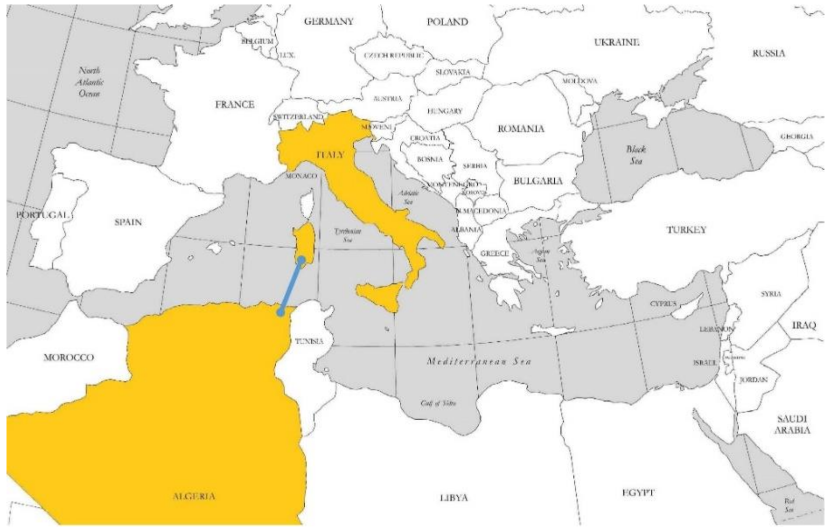
Project #15 – ALGERIA - ITALY

Description

There are presently no existing interconnections between Algeria and Italy. The Algeria grid is currently interconnected with Morocco and Tunisia, whereas the Italian grid is currently interconnected with France, Switzerland, Austria, Slovenia, Greece and Montenegro. Italy is a member of ENTSO-E and part of Continental Europe Synchronous Area.

The Total Net Transfer Capacity between the Italian Grid and the central Europe is between 8435 and 6905 MW for import, winter and summer peak respectively.

The NTC between the Italian Grid and Eastern countries is around 1100 MW (Greece 500 MW and Montenegro 600 MW for both winter and summer). With respect to the South border, considering the grid developments foreseen in the coming years, the NTC value is expected to reach 600 MW (Italy - Tunisia).



Concerning the interconnection between Algeria and Tunisia, there are currently: one 400 kV transmission line; one 220 kV transmission line; one 150 kV transmission line; and two 90 kV transmission lines (150kV and 90 kV lines to be decommissioned in a middle-term horizon). This infrastructure enables an estimated total Net Transfer Capacity of 250 MW.

Concerning the interconnection between Morocco and Algeria, there are currently two 400 kV transmission lines and two 220 kV transmission lines, theoretically enabling an estimated Net Transfer Capacity of 1000 MW. However, until now, the transit has been limited to 300 MW from Morocco to Algeria and 600 MW from Algeria to Morocco, with the two 220 kV lines being disconnected in order to avoid a looping effect. The expected NTC between these two countries in the 2030 horizon is 1000 MW

Regarding the interconnection project between Algeria and Italy, it will increase the total expected NTC in Algeria border from 1250 MW to 2250 MW and the total expected NTC in the border of Italy from 10135 MW to 11135 MW (considering Import NTC in winter).

The project consists of a new interconnection between Algeria (Cheffia) and Italy_Sardinia (Cagliari Sud) through an HVDC submarine cable. The HVDC interconnection will have a capacity of 1000MW and a total length of around 350 km. The maximum depth for the installation of the undersea cable will be over than 2000m. On the Algerian side, the connection of the HVDC Converter Station to the national grid will comprise two 50 km 400 kV AC overhead lines.

It is worth noting that this project is an explorative study which is not related, at the moment, to any official planning activity by the TSOs involved. In fact, this project is not included neither in the respective National Development Plans by Sonelgaz and Terna nor in any intergovernmental agreements between the two Countries. It should be also noted that an interconnection between Italy and Algeria was studied for the first time in 2004 following an intergovernmental agreement and later on in 2013 following an agreement of cooperation between Sonelgaz and Terna. Both studies were performed without data and contributions by the neighboring TSOs. Within the framework of Med-TSO the study takes into consideration its impact at regional level.

Project Description Table

Description	*Substation (from)*	*Substation (to)*	*GTC contribution (MW)*	*Total Route length (km)*	*Present status*	*Expected commissioning date*	*Evolution*
New interconnection between Algeria and Italy	Cheffia - Algeria	Cagliari Sud - Italy	1000	350	Exploratory study	TBD	

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Project Merits

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

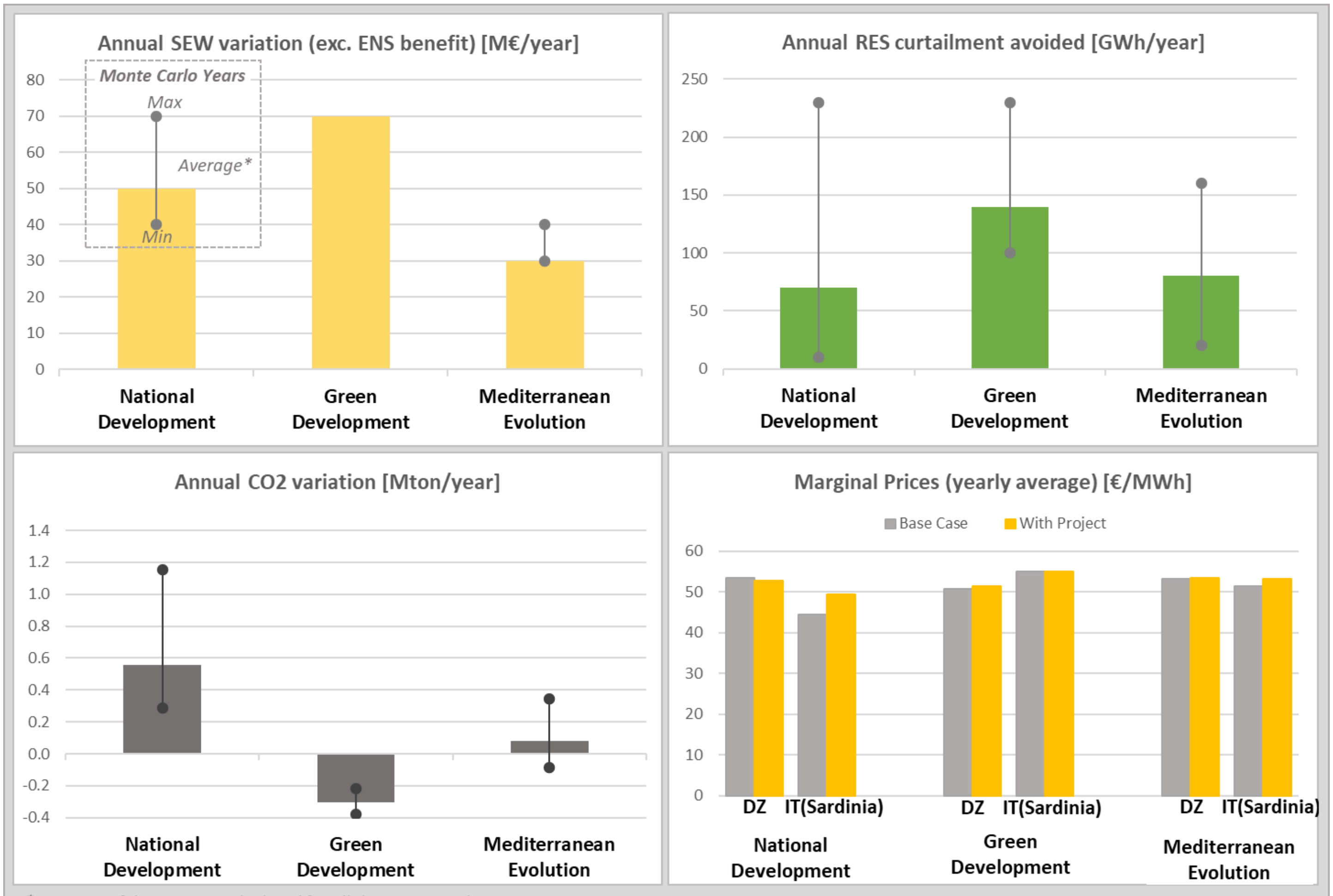
	PROJECT MERITS	ASSOCIATED SYSTEM NEEDS	PROJECT 15
Market	Reduce high price differentials between different market nodes and/or countries	Power studies with a 2030 time horizon can highlight significant differences in average marginal prices between countries, groups of countries or bidding zones. These 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	
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	
	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	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 #15 – ALGERIA - ITALY

Project assessment analysis

CBA Indicators

Project 15 yields a positive impact in the expected values of both the Social-Economic Welfare and the RES Curtailment in all three Scenarios. As for the CO2 emissions the expected values are Scenario-dependent, with expected increases in the ND and ME Scenarios and a decrease in the GD Scenario. As for the Energy not Supplied indicator, the impact of the project is negligible, considering the value of this indicator is also negligible in the base case (i.e. without the project) in the involved countries.



Average of the outputs calculated for all the Monte Carlo Years

Project #15 – ALGERIA - ITALY

Project assessment analysis

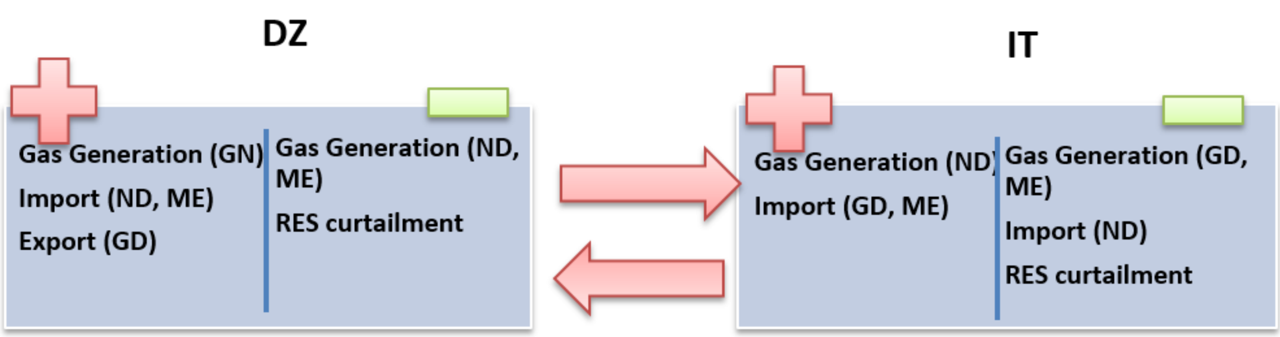
Market Studies

The impacts of Project 15 are scenario dependent. In the National Development and Mediterranean Evolution Scenarios we see a decrease in global Gas Generation, although there is a significant increase in Gas Generation in Italy in the ND Scenario. This global decrease in Gas Generation is mostly compensated by Lignite (from countries outside the MedTSO perimeter) but also by Nuclear, by a reduction in pump & battery storage consumption greater than the reduction observed in the turbine and discharge of these technologies, by other non-renewable generation and finally by the avoidance of RES Curtailment.

As for the Green Development Scenario, we see a less significant reduction in Gas Generation, coupled with also a reduction in Lignite Generation (mostly outside MedTSO perimeter). In this Scenario there is also a more significant avoidance of RES Curtailment and again a reduction in pump & battery storage consumption greater than the reduction observed in the turbine and discharge of these technologies.

- **Generation mix:**
  - **National Development Scenario**
    - **DZ:** decrease in Gas Generation
    - **IT:** increase in Gas Generation, greater contribution of hydro pump + battery storage, and reduction in RES Curtailment
  - **Green Development Scenario**
    - **DZ:** increase in Gas Generation
    - **IT:** decrease in Gas Generation and reduction in RES Curtailment
  - **Mediterranean Evolution Scenario**
    - **DZ:** decrease in Gas Generation
    - **IT:** decrease in Gas Generation and reduction in RES Curtailment

Country balance and cross-country power flows: the flows observed in this new interconnection are scenario-dependent, resulting in exports from Italy to Algeria in the National Development Scenario, exports from Algeria to Italy in the Green Development Scenario and in balanced exchanges in the Mediterranean Evolution Scenario.
In addition to this new energy flow between the two banks of the Mediterranean basin, the project significantly impacts the exchanges between Sardinia and continental Italy. Conversely, the Exchanges between Algeria and Maghreb countries (Tunisia and Morocco) and between Tunisia and Italy (trough the future interconnection project) are only slightly impacted.



Project #15 – ALGERIA - ITALY

Project assessment analysis

This project consists in a new HVDC interconnection between Algeria and Italy-Sardinia. The HVDC interconnection will have a capacity of 1000MW and a total length of 350km. On the Algerian side, the connection of the HVDC converter station to the national grid will comprise two 50km 400kV AC overhead lines.

For this project 3 different scenarios were distinguished and 9 Points in Time were defined. For the analysis, both the system of Sardinia and the system of Algeria are represented with a full network model.

The N and N-1 static analysis applied to transmission level identified the reinforcements for the system of Algeria. For the third countries that are included in the project no internal reinforcements are suggested.

<table>
<tr><th colspan="2">Scenario 1, 2, 3</th></tr>
<tr><th>Description (Italy)</th><th>Description (Algeria)</th></tr>
<tr><td></td><td>New 400kV OHL line between Ramdane djamel and Berrahal</td></tr>
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Project assessment analysis

The overall investment cost for this project is estimated to be between 830M€ and 870M€, 4% of which represent investment cost for internal reinforcements for the system of Algeria. The more detailed breakdown of the cost is presented below.

Investment cost-Interconnection		
Line	***Cost [M€]****	
	LCC	***VSC***
DC cable	520	520
AC/DC converter station Algeria	130	150
AC/DC converter station Italy	130	150
AC line Algeria	20	20
line bay Algeria	10	10
TOTAL	**810**	**850**

Investment cost –internal reinforcements	
Lines (Algeria)	***Cost [M€]****
400kV OHL Ramdane Djamel-Berrahal	20
TOTAL	**20**

*Rounded values

Project #15 – ALGERIA - ITALY

Project cost benefit analysis results

Assessment results for the Project #15: Algeria - Italy											
GTC increase direction 1 (MW)			1000								
GTC increase direction 2 (MW)			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		DZ	1250	2250	1000	1250	2250	1000	1250	2250	1000
		IT	11150	12150	1000	11150	12150	1000	11150	12150	1000
GTC/NTC - Export		DZ	1250	2250	1000	1250	2250	1000	1250	2250	1000
		IT	6930	7930	1000	6930	7930	1000	6930	7930	1000
Interconnection Rate - Import/Export (%) [1]		DZ	3.5% / 3.5%	6.3% / 6.3%	2.8%	3.4% / 3.4%	6.1% / 6.1%	2.7%	2.9% / 2.9%	5.2% / 5.2%	2.3%
		IT	7.2% / 4.5%	7.8% / 5.1%	0.6%	7.2% / 4.5%	7.8% / 5.1%	0.6%	8.2% / 5.1%	8.9% / 5.8%	0.7%
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)	50	40	70	70	70	70	30	30	40
	B2 - RES Integration[3]	(GWh/y)	70	10	230	140	100	230	80	20	160
	B3 - CO2	(Mton/y)	0.6	0.3	1.2	-0.3	-0.4	-0.2	0.1	-0.1	0.3
	B4 - Losses[2]	(M€/y)	20			40			20		
		(GWh/y)	330			700			280		
	B5a - SoS Adequacy[4]	(GWh/y)	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	2.1
		(M€/y)	0	0	0	0	0	0	0	0	6
	B5b - SoS System Stability										
Residual Impact Indicators	S1 - Environmental Impact										
	S2 - Social Impact										
	S3 - Other Impact										
Costs	C1 - Estimated Cost[5]	(M€)	850								

[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)

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-CO2 [Mton/Year] =	Negative when a project reduces the whole quantity of CO2 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

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