Project #5 – ALGERIA – TUNISIA - LYBIA

Description

The interconnection between Algeria and Tunisia was firstly implemented in the 1950s and there are currently five interconnection lines between these two countries (two 90kV lines, one 150kV line, one 225kV line and one 400 kV line).

Both electrical systems (Algerian and Tunisian) are operated synchronously with the Continental European System since 1997, following the commissioning of the Morocco – Spain interconnection.

In the 2030 horizon, all 90 kV and 150 kV lines will be decommissioned and the estimated total Net Transfer Capacity of the interconnection between these countries is expected to be 250 MW.

Concerning the interconnection between Tunisia and Libya, it was built in 2005 and comprises three 225 kV lines. It should be noted that these lines are operated as an island system, in order to feed Libyan load from the Tunisian network. Despite the two tests of synchronization performed in the past, the Libyan network has never been synchronized with the Maghreb system and therefore neither with Continental Europe. The current Net Transfer Capacity of the interconnection between Tunisia and Lybia is estimated at 500 MW.

Regarding the new interconnection project between Algeria, Tunisia and Lybia, it will increase the total expected NTC between Algeria and Tunisia with an additional 750 MW and between Tunisia and Libya with an additional 1250 MW.

The project comprises the following infrastructure:

- A second 400 kV interconnection line between FKirina (Algeria) and Kondar (Tunisia) through an AC overhead line with a 1000 MW capacity and total length of around 250 km (80 Km in Algerian side and 170 Km in Tunisian side);
- A 400 kV interconnection between Bouchemma (Tunisia) and Sorman (Libya) through a double-circuit AC overhead line, with a 2*1000 MW capacity and total length of around 2*300 km (2*250 Km in Tunisian side and 2*50 Km in Libyan side)

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 Tunisia	Fkirina - Algeria	Kondar - Tunisia	1000	250	Long-term project	TBD	
New interconnection between Tunisia and Libya	Sorman - Libya	Bouchema - Tunisia	1750	300	Long-term project	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 5
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	X
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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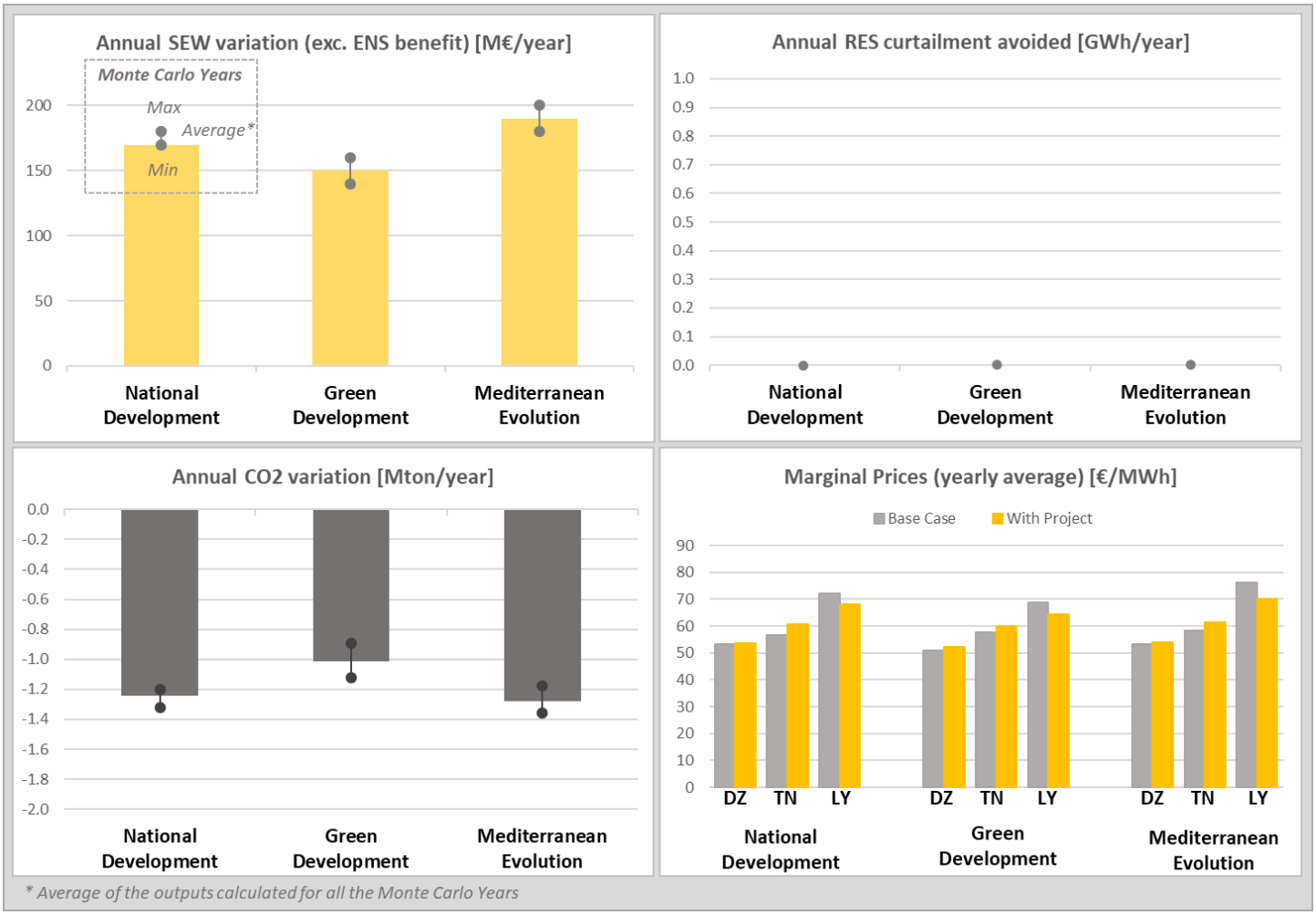
Project assessment analysis

CBA Indicators

Project 5 yields a positive impact in the expected values of the indicators for Social-Economic Welfare and Annual CO2 variation, in all three Scenarios. As for the RES curtailment avoided and Energy not Supplied indicator, the impact of the project is negligible.

It should be highlighted that the cluster of the two projects (Algeria-Tunisia and Libya-Tunisia) drives a greater increase in the SEW variation and a greater decrease in the CO2 variation than the sum of the two individual projects, meaning that the cluster of the two projects together results in synergies in the expected benefit (considering only these two indicators). As for the RES curtailment, a similar conclusion is scenario-dependent.



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

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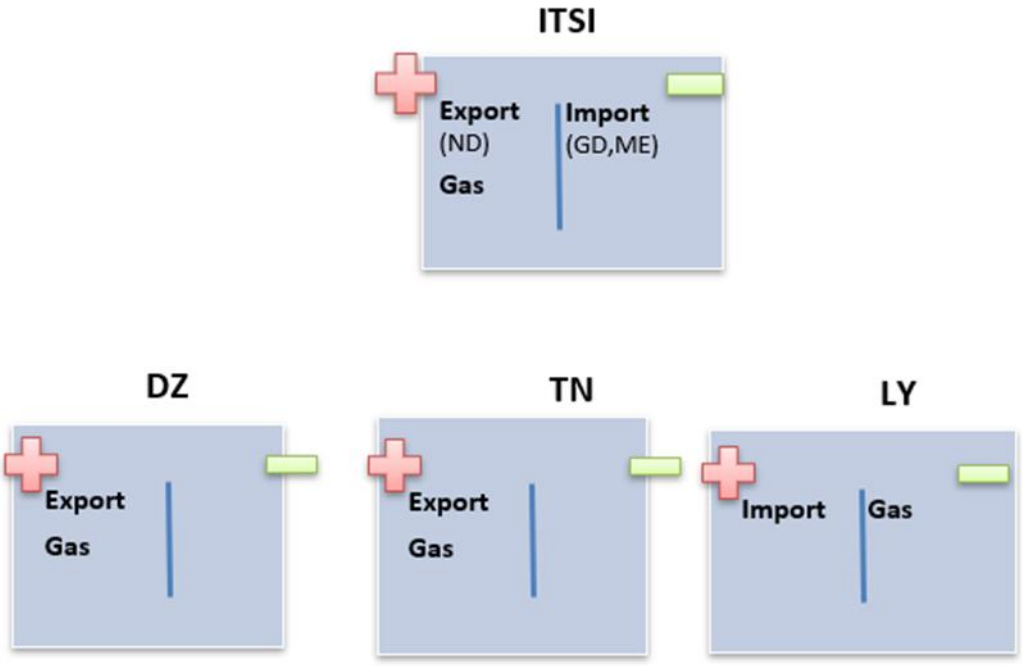
Project assessment analysis

Market Studies

Project 5 drives no major changes in the overall generation mix. However, we see a significant increase in Gas Generation in Algeria, and a more moderate increase in Italy, Morocco and Tunisia, in contrast with a significant decrease in Gas Generation in Libya and, to a lesser extent, in Egypt.

- **Generation mix:**
  - **DZ:** Increase in Gas Generation
  - **TN:** Increase in Gas Generation
  - **LY:** Decrease in Gas Generation
  - **IT:** Increase in Gas Generation
  - **MA:** Increase in Gas Generation
  - **EG:** Decrease in Gas Generation

Country balance and cross-country power flows: the flows observed in this new interconnections are mostly from Algeria to Tunisia and from Tunisia to Libya. Additionally, we see a decrease in Algeria's exports to Morocco (or an increase in Algeria's imports from Morocco, depending on the Scenario), an increase in the exports from Sicily (Italy) to Tunisia, and a decrease in the exports from Egypt to Libya. Furthermore, it should be noted that due to the projects, Algeria and Tunisia become net exporters in the three simulated Scenarios, whereas in the base case this were scenario-dependent. In this case, Tunisia plays the role of a transit system, as a significant part of the energy imported from Algeria and Italy is exported to Libya



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Project assessment analysis

The project examines the interconnections of the Tunisian system with the system of Algeria and Libya.

The exiting interconnection between Tunisia and Libya is done through a 220kV line. The new 400kV double circuit will increase the interconnection capacity between these two countries for an additional 1250MW.

The complete model for the system of Libya was not available, hence this country is represented as an external bus bar. However, the systems of Tunisia and Algeria are fully represented and the existing 400kV interconnection will be increased with an additional 400kV AC OHL with a capacity of 750 MW.

The study covered 3 different scenarios and 7 Points in time. The security analysis applied to the 400kV identified the reinforcements for the system of Tunis and the system of Algeria. For the third countries, that are included in the project no internal reinforcements are suggested.

Scenario 1, 2, 3	
Description (Tunisia)	**Description (Algeria)**
New 400kV OHL line between Bouchemma - Skhira	New 400kV OHL line between Ramdane djamel and Berrahal
Upgrade the line between Medenine and PV Labba	
	

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Project assessment analysis

The overall investment cost for this project is estimated to be around 254.5 M€, 20% of which represent investment cost for internal reinforcements. The more detailed breakdown of the cost is presented below.

Investment cost-Interconnection	
Lines	***Cost [M€]****
AC line Tunisia	80
AC line Libya	40
Line bay Tunisia	3
Line bay Libya	3
AC line Tunisia	50
AC line Algeria	20
Line bay Tunisia	2
Line bay Algeria	2
line reactor Tunisia	1
line reactor Libya	1
line reactor Algeria	0.5
TOTAL	**203**

Investment cost –internal reinforcements	
Lines (Tunisia)	***Cost [M€]****
400kV OHL Bounchemma-Skhira	30
225kV OHL Medenine-PV Labba	2
Lines (Algeria)	
400kV OHL Ramdane Djamel-Berrahal	20
TOTAL	**52**

*Rounded values

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Project cost benefit analysis results

Assessment results for the Project #5: Algeria - Tunisia - Libya											
GTC increase direction 1 (MW)			DZ-TN: 1000; LY-TN: 1750								
GTC increase direction 2 (MW)			DZ-TN: 1000; LY-TN: 1750								
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	2000	750	1250	2000	750	1250	2000	750
		TN	1350	3350	2000	1350	3350	2000	1350	3350	2000
		LY	680	1930	1250	680	1930	1250	680	1930	1250
GTC/NTC - Export		DZ	1250	2000	750	1250	2000	750	1250	2000	750
		TN	1350	3350	2000	1350	3350	2000	1350	3350	2000
		LY	680	1930	1250	680	1930	1250	680	1930	1250
Interconnection Rate - Import/Export (%) [1]		DZ	3.5% / 3.5%	5.6% / 5.6%	2.1%	3.4% / 3.4%	5.4% / 5.4%	2.0%	2.9% / 2.9%	4.7% / 4.7%	1.7%
		TN	16.5% / 16.5%	40.9% / 40.9%	24.4%	14.0% / 14.0%	34.8% / 34.8%	20.8%	13.0% / 13.0%	32.1% / 32.1%	19.2%
		LY	3.5% / 3.5%	9.8% / 9.8%	6.4%	3.1% / 3.1%	8.9% / 8.9%	5.8%	3.1% / 3.1%	8.9% / 8.9%	5.8%
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)	170	170	180	150	140	160	190	180	200
	B2 - RES Integration[3]	(GWh/y)	0	0	0	0	0	0	0	0	0
	B3 - CO2	(Mton/y)	-1.2	-1.3	-1.2	-1.0	-1.1	-0.9	-1.3	-1.4	-1.2
	B4 - Losses[2]	(M€/y)	50			60			40		
		(GWh/y)	700			880			780		
	B5a - SoS Adequacy[4]	(GWh/y)	0.2	0.0	2.6	0.0	0.0	0.0	0.9	0.0	7.2
		(M€/y)	0	0	8	0	0	0	3	0	22
	B5b - SoS System Stability										
Residual Impact Indicators	S1 - Environmental Impact										
	S2 - Social Impact										
	S3 - Other Impact										
Costs	C1 - Estimated Cost[5]	(M€)	255								

[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
neutral impact
positive impact
Not Available/Not Applicable
monetized