and electricity system load increase based on the GDP growth forecast for Latvia issued by the Ministry of Economics, taking into account the planned generation and load development rate to achieve the European Union 2030 targets, Latvia's Long-Term Energy Strategy 2030 and the National Energy and Climate Plan 2021-2030 developed by the Ministry of Economics. Electricity consumption is expected to increase due to increased interest in the purchase of electric cars and electromobility, which is expected to replace the pool of existing internal combustion engine vehicles. Such an assumption was made based on the support mechanisms adopted by the Latvian government for the purchase of electric cars. In this scenario, in addition to the development rates of scenarios A and B, possible future power plants are also taken into account, the commissioning of which, according to the information available to the TSO, is considered as possible. In this scenario, forecasting state support and development of the transmission electricity system infrastructure, electricity producers from renewable energy sources are forecasted faster development of wind, solar, biomass and biogas power plants, as RES will be able to replace Riga CHP-1 and Riga CHP-2 capacity, as a result of which Latvia would transition from fossil fuel to RES. In the scenario, it is assumed that from 2030 Riga CHP-1 and Riga CHP-2 will not be able to be competitive with RES due to cancel of the state support scheme, therefore they stop producing electricity and will not participate in covering of the maximum load. The development of the offshore wind farms is proceeding according to the plan, and TSO assumes that offshore wind farm projects are developing rapidly, in part due to relaxed state conditions and procedures for the development of wind farm projects. It is assumed that the offshore wind park project (for example ELWIND) is being implemented in full, which would be 500 MW of installed capacity in Latvia for the year 2030. Since year 2021 Imanta CHP does not participate in the adequacy provision, and the station has stopped the operation due to changes in state support schemes.

Note: *Power plants output in the tables is shown in net values and takes into account the power plant planned annual maintenance schedules.*



Assumptions and explanations for the tables:

1) According to statistical data, the average multi-annual net production of Daugava cascade hydropower plants (hereinafter - Daugava HPP) is 2700 GWh per year.

2) In 2010, a five-party agreement of BRELL ring between the Estonian, Latvian, Lithuanian, Russian and Belarusian TSO provides for the mutual provision of emergency reserves from the beginning of the realization and up to 12 hours. Emergency reserve for Latvia provides BRELL five-party agreement on common emergency reserve maintenance for each of the parties involved, maintaining 100 MW each, which consists of the sum of 500 MW. Taking into account the loading of the largest generation unit in Latvia, the capacity reserve for the needs of the Latvian electricity system should be provided in accordance with the planned loading of the biggest generation unit, i.e. up to 440 MW of Riga CHP–2 largest unit (steam and gas turbines). Taking into account that the reserve of available capacity in Latvia is 100 MW, the missing amount of capacity - 340 MW - can be guaranteed to be received from neighbouring electricity systems only for 12 hours. After year 2025, when the electricity systems of the Baltic countries will work synchronously with the electricity system of Continental Europe, the reserves required for the Latvian electricity system will be called Balancing Reserves. All the necessary reserves will be used for balancing and maintaining the system frequency, so from year 2026 there will be no need to maintain additional reserves for balancing.

3) Necessary power reserve for provision of Latvian power system operational security according to planned load and generation development scenarios.

4) The regulation reserve of the electricity system is estimated as 6 % of the maximum load of the system and 10 % of the installed capacity of wind power plants, estimating the day of the winter peak.

5) For power balance monthly assessment it is necessary to account water inflow for Daugava HPPs in river Daugava. For "Conservative scenario" (A) January least average inflow since 2000 has been in 2003 (150 m^3/s, which corresponds to 270 MW of power for covering peak demand). In "Base scenario" (B) inflow for Daugava HPPs is assumed 200 m^3/s, which corresponds to 350 MW power equivalent. In "Optimistic scenario" (EU2030) inflow for Daugava HPPs is assumed 230 m^3/s, which corresponds to 400 MW power equivalent. For coverage of minimum load during the June the same inflow values are assumed for each scenario respectively.

6) Installed capacities of power stations in the tables are presented, including their own self-consumption (gross), but the rest of the tables are shown excluding self-consumption (net). Gross output is the total capacity of the power station developed by all main generator units and generators for self-consumption. Net power output is gross output minus the power of the self-consumption equipment required for feeding power and power losses in transformers.

7) The installed and net capacity of wind power plants in the Conservative scenario (A), Base scenario (B), Optimistic scenario (EU2030) is adopted on the basis of the forecast submitted by the Ministry of Economics on the development of high-capacity wind farms, technical regulations issued by the AS "Augstsprieguma tikls" and AS "Sadales tikls", as well as the Latvian National Energy and Climate Plan 2030, approved by the Ministry of Economics.

8) In the Conservative scenario (A), Base scenario (B), and Optimistic scenario (EU2030) the net capacity of biomass and biogas power plants is presented on the basis of technical regulations issued by AS "Augstsprieguma tikls" and AS "Sadales tikls", as well as Latvian National Energy and Climate Plan 2030.

9) In the electricity balance tables, in the Conservative scenario (A) and the Base scenario (B), the electricity production of Riga CHP–1, Riga CHP–2 and Imanta CHP is evaluated according to the electricity market conditions in the Latvian bidding area. In the optimistic scenario (EU2030) until 2029, the electricity production of Riga CHP–2 and Riga CHP–1 is evaluated as maximum possible, that is, according to the electricity market conditions in the Latvian bidding area, developing the maximum possible amount of electricity on an annual basis. In order for a co-generation power plants to receive State

support for the installed capacity, which is determined by Cabinet Regulation No. 221 "Regulations on Electricity Generation and Pricing in Producing Electricity in Cogeneration", the number of hours of use of installed electricity capacity should be at least 1200 annually.

10) In the hourly load demand tables production in the power stations of Latvia is shown with not inclusion possible power reserves (assumption 3). Power reserves for the needs of Latvian power system will be provided via market based reserve purchases from the participants of Latvian or Baltic power systems.

11) In the conservative scenario (A), it is assumed that Riga CHP–2 can work in cogeneration mode only, when its maximum net capacity reaches 803 MW. In the base scenario (B) and the Optimistic scenario (EU2030), the maximum net capacity of Riga CHP–2 can reach up to 850 MW, assuming that the plant can operate in condensation mode.

12) On June 28, 2018, a political decision was made on the synchronization of the Baltic States with Continental Europe and disconnection (desynchronization) from the electricity systems of Russia and Belarus. These measures will be implemented until the end of 2025. The measures mentioned above will be implemented until the end of 2025, but due to the complicated existing geopolitical situation in the world and the war in Ukraine, desynchronisation in emergency conditions from the electricity systems of Russia and Belarus could happen even sooner.

13) By the end of 2025, the Latvian TSO is planning to install battery energy storage systems (BESS) with the total capacity of 80 MW/160 MWh in order to ensure frequency regulation and provide Frequency Containment Reserve (FCR), automatic Frequency Restoration Reserve (aFRR) and manual Frequency Restoration Reserve (mFRR). According to AST estimations, the total required reserves could reach up to 225 MW, including a FCR of ~10 MW, aFRR of ~30 MW, as well as mFRR of up to 185 MW. The BESS is intended to provide reserve power only, therefore the power generation tables do not show the amount of power from the BESS.

INSTALLED CAPACITIES (GROSS) OF POWER STATIONS, MW

Table 2

YEARS		2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Power stations with installed capacity above 40 MW [6]	1	2644	2666	2666	2674	2674	2674	2674	2674	2674/1635	2674/1635	2674/1635
Including: Daugava HPPs	1.1	1558	1580	1580	1588	1588	1588	1588	1588	1588	1588	1588
Riga CHP–1 [11]	1.2	158	158	158	158	158	158	158	158	158/0	158/0	158/0
Riga CHP–2 [11]	1.3	881	881	881	881	881	881	881	881	881/0	881/0	881/0
Imanta CHP [13]	1.4	48/0	48/0	48/0	48/0	48/0	48/0	48/0	48/0	48/0	48/0	48/0
Installed capacity of small power stations (Conservative Scenario A)	2	377	400	423	445	468	491	513	536	930	963	996
Including: Natural gas co-generation stations	2.1	80	77	75	73	70	68	65	63	50	48	46
Hydro power stations	2.2	29	29	29	29	29	29	29	29	30	30	30
Wind power stations [7]	2.3	88	100	113	125	138	150	163	175	550	555	560
On-shore	2.3.1	88	100	113	125	138	150	163	175	200	205	210
Off-shore	2.3.2	0	0	0	0	0	0	0	0	350	350	350
Biomass power stations [8]	2.4	96	99	101	104	107	110	113	116	120	123	126
Biogas power stations [8]	2.5	59	60	62	63	65	67	68	70	80	82	84
Solar power stations	2.6	26	35	43	51	59	67	75	84	100	125	150
Installed capacity of small power stations (Base Scenario B)	3	416	478	540	601	669	735	801	868	1520	1613	1705
Including: Natural gas co-generation stations	3.1	78	74	70	65	61	57	53	48	40	37	34
Hydro power stations	3.2	29	29	29	29	30	30	30	30	30	31	31
Wind power stations [7]	3.3	118	160	203	245	288	330	373	415	1000	1050	1100
On-shore	3.3.1	118	160	203	245	288	330	373	415	500	550	600
Off-shore	3.3.2	0	0	0	0	0	0	0	0	500	500	500
Biomass power stations [8]	3.4	98	103	108	113	118	123	127	132	150	160	170
Biogas power stations [8]	3.5	60	63	67	70	73	76	79	82	100	105	110
Solar power stations	3.6	33	49	64	79	100	120	140	160	200	230	260
Installed capacity of small power stations (Optimistic Scenario EU 2030)	4	429	504	579	653	728	989	1200	1412	1821	2047	2283
Including: Natural gas co-generation stations	4.1	76	70	64	57	51	45	39	32	20	18	16
Hydro power stations	4.2	29	29	29	29	30	30	30	30	31	31	31
Wind power stations [7]	4.3	120	165	210	255	300	530	710	890	1200	1380	1560
On-shore	4.3.1	120	165	210	255	300	380	460	540	700	780	860
Off-shore	4.3.2	0	0	0	0	0	150	250	350	500	600	700
Biomass power stations [8]	4.4	100	107	115	122	129	136	144	151	180	187	194
Biogas power stations [8]	4.5	63	70	76	82	88	94	100	106	140	146	152
Solar power stations	4.6	41	63	85	108	130	154	178	202	250	285	330

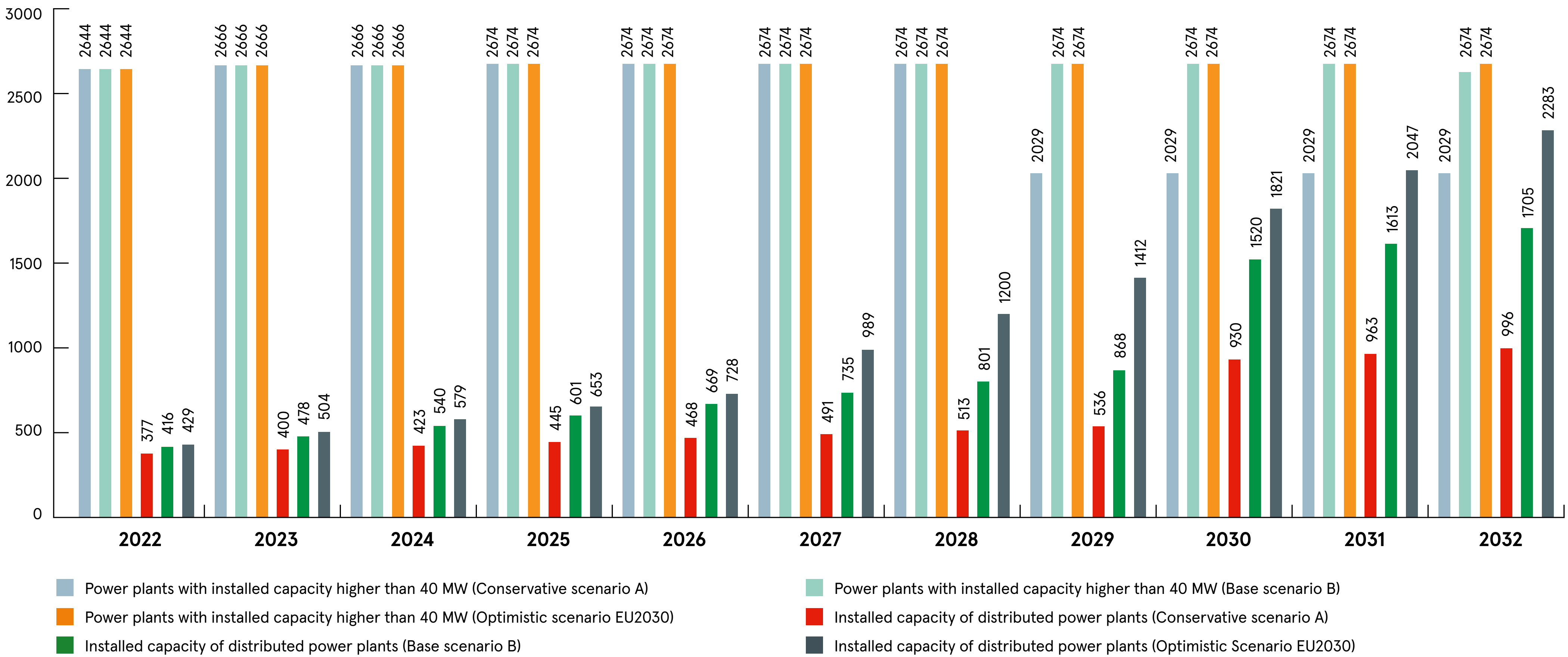


Fig. 3. Development of installed capacities for power plants in different development scenarios, MW (gross)

LATVIAN POWER SYSTEM BALANCE FOR SCENARIO A WINTER PEAK LOAD HOURS, MW (NETT)

Table 3

YEARS		2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Maximum load	1	1273	1294	1313	1332	1350	1368	1387	1406	1425	1445	1465
Power stations with installed capacity above 40 MW	2	2506	2528	2528	2536	2536	2536	2536	2536	2536	2536	2536
Including: Daugava HPPs	2.1	1550	1572	1572	1580	1580	1580	1580	1580	1580	1580	1580
Riga CHP–1	2.2	153	153	153	153	153	153	153	153	153	153	153
Riga CHP–2	2.3	803	803	803	803	803	803	803	803	803	803	803
Imanta CHP	2.4	0	0	0	0	0	0	0	0	0	0	0
Small power stations	3	351	373	394	416	437	459	480	502	890	921	951
Including: Natural gas co-generation power stations	3.1	73	70	68	66	64	61	59	57	45	44	42
Hydro power stations	3.2	28	28	28	28	28	28	28	28	29	29	29
Wind power stations	3.3	87	99	111	124	136	149	161	173	545	550	554
Onshore	3.3.1.	87	99	111	124	136	149	161	173	198	203	208
Offshore	3.3.2.	0	0	0	0	0	0	0	0	347	347	347
Biomass power stations	3.4	87	90	92	95	97	100	102	105	109	112	115
Biogas power stations	3.5	54	55	56	58	59	61	62	63	73	75	76
Solar power stations	3.6	24	31	38	46	53	61	68	75	90	113	135
Available capacities for peak load and reserve guaranteeing	4	1399	1404	1410	1415	1500	1506	1511	1517	1616	1628	1639
Including: Daugava HPPs [5]	4.01	270	270	270	270	270	270	270	270	270	270	270
Riga CHP–1	4.02	153	153	153	153	153	153	153	153	153	153	153
Riga CHP–2	4.03	803	803	803	803	803	803	803	803	803	803	803
Imanta CHP	4.04	0	0	0	0	0	0	0	0	0	0	0
Natural gas co-generation power stations	4.05	51	49	48	46	45	43	41	40	32	31	29
Hydro power stations	4.06	6	6	6	6	6	6	6	6	6	6	6
Wind power stations	4.07	9	10	11	12	14	15	16	17	109	110	111
Biomass power stations	4.08	98	101	104	107	110	112	115	118	127	130	134
Biogas power stations	4.09	10	12	15	18	21	24	27	30	36	45	54
Battery Energy Storage System [13]	4.10	0	0	0	0	80	80	80	80	80	80	80
Power system emergency reserve [2]	5	100	100	100	100	225	225	225	225	225	225	225
Power system regulating reserve [4]	6	85	88	90	92	0	0	0	0	0	0	0
Total reserve in Latvia[3]	7=5+6	185	188	190	192	225	225	225	225	225	225	225
Power surplus (+), deficit (–)	8=4-1	–59	–78	–93	–109	–75	–87	–101	–115	–35	–42	–50
Power adequacy	9=4/1	95%	94%	93%	92%	94%	94%	93%	92%	98%	97%	97%

LATVIAN POWER SYSTEM BALANCE FOR SCENARIO B WINTER PEAK LOAD HOURS, MW (NETT)

Table 4

YEARS		2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Maximum load	1	1273	1294	1313	1332	1350	1368	1387	1406	1425	1445	1465
Power stations with installed capacity above 40 MW	2	2506	2528	2528	2536	2536	2536	2536	2536	2536	2536	2536
Including: Daugava HPPs	2.1	1550	1572	1572	1580	1580	1580	1580	1580	1580	1580	1580
Riga CHP–1	2.2	153	153	153	153	153	153	153	153	0	0	0
Riga CHP–2	2.3	850	850	850	850	850	850	850	850	850	850	850
Imanta CHP	2.4	42	0	0	0	0	0	0	0	0	0	0
Small power stations	3	389	448	508	567	632	695	759	822	1462	1551	1638
Including: Natural gas co-generation power stations	3.1	71	67	63	59	56	52	48	44	36	34	31
Hydro power stations	3.2	28	28	28	28	29	29	29	29	29	30	30
Wind power stations	3.3	116	158	200	243	285	327	369	411	990	1040	1089
Onshore	3.3.1.	116	158	200	243	285	327	369	411	495	545	594
Offshore	3.3.2.	0	0	0	0	0	0	0	0	495	495	495
Biomass power stations	3.4	89	93	98	102	107	111	116	120	136	145	155
Biogas power stations	3.5	55	58	60	63	66	69	72	74	91	95	100
Solar power stations	3.6	30	44	58	71	90	108	126	144	180	207	234
Available capacities for peak load and reserve guaranteeing	4	1534	1547	1560	1573	1669	1684	1698	1713	1747	1776	1805
Including: Daugava HPPs [5]	4.01	350	350	350	350	350	350	350	350	350	350	350
Riga CHP–1	4.02	153	153	153	153	153	153	153	153	0	0	0
Riga CHP–2	4.03	850	850	850	850	850	850	850	850	850	850	850
Imanta CHP	4.04	0	0	0	0	0	0	0	0	0	0	0
Natural gas co-generation power stations	4.05	51	49	48	46	45	43	41	40	32	31	29
Hydro power stations	4.06	6	6	6	6	6	6	6	6	6	6	6
Wind power stations	4.07	12	16	20	24	28	33	37	41	198	208	218
Biomass power stations	4.08	101	106	111	116	121	126	131	136	159	169	178
Biogas power stations	4.09	12	18	23	28	36	43	50	58	72	83	94
Battery Energy Storage System [13]	4.10	0	0	0	0	80	80	80	80	80	80	80
Power system emergency reserve [2]	5	100	100	100	100	225	225	225	225	225	225	225
Power system regulating reserve [4]	6	88	93	99	104	0	0	0	0	0	0	0
Total reserve in Latvia [3]	7=5+6	188	193	199	204	225	225	225	225	225	225	225
Power surplus (+), deficit (–)	8=4–1	73	59	49	37	93	90	87	82	97	106	115
Power adequacy	9=4/1	106%	105%	104%	103%	107%	107%	106%	106%	107%	107%	108%

LATVIAN POWER SYSTEM BALANCE FOR SCENARIO EU2030 WINTER PEAK LOAD HOURS, MW (NETT)

Table 5

YEARS		2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Maximum load	1	1273	1294	1313	1332	1350	1368	1387	1406	1425	1445	1465
Power stations with installed capacity above 40 MW	2	2506	2528	2528	2536	2536	2536	2536	2536	2536	2536	2536
Including: Daugava HPPs	2.1	1550	1572	1572	1580	1580	1580	1580	1580	1580	1580	1580
Riga CHP–1	2.2	153	153	153	153	153	153	153	153	0	0	0
Riga CHP–2	2.3	850	850	850	850	850	850	850	850	0	0	0
Imanta CHP	2.4	0	0	0	0	0	0	0	0	0	0	0
Small power stations	3	401	472	544	615	686	942	1148	1355	1752	1949	2201
Including: Natural gas co-generation power stations	3.1	69	63	58	52	46	41	35	30	18	16	15
Hydro power stations	3.2	28	28	28	28	28	28	28	28	30	30	30
Wind power stations	3.3	119	163	208	252	297	525	703	881	1188	1344	1545
Onshore	3.3.1.	119	163	208	252	297	376	455	535	693	772	851
Offshore	3.3.2.	0	0	0	0	0	149	248	347	495	571	693
Biomass power stations	3.4	91	98	104	111	117	124	131	137	164	170	176
Biogas power stations	3.5	58	63	69	74	80	86	91	97	127	133	138
Solar power stations	3.6	37	57	77	97	117	139	160	182	225	257	297
Available capacities for peak load and reserve guaranteeing	4	1590	1609	1629	1648	1748	1786	1820	1853	930	965	1008
Including: Daugava HPPs [5)]	4.01	400	400	400	400	400	400	400	400	400	400	400
Riga CHP–1	4.02	153	153	153	153	153	153	153	153	0	0	0
Riga CHP–2	4.03	850	850	850	850	850	850	850	850	0	0	0
Imanta CHP	4.04	0	0	0	0	0	0	0	0	0	0	0
Natural gas co-generation power stations	4.05	51	49	48	46	45	43	41	40	32	31	29
Hydro power stations	4.06	6	6	6	6	6	6	6	6	6	6	6
Wind power stations	4.07	12	16	21	25	30	52	70	88	119	134	154
Biomass power stations	4.08	104	113	121	130	138	147	155	164	204	212	220
Biogas power stations	4.09	15	23	31	39	47	55	64	73	90	103	119
Battery Energy Storage System [13)]	4.10					80	80	80	80	80	80	80
Power system emergency reserve [2)]	5	100	100	100	100	225	225	225	225	225	225	225
Power system regulating reserve [4)]	6	88	94	100	105	0	0	0	0	0	0	0
Total reserve in Latvia [3)]	7=5+6	188	194	200	205	225	225	225	225	225	225	225
Power surplus (+), deficit (–)	8=4-1	129	121	117	111	173	193	208	222	–720	–705	–681
Power adequacy	9=4/1	110%	109%	109%	108%	113%	114%	115%	116%	49%	51%	53%

POSSIBLE POWER BALANCE FOR SCENARIO A (ANNUAL VALUES), GWH

Scenario A *Table 6*

YEARS		2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Energy demand	1	7361	7408	7436	7465	7489	7509	7528	7551	7570	7588	7605
Output in power stations with installed capacity above 40 MW	2	4032	4321	4321	4334	4334	4334	4334	4334	4334	4334	4334
Including: Daugava HPPs [1)]	2.1	2803	2717	2717	2730	2730	2730	2730	2730	2730	2730	2730
Riga CHP–1 [9), 13)]	2.2	300	480	480	480	480	480	480	480	480	480	480
Riga CHP–2 [9)]	2.3	929	1124	1124	1124	1124	1124	1124	1124	1124	1124	1124
Imanta CHP	2.4	0	0	0	0	0	0	0	0	0	0	0
Small power stations	3	1448	1482	1516	1550	1587	1621	1656	1690	2618	2649	2677
Including: Natural gas co-generation power stations	3.1	436	422	409	396	382	369	355	342	273	262	251
Hydro power stations	3.2	67	67	67	66	69	69	69	69	69	71	71
Wind power stations	3.3	173	198	223	248	272	297	322	347	1262	1272	1282
Onshore	3.3.1.	173	198	223	248	272	297	322	347	396	406	416
Offshore	3.3.2.	0	0	0	0	0	0	0	0	866	866	866
Biomass power stations	3.4	436	448	461	474	487	500	512	525	545	559	573
Biogas power stations	3.5	332	340	349	358	366	375	384	392	451	462	473
Solar power stations	3.6	5	6	8	9	11	12	14	15	18	23	27
Possible annual export/import	4=(2+3)-1	–1881	–1606	–1599	–1581	–1568	–1554	–1539	–1527	–618	–605	–594
Annual adequacy	5=(2+3)/1	74%	78%	78%	79%	79%	79%	80%	80%	92%	92%	92%

POSSIBLE POWER BALANCE FOR SCENARIO B (ANNUAL VALUES), GWH

Scenario B *Table 7*

YEARS			2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Energy demand		1	7474	7542	7591	7642	7688	7731	7774	7821	7864	7908	7951
Output in power stations with installed capacity above 40 MW		2	4549	4549	4549	4549	4549	4549	4549	4549	4008	4008	4008
Including:	Daugava HPPs [1)]	2.1	2754	2754	2754	2754	2754	2754	2754	2754	2754	2754	2754
	Riga CHP–1 [9), 13)]	2.2	541	541	541	541	541	541	541	541	0	0	0
	Riga CHP–2 [9)]	2.3	1254	1254	1254	1254	1254	1254	1254	1254	1254	1254	1254
	Imanta CHP	2.4	0	0	0	0	0	0	0	0	0	0	0
Small power stations		3	1554	1670	1785	1900	2020	2136	2253	2370	3904	4078	4249
Including:	Natural gas co-generation power stations	3.1	436	422	409	396	382	369	355	342	273	262	251
	Hydro power stations	3.2	75	75	75	75	77	77	77	77	77	80	80
	Wind power stations	3.3	233	317	401	485	569	653	738	822	2228	2327	2426
	Onshore	3.3.1.	233	317	401	485	569	653	738	822	990	1089	1188
	Offshore	3.3.2.	0	0	0	0	0	0	0	0	1238	1238	1238
	Biomass power stations	3.4	445	467	490	512	535	557	579	602	682	727	773
	Biogas power stations	3.5	357	375	393	411	429	447	465	484	591	620	650
	Solar power stations	3.6	9.0	13.1	17.3	21.4	27.0	32.4	37.8	43.2	54.0	62.1	70.2
Possible annual export/import		4=(2+3)-1	–1371	–1323	–1257	–1193	–1120	–1046	–972	–902	48	178	307
Annual adequacy		5=(2+3)/1	82%	82%	83%	84%	85%	86%	87%	88%	101%	102%	104%

POSSIBLE POWER BALANCE FOR SCENARIO EU2030 (ANNUAL VALUES), GWH

Scenario EU2030 *Table 8*

YEARS		2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Energy demand	1	7511	7608	7686	7767	7843	7917	7992	8072	8149	8227	8306
Output in power stations with installed capacity above 40 MW	2	9820	9820	9820	9820	9820	9820	9820	9820	2754	2754	2754
Including: DAUGAVA HPPS [1)]	2.1	2754	2754	2754	2754	2754	2754	2754	2754	2754	2754	2754
Riga CHP–1 [9), 13)]	2.2	1114	1114	1114	1114	1114	1114	1114	1114	0	0	0
Riga CHP–2 [9)]	2.3	5952	5952	5952	5952	5952	5952	5952	5952	0	0	0
Imanta CHP	2.4	0	0	0	0	0	0	0	0	0	0	0
Small power stations	3	1606	1758	1910	2060	2437	2807	3177	3621	4210	4734	4961
Including: Natural gas co-generation power stations	3.1	436	422	409	396	382	369	355	342	273	262	251
Hydro power stations	3.2	75	75	75	75	77	77	77	77	77	80	80
Wind power stations	3.3	238	327	416	505	817	1124	1431	1812	2129	2584	2743
Onshore	3.3.1.	238	327	416	505	594	752	911	1069	1386	1545	1703
Offshore	3.3.2.	0	0	0	0	223	371	520	743	743	1040	1040
Biomass power stations	3.4	501	537	573	610	646	682	718	754	900	935	970
Biogas power stations	3.5	346	380	413	447	480	514	547	581	764	796	829
Solar power stations	3.6	11.0	17.0	23.0	29.1	35.1	41.6	48.1	54.5	67.5	77.0	89.1
Possible annual export/import	4=(2+3)-1	3915	3970	4044	4114	4414	4709	5004	5368	-1186	-739	-591
Annual adequacy	5=(2+3)/1	152%	152%	153%	153%	156%	159%	163%	167%	85%	91%	93%

POWER DEMAND AND POSSIBLE SOURCES OF GUARANTEEING, HOURLY BALANCE FOR SCENARIO A (PEAK LOAD), MW

Power demand and possible sources for guaranteeing, hourly values – Scenario A Conservative development
Year 2022. January (working day, Wednesday of the third week, peak load)

Table 9

Hour	Riga CHP–1	Riga CHP–2 [11]	Imanta CHP	Biomass and biogas	Gas fuelled co-generation	Small HPPs	Wind power	Solar power	Daugava HPPs [10]	Import	Load
01:00	153	526	0	98	51	6	9	0	23	0	865
02:00	153	496	0	98	51	6	9	0	13	0	825
03:00	153	479	0	98	51	6	9	0	19	0	814
04:00	153	478	0	98	51	6	9	0	23	0	818
05:00	153	478	0	98	51	6	9	0	30	0	824
06:00	153	513	0	98	51	6	9	0	42	0	870
07:00	153	559	0	98	51	6	9	0	108	0	983
08:00	153	637	0	98	51	6	9	0	171	0	1124
09:00	153	656	0	98	51	6	9	0	253	0	1225
10:00	153	692	0	98	51	6	9	0	262	0	1271
11:00	153	677	0	98	51	6	9	10	270	0	1273
12:00	153	738	0	98	51	6	9	10	188	0	1251
13:00	153	710	0	98	51	6	9	10	181	0	1216
14:00	153	711	0	98	51	6	9	10	188	0	1225
15:00	153	683	0	98	51	6	9	10	211	0	1220
16:00	153	682	0	98	51	6	9	10	217	0	1225
17:00	153	717	0	98	51	6	9	0	239	0	1272
18:00	153	681	0	98	51	6	9	0	255	0	1252
19:00	153	661	0	98	51	6	9	0	251	0	1228
20:00	153	674	0	98	51	6	9	0	195	0	1185
21:00	153	697	0	98	51	6	9	0	134	0	1147
22:00	153	646	0	98	51	6	9	0	118	0	1080
23:00	153	607	0	98	51	6	9	0	74	0	997
00:00	153	555	0	98	51	6	9	0	46	0	918
Produced amount of energy MWh	3660	14953	0	2362	1219	133	208	57	3513	0	26106

Power demand and possible sources for guaranteeing, hourly values. – Scenario A Conservative development
Year 2027 January (working day, Wednesday of the third week, peak load)

Table 10

Hour	Riga CHP–1	Riga CHP–2 [11]	Imanta CHP	Biomass and biogas	Gas fuelled co-generation	Small HPPs	Wind power	Solar power	Daugava HPPs [10]	Import	Load
01:00	153	578	0	112	43	6	15	0.00	23	0	930
02:00	153	545	0	112	43	6	15	0.00	13	0	887
03:00	153	528	0	112	43	6	15	0.00	19	0	875
04:00	153	527	0	112	43	6	15	0.00	23	0	879
05:00	153	528	0	112	43	6	15	0.00	30	0	886
06:00	153	566	0	112	43	6	15	0.00	42	0	935
07:00	153	621	0	112	43	6	15	0.00	108	0	1057
08:00	153	709	0	112	43	6	15	0.00	171	0	1208
09:00	153	736	0	112	43	6	15	0.00	253	0	1317
10:00	153	775	0	112	43	6	15	0.00	262	0	1366
11:00	153	746	0	112	43	6	15	24	270	0	1368
12:00	153	805	0	112	43	6	15	24	188	0	1345
13:00	153	774	0	112	43	6	15	24	181	0	1308
14:00	153	776	0	112	43	6	15	24	188	0	1316
15:00	153	747	0	112	43	6	15	24	211	0	1311
16:00	153	747	0	112	43	6	15	24	217	0	1317
17:00	153	800	0	112	43	6	15	0.00	239	0	1367
18:00	153	762	0	112	43	6	15	0.00	255	0	1346
19:00	153	740	0	112	43	6	15	0.00	251	0	1320
20:00	153	750	0	112	43	6	15	0.00	195	0	1273
21:00	153	770	0	112	43	6	15	0.00	134	0	1233
22:00	153	715	0	112	43	6	15	0.00	118	0	1161
23:00	153	670	0	112	43	6	15	0.00	74	0	1072
00:00	153	612	0	112	43	6	15	0.00	46	0	987
Produced amount of energy MWh	3660	16527	0	2695	1033	133	356	145	3513	0	28063

Power demand and possible sources for guaranteeing, hourly values. – Scenario A Conservative development
Year 2032 January (working day, Wednesday of the third week, peak load)

Table 11

Hour	Riga CHP–1	Riga CHP–2 [11]	Imanta CHP	Biomass and biogas	Gas fuelled co-generation	Small HPPs	Wind power	Solar power	Daugava HPPs [10]	Import	Load
01:00	153	540	0	134	29	6	111	0	23	0	995
02:00	153	504	0	134	29	6	111	0	13	0	949
03:00	153	486	0	134	29	6	111	0	19	0	936
04:00	153	485	0	134	29	6	111	0	23	0	941
05:00	153	486	0	134	29	6	111	0	30	0	949
06:00	153	528	0	134	29	6	111	0	42	0	1001
07:00	153	591	0	134	29	6	111	0	108	0	1131
08:00	153	690	0	134	29	6	111	0	171	0	1293
09:00	153	724	0	134	29	6	111	0	253	0	1409
10:00	153	768	0	134	29	6	111	0	262	0	1462
11:00	153	708	0	134	29	6	111	54	270	0	1465
12:00	153	766	0	134	29	6	111	54	188	0	1440
13:00	153	732	0	134	29	6	111	54	181	0	1400
14:00	153	735	0	134	29	6	111	54	188	0	1409
15:00	153	706	0	134	29	6	111	54	211	0	1403
16:00	153	706	0	134	29	6	111	54	217	0	1409
17:00	153	792	0	134	29	6	111	0	239	0	1463
18:00	153	753	0	134	29	6	111	0	255	0	1440
19:00	153	729	0	134	29	6	111	0	251	0	1412
20:00	153	736	0	134	29	6	111	0	195	0	1363
21:00	153	753	0	134	29	6	111	0	134	0	1320
22:00	153	693	0	134	29	6	111	0	118	0	1242
23:00	153	641	0	134	29	6	111	0	74	0	1147
00:00	153	577	0	134	29	6	111	0	46	0	1056
Produced amount of energy MWh	3660	15830	0	3207	703	137	2661	324	3513	0	30036

POWER DEMAND AND POSSIBLE SOURCES OF GUARANTEEING, HOURLY BALANCE FOR SCENARIO B (PEAK LOAD), MW

Power demand and possible sources for guaranteeing, hourly values. – Scenario B Base scenario
Year 2022. January (working day, Wednesday of the third week, peak load)

Table 12

Hour	Riga CHP–1	Riga CHP–2 [11]	Imanta CHP	Biomass and biogas	Gas fuelled co-generation	Small HPPs	Wind power	Solar power	Daugava HPPs [10]	Import	Load
01:00	153	514	0	101	51	6	12	0	30	0	865
02:00	153	486	0	101	51	6	12	0	17	0	825
03:00	153	469	0	101	51	6	12	0	24	0	814
04:00	153	466	0	101	51	6	12	0	30	0	818
05:00	153	464	0	101	51	6	12	0	39	0	824
06:00	153	495	0	101	51	6	12	0	54	0	870
07:00	153	522	0	101	51	6	12	0	140	0	983
08:00	153	581	0	101	51	6	12	0	222	0	1124
09:00	153	576	0	101	51	6	12	0	328	0	1225
10:00	153	609	0	101	51	6	12	0	340	0	1271
11:00	153	590	0	101	51	6	12	12	350	0	1273
12:00	153	674	0	101	51	6	12	12	244	0	1251
13:00	153	648	0	101	51	6	12	12	235	0	1216
14:00	153	648	0	101	51	6	12	12	244	0	1225
15:00	153	612	0	101	51	6	12	12	274	0	1220
16:00	153	610	0	101	51	6	12	12	282	0	1225
17:00	153	641	0	101	51	6	12	0	310	0	1272
18:00	153	600	0	101	51	6	12	0	331	0	1252
19:00	153	581	0	101	51	6	12	0	326	0	1228
20:00	153	611	0	101	51	6	12	0	253	0	1185
21:00	153	652	0	101	51	6	12	0	174	0	1147
22:00	153	606	0	101	51	6	12	0	152	0	1080
23:00	153	580	0	101	51	6	12	0	96	0	997
00:00	153	536	0	101	51	6	12	0	60	0	918
Produced amount of energy MWh	3660	13770	0	2418	1219	133	279	72	4554	0	26106

Power demand and possible sources for guaranteeing, hourly values. – Scenario B Base scenario
Year 2027. January (working day, Wednesday of the third week, peak load)

Table 13

Hour	Riga CHP–1	Riga CHP–2 [11]	Imanta CHP	Biomass and biogas	Gas fuelled co-generation	Small HPPs	Wind power	Solar power	Daugava HPPs [10]	Import	Load
01:00	153	540	0	126	43	6	33	0	30	0	930
02:00	153	510	0	126	43	6	33	0	17	0	887
03:00	153	491	0	126	43	6	33	0	24	0	875
04:00	153	489	0	126	43	6	33	0	30	0	879
05:00	153	487	0	126	43	6	33	0	39	0	886
06:00	153	522	0	126	43	6	33	0	54	0	935
07:00	153	557	0	126	43	6	33	0	140	0	1057
08:00	153	627	0	126	43	6	33	0	222	0	1208
09:00	153	629	0	126	43	6	33	0	328	0	1317
10:00	153	666	0	126	43	6	33	0	340	0	1366
11:00	153	615	0	126	43	6	33	43	350	0	1368
12:00	153	698	0	126	43	6	33	43	244	0	1345
13:00	153	670	0	126	43	6	33	43	235	0	1308
14:00	153	670	0	126	43	6	33	43	244	0	1316
15:00	153	634	0	126	43	6	33	43	274	0	1311
16:00	153	632	0	126	43	6	33	43	282	0	1317
17:00	153	697	0	126	43	6	33	0	310	0	1367
18:00	153	655	0	126	43	6	33	0	331	0	1346
19:00	153	634	0	126	43	6	33	0	326	0	1320
20:00	153	661	0	126	43	6	33	0	253	0	1273
21:00	153	699	0	126	43	6	33	0	174	0	1233
22:00	153	648	0	126	43	6	33	0	152	0	1161
23:00	153	616	0	126	43	6	33	0	96	0	1072
00:00	153	566	0	126	43	6	33	0	60	0	987
Produced amount of energy MWh	3660	14612	0	3028	1033	133	784	259	4554	0	28063

Power demand and possible sources for guaranteeing, hourly values. – Scenario B Base scenario
Year 2032. January (working day, Wednesday of the third week, peak load)

Table 14

Hour	Riga CHP–1	Riga CHP–2 [11]	Imanta CHP	Biomass and biogas	Gas fuelled co-generation	Small HPPs	Wind power	Solar power	Daugava HPPs [10]	Import	Load
01:00	0	534	0	178	29	6	218	0	30	0	995
02:00	0	501	0	178	29	6	218	0	17	0	949
03:00	0	481	0	178	29	6	218	0	24	0	936
04:00	0	479	0	178	29	6	218	0	30	0	941
05:00	0	479	0	178	29	6	218	0	39	0	949
06:00	0	516	0	178	29	6	218	0	54	0	1001
07:00	0	560	0	178	29	6	218	0	140	0	1131
08:00	0	640	0	178	29	6	218	0	222	0	1293
09:00	0	651	0	178	29	6	218	0	328	0	1409
10:00	0	691	0	178	29	6	218	0	340	0	1462
11:00	0	590	0	178	29	6	218	94	350	0	1465
12:00	0	671	0	178	29	6	218	94	244	0	1440
13:00	0	640	0	178	29	6	218	94	235	0	1400
14:00	0	641	0	178	29	6	218	94	244	0	1409
15:00	0	604	0	178	29	6	218	94	274	0	1403
16:00	0	603	0	178	29	6	218	94	282	0	1409
17:00	0	722	0	178	29	6	218	0	310	0	1463
18:00	0	679	0	178	29	6	218	0	331	0	1440
19:00	0	656	0	178	29	6	218	0	326	0	1412
20:00	0	679	0	178	29	6	218	0	253	0	1363
21:00	0	714	0	178	29	6	218	0	174	0	1320
22:00	0	659	0	178	29	6	218	0	152	0	1242
23:00	0	620	0	178	29	6	218	0	96	0	1147
00:00	0	565	0	178	29	6	218	0	60	0	1056
Produced amount of energy MWh	0	14576	0	4276	703	137	5228	562	4554	0	30036

POWER DEMAND AND POSSIBLE SOURCES OF GUARANTEEING, HOURLY BALANCE FOR SCENARIO EU 2030 (PEAK LOAD), MW

Power demand and possible sources for guaranteeing, hourly values. – Scenario EU 2030 Optimistic development
Year 2022 January (working day, Wednesday of the third week, peak load)

Table 15

Hour	Riga CHP–1	Riga CHP–2 [11]	Imanta CHP	Biomass and biogas	Gas fuelled co-generation	Small HPPs	Wind power	Solar power	Daugava HPPs [10]	Import	Load
01:00	153	506	0	104	51	6	12	0	34	0	865
02:00	153	480	0	104	51	6	12	0	20	0	825
03:00	153	462	0	104	51	6	12	0	27	0	814
04:00	153	458	0	104	51	6	12	0	35	0	818
05:00	153	455	0	104	51	6	12	0	45	0	824
06:00	153	484	0	104	51	6	12	0	62	0	870
07:00	153	498	0	104	51	6	12	0	160	0	983
08:00	153	546	0	104	51	6	12	0	253	0	1124
09:00	153	526	0	104	51	6	12	0	374	0	1225
10:00	153	557	0	104	51	6	12	0	389	0	1271
11:00	153	544	0	104	51	6	12	4	400	0	1273
12:00	153	644	0	104	51	6	12	4	279	0	1251
13:00	153	620	0	104	51	6	12	4	268	0	1216
14:00	153	618	0	104	51	6	12	4	278	0	1225
15:00	153	578	0	104	51	6	12	4	313	0	1220
16:00	153	575	0	104	51	6	12	4	322	0	1225
17:00	153	593	0	104	51	6	12	0	354	0	1272
18:00	153	549	0	104	51	6	12	0	378	0	1252
19:00	153	531	0	104	51	6	12	0	372	0	1228
20:00	153	571	0	104	51	6	12	0	289	0	1185
21:00	153	623	0	104	51	6	12	0	199	0	1147
22:00	153	581	0	104	51	6	12	0	174	0	1080
23:00	153	562	0	104	51	6	12	0	110	0	997
00:00	153	524	0	104	51	6	12	0	69	0	918
Produced amount of energy MWh	3660	13082	0	2500	1219	133	285	21	5204	0	26106

Power demand and possible sources for guaranteeing, hourly values. – Scenario EU 2030 Optimistic development Year 2027 January (working day, Wednesday of the third week, peak load)

Table 16

Hour	Riga CHP–1	Riga CHP–2 [11]	Imanta CHP	Biomass and biogas	Gas fuelled co-generation	Small HPPs	Wind power	Solar power	Daugava HPPs [10]	Import	Load
01:00	153	495	0	147	43	6	52	0	34	0	930
02:00	153	467	0	147	43	6	52	0	20	0	887
03:00	153	447	0	147	43	6	52	0	27	0	875
04:00	153	444	0	147	43	6	52	0	35	0	879
05:00	153	441	0	147	43	6	52	0	45	0	886
06:00	153	474	0	147	43	6	52	0	62	0	935
07:00	153	497	0	147	43	6	52	0	160	0	1057
08:00	153	555	0	147	43	6	52	0	253	0	1208
09:00	153	542	0	147	43	6	52	0	374	0	1317
10:00	153	577	0	147	43	6	52	0	389	0	1366
11:00	153	529	0	147	43	6	52	39	400	0	1368
12:00	153	627	0	147	43	6	52	39	279	0	1345
13:00	153	600	0	147	43	6	52	39	268	0	1308
14:00	153	599	0	147	43	6	52	39	278	0	1316
15:00	153	559	0	147	43	6	52	39	313	0	1311
16:00	153	556	0	147	43	6	52	39	322	0	1317
17:00	153	613	0	147	43	6	52	0	354	0	1367
18:00	153	568	0	147	43	6	52	0	378	0	1346
19:00	153	547	0	147	43	6	52	0	372	0	1320
20:00	153	584	0	147	43	6	52	0	289	0	1273
21:00	153	634	0	147	43	6	52	0	199	0	1233
22:00	153	586	0	147	43	6	52	0	174	0	1161
23:00	153	562	0	147	43	6	52	0	110	0	1072
00:00	153	517	0	147	43	6	52	0	69	0	987
Produced amount of energy MWh	3660	13019	0	3521	1033	133	1259	233	5204	0	28063

Power demand and possible sources for guaranteeing, hourly values. – Scenario EU 2030 Optimistic development
Year 2032 January (working day, Wednesday of the third week, peak load)

Table 17

Hour	Riga CHP–1	Riga CHP–2 [11]	Imanta CHP	Biomass and biogas	Gas fuelled co-generation	Small HPPs	Wind power	Solar power	Daugava HPPs [10]	Import	Load
01:00	0	0	0	220	29	6	154	0	34	551	995
02:00	0	0	0	220	29	6	154	0	20	520	949
03:00	0	0	0	220	29	6	154	0	27	499	936
04:00	0	0	0	220	29	6	154	0	35	496	941
05:00	0	0	0	220	29	6	154	0	45	494	949
06:00	0	0	0	220	29	6	154	0	62	530	1001
07:00	0	0	0	220	29	6	154	0	160	562	1131
08:00	0	0	0	220	29	6	154	0	253	630	1293
09:00	0	0	0	220	29	6	154	0	374	625	1409
10:00	0	0	0	220	29	6	154	0	389	664	1462
11:00	0	0	0	220	29	6	154	90	400	565	1465
12:00	0	0	0	220	29	6	154	90	279	661	1440
13:00	0	0	0	220	29	6	154	90	268	632	1400
14:00	0	0	0	220	29	6	154	90	278	631	1409
15:00	0	0	0	220	29	6	154	90	313	590	1403
16:00	0	0	0	220	29	6	154	90	322	588	1409
17:00	0	0	0	220	29	6	154	0	354	699	1463
18:00	0	0	0	220	29	6	154	0	378	653	1440
19:00	0	0	0	220	29	6	154	0	372	631	1412
20:00	0	0	0	220	29	6	154	0	289	665	1363
21:00	0	0	0	220	29	6	154	0	199	711	1320
22:00	0	0	0	220	29	6	154	0	174	658	1242
23:00	0	0	0	220	29	6	154	0	110	628	1147
00:00	0	0	0	220	29	6	154	0	69	577	1056
Produced amount of energy MWh	0	0	0	5284	703	137	3707	540	5204	14460	30036

POWER DEMAND AND POSSIBLE SOURCES OF GUARANTEEING, HOURLY BALANCE FOR SCENARIO A (MINIMUM LOAD), MW

Scenario A Conservative development
Year 2022 June – minimum monthly load

Table 18

Hour	Riga CHP–1	Riga CHP–2 [11]	Imanta CHP	Biomass and biogas	Gas fuelled co-generation	Small HPPs	Wind power	Solar power	Daugava HPPs [10]	Import	Load
01:00	0	0	98	51	6	9	0	497	59	719	0
02:00	0	0	98	51	6	9	0	420	40	624	0
03:00	0	0	98	51	6	9	0	390	36	589	0
04:00	0	0	98	51	6	9	0	378	23	565	0
05:00	0	0	98	51	6	9	0	366	23	553	0
06:00	0	0	98	51	6	9	0	340	21	524	0
07:00	0	0	98	51	6	9	0	340	49	531	21
08:00	0	0	98	51	6	9	0	340	110	571	43
09:00	0	0	98	51	6	9	10	340	175	633	55
10:00	0	0	98	51	6	9	10	340	246	711	48
11:00	0	0	98	51	6	9	10	340	268	771	10
12:00	0	0	98	51	6	9	10	362	270	805	0
13:00	0	0	98	51	6	9	10	392	251	816	0
14:00	0	0	98	51	6	9	10	399	241	813	0
15:00	0	0	98	51	6	9	10	400	240	813	0
16:00	0	0	98	51	6	9	10	421	215	808	0
17:00	0	0	98	51	6	9	10	437	191	801	0
18:00	0	0	98	51	6	9	10	464	159	795	0
19:00	0	0	98	51	6	9	10	476	144	793	0
20:00	0	0	98	51	6	9	0	491	135	789	0
21:00	0	0	98	51	6	9	0	484	136	783	0
22:00	0	0	98	51	6	9	0	501	110	775	0
23:00	0	0	98	51	6	9	0	501	89	753	0
00:00	0	0	98	51	6	9	0	488	82	733	0
Produced amount of energy MWh	0	0	2362	1219	134	208	105	9904	3313	17068	177

Scenario A Conservative development
Year 2027 June – minimum monthly load

Table 19

Hour	Riga CHP–1	Riga CHP–2 [11]	Imanta CHP	Biomass and biogas	Gas fuelled co-generation	Small HPPs	Wind power	Solar power	Daugava HPPs [10]	Import	Load
01:00	0	0	112	43	6	15	0	539	59	773	0
02:00	0	0	112	43	6	15	0	455	40	671	0
03:00	0	0	112	43	6	15	0	422	36	633	0
04:00	0	0	112	43	6	15	0	408	23	607	0
05:00	0	0	112	43	6	15	0	395	23	594	0
06:00	0	0	112	43	6	15	0	367	21	564	0
07:00	0	0	112	43	6	15	0	346	49	571	0
08:00	0	0	112	43	6	15	0	340	110	613	13
09:00	0	0	112	43	6	15	24	340	175	680	35
10:00	0	0	112	43	6	15	24	340	246	764	22
11:00	0	0	112	43	6	15	24	361	268	829	0
12:00	0	0	112	43	6	15	24	395	270	865	0
13:00	0	0	112	43	6	15	24	426	251	877	0
14:00	0	0	112	43	6	15	24	433	241	874	0
15:00	0	0	112	43	6	15	24	434	240	874	0
16:00	0	0	112	43	6	15	24	454	215	869	0
17:00	0	0	112	43	6	15	24	470	191	861	0
18:00	0	0	112	43	6	15	24	496	159	855	0
19:00	0	0	112	43	6	15	24	508	144	852	0
20:00	0	0	112	43	6	15	0	538	135	849	0
21:00	0	0	112	43	6	15	0	530	136	842	0
22:00	0	0	112	43	6	15	0	547	110	833	0
23:00	0	0	112	43	6	15	0	545	89	809	0
00:00	0	0	112	43	6	15	0	531	82	788	0
Produced amount of energy MWh	0	0	2695	1033	133	356	266	10621	3313	18348	70

Scenario A Conservative development
Year 2032 June – minimum monthly load

Table 20

Hour	Riga CHP–1	Riga CHP–2 [11]	Imanta CHP	Biomass and biogas	Gas fuelled co-generation	Small HPPs	Wind power	Solar power	Daugava HPPs [10]	Import	Load
01:00	0	0	134	29	6	111	0	489	59	828	0
02:00	0	0	134	29	6	111	0	398	40	718	0
03:00	0	0	134	29	6	111	0	362	36	678	0
04:00	0	0	134	29	6	111	0	347	23	649	0
05:00	0	0	134	29	6	111	0	340	23	636	7
06:00	0	0	134	29	6	111	0	340	21	603	37
07:00	0	0	134	29	6	111	0	340	49	611	57
08:00	0	0	134	29	6	111	0	340	110	656	73
09:00	0	0	134	29	6	111	54	340	175	728	120
10:00	0	0	134	29	6	111	54	340	246	818	102
11:00	0	0	134	29	6	111	54	340	268	888	54
12:00	0	0	134	29	6	111	54	340	270	926	17
13:00	0	0	134	29	6	111	54	354	251	939	0
14:00	0	0	134	29	6	111	54	361	241	936	0
15:00	0	0	134	29	6	111	54	361	240	935	0
16:00	0	0	134	29	6	111	54	382	215	930	0
17:00	0	0	134	29	6	111	54	397	191	922	0
18:00	0	0	134	29	6	111	54	423	159	915	0
19:00	0	0	134	29	6	111	54	434	144	912	0
20:00	0	0	134	29	6	111	0	494	135	908	0
21:00	0	0	134	29	6	111	0	486	136	901	0
22:00	0	0	134	29	6	111	0	502	110	891	0
23:00	0	0	134	29	6	111	0	498	89	866	0
00:00	0	0	134	29	6	111	0	482	82	844	0
Produced amount of energy MWh	0	0	3207	703	137	2661	594	9491	3313	19638	469

POWER DEMAND AND POSSIBLE SOURCES OF GUARANTEEING, HOURLY BALANCE FOR SCENARIO B (MINIMUM LOAD), MW

Scenario B Base development
Yar 2022 June – minimum monthly load

Table 21

Hour	Riga CHP–1	Riga CHP–2 [11]	Imanta CHP	Biomass and biogas	Gas fuelled co-generation	Small HPPs	Wind power	Solar power	Daugava HPPs [10]	Import	Load
01:00	0	0	101	51	6	12	0	474	76	719	0
02:00	0	0	101	51	6	12	0	403	52	624	0
03:00	0	0	101	51	6	12	0	374	46	589	0
04:00	0	0	101	51	6	12	0	366	30	565	0
05:00	0	0	101	51	6	12	0	354	30	553	0
06:00	0	0	101	51	6	12	0	340	27	524	12
07:00	0	0	101	51	6	12	0	340	63	531	41
08:00	0	0	101	51	6	12	0	340	143	571	81
09:00	0	0	101	51	6	12	12	340	227	633	115
10:00	0	0	101	51	6	12	12	340	319	711	129
11:00	0	0	101	51	6	12	12	340	348	771	97
12:00	0	0	101	51	6	12	12	340	350	805	66
13:00	0	0	101	51	6	12	12	340	326	816	30
14:00	0	0	101	51	6	12	12	340	312	813	20
15:00	0	0	101	51	6	12	12	340	311	813	19
16:00	0	0	101	51	6	12	12	349	279	808	0
17:00	0	0	101	51	6	12	12	373	248	801	0
18:00	0	0	101	51	6	12	12	409	206	795	0
19:00	0	0	101	51	6	12	12	425	187	793	0
20:00	0	0	101	51	6	12	0	446	174	789	0
21:00	0	0	101	51	6	12	0	438	177	783	0
22:00	0	0	101	51	6	12	0	463	143	775	0
23:00	0	0	101	51	6	12	0	469	115	753	0
00:00	0	0	101	51	6	12	0	458	106	733	0
Produced amount of energy MWh	0	0	2418	1219	133	279	132	9202	4294	17068	610

Scenario B Base development
Yar 2027 June – minimum monthly load

Table 22

Hour	Riga CHP–1	Riga CHP–2 [11]	Imanta CHP	Biomass and biogas	Gas fuelled co-generation	Small HPPs	Wind power	Solar power	Daugava HPPs [10]	Import	Load
01:00	0	0	126	43	6	33	0	489	76	773	0
02:00	0	0	126	43	6	33	0	411	52	671	0
03:00	0	0	126	43	6	33	0	379	46	633	0
04:00	0	0	126	43	6	33	0	370	30	607	0
05:00	0	0	126	43	6	33	0	357	30	594	0
06:00	0	0	126	43	6	33	0	340	27	564	11
07:00	0	0	126	43	6	33	0	340	63	571	40
08:00	0	0	126	43	6	33	0	340	143	613	77
09:00	0	0	126	43	6	33	43	340	227	680	137
10:00	0	0	126	43	6	33	43	340	319	764	145
11:00	0	0	126	43	6	33	43	340	348	829	109
12:00	0	0	126	43	6	33	43	340	350	865	75
13:00	0	0	126	43	6	33	43	340	326	877	39
14:00	0	0	126	43	6	33	43	340	312	874	29
15:00	0	0	126	43	6	33	43	340	311	874	28
16:00	0	0	126	43	6	33	43	340	279	869	0
17:00	0	0	126	43	6	33	43	363	248	861	0
18:00	0	0	126	43	6	33	43	399	206	855	0
19:00	0	0	126	43	6	33	43	415	187	852	0
20:00	0	0	126	43	6	33	0	467	174	849	0
21:00	0	0	126	43	6	33	0	458	177	842	0
22:00	0	0	126	43	6	33	0	483	143	833	0
23:00	0	0	126	43	6	33	0	487	115	809	0
00:00	0	0	126	43	6	33	0	475	106	788	0
Produced amount of energy MWh	0	0	3028	1033	133	784	475	9292	4294	18348	691

Scenario B Base development
Yar 2032 June – minimum monthly load

Table 23

Hour	Riga CHP–1	Riga CHP–2 [11]	Imanta CHP	Biomass and biogas	Gas fuelled co-generation	Small HPPs	Wind power	Solar power	Daugava HPPs [10]	Import	Load
01:00	0	0	178	29	6	218	0	320	76	828	0
02:00	0	0	178	29	6	218	0	235	52	718	0
03:00	0	0	178	29	6	218	0	200	46	678	0
04:00	0	0	178	29	6	218	0	189	30	649	0
05:00	0	0	178	29	6	218	0	175	30	636	0
06:00	0	0	178	29	6	218	0	170	27	603	25
07:00	0	0	178	29	6	218	0	170	63	611	53
08:00	0	0	178	29	6	218	0	170	143	656	88
09:00	0	0	178	29	6	218	94	170	227	728	193
10:00	0	0	178	29	6	218	94	170	319	818	196
11:00	0	0	178	29	6	218	94	170	348	888	155
12:00	0	0	178	29	6	218	94	170	350	926	118
13:00	0	0	178	29	6	218	94	170	326	939	81
14:00	0	0	178	29	6	218	94	170	312	936	71
15:00	0	0	178	29	6	218	94	170	311	935	71
16:00	0	0	178	29	6	218	94	170	279	930	43
17:00	0	0	178	29	6	218	94	170	248	922	21
18:00	0	0	178	29	6	218	94	185	206	915	0
19:00	0	0	178	29	6	218	94	201	187	912	0
20:00	0	0	178	29	6	218	0	303	174	908	0
21:00	0	0	178	29	6	218	0	294	177	901	0
22:00	0	0	178	29	6	218	0	318	143	891	0
23:00	0	0	178	29	6	218	0	320	115	866	0
00:00	0	0	178	29	6	218	0	306	106	844	0
Produced amount of energy MWh	0	0	4276	703	137	5228	1030	5085	4294	19638	1115

POWER DEMAND AND POSSIBLE SOURCES OF GUARANTEEING, HOURLY BALANCE FOR SCENARIO EU2030 (MINIMUM LOAD), MW

Scenario EU2030 Optimistic development
Year 2022 June – minimum monthly load

Table 24

Hour	Riga CHP–1	Riga CHP–2 [11]	Imanta CHP	Biomass and biogas	Gas fuelled co-generation	Small HPPs	Wind power	Solar power	Daugava HPPs [10]	Import	Load
01:00	0	0	104	51	6	12	0	460	87	719	0
02:00	0	0	104	51	6	12	0	392	60	624	0
03:00	0	0	104	51	6	12	0	364	53	589	0
04:00	0	0	104	51	6	12	0	358	34	565	0
05:00	0	0	104	51	6	12	0	346	34	553	0
06:00	0	0	104	51	6	12	0	340	31	524	19
07:00	0	0	104	51	6	12	0	340	72	531	54
08:00	0	0	104	51	6	12	0	340	164	571	105
09:00	0	0	104	51	6	12	15	340	259	633	153
10:00	0	0	104	51	6	12	15	340	364	711	181
11:00	0	0	104	51	6	12	15	340	398	771	153
12:00	0	0	104	51	6	12	15	340	400	805	122
13:00	0	0	104	51	6	12	15	340	372	816	83
14:00	0	0	104	51	6	12	15	340	357	813	71
15:00	0	0	104	51	6	12	15	340	356	813	70
16:00	0	0	104	51	6	12	15	340	318	808	37
17:00	0	0	104	51	6	12	15	340	283	801	9
18:00	0	0	104	51	6	12	15	373	235	795	0
19:00	0	0	104	51	6	12	15	392	213	793	0
20:00	0	0	104	51	6	12	0	418	199	789	0
21:00	0	0	104	51	6	12	0	409	202	783	0
22:00	0	0	104	51	6	12	0	439	163	775	0
23:00	0	0	104	51	6	12	0	449	131	753	0
00:00	0	0	104	51	6	12	0	439	122	733	0
Produced amount of energy MWh	0	0	2500	1219	133	285	161	8920	4908	17068	1057

Scenario EU2030 Optimistic development
Year 2027 June – minimum monthly load

Table 25

Hour	Riga CHP–1	Riga CHP–2 [11)	Imanta CHP	Biomass and biogas	Gas fuelled co-generation	Small HPPs	Wind power	Solar power	Daugava HPPs [10)	Import	Load
01:00	0	0	147	43	6	52	0	438	87	773	0
02:00	0	0	147	43	6	52	0	363	60	671	0
03:00	0	0	147	43	6	52	0	340	53	633	8
04:00	0	0	147	43	6	52	0	340	34	607	15
05:00	0	0	147	43	6	52	0	340	34	594	28
06:00	0	0	147	43	6	52	0	340	31	564	55
07:00	0	0	147	43	6	52	0	340	72	571	89
08:00	0	0	147	43	6	52	0	340	164	613	138
09:00	0	0	147	43	6	52	52	340	259	680	219
10:00	0	0	147	43	6	52	52	340	364	764	241
11:00	0	0	147	43	6	52	52	340	398	829	209
12:00	0	0	147	43	6	52	52	340	400	865	175
13:00	0	0	147	43	6	52	52	340	372	877	135
14:00	0	0	147	43	6	52	52	340	357	874	123
15:00	0	0	147	43	6	52	52	340	356	874	122
16:00	0	0	147	43	6	52	52	340	318	869	90
17:00	0	0	147	43	6	52	52	340	283	861	62
18:00	0	0	147	43	6	52	52	340	235	855	20
19:00	0	0	147	43	6	52	52	340	213	852	2
20:00	0	0	147	43	6	52	0	402	199	849	0
21:00	0	0	147	43	6	52	0	393	202	842	0
22:00	0	0	147	43	6	52	0	422	163	833	0
23:00	0	0	147	43	6	52	0	430	131	809	0
00:00	0	0	147	43	6	52	0	419	122	788	0
Produced amount of energy MWh	0	0	3521	1033	133	1259	577	8647	4908	18348	1730

Scenario EU2030 Optimistic development
Year 2032 June – minimum monthly load

Table 26

Hour	Riga CHP–1	Riga CHP–2 [11]	Imanta CHP	Biomass and biogas	Gas fuelled co-generation	Small HPPs	Wind power	Solar power	Daugava HPPs [10]	Import	Load
01:00	0	0	220	29	6	154	0	0	87	828	–331
02:00	0	0	220	29	6	154	0	0	60	718	–249
03:00	0	0	220	29	6	154	0	0	53	678	–215
04:00	0	0	220	29	6	154	0	0	34	649	–206
05:00	0	0	220	29	6	154	0	0	34	636	–192
06:00	0	0	220	29	6	154	0	0	31	603	–162
07:00	0	0	220	29	6	154	0	0	164	611	–37
08:00	0	0	220	29	6	154	0	0	247	656	0
09:00	0	0	220	29	6	154	119	0	200	728	0
10:00	0	0	220	29	6	154	119	0	289	818	0
11:00	0	0	220	29	6	154	119	0	359	888	0
12:00	0	0	220	29	6	154	119	0	398	926	0
13:00	0	0	220	29	6	154	119	0	372	939	–38
14:00	0	0	220	29	6	154	119	0	357	936	–50
15:00	0	0	220	29	6	154	119	0	356	935	–51
16:00	0	0	220	29	6	154	119	0	318	930	–83
17:00	0	0	220	29	6	154	119	0	283	922	–110
18:00	0	0	220	29	6	154	119	0	235	915	–152
19:00	0	0	220	29	6	154	119	0	213	912	–170
20:00	0	0	220	29	6	154	0	0	199	908	–299
21:00	0	0	220	29	6	154	0	0	202	901	–290
22:00	0	0	220	29	6	154	0	0	163	891	–319
23:00	0	0	220	29	6	154	0	0	131	866	–325
00:00	0	0	220	29	6	154	0	0	122	844	–313
Produced amount of energy MWh	0	0	5284	703	137	3707	1307	5118	4908	19638	1526

3.2. Information on energy cross-border trade amounts, comparing year 2021 with 2020 and 2019

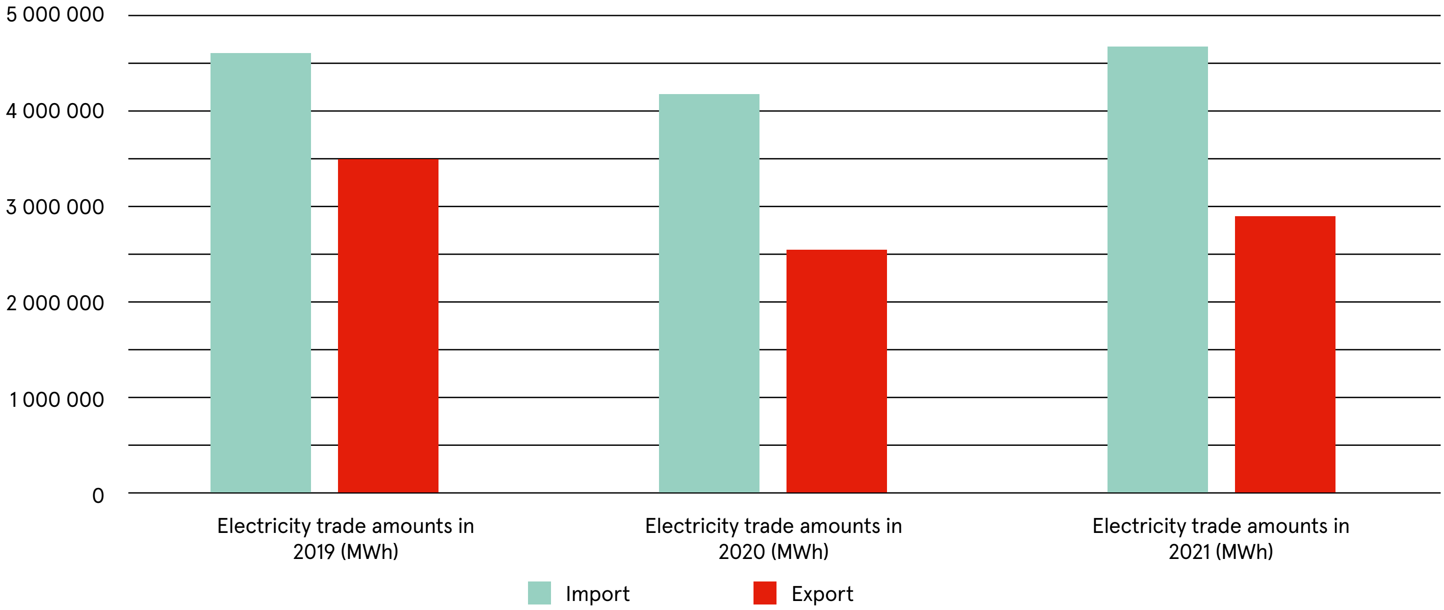


Table 27

	Electricity trade amounts in 2019 (MWh)	Electricity trade amounts in 2020 (MWh)	Electricity trade amounts in 2021 (MWh)
Import	4 610 761	4 173 365	4 666 370
Export	3 492 683	2 547 730	2 893 735

Table 27 shows that in 2021, compared to 2019 and 2020, electricity import is close to previous years' electricity Import. Compared to 2019, import has not changed and is very close, but compared to 2020, electricity import has increased by 11%. The export of electricity in compare to the years 2019 and 2020 is within the range of the values of the previous years, which indicates that the long-term export volume remains unchanged. The Latvian electricity system has imported 1,772,635 MWh (the difference between import and export) from the electricity systems of neighbouring countries, which covered Latvia's electricity consumption on an annual basis, and this amount is approximately equal to 24% of Latvia's total electricity consumption.

3.3. TSO's assessment of the periods in which the generation capacities were not adequate to the demand, and proposals for ensuring the generation capacity for the following years (possibility of capacity development in specific locations, consumption management measures, construction of new system facilities)

The Latvian TSO, as the responsible institution in Latvia for the reliable and stable operation of the electricity system as well as responsible for security of supply under electricity market conditions, is working with Estonia and Lithuania according to the principles of Nordic electricity market "Nord Pool", ensures the trading of market transactions in the Latvian trading area, providing power balance between Latvian consumption and production, and control and publish available interconnection capacities for trade with neighbouring electricity systems. Since the adoption of the European Union (EU) Energy Action Plan 2050, which states that generation development and national power adequacy must be focused on areas with RES potential to stimulate the reduction of CO_2 and other greenhouse gas emissions and the development of more efficient, competitive power plants. The power adequacy within a country is not an evident indicator of the adequacy of base generating capacity, but it must be taken into account together with available transmission capacities to/from the country or region.

In normal operating conditions of the Latvian electricity transmission system, the interconnection transmission capacities with neighbouring electricity systems is sufficient to ensure the forecasted electricity import/export. In previous years, no situations have been identified when it would have been necessary to disconnect any electricity users or regions in Latvia due to insufficient generating capacity or insufficient interconnection capacity with the neighbouring countries. Until now, working synchronously with the Russian unified power system, Latvian TSO has been able to guarantee flows in the Latvian electricity system in all operation conditions, regardless of the amount of generating units operating in the territory of Latvia. At the same time, considering the power adequacy at the national and regional level (see section 3.6 for details), the generating capacities in the Latvian electricity system are insufficient to cover the maximum load of the Latvian electricity system and ensure the necessary power reserves in the respective scenarios, as well as to ensure the operation of the Latvian electricity system, especially in emergency situations caused by a capacity reductions in cross-borders with neighbouring countries. Taking into account mentioned above and the further progress of Baltic States synchronization with continental Europe, the TSO considers that the development of sustainable generation and balancing capacities is necessary to ensure the secure operation of the Latvian electricity system.

Analysing the power adequacy for the next years, the Conservative Scenario (A) power (MW) adequacy analysis (Table 3) shows that the generating capacity

is insufficient to cover the peak load, provide system reserves and guarantee secure power supply requirements during the winter months starting from 2022 till 2032. The slow development of the renewable energy sources in Latvian electricity system, as well as slow rate of economic growth is planned in the Conservative scenario (A), while the existing cogeneration power plants are planned to participate in covering the power balance, thus, operation of the natural gas cogeneration power plants, including Riga CHP–1 and Riga CHP–2, under free electricity market conditions, where it will be difficult for these plants to remain competitive and the volume of gas import will be limited. Due to changes in the State support scheme, TSO forecasts that the amount of electricity produced by Riga CHP–2 and Riga CHP–1 will also be lower than the historical average. Riga CHP–1 and Riga CHP–2 power plants will be in operation to participate in the peak load covering, but electricity generation is expected to be reduced. In the Conservative scenario (A), based on generation development plans, the capacity deficit will reach 2% in 2030 and 8% in 2025. Is planned that in 2030, 347 MW of the total net capacity of wind power plants could be covered by off-shore wind farms, the real development rates of which are currently difficult to predict, taking into account that no wind power plants have been installed in the territorial waters of the Baltic States. Due to the slow plans of wind power plants development in the Conservative scenario (A), it is planned that the development of off-shore wind farms could start not earlier than 2030 (the minimum time for the construction of wind farms with studies and permitting process is approximately 4-6 years), when an ELWIND offshore wind farm project or other similar project could be partly implemented. During whole evaluating period (2022-2032), the power adequacy ranges are from 92% to 98%, which indicates that the generating capacities are insufficient to cover the electricity consumption, and the power deficit increases from 35 MW to 109 MW during whole evaluated period. The Conservative scenario (A) clearly shows that, in order to ensure the electricity balance in the system, it is very important not to lose/reduce the existing Latvian base load generation (Daugava HPPs, Riga CHP–1 and Riga CHP–2) in the Latvian electricity system. In the Conservative scenario (A), electricity production is shown taking into account that Riga CHP–1 and Riga CHP–2 are operating according to the free electricity market conditions, when the stations are less efficient and in conditions of free competition are able to produce only a part of the maximum possible output. The electricity balance table (Table 6) shows that electrical energy deficit for the Latvian electricity system in the Conservative scenario (A) is expected from approximately 594 GWh to 1881 GWh, which will be possible to import through interconnections from neighbouring countries to ensure the electricity balance in the system.

In the Base scenario (B), the power (MW) adequacy analysis (Table 4) shows that the Latvian electricity system is able to cover the peak load from 2022 to 2032 and, in future the power surplus increases by 3-8%. The Base scenario (B) shows that it is essential not to lose/reduce the existing Latvian base generation (Daugava HPP, Riga CHP–1 and Riga CHP–2). In the Base scenario (B), it is assumed that the development of the off-shore wind farms could start operation in 2030, and the development of wind power plants will proceed slightly faster than it is planned in the Conservative scenario (A). This assumption is based on the fact that ELWIND or another similar wind farm project could be fully implemented by 2030, when the installed capacity of the offshore wind farm would reach 500 MW. From the electricity balance table (Table 7) can be seen that in the Base scenario (B) the supply of electric energy will not be sufficient in the period from 2022 to 2029 (82-88%), but after implementation of ELWIND project or another offshore wind farm project in 2030 electricity supply will exceed 100%. Until 2030, Latvia will import electricity from the neighbouring countries to ensure the electricity balance, and the capacities of interconnections will be sufficient to ensure Latvia's power adequacy. In the Base scenario (B), it is assumed that Riga CHP–2 works according to the free electricity market conditions, but from 2030 Riga CHP–1 is out of operation.

In the Optimistic scenario (EU 2030), the power (MW) adequacy analysis table (Table 5) shows that the Latvian electricity system is able to cover the peak load from 2022 to 2029 (108% to 116%). Starting from 2030, the Riga CHP–1 and Riga CHP–2 gas fired power plants will be out of operation, because RES generation will be able to replace them and the power deficit can be imported from the RES of neighbouring countries. The surplus of capacity in Latvia indicates that it is possible to export power to the electricity systems of neighbouring countries to help cover their peak loads. In the Optimistic scenario (EU 2030) is assumed that the development of off-shore wind farms could start from 2027 step by step. This assumption is based for assumption, that installation of the wind turbines in the sea for ELWIND or another similar wind farm project, could be started from 2027 and the project could be commissioned by 2030, when the installed capacity of the offshore wind farm will reach 500 MW. The electricity balance table (Table 8) shows that in the Optimistic scenario (EU 2030) the provision of electricity will be sufficient from 2022 to 2029 (152-167%), but from 2030 the electricity balance can be covered only from 85% to 93%. In order to ensure Latvia's electricity balance, it will be necessary to import electricity from neighbouring countries. In the Optimistic scenario (EU2030) is assumed that after 2030, Riga CHP–1 and Riga CHP–2 will not be competitive with RES generation capacities in the region, therefore these power plants are put out of operation. In the Optimistic scenario (EU2030) is assumed that the production from the gas fired power plants is not based on the electricity market principles and, in order to ensure the security of the Latvian electricity system and electricity supply in Latvia, it is able to produce the maximum possible amount of electricity, taking into account the annual repair schedule of the power plant. In the optimistic scenario (EU2030), with even more rapidly increasing share of onshore wind power plants in the Latvian electricity system, the need for a regulation reserve will increase. The capacity of the interconnections will be sufficient to export surplus power and electricity to the neighbouring countries.

During analysis of the ability to cover the winter daily peak load, the total reserve of the Latvian power system is not included in the evaluation. In the Conservative Scenario (A), is concluded that from 2022 to 2032, the Latvian electricity system will be able to cover the daily load schedule, and there will be no need to import electricity to cover the daily peak load (Tables 9-11). In the Base scenario (B), the Latvian TSO will be able to fully cover the daily peak load from 2022 to 2032 (Tables 12-14). It is possible to cover 100 % of the daily peak load, because the required total power reserve is not included in the evaluation. In the Base scenario (B) it will be possible to export power to neighbouring power systems, if necessary, to help neighbouring countries covering their peak loads during the winter months, as the interconnections allow for the export/import of power surplus.

In the Optimistic scenario (EU 2030), the Latvian TSO will be able to cover the daily load fully in 2022 (Table 15) and 2027 (Table 16), but in 2032 (Table 17) there will be a large power deficit, which will vary from 494 MW and up to 711 MW. Such a scenario shows that in addition to the development of renewable energy sources and the development of off-shore wind farms, it is necessary to develop base load capacities which will able to cover the load during the peak hours of the day. The main influencing factors for covering the winter peak load are the water inflow for the Daugava HPPs and the production characteristics of wind power stations.

To cover the daily minimum load in the summer period, in the Conservative scenario (A), Riga CHP–1 and Imanta CHP are out of operation in 2022 (table 18), and the power balance is basically provided by RES generation – biomass and biogas, wind power plants, Daugava HPPs, small HPPs, solar power plants, and distributed natural gas cogeneration plants, while the regulation of the electricity system is carried out by Riga CHP–2. Power export is possible during the minimum load hours of the day, when the minimum production of Riga CHP–2 is assumed at 340 MW level, to provide power adequacy during whole day. In the Conservative scenario (A), biomass and biogas power plants, small HPPs, wind and solar power plants, Daugava HPPs and small natural gas cogeneration plants operate as base load power plants till 2027, and Riga CHP–2 is providing the regulation (Table 19). The minimum output of Riga CHP–2 is assumed 340 MW, to provide power adequacy during the day.), In such a scenario, it will be possible to export electricity to neighbouring electricity systems if necessary to help neighbouring countries to cover load during the minimum load periods and it is assumed to be between 13 MW and 35 MW. In 2032, the base load power plant Riga CHP–1 is stop of operation, the power balance is provided by RES, and the power system is regulated by Riga CHP–2. The minimum production of Riga CHP–2 is 340 MW, will possibility to provide power output up to 502 MW. Latvia's electricity system will export 469 MWh of electricity during the day (Table 20).

To cover the daily minimum load in the Base Scenario (B) in 2022, Riga CHP–1 and Imanta CHP are out of operation (Table 21), is mainly provided by RES – biomass and biogas, wind power plants, Daugava HPPs, small HPPs, solar power plants, and small natural gas co-generation plants, and regulation is provided by Riga CHP–2. The minimum output of Riga CHP–2 is assumed to be 340 MW. In such scenario, the electricity export to neighbouring electricity systems will be from 12 MW to 129 MW. In the Base scenario (B) in 2027, biomass and biogas power plants, small HPP, wind and solar power plants, Daugava HPPs and small natural gas cogeneration plants operate as base load power plants, and Riga CHP–2 is providing the regulation services (Table 22). The minimum output of Riga CHP–2 is 340 MW, in order to provide power adequacy during the day. The electricity export neighbouring countries is expected from 11 MW to 145 MW. In year 2032 (Table 23), the base load power plants will not change, only due to the increase share of RES, Riga CHP–2 can work with a minimum capacity of 170 MW and will be able to provide a power balance with one block (442 MW).

For the coverage of minimum load in the Optimistic scenario (EU 2030), when the fastest development and implementation of RES generation is planned, in 2022 Riga CHP–1 and Imanta CHP are out of operation (Table 24), and the power adequacy is provided by RES generation – biomass and biogas, wind power plants, Daugava HPPs, small HPPs, solar power plants, and small natural gas cogeneration plants, while only the Riga CHP–2 is providing the system regulation service. The minimum output of Riga CHP–2 is assumed 340 MW. Power export is planned from 9 MW to 181 MW, and the amount of exported electricity will be approximately 1057 MWh. In the optimistic scenario (EU2030) in 2027, biomass and biogas power plants, small HPPs, wind and solar power plants, Daugava HPP and small natural gas cogeneration plants operate as base load power plants, while the Riga CHP–2 is the regulation provider (Table 25). The minimum output of Riga CHP–2 is assumed 340 MW. Power export will be provided by interconnection capacities that are adequate, and the amount of power export will be from 2 MW to 241 MW. Approximately 1730 MWh of electricity will be exported per day. In 2032, the portfolio of base load power plants will not be changed (Table 26), and its will be renewable energy plants, but due to high gas prices and CO_2 prices, big gas power plants will be closed, as a result, the Latvian electricity system will import electricity from neighbouring countries from 37 MW to 331 MW, and the amount of electricity Import will be approximately 3592 MWh. The cover peak day load in Latvia in such scenario will be provided by RES production of neighbouring countries and their import to power system of Latvia.

By increasing the production of electricity from RES, there are problems with covering the daily minimum and maximum load. At the minimum load, in order to provide the electricity system regulation service, it is necessary to operate highly manoeuvrable gas stations (at their minimum capacity), which then ensures the coverage of the daily load peaks. In this way, in order to ensure the reliability of the system and fulfilment of the electricity balance function, it is necessary to export electricity produced from RES at minimum load to neighbouring countries, but at peak load mode it is necessary to maintain additional gas powered stations, since RES alone cannot cover the daily consumption at the peak load mode.

With the development of RES, there is a greater need for a fast regulated power reserve that is able to provide the power balance according to the needs of the daily load. To ensure a quickly adjustable power reserve, TSO can buy service from already existing power plants in Latvia, from electricity producers in neighbouring countries, or to provide the above mentioned service with installation of Battery Energy Storage Systems (BESS), where based on the market test results, initiated by Baltic TSOs, on 24 of September 2021, the Cabinet of Ministers decision No. 674 (https://www.vestnesis.lv/op/2021/187.3) has been done. BESS will be installed in 330/110 kV substations. Information about the necessary, available capacity reserves (MW) and the amount of reserves used (MWh) in 2021 is provided in Table 28.

Table 28

Month	Maximum required power reserve	Available power reserve		Utilised power reserve
		In Latvia	BRELL agreement up to 12 hours	
	MW	MW	MW	MW
January	440	100	340	100
February	440	100	340	0
March	440	100	340	0
April	440	100	340	0
May	440	100	340	33.333
June	440	100	340	0
July	440	100	340	0
August	440	100	340	0
September	440	100	340	0
October	440	100	340	0
November	440	100	340	0
December	440	100	340	0

3.4. TSO conclusions on generation capacity and power availability for the needs of power supply providing for Latvian consumers

Looking at the power adequacy (Table 3), it can be seen that in 2022, in the Conservative Scenario (A), power self-sufficiency of the Latvian electricity system is approximately 95%, but with electricity (Table 7) – 74%. In the Conservative scenario (A) the permanent power capacity deficit is expected, which reflects the existing situation without significant changes. In this scenario, there are no plans to close the high-power gas fired power plants in Riga.

In the Base Scenario (B) the supply of power above 100 % will be during whole evaluating period. In the Base scenario (B), the provision of electricity from 2022 to 2029 will be between 82% and 88%, but after the construction of ELWIND or another off-shore wind power plant project, the provision of electricity will exceed 100%. The missing amount of electricity will be imported through interconnections from neighbouring countries.

In the Optimistic scenario (EU 2030), the amount of electricity produced from 2022 to 2032 will be from 152% to 167%, which indicates that the Latvian electricity system will be able to cover the electricity balance during whole evaluation period. In case of maximum production, the Latvian electricity system will be able to export electricity to the neighboring countries.

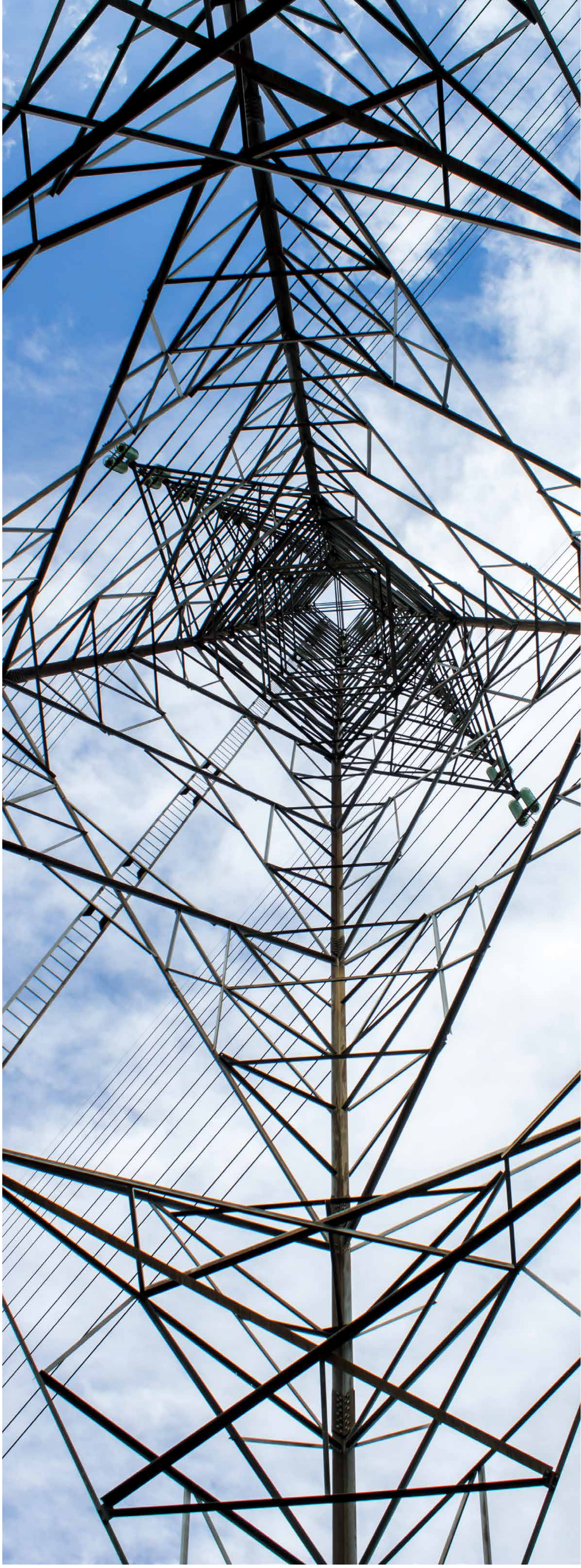
After 2029, when the high-capacity gas fired power plants will be closed, the electricity deficit from 15% to 7% will be in place, which will be covered by the electricity import from neighboring countries. The power adequacy table shows that in the Optimistic scenario (EU 2030) capacities are sufficient in the evaluated period from 2022 to 2029. Taking into account the possible shutdown of Riga CHPs after 2029, the power deficit for 2030 will be approximately 51% or 720 MW. Taking into account Baltic States synchronisation with Continental Europe after 2025, the need of power reserves will increase.

3.5. Development of the Latvian electricity transmission network, taking into account the development of RES and necessary connections to the transmission network

The commissioning of new big capacity power plants in Latvia is not planned until 2031 and, according to the information at the disposal of AS "Augstsprieguma tikls", no decisions have been made on the implementation of high-capacity power plant projects in the Baltic States. At the same time, the Ministry of Economics of the Republic of Latvia, as the institution responsible for the energy sector policy in Latvia, points out that the National Energy and Climate Plan (NECP) sets targets for wind energy development by 2030, expecting of development of at least 800 MW of installed wind energy capacities in Latvia.

Based on the above mentioned information, on 18 September 2020, the Governments of Estonia and Latvia jointly signed a Memorandum of Understanding on the development of a joint wind farm project in the Baltic Sea. The joint off-shore wind farm project is planned as a hybrid project, building both an off-shore wind farm and transmission infrastructure together with an interconnection between Estonia and Latvia, which will make it possible to receive the status of a regional project and request EU co-financing from the Connecting Europe Facility funds in the future. The existing transmission infrastructure will also facilitate the construction of other wind farms in the region, as the grid infrastructure for the common park would allow other potential wind farms to connect to the network in the same region. The installed capacity of the joint Estonian-Latvian wind farm is expected 1000 MW (500 MW for Latvia and 500 MW for Estonia), which is approximately 30 % of the daily peak load of both countries.

In December 2020 ENTSO-E members, TSOs of the Baltic Sea Region from Latvia (AS Augstsprieguma tikls), Estonia (Elering), Lithuania (Litgrid), Finland (Fingrid), Sweden (SvK), Germany (50 Hertz Transmission) and Denmark (Energinet) signed a Memorandum of Understanding on development and promotion of off-shore wind farm infrastructure development in the Baltic Sea. The aim of the Baltic Off shore grid initiative is to promote the



development of wind farms in the Baltic Sea and for transmission system operators to cooperate in the development and construction of transmission network infrastructure (see Fig. 4), which was also has been done in 2021, developing the mentioned topic and activities on the ENTSO-E level.

The EU has approved a strategy (COM/2015/080) on the Clean Energy Package which provides for a certain amount of electricity generated from RES by 2030 and 2050, as a result of which cooperation between neighbouring TSOs is needed to ensure efficient and cost-effective development of the transmission network and establishment of connection points. EU Member States have developed their National Energy Development Plans, which provide development of wind energy production in long-term, so the cooperation must begin immediately, and aim of the document is to facilitate this. The aim of the initiative is to simultaneously promote the construction of interconnections, which will ensure the transmission of wind energy from production sites to the consumption centres and the construction of new interconnections. The aims of Baltic Sea Offshore Grid Initiative are to share the information between Member States and build a common transmission network in the Baltic Sea, to develop and improve common principles for the development of the Baltic Sea transmission network, to include projects in the Pan-European Ten Year Network Development Plan and to initiate the study in the Baltic Sea. The development of off-shore wind farms and the development of the transmission network should be economically viable, cost-effective and based on market-oriented solutions.

In 2020, the Latvian government approved the Latvian National Maritime Spatial Plan developed by the Ministry of Environmental Protection and Regional Development, which identifies and fixed potential sites for off-shore wind farms construction. Based on this On September 18 2020, the Ministry of Economics of Latvia and the Ministry of Economic Affairs and Communications of Estonia, which are responsible for the energy sector in their respective countries, signed a Memorandum of Understanding (MoU) on the development of a joint offshore wind farm project in the Baltic Sea, developing wind farm areas identified in the Maritime Spatial Plan. The project is named ELWIND. The decisions in each country about wind farm area locations and role of the TSOs, responsible for the transmission infrastructure are expected in each country, where

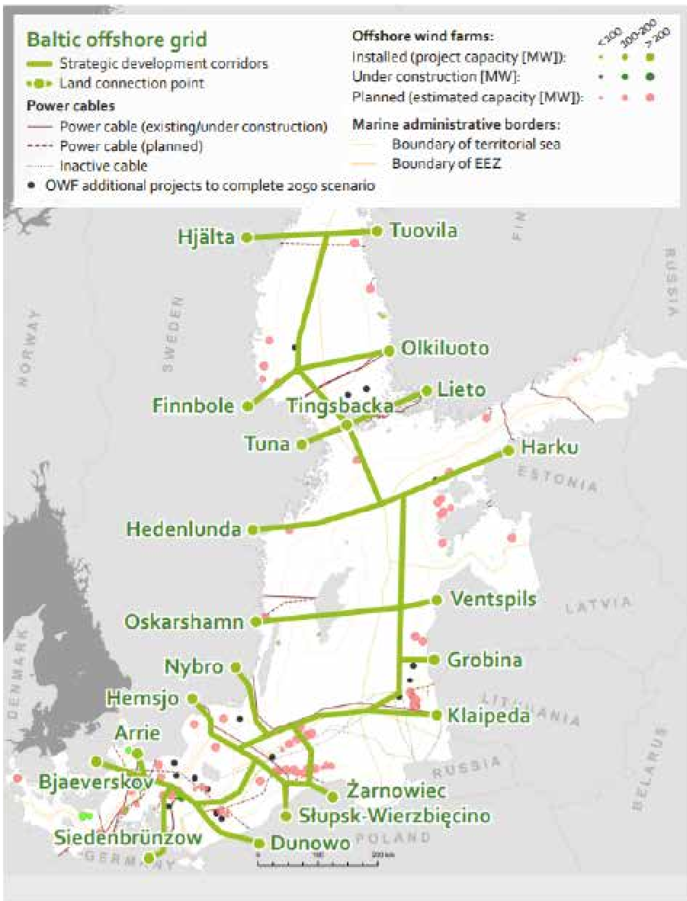


Fig. 4. Common Baltic Sea off-shore transmission network

Ministries responsible for energy in Latvia and Estonia make the relevant decisions, the project could be implemented as a hybrid project, with the construction of the fourth electricity interconnection between Latvia and Estonia. As the project has regional status, it is candidate for co-financing from the EU co-financing from CEF RES (the Connecting Europe Facility for Renewables), which is planned to support wind farms, as well as from CEF-Energy fund, which is intended for the construction of electricity transmission infrastructure. On the Estonian side, the Estonian Ministry of Economics and Communications is responsible for the development of the ELWIND wind farm project, while on the Latvian side, the Ministry of Economics and the Latvian Investment and Development Agency (LIAA) are involved in the project. Latvian and Estonian transmission system operators AST and Elering are currently involved in the project as observers and are planning to be involved in the project in the event of appropriate state decisions, as entities responsible for the development of infrastructure and the construction of connections to the power transmission network in each country. At the end of 2021, AST and Elering together with consultant Skepast&Puhkim prepared a detailed right-of-way study for the possible on-shore connections options. As well as the technical off-shore catalogue study has been prepared in the end of 2021 by consultant BLIX, ordered by AST and Elering for existing technologies, solutions and costs of the construction of off-shore wind farms and respective infrastructure. The auction of the wind park project for the potential investor is planned after 2025, and the implementation of the project itself, together with the construction of the infrastructure, is planned until 2030.

Estonia and Lithuania are also planning to develop large off-shore wind farms in the Baltic States by 2030. According to the information available to the Latvian TSO, the development of the Saare Wind Energy off-shore wind park project is planned in Estonia - with a capacity of up to 1400 MW on the west coast of Estonia near the island of Saaremaa. Similarly, Lithuania plans to develop high-power off-shore wind farms with an installed capacity of 700 MW by 2030 on the west coast of the Baltic Sea. In the next decade, a large development trend of off-shore wind farms can be observed, which will make a significant contribution to the overall reduction of CO_2 emissions in the EU and mitigation of climate change.

Starting from 2020, the interest of development of onshore wind farms in the territory of Latvia has significantly increased, which is fixed in the technical requirements issued by AST for the development of new generating capacities (Table 29, data is for 06 of June 2022). At present, AST has issued technical requirements for wind farms developers to the connections of on-shore transmission network in Latvia with a total installed capacity close to 3000 MW, which is close to the maximum that can be connected to the existing power transmission network without significant reinforcements. Currently, according to the amount of technical requirements issued by AST, a bigger interest is noted for solar park connections than for wind parks. The reason for this is that according to existing legislation, an environmental impact assessment is not required for solar generation parks.

Consequently, the situation than development of solar parks has advantages in relation to wind parks has arisen, even though wind parks have advantages in terms of efficiency. According to AST available information, there is also interest in the distribution network level for the connection of RES generating capacity of approximately 1000 MW, which creates new technological challenges for the electricity system, since the power flow from the transmission network to the distribution network can be turned in the direction from the distribution network to the transmission network. Therefore, the joint and coordinated development planning between distribution and transmission networks is necessary. The development of generating capacity and connection to the electricity transmission network requires TSOs to plan for the long term and reserve transmission network capacities, as a result of which it is necessary to reinforce Latvia's internal transmission network, to develop interconnections with neighbouring electricity systems, to develop electricity consumption technologies, to provide quick power reserves and to think about the issues of inertia and dynamic stability of the electricity system from stable and security operation point of view.

Table 29

	Issued Technical Requirements, MW	**Solar power stations, MW**	**Wind power stations, MW**
Kurzeme	1823.05	911.9	911.15
Zemgale	337	235	102
Vidzeme	538.9	281.9	257
Latgale	356	240	116
Total:	**3054.95**	**1668.8**	**1386.15**

The development of high-capacity off-shore wind farms, shows necessity and importance to develop interconnections with the electricity systems of neighbouring countries in order to facilitate the EU's goal of integration of the electricity market and ensuring power system security and stability, as well as promoting of RES integration in the region. The preferred implementation time of the project is 2040. The project is included in the European 10 year Development Plan 2022 under the name LaSGo link and is included in the fifth list of the Projects of Common Interests (PCI List) approved in November 2021. The transmission capacity of the interconnection between Latvia and Sweden is planned till 700 MW. The project has a possibility of EU co-financing receiving in the future for both implementation and more detailed project studies, as well as the preparation of cost-benefit analysis. In connection with the implementation of the ELWIND project, it is necessary to reinforce the Latvian internal transmission network, including reinforcement of the existing interconnection Grobiņa (LV) – Darbenai (LT) between Latvia and Lithuania.

3.6. TSO conclusions on electricity generation capacity and availability of electrical energy in the European Union and at regional level

In 2021, the power adequacy at the regional level was assessed in the transmission systems operators association ENTSO-E, where the Latvian TSO AS "Augstsprieguma tikls" is an active member and participates in the development of the report by submitting the input data of the Latvian electricity system. The European Resource Adequacy Assessment 2021 (ERAA 2021) was developed, which assessed capacity adequacy for 2025 and 2030 (see Figure 5).

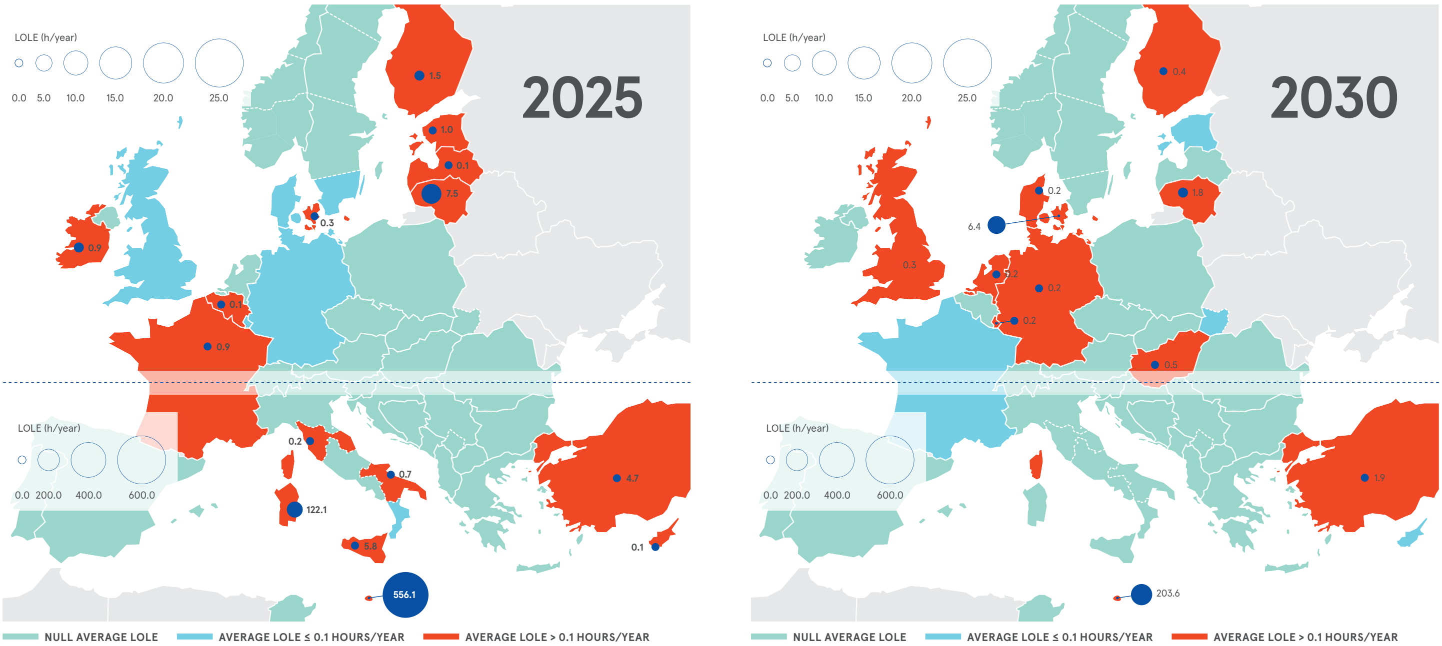


Fig. 5. LOLE values for 2025 and 2030

Until now, ERAA report was called the Mid-term Adequacy Forecast. The full European Resource Adequacy Assessment Report in English is available here: https://eepublicdownloads.azureedge.net/clean-documents/sdc-documents/ERAA/ERAA_2021_Executive%20Report.pdf. The ERAA report has been developed, using the Monte Carlo method of mathematical analysis, where 6 different scenarios were evaluated, including four scenarios for 2025 and two for 2030. Five different market simulation tools were used to achieve higher credibility of the evaluated results. Power adequacy is characterized by the LOLE (Loss of Load Expectation) value, which is calculated for each bidding area. The scenarios "National Estimates 2025" and "National Estimates 2030" are based on the information submitted by transmission system operators, therefore they are considered as the most important for the assessment of European power adequacy. The figure 5 shows that LOLE values in 2025 for Latvia are 0.1 hours per year, which corresponds to European Union guidelines, being within the limits of up to 3 hours/year. In the Baltic States, in the year 2030 electricity outage is observed only in the Lithuanian electricity system, with the LOLE value decreasing from 7 hours per year to 1.8 hours per year, compared to 2025. Due to Lithuania's large power deficit, Latvia's electricity system may also be affected, and the probability and volume of electricity non supply will increase. Lithuania plans to develop high-capacity off-shore wind farms to reduce the electricity deficit and meet the goals of Lithuania's national climate plan. From the ENTSO-E ERAA 2021 study, was concluded that Latvia's generation capacity at the regional level is sufficient in 2030, but a very small and insignificant electricity deficit is expected in 2025.

4.

TRANSMISSION SYSTEM ADEQUACY FOR DEMAND AND MAINTENANCE QUALITY

4.1. TSO conclusions on the power transmission system adequacy for the tasks of energy transmission and the ability to provide non-interrupted functioning of the power system in outage of one of the systems units and activities (individually and jointly with other transmission system operators) for the reliable operation of the transmission system for the coming years (minimum forecast period – 10 years)

At present, the cross-capacity of the Latvian-Estonian interconnection has been reduced in various modes of operation of Baltic transmission networks. These restrictions have been enforced by AS Elering (Estonian TSO) on cross-border and internal 330 kV transmission lines. The restrictions are planned to be eliminated by the end of 2025. Taking into account the loading of the interconnections of the Baltic States with the Nordic countries and Poland, in normal operating modes the transmission capacity of the Estonian-Latvian cross-border is not critical and not overloaded in normal operating modes, but in emergency and maintenance modes it still remains limited with significant congestions.

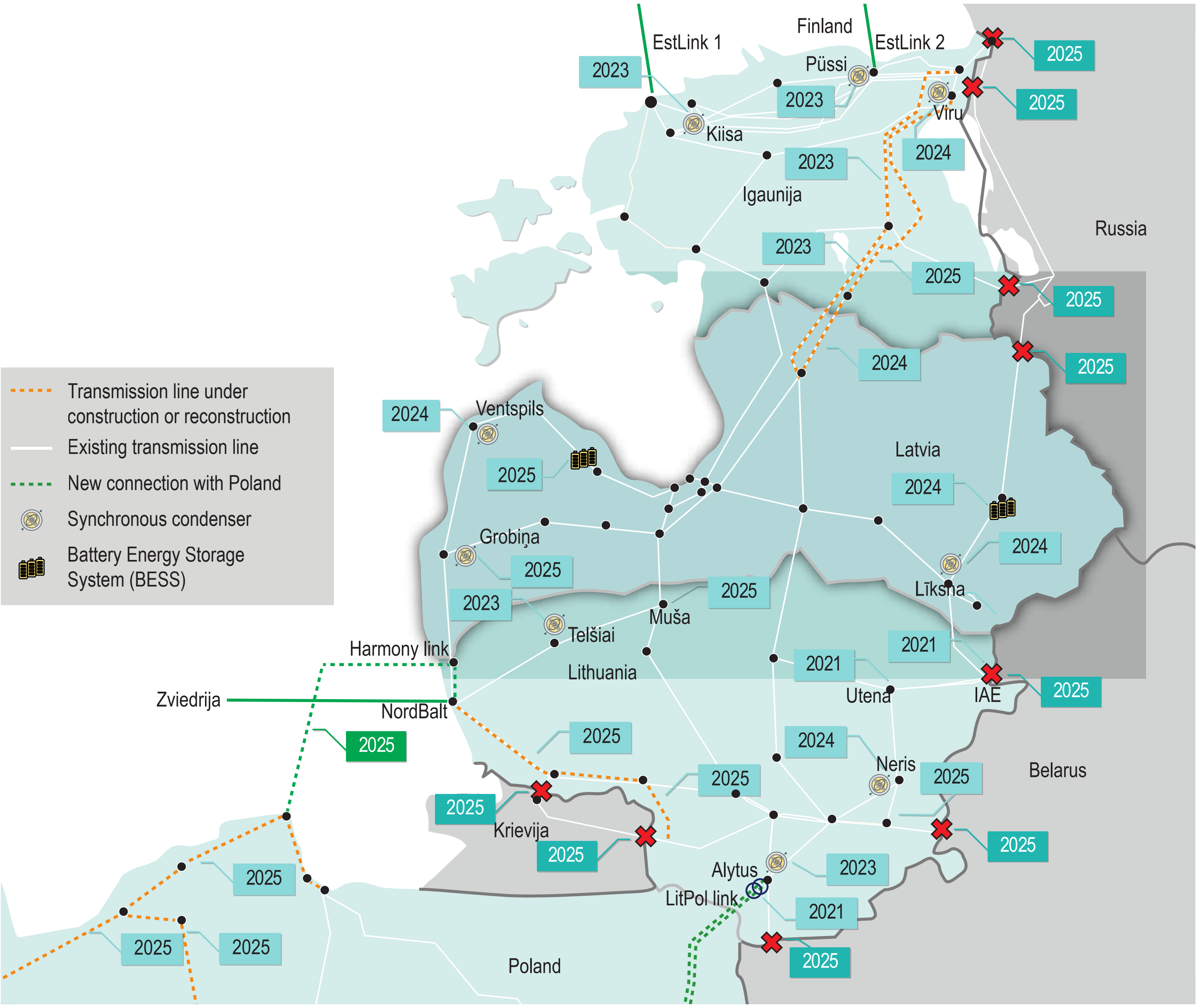


Fig.6. Baltic projects, in accordance with the development plans of the Baltic TSOs

In March 2021, the third Estonian-Latvian interconnection project has been commissioned, which increased the transmission capacity in the Estonian-Latvian cross-border. However, in order to fully eliminate the restrictions on the capacity of the Estonian-Latvian cross-border, during time period until 2025, it is planned to reconstruct the two existing interconnections with Estonia - from the substation Valmiera (Latvia) to the 330 kV substations in Estonia Tartu and Tsirguliina, as well as inside Estonia it is planned to reconstruct the 330kV transmission line Viru-Tsirguliina. This means that the transmission capacity of the Latvian-Estonian cross-border will still be limited until 2025, but the restrictions will be less than before 2021.

The transmission capacity in the Latvia-Lithuania cross-border is currently sufficient for trade and does not cause additional problems for electricity transmission in normal modes of operation, except in the case of the planned development of the ELWIND offshore wind farm, when the reinforcement of the cross-border capacity is necessary in order to be able to transfer the electricity produced by RES to the Lithuanian electricity system, where large deficit of generating capacities is expected (ERAA 2021 study).

The development of the Latvian-Russian interconnection is not planned, and due to the war in Ukraine in February 2022, the transmission transfer capacity of the Baltic States to the regions of Russia and Kaliningrad has been reduced to 300 MW, which is 150 MW to/from Russia and 150 MW to/from Kaliningrad. Due to the war in Ukraine, the Baltic TSOs are considering the possibility of an emergency desynchronization from BRELL, therefore the transmission capacity on the border between the Baltic States and Russia/Belarus is reduced to be prepared for that.

4.2. Information about the planned system interconnections and internal power system infrastructure projects of strategic importance (minimum forecast period – 10 years)

BALTIC STATES SYNCHRONIZATION WITH CONTINENTAL EUROPE NETWORKS AND DESYNCHRONIZATION FROM THE RUSSIAN UNIFIED ELECTRICITY SYSTEM

Co-financed by the European Union
Connecting Europe Facility

Based on the 2018 political decision of the Baltic States synchronization with the synchronous zone of continental Europe, as well as implementing the technical requirement from connection agreement, signed in May 2019 between the Baltic States and the European TSO, work on the synchronization of the electricity systems of the Baltic States with the continental Europe and desynchronization from the power system of Russia will continue in 2022. The Baltic synchronization project is included in the fifth list of projects of common interest (hereinafter - PCI), as well as in European and national development documents.

The synchronization project is planned to be implemented in two phases, where the first phase is related for strengthening activities of the internal Baltic electricity transmission network, while the second phase is related for activities for construction of the DC interconnection "Harmony link" between Lithuania and Poland, as well as measures for stability and frequency regulation provision in the Baltic States.

Under activities of the first phase of synchronization, the strengthening of the power transmission network of the Baltic States is planned, including the installation of equipment that will ensure the necessary amount of inertia and frequency regulation and control in synchronization mode with continental Europe. Under 1st phase of the Synchronisation project in Latvia, the reconstruction of two existing Estonian-Latvian interconnections Valmiera-Tartu and Valmiera-Tsirguliina, installation of one synchronous condenser, as well as modernization and installation of power control and automation, which are identified in the list of technical requirements of the connection agreement, are planned. In 2019 all Baltic Synchronization Phase 1 projects received 75% co-financing from CEF grants, and on March 2019 the Grant Agreement among the TSOs of the Baltic States and the European Innovation and Network Executive Agency has been signed on the conditions for the use of the allocated co-financing.

The reconstruction of the existing 330 kV interconnections Valmiera – Tartu and Valmiera – Tsirguliina is ongoing according to the planned schedule, but taking into account the geopolitical situation in the world and the global prices increase in all sectors, there are possible delays in the implementation of the project. The reconstruction of both 330 kV lines is combined in one activity (see Fig. 6). Taking into account that the Estonian TSO plans to reconstruct the power lines to the Narva power stations as part of the 1st phase of the synchronization project, in order not to reduce the transmission capacity for the electricity market, the Latvian and Estonian TSOs plan to reconstruct the existing lines step by step according to the power line outages time schedule harmonised by AST and Elering. Based on the procurement procedure announced in 2020, a contract with the construction community EMPOWER and LEONHARD WEISS was signed on July 15, 2021 for the development and construction of the both interconnection. The reconstruction works of the Valmiera-Tartu line are expected to start in 2022, but the commissioning is planned on 2023, while the reconstruction of 330 kV electricity transmission line Valmiera-Tsirguliina is planned immediately after the reconstruction of the Valmiera-Tartu electricity transmission line with the commissioning date at the end of 2024. Both projects are included in the PCI list for Baltic synchronization projects, and the investments are included in all national and European development documents.

As part of the synchronization phase 1 project, electricity and remote control systems of the power transmission network will be modernized by installing power monitoring and control equipment (PMU – Phasor Measurement Units and WAMS – Wide Area Monitoring System) in all the most important substations, as well as installing frequency control equipment in power stations and substations. The deadline for the implementation of the measures mentioned above is 2025, when the Baltic electricity systems are planned to be synchronized with continental Europe and desynchronized from the Russia/Belarus power system. However, due to the current geopolitical situation, the Baltic States must be ready for an emergency desynchronization even before the planned date. Contracts have been concluded for the implementation of the above mentioned activities, and work of project implementation is ongoing.

In addition to frequency regulation measures, in order to ensure stable operation of the electricity system in synchronization mode, Baltic TSOs must provide a sufficient amount of inertia on 24/7 mode – and based on the evaluation, Latvia should provide 5700 MWs of inertia. As part of the synchronisation 1st phase project, the installation of one 200 MVA stationary synchronous condenser is planned for the provision of the sufficient amount of inertia. In the second half of 2021, AST has announced a public procurement for the technical design and construction of synchronous condensers, and in the second half of 2022, the contract for the installation and construction of synchronous condensers will be signed.

As part of the 2nd phase of the Baltic synchronization project, the construction of direct current interconnection between Poland and Lithuania (Harmony link) is planned, the creation of the necessary infrastructure for connecting the interconnection to the power transmission network, the reinforcement of the power transmission network in Lithuania and Poland for secure and stable system operation, the installation of six synchronous condensers in the Baltic states, installation of Battery Energy Storage systems, as well as installation of frequency regulation equipment and IT infrastructure are planned. The 75% European co-financing for the total amount of 960 million EUR for the activities of synchronisation phase 2 part 1 projects, i.e. Harmony link, 6 synchronous condensers and the reinforcement of the Polish transmission network, has been received from CEF grants in 2020. The AST part of 74 MEUR is planned for the construction of two synchronous condensers. Whereas the projects of Synchronisation phase 2 part 2, has received 75% co-financing from CEF funds in January 2022 for the total amount of 238 MEUR, and Grant Agreement with the European Climate, Infrastructure and Environment Agency has been signed in June 2022. AST part under synchronization phase 2, part 2 project, is 49.9 MEUR, planned for the installation of battery energy storage systems, the modernization of the instrument transformers and metering system, upgrade of system protection automatics, as well as upgrade of IT activities and information technology systems.

After synchronizing with continental Europe and desynchronizing from the Russian electricity system, in 2026 AST should provide frequency regulation measures and provide frequency maintenance and restoration reserves. Taking into account that the market for frequency balancing and restoration reserves is not developed in the Baltics, and there is a considerable risk that the availability of such reserves in the market will not be possible, for implementation of the synchronization project on time in 2025, on September 24, 2021, the Cabinet of Ministers of Republic of Latvia with decision No. 674 (https://www. vestnesis.lv/op/2021/187.3) as transitional solution, allowed to AST to purchase, develop, manage and operate Battery Energy Storage System (BESS) to provide the necessary reserves during the implementation of the synchronization project and until such reserves availability in the market with a reasonable costs. According to AST evaluation, provision of the mentioned services with BESS is more efficient and with lower operational and maintenance costs, in compare with purchasing this service on the market from existing power plants. The need for the use of such equipment was also confirmed by the market test study, prepared in 2021 by the electricity TSOs of Latvia, Lithuania and Estonia, from which was concluded that neither in Latvia nor in the Baltic States in general, with the existing power stations, will it be possible to provide automatic frequency curtailment reserves (FCR), automatic frequency restoration reserves (aFRR) and manual frequency restoration reserves (hereinafter – mFRR). In order to avoid this risk, AST started the implementation of BESS projects with a total capacity of 80MW/160MWh, with the aim of providing, maintaining and activating the necessary reserves. The project is planned to be implemented by the end of 2025.

One of the technical requirements came from the catalogue of measures that AST, together with the other Baltic TSOs must fulfil in accordance with the connection agreement with continental Europe, is the preparation of dynamic stability studies, based on which the European TSO consortium will issue recommendations for protection and system automation, as well as ensuring frequency stability and load/frequency control in the Baltic States. Based on this, in April 2021, the Baltic TSOs signed the Service Contract with the Consortium of European TSO for the preparation of 5 studies regarding dynamic stability, stability of isolated operation, FSAS (Frequency stability assessment system) and LFC (Load frequency controller). All studies are planned to be completed by the end of 2022.

4.3. TSO conclusions on the electricity transmission system reliability and adequacy of all consumers to provide secure power supply in the previous year and the following years (minimum forecast period – 10 years).

Implementation of the projects mentioned in the paragraph 4.2 will provide secure and reliable operation of transmission network, compliance with the increasing electricity consumption, possibilities to connect new power plants, stable operation of the power plants and electricity transit through Latvia and the Baltic States, as well as will claim the interconnection of the Baltic States with the European electricity transmission networks.

The 330 kV and 110 kV transmission network is foreseen to reconstruct, modernized and developed in accordance with the Electricity Transmission System Development Plan of Latvia developed by AST and approved by the Public Utilities Commission (PUC), which is published on the AST and PUC websites. In parallel with the 330 kV transmission network, the 110 kV transmission network should be also developed, especially in the places where the N-1 reliability criterion cannot be met. The planned reconstruction of 110 kV substations and planned replacement of aged transformers is planned in the 110 kV network.

4.4. Existing power generation capacities greater than 1 MW, for January 1, 2022.

Latvian power system power stations with installed capacity above 1 MW are presented in the Table 30.

Table 30

No.	Name of the station	Installed capacity (MW)
Natural gas co-generation stations – 99.95 MW		
1	BK Enerģija	3.9
2	DLRR Enerģija SIA	1.698
3	Energy & Communication, AS	3.9
4	LATNEFTEGAZ SIA	3.986
5	Rēzeknes siltumtīkli SIA	5.572
6	Elektro bizness SIA	2.7
7	Mārupes siltumnīcas SIA	1.999
8	Olainfarm enerģija AS	2
9	Olenergo AS	3.12
10	Zaļā dārzniecība SIA	1.999
11	RTU Enerģija SIA	1.56
12	LIEPĀJAS ENERĢIJA, SIA	4
13	Juglas jauda, SIA	14,9
14	RĪGAS SILTUMS AS (SC Imanta)	47.7
15	RĪGAS SILTUMS AS	3.23
16	BALTIC COMMUNICATION NETWORK SIA	1.3
17	B-ENERGO, SIA	1.998
18	BIOSIL, SIA	1.998
19	DAUGAVPILS SILTUMTĪKLI PAS	2.055
20	DIENVIDLATGALES ĪPAŠUMI, SIA	1.998
21	RB VIDZEME	1.998
22	RESIDENCE ENERGY	1.24
Bio-mass, bio-gas stations – 94.36 MW		
1	AD Biogāzes stacija, SIA	1.96
2	Agro Iecava, SIA	1.95
3	Conatus BIOenergy, SIA	1.96
4	Bioenerģija-08, SIA	
5	Biodegviela, SIA	2
6	Getliņi EKO, BO SIA	6.5
7	Grow Energy, SIA	1.995
8	LIEPĀJAS RAS, SIA	1.1
9	GRAANUL INVEST, SIA	6.5
10	Liepājas Enerģija, SIA	2.4
11	GAS STREAM SIA	1
12	Pampāļi, SIA	1
13	EcoZeta, SIA	1.4
14	Saldus enerģija, SIA	1.8
15	Piejūras Energy, SIA	1.6
16	Agro Lestene, SIA	1.5

No.	Name of the station	Installed capacity (MW)
17	OŠUKALNS, SIA	1.4
18	EGG Energy SIA	1.996
19	Fortum Jelgava SIA	23,82
20	Agrofirma Tērvete AS	1.5
21	SM Energo SIA	1.1
22	Enefit power and Heat Valka SIA	2.4
23	Betula Premium SIA	1.9
24	Incukalns Energy SIA	3.999
25	Graanul Pellets Energy SIA	3.99
26	PREIĻU SILTUMS SIA	1.15
27	JE Enerģija SIA	1
28	TUKUMS DH SIA	1.705
29	Technological solutions SIA	3.98
30	DJF SIA	1.4
31	EKO NRG SIA	3.380
32	Energia Verde SIA	3.5
33	Rīgas Enerģija SIA	4
34	ENERGY RESOURCES CHP RĒZEKNES SPECIĀLĀS EKONOMISKĀS ZONAS SIA	3.98
35	RIGENS, SIA	1.998
36	Dobeles EKO SIA	3.990
37	RĪGAS SILTUMS AS (SC Ziepniekkalns)	4
38	Baltijas dārzeņi SIA	1.329
39	ZIEDI JP AS	1.998
40	NODEGI ZS	2.4
Wind power stations – 63 MW		
1	Baltnorvent, SIA, Alsungas VES	2
2	BK Enerģija, SIA	1.95
3	Enercom Plus, SIA	1
4	Impakt, SIA Užavas VES	1
5	Lenkas energo, SIA Lenkas VES	2
6	VĒJA PARKS 10, SIA	1.8
7	VĒJA PARKS 11, SIA	1.8
8	VĒJA PARKS 12, SIA	1.8
9	VĒJA PARKS 13, SIA	1.8
10	VĒJA PARKS 14, SIA	1.8
11	VĒJA PARKS 15, SIA	1.8
12	VĒJA PARKS 16, SIA	1.8
13	VĒJA PARKS 17, SIA	1.8
14	VĒJA PARKS 18, SIA	1.8
15	VĒJA PARKS 19, SIA	1.8
16	VĒJA PARKS 20, SIA	1.8
17	WINERGY, SIA	20.7
18	Silfs V SIA	1.1
19	Vides enerģija SIA	6.9

No.	Name of the station	Installed capacity (MW)
20	W.E.S. SIA	4.75
21	NBT5 ENERGY	1.75
Hydro power stations – 1.2 MW		
1	Spridzēnu HES, SIA	1.2
Latvenergo power stations – 2600 MW		
1	Ķeguma HES	248
2	Rīgas HES	402
3	Pļaviņu HES	908
4	Rīgas TEC-1	158
5	Rīgas TEC-2	832/881
6	Aiviekstes HES	1.47
7	Ainažu VES	1

4.5. Action in case of peak demand or shortage of suppliers

In case of the deficit of power and energy in Latvian territory and in the neighboring countries to cover the consumption of the Latvian power system, the TSO will be forced to limited or disable from the network a certain number of consumers in order to balance the power consumption and the generation in Latvian power system. In this case, the TSO will act according to Latvian legislation and will inform the Ministry of Economics of the problem of ensuring the balance of power.

5.

KEY TSO RECOMMENDATIONS AND CONCLUSIONS

- The synchronization project is the high priority project in the Baltics and Latvia, which must be implemented latest by the end of 2025. Baltic TSOs prepare all the necessary measures to ensure secure and stable operation of the system in case of emergency desynchronization and immediate synchronization with continental Europe as well. Continuing the integration of the electricity systems of the Baltic States into the networks of continental Europe, the Baltic States must implement ambitious projects in a relatively short time, which require support at the national and European level.
- The results of the power adequacy assessment prepared by ENTSO-E do not show significant risks of power adequacy in Latvia until 2030. Considering the significant capacities of natural gas fired power plants in the Baltic energy system, it is necessary to provide alternative sources in the region instead natural gas supply.
- Deficit of generating capacities is expected in the next decade in Latvia and in whole Baltic region, therefore the import of electricity will help to ensure the demand of electricity until 2030. It is planned to close and de-commission almost half of the generation capacities of large thermal power plants, and significant wind energy development in the Baltic region is expected. To ensure security of supply and system stability, this will ask a bigger amount of balancing power, which, according to current forecasts, will be insufficient. Therefore, in order not to reduce the security of supply and Latvian power system stability in the next decade, it is important to provide that Latvia's existing generation base load capacities should not be reduced.
- Taking into account the assumptions, mentioned above and future Baltic synchronization with Continental Europe, as well as the expected development of large off-shore wind farms in the region, the development of production and balancing capacities is essential to ensure the secure and stable operation of the electricity system in Latvia.
- Interconnections, reinforcement of the transmission network and the closer integration of the Baltic electricity system into the European electricity market will play an important role to cover the forecasted electricity demand and meeting the growing number of producers connections. This is especially actual in the EU2030 scenario, with the significant increase of RES capacities after 2030, which means the necessity to develop interconnections to Sweden, Lithuania and Estonia and to reinforce the internal 330 kV transmission network.
- In order to reduce carbon dioxide emissions and move towards the goal of a climate-neutral energy system, ensuring that investments in the development of the electricity system does not create an increasing tariff for consumers, it is necessary to develop electrification by replacing the fossil fuels production with use of electricity in all sectors of the economy, including the transport sector, the heating sector, the industrial sector, as well as in new industries, such as the production and use of hydrogen.
- Taking into account that natural gas and electricity supplies from Russia to the Baltic States and to Finland have been stopped, the higher risk of power adequacy provision in the region is expected in winter 2022/2023.

AS "Augstsprieguma tīkls" **A. Daugulis**
Board Member