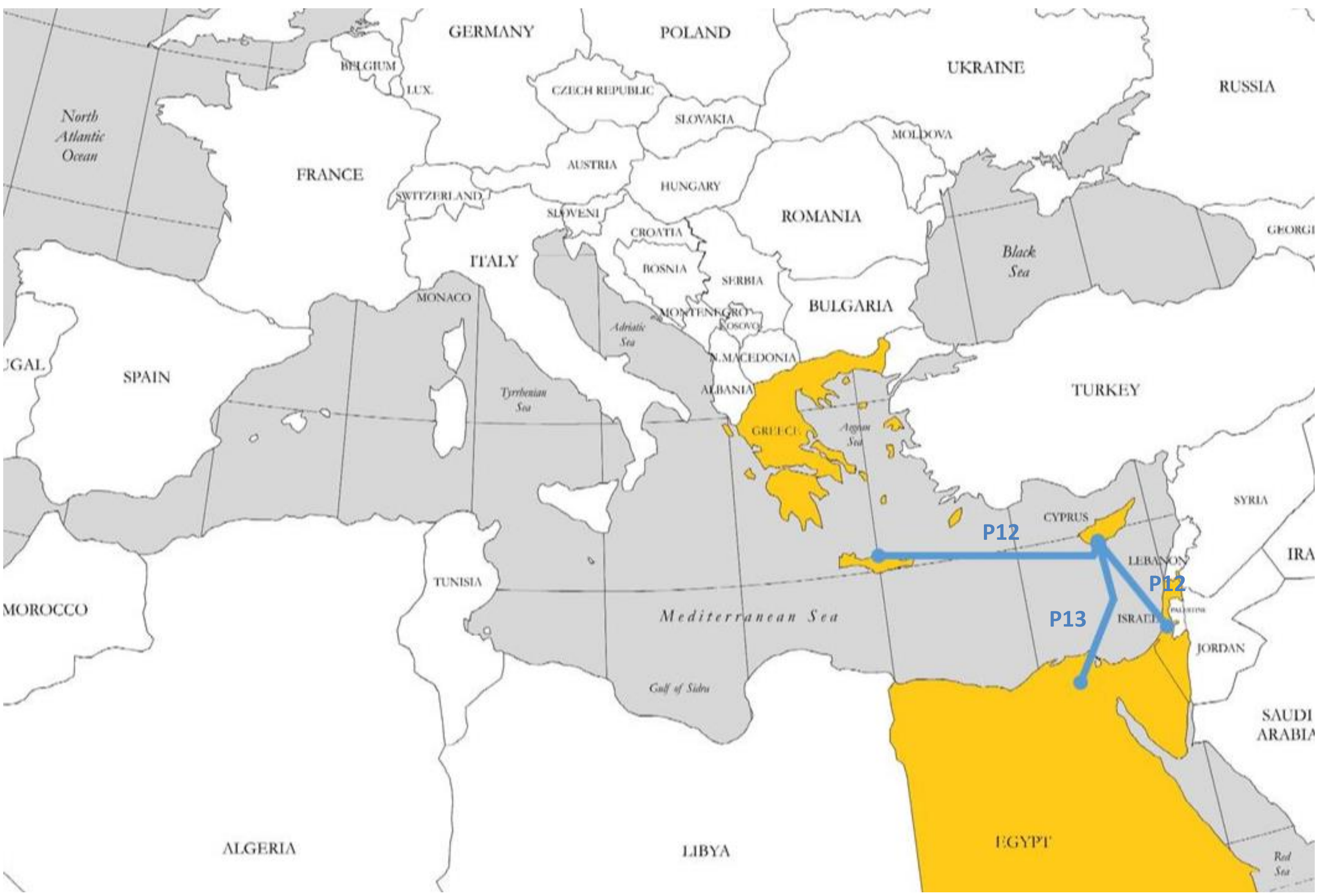
Project #13 – CYPRUS – EGYPT (in addition to Project 12)

Description

There are currently no interconnections between Cyprus and Egypt.

At present the system of Cyprus is electrically isolated, while the Egyptian grid is interconnected with the grids of Libya, Jordan, Sudan and a new interconnection with Saudi Arabia is under way by 2030. This project is studied as a consequent step to Project 12 which is considered as the base case, foreseeing two new interconnections: one between Greece (Crete) and Cyprus and one between Cyprus and Israel. In the area and especially Egypt tremendous quantities of Natural Gas have been discovered. Project 13 provides an opportunity to transfer electrical energy generated from Natural Gas towards EU.

Project 13 consists of one new interconnection which includes two cables (2×500MW) to be constructed from Egypt to Cyprus, with respective rating of DC to AC converters. The project will connect the Egyptian grid to Cyprus at Kofinou substation. More precisely in the case of Cyprus, the international interconnection cables 4×500MW for Crete and Israel and 2×500MW from Egypt will end up on Cyprus shore, in a single point/single location. Two DC/AC converters that are rated 500MW will allow inflow and outflow of energy from and to the island. However, because of stability reasons, import and export capacity for Cyprus is limited to 500 MW.



Project Description Table

Description	***Substation (from)***	***Substation (to)***	***GTC contribution (MW)***	***Total Route length (km)***	***Present status***	***Expected commissioning date***	***Evolution***
New interconnection between Cyprus and Egypt (HVDC)	Kofinou (CY)	Egypt (EG)	1000	500	Under Permitting / Tendering	First half of 20s	

Project #13 – CYPRUS – EGYPT (in addition to Project 12)

Project Merits

The major merits of the project relevant to the Mediterranean electricity system are listed below:

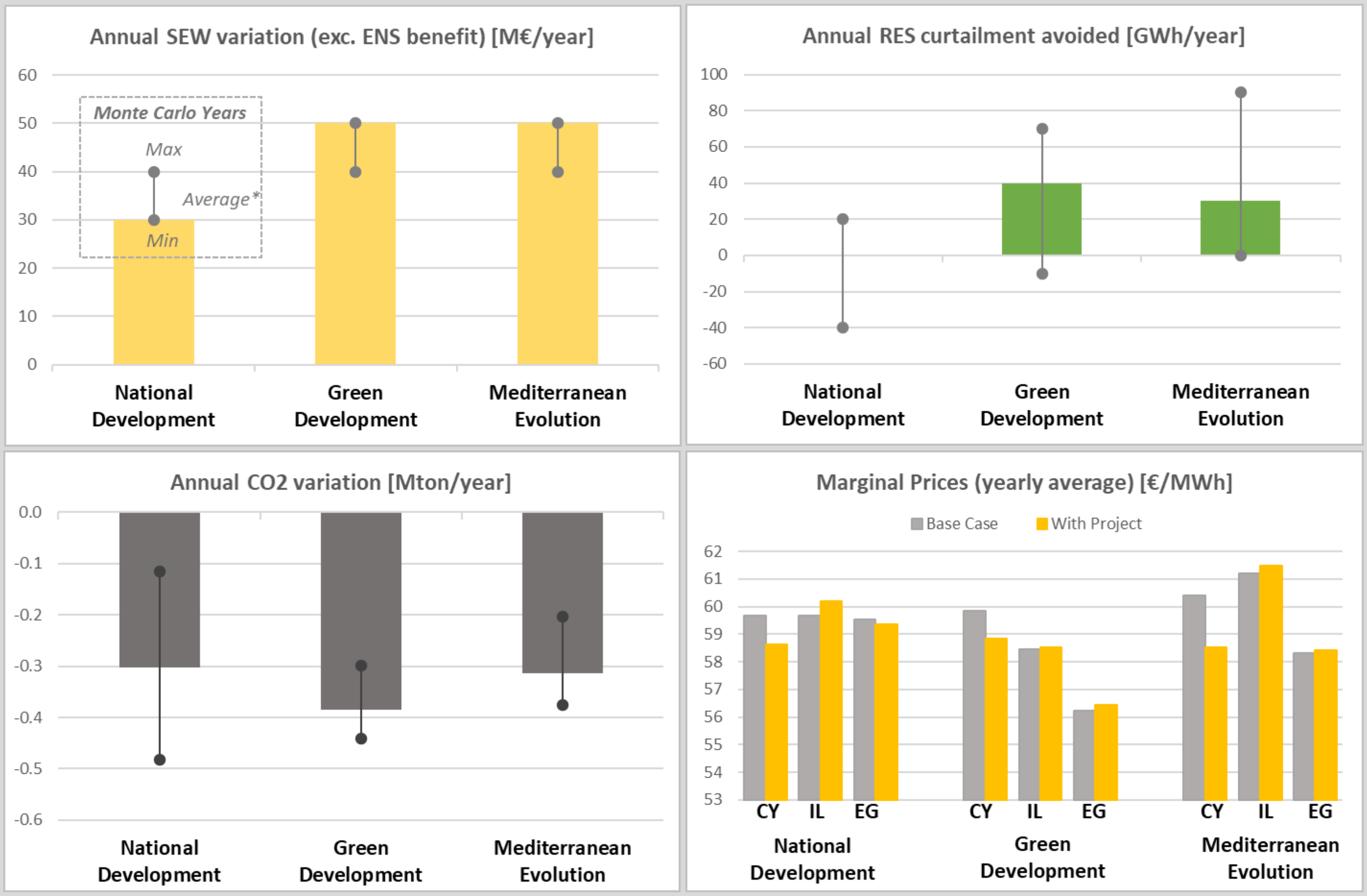
	PROJECT MERITS	ASSOCIATED SYSTEM NEEDS	PROJECT 13
Market	Reduce high price differentials between different market nodes and/or countries	Power studies with a 2030 time horizon can highlight significant differences in average marginal prices between countries, groups of countries or bidding zones. These differences are generally the consequence of structural differences in the composition of production fleets. The increase in the exchange capacity between these zones allows an economic optimization of the use of the generation plants and will be accompanied by electricity flow massively oriented in one direction, from the lower price country to the higher prices country, thus reducing the price differential.	X
Dispatch, Adequacy and Security of Supply	Positively contribute to the integration of renewables	Infrastructure to mitigate RES curtailment and to improve accommodation of flows resulting from RES geographic spreading.	X
	Contribute to solving issues related to adequacy and security of supply	Infrastructure that presents a benefit for the security of supply or system adequacy, in general by allowing additional importation at peak hours, in countries and areas presenting current of future risk of deficiencies	X
Operation	Fully or partially contribute to resolving the isolation of countries in terms of power system connectivity or to meeting specific interconnection targets	Infrastructure to connect island systems, or to improve exchange capacity of countries showing low level of connectivity, or to contribute to meeting specific interconnection capacity targets	X
	Introduce additional System Restoration mechanisms	Infrastructure that could provide capability for Black Start & Islanding Operation thus decreasing the need for generation units with such capabilities	X
	Improve system flexibility and stability	Infrastructure to improve system flexibility and stability, by increasing sharing possibilities, namely in countries were expected changes in the generation fleet may raise concerns in those specific issues. Decreasing levels of dispatchable generation can be compensated by infrastructure and/or market design to provide balancing flexibility at cross-border level (international pooling/sharing of reserves, coordinated development of reserve capacity). The large increase in the penetration of asynchronous renewable generation is leading to Higher Rate of Change of Frequency (RoCoF) on the system, creating transient stability issues and causing voltage dips. This can be compensated through infrastructure designed to contain frequency during system events.	X
	Increase system voltage stability	Reactive power controllability of converters can be used to increase system voltage stability	X
	Enable cross-border flows to overcome internal grid congestions	Infrastructure to facilitate future scenarios and enable cross border flows, accommodating new power flow patterns, overcoming internal grid congestions	
	Mitigate loop flows in bordering systems	Infrastructure to mitigate the loop flows occurrence in the borders between Mediterranean countries, contributing to the improvement of exchange capacity.	
	Contribute to the flexibility of the power systems through the control of power flows	Contribution to flexibility of power system operation by controlling power flows and optimizing usage of existing infrastructure	
Physical infrastructure	Refurbishment of obsolete infrastructure	Infrastructure to contribute to the refurbishment of obsolete part of grid initially designed in different context	

Project #13 – CYPRUS – EGYPT (in addition to Project 12)

Project assessment analysis

CBA Indicators

Project 13 yields a positive impact in the expected values of the CBA indicators across the 3 simulated scenarios. Specifically, the project drives in a consistent increase in the SEW and a decrease in CO_2 emissions, while a small decrease in RES curtailment is also noticed, with the greater expected benefit in the Green Development and Mediterranean Evolution scenarios.



** Average of the outputs calculated for all the Monte Carlo Years*

Project #13 – CYPRUS – EGYPT (in addition to Project 12)

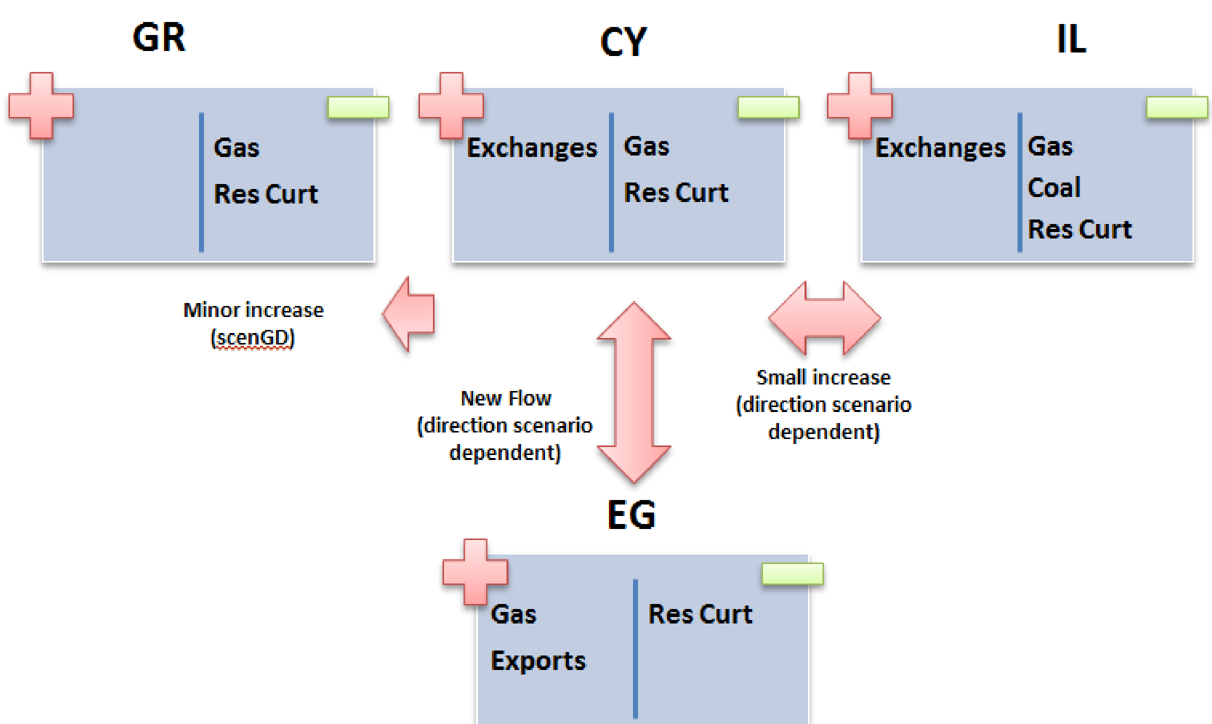
Project assessment analysis

Market Studies

Project 13 results in substitution of coal and gas based generation mainly by gas based generation, while with optimal use of storage a few decrease of RES curtailment is observed, particularly in the scenarios Green Development and Mediterranean Evolution. More specifically:

- **Generation mix:**
  - **Scenario National Development:** RES and gas based generation in Egypt, oil based generation in Cyprus and coal based generation in Israel are substituted by gas based generation in Israel, while generation mix of the other counties involved remains unaffected by the project
  - **Scenario Green Development:** Egypt is heavily exporting with local gas based generation substituting generation of the same fuel in all the other countries involved, particularly in Israel where coal generation is also reduced
  - **Scenario Mediterranean Evolution:** there is not a noticeable effect of the project in the generation mix of the countries involved.

- **Country balance and cross-country power flows:** the project drives significant exchanges between Cyprus and Egypt in all scenarios. A noticeable increase in Cyprus exchanges with Israel is also reported, while the interconnection with Greece is less affected by the project. Particularly in scenario Green Development Egypt is heavily exporting to all countries through Cyprus.



Project #13 – CYPRUS – EGYPT (in addition to Project 12)

Project assessment analysis

This project consists in a new interconnection between Cyprus and Egypt, in addition to the interconnections between Greece, Cyprus and Israel which represent Project 12. The interconneciton between Cyprus and Egypt is going to be realized with HVDC 500kV cables and a total capacity of a 1000 MW.

For the analysis the systems of Greece (Crete included) and Cyprus were represented with their full network models. However, the model for the systems of Israel and Egypt was not available. Therefore, the systems of these countries were represented as an external bus with load/generator to simulate energy interchange between the countries.

The secutiry analysis performed for 8 Points in Time selected did not identify any necessary additional internal reinforcements for the systems of Greece and Cyprus. Also for the third countries that are included in the project no internal reinforcements were suggested.

The overall investement cost is around 890 M€. The more detailed breakdown of the cost is present below.

Investment cost-Interconnection	
Line	***Cost [M€]****
DC cable Cyprus - Egypt	740
AC/DC converter stations Egypt	150
TOTAL [M€]	**890**

*Rounded values

Project #13 – CYPRUS – EGYPT (in addition to Project 12)

Project cost benefit analysis results

Assessment results for the Project #13 – CYPRUS – EGYPT (in addition to Project 12)											
GTC increase direction 1 (MW)			(CY-EG) 1000								
GTC increase direction 2 (MW)			(EG-CY) 1000								
Scenario Specific			MedTSO Scenario								
			1 - National Development (ND)			2 - Green Development (GD)			3 - Mediterranean Evolution (ME)		
			Reference Scenario	With new project	Delta	Reference Scenario	With new project	Delta	Reference Scenario	With new project	Delta
GTC/NTC - Import		CY	1000	2000	1000	1000	2000	1000	1000	2000	1000
		IL	1000	1000	0	1000	1000	0	1000	1000	0
		EG	3730	4730	1000	3730	4730	1000	3730	4730	1000
GTC/NTC - Export		CY	1000	2000	1000	1000	2000	1000	1000	2000	1000
		IL	1000	1000	0	1000	1000	0	1000	1000	0
		EG	3730	4730	1000	3730	4730	1000	3730	4730	1000
Interconnection Rate - Import/Export (%) [1]		CY	42.6% / 42.6%	85.3% / 85.3%	42.6%	35.4% / 35.4%	70.8% / 70.8%	35.4%	35.4% / 35.4%	70.8% / 70.8%	35.4%
		IL	4.5% / 4.5%	4.5% / 4.5%	0.0%	3.5% / 3.5%	3.5% / 3.5%	0.0%	3.5% / 3.5%	3.5% / 3.5%	0.0%
		EG	4.2% / 4.2%	5.4% / 5.4%	1.1%	4.0% / 4.0%	5.0% / 5.0%	1.1%	3.5% / 3.5%	4.5% / 4.5%	0.9%
Scenario Specific			MedTSO Scenario								
			1 - National Development (ND)			2 - Green Development (GD)			3 - Mediterranean Evolution (ME)		
Based on Monte Carlo Years			Average	Min	Max	Average	Min	Max	Average	Min	Max
Benefit Indicators	B1 - SEW[2]	(M€/y)	30	30	40	50	40	50	50	40	50
	B2 - RES Integration[3]	(GWh/y)	0	-40	20	40	-10	70	30	0	90
	B3 - CO_2	(Mton/y)	-0.3	-0.5	-0.1	-0.4	-0.4	-0.3	-0.3	-0.4	-0.2
	B4 - Losses[2]	(M€/y)	20			20			20		
		(GWh/y)	260			340			370		
	B5a - SoS Adequacy[4]	(GWh/y)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		(M€/y)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	B5b - SoS System Stability										
Residual Impact Indicators	S1 - Environmental Impact										
	S2 - Social Impact										
	S3 - Other Impact										
Costs	C1 - Estimated Cost[5]	(M€)	890								

[1] considering the GTC/NTC for 2030 and the Installed generation for 2030

[2] considering adequate rounding of values (to the tens)

[3] ignoring low values and negative values of RES integration (average values below 50GWh lead to setting average, min and max equal to zero) and considering adequate rounding of values (to the tens)

[4] ignoring low values (average values below 0.1 GWh/y lead to setting average, min and max equal to zero)

[5] based on the average value of the different technology options considered in the analysis (if applicable)

Rules for sign of Benefit Indicators

B1- Sew [M€/year] =	Positive when a project reduces the annual generation cost of the whole Power System
B2-RES integration [GWh/Year] =	Positive when a project reduces the amount of RES curtailment
B3-CO_2 [Mton/Year] =	Negative when a project reduces the whole quantity of CO_2 emitted in one year
B4-Losses - [M€/Year] and [GWh/Year] =	Negative when a project reduces the annual energy lost in the Transmission Network
B5a-SoS [GWh/Year] and [M€/y]=	Positive when a project reduces the risk of lack of supply

Assessment	Color code
negative impact	red
neutral impact	light pink
positive impact	light green
Not Available/Not Applicable	grey
monetized	yellow