Project Sheet

GREGY Interconnector

Project type	transmission
Project id	1041
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Created on	Feb 11, 2021 5:09:35 PM

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ENTSO-E

Key Information

Cross Border Project
AC transmission line
New

Under Consideration

Description

The GREGY interconnection project concerns the possibility to create a new energy highway within the Mediterranean Basin, between South East region of ENTSOE and South Eastern Mediterranean power systems by interconnecting Egypt and Greece. Rational behind the project is to establish a new interconnection between two large synchronous areas enabling series of benefits such as market coupling, enhanced security of supply (Adequacy, Flexibility, Stability) and socio-economic welfare.

GREGY is also part of a bigger project including the construction of large wind farms (app. 3300MW) in order to exploit the high wind potential of Egypt, mainly on the Suez Gulf and bank sides of the Nile. Therefore, the project is expected to allow RES energy exports from Egypt to Greece at times of high RES generation and also vice versa contributing to a significant increase of participation of renewables in the energy mix and reduction of greenhouse emissions of the power sector.

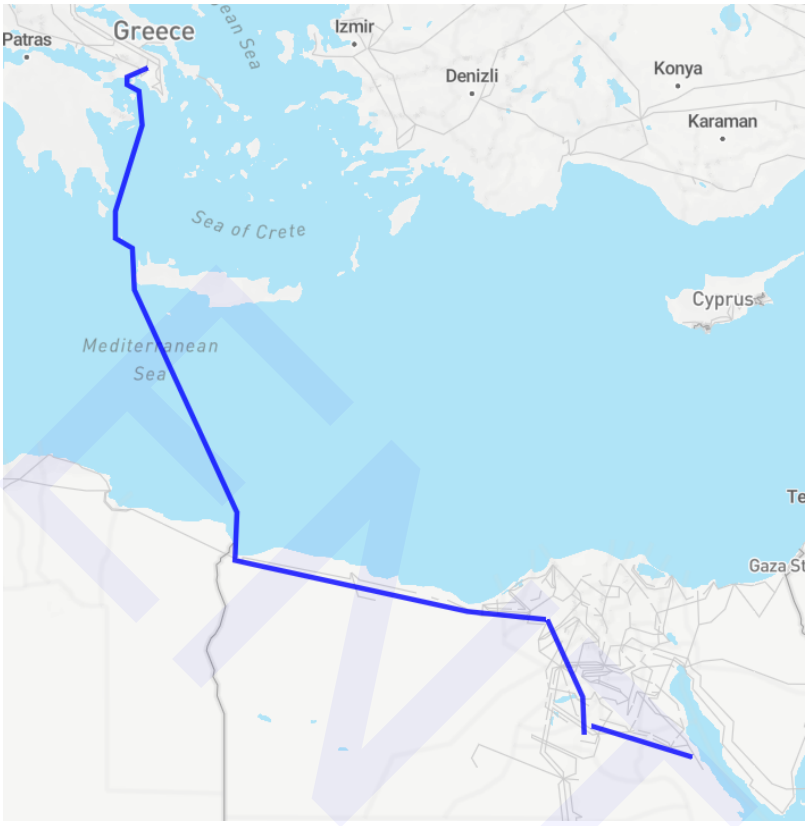
GREGY project consists of an HVDC interconnection from Wadi-El-Natroon (Egypt) to Attica area (Greece) of total length approximately 1373km and HVAC network connecting Egypt converter station to wind farms location (app. 640km).

Project promoters

ELICA S.A.

Countries

Egypt
Greece



National development plan(s)

No

Additional information on the project

Project sheet backlog

19 Jan. 2021 - Addition of results in third countries for indicator B2a_€

6 Jan. 2021 - Correction of results in third countries for indicator B2a

5 Jan. 2021 - NTC increase value corrected to 3000 MW

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

Project Description & Context

Project Investments

Main investment(s):

Wadi El Natroon - Acharnes HVDC Link. This investment includes two LCC converter stations at both ends of the bipolar 600kV HVDC link along with the grounding electrodes. The interconnection circuits consist of approximately 500km of overhead HVDC lines (ACSR/ PLOVER), approximately 30km length of underground cables (Al 1800mm2) and approximately 843km of submarine Cables (Cu 1000mm2, Al 1300mm2).

AC 500KV interconnection line (double circuit OHL) which connects Wind Farms of Ras Ghareb to Nile West point

AC 500KV Interconnection Lines (two double-circuit OHLs) which connect Nile West Point with Wadi El Natroon EHV Center

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
DC transmission line	1373	Wadi El Natroon	Acharnes	Under Consideration	2028		
AC transmission line	420	Ras Ghareb Wind Farms Substation	Nile West	Under Consideration	2028		
AC transmission line	220	NILE WEST POINT	WADI EL NATROON	Under Consideration	2028		

Reason for investment clustering

The total project includes the connection of Wind Farms installed at Suez Area with Greek power system which will enable energy market trading between Greek and Egypt. The project is rather complex since, besides its extensive length, it implicates various transmission system technologies, such as AC and DC lines, overhead, underground and submarine transmission lines. There is high technical and economical correlation among this diversification leading inevitably to the proposed clustering, which will help towards a more effective technical and economical assessment of the overall project. The transfer to Greece of low cost energy from the envisaged wind power plants in Egypt is an integral part of the GREGY project, therefore the

clustering of the HVDC link and the prescribed EHV AC grid is necessary.

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.

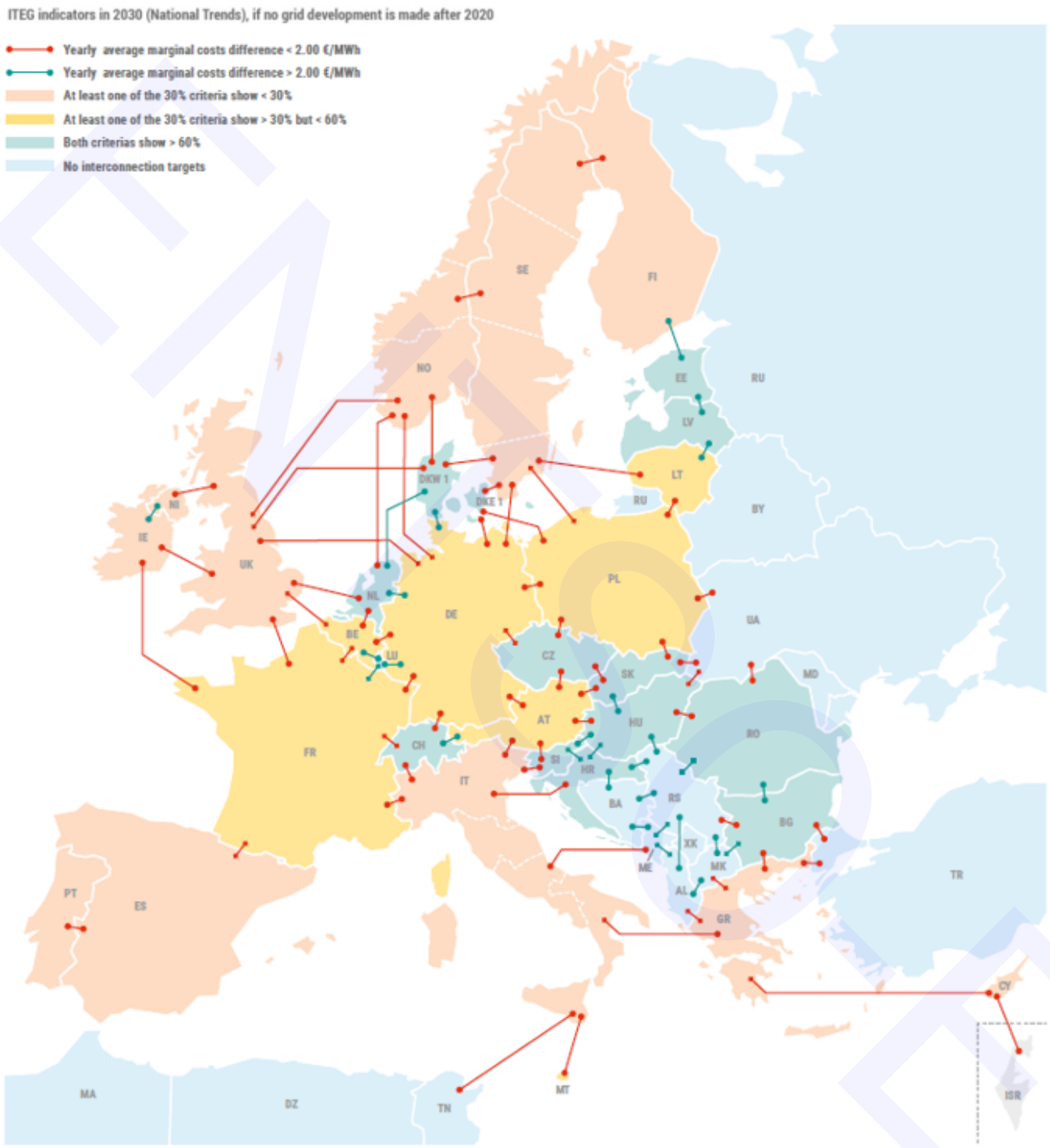
Need		How the project addresses each need (explanation provided by the project promoter(s))
	Infrastructure to reduce price differentials between EU and/or non-EU countries	GREGY establishes a high capacity connection route between southeast Europe and Egypt along with nearby power systems, enabling electricity trading. Therefore, it will constitute a critical asset towards coupling of power markets of EU with North Africa and the Middle East.
	Infrastructure to address system adequacy deficiencies and/or mitigate the risk of power failures.	GREGY interconnector will allow sharing of the need for back-up adequacy resources among the interconnected countries. The risk of power failures, even in severe incidents, can be significantly reduced, provided that the interconnector will be able to cover power deficit up to 3GW.
	Infrastructure and/or market design to provide balancing flexibility (e.g. international pooling / sharing of reserves, coordinated development of reserve capacity)	GREGY interconnector will also enable access to new balancing sources for both power systems. High capacity of interconnection will permit trading of significant volumes of balancing and reserve services, increase flexibility and allow optimal operation of variable RES.
	Infrastructure designed to enable cost-efficient grid connection of high volumes of RES and/or reduce RES curtailment	GREGY is part of a bigger project including the construction of large wind power plants (approximately 3300 MW), so that the high wind potential of Egypt can be optimally exploited.

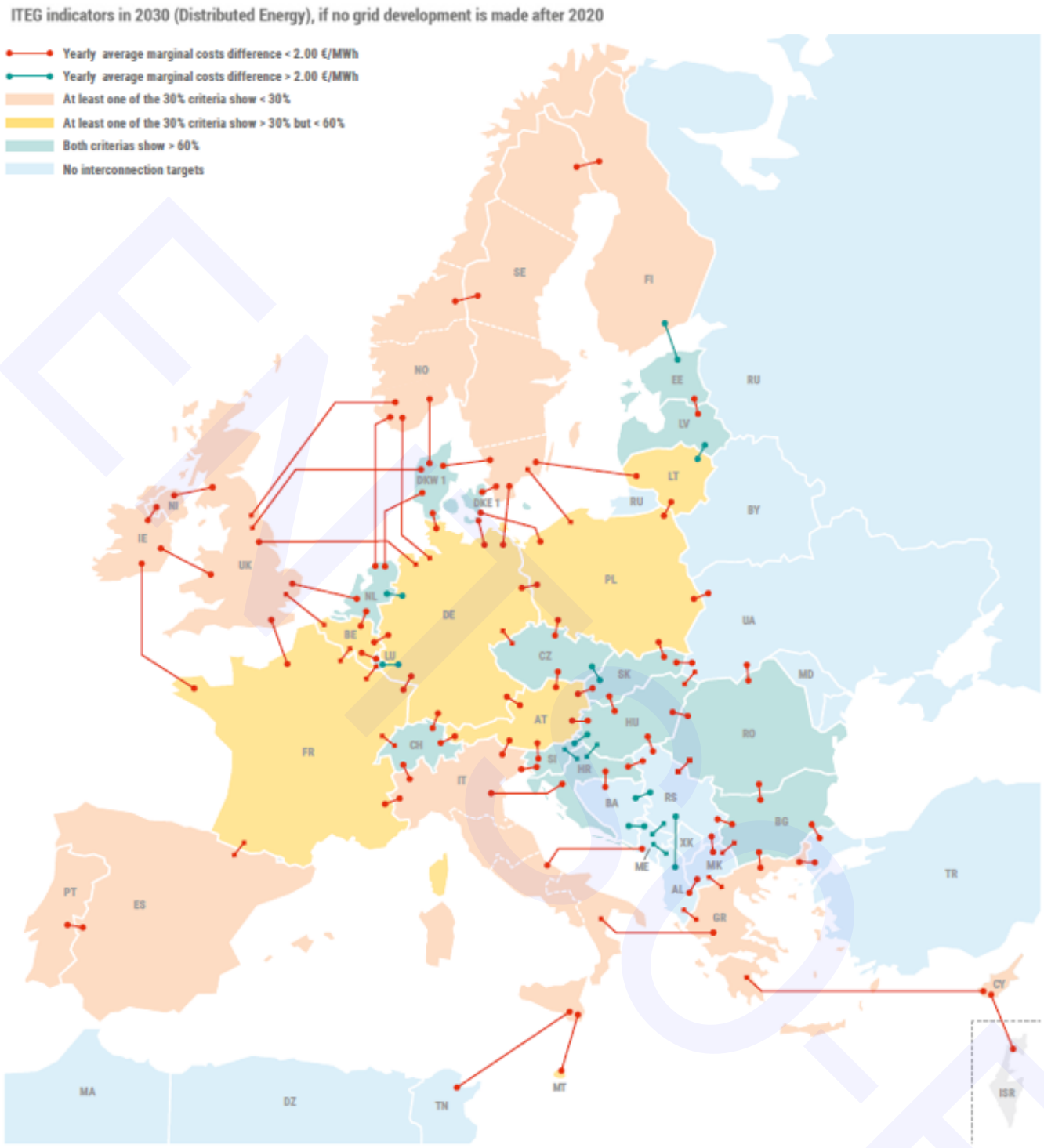
Interconnection targets

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
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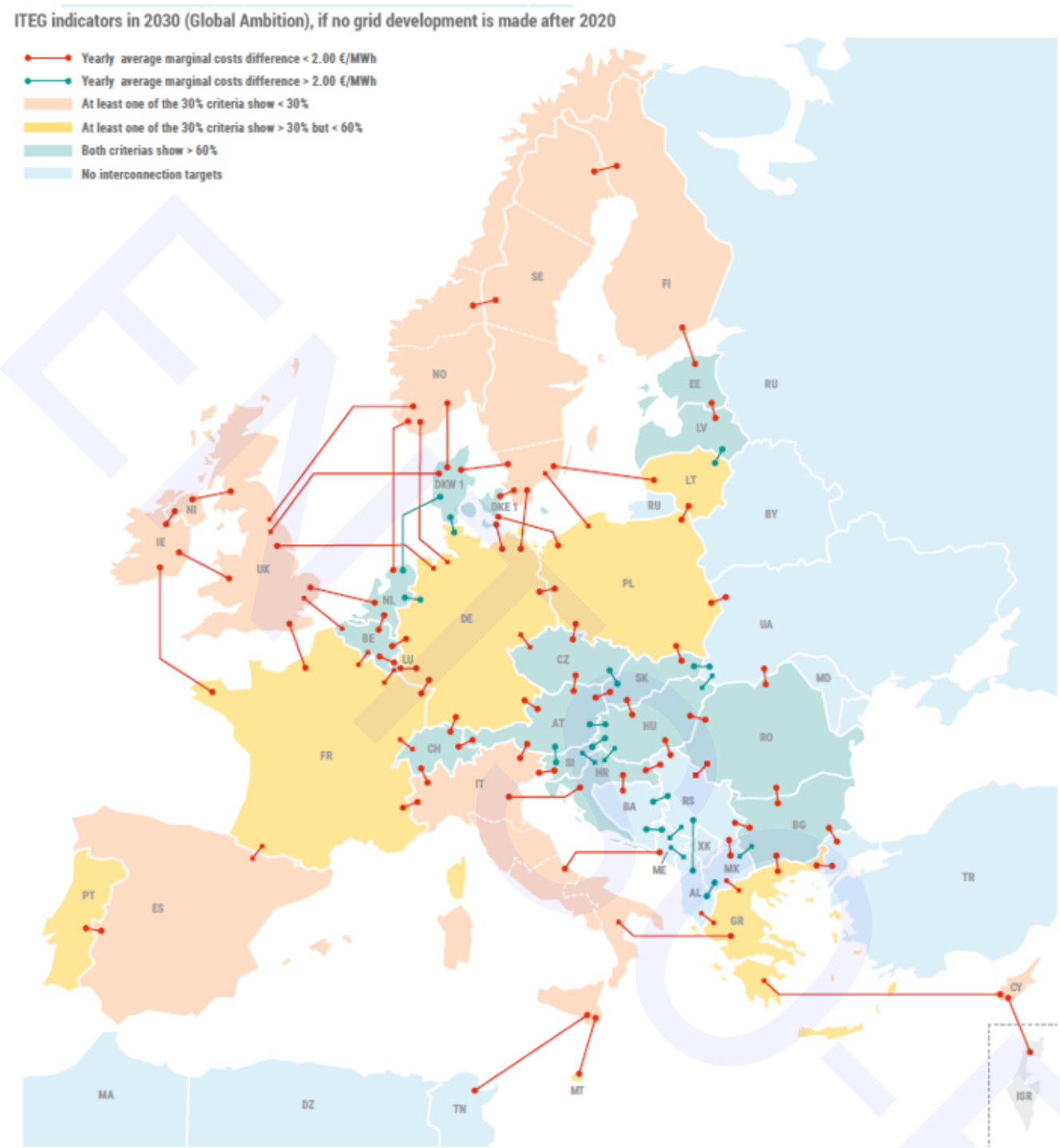
CY
MA
DZ
TN
MT
ISR



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.

In particular, GREGY project consists of three main parts:

-A double-pole HVDC interconnection from Wadi-El-Natroon (Egypt) to Attica area (Greece) of total length approximately 1373km including HVDC overhead lines, submarine and underground HVDC cables.

-AC part connecting Egypt converter station (Wadi-El-Natroon) to Nile-West (app 220km).

-AC part connecting Nile-West to Suez Wind Farms (Ras Ghareb) passing through Nile East area (app. 420km) .

The total approximate length of the HVDC Link is 1373 km with a max sea depth 2527m. High sea depths correspond to a relative short distance, about 48km.

The mature Line Commutated Converter (LCC) technology will be used, as it is most suitable for such high-power transmission.

Wind farms are expected to be located mainly on the Western bank of the Suez Gulf and on East and West bank sides of Nile where wind energy potential is high. However, the selection of the exact location and the capacity installed in each region will be determined based on the future availability of sites. This may have an impact on AC connection grid to Wadi El Natroon.

Project Assessment

Transfer capacity increase (National Trends 2025)

	Border	A B	B A
Transfer capacity increase (in MW)	Greece - Egypt	3000	3000

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	85 79 73	191 186 180	<	<	ENTSO-E assessment
B1_CO2 Annual Socio-Economic Welfare increase resulting from CO2 emissions reduction	max average min	-177 -189 -202	-333 -377 -417	>	<	ENTSO-E assessment
B1_RES Annual Socio-Economic	max average	1 0	7 2	>	>	ENTSO-E assessment

Welfare increase resulting from RES integration	min	0	0			

This project involves countries outside of the ENTSO-E area.

B1 SEW (Meuro/ year) in third country/ies	max average min	56 50 44	89 84 80	>	<	ENTSO-E assessment
B1_RES (Meuro/ year) in third country/ies	max average min	0 0 0	0 0 0	<	<	ENTSO-E assessment
B1_CO2 (Meuro/ year) in third country/ies	max average min	215 211 207	285 277 268	>	>	ENTSO-E assessment

Reduction of CO2 and GHG emissions

B4 Non-CO2 emissions (kg/year)

B4a Nitrogen oxides	average	4553	32889	n/a	n/a	ENTSO-E assessment
B4b Ammonia	average	-200	-191	n/a	n/a	ENTSO-E assessment
B4c Sulfur dioxide	average	4547	36417	n/a	n/a	ENTSO-E assessment
B4d Particular matter 5	average	1611	-165035	n/a	n/a	ENTSO-E assessment
B4e Particulate matter 10	average	362	1903	n/a	n/a	ENTSO-E assessment
B4f Non-methane volatile organic compounds	average	930	-168119	n/a	n/a	ENTSO-E assessment
B2a Annual CO2 variation from market simulation (ktonnes / year)	max average min	8769 8233 7697	14891 13476 11905	<	<	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	-305 -634 -1367	-431 -970 -2170	> > >	> > >	ENTSO-E assessment
B2b Annual CO2 variation due to network losses (ktonnes / year)		average	1412	1635	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	-40 -83 -178	-41 -92 -205	n/a	n/a	ENTSO-E assessment

This project involves countries outside of the ENTSO-E area.

B2a (ktonnes/year) in third country/ies		average	-9166	-9879	>	>	ENTSO-E assessment
B2a_€ (M€/ year) in third country/ies	CO2 price	60€/ ton 100€/ ton 189€/ ton	339 706 1522	316 711 1590	n/a	n/a	ENTSO-E assessment

Integration of renewable energy sources

B3 Annual avoided curtailment (RES integration) (GWh / year)		max average min	16 8 0	184 62 0	>	>	ENTSO-E assessment
B3a Connected RES (MW)	-				n/a	n/a	ENTSO-E assessment

This project involves countries outside of the ENTSO-E area.

B3 (GWh / year) in third countries	max average min	0 0 0	0 0 0	<	<	ENTSO-E assessment

Impact on grid losses

B5 Variation of network losses (GWh / year)	average	3121	3467	n/a	n/a	ENTSO-E assessment
B5_€ Variation of network losses monetised (M€ / year)	average	114	126	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	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	128	136	ENTSO-E assessment

B1_CO2 Annual Socio-Economic Welfare increase resulting from CO2 emissions reduction	average	-375	-430	ENTSO-E assessment
B1_RES Annual Socio-Economic Welfare increase resulting from RES integration	average	41	11	ENTSO-E assessment

This project involves countries outside of the ENTSO-E area.

B1 SEW (Meuro/year) in third country/ies	average	93	78	ENTSO-E assessment
B1_RES (Meuro/year) in third country/ies	average	0	0	ENTSO-E assessment
B1_CO2 (Meuro/year) in third country/ies	average	362	304	ENTSO-E assessment

Reduction of CO2 and GHG emissions

B2a Annual CO2 variation from market simulation (ktonnes / year)		average	7074	12300	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	-50 -332 -962	-307 -799 -1894	ENTSO-E assessment

This project involves countries outside of the ENTSO-E area.

B2a (ktonnes/year) in third country/ies		average	-6836	- 8677	ENTSO-E assessment
B2a_€ (M€/ year) in third country/ies	CO2 price	60€/ ton 100€/	48 321 930	217 564 1336	ENTSO-E assessment

ton 189€/ ton			

Integration of renewable energy sources

B3 Annual avoided curtailment (RES integration) (GWh / year)	average	704	234	ENTSO-E assessment
B3a Connected RES (MW)	-			ENTSO-E assessment

This project involves countries outside of the ENTSO-E area.

B3 (GWh / year) in third countries	average	0	0	ENTSO-E assessment

Non scenario-dependent indicator(s)

B8.0 Stability (Transient, Voltage and Frequency Stability)	Transient stability	Voltage stability	Frequency stability	
Wadi El Natroon - Acharnes HVDC (New HVDC)	++	++	+ (between sync areas)	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.
AC Overhead Line 1 (Ras Ghareb-Nile West) (New AC line)	++	++	0	
AC Overhead Line 2 (Nile West-Wadi El Natroon EHV) (New AC line)	++	++	0	

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	76	ENTSO-E assessment
B1_CO2 Annual Socio-Economic Welfare increase resulting from CO2 emissions reduction	average	-221	ENTSO-E assessment
B1_RES Annual Socio-Economic Welfare increase resulting from RES integration	average	0	ENTSO-E assessment

This project involves countries outside of the ENTSO-E area.

B1 SEW (Meuro/year) in third country/ies	average	52	ENTSO-E assessment
B1_RES (Meuro/year) in third country/ies	average	0	ENTSO-E assessment
B1_CO2 (Meuro/year) in third country/ies	average	257	ENTSO-E assessment

Reduction of CO2 and GHG emissions

B2a Annual CO2 variation from market simulation (ktonnes / year)	average	7881	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	-252 -567 -1269	ENTSO-E assessment

This project involves countries outside of the ENTSO-E area.

B2a (ktonnes/year) in third country/ies	average	- 9172	ENTSO-E assessment

B2a_€ (M€/ year) in third country/ies	CO2 price	60€/ ton 100€/ ton 189€/ ton	294 660 1477	ENTSO-E assessment

Integration of renewable energy sources

B3 Annual avoided curtailment (RES integration) (GWh / year)	average	7	ENTSO-E assessment
B3a Connected RES (MW)	-		ENTSO-E assessment

This project involves countries outside of the ENTSO-E area.

B3 (GWh / year) in third countries	average	0	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
Wadi El Natroon - Acharnes HVDC	Under Consideration	83	Habitats Directive (92/43/ EEC)

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.

Additional information by the project promoter(s)

https://natura2000.eea.europa.eu/Natura2000/SDF.aspx?site=GR4340024&release=10

The project is under consideration, therefore distance is indicative. Upon definition of the final route, it may be revised. Residual environmental impact is only defined for the part of the project located in Greece, as there is no information on residual environmental impact for the part in Egypt. Please note that there are not any Natura areas in Egypt.

Residual social impact

Investment	Investment status	Distance (km)	Type of sensitivity
Wadi El Natroon - Acharnes HVDC	Under Consideration	18.5	Sensitivity regarding population density - Land that is close to densely populated areas

Note based on CBA Guideline 3.0: Given that the actual route of the project might not be defined yet because of the low degree of maturity of its investment(s), a residual social impact assessment is not yet available.

Additional information by the project promoter(s)

http://msa.ypeka.gr/

Please note that the project is under consideration phase, therefore distance is indicative. Upon definition of the final route, it may be revised. Residual social impact is only defined for the part of the project located in Greece, as there is no information on residual social impact for the part in Egypt.

Project Costs

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

	CAPEX (Meuro)	Uncertainty range (%)	OPEX
1682. Wadi El Natroon - Acharnes HVDC	3525	10	76.186
1687. AC Overhead Line 1 (Ras Ghareb-Nile West)	232	10	0.772
1690. AC Overhead Line 2 (Nile West-Wadi El Natroon EHV)	243	10	0.814
Total	4000		77.772

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

1682

1687

1690