Project Sheet

Baltic States Synchronization with Continental Europe

Project type	transmission
Project id	170
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ENTSO-E

Key Information

Cross Border Project
Offshore DC transmission cable
New

PCI number 4.8 (4th list, 31 Oct. 2019)
Under Construction

Description

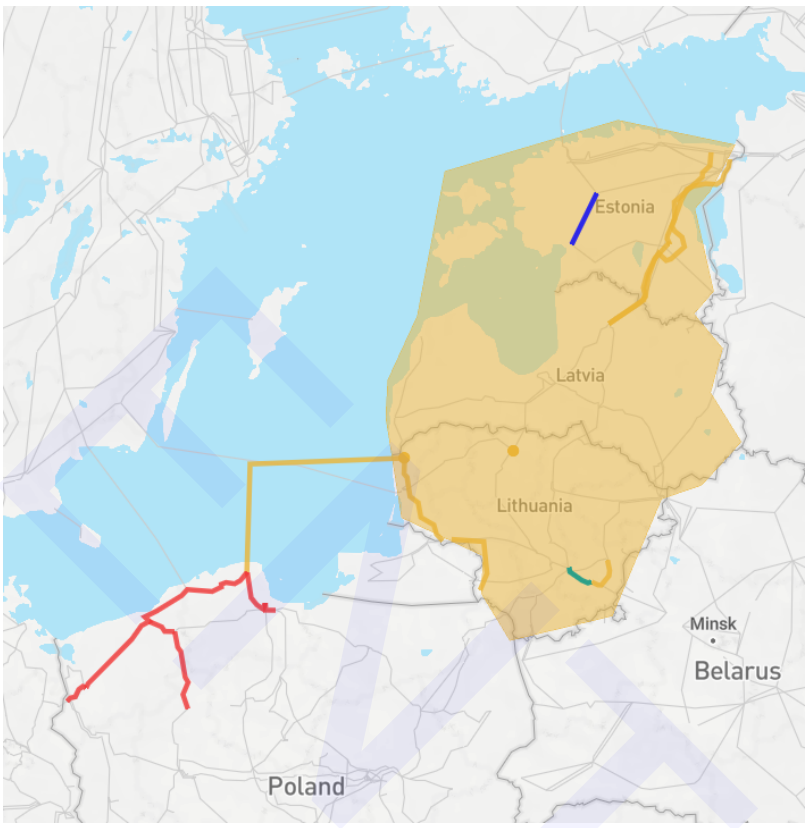
Goal of the project is to prepare Baltic states electrical networks for synchronous operation with Continenatal Europe. This project covers a lot of new investments for internal grid reinforcements - new 330 kV and 400 kV AC lines, voltage stabiliser units, synchronous compensators, upgrades of PSS in power stations, internal 110 kV network reinforcement required for synchronization and separation of 110 kV Baltic grid from IPS/UPS system, additional studies. As part of the project, after the synchronization, a new HVDC connection will be established between LT-PL (investment No. 1034) allowing for a commercial exchange of the Baltic States with Continental Europe in the amount of 700 MW.

Project promoters

AST
ELERING
Polskie Sieci Elektroenergetyczne S.A.
LITGRID AB

Countries

Estonia
Lithuania
Latvia
Poland



National development plan(s)

Lithuania: "Development of the Lithuanian electric power system and transmission grids. 2017-2026" (http://www.litgrid.eu/uploads/files/dir417/dir20/dir1/12_0.php), 2017, page 51. Latvia: NDP "The Power Transmission System Development Plan 2020-2029", approved by resolution of the Public Utilities Commission Council No.149 of 19 September 2019, Projects No. 3 and 4, Annex 3. Poland: Plan rozwoju w zakresie zaspokojenia obecnego i przyszłego zapotrzebowania na energię elektryczną na lata 2021-2030", Poland, Year 2020, Project 170, Page 10, https://www.pse.pl/documents/20182/8c629859-1420-432f-8437-6b3a714dda9c?safeargs=646f776e6c6f61643d74727565
.

Additional information on the project

https://www.litgrid.eu/index.php/grid-development-/strategic-projects-/synchronous-operation-/137#

Related projects

This project is closely related to the project No. 123 LitPol Link Stage 2. The synchronization of the Baltic States with continental Europe will be carried out through the land connection Alytus (LT) - Ełk Bis (PL) implemented in this project and the accompanying infrastructure. The transmission capacity on this connection will be fully dedicated to technical exchange. No trade is planned on this connection.

Project sheet backlog

5 Jan. 2021 -

New HVDC interconnector "Harmony Link": completion of investment description and update of commissioning year

Further infrastructure aspects related to the implementation of the synchronisation of the Baltic States' system with the continental European network: rephrasing of the investment description

Reconstruction of 330 kV OHL LE-Vilnius: update of investment status

Upgrades in Alytus substation (LT): update investment commissioning year

New 330 kV Darbenai substation: completion of the investment description

Construction of new 400kV line Dunowo-Zydowo Kierzkowo: update of investment commissioning year

Construction of new 400kV line Pila Krzewina-Zydowo Kierzkowo: update of investment commissioning year

Modernization of 400kV OHL Krajnik-Morzyczyn: update of the investment description

Modernization of 400kV OHL Morzyczyn-Dunowo-Slupsk-Zarnowiec: update of the investment description and commissioning year

Modernization of 400kV OHL Zarnowiec-Gdansk/Gdansk Przyjazn-Gdansk Blonia: update of the investment description and commissioning year

Reconstruction of switchgears with shunt reactors: update of investment status

Reconstructions in North Eastern Lithuania: further detailing of investment description

Inclusion of additional details regarding investment 'New 330 kV OHL Darbenai-Bitenai' in the field 'Updated data provided by the project promoter after the deadline for CBA assessment'

6 Nov. 2020 - Publication as part of the draft TYNDP 2020 package for consultation

Project Description & Context

Project Investments

Main investment(s): New HVDC subsea cable connection between Lithuania and Poland. The project includes HVDC submarine and land cable system and converter stations at each end

Type of element	Total route length (km)	From substation 1	To substation 2	Present status	Commissioning year	Progress of the investment	Explanation in case of delay or reclustering
Offshore DC transmission cable	400	Darbenai	Zarnowiec	In Permitting	2026	Investment on time	

Other investments

Description	Type of element	Total route length (km)	From substation 1	To substation 2	Present status	Commissioning year	Progress of the investment	Explanation in case of delay or reclustering
New 330 kV OHL Vilnius-Neris	AC transmission line	80	Vilnius	Neris	In Permitting	2025	Investment on time	
Reinforcement of existing 330 kV OHL between Paide and Sindi 330 kV substations in Estonia. Old line will be replaced with new towers and wires of 3x400 mm2 in phase. The thermal capacity of the line is	AC transmission line	76	Sindi	Paide	Under Consideration	2025	Cancelled	

Description	Type of element	Total route length (km)	From substation 1	To substation 2	Present status	Commissioning year	Progress of the investment	Explanation in case of delay or reclustering
planned 1143 MVA. The investment is also a backbone for Baltics Synchronization with CE (project nr 170).								
Reinforcement of existing 330 kV OHL. The investment is also a backbone for Baltics Synchronization with CESA.	AC transmission line	133	Tartu	Valmiera	In Permitting	2025	Investment on time	
Reinforcement of existing 330 kV OHL. The investment is also a backbone for Baltics Synchronization with CESA	AC transmission line	60	Tsirguliina	Valmiera	In Permitting	2025	Investment on time	
Reinforcement of existing 330 kV OHL between Balti and Tartu 330 kV substations in Estonia. Old line will be replaced with new towers and wires of 3x400 mm2 in phase. The	AC transmission line	168	Balti	Tartu	In Permitting	2023	Investment on time	

Description	Type of element	Total route length (km)	From substation 1	To substation 2	Present status	Commissioning year	Progress of the investment	Explanation in case of delay or reclustering
thermal capacity of the line is planned 1143 MVA. The investment is also a backbone for Baltics Synchronization with CESA (project nr 170).								
Reinforcement of existing 330 kV OHL between Viru and Tsirguliina 330 kV substations in Estonia. Old line will be replaced with new towers and wires of 3x400 mm2 in phase. The thermal capacity of the line is planned 1143 MVA. The investment is also a backbone for Baltics Synchronization with CESA (project nr 170).	AC transmission line	243	Viru	Tsirguliina	In Permitting	2025	Investment on time	
Further infrastructure aspects 'not-known-today'					Under Consideration	2025	New Investment	

Description	Type of element	Total route length (km)	From substation 1	To substation 2	Present status	Commissioning year	Progress of the investment	Explanation in case of delay or reclustering
related to the implementation of the synchronisation of the Baltic States' system with the continental European Network arising from ongoing synchronisation studies								
Reconstruction of 330 kV OHL LE-Vilnius from single-circuit into double-circuit	AC transmission line	41	Lietuvos E	Vilnius	Completed	2020	Investment on time	
Utenos TP substations and 330/1110/10 kV Ignalinos AE TP substations reconstruction. Relocation of HV equipment (from 330/110/10 kV Ignalinos AE TP substation to 330/110/10 kV Lietuvos E TP substation) and changing topology of 330 kV					Under Construction	2021	Investment on time	

Description	Type of element	Total route length (km)	From substation 1	To substation 2	Present status	Commissioning year	Progress of the investment	Explanation in case of delay or reclustering
overhead lines								
Construction of three new 400/330 kV autotransformers in Alytus substation, to make LT-PL border operation in AC mode.					Under Construction	2021	Investment on time	
If Studies concerning not known today further infrastructure aspects related to the implementation of the synchronisation of the Baltic States' system with the continental European network, identify the necessity to install additional SVC. New Battery Energy Storage System (BESS) units - for frequency regulation (FCR and FRR) and to ensure power system secure and stable					Under Consideration	2025	Investment on time	

Description	Type of element	Total route length (km)	From substation 1	To substation 2	Present status	Commissioning year	Progress of the investment	Explanation in case of delay or reclustering
operation.								
Upgrade of PSS in power stations. AGC impementation and commissioning in SCADA systems and power plants. WAMS and WAMPAC systems. Upgrade of instrument transformers and metering system in transmission network and is necessary to provide stable metering system during synchronous operation with Continental Europe or during island operation in emergency cases. System upgrades (automatics modernisation), SCADA and dispatcher trainer. In order to ensure system stability after high sudden power imbalance during BSPS					Planned But Not Yet Permitting	2025	Investment on time	

Description	Type of element	Total route length (km)	From substation 1	To substation 2	Present status	Commissioning year	Progress of the investment	Explanation in case of delay or reclustering
island operation, activation of fast frequency reserves within view milliseconds via HVDC's links is crucial. For this project is necessary to perform research, modelling and upgrading control system of HVDC's.								
New 330 kV Musa substation					In Permitting	2025	Investment on time	
New 330 kV OHL Bitenai-KHAE. One part of the new line will be constructed as second circuit on exicting 330 kV OHL Bitenai-Jurbarkas (44km), one part will be new line (74 km), and as third part of new line will be used part of exicting	AC transmission line	234	Bitenai	KHAE	In Permitting	2025	Investment on time	

Description	Type of element	Total route length (km)	From substation 1	To substation 2	Present status	Commissioning year	Progress of the investment	Explanation in case of delay or reclustering
330 kV OHL KHAE-Sovetsk.								
New 330 kV OHL Darbenai-Bitenai	AC transmission line	147	Darbenai	Bitenai	In Permitting	2025	Investment on time	
New 330 kV Darbenai substation, necessary for the connection of the new 330 kV lines as well as new HVDC subsea cable known as Harmony Link. This project includes territory planning, land acquisition and construction phases.					In Permitting	2025	Investment on time	
Dunowo-Zydowo Kierzkowo 400kV line is necessary to assure that after commissioning of Harmony Link and offshore wind farms, full capabilities would be available on the Polish-	AC transmission line	57.11	Dunowo	Zydowo Kierzkowo	Planned But Not Yet Permitting	2025	New Investment	

Description	Type of element	Total route length (km)	From substation 1	To substation 2	Present status	Commissioning year	Progress of the investment	Explanation in case of delay or reclustering
Lithuanian subsea interconnector. This project includes reconstruction of Dunowo substation with installation of 400/110 kV transformers and construction of new double-circuit 400 kV.								
Pila Krzewina-Zydowo Kierzkowo 400kV line is interrelated with project aiming in building Dunowo-Zydowo Kierzkowo line. This project includes reconstruction and modernization of Pila Krzewina electrical station with installation of 400/110 kV transformers and reactive power compensation devices and	AC transmission line	119	Pila Krzewina	Zydowo Kierzkowo	Planned But Not Yet Permitting	2025	New Investment	

Description	Type of element	Total route length (km)	From substation 1	To substation 2	Present status	Commissioning year	Progress of the investment	Explanation in case of delay or reclustering
construction of new double-circuit 400 kV.								
To allow effective energy flows in the north-west part of Poland after commissioning of Harmony Link, modernization of “North Line” (line between Krajnik and Gdansk Blonia) is necessary. The first project of North Line is modernization of Krajnik-Morzyczyn 400kV line.	AC transmission line	41.5	Krajnik	Morzyczyn	Planned But Not Yet Permitting	2023	New Investment	
Modernisation of Morzyczyn-Dunowo-Slupsk-Zarnowiec 400kV line would be the longest part included in modernization of North Line. Because of its length this project consists of three	AC transmission line	288.5	Morzyczyn	Zarnowiec	Planned But Not Yet Permitting	2025	New Investment	

Description	Type of element	Total route length (km)	From substation 1	To substation 2	Present status	Commissioning year	Progress of the investment	Explanation in case of delay or reclustering
sections: Modernization of Morzyczyn-Dunowo 400 kV, Modernization of Dunowo-Slupsk 400 kV, Modernization of Slupsk-Zarnowiec 400 kV.								
Modernisation of Zarnowiec-Gdansk/ Gdansk Przyjazn-Gdansk Blonia 400kV line would be the last part included in modernization of North Line.	AC transmission line	77	Zarnowiec	Gdansk Blonia	Planned But Not Yet Permitting	2024	New Investment	
Synchronous condensers providing inertia, voltage stability,frequency stability and short-circuit power in Lithuania, Latvia and Estonia					In Permitting	2025	Investment on time	
FSAS is a common Baltic IT platform, necessary to ensure frequency monitoring in Baltic system,					Planned But Not Yet Permitting	2025	New Investment	

Description	Type of element	Total route length (km)	From substation 1	To substation 2	Present status	Commissioning year	Progress of the investment	Explanation in case of delay or reclustering
in order to ensure frequency stability in the region in synchronous mode with the CEN and in izolated mode after incidents.								
Due to the synchronisation project the total length of the power lines will increase. Increase in the total length of power lines higher reactive power generation by these lines. In order to reduce the risk that the voltages will rise too high, sufficient amount of reactive power compensation is needed, which can be achieved with the existing shunt reactors. Nevertheless, the shunt reactors need					Planned But Not Yet Permitting	2025	New Investment	

Description	Type of element	Total route length (km)	From substation 1	To substation 2	Present status	Commissioning year	Progress of the investment	Explanation in case of delay or reclustering
reliable switchgear to help to minimise the risk induced by commutation errors.								

Reason for investment clustering

After desynchronisation of Baltic States from Russia and Belarus electricity networks, electricity system in Baltic States should be ready for reliable and secure operation having one synchronous double-circuit 400 kV AC line on border with Poland. This goal could be achievable only when eliminating all negative contingency (n-1) factors and eliminating internal bottlenecks in Baltics and Poland. All investments in this project serves one or another goal from above.

Is the project in the reference grid?

No

System Needs addressed by the project

Project promoter(s) selected up to 4 system needs that are addressed by their project in a predefined list. Available needs ranged from reduction of price differentials between countries, improvement of system flexibility and stability, enabling cost-efficient connection of high volumes of RES, improvement of voltage stability...
As part of the TYNDP 2020, ENTSO-E released a study investigating cross-border system needs in the 2030 and 2040 horizons.

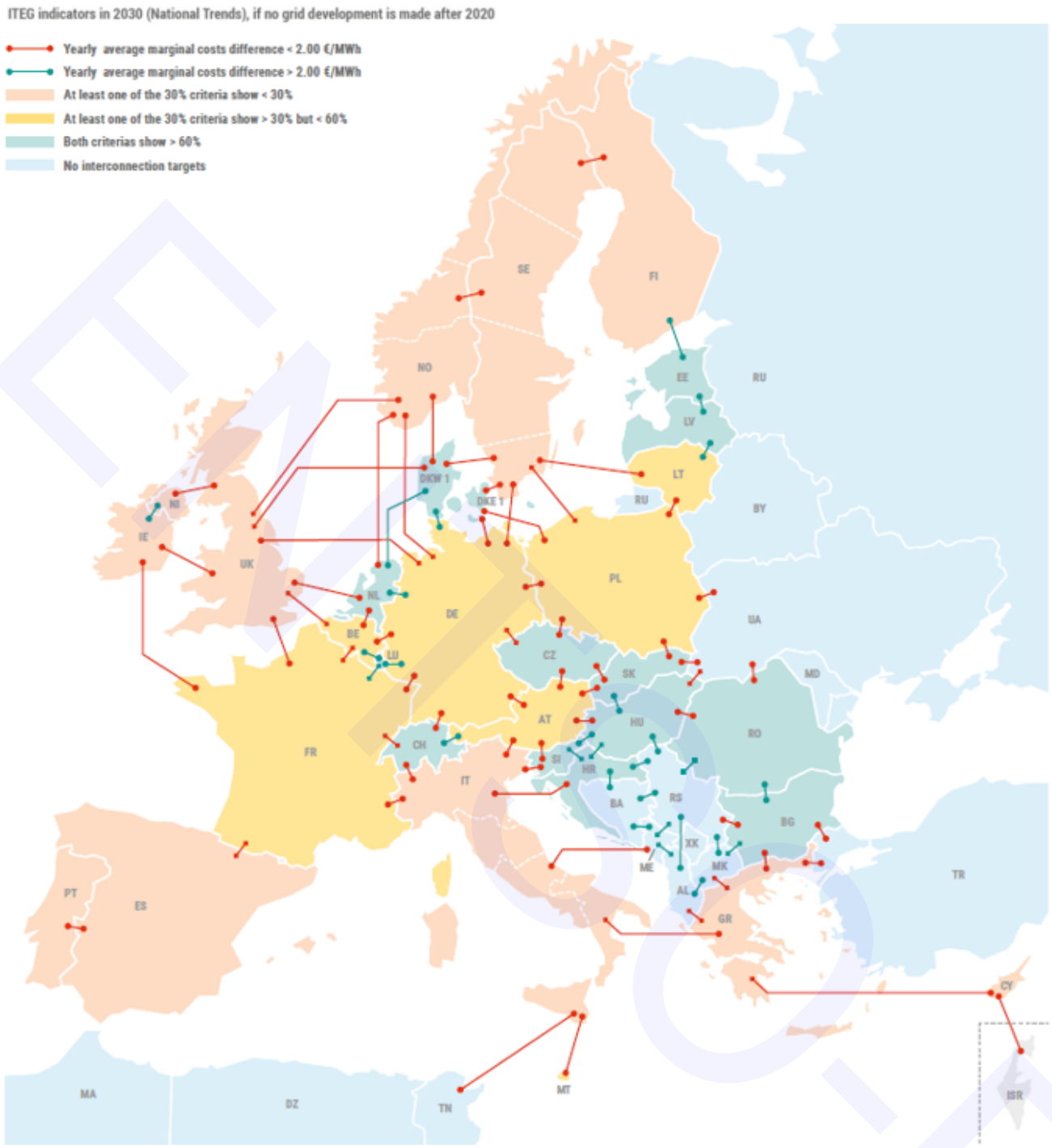
Need		How the project addresses each need (explanation provided by the project promoter(s))
	Infrastructure to allow by 2025 for the synchronisation of the Baltic States with the rest of the EU network	New 700 MW HVDC interconnector "Harmony Link" between Lithuania and Poland, upgrades in Alytus (LT) substation, other internal network strenghtening in Poland, Lithuania, Latvia and Estonia will enable to establish synchronous operation of Baltics States with EU network.
	Infrastructure to improve system flexibility and stability e.g. improve system or local ramp rate, improve transient stability or RoCoF to meet system Needs.	New investments HVDC Harmony Link, common Baltic Frequency Stability Assessment System (FSAS), upgrading of monitoring and control systems, new voltage stabiliser units, new synchronous condensers will improve transient and frequency stability in Baltic States.

Need		How the project addresses each need (explanation provided by the project promoter(s))
	Infrastructure to reduce price differentials between EU and/or non-EU countries	New 700 MW HVDC Harmony Link will be used for trading between Baltic States and this will reduce price differentials between Baltic States and EU.
	Infrastructure to address system adequacy deficiencies and/or mitigate the risk of power failures.	New 700 MW HVDC Harmony Link will increase system adequacy in Baltic Staes, will mitigate risk of power failures and has black start capabilities.

Interconnection targets

In 2017, the Interconnection Target Expert Group proposed alternative indicators to the 15% interconnection criteria for every country and electrified island with a new methodology developed collaboratively between the European Commission, ENTSO-E, ENTSOG, industry, universities and other experts. The methodology is based on three indicators:
1. Price differential between EU countries, with an objective to reduce it below 2 EUR/MWh
2. Ratio between nominal transmission capacity and installed RES capacity, with a target of past 30%
3. Ratio between nominal transmission capacity and peak load, with a target of past 30%

The following maps show the ITEG methodology applied to the TYNDP 2030 scenarios, with the 2020 grid.


ITEG indicators in 2030 (National Trends), if no grid development is made after 2020
Yearly average marginal costs difference < 2.00 €/MWh
Yearly average marginal costs difference > 2.00 €/MWh
At least one of the 30% criteria show < 30%
At least one of the 30% criteria show > 30% but < 60%
Both criterias show > 60%
No interconnection targets
SE
FI
NO
EE
RU
LV
LT
DKW 1
DKE 1
RU
BY
NI
IE
UK
PL
NL
DE
UA
BE
LU
CZ
SK
MD
AT
HU
RO
FR
CH
SI
HR
IT
BA
RS
BG
XK
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MK
AL
TR
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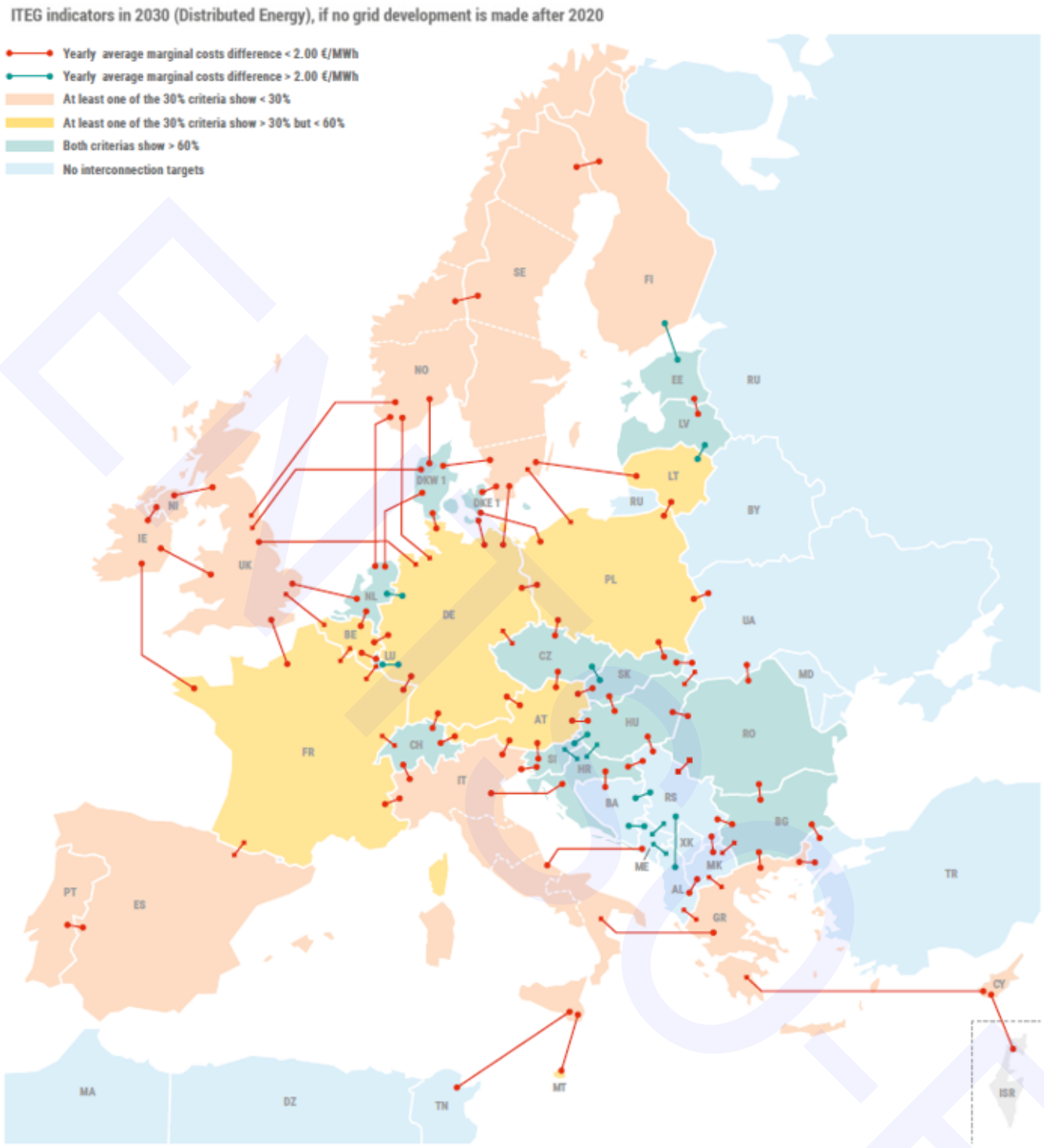
ITEG indicators in 2030 (Distributed Energy), if no grid development is made after 2020
Yearly average marginal costs difference < 2.00 €/MWh
Yearly average marginal costs difference > 2.00 €/MWh
At least one of the 30% criteria show < 30%
At least one of the 30% criteria show > 30% but < 60%
Both criterias show > 60%
No interconnection targets
SE
FI
NO
EE
RU
LV
LT
DKW 1
DKE 1
RU
BY
NI
IE
UK
PL
NL
DE
UA
BE
LU
CZ
SK
MD
AT
HU
RO
FR
CH
SI
HR
IT
BA
RS
BG
XK
ME
MK
AL
TR
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CY
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DZ
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MT
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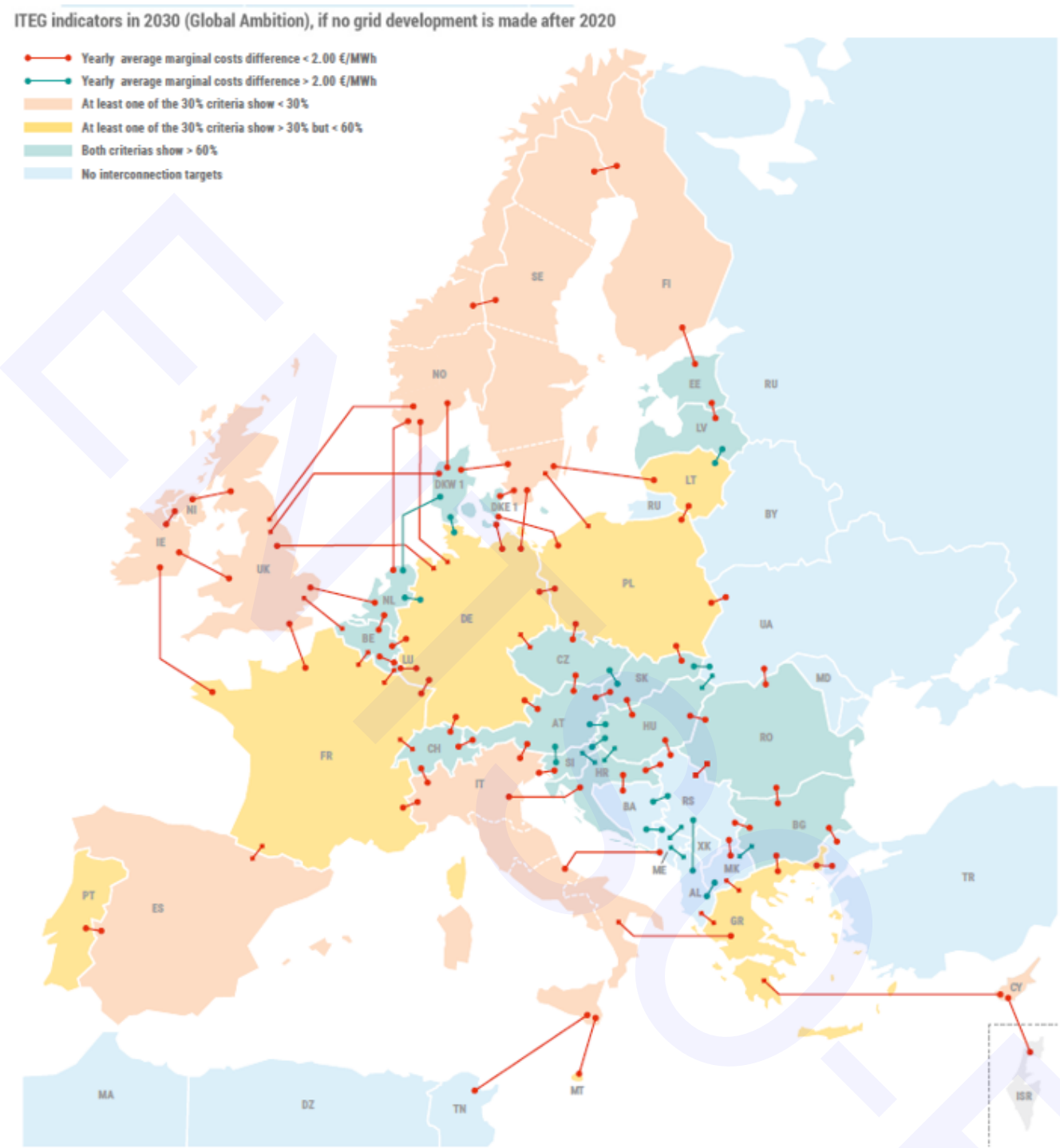


Updated data provided by the project promoter after the deadline for CBA assessment - This data is provided for information only and has not been used by ENTSO-E in the cost-benefit analysis.

Promoters provided additional details on the description of investment 1659 New 330 kV OHL Darbenai-Bitenai: 'New 330 kV OHL Darbenai-Bitenai. One part of the new line will be constructed as second circuit on exsisting 330 kV OHL Grobinė-Klaipėda (49 km), second part will be new line betwen 330 kV OHL Grobinė-Klaipėda and Klaipėda-Šyša (11 km). Third part of new line also will be constructed as second circuit on exsisting 330 kV OHL Klaipėda-Šyša-Bitėnai (80 km).'

Project Assessment

Transfer capacity increase (National Trends 2025)

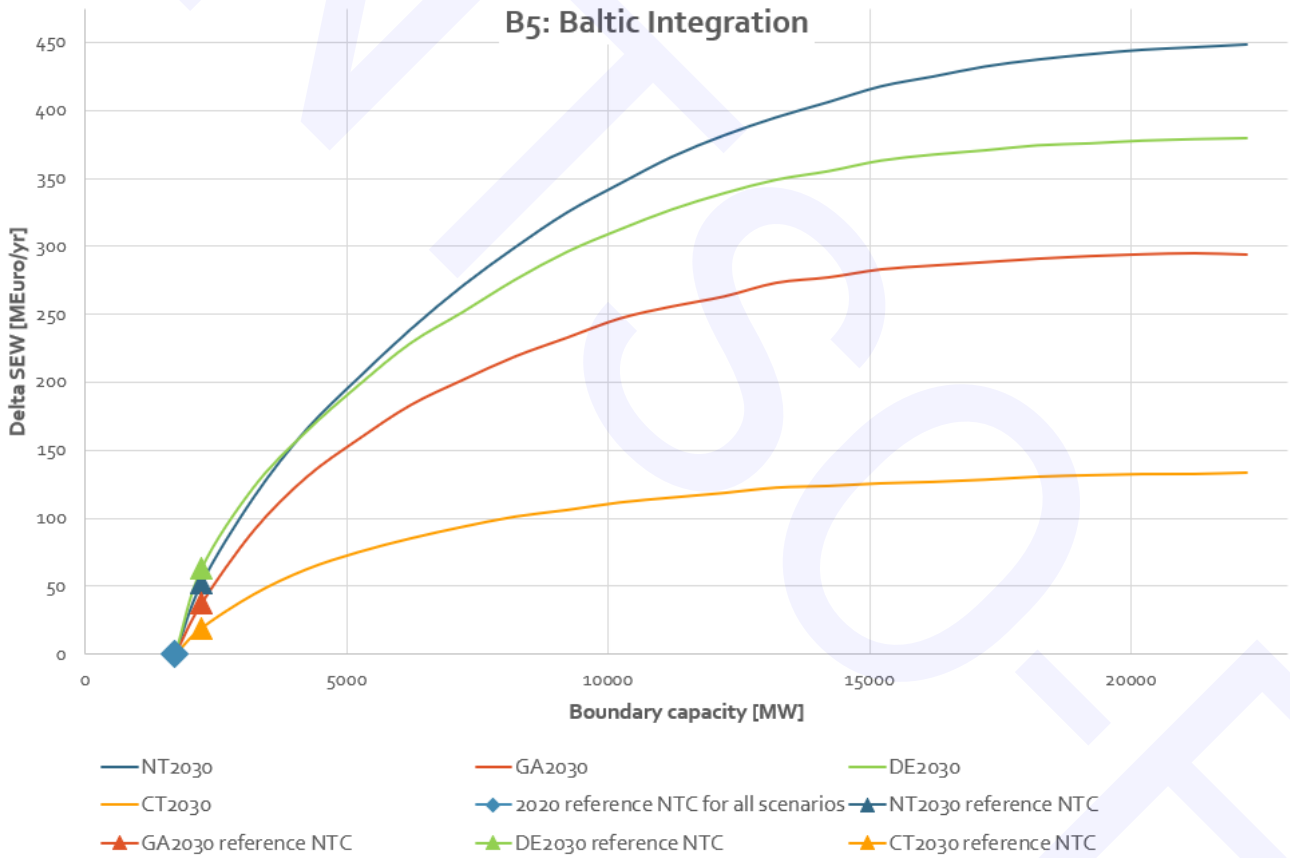
	Border	A B	B A
Transfer capacity increase (in MW)	Lithuania - Poland	500	1000

Boundary capacity diagram

Network boundary the projects helps mitigate

Baltic Integration

Boundary capacity diagram



CBA results

ENTSO-E has assessed the benefits delivered by each project in 2025 (scenario National Trends 2025) and in 2030 (three scenarios: National Trends, Distributed Energy and Global Ambition). Indicators B1 to B6 were computed by ENTSO-E, while promoters had the possibility to compute and submit so-called project-level benefits (B7 to B10). The benefits must be understood as benefits for Europe as a whole, not for the promoters of the project.
Results are presented per scenario.

Central scenario: National Trends

National Trends is the central policy scenario of the TYNDP2020, designed to reflect EU member state's National Energy and Climate Plans (NECP), in line with the requirement to meet current European 2030 energy strategy targets.

			Comparison of the COP21 scenarios with NT2030 average result		
	NT2025	**NT2030**	**DE2030 is < or > than NT2030**	**GA2030 is < or > than NT2030**	

Increase in socio-economic welfare

B1 Annual Socio-Economic Welfare (SEW) increase (M € / year)	max average min	38 33 27	87 78 74	<	<	ENTSO-E assessment
B1_CO2 Annual Socio-Economic Welfare increase resulting from CO2 emissions reduction	max average min	19 18 17	46 40 31	<	<	ENTSO-E assessment
B1_RES Annual Socio-Economic Welfare increase resulting from RES integration	max average min	4 3 1	11 5 1	>	>	ENTSO-E assessment

Reduction of CO2 and GHG emissions

B4 Non-CO2 emissions (kg/year)

B4a Nitrogen oxides	average	0	-590	n/a	n/a	ENTSO-E assessment
B4b Ammonia	average	0	-10	n/a	n/a	ENTSO-E assessment
B4c Sulfur dioxide	average	0	-571	n/a	n/a	ENTSO-E assessment
B4d Particular matter 5	average	0	3914	n/a	n/a	ENTSO-E assessment
B4e Particulate		0	-32	n/a	n/a	ENTSO-E

matter 10		average				assessment
B4f Non-methane volatile organic compounds		average	0	3962	n/a	n/a	ENTSO-E assessment
B2a Annual CO2 variation from market simulation (ktonnes / year)		max average min	-746 -792 -837	-1107 -1421 -1639	>	>	ENTSO-E assessment
B2a_€ Annual Societal cost variation resulting from CO2 variation from market simulation monetised (M € / year)	CO2 price	60€/ ton 100€/ ton 189€/ ton	29 61 131	45 102 229	< <<br <	< <<br <	ENTSO-E assessment
B2b Annual CO2 variation due to network losses (ktonnes / year)		average	-7	172	n/a	n/a	ENTSO-E assessment
B2b_€ Annual Societal cost variation resulting from CO2 variation from network simulation monetised (M € / year)	CO2 price	60€/ ton 100€/ ton 189€/ ton	0 1 1	-4 -9 -19	n/a	n/a	ENTSO-E assessment

Integration of renewable energy sources

B3 Annual avoided curtailment (RES integration) (GWh / year)		max average min	87 53 18	281 144 14	>	<	ENTSO-E assessment
B3a Connected RES (MW)	-				n/a	n/a	ENTSO-E assessment

Impact on grid losses

B5 Variation of network losses (GWh / year)	average	-14	210	n/a	n/a	ENTSO-E assessment
B5_€ Variation of network losses monetised (M€ / year)	average	-1	8	n/a	n/a	ENTSO-E assessment

Security of supply

B6 Annual reduction in Energy Not Served (MWh / year)	max average min		10867.7142857143	n/a	n/a	ENTSO-E assessment
B6_€ Annual Socio-Economic Welfare increase resulting from reduction in Energy Not Served monetised (M€ / year)	average	n/a	28	>	n/a	ENTSO-E assessment

Scenarios: Distributed Energy & Global Ambition

DE and GA are two scenarios created in line with the COP21 targets to understand the impact on infrastructure needs agains different pathways reducing EU-28 emissions to net-zero by 2050. For these two scenarios, projects were assessed with a subset of CBA parameters.

		DE2030	GA2030	

Increase in socio-economic welfare

B1 Annual Socio-Economic Welfare (SEW) increase (M€ / year)	average	57	52	ENTSO-E assessment
B1_CO2 Annual Socio-Economic Welfare increase resulting from CO2 emissions reduction	average	23	34	ENTSO-E assessment
B1_RES Annual Socio-Economic Welfare increase resulting	average	9	6	ENTSO-E assessment

from RES integration			

Reduction of CO2 and GHG emissions

B2a Annual CO2 variation from market simulation (ktonnes / year)	average	-433	-974	ENTSO-E assessment
B2a_€ Annual Societal cost variation resulting from CO2 variation from market simulation monetised (M€ / year)	CO2 price 60€/ ton 100€/ ton 189€/ ton	3 20 59	24 63 150	ENTSO-E assessment

Integration of renewable energy sources

B3 Annual avoided curtailment (RES integration) (GWh / year)	average	178	140	ENTSO-E assessment
B3a Connected RES (MW)	-			ENTSO-E assessment

Benefits submitted by promoters based on scenarios other than the TYNDP2020 scenarios

	2025	2030	
B8 Focus on Frequency quality targets (energy aspect): for HVDC interconnectors between synchronous areas (MWh/ year)		42200	This indicator was submitted by the promoter(s). Based on the information provided, ENTSO-E has not been able to confirm the consistency of the proposed indicator with the CBA Guideline 3.0. About the computation of this indicator by the project promoter(s)

This indicator was computed based on 2030 Sustainable Transition, from TYNDP2018. , in a study performed by Institute of Power Engineering Research Institute, Gdansk Division in 2018. The promoter(s) stated that the submitted value was computed in accordance with the CBA Guideline and explained it as follows:

Study evaluates Nadir and Rocof values. System inertia was calculated in one year hourly base. NADIR and ROCOFF was checked at minimum system inertia value. Necessary inertia value was determined keeping NADIR requirement above 49,3 Hz and keeping ROCOF <1Hz/s.

The promoter(s) certified that the values submitted and assessed in the study relate to countries located within the ENTSO-E perimeter only.

	2025	2030	
B8 Blackstart services – Application for synchronization with Continental Europe (Meuro/year)		5,8	This indicator was submitted by the promoter(s). ENTSO-E confirms the consistency of the proposed indicator with the CBA Guideline 3.0. About the computation of this indicator by the project promoter(s)

This indicator was computed based on Scenario Bb , in a study performed by Gothia Power in 2013. The promoter(s) stated that the submitted value was computed in accordance with the CBA Guideline and explained it as follows:

Study consists of 5 report, Report 5 is about socio-economic analyses, there were calculateded blackout costs for Baltic states (Estonia, Latvia and Lithuania).

The promoter(s) certified that the values submitted and assessed in the study relate to countries located within the ENTSO-E perimeter only.

B10 Reduction of Necessary Reserve for Redispatch Power Plants	2025	2030	
In Meuro/year	840,5	840,5	This indicator was submitted by the promoter(s). Based on the information provided, ENTSO-E has not been able to confirm the consistency of the proposed indicator with the CBA Guideline 3.0. About the computation of this indicator by the project promoter(s)
In MW	900	900	

This indicator was computed based on Three interconnection scenarios. The input data as well as the results of the technical and economic evaluations refer to the target year 2025. , in a study performed by Consentec GmbH, in cooperation with University of Stuttgart Institute of Combustion and Power Plant technology (IFK) in 2018. The promoter(s) stated that the submitted value was computed in accordance with the CBA Guideline and explained it as follows:

CBA 3 definition for this indicator is "Change in needed reserves of redispatch power plants". Indicator calculates as difference of needed reserve power plants, with and without project. This study calculated and monetised this indicator, results are on page XI. In Baltic States island operation all units in Baltics are in must-run mode, redispatch of up to 900 MW between Baltic-

Nordic is necessary during 5760 hours, that will cost up to 850 mEur/a (Scenario 1 island operation without EPC support). In synchronous operation mode with Harmony Link, costs will be 9,5 mEur/a (Scenario 3 synchronous operation with EPC support). Difference without and with project is 850-9,5=840,5 mEur/a.

The promoter(s) certified that the values submitted and assessed in the study relate to countries located within the ENTSO-E perimeter only.

Non scenario-dependent indicator(s)

B8.0 Stability (Transient, Voltage and Frequency Stability)	Transient stability	Voltage stability	Frequency stability	
New 330 kV OHL Vilnius-Neris (New AC line)	++	++	0	Qualitative assessment by ENTSO-E based on information on the project technology provided by the project promoter(s). This indicator is not dependent on scenarios or time horizons.
New HVDC interconnector "Harmony Link" (New HVDC)	++	++	+ (between sync areas)	
Reconstruction of 330 kV OHL LE-Vilnius (New AC line)	++	++	0	
New 330 kV OHL Bitenai - KHAE (New AC line)	++	++	0	
New 330 kV OHL Darbenai-Bitenai (New AC line)	++	++	0	
Construction of new 400kV line Dunowo-Zydowo Kierzkowo (New AC line)	++	++	0	
Construction of new 400kV line Pila Krzewina-Zydowo Kierzkowo (New AC line)	++	++	0	
Synchronous condensers in Lithuania, Latvia and Estonia (Synchronous condenser)	+	++	++	

Sensitivity Study: Current Trends

'Current Trends' describes a future where the energy transition is slower than planned.

	CT2030	

Increase in socio-economic welfare

B1 Annual Socio-Economic Welfare (SEW) increase (M€ / year)	average	4	ENTSO-E assessment
B1_CO2 Annual Socio-Economic Welfare increase resulting from CO2 emissions reduction	average	3	ENTSO-E assessment
B1_RES Annual Socio-Economic Welfare increase resulting from RES integration	average	2	ENTSO-E assessment

Reduction of CO2 and GHG emissions

B2a Annual CO2 variation from market simulation (ktonnes / year)	average	-112	ENTSO-E assessment
B2a_€ Annual Societal cost variation resulting from CO2 variation from market simulation monetised (M€ / year)	CO2 price	60€/ ton 100€/ ton 189€/ ton	4 8 18	ENTSO-E assessment

Integration of renewable energy sources

B3 Annual avoided curtailment (RES integration) (GWh / year)	average	46	ENTSO-E assessment
B3a Connected RES (MW)	-		ENTSO-E assessment

Residual impact

Information on the residual impact of the project was provided by the project promoter(s).

Residual environmental impact

Investment	Investment status	Distance (km)	Type of sensitivity
New 330 kV OHL Darbenai-Bitenai	In Permitting	10.38	Other nature protection areas under national law

Note based on CBA Guideline 3.0: Given that the actual route of the project might not be defined due to the low degree of maturity of its investment(s), an environmental assessment is not yet available.

Project Costs

The project costs were provided by the project promoter(s).

	CAPEX (Meuro)	Uncertainty range (%)	OPEX
382. New 330 kV OHL Vilnius-Neris	23.7	+5%, - 5%	0.024
1004. 330kV OHL Paide-Sindi (L346)	15	+5%, - 5%	0.04
1010. 330 kV OHL Tartu-Valmiera	30.66	+5%, - 5%	0.094
1011. Valmiera -Tsirguliina 330 kV	22	+5%, - 5%	0.13
1012. 330 kV OHL Tartu-Balti (L300)	51.2	+5%, - 5%	0.11
1013. Viru-Tsirguliina 330kV OHL	73.2	+5%, - 5%	0.17
1034. New HVDC interconnector "Harmony Link"	682.6	+5%, - 5%	2.45
1118. Further infrastructure aspects related to the implementation of the synchronisation of the Baltic States' system with the continental European network	10.5	+5%, - 5%	0.105
1565. Reconstruction of 330 kV OHL LE-Vilnius	19.3	+5%, - 5%	0.019
1566. Reconstructions in North Eastern Lithuania	24.26	+5%, - 5%	0.024
1568. Upgrades in Alytus substation (LT)	22.44	+5%, - 5%	0.022
1571. New Voltage stabiliser units (SVC), Battery Energy Storage System (BESS) control units in Lithuania, Latvia and Estonia.	138	+5%, - 5%	1.38
1572. Monitoring and control system upgrades in Lithuania, Latvia and Estonia. Upgrading control systems of exicting HVDC connections (EstLink 1 and EstLink 2 and NordBalt).	43.2	+5%, - 5%	0.432
1632. New 330 kV Musa substation	6.14	+5%, - 5%	0.006
1634. New 330 kV OHL Bitenai - KHAE	42.1	+5%, - 5%	0.042
1659. New 330 kV OHL Darbenai-Bitenai	62.8	+5%, -5%	0.063
1660. New 330 kV Darbenai substation	12	+5%, - 5%	0.012
1661. Construction of new 400kV line Dunowo-Zydowo Kierzkowo	57.79	+5%, -5%	0.11
1662. Construction of new 400kV line Pila Krzewina-Zydowo Kierzkowo	110.78	+5%, -5%	0.22

	CAPEX (Meuro)	Uncertainty range (%)	OPEX
1663. Modernization of 400kV OHL Krajnik-Morzyczyn	2.1	+5%, -5%	0.04
1664. Modernization of 400kV OHL Morzyczyn-Dunowo-Slupsk-Zarnowiec	16.6	+5%, -5%	0.3
1665. Modernization of 400kV OHL Zarnowiec-Gdansk/ Gdansk Przyjazn-Gdansk Blonia	4.5	+5%, -5%	0.1
1669. Synchronous condensers in Lithuania, Latvia and Estonia	333	+5%, - 5%	4.5
1702. Common Baltic Frequency Stability Assessment System (FSAS). Modernisation of System Protection Schemes (SPS) and Under Frequency Load Shedding (UFLS).	11.4	+5%, - 5%	0.114
1703. Reconstruction of switchgears with shunt reactors	4.3	+5%, - 5%	0.01
Total	1819.57		10.517

Explanation provided by the project promoter on the CAPEX uncertainty range:

382	
1004	We consider km price for 330/110 kV OHL line in EE is 320656€/km. It is cheaper than ENTSO-E reference cost.
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