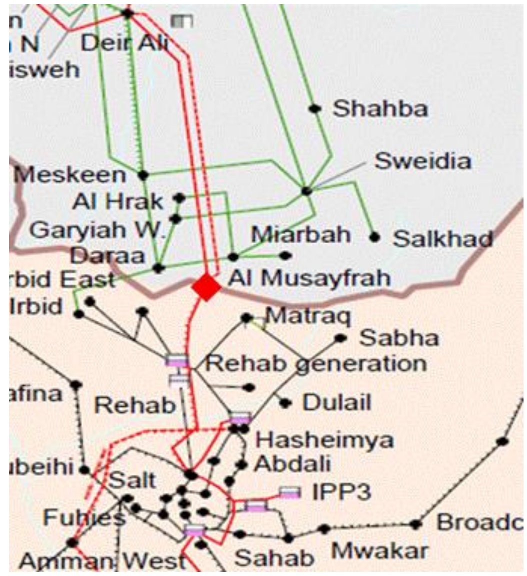
Project #9 – JORDAN – SYRIA

Description

The interconnection between Jordan and Syria was implemented in January 2001. The Jordanian and Syrian grids are linked with one 400 kV single circuit transmission line of 154 km connecting Der Ali 400/230 kV substation in Syria with Amman north 400/132 kV substation in Jordan, with a designed transmission capacity of 800 MW. In the current situation, this interconnection is out of operation.

Jordan and Syria are part of the 8 countries interconnection, including also Egypt, Turkey, Lebanon, Iraq, Palestine, and Libya.

The project consists of one new interconnection between Jordan and Syria to be realized through an AC overhead line. It is expected to increase the current transfer capacity between Jordan and Syria of about 800MW. This will allow mainly meeting the Syrian demand and also to integrate more renewable resources and base load units in the region.



Project Description Table							
Description	***Substation (from)***	***Substation (to)***	***GTC contribution (MW)***	***Total Route length (km)***	***Present status***	***Expected commissioning date***	***Evolution***
New interconnection between Jordan-Syria (AC)	Jordan (JO) Hassan_Ind	Syria (SY) Dir Ali	800	102	Long-term project	2030-2035	

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Project Merits

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

	PROJECT MERITS	ASSOCIATED SYSTEM NEEDS	PROJECT 9
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	
	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	
	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.	
	Increase system voltage stability	Reactive power controllability of converters can be used to increase system voltage stability	
	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	X
	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	

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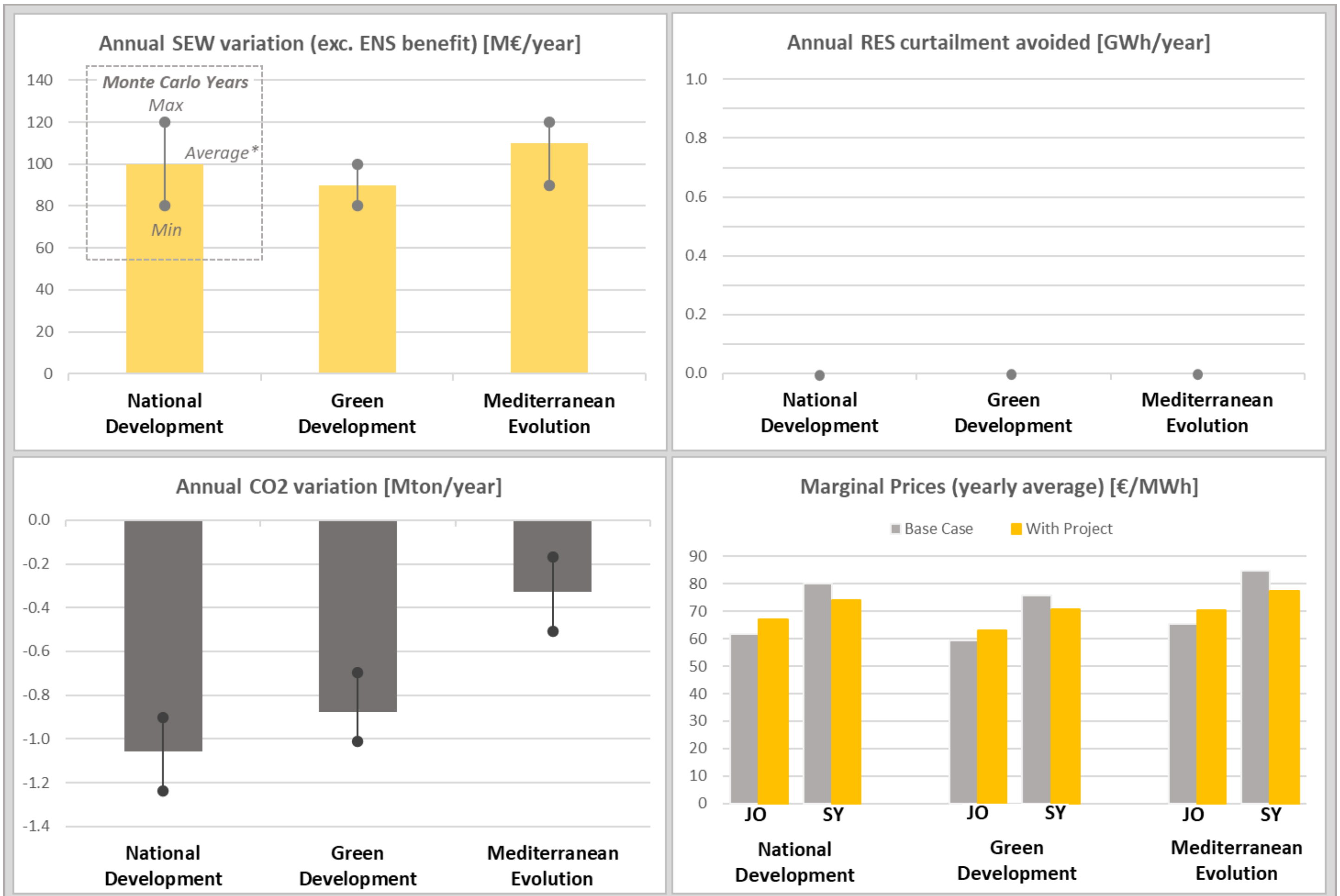
Project assessment analysis

CBA Indicators

Project 9 yields a consistent positive impact in the expected values of the SEW and CO_2 emissions across the 3 simulated scenarios. In what concerns the impact of the project on RES curtailment the analysis does not produce stable results which could be further evaluated (wide range of maximum and minimum values and negligible average value for the MC Years).



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

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Project assessment analysis

Market Studies

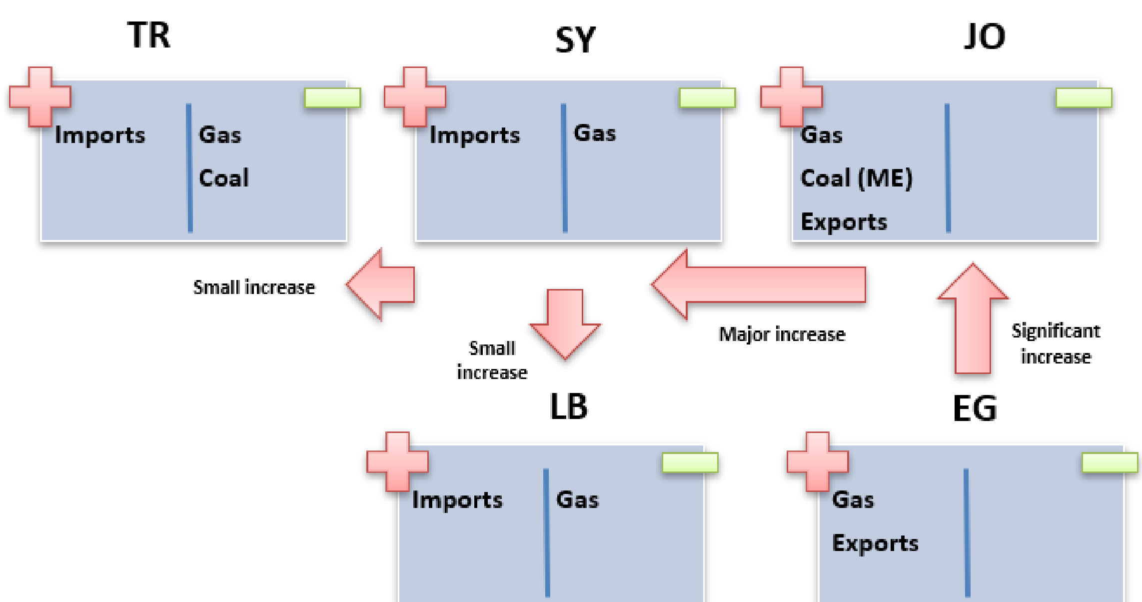
Project 9 drives an overall replacement of coal-based generation by gas-based generation. Specifically, the introduction of the project leads to significant exports from Jordan to Syria (with some of the power imported from Egypt through Jordan), with the substitution of gas-based generation in Syria with gas-based generation originating mainly from Jordan and to a lesser extent from Egypt. It is also worth noting that the overall reduction observed in coal-based generation is due in Turkey (which also sees a smaller reduction in gas generation) and is substituted by gas-based generation imported from Syria. Similarly, the project also drives a reduction in Lebanon's gas generation which is also compensated by increasing imports from Syria. More specifically:

- **Generation mix:**
  - **JO:** increase in local gas-based generation in all scenarios
  - **SY:** decrease in local gas-based generation in all scenarios
  - **EG:** increase in local gas-based generation in all scenarios
  - **TR:** decrease in local coal and gas-based generation in all scenarios
  - **LB:** decrease in local gas-based generation in all scenarios

- **Country balance and cross-country power flows:** due to the increase in the NTCs between Jordan and Syria with the new interconnection, there is a significant increase in the exports from Jordan to Syria in all scenarios with some of the power imported from Egypt. A smaller but noticeable increase in the exchanges of Syria with neighboring countries is also observed, particularly Egypt and less Turkey and Lebanon.

Note

1. Since no data were directly provided to Med-TSO by the Syrian TSO, the Syrian system was modelled starting from available data to obtain an average scenario.
2. The combined effect of the implementation of Project 9 – JOSY and Project 10 – SYTR was also assessed with an additional simulation. The analysis concludes that the combined implementation results in slightly lower expected values of the SEW across the 3 simulated scenarios, compared to the separate implementation of the two projects. The results of this additional simulation may be found in the detailed project assessment (see paragraph Additional Information).



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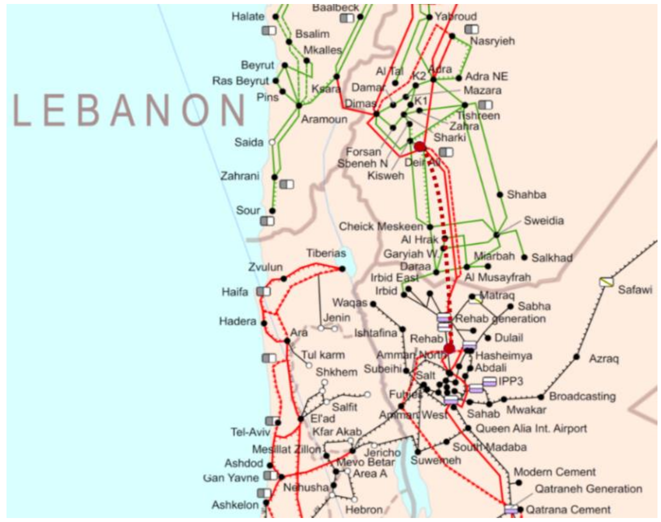
Project assessment analysis

The project consists in a new 400kV AC OHL between Jordan and Syria. The new line will increase the interchange capacity between these two countries for an additional 800 MW.

The system of Jordan was represented with a complete network model. For the system of Syria the model was not available, thus the Syrian system was represented as an external bus bar with load/generator to simulate energy interchange.

For the N and N-1 security analysis applied to the transmission network, 3 different scenarios have been distinguished and 8 points in time in total were examined. The details for the reinforcements identified for the system of Jordan are given below. For the third countries included in the project no internal reinforcements were suggested.



Scenario 1, 2	Scenario 3
Description (Jordan)	Description (Jordan)
Doubling the existing 400kV double circuit between Aqaba and Ma'an	Doubling the existing 400kV double circuit between Aqaba and Ma'an
New line between Amman North and Samra 400 kV	New line between Amman North and Samra 400 kV
New line between Amman South and Qatrana 400 kV	
New 240 MVA 400/132/33 kV transformer in Aqaba	
New 400 MVA 400/132/33 kV transformer in Ma'an	
	

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Project assessment analysis

The overall investment cost is expected to be 150.2M€, 76% of which represent investment for internal reinforcements in Jordan. The system of Syria has not been evaluated, hence no internal costs are related with this country. The more detailed breakdown of the cost is presented below.

Investment cost-Interconnection	
Line	***Cost [M€]****
AC line Jordan	3
AC line Syria	30
Line bay Jordan	1
Line bay Syria	2
TOTAL	36

Investment cost –internal reinforcements*	
New lines	***Cost [M€]****
Aqaba - Ma'an 400 kV (JO)	50
line bays	3
Reactive power compensation	1
Amman North - Samra 400 kV (JO)	10
line bays	3
Amman South - Qatrana 400 kV (JO)	30
line bays	3
Reactive power compensation	1
New Transformers	
New 240 MVA 400/132/33 kV transformer in Aqaba	3
Transformer bay 400 kV	1
Transformer bay 132 kV	0.5
Transformer bay 33 kV	0.1
Reactive power compensation 33 kV	1
New 400 MVA 400/132/33 kV transformer in Ma'an	5
Transformer bay 400 kV	1
Transformer bay 132 kV	0.5
Transformer bay 33 kV	0.1
Reactive power compensation 33 kV	1
TOTAL	114.2

*the solution with the highest costs of reinforcements is here shown
**Rounded values

Project #9 – JORDAN – SYRIA

Project cost benefit analysis results

Assessment results for the Project #9: Jordan-Syria												
GTC increase direction 1 (MW)			800									
GTC increase direction 2 (MW)			800									
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		JO	2350	3150	800	2350	3150	800	2350	3150	800	
		SY	1900	2700	800	1900	2700	800	1900	2700	800	
GTC/NTC - Export		JO	2550	3350	800	2550	3350	800	2550	3350	800	
		SY	1900	2700	800	1900	2700	800	1900	2700	800	
Interconnection Rate - Import/Export (%) [1]		JO	29.0% / 31.5%	38.9% / 41.4%	9.9%	25.1% / 27.2%	33.7% / 35.8%	8.5%	22.7% / 24.6%	30.4% / 32.4%	7.7%	
		SY	17.6% / 17.6%	25.0% / 25.0%	7.4%	13.9% / 13.9%	19.7% / 19.7%	5.8%	12.1% / 12.1%	17.2% / 17.2%	5.1%	
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)	100	80	120	90	80	100	110	90	120	
	B2 - RES Integration[3]	(GWh/y)	0	0	0	0	0	0	0	0	0	
	B3 - CO_2	(Mton/y)	-1.1	-1.2	-0.9	-0.9	-1.0	-0.7	-0.3	-0.5	-0.2	
	B4 - Losses[2]	(M€/y)	10			-20			20			
		(GWh/y)	100			-380			210			
	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	0.3	4.6	0.0	
	B5b - SoS System Stability											
Residual Impact Indicators	S1 - Environmental Impact											
	S2 - Social Impact											
	S3 - Other Impact											
Costs	C1 - Estimated Cost[5]	(M€)	150									

[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	green
Not Available/Not Applicable	grey
monetized	yellow