The Mediterranean Master Plan

Consolidating a Secure and Sustainable Electricity Infrastructure in the Mediterranean Region

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SUMMARY

This paper, presented on behalf of TC1 Planning and WG Economic Studies and Scenarios of Med-TSO, has been developed within the framework of the "Mediterranean Project", funded by the European Commission (DG NEAR), with the objective to support the assessment of High Voltage electricity transmission projects in the Mediterranean Region.

The Northern and Southern shores of the Mediterranean basin present different characteristics that offer potentialities and complementarities. Countries of both banks have realized these synergies can become key to exchange energy and meet the targets of the energy transition in the next decades.

On the basis of these perspectives, in 2012 a group of Mediterranean electricity companies decided to establish, on a voluntary basis, Med-TSO - the Association of Mediterranean Transmission System Operators, with the objective to set up a technical platform for multilateral cooperation in the Mediterranean electricity sector, aiming at fostering the progressive integration of the Mediterranean Power Systems, by harmonizing rules and procedures for Planning the Transmission Grids and operating the Power Systems.

After a brief introduction to Med-TSO, the paper deals with the Mediterranean Master Plan, delivered by the Association as a result of an intensive cooperation among the Members, and, in particular, through the very collaborative work carried out in the frame of Med-TSO's Technical Committee 1 "Planning" (TC1[5]) and Working Group "Economic Studies and Scenarios" (WG ESS). The Master Plan will have a key role for consolidating a secure and sustainable electricity infrastructure with a focus on interconnections and integration of renewables in the Mediterranean Region.

The paper underlines the process that has been agreed among Med-TSO Members to harmonize gradually the grid planning practices between Med-TSO and ENTSO-E.

KEYWORDS

Renewables, interconnections, reference scenarios, Med-TSO, grid models, market studies, network studies.

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1. INTRODUCTION

The integration of the Euro-Mediterranean Region has to be seen no longer an opportunity, but an unavoidable requirement to bring the two shores of the Mediterranean closer and thereby tackle the shortcomings together, especially considering the current phase of instability.

The social and work-related problems are severe on both shores, and the development of infrastructures (energy, water, transport) is the key to a new progress path, based on employment, job creation and innovation. In this respect, energy plays a vital role for the security and the development of the Mediterranean countries.

Adequate, integrated and efficient electricity infrastructures, through the shared use of energy, pave the way towards the achievement of development and security goals in the Mediterranean Region. In this context, a global approach, involving all the countries in the region is crucial. This is possible through the promotion of multilateral cooperation, following a "bottom-up" approach, able to create added value from complementarities between the two shores of the Mediterranean and to provide a global response to the ongoing changes in the Region.

Med-TSO is a voluntary Association of the Mediterranean TSOs[6]. It was established on the 19th of April 2012, in Rome. Initially composed of electricity companies from 15 countries of the Mediterranean (Fig. 1), it counts now 20 members from 18 countriesas shown in Figure 1 below.

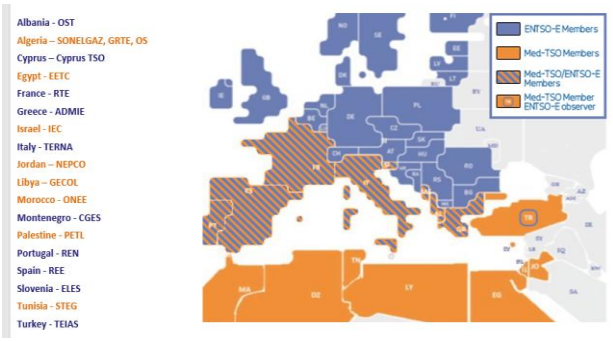

Figure 1. Med-TSO Members

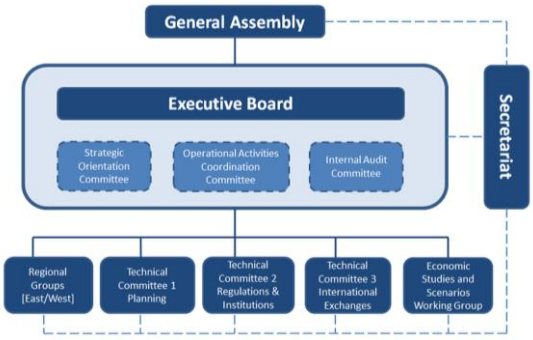

Figure 2. Med-TSO Organisation.

The activities of Med-TSO are performed through the contribution of the Members within the technical bodies (committees and working groups). The work is set on the basis of geographical or thematic issues (i.e. technical, regulatory, economic and financial issues) dealing with the following lines of activities of a TSO: Planning, Operation, Electricity Exchanges (Figure 2).

Med-TSO proposed to the European Commission to set up a cooperation platform for identifying and analysing potential HV electricity infrastructure projects. A trilateral Memorandum of Understanding with the European Commission and MEDREG[7], was signed in Rome in November 2014. With this cooperation framework the EC recognized Med-TSO as a "long term partner of the EC", acknowledging the proposed Med-TSO platform as an efficient instrument for cooperation.

At the beginning of 2015, Med-TSO launched the Mediterranean Project, a three-year lasting action, funded by the EC (Grant Contract ENI/2014/347-006), aimed at supporting the harmonization of methods and practices in the Mediterranean Region, organized according to the following five main

[6] Transmission System Operators: operators of the electricity grid, whose essential function is to ensure the balance between demand and supply of electricity on the grid, either in real time or in the medium to long term, managing network resources (generation plants and transmission) in accordance with the rules and models of the market.

[7] The association of the Mediterranean Energy Regulators: www.medreg-regulators.org

streams of activities: regulation, infrastructure, International Electricity Exchanges, Knowledge Network and Med-TSO Database.

The Mediterranean Project has been completed successfully at the beginning of 2018. Med-TSO intends to continue, consolidate and improve the activities carried out to date in a sustainable and enduring way.

2. THE MEDITERRANEAN MASTER PLAN

The "Master Plan of the Mediterranean Electricity Interconnections" (Master Plan) is a long term HV Electricity Network Development Plan at the time horizon 2030, addressing a set of common Coordinated Planning Methodology and Procedures. It is based on a number of realistic reference energy scenarios, build on market and grid models, with performed market and network studies. It identifies the main system development needs all over the Mediterranean and within sub-regions and it defines potential development projects according to reference interconnection capacities, and the future reference grid according to the market studies results.

The main objective of the Master Plan is to demonstrate that exchanging energy is beneficial to both shores of the Mediterranean Region. This is a concrete sign of cooperation amongst the countries as well.

The Mediterranean Master Plan identifies 14 clusters of cross border interconnections, for a total of more than 18,000 MW of transfer capacity at the time horizon 2030.

Market and Network Analyses assess the feasibility and the standard costs of the clusters. All the studies are undertaken according to a methodology that takes into account potential uncertainties through four scenarios driven by several variable factors, such as level of RES integration, economic parameters, etc. This approach is fully in line with scenarios and practices adopted at a European level by ENTSO-E in its Ten-Year Network Development Plan (TYNDP) 2016.

2.1. Methodology

The general process used by Med-TSO for coordinated planning [1] is summarised below based on shared rules for their planning and operation amongst members.

As a first step towards this goal, a "Methodology for the Long term Network development Plan" [2] includes the following main actions:

1. Definition of regional scenarios based on National Development Plans
2. Creating reference models of power system at regional level to perform market simulations
3. Analysing the network behaviour (load flow calculations) and the investments needed to fulfil the security requirements
4. Performing the first part of the Cost Benefits Analysis (CBA) for the new investments.

A short description of each of the above steps is provided in this paper.

The delivery of this Master Plan requires exploring the following aspects:

- the current regulatory status of the electricity sectors in the participating Countries;
- the issue of new interconnections and cross-border exchanges in terms of infrastructure's development. In that respect, the Regional Working Groups (RWGs) started from existing developments and studies, exploring uncertainties encountered by the TSO Members, and outlined common steps aiming at facilitating the development of the new facilities;
- the opportunities and necessities for further integration from technical and economic perspectives, starting from the assessment of the current status and expected evolution of electricity markets and regulation sector in the Mediterranean region.

Furthermore, the RWGs have been committed to set-up reports containing:

- the present and the future interconnection's infrastructure;

- the needs from the technical, economic, and financial perspectives, to reach the final goal of the establishment of the target exchanges among the Countries and a regional integrated electricity market;
- the list of the most relevant reinforcement projects that are required for the development of an integrated, reliable and efficient network in the region.

2.2. Med-TSO 2030 Reference Scenarios

Med-TSO Reference Scenarios explore 4 possible future situations of load and generation in 2030. These scenarios are the baseline on which the interconnection projects of the Mediterranean Master Plan are assessed.

. Scenarios take int consideration the trends that will affect the power systems of the two banks.The Northern bank is engaged in ambitious decarbonisation targets and market integration within a general stagnation of the electricity demand. The Southern bank is characterized by large potential of renewable generation and by a fairly high rate of growth of the demand, supported by concrete examples of plans and deployment of RES. While the market is still in evolution.

This activity [4] has been performed within the Working Group Economic Studies and Scenario. Since end-2015 and 2016, the work was mainly focus on defining the scenarios, performing the data collection and running of the Market Model. The scenarios have been updated in 2017, taking into account several new national Energy Plan following the COP21 involvements. The assessment of all Mediterranean Master Plan projects is done based on a Cost-Benefit Analysis (CBA) methodology, performed during 2017.

The aim of those Med-TSO 2030 scenarios is to build the path from now to several possible futures (trends on load and Generation) to give a robust framework for Grid development studies. The Euro-Mediterranean Region is characterized by wide contrasts and complementarity in terms of load growth and of Renewable Energy Development [5]. It results a considerable level of uncertainty regarding the long-term load forecast in the countries where growth rate remains significantly positive. Moreover, many areas show a very good potential in terms of wind or insulation that could offer opportunity of a massive RES development.

In this context of uncertainty, a set of four long-term Med-TSO 2030 Scenarios has been built. The aim of the scenario building process was also to ensure a Mediterranean Framework and overall coherency. For that, the first step was to choose commonly a set of drivers (economic, demographic, technology, etc.). Those drivers have been later converted into national parameters by each Member, including the specificities of its own Country. In parallel, the Market Model has been completed to include all non-Med-TSO European countries in coherency with ENTSO-E TYNDP 2016.

The following aspects have been analyzed: the methodology used for scenario definition and data gathering, the storylines for the four scenarios, a brief introduction on the current situation (2015-2016) in the Med-TSO countries, the Macroeconomic Model considered for the studies, the results and the next steps.

Med-TSO scenarios are defined with reference to six sets of drivers: economy and population, renewable energy development; technology development; new load; market integration; thermal carbon free technologies.

In particular four scenarios have been chosen and further developed:

- Scenario 1 – Business as usual
- Scenario 2 – Green Future
- Scenario 3 – High interconnection development
- Scenario 4 – Green Future & Market Integration

2.2.1. Scenario 1 - Business as usual and security of supply improvement

This scenario is a conservative medium scenario (Figure 3). The load consumption increases with the observed trend in each Med-TSO country. The development of new use of electricity is considered at low level and the effort on improving energy efficiency is average.

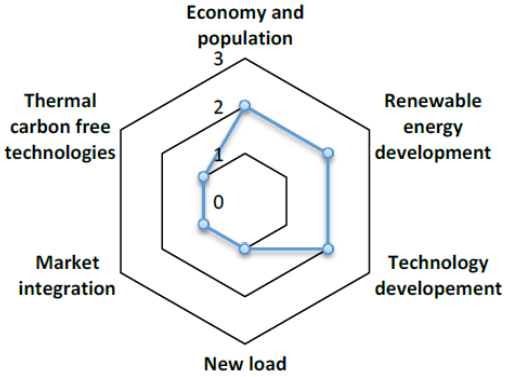

Figure 3 – Scenario 1 - Business as usual and security of supply improvement

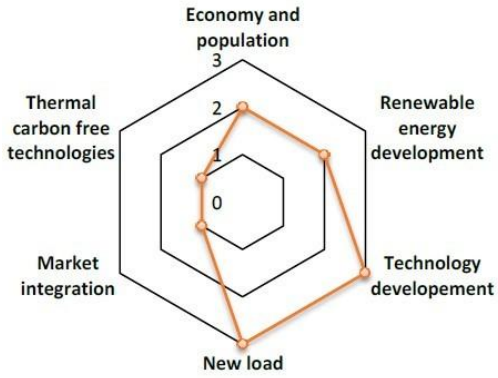

Figure 4 – Scenario 2 - Green future based on gas and on local integration of renewable energies

The hypothesis on the economic environment is one of the partial cash-up phase of global demand in the North (development up to 3%). The development in South and East of Mediterranean is between 4 and 7%.

Energy policy is marked by the continuation of the current trend in each country. The policy of supporting renewable energies is pursued but their growth remains well short of the level seen in other countries like Spain and Italy.

Interconnection and internal grid in the South is based on the improvement of the security of supply.

2.2.2. Scenario 2 - Green future based on gas and on local integration of renewable energies

This scenario is a green scenario based on a bottom-up approach (Figure 4). Each country has decided a common politic tool to integrate RES and minimize climatic changes.

The CO_2 price is high in the whole Euro-Mediterranean Power System. South countries policy is based on an attentive use of primary resources and the development of renewable energy funds with primary resources incomes.

Gas power plants, that represent the higher percentage against total installed capacity, are built in the South for the guaranty of supply and to minimize CO_2 emissions since the price of CO_2 is high enough to have a Merit Order with gas before coal. These gas power plants will have also to be flexible to deal with a new energy mix based on renewable energy.

The load consumption increases higher than the same medium trend in each MED TSO country because of the development of new electricity uses like public transportation.

The hypothesis on the economic environment is one of the partial cash-up phase of global demand in the North. The development in the south and east of Mediterranean is between 3 and 7%.

Interconnection development in the South is based on the improvement of the security of supply and exportation of RES.

2.2.3. Scenario 3 - High economic growth which supports high interconnection development

This scenario assumes that following new primary resources discovered the economy of the Mediterranean area goes up especially in the South (Figure 5). A higher GDP growth could be expected in the South (more than 3%) and a lower growth (less than 3%) for the European countries. South countries decide to develop free carbon thermal power plant to support the electricity demand

and RES development. New interconnections are necessary to share the low cost electricity of this kind of power plants and to share production margins.

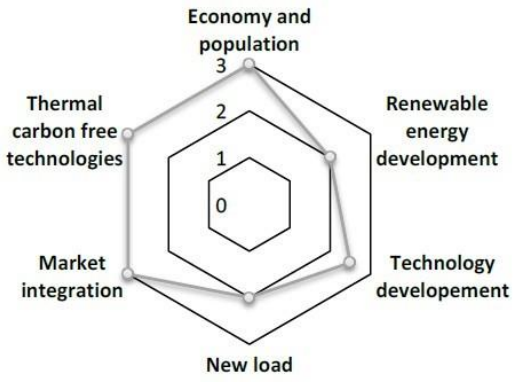

Figure 5 – Scenario 3 - High economic growth which supports high interconnection development

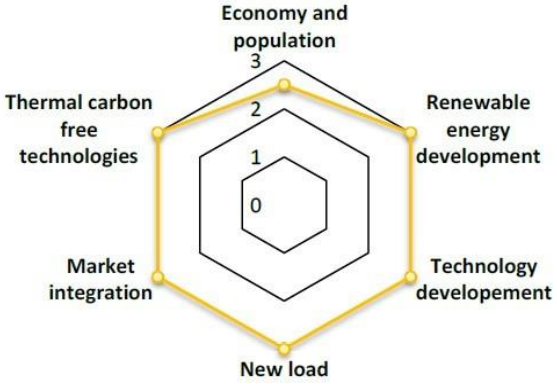

Figure 6 – Scenario 4 - Green future and market integration at an international level

2.2.4. Scenario 4 - Green future and market integration at an international level

This scenario is based on a top-down approach with three issues (Figure 6):

- The CO_2 reduction for electricity production but also for transportation (new electricity uses)
- High technology development for load and generation management especially in the north bank.
- The RES and Nuclear investment in the South to support electricity demand, to limit the consumption of primary resources and to export the surplus of electricity.

This scenario is linked to the necessity to develop high multinational interconnections to support a global electricity market all around the Mediterranean area.

It is important to note that, for all scenarios, the "RES development" driver is always at least equal to 2. Indeed, all the questioned experts consider for their country a “Medium to Strong” evolution of the RES development, and generally in acceleration by comparison with the past trend.

In a global vision, the scenarios can be presented according to several general characteristics: consumption in 2030, development of renewable energies, market Integration and development of interconnection, etc.

2.2.5. How these scenarios are linked to other available scenarios

Power system modeling intends to represent all the interconnected countries. For the Euro-Mediterranean Power system, there is therefore a key issue to retain assumptions for all countries in the perimeter of ENTSO-E for each of the four scenarios. This consistency is facilitated because the scenario building methodology used by Med-TSO is similar to what adopted in ENTSO-E, in particular four visions are introduced to be used for Ten-Year Network Development Plan (TYNDP 2016) calculation: Vision 1: “Slowest progress” ; Vision 2: “Constrained Progress” ; Vision 3: “National Green transition” ; Vision 4: “European Green revolution”.

To have a coherent approach among Members also at the two TSO association level, the economic model for each Med-TSO scenario is coherent with ENTSO-E Visions for European countries when the adopted matching is as shown in the Table 2.

However, the detailed comparison of scenarios 2 and 3 of Med-TSO and ENTSO-E reveals a difference in the use of coal and gas power plants. In fact, Med-TSO has preferred in scenario 2 a control of CO_2 emissions which is based in part on the use of natural gas to the detriment of coal (gas power plants are built in the South for the guaranty of supply and to minimize CO_2 emissions).

For that, Energy and CO_2 price need to be set up to have a Merit Order with gas before coal, that implies a switch of Visions 2 and 3 fuel and CO_2 prices compared to ENTSO-E TYNDP 2016 assumptions. A synthesis is illustrated in Table 1 and Table 2.

IEA Reference Scenario		Current Policies	IEA "450" except coal price IEA "New Policies"	Current Policies	IEA "450" except CO2 price (UK FES High)
Simulation Scenarios		Med-TSO 1	Med-TSO 2	Med-TSO 3	Med-TSO 4
		Vision 1 2030	Vision 3 2030	Vision 2 2030	Vision 4 2030
Fuel prices (€/ net GJ)	Nuclear	0.46	0.46	0.46	0.46
	Lignite	1.1	1.1	1.1	1.1
	Hard coal	3.01	2.8	3.01	2.19
	Gas	9.49	7.23	9.49	7.23
	Light oil	17.34	13.26	17.34	13.26
	Heavy oil	13.7	9.88	13.7	9.88
	Oil shale	2.3	2.3	2.3	2.3
CO_2 prices (€/ton)		17	71	17	76

Table 1 - Fuel price values.

Med-TSO	ENTSO-E TYNDP 2016
Scenario 1 **Business as usual** and security of supply improvement	**Vision 1** **Slowest progress**
Scenario 2 **Green future** based on gas & local integration of renewable energies (& management of the complexity of this kind of grids)	**Vision 2** **Constrained Progress** (CO_2 and fuel price of Vision 3)
Scenario 3 High economic growth which supports high **Interconnection development** and free carbon thermal plants development in the South of the Mediterranean area	**Vision 3** **National Green Transition** (CO_2 and fuel price of Vision 2)
Scenario 4 **Green future and market integration** at an international level	**Vision 4** **European green revolution**

Table 2 - Comparison Med-TSO and ENTSO-E scenarios.

3. THE MARKET ANALYSIS

Description of the activity

Based on the scenarios definition, Med-TSO Working Group Economic Studies and Scenarios (WG ESS) has performed a data collection in order to build a set of four market models. A model is an equivalent bus-bar without the detail of the transmission grid; the models of the load and the generation (thermal power plants, not dispatchable productions such as other non-RES and RES generators, run of river units and hydro pumping power plants, wind farms and photovoltaic power plants) are specified.

Every country has a defined Bilateral Transfer Capacities (BTC) with interconnected neighboring countries that helps to guarantee the security of the electricity supply power system and allows economic exchanges of electricity. Med-TSO BTCs for year 2030 have been addressed by Med-TSO members, while TYNDP 2016 public data have been used for ENTSO-E countries.

The study is accomplished through the application of a Monte Carlo simulation model on a Mediterranean/European wide basis. The Market Studies software tool carries out an optimal coordinated hydrothermal scheduling of the modelled electric system generation set, over a period of one year. The simulation tool implements a day-ahead energy market, characterized by a system marginal cost and by a congestion management based on a zonal market-splitting.

Med-TSO WG ESS considered appropriate to split the process into two rounds, following an incremental process. The objective of this approach is to validate the assumptions of the Market Model on the basis of provisional results. A consistency check has been carried out at the end of the first round for updating the consumption and production assumptions based on the most recent information, in particular to take into account the latest developments in national environment policies and development of renewable energies.

This consistency check is also intended to revise the list of projects between countries. This control validated that all projects considered in the first round were useful in terms of exchange. But this control also showed that some interconnections had a high saturation rate even though no project had been initially selected. The list of Projects to be assessed has been improved in order to cover those interconnections.

The analysis performed in the second round included additional clusters studied and a total number of simulation increased from the initial 40 (10 clusters for the 4 scenarios) to a total of 54 including 3 more clusters studied (green in Figure 3 below) and the analysis of the additional 600 MW of capacity for the interconnection between Italy and Tunisia.

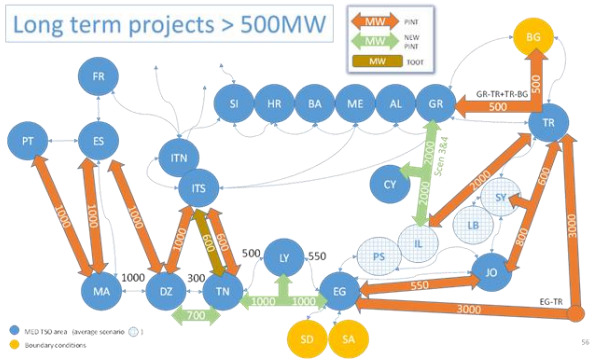

Figure 7. Clusters studied.

No.	Interconnection Project / Cluster
1	Cluster MA-PT (Morocco - Portugal)
2	Cluster MA-ES (Morocco - Spain)
3	Cluster DZ-ES (Algeria - Spain)
4	Cluster DZ-TN (Algeria - Tunisia)
5	Cluster DZ-IT (Algeria - Italy)
6	Cluster TN-IT 1 (Tunisia – Italy 1)
7	Cluster TN-IT 2 (Tunisia – Italy 2)
8	Cluster TN-LY-EG (Tunisia - Libya - Egypt)
9	Cluster GR-TR-BG (Greece-Turkey-Bulgaria)
10	Cluster GR-CY-IS (Greece- Cyprus -Israel)
11	Cluster TR-EY (Turkey - Egypt)
12	Cluster TR-IS (Turkey - Israel)
13	Cluster EY-JO (Egypt - Jordan)
14	Cluster JO-SY-TR (Jordan - Syria - Turkey)

Table 3. List of Projects / Clusters selected.

The analysis has been complemented together with the original clusters in the second iteration (Round B), using the same level of details.

For each project and each scenario, the market model calculates several annual indicators e.g.: the variation of Expected Energy not supply, the variation of CO_2 emissions and RES curtailment, required to perform the CBA assessment.

WG ESS has further performed data formatting and analyzing activities to provide TC1 several sets of detailed study case for network studies, selected to ensure the statistical representativeness of the situations.

4. NETWORK PROJECTS

For the purpose of the Network analysis the14 projects (clusters) that resulted from the second round of market studies have been distributed among three corridors, Western, Central and Eastern, as indicated in Table 3.

These 14 projects been studied both for interconnections and internal reinforcements. All projects have been assessed according to the Med-TSO Cost and Benefit Analysis (CBA), once costs of assets and losses associated to each of them have been computed.

4.1. Project Italy – Tunisia: an example of Interconnection Project

The project is analyzed in two steps (clusters): first interconnection - Cluster TN-IT 1 (600 MW) and the second interconnection - Cluster TN-IT 2 reinforcing the first one with 600 MW additional interconnection capacity.

Cluster TN-IT 1 - The project consists in an interconnection between Tunisia and Italy to be realized through an HVDC submarine cable (Fig. 8). The project is supported by the Italian and Tunisian Governments. The project will contribute to reducing present and future limitations to the power exchanges on the northern Italian border under specific conditions, and therefore it will allow to increase significantly the transmission capacity and its exploitation by at least 500 MW on that boundary.

The Italy – Tunisia project consists mainly of a 600 MW 400-500 kV HVDC submarine cable of about 200 km (sea depth around 750 m) between the Cap Bon peninsula (Tunisia) and Sicily (Italia). This Project is promoted by the two national TSOs STEG and TERNA in the framework of the studies carried out by Med-TSO within the Mediterranean Project I.

Based on the recent pre-feasibility study, the connection nodes have been preliminary fixed at:

- On the Tunisian side: the new 400 kV substation in the area of Cap Bon; at the 400 kV existing electrical substation of Mornaguia. The converter station shall be located in the peninsula area of Cap Bon and n.2 new 400kV OVHL will be necessary to link the new substation with the existing electrical 400 kV internal grid. The need of other synchronous compensator in the area of Cap Bon needs to be evaluated and is depending on the technology of the converter station.

– On the Italian side: at the 220 kV bus-bar of the existing electrical substation of Partanna in Sicily. The converter station shall be located in an area close to this substation.

The new 380 kV double circuit line Chiaramonte Gulfi - Ciminna (currently under permitting), further local reinforcements of the existing high voltage grid and the installation of any synchronous compensator in Sicily (still under evaluation) should be the necessary internal reinforcements. The project implementation is under feasibility study phase: (Terrestrial and Marine Survey Study and Environmental and Social Impact Study).

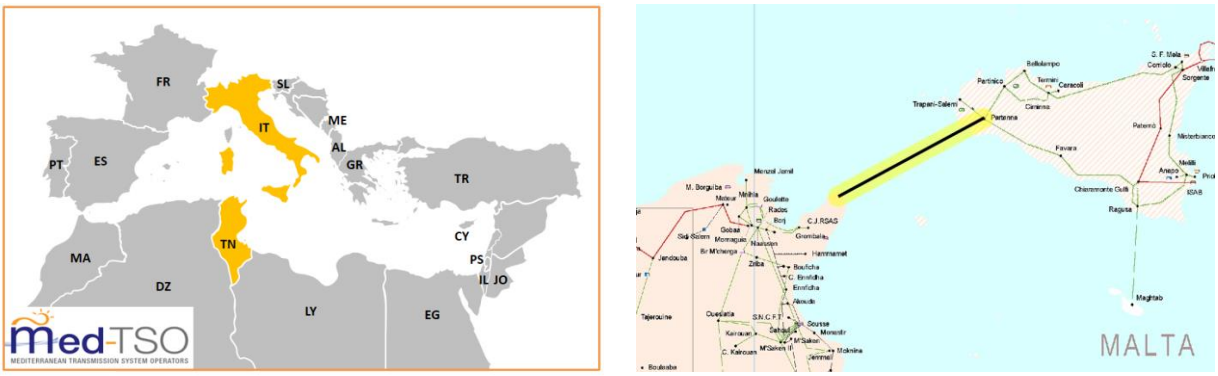

Figure 8. Interconnection Project Italy – Tunisia.

Cluster TN-IT 2 - The project involves the reinforcement of the first interconnection (600 MW) between Tunisia and Sicily to be realized through an HVDC submarine cable and the reinforcement of the substation of Partanna. The project may contribute to reduce present and future limitations to the power exchanges on the northern Italian border under specific conditions, and therefore it may allow increasing significantly the transmission capacity and its exploitation by on that boundary.

4.2. CBA Methodology

The CBA methodology [6],[7] described in this chapter has been developed by Med-TSO as adaptation of the same proposal submitted to ACER by ENTSO-E in July 2016 and compliant with the Regulation (EU) 347/2013 for trans-European energy infrastructure. It sets out the Med-TSO criteria for the assessment of costs and benefits of a transmission project, all of which stem from ENTSO-E practice based on European policies on market integration, security of supply and sustainability.

The goal of project assessment is to characterize the impact of transmission projects, both in terms of added value for society (increase of capacity for exchanges of energy and balancing services between market areas, RES integration, increased security of supply) as well as in terms of costs. In order to ensure a full assessment of all transmission benefits, some of the indicators are monetized, while others are quantified in their typical physical units (such as tons of CO_2 or GWh). A general overview of the indicators used for project assessment is included in the Figure 9 below.

This set of common indicators forms a complete and solid basis for project assessment across the Mediterranean area within the scope of the Mediterranean Project. The multi-criteria approach highlights the characteristics of a project and gives sufficient information to the decision makers.

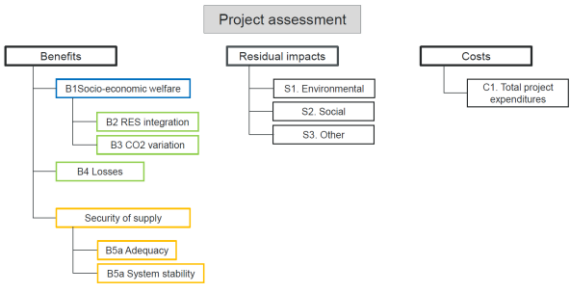

Figure 9. The main categories of the project assessment methodology.

5. NEXT STEPS

Med-TSO has successfully concluded the "Mediterranean Project I" and is fully committed to continue on the way of the harmonization and consolidation of a more and more secure and electricity infrastructure in the Mediterranean Region in the spirit of its mission. A new project called "Mediterranean Project II" [8] is developed in the frame of the initiatives aimed at reducing the cost and the environmental footprint of electricity in the Mediterranean region and in the connected neighbouring regions. It pursues the specific objectives described in the next paragraphs. All these initiatives have as beneficiaries the final customers/citizens and the planet, in the context of climate change and economical and societal development.

As a project proposed by the regional association of the TSOs and, therefore, from the TSOs' perspective, the overall objective of the Action is to promote the progressive integration and interconnection of Power Systems and the enhancement of cross-border electricity exchanges in the Mediterranean region. In fact, this overall objective would allow to:

5.1. Specific objectives

The overall objective of the new project is expected to be achieved through the coordination of both national development plans, operation and rules to access the grids. Therefore, the first specific objective of this proposal is to build up on the results of the "Mediterranean Project", continuing in setting up common standards and rules and facilitating the integration of the Mediterranean Power Systems, with a special attention to cross-border sub-regional and neighborhood-wide cooperation. The Action is also aimed at consolidating the network among Med-TSO Associates for exchanging knowledge and experiences, as well as improving the common Mediterranean database for sharing data and information to facilitate, therefore, the undertaking of regional studies.

Furthermore, Med-TSO has identified the need for strengthening the TSOs' cooperation in both system operation and system development. This is necessary, in particular, for facing the expected growth of RES, facilitated by the current decrease of their installation cost. The Mediterranean Region has been identified as one of the most sensitive regions to climate change in the world. The entry into force of the Paris Agreement at COP22 is an important signal with direct impact on the roadmaps for renewables integration, based on now-binding targets, with the new EU-wide target of a 35% clean energy share by 2030. The increased volatile flows that the TSOs need to control call for a reinforced cooperation within the interconnected power systems.

The already mentioned overall system efficiency to be gained through the integration of the transmission grids calls for additional key specific objectives to be achieved with the multilateral cooperation proposed in the Action. Assessing the use of innovative technologies in new projects and exchange of know-how can contribute to this objective, as well as defining the conditions for sharing resources (power generation), because they can determine significant cost reductions and more limited risk of investments in infrastructures. In addition, the possibility to combine and operate power systems that have complementarity of load profiles and generation mix in a more integrated way is another benefit highlighted by the Action, with direct impact on increasing the energy efficiency.

In order to support such increased cooperation, there is a strong need to address new activities for harmonizing the rules and integrating the systems, as proposed by Med-TSO. In continuity with the organization of the previous Mediterranean Project, Med-TSO proposes a new Action structured along the following activity streams: Planning of infrastructures; Regulation & Power System Rules; Scenarios Adequacy and Market Studies; Grid development & Market integration; Operation of Power Systems; Training and Knowledge sharing.

5.2. Key Expected Results

The key expected results are:

5.2.1. Planning of infrastructures

An integrated package of activities is developed in the frame of the Action, aimed at delivering a periodical Mediterranean Network Development Plans (MNDP);

5.2.2. Regulation & Power System Rules

The relevant activities measure the progress in the harmonization of regulation in the Mediterranean region for power system rules (in the perimeter of the network codes). This includes a "zonal approach", with a program for implementing faster at least a subset of rules in some selected zones of the Mediterranean (pilot projects). Expected results are a proposal on harmonization of technical rules in the fields of management and sharing of system services; a Zonal Target Regulatory Framework [9].

5.2.3. Scenarios Adequacy and Market Studies

The Association intends to draw some possible future scenarios for the Mediterranean Power System. To this aim, the following results are expected: a set of mid- and long-term scenarios of the Mediterranean Power System. The Market model is built to apply the CBA methodology for assessing interconnection transmission projects.

As a new activity, a periodic Adequacy Report, including Winter or/and Summer Outlook Reports, to complement a statistical approach by severe scenarios simulations which are useful to prepare the crisis management tools.

5.2.4. Grid development & Market Integration

New complementary activities are foreseen, according to Med-TSO's Action Plan, to cover relevant aspects of the TSO's business: business models for investments in interconnections (taking into account also the benefits in terms of RES integration); grid integration in the Mediterranean and impact on climate change (increased energy efficiency as a result of electricity transmission network integration); allocation of costs and risks for new investments.

5.2.5. Operation

The Action Plan expects to increase the exchange of information related to the operation of the Med-TSO Members' Power Systems. To this aim, the following features should be developed: a Common Web-Platform for TSOs members to gather information on cross-border interconnections; a periodical report on the behavior of the regional electricity system.

5.2.6. Training and Knowledge sharing

Human Resources Management is a priority for the development of a new culture, capable to activate new development processes. To this aim, it is proposed to set up an intensive exchange of expertise, training, workshops and events for knowledge dissemination, both internal and external.

6. FINAL REMARKS

The major impact of the proposed Mediterranean Master Plan and its continuation is related to regional cooperation in the European Neighbourhood, complementing the current national assistance programmes. This will mainly address regional challenges in the electricity sector, promote cooperation amongst TSOs partners and builds bridges with direct impact on the cooperation and social stability in the Mediterranean Region. The new Action Plan encourages South-North and South-South cooperation and promotes dialogue, exchange of views and knowledge sharing, with direct impact on electricity market integration.

Regional cooperation usually involves all the countries in the Southern Neighbourhood, but can also take place at sub-regional level. The Mediterranean Region is not homogenous; therefore, the

proposed sub-regional (zonal) approach may take into account properly the national diversities, promoting faster harmonisation where possible.

In terms of sustainability, one of the main outcomes of the new Action Plan is to define the way to facilitate market development, exchanges and RES integration through optimized and increased electricity exchanges among Med-TSO countries.

The new Action Plan requires multilateral cooperation, between Institutions and Companies, and a strong political will. In fact, Med-TSO's initiative is based on multilateral cooperation as instrument of integration of the Mediterranean Electricity Systems, whose benefits result from the sharing of resources (primary energy sources, power generation, know-how), costs and risks of investments in infrastructure.

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BIBLIOGRAPHY

[1] Med-TSO Mediterranean Project Deliverable Report "The Grid Planning Methodology"

[2] Paving the Way for the Mediterranean Solar Plan ENPI 2010/248-486 Task C: Guidelines for coordinated Planning

[3] Paving the Way for the Mediterranean Solar Plan ENPI 2010/248-486 Task C: National Development Plans 2012-2023

[4] Med-TSO Mediterranean Project Deliverable Report "D2.2.1&2 Med-TSO Scenario 2030 Report"

[5] Med-TSO Mediterranean Project Deliverable Report "D2.2.3 Theoretical economic scheme concerning the integration: Complementarities of the load curves, around the Mediterranean and within sub-regional groupings"

[6] Med-TSO Mediterranean Project Deliverable Report "D2.2.4 Description of Cost Benefit Analysis Methodology for transmission project assessment"

[7] Med-TSO Mediterranean Project Deliverable Report "D3.3 Analysis and application of CBA methodology - criteria and assessment for interconnections cases studies"

[8] Med-TSO Mediterranean Project II Proposal

[9] Med-TSO TC1 CIGRE 2018 Paper "Towards a Common Target Regulatory Framework. Harmonising Technical Rules for the Mediterranean Power Systems from a TSO perspective".