

Project #7 – ISRAEL – TURKEY

Description

At present there are no interconnections between Israel and Turkey.

The Turkish grid is currently interconnected with the grids of Greece, Bulgaria, Syria, Iraq, Iran, Nakhchivan (Azerbaijan) and Georgia. More specifically:

- Through the interconnections to Greece and Bulgaria, the Turkish grid is synchronously interconnected to Continental Europe Synchronous Area (CESA). Due to some limiting factors not related to the grid expansion, total NTC values are limited to 650 MW on CESA to Turkey direction and 500 MW on the opposite direction. The second interconnection between Greece and Bulgaria and the related strengthening of the 400 KV South-East Bulgaria which is under way, are expected to contribute to the increase of NTC to 1350 MW on CESA to Turkey direction and to 1250 MW on the opposite direction.
- The Turkish and Syrian grids are linked with one 400 kV AC overhead interconnection line, connected to Aleppo SS at the Syrian side and to Birecik HPP Substation at the Turkish side. Before TEIAS synchronously connected to ENTSO-E network, the interconnection had been used to connect 2 units of Birecik HPP in Turkey to feed the Syrian network (unit direction method). After joining the ENTSO-E, TEIAS had to switch off the line. A Back to Back (B2B) converter substation is planned to be constructed next to Birecik HPP Substation on Turkish side and was already in the investment plan of TEIAS before the war in Syria. TEIAS postponed this investment until the stabilization of the situation in Syria. After the completion of the converter station the two grids will be fully connected asynchronously to each other B2B.
- The Turkish grid is also connected to Georgia B2B asynchronously and through isolated region method with the grids of Iraq and Iran. The construction of B2B station in Van (Turkey) is ongoing and after commissioning of the B2B station in Van, Turkey and Iran grids will be connected asynchronously.

The project consists of a new interconnection between Israel and Turkey to be realized through HVDC submarine cable. The new HVDC submarine link is expected to be implemented using VSC technology considering the advantages over LCC.

The project is aiming to increase the interconnection capacity between Turkey and the Israel to 2000 MW and develop a new corridor in the Eastern Mediterranean.



Project Description Table

Description	Substation (from)	Substation (to)	GTC contribution (MW)	Total length (km)	Route	Present status	Expected commissioning date	Evolution
New interconnection between Israel and Turkey	Israel (IL)	Turkey (TR)	2000	500		Long-term project	Project under consideration	

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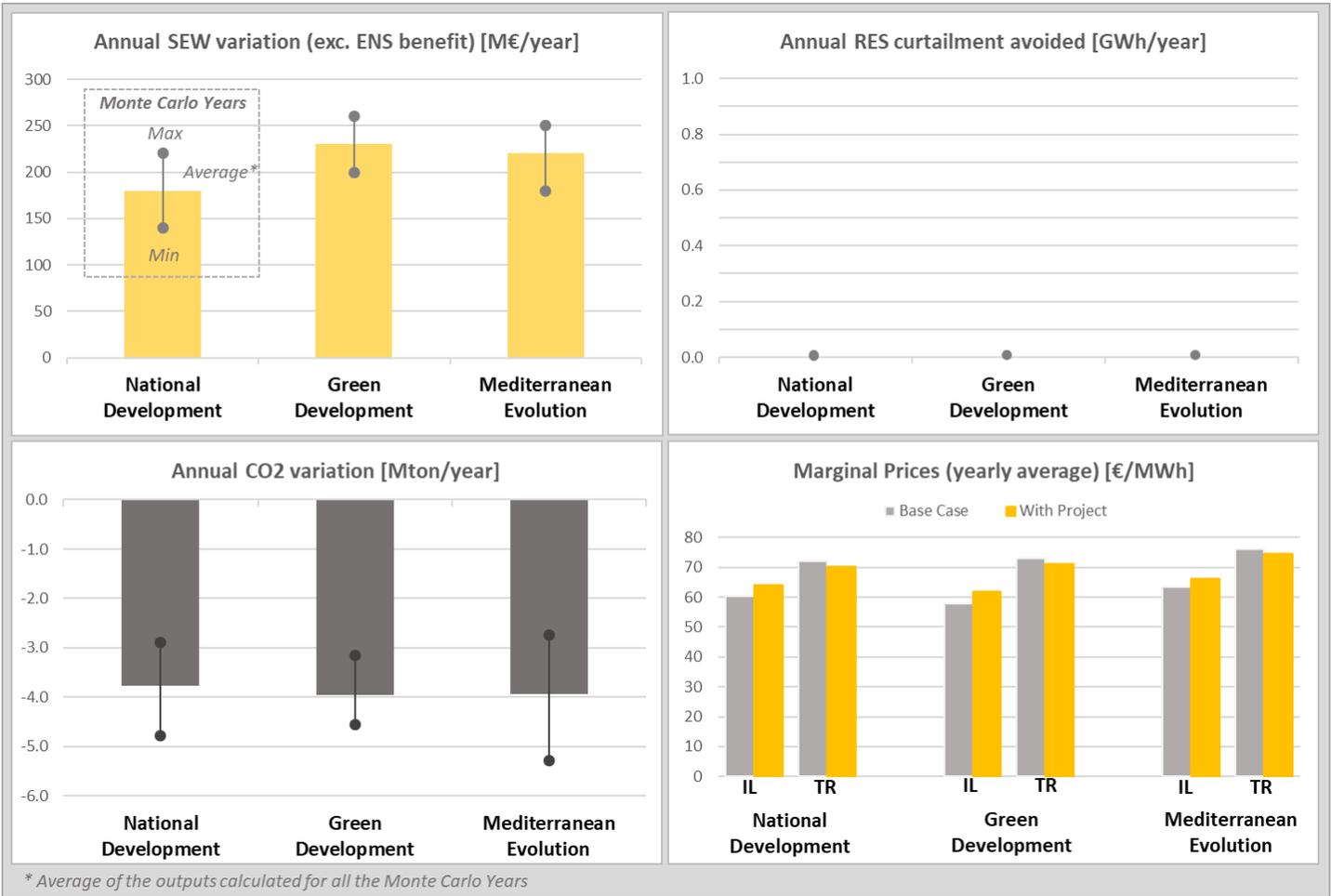
Project Merits

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

	PROJECT MERITS	ASSOCIATED SYSTEM NEEDS	PROJECT 7
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 or 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	X
	Improve system flexibility and stability	Infrastructure to improve system flexibility and stability, by increasing sharing possibilities, namely in countries where 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	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	

CBA Indicators

Project 7 yields a positive impact in the values of the CBA indicators across the 3 simulated scenarios. A considerable increase of the SEW is reported as a result of the use of the new interconnection, while there is also a small decrease in RES curtailment with the greater expected benefit being noticed in the Green Development and Mediterranean Evolution scenarios and a consistent decrease in overall CO₂ emissions.

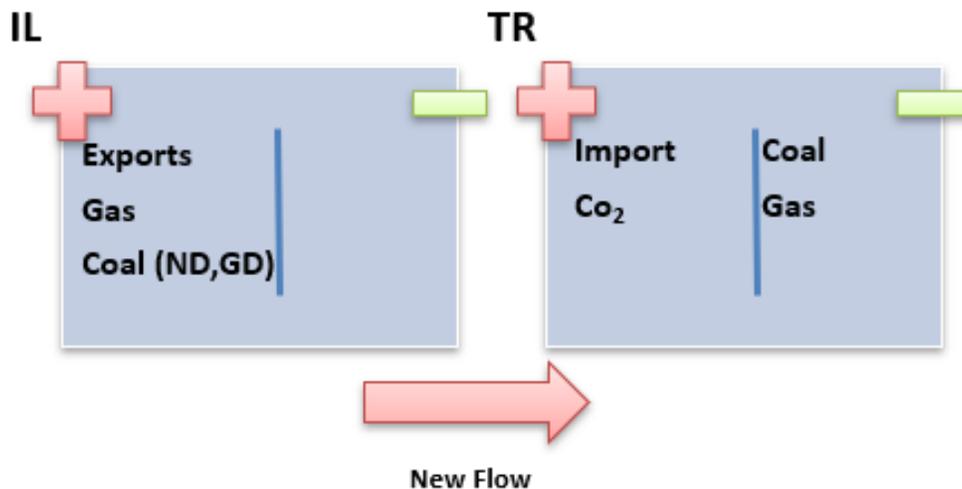


Market Studies

Project 7 drives an overall replacement of coal-based by gas-based generation. Furthermore, this new interconnection leads to significant imports to Turkey from Israel, resulting in the substitution of local coal and gas-based generation, with a consequent slight impact for overall decrease of CO₂ emissions, since the coal-based generation is replaced by gas-based generation in Israel in all scenarios. More specifically:

- **Generation mix:**
 - **IL:** considerable increase in gas-based generation in all scenarios and a smaller increase in coal-based generation in the National Development and Green Development Scenarios
 - **TR:** reduction in local coal and gas-based generation in all scenarios
- **Country balance and cross-country power flows:** the flows observed in the new interconnection are mostly from Israel to Turkey, with an expected significant number of hours of saturation of the flow in this direction. A slight decrease in exchanges of Turkey with Syria is observed during peak hours. This new transfer route between Israel and Turkey does not have a significant impact on the exchanges with other neighboring countries, with the exception of Syria.

Note: Since no data were provided to Med-TSO by the Israeli TSO, the Israeli system was modelled starting from available data and information to obtain the three contrasted data sets according to the Med-TSO scenarios storylines.



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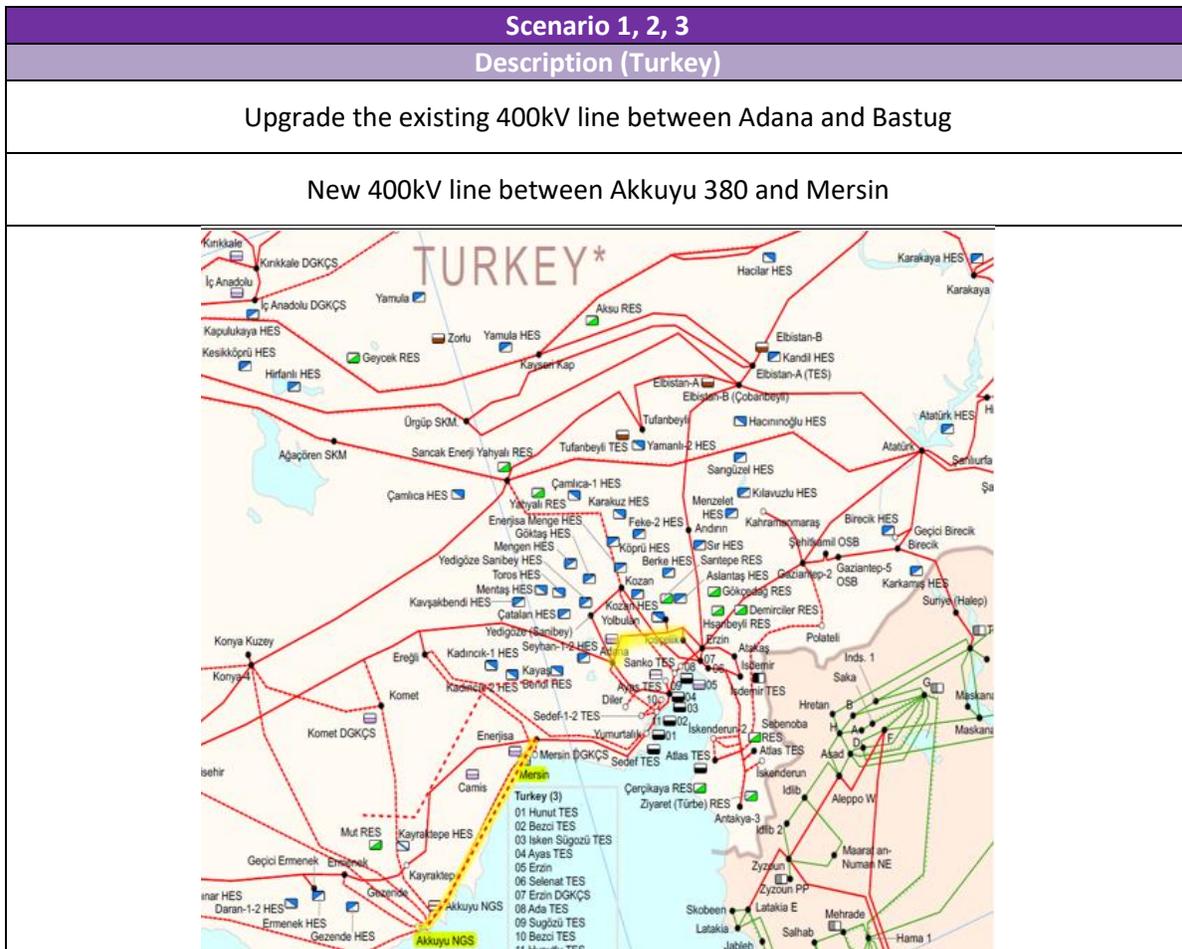
Project assessment analysis

This project consists in a new interconnection between Turkey and Israel, to be realized through 500kV HVDC cable with a 2000MW capacity and a total length of 500km.

For the security analysis the Turkish system has been fully represented by its transmission network model. On the other hand, the network model for the system of Israel was not available. Therefore, the system of Israel was represented as an external bus with load/generator to simulate energy interchange.

For this project 3 scenarios (S1, S2 and S3) were distinguished and a total number of 9 Points in Time have been defined.

The N and N-1 static analysis adopted to the transmission level identified the following reinforcements for the system of Turkey, while for the third countries included in the project no internal reinforcements were suggested.



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Project assessment analysis

The overall investment cost is about 1275 M€, less than 2.7% of which represent investment for internal reinforcements in Turkey. The system of Israel has not been evaluated, hence no internal costs are related with this country. The more detailed breakdown of the cost is presented below.

<i>Investment cost-Interconnection*</i>	
<i>Line</i>	<i>Cost [M€]</i>
DC cable	880
AC/DC converter station Israel	180
AC/DC converter station Turkey	180
TOTAL	1240

<i>Investment cost-Internal reinforcements*</i>	
<i>Upgraded lines</i>	<i>Cost [M€]</i>
400 kV Adana - Bastug OHL	10
New Lines	
400kV Akkuyu 380 – Mersin OHL	24
Line bays	1
TOTAL	35

*Rounded values

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Project cost benefit analysis results

Assessment results for the Project #7: Israel - Turkey											
GTC increase direction 1 (MW)		2000									
GTC increase direction 2 (MW)		2000									
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	IL	0	2000	2000	0	2000	2000	0	2000	2000	
	TR	3560	5560	2000	3560	5560	2000	3560	5560	2000	
GTC/NTC - Export	IL	0	2000	2000	0	2000	2000	0	2000	2000	
	TR	3080	5080	2000	3080	5080	2000	3080	5080	2000	
Interconnection Rate - Import/Export (%) ¹	IL	0.0% / 0.0%	9.0% / 9.0%	9.0%	0.0% / 0.0%	7.1% / 7.1%	7.1%	0.0% / 0.0%	7.1% / 7.1%	7.1%	
	TR	2.9% / 2.5%	4.6% / 4.2%	1.7%	2.8% / 2.4%	4.3% / 4.0%	1.6%	2.5% / 2.2%	3.9% / 3.6%	1.4%	
Scenario Specific		MedTSO Scenario									
		1 - National Development (ND)			2 - Green Development (GD)			3 - Mediterranean Evolution (ME)			
		Average	Min	Max	Average	Min	Max	Average	Min	Max	
Based on Monte Carlo Years											
Benefit Indicators	B1 - SEW ²	(M€/y)	180	140	220	230	200	260	220	180	250
	B2 - RES Integration ³	(GWh/y)	0	0	0	0	0	0	0	0	0
	B3 - CO ₂	(Mton/y)	-3.8	-4.8	-2.9	-3.9	-4.6	-3.2	-3.9	-5.3	-2.7
	B4 - Losses ²	(M€/y)	40			50			60		
		(GWh/y)	850			880			940		
	B5a - SoS Adequacy ⁴	(GWh/y)	0.0	0.0	0.0	0.0	0.0	0.0	0.4	3.1	0.0
(M€/y)		0.0	0.5	0.0	0.1	1.1	0.0	1.2	9.3	0.0	
B5b - SoS System Stability											
Residual Impact Indicators	S1 - Environmental Impact										
	S2 - Social Impact										
	S3 - Other Impact										
Costs	C1 - Estimated Cost ⁵	(M€)	1280								

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	
neutral impact	
positive impact	
Not Available/Not Applicable	
monetized	