Project Sheet

Crete-North Greece-North Macedonia-Bulgaria Interconnector

Project type	transmission
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Created by	Lea Dehaudt
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ENTSOE

Key Information

Cross Border Project
Offshore DC transmission cable
New

Under Consideration

Description

The Crete-North Greece-North Macedonia-Bulgaria Interconnector is a multiterminal HVDC interconnection project of 2000 MW connecting Crete, North of Greece (Thessaloniki), North Macedonia and Bulgaria. It will complement the project LEG1 (HVDC interconnection between Libya and Crete), reinforcing bidirectional electricity exchange between South-East Europe and North Africa.

The project will have a DC voltage of 525 kV.

VSC is preliminary chosen for converter technology because it is more favorable for power trading and has other advantages such as blackstart capacity and voltage stability support.

This project will increase power exchange capacity between Greece, North Macedonia and Bulgaria and give to these countries access to solar energy from Libya, contributing to the achievement of the EC's Green Deal 2030 objectives

Project promoters

GreenPower 2020

Countries

Bulgaria
Greece
North Macedonia

National development plan(s)

Additional information on the project

Project sheet backlog

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

Project Description & Context

Project Investments

Main investment(s): The project will have a DC voltage of +/-525 kV. It will transmit 2000MW through bipolar HVDC cables. Converter technology is VSC. It will connect to LEG1 converter station of Linoperamata (Crete).

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	600	Linoperamata	Thessaloniki	Under Consideration	2036		

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
The project will have a DC voltage of +/-525 kV. It will transmit 2000MW through bipolar HVDC cables. Converter technology is VSC.	DC transmission line	110	Thessaloniki	Dubrovo	Under Consideration	2036		
The project will have a DC voltage of +/-525 kV. It will transmit 2000MW through bipolar HVDC cables.	DC transmission line	170	Dubrovo	Ch. Mogila	Under Consideration	2036		

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
Converter technology is VSC.								

Reason for investment clustering

This is both a national and a cross-border project.
One investment feeds the other.

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.

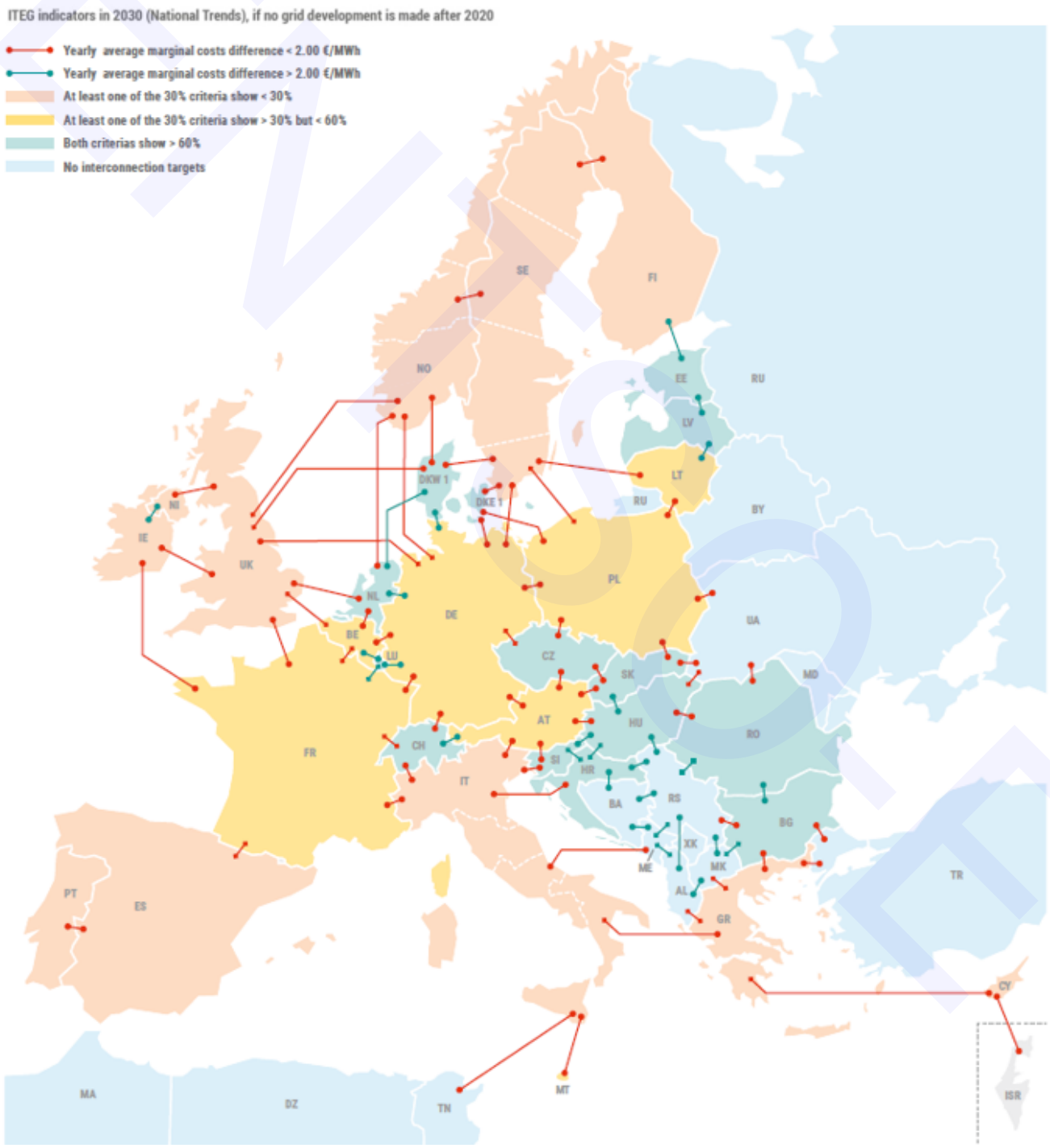
Need		How the project addresses each need (explanation provided by the project promoter(s))
	Infrastructure to reduce price differentials between EU and/or non-EU countries	ENTSO-E's System needs study finds a difference in electricity prices of 7.53 €/MWh between Greece and Bulgaria in 2040. Interconnecting these countries shall participate in reducing the price differential.
	Infrastructure to address system adequacy deficiencies and/or mitigate the risk of power failures.	VSC links have controllable AC output voltage and frequency, increasing grid stabilityVSC converters can be used to support the grid by mixingactive and reactive power during stressed conditions
	Capability for Black Start & Islanding Operation	VSC converter is availablealmost instantly after the blackout and includes blackstart capability and special modes of operation for islanded grids.
	Infrastructrure improving voltage stability by offering reactive power controllability of converters by system operator(s)	The VSC converters will provide 500 MVar of reactive power and will be able to operate in STATCOM mode.

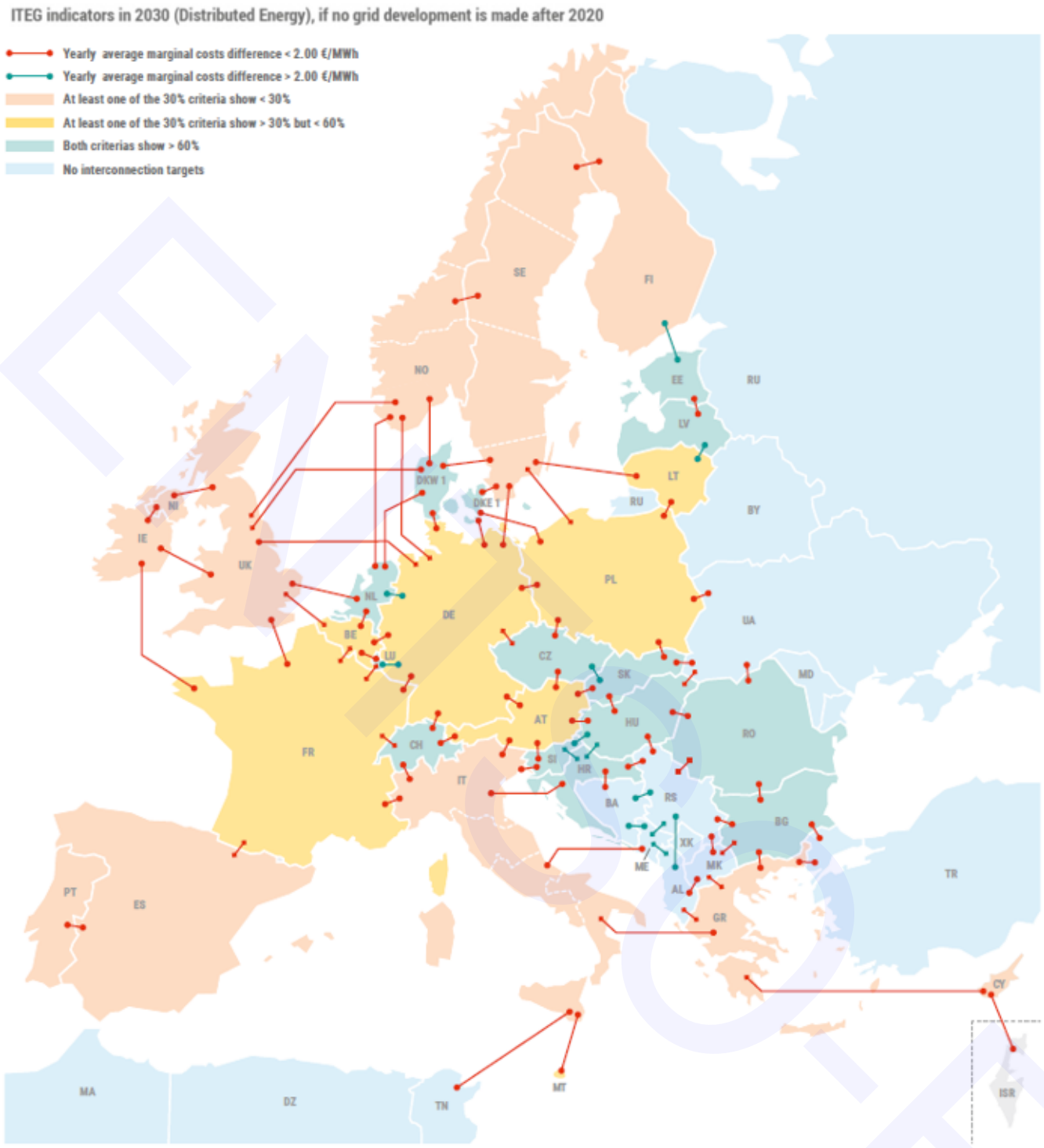
Interconnection targets

In 2017, the Interconnection Target Expert Group proposed alternative indicators to the 15%

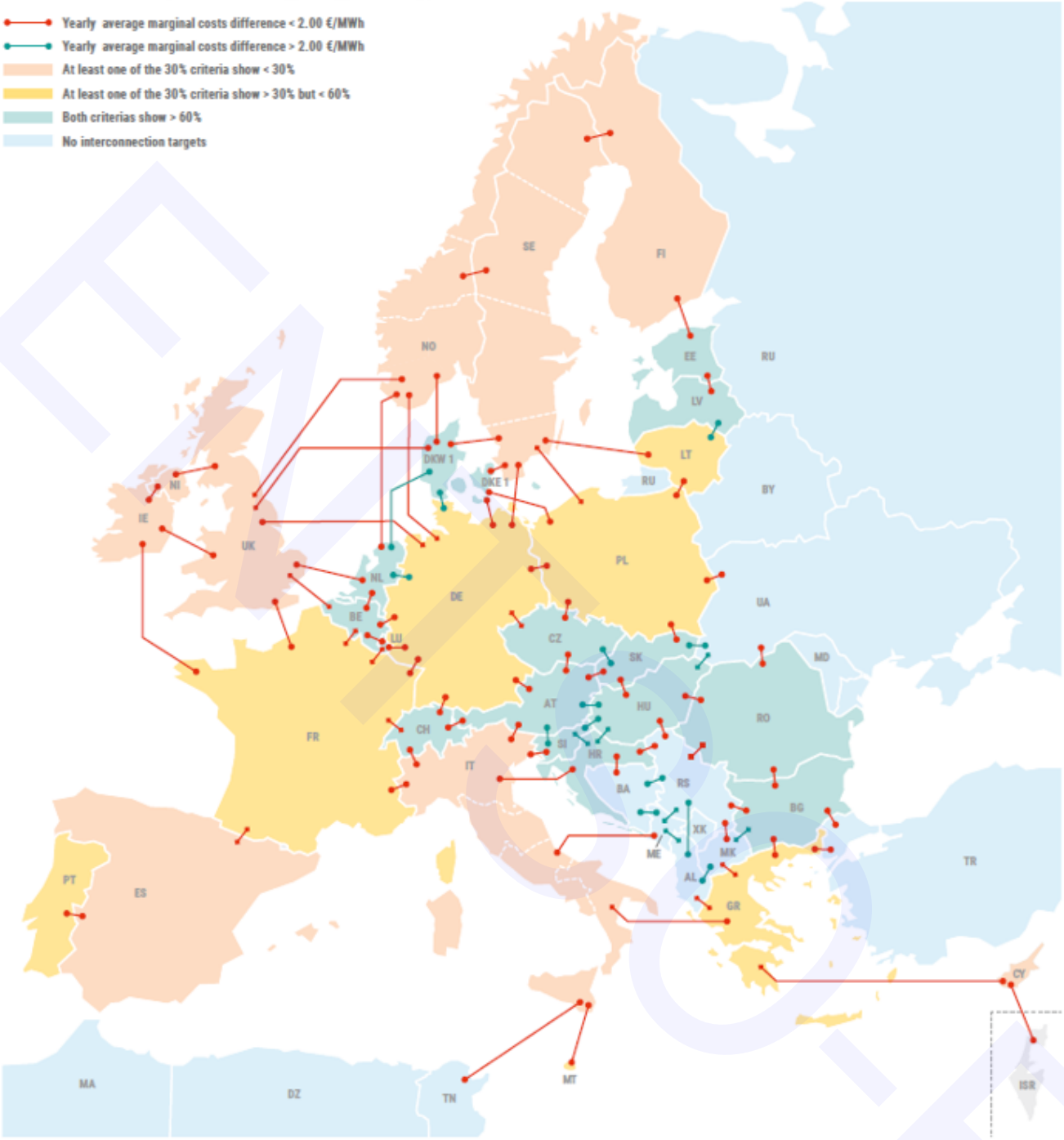
interconnection criteria for every country and electrified island with a new methodology developed collaboratively between the European Commission, ENTSO-E, ENTSOG, industry, universities and other experts. The methodology is based on three indicators:
1. Price differential between EU countries, with 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 (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
PT
ES
GR
CY
MA
DZ
TN
MT
ISR

ITEG indicators in 2030 (Global Ambition), if no grid development is made after 2020



Project Assessment

Transfer capacity increase (National Trends 2025)

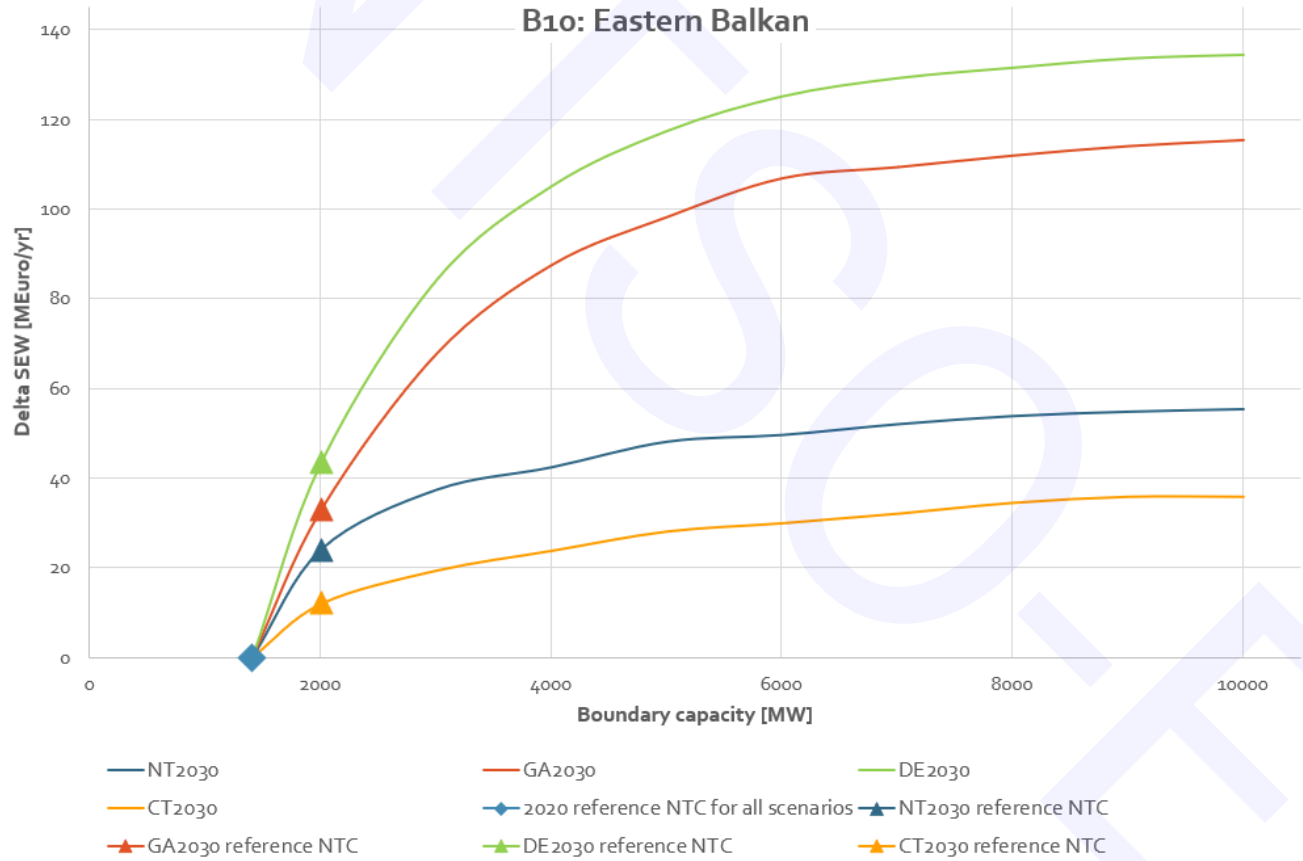
	Border	A B	B A
Transfer capacity increase (in MW)	Greece - North Macedonia	2000	2000
Transfer capacity increase (in MW)	North Macedonia - Bulgaria	2000	2000

Boundary capacity diagram

Network boundary the projects helps mitigate

Eastern Balkan

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.

Because it is a Future project, addressing system needs and with a planned commissioning date after 2025, this project has only been assessed in the 2030 scenarios and based on a subset of CBA indicators.

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		5 3 2	n/a	n/a	ENTSO-E assessment
B1_CO2 Annual Socio-Economic Welfare increase resulting from CO2 emissions reduction	max average min		-1 -2 -3	n/a	n/a	ENTSO-E assessment
B1_RES Annual Socio-Economic Welfare increase resulting from RES integration	max average min		0 0 0	n/a	n/a	ENTSO-E assessment

Reduction of CO2 and GHG emissions

B2a Annual CO2 variation from market simulation (ktonnes / year)	max average min		115 71 27	n/a	n/a	ENTSO-E assessment
B2a_€ Annual Societal cost	CO2 price 60€/ ton		-2 -5	n/a n/a	n/a n/a	ENTSO-E assessment

variation resulting from CO2 variation from market simulation monetised (M € / year)	100€/ ton 189€/ ton		-11	n/a	n/a	
B2b Annual CO2 variation due to network losses (ktonnes / year)	average		N/A	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		N/A N/A N/A	n/a	n/a	ENTSO-E assessment

B4 Non-CO2 emissions (kg/year)

B4a Nitrogen oxides	average		111	n/a	n/a	ENTSO-E assessment
B4b Ammonia	average		-3	n/a	n/a	ENTSO-E assessment
B4c Sulfur dioxide	average		206	n/a	n/a	ENTSO-E assessment
B4d Particular matter 5	average		358	n/a	n/a	ENTSO-E assessment
B4e Particulate matter 10	average		8	n/a	n/a	ENTSO-E assessment
B4f Non-methane volatile organic compounds	average		349	n/a	n/a	ENTSO-E assessment

Integration of renewable energy sources

B3 Annual avoided curtailment (RES integration) (GWh / year)	max average min		4 3 1	n/a	n/a	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		N/A	n/a	n/a	ENTSO-E assessment
B5_€ Variation of network losses monetised (M€ / year)	average		N/A	n/a	n/a	ENTSO-E assessment

Security of supply

B6 Annual reduction in Energy Not Served (MWh / year)	max average min		N/A	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	N/A	n/a	n/a	ENTSO-E assessment

Residual impact

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

Project Costs

	CAPEX (Meuro)	Uncertainty range (%)	OPEX
1746. Crete-Northern Greece	1900	20	30
1747. Northern Greece-North Macedonia	800	20	30
1748. North Macedonia-Bulgaria	1100	20	30
Total	3800		90

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

1746

1747

1748