Med-TSO
MEDITERRANEAN TRANSMISSION SYSTEM OPERATORS

CONSOLIDATING A SECURE AND SUSTAINABLE ELECTRICITY INFRASTRUCTURE IN THE MEDITERRANEAN REGION

THE MEDITERRANEAN PROJECT

Med-TSO is supported by the European Union

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The photo in the cover is the winner of the contest promoted by Med-TSO to all the employees of the TSOs members of the Association.
The title of the contest was "Mediterranean bridge: a new perspective in the Energy transition between countries".
The winning photo is "THE VIEW OF ENERGY", author Niki Manthati from ADMIE (Greece)

Energy integration in the Euro-Mediterranean Region is no longer an opportunity, but an unavoidable requirement to bring the two shores of the Mediterranean sea closer. The development of infrastructures (energy, water and transport) is key for a new progress path, based on employment, job creation and innovation. In this respect, energy plays a vital role for the security and the sustainable development of the Mediterranean countries.

The past three years have been really challenging for the Mediterranean TSO, who moved from endless reflections and debates on future interconnection developments, grid balancing and integration of renewable sources to this Mediterranean Project, a set of concrete deliverables that represents an effective contribution for changing European, Northern African and Middle Eastern Power Systems.

Competence, knowledge sharing and process leadership have been put into play by our Association. All the Members have invested their time to understand each other, appreciate differences amongst them and implement a coordinated way of working.

The outcomes of our Mediterranean Project are all based on the following principles: strengthening cooperation to promote the integration of the regional Power Systems, enhancing the efficiency of the existing interconnections and promoting new ones, always focusing on improving security of supply while guaranteeing a sustainable development.

I want to thank all the people who have supported this successful agenda with their strong commitment and contributed to find out how to empower grid interoperability and improve the mutual technical - but also cultural - knowledge.

From the past three years, I see how much we have learnt from each other and now I can see how much we can grow even more.

Today, we present and share our results, with the perspective to continue building up the power bridge between the two shores of the Mediterranean Sea, as together we could be stronger and improve a sustainable life style for all of us.

To achieve this objective, we need, all of us need, to accelerate the process for designing shared regulations and rules, as well as for integrating the grids of our countries.

This is our future and we must commit ourselves to guarantee it safe and with equal opportunities for all our countries.

Moncef Harrabi
President of Med-TSO

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.

When launching the Mediterranean Project, three years ago, the first challenging objective was to demonstrate the possibility to implement a cooperative and supportive working model in one of the most complicated regions in the world.

Since then, a great deal of water has passed under the bridge and, looking at the concrete achievements gained through the Mediterranean project, I believe we can be fully satisfied.

During these years, Med-TSO has put in place a process aiming at harmonizing gradually many processes and procedures in the Mediterranean region, encompassing a wide range of actions.

The Mediterranean Master Plan, as a result of the intensive cooperation among the Members, is the first example of a coordinated development plan of electricity infrastructures in the Region, bottom-up driven by the Companies in charge of managing the Power Systems of 18 countries around the shores of the Mediterranean Sea.

A path for implementing a common framework of technical rules and procedures to manage and operate the system has been defined, and the roadmap for its effective implementation has been agreed by the TSOs.

The positive effects of interconnections in terms of security of supply and RES integration have been assessed, also in the perspective of sharing balancing services and optimizing the operation of the Power System.

A common database has been put in place, owned and managed by the Association on behalf of the Members, to be the basis for the launch of further initiatives in the Region.

Knowledge sharing initiatives have been launched to promote the dissemination of the Mediterranean Project results and establish a common view on the integration of the Regional Power Sector

However, we do not want to stop here. Based on the outcomes of the Mediterranean Project, a new Action Plan is ready to start. Again, even more, it requires multilateral cooperation and a strong involvement of Institutions and stakeholders.

The objective is not to demonstrate the feasibility of regional multilateral cooperation – we have already proved it – but to give concrete answers to sustainable development, security of supply and markets integration, the challenges that Europe, Northern Africa and Middle East have to face in the next years.

Angelo Ferrante
Secretary General of Med-TSO

Photo contest: “Mediterranean bridge: a new perspective in the Energy transition between countries”.
Second placed photo: “AMANECIENDO (sunrising)” - author Mikel Zabala from REE (Spain)

TABLE OF CONTENTS

1 Executive Summary 7

2 Introduction 9

3 The Mediterranean Master Plan 13

4 A common Set of Rules for the Mediterranean Power System and Transmission Grid Code 29

5 International Electricity Exchanges 35

6 Med-TSO Data Base (DBMED) 41

7 The Grid Map 43

8 Knowledge Sharing 45

9 Next Steps 47

10 Acknowledgements 49

EXECUTIVE SUMMARY

This publication describes the 3-year activity outcomes of the Mediterranean Project developed by Med-TSO, the Association of the Mediterranean TSOs for electricity. It is the result of a very intensive cooperation among the Members performed through the collaborative work carried out in the frame of the Technical Committees of the Association.

The Mediterranean Project encompasses a wide range of actions about: a) the development of a reference Euro Mediterranean Grid and the development of a Mediterranean Master plan; b) the definition of a set of rules for a regional Grid Code; c) the optimization of the international electricity exchanges; d) the creation of a Mediterranean data base; e) the implementation of a knowledge sharing program; and f) the adoption of proper visibility initiatives.

These 3 years of activity have concluded positively with important results to be kept alive for the future.

THE MEDITERRANEAN MASTER PLAN

The Mediterranean Master Plan plays a key role for consolidating a secure and sustainable electricity infrastructure through the development of interconnections, while facilitating the integration of Renewable Energy Sources (RES) in the Mediterranean Region. Fourteen interconnection projects have been identified and assessed (9 of them supposed to be deployed in HVDC technology), according to the different energy scenarios elaborated at the year horizon 2030 (target year). Seven of these projects link countries never interconnected before and, in addition, one of the outcomes is the end of the isolation of Cyprus.

In concrete terms, the Master Plan shows:

- almost **18 000 MW of new interconnection capacity**;
- **limited needs of reinforcements** (2 200 km of new lines, 840 km of reconductoring and less than 40 new bays and transformers);
- about **16 000 MEUR** of additional investments.

Costs of projects (with their relevant grid reinforcements needed to guarantee harmonized security) are considered for applying a **Cost-Benefit Analysis (CBA)**, whose methodology is derived by that elaborated at European level by ENTSO-E[1].

Finally, the concept of **Reference Grid** finds a visual representation in a map developed in cooperation with ENTSO-E, showing the current 400 and 220 kV transmission grids of the Med-TSO area.

A COMMON SET OF RULES (MEDITERRANEAN GRID CODE)

Med-TSO has developed a shared set of technical rules and procedures as the basis for a future Mediterranean Grid Code. With pragmatism and unprecedented spirit of cooperation, a systematic investigation on the state of regulation in the TSOs has been carried out. 135 items have been identified worth of discussion and 36 aspects worth harmonizing, spread into four areas (legal, connection, operation and market). After thorough discussion, 66 items and 24 aspects have been considered of highest priority. A comprehensive analysis is therefore available and priorities have been envisaged. A road map has been agreed in three steps: short, medium and long term.

1 ENTSO-E is the European Network of Transmission System Operators, representing 43 electricity TSOs from 36 countries across Europe, established and given legal mandates by the EU's Third Package for the Internal Energy Market in 2009.

INTERNATIONAL ELECTRICITY EXCHANGES

First result of this stream of activities is the assessment of the potential development of regional cross border exchanges. Starting from a questionnaire of about 100 topics, the appraisal has shown a certain heterogeneity between North and South. In the Southern bank, NTC is used mainly for security and room for market exists. Differences are also identified in the capacity allocation process, as well as in the availability of published data. A certain alignment, instead, is found in the technical way to operate the systems (e.g. N-1 security criteria).

The outcomes of a second enquiry are available on sharing services among TSOs in a RES integration perspective. Based on 180 questions for six thematic areas, conclusions show significant differences between North and South. Sharing services is possible but bilateral agreements prevail on market rules.

THE MEDITERRANEAN DATA BASE

A data base for the Mediterranean power systems (DBMED) has been developed and is now available. DBMED has been specified, designed and deployed to cover the needs of historical data, network and market studies. DBMED is developed as a web-based tool with a dedicated server for storing and exchanging data. It operates on a multi-user platform, considering possible different authorization levels and ensuring safe access to DBMED information stored and exchanged by Med-TSO Members.

KNOWLEDGE SHARING AND VISIBILITY

Several workshop have been organized for sharing the experience and disseminating the results of the Mediterranean Project. In addition, a series of topics, to be covered by additional training courses, have been envisaged. Among them, HVDC theory and practice sessions have been scheduled to meet the needs of sharing knowledge about this technology, envisaged to be the most used for crossing the Mediterranean Sea.

Concrete visibility of Med-TSO and of the Mediterranean Project activities has been reached by participating in various events and by inviting the prominent stakeholders at Med-TSO events.

Med-TSO Association is fully committed to consolidate the activities performed in the frame of the Mediterranean Project by launching another Action, also in this case supported by the European Commission, aimed at strengthening and integrating the Mediterranean electricity systems, in line with the objectives of EU's Neighbourhood policy on Energy and Climate Change.

The key expected objectives of the proposed new Action are:

- Consolidating the Planning process, by updating and improving the Mediterranean Master Plan;
- Continuing the harmonization of regulation and technical rules in the Mediterranean region;
- Elaborating Adequacy reports and Market Studies;
- Starting cooperation in the Operation area, setting up a Common Web-Platform for gathering information and drafting periodical reports;
- Launch an intensive exchange of expertise between the Members of the Association and towards both the main stakeholders in the region.

INTRODUCTION

The creation of security, stability and prosperity, shared at a regional level, represents a common objective of the Mediterranean countries. This objective can be pursued only through a global approach, therefore including all the countries and factors that determine it. This is possible through the promotion of multilateral cooperation, following a "bottom-up" approach, able to exploit complementarities and provide a global response to the ongoing changes in the Mediterranean. Harmonization and synchronization of processes is considered a key factor of success.

THE MEDITERRANEAN CONTEXT

The Euro-Mediterranean Region is a community of about a billion people, whose integration is no longer just an opportunity, but an unavoidable requirement: to ensure a common future, safer and healthier for all populations of the Southern as well as the Northern shore, and especially for the next generations. Due to the awareness that security objectives, sharing of prosperity, stability and civil cohabitation can be pursued only through a joint effort, many Mediterranean countries have demonstrated willingness for multilateral cooperation.

At the same time, in Europe, the symptoms of a crisis have deepened, which no longer has just financial traits but is also characterized by structural elements. The crisis has several causes that stem from the past, including the social structure changing, because of the progressive ageing of population in the Northern Mediterranean Countries (with related social problems) and the decrease (or stagnation) of consumptions. The Southern shore is affected by phenomena of economic growth, although discontinuous, young population and increasing consumptions.

Energy plays a vital role **for the security** of the Mediterranean countries **and no significant economy progresses can be imagined in modern societies without the support of reliable energy**.

Important ongoing transformations affect the Euro Mediterranean energy scenarios. These are not transitory phenomena, but symptomatic of a current structural change. A tumultuous evolution that, if not governed, can generate unquantifiable risks.

In particular:

- The creation of the gas spot market, resulting from the commercial operation of the so-called shale gas, opens **new and relevant perspectives of supply**, geographically diversified: an **evolution of the competitive scenario**, both in terms of volumes and prices. This perspective boosts a new market, liquid and competitive, of a fuel (gas) until now managed on a bilateral basis through long-term contracts with high rigidities.
- The introduction of renewable energy sources (RES) energy on the market, **at administrated prices and for relevant volumes**, has conditioned the **capacity of the market to remunerate investments** and the **security of the electricity service**, especially on the eve of the unification of the internal European Market (market coupling).
- The contradictory evolution of the energy demand, showing a contraction of the energy demand in the main countries of the Northern shore and the growth in the countries of the Southern shore, limited only by phenomena of instability and uncertainty in most of these countries.

In this situation:

- The **Euro Mediterranean area globally has the resources** (know-how and primary energy sources) to support the regional development.
- The **slackening of constraints and the vaporization of complementarities constitute a must**: integration of energy systems, through converging rules and interconnection infrastructure.
- The **future regional energy scenario will be characterized by gas and RES**, and therefore by a growing demand for flexibility, security and efficiency, which requires new regulation at regional level.

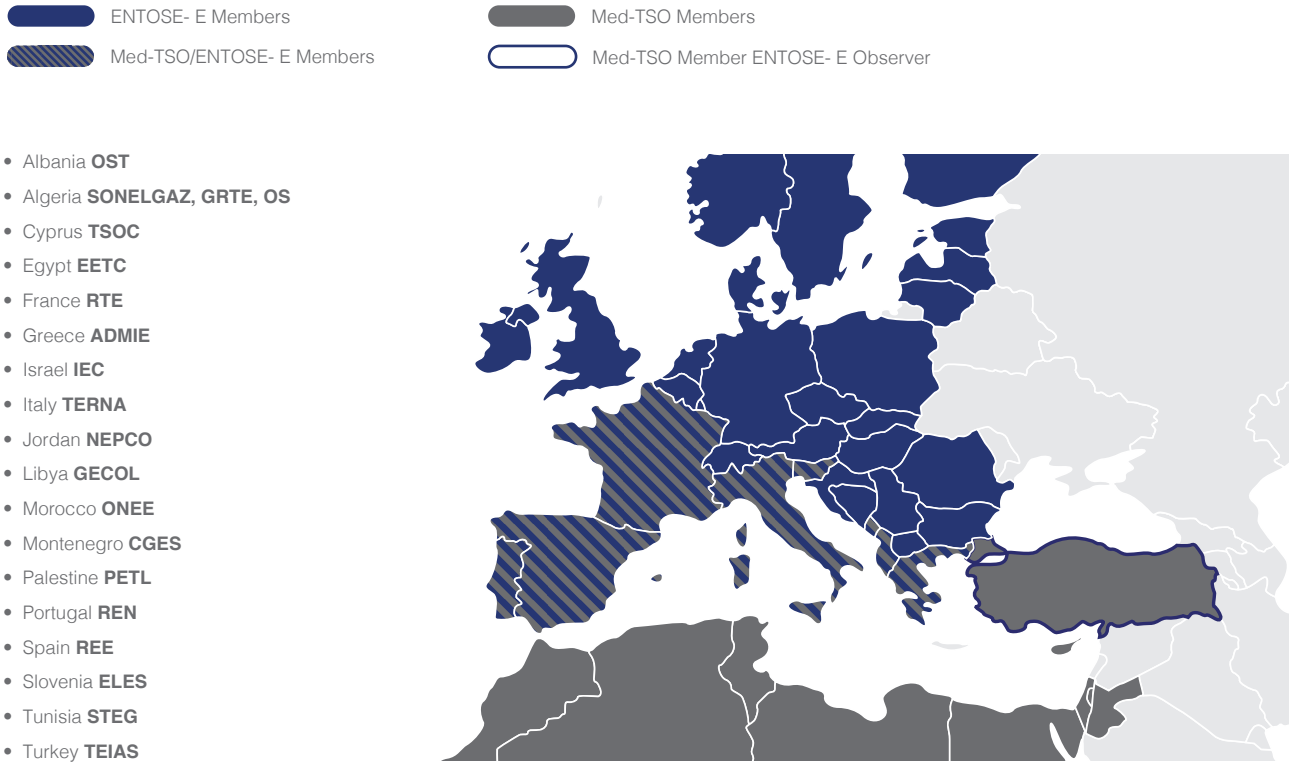
On the basis of these perspectives, 18 countries around the Mediterranean agreed to found in 2012 voluntarily the Association of the Mediterranean Transmission System Operators (Med-TSO)[2], as a technical platform for multilateral cooperation aiming at harmonizing rules on planning the grids, inter-operating the systems and designing a common Market.

The scope of the Med-TSO Association is also the background of the Mediterranean Project, funded by the European Commission, thought with the objective to support the assessment of High Voltage electricity infrastructure projects in the Mediterranean Region and creating the conditions for exchanges inspired to the same rules and standards.

Following 38 months of intense work, the Mediterranean Project will be delivering its results by the end of April 2018. On 10 April, the key findings[3] of the project are presented in a Closing Conference at the European Parliament in Brussels, offering a forum to discuss the future implementation of the project achievements.

MEDITERRANEAN TRANSMISSION SYSTEM OPERATORS FOR ELECTRICITY – MED-TSO ASSOCIATION

Med-TSO is the voluntary Association of the Mediterranean TSOs[4]. 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 Countries: OST (Albania), SONELGAZ, GRTE, OS (Algeria), EETC (Egypt), RTE (France), ADMIE (Greece), IEC (Israel), TERNA (Italy), NEPCO (Jordan), GECOL (Libya), ONEE (Morocco), CGES (Montenegro), PETL (Palestine), REN (Portugal), REE (Spain), ELES (Slovenia), STEG (Tunisia), TEİAŞ (Turkey), TSOC (Cyprus) as shown in Figure 1 below.



- Albania **OST**
- Algeria **SONELGAZ, GRTE, OS**
- Cyprus **TSOC**
- Egypt **EETC**
- France **RTE**
- Greece **ADMIE**
- Israel **IEC**
- Italy **TERNA**
- Jordan **NEPCO**
- Libya **GECOL**
- Morocco **ONEE**
- Montenegro **CGES**
- Palestine **PETL**
- Portugal **REN**
- Spain **REE**
- Slovenia **ELES**
- Tunisia **STEG**
- Turkey **TEIAS**

Figure 1 - Med-TSO members

2 More information: www.med-tso.com

3 The final reports of the project will be available by the end of June 2018. Med-TSO reserves all rights to complement, modify and cancel the content of this booklet until the publication of the final reports of the Mediterranean Project. Please consult www.med-tso.com.

4 Transmission System Operators are operators of the electricity sector, whose essential functions are managing the Transmission Grids, from planning to operation, and operating the Power Systems in order to ensure the optimal balance between demand and supply of electricity in any phase till real time control..

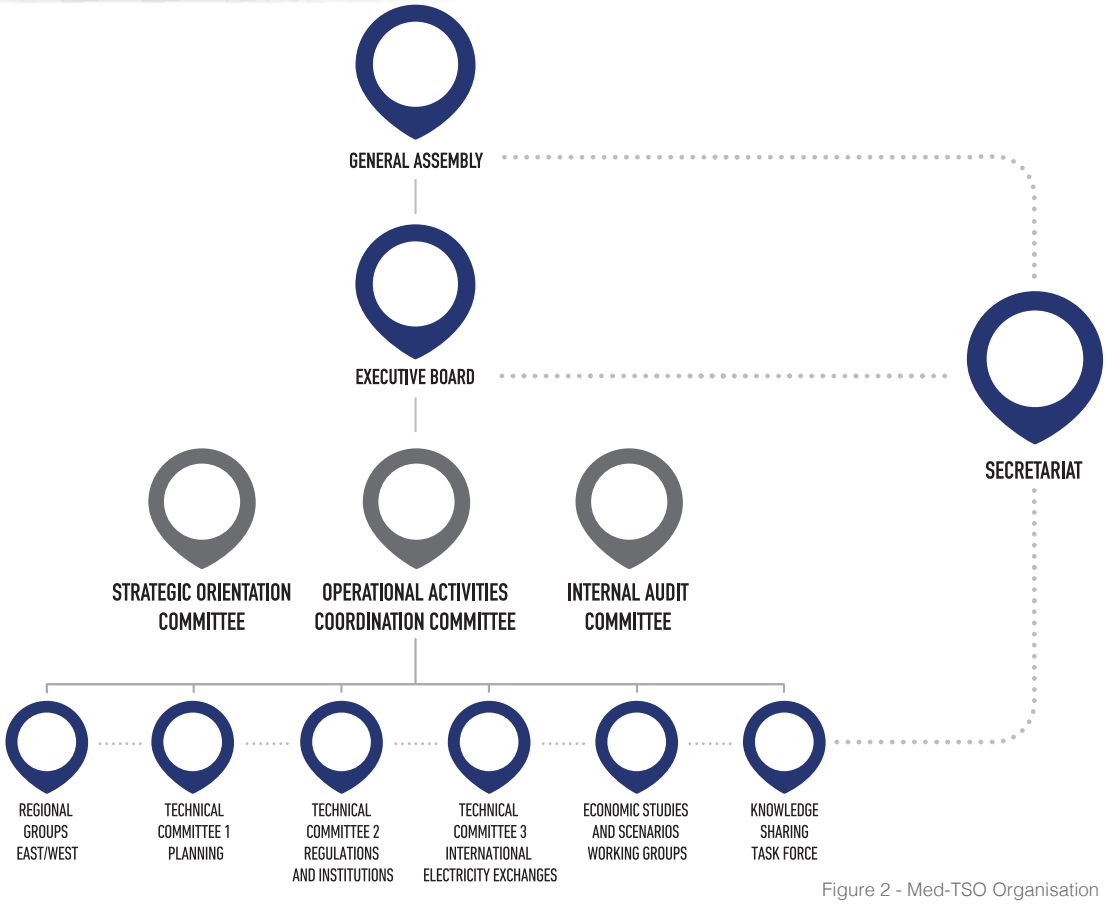


Figure 2 - Med-TSO Organisation

The activities of Med-TSO are performed through the contribution of the Members within the Technical Committees and Working Groups. The work is set-out on the basis of geographical or thematic issues (i.e. technical, regulatory, economic and financial issues), crossing the following activities of a TSO: Planning, Operation, Electricity Exchanges, Regulation (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[5], was signed in Rome in November 2014. With this cooperation framework the EC recognized Med-TSO association as a "long term partner of the EC", acknowledging the proposed Med-TSO platform as an efficient instrument for cooperation.

MEDITERRANEAN PROJECT

At the beginning of 2015, Med-TSO launched the Mediterranean Project, a three-year lasting program of activities, funded by the EC (Grant Contract ENI/2014/347-006), aimed at supporting the assessment of infrastructure projects in the Mediterranean Region, organized according to the following five main streams of activities: Rules, Infrastructure, International Electricity Exchanges, Knowledge Network and Med-TSO Database.

The main objective of the project is to promote the progressive integration of Power Systems of the two Mediterranean shores. To this purpose the project envisages several objectives inspired to the harmonization of rules, processes and standards in any stage of the life of power systems: from planning to operation. Not least to mention is the ambition to share knowledge and to design processes able to make the planning, operation and future markets enduring and sustainable. Worth to mention is also the enhancement of cross-border electricity exchanges in the Mediterranean region, through the coordination of national HV electricity grid development plans and the harmonisation of access and operational rules. The Mediterranean Project ended at the beginning of 2018.

5 The association of the Mediterranean Energy Regulators: www.medreg-regulators.org.

Photo contest: “Mediterranean bridge: a new perspective in the Energy transition between countries”.
Third placed photo: “BRIDGE TO THE FUTURE” - author Fabio Marcoleoni from TERNA (Italy)

THE MEDITERRANEAN MASTER PLAN

The Mediterranean Master Plan of Electricity Interconnections is one of the outcomes of the Mediterranean project. It is a tangible result of the intense cooperation amongst Med-TSO Members, proven by the complex coordination contents of the activity. Actually, the work carried out to finalize the first Mediterranean Master Plan included several tasks, as follows:

- Agree on a set of common coordinated planning methodology and procedures, as a precondition to develop a sound and enduring attitude to cooperation;
- Define a number of realistic reference energy scenarios at the time horizon 2030, taking into account the consistency of the National Development Plans in several multiple factors, such as new resources, market integration, technology development, power systems complementarities between northern and southern Mediterranean countries, the evolution of demand and generation, as well as political and macro-economic aspects;
- Build market and grid models for the evaluation of the impact of reference scenarios against current and future Euro-Mediterranean electricity systems (considering new possible interconnections). This work relies on the support provided by methods already developed by ENTSO-E, adapted to the specificity of the Mediterranean region;
- Define concrete Projects of cross border interconnections supported by: a) market studies, to evaluate the reference interconnection capacities and b) network studies, to assess the fulfilment of the security of operation;
- Define and assess, following a cost-benefit analysis (CBA) methodology, i) several potential development projects, according to the reference interconnection capacities, and ii) the future reference grid, according to the market studies results.
- The Mediterranean Master Plan is therefore a long term HV Electricity Network Development Plan with the time horizon 2030, based on a set of common coordinated planning methodology and procedures. It builds on a number of realistic reference energy scenarios, analysed through market and grid models and studies. It identifies the main system development needs all over the Mediterranean, assessed through a sub-regional approach, .

The Mediterranean Master Plan identifies 14 clusters of cross-border interconnections assessed at the time horizon 2030. A cluster is defined as a set of investments - new lines, new substations, other equipment for active and/or reactive power control, generally comprising both cross-border interconnections and domestic reinforcements - necessary to realise a firm increase of energy exchange, measured through Gross Transmission Capacity (GTC) or, as an alternative, Net Transfer Capacity (NTC) across two particular countries/grid portions.

Network analysis assesses feasibility and standard costs of such clusters, whose sustainability is previously proven by market studies.

In concrete terms, the studies show:

- almost **18 000 MW of new interconnection capacity**;
- **limited needs of reinforcements** (2 200 km of new lines, 840 km of reconductoring and less than 40 new bays and transformers);
- about **16 000 MEUR** of additional investments.

METHODOLOGY

The integration of the power systems of the Mediterranean basin, through their electrical interconnections, requires shared rules for their planning and operation amongst members.

A description of each of the above steps is provided in this paper. It includes recommendations for the creation of a common Data Base of the interconnected power systems, criteria for ensuring the system adequacy and security, procedure for conducting market studies and technical and economic indicators to assess the impact of the proposed new projects.

Finally, a simplified procedure was defined to launch a first application of the above methodology – which needs to be implemented in successive steps – to the planning of the Mediterranean interconnected system at a future horizon year 2030.

To elaborate the Master Plan, the following aspects have been explored:

- 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 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.

The outcome, described in separate detailed project reports, contains:

- 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.

MED-TSO 2030 REFERENCE SCENARIOS

Reference Scenarios explore possible future situations of load and generation, interacting with the Euro-Mediterranean Power system. These scenarios are the baseline on which the interconnection projects of the Mediterranean Master Plan are assessed.

The scenarios are not forecasts. Scenario analysis is a modern way to handle uncertainties in forecast processes. Scenarios build the path from now to several possible futures (trends on load and generation) as a 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. It results a high 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 irradiation that could offer opportunity for a massive RES development.

Four scenarios have been selected with focus on 2030. The Northern shore is engaged in ambitious decarbonisation targets and market integration within a general stagnation of the electricity demand. The Southern shore 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.

1. This activity has been performed by the Med-TSO Working Group Economic Studies and Scenarios. In 2016, the work was mainly focused on defining the scenarios, performing the data collection and running the Market Model. The scenarios have been updated in 2017, taking into account several new national Energy Plan following the COP21 commitments.
2. In this context of high 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 jointly determine 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 country.
3. In parallel, the Market Model has been completed to include all non-Med-TSO European countries in coherency with ENTSO-E TYNDP 2016.

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. The different combination of such drivers generated the four reference scenarios

- Scenario 1 – Business as usual and security of supply improvement
- Scenario 2 – Green Future based on gas and on local integration of renewable energies
- Scenario 3 – High economic growth to supports high interconnection development
- Scenario 4 – Green Future & Market Integration at an international level

ENTSO-E and Med-TSO scenarios are consistent; however, there are some differences in scenarios 2 and 3 of Med-TSO and ENTSO-E due to the preferred use of gas (instead of coal) power plants in Med-TSO scenarios (gas power plants are built in the South for the adequacy of supply and to minimize CO2 emissions). For that reason, energy and CO2 prices need to be set up in such a way to have gas before coal in the Merit Order, thus implying a switch of Visions 2 and 3 fuel and CO2 prices in Med-TSO analysis, compared to the ENTSO-E TYNDP 2016 assumptions.

SCENARIO 1
Business as usual and security of supply improvement

This 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 medium.

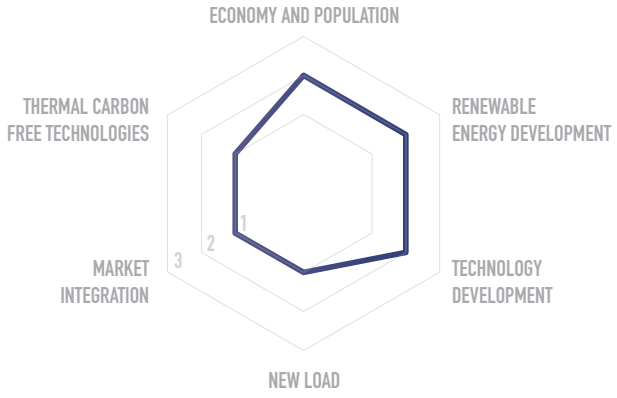


Figure 3 – Scenario 1: Business as usual and security of supply improvement

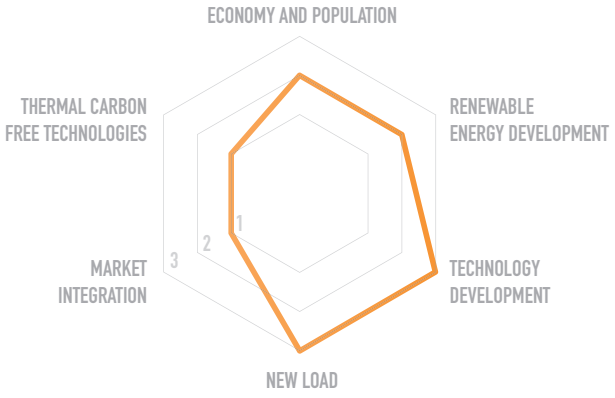


Figure 4 – Scenario 2: Green future based on gas and on local integration of renewable energies

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.**

SCENARIO 2
Green future based on gas and on local integration of renewable energies

This 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.

Heare D3, as an average, below the CO2 price is high in the whole Euro-Mediterranean power system. South shore 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, representing the higher percentage of the total installed capacity, are built in the South for the adequacy of supply and to minimize CO2 emissions since the price of CO2 is high enough to have a gas before coal in the Merit Order with. These gas power plants will have also to be flexible to deal with a new energy mix based on renewable energy.

Load consumption increases higher than the average trend in each MED TSO Country because of the development of new electricity uses like public transportation.

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

SCENARIO 3
High economic growth which supports high interconnection development

This scenario assumes that, following discovery of new primary resources, the economy of the Mediterranean area goes up especially in the South (Figure 5). Therefore, a higher GDP growth is expected in the South (more than 3%) and a lower growth (less than 3%) for the European countries. South Countries decide to develop carbon-free thermal power plants 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 support the relevant energy exchanges.

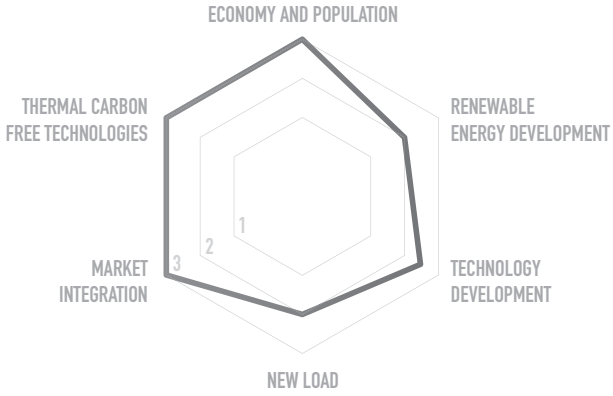


Figure 5 – Scenario 3 - High economic growth which supports high interconnection development

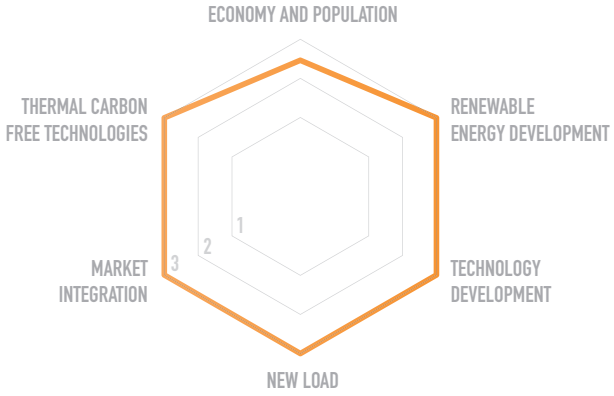


Figure 6 – Scenario 4 - Green future and market integration at an international level

SCENARIO 4
Green future and market integration at an international level

This scenario is based on a top-down approach based on the following three assumptions (Figure 6):

- Strong CO2 reduction due to carbon-free electricity production and new electricity uses (transports)
- High technology development for load and generation management, especially in the North shore.
- 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 several multinational interconnections supporting a global electricity market all around the Mediterranean area.

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

ABOUT MACRO TRENDS

During the reference period (2016-2030), the Med-TSO 2030 Scenarios foresee an increase in the production capacity of approximately 250 to 400 GW in the Mediterranean area, of which 40% to 60% from renewable energy sources, corresponding to an expected increase in electricity demand of about 1 000 TWh.

In a simplified way, according to the figures of the two most contrasted scenarios (Scenarios 1 and 4), demand will grow faster in the Southern shore, more than doubling the current values from now to 2030. Western and Northern shore demand will increase of about 7 to 18 % points in average, while North-Eastern region demand will grow at an intermediate rate, between 40% and 70%.

Regarding generation, development of RES represent around half of the new capacity.

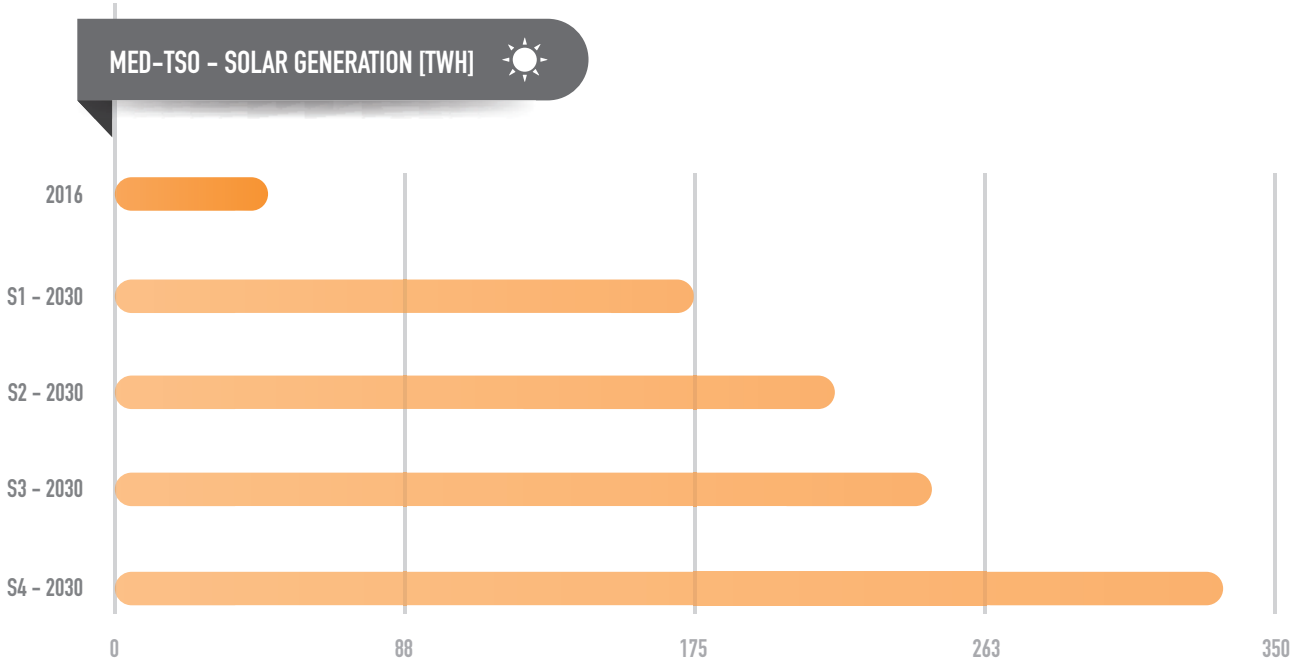


Figure 7: Solar Generation 2016 vs 2030 Scenarios

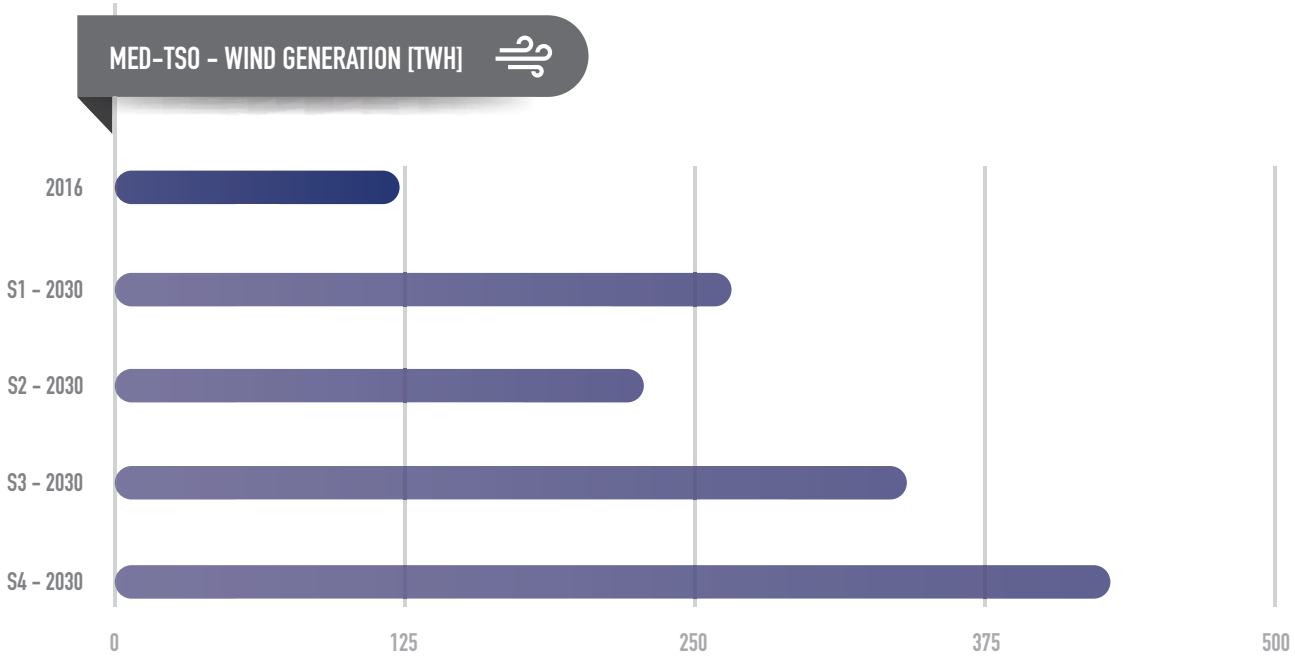


Figure 8: Wind Generation 2016 vs 2030 Scenarios

In terms of energy, solar generation increases between 3 and 7 times, while wind generation increases between 2 and 4 times. The growth in energy is higher than the growth in installed capacity.

Consequently, the share of renewable generation within the Mediterranean area is expected to raise from 25% in 2016 up to 32% in the Scenario 1, and up to 42% in the Scenario 4 at the target year 2030.

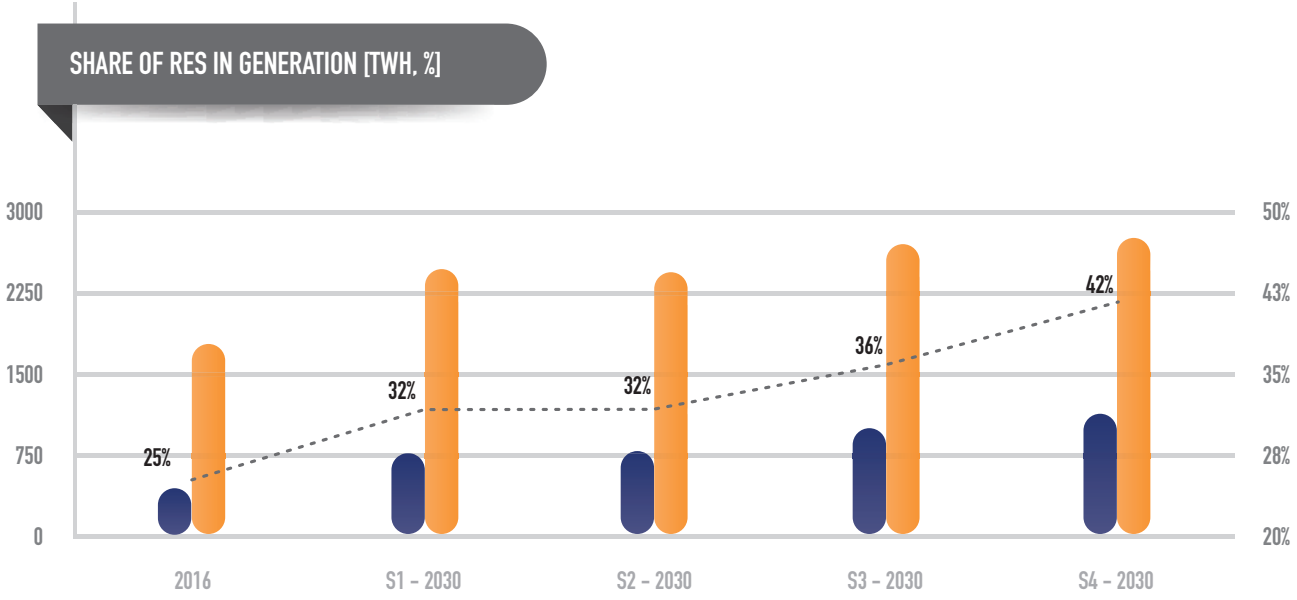


Figure 9 - Generation 2016 VS 2030 scenarios, RES share against demand

When assessing electricity complementarities among systems of an area, the first and obvious aspect that comes to mind is the demand. Indeed, since electricity loads depend on industrial production patterns, temperatures, day/night cycle but also on people habits, all of these parameters vary significantly within the whole Mediterranean area and this offers synergy opportunities. The most impacting driver for complementarity is the contrasted weather parameters between North and South that bring respectively an annual winter peak or a summer peak, associated with the dissimilar development of electric heating and air conditioning.

THE MARKET ANALYSIS

Based on the scenarios definition, a set of four market models has been set up. These models do not take into account the details of the transmission grids. They represent load and generation concentrated in a single node per each market area (usually one per country) and by specifying power plants characteristics. (thermal, wind, photovoltaic, other -RES and non-RES undispatchable generation, run of river).

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

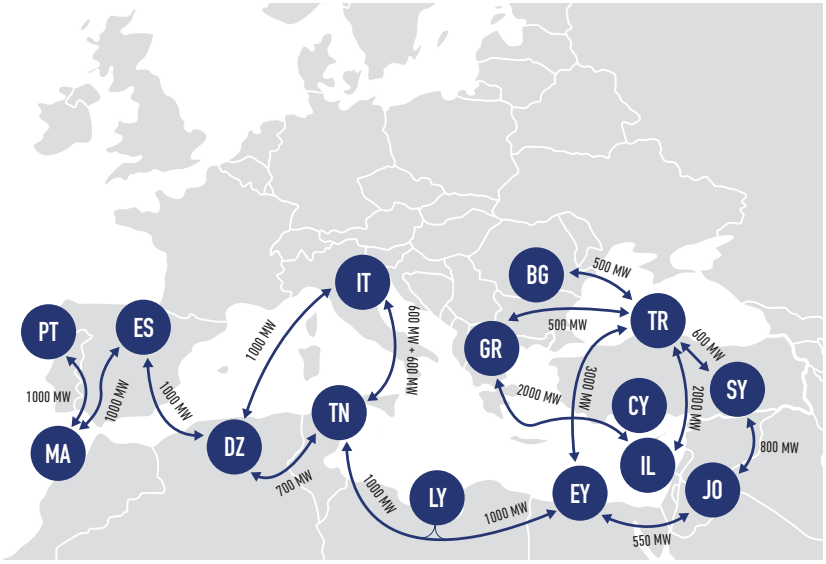
A Monte Carlo simulation model on a Mediterranean/European-wide basis is applied to carry out the market studies. The tool undertakes an optimal coordinated hydrothermal scheduling of the modelled electric system generation set, over a period of one year on an hourly basis. The simulation tool performs a day-ahead energy market, characterized by a system marginal cost and by a congestion management based on a zonal market-splitting.

Med-TSO has performed the studies in two rounds, according to an incremental process. The objective of this approach was 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 was also intended to revise the list of interconnection clusters. This control validated that all the clusters considered in the first round were useful in

terms of exchange, but it also showed that some interconnections had a high saturation rate even though no cluster had been initially selected. Therefore, the list of Clusters to be assessed has been increased in order to cover those interconnections.

The analysis performed in the second round includes 4 additional interconnections.



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 (Tunisia – Italy 1)
7	Cluster TN- IT (Tunisia – Italy 2)
8	Cluster TN- LY- EG (Tunisia – Lybia – 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)

Figure 10 – Mediterranean Project Clusters

For each cluster and each scenario, the market model calculates several annual indicators, as the variation of Expected Energy Not Supplied (ENS), of CO2 emissions and of RES curtailment, all required to perform the CBA assessment.

Being a Monte Carlo model, many other outputs are available as hourly time-series: exchanges between countries, marginal prices, detailed generation by type, and lack of supply.

Furthermore, data formatting and analysis have been performed to provide several sets of detailed study cases for network studies, selected to ensure the statistical representativeness of the situations.

The 14 projects add about 17 850 MW of new interconnection capacity, 8 200 MW of them are in/out ENTSO-E area. The most affected countries are Turkey, with 6 600 MW new capacity due to 5 new terminals, and Egypt with 4 550 MW (3 terminals). This outcome confirms the potential perspectives that generated the initial idea of launching of the Mediterranean Project.

THE NETWORK ANALYSIS

Market studies have shown the benefits in terms of both economics and adequacy of 14 projects. The network analysis, carried out by the Technical Committee 1 (Planning) of Med-TSO, aims at assessing the attributes of each project when the transmission network and its physical laws are taken into account. Considering a new interconnection calls for verifying that the modification of the load flows will not hamper the security of operation and, in case, for highlighting the necessary reinforcements to the existing network that have to be designed.

At the end of the network analysis, security standards are fulfilled and the costs of the interconnection and the related reinforcements are known, together with the changes in losses that affect the efficiency introduced by the project. These further parameters are passed to the CBA for a final assessment of the viability of each project.

A crucial point of the network studies analysis is the simulation of the behavior of the grids. They have to comply with two requisites: a) the individual country networks have to be merged in one model, and b) the operating conditions (input of generated power and output of demanded power) at each node of the grid have to be significantly representative of the scenarios simulated in the market studies.

This process requires an intensive and coordinated work among the Members for defining about 100 simulation snapshots (each constituted by a merged network model and its functioning conditions).

The network analysis has been performed on the 14 clusters indicated in Fig. 10 as a result of the second round of the market studies. Studies have been grouped in three corridors, Western, Central and Eastern, as shown in Fig. 11, considering both the proposed interconnection projects and their relevant internal grid reinforcements. All clusters have been assessed according to the Med-TSO Cost and Benefit Analysis (CBA), developed with reference to ENTSO-E, and with inputs provided by market and network studies. Security analysis has been performed for the clusters of each corridor.

The concept of corridor is an important outcome of the Mediterranean Master Plan. The geomorphology of the Mediterranean basin and the current network structure in the Southern and Eastern Mediterranean countries suggest to adopt a "by-corridor" approach allowing also to decouple the network studies (Fig. 12) and make the analysis easier.

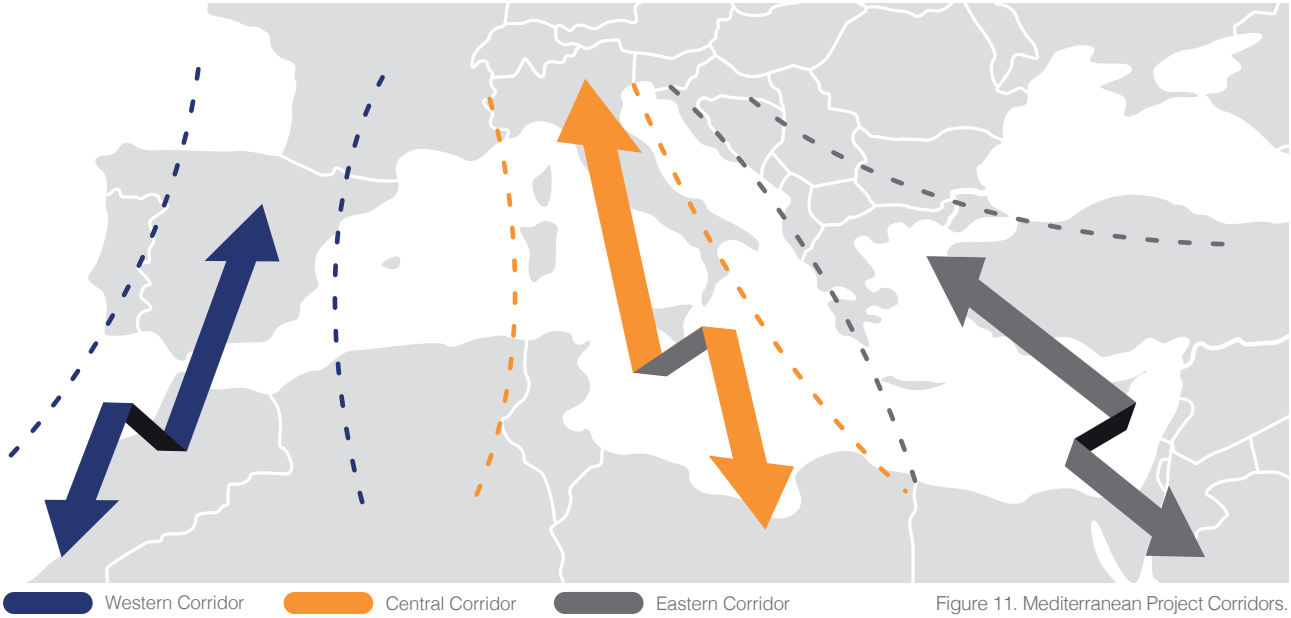


Figure 11. Mediterranean Project Corridors.

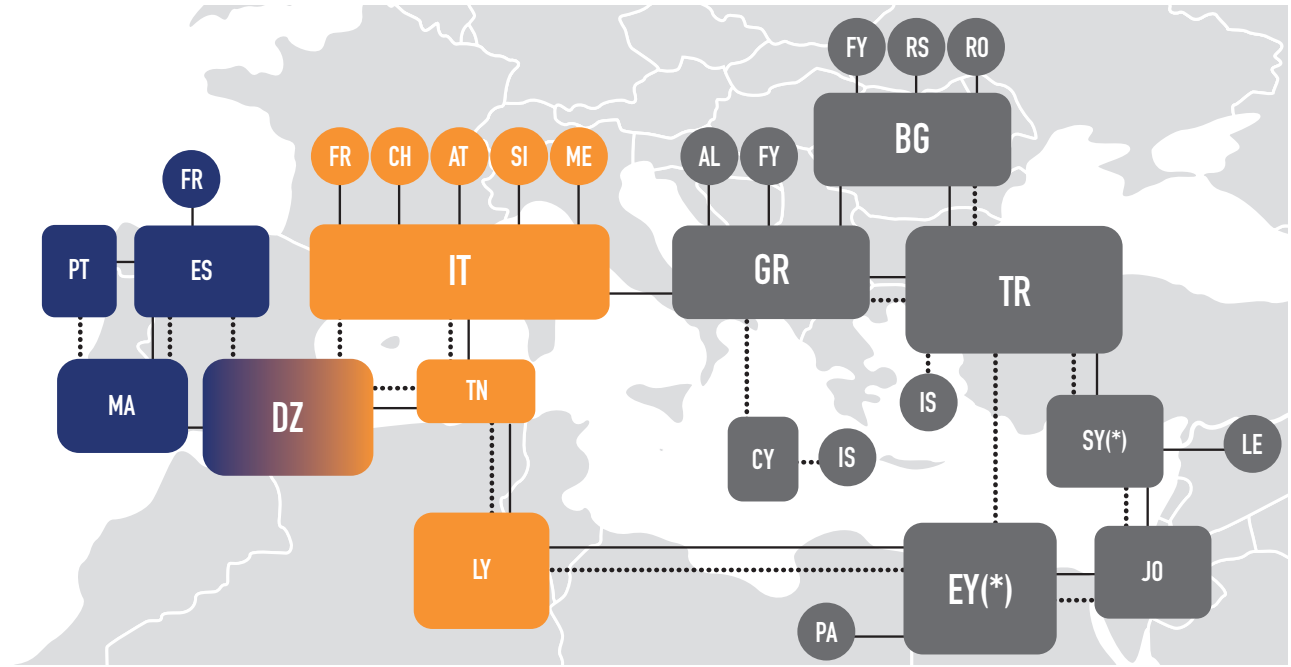


Figure 12. General grid representation scheme

SYNTHETIC DESCRIPTION OF THE CLUSTERS

In the following, a synthetic description of the 14 clusters, grouped by corridors, is reported. Maps have the only purpose to provide a simplified graphical representation of the proposed interconnectors.

WESTERN CORRIDOR

Morocco – Portugal (MA-PT)

The Cluster consists of a new interconnection between Portugal and Morocco in HVDC technology.

The HVDC interconnection will have a capacity of 1000 MW and a total length of around 265 km, of which approximately 220 km will be in submarine cable.

The HVDC link consider the configuration of 2 circuits (bipolar converter) of 500 MW each, between TAVIRA substation of 400 kV (PT) and BENI HARCHAN substation of 400 kV (MA).

This interconnection is promoted by REN and ONEE.

The security analysis performed with the merged full models of the systems of Portugal, Morocco, Algeria and Spain identified the internal reinforcements in the Portuguese, Moroccan and Spanish systems.

The overall investment cost ranges between 657 and 724 MEUR, 23% - 26% of which represents investment for internal reinforcements in Morocco, Portugal and Spain related to the project.

Morocco – Spain (MA-ES)

The Cluster consists of a new interconnection between Morocco and Spain that will increase the NTC between both countries in 1000 MW (additional to the 2 existing links) and to be realized through a third AC link.

The HVAC interconnection will have a capacity of 1000 MW and a total lenght of around 70 km, 30 km of which are of undersea cable.

The HVAC link consider the configuration of 1000 MW circuit, between TARIFA substation of 400 kV (ES) and BENI HARCHAN substation of 400 kV (MA).

This interconnection is proposed by REE and ONEE in the frame of Med-TSO studies..

The overall investment cost ranges between 397 and 414 MEUR, 62% - 64% of which represents investment for internal reinforcements in Morocco and Spain related to the project.

Algeria – Spain (DZ-ES)

The project consists of a new interconnection, between Algeria and Spain to be realized through an HVDC submarine cable.

The HVDC interconnection will have a capacity of 1000 MW and a total length of around 240 km. The maximum depth for the installation of the undersea cable will be around 2000 m.

The HVDC link consider the configuration of 2 circuits (bipolar converter) of 500 MW each, between CARRIL substation of 400 kV (ES) and AIN FATAH substation of 400 kV (DZ).

This interconnection is proposed by REE and SONELGAZ in the frame of Med-TSO studies.

The overall investment cost ranges between 899 and 926 MEUR, 25% - 27% of which represents investment for internal reinforcements in Algeria and Spain related to the project.

CENTRAL CORRIDOR

Algeria – Italy (DZ-IT)

The project consists of a new interconnection with a carrying capacity of 1000 MW between Algeria and Italy (Sardinia) in HVDC technology. submarine cable.

The study project has been proposed by Sonelgaz and Terna.

For the interconnection project between Algeria and Italy, no severe overloads have been detected due to the new interconnection for neither the Italian or Tunisian systems. Therefore, no reinforcements were defined for neither of them.

In the case of the Algerian system, some overloads are detected in the area between Ramdane Djamel and Berrahl substations. To solve this situation, a single reinforcement has been defined in Algeria, consisting in doubling a 400 kV line between Berrahal and Ramdane Djamel substations.

The overall investment cost is about 848 MEUR, 2% of which represents investment for internal reinforcements in Algeria related to the project.

Tunisia – Italy (TN-IT)

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

Cluster TN-IT 1 - The Cluster consists of a new interconnection between Tunisia and Sicily in HVDC technology and submarine cable .The realization of the Cluster is supported by the Italian and Tunisian Governments to increase the interconnection capacity of the Euro-Mediterranean system. The Cluster 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 new interconnection will be developed between the substations of Partanna (IT - Sicily) and Mornaguia (TN – Cape Bon).

The overall investment cost is about 641 MEUR, 19% of which represents investment for internal reinforcements in Tunisia related to the project.

Tunisia – Italy (TN-IT) 2

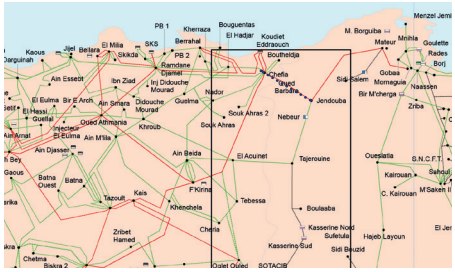
The Cluster envisages the reinforcement of the first interconnection (600 MW) between Tunisia and Sicily to be realized through an HVDC submarine cable. The Cluster may contribute to reduce present and future limitations to the power exchanges on the Northern Italian border under specific conditions, and therefore it may allow to increase significantly the transmission capacity and its exploitation by on that boundary.

The overall investment cost is about 583 MEUR, 11% of which represents investment for internal reinforcements in Tunisia related to the project.

Algeria – Tunisia (DZ-TN)

The project consists of a new AC interconnection between Algeria and Tunisia, with a capacity of 700 MW.

This cluster was added because of the significant number of saturation hours detected in the preliminary market sim ulations between Algeria and Tunisia. It consists of a second 400 kV OHL from the substation Jendouba in Tunisia to the substation Chefia in Algeria.



No remarkable overloads associated to the new interconnection were identified in the Algerian system, thus no internal reinforcements were defined for Algeria. Reinforcements are needed in Tunisia in order to evacuate energy from the Jendouba Substation. Between the proposed alternatives , the most effective involves the construction of a new 140 km 400 kV circuit Oueslatia - Mornaguia and a new 150 km 400 kV circuit between Jendouba and Oueslatia.

The overall investment cost is about 155 MEUR, 82% of which represents investment for internal reinforcements in Tunisia related to the project.

Tunisia – Libya – Egypt (TN-LY-EY)

The project consists of a new interconnection between Tunisia, Libya and Egypt corresponding to 1000 MW of capacity.

The main outcomes of the contingency analysis for each system involved in the project could be summarized to the following.

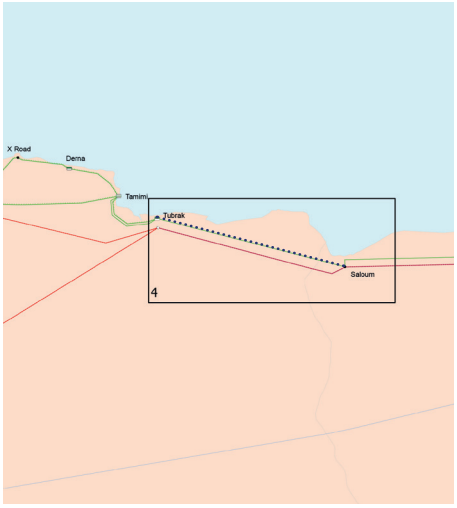
Detail of TNLY interconnection area

Tunisia

The energy interchange with Libya through the projected 400 kV interconnection comes down to the 220 kV network at the Bou Chema substation. This fact may undergo some overloads at the 220 kV network. To overcome this, it is planned to include new 400 kV reinforcements between Bou Chema and Oueslatia (250km) and between Oueslatia and Mornaguia (150km), as well as 3 new 400 MVA, 220/400 kV transformers at both Oueslatia and Bou Chema substations.

Libya

Relevant overloads detected at the 220 kV network. To overcome this, the reinforcement of the 84 km OHL from Tubroc to Saloum is considered.



Detail of LYEY interconnection area

The overall investment cost is about 540 MEUR, 39% of which represents investment for internal reinforcements in Tunisia and Libya related to the project.

EASTERN CORRIDOR

Greece - Turkey - Bulgaria (GR-TR-BG)

The Cluster consists in two new interconnections: one between Greece and Turkey and one between Bulgaria and Turkey to be realized through AC overhead lines. The project is promoted by IPTO, TEIAS and ESO. The main driver for the realization of the Cluster is to further increase the interconnection capacity between Turkey and the CESA (Continental Europe Synchronous Area) of about 1000 MW.

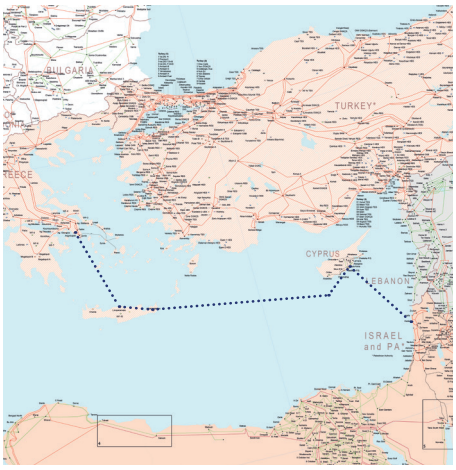
Two internal reinforcements in the Greek system close to the connection point of the Cluster, consisting in the construction of two double 400 kV OHL of a total length of 165 km have been considered needed to guarantee security of operation. Also for Turkish system reinforcements are located close to the boarder and consist in the replacement of conductors of the existing 400 kV OHL of a total length of 25 km and the use of the spare circuit of Verbena (Hamitabat) – Habibler 400 kV OHL to reinforce the region.

In the analysis performed NTC values considered exceed significantly the increase in the NTC foreseen by the new Cluster. This is due to the fact that the three systems represent an interconnected triangle, situation which presents some difficulty in controlling the power flows in the interconnections to meet the values defined in the network scenarios. Thus, as a general remark it should be stressed that the internal reinforcements identified are required only in case the NTCs increase exceeds the foreseen values.

The overall investment cost is about 208 MEUR, 32% of which represents investment for internal reinforcements in Greece and Turkey related to the project.

Greece - Cyprus - Israel (GR-CY-IS)

The Cluster refers to the Euro-Asia Interconnector, consisting of a HVDC VSC 500 kV submarine cable for the interconnection of the systems of Greece, Cyprus and Israel. The link has a capacity of 2 000 MW and a total length of around 832 nautical miles/ around 1541 km (approx. 314 km between Cyprus and Israel, 894 km between Cyprus and Crete and 333 km between Crete and Athens) and allows for reverse transmission of electricity. This Cluster was promoted for TYNDP inclusion by a non-ENTSO-E member, complying with the EC's draft guidelines for treatment of all promoters. It is expected to end the Energy Isolation of Cyprus, the last member of the European Union which remains fully isolated without any electricity or gas interconnections.



It will also create the electricity highway from Israel-Cyprus-Crete-Greece (Europe) through which the European Union can securely be supplied with electricity produced by the gas reserves in Cyprus and Israel, as well as from the available Renewable Energy Sources, contributing at the same time to the completion of the European Internal market. Furthermore, it will promote the substantial development of the RES with the resulting reduction of the CO2 emissions and offer significant economic and geopolitical benefits to the involved countries.

The security analysis performed with the merged full models of the systems of Greece and Cyprus did not identify any reinforcement in the two systems involved in the Cluster.

The overall investment is about 5 952 MEUR, no reinforcements are neededin the involved countries.

Turkey – Egypt (TR-EY)

The Cluster is located in eastern Mediterranean and consists of a HVDC submarine cable between Turkey and Egypt.

The Cluster is planned as an alternative to existing north-south corridor passing through Turkey, Syria, Jordan and Egypt. The main driver of the Cluster is to develop a new corridor in the eastern Mediterranean region and to increase renewable energy integration in the region. Estimated capacity is about 3000MW.

The security analysis performed with the full models of the system of Turkey identified in the Turkish system several reinforcements related to the Cluster. To reinforce Turkish grid in the vicinity of TREY Cluster's connection point, connection of planned 400 kV Kozan – Sanko OHL should be modified by connecting this OHL to Misis OSB substation. After modification process, Kozan – Sanko OHL would be operated as 400kV Kozan – Misis OSB OHL and 400 kV Misis OSB – Sanko OHL. Additionally, replacement of existing 400 kV 2bundle Adana – Bastug, Toscelik – Bastug, Erzin – Toscelik, and Erzin – Toscelik OHLs with 3-bundle conductors are required to reinforce the region.

On the Egypt side the connection point and the reinforcements have to be indicated.

The overall investment cost is about 2908 MEUR, 1% of which represents investment for internal reinforcements in Turkey related to the project. The system of Egypt has not been evaluated.

Turkey - Israel (TR-IS)

The Cluster is located in eastern Mediterranean and consists of a DC submarine cable between Turkey and Israel.

The main driver of the Cluster is to develop a corridor between Turkey and Israelto create trade possibilities and to increase renewable energy integration in the region. Estimated capacity is about 2000 MW.

The security analysis performed with the full models of the system of Turkey for 9 PiTs selected identified only one reinforcement related to the Cluster. To reinforce Turkish grid 400 kV Mersin – Adana OHL is required. Also replacement of existing 400 kV 2-bundle Toscelik – Bastug OHL with 3-bundle conductors is needed to reinforce the region.

The overall investment cost is about 1738 MEUR, less than 1% of which represents investment for internal reinforcements in Turkey related to the project. The system of Israel has not been evaluated.

Egypt - Jordan (EY-JO)

The Cluster is related to adding a new interconnection between Jordan and Egypt, which will lead to double the current capacity between Egypt-Jordan to be 1100 MW.

Jordan and Egypt are electrically interconnected since 1998 via a 13 km, 400 kV submarine cable across the Gulf of Aqaba to Taba, with an exchange capacity of 550 MW. Egypt and Jordan are part of the 8 Countries interconnection, including also Syria, Lebanon, Turkey, Iraq, Palestine, and Libya.

The project is expected to increase the interconnection capacity between Egypt, and Jordan to reach 1100 MW. This will enhance the integration of RES generation and increase grid stabilization, helping both countries to meet their load demand, with the positive effect of postponing investments in both generation and transmission.

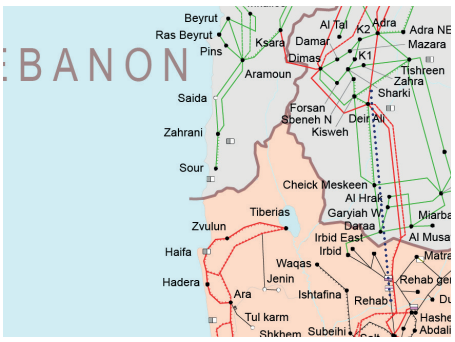
The security analysis identified:

- A new reinforcement in the Jordanian system consisting in doubling the existing 400 kV double circuit between MAAMN and Aqaba (4 circuits between MAAMN and ATP400.
- A new reinforcement in the Egyptian system consisting in doubling the 500 kV circuit between O-MOUSA and Taba and the 500/400 kV transformer at TABA substation.

The overall investment cost is about 198 MEUR, 69% of which represents investment for internal reinforcements in Jordan and Egypt related to the project.

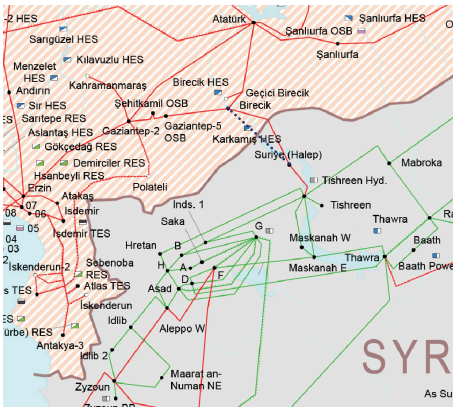
Jordan - Syria - Turkey (JO-SY-TR)

The Cluster is located in eastern Mediterranean and consists of two new interconnections: one between Jordan and Syria and one between Syria and Turkey, to be realized through AC overhead lines and an HVDC Back-to-Back station in Turkey. The Cluster is expected to double the current to become 1600 MW between Jordan and Syria and 1200 between Turkey and Syria. The Cluster is promoted by NEPCO and TEIAS (under the umbrella of the studies carried out by Med-TSO within the Mediterranean Cluster I).



Jordan, Syria, and Turkey are electrically connected by a 400 kV grid, with existing capacity of 600 MW (Turkey-Syria) and 800 MW (Jordan-Syria). These countries are part of the 8 Countries interconnection, including also Egypt, Lebanon, Iraq, Palestine, and Libya.

The main driver of the Cluster is to further increase the interconnection capacity between Syria, Turkey, and Jordan by another 800 MW between Jordan and Syria and 600 MW between Turkey and Syria. This will allow mainly meeting the Syrian demand and to integrate more renewable resources and base load units in the region.



The security analysis performed with the full models of the systems of Jordan and Turkey and equivalent models of the system of Syria for 9 PiTs selected did not identify any reinforcements in the system of Jordan, while:

- A new reinforcement was identified in the Syrian network, consisting in doubling the existing 400 kV double circuit between ADRA 2 and DIR-ALI (4 circuits between ADRAZ and DIR-ALI).
- Two main relevant reinforcements were identified in the Turkish network, consisting in the replacement of the 2bundle OHLs with 3bundle conductors to reinforce the region (replacement of 400 kV 2-bundle Ataturk – Birecik OHL with double circuit 3bundle conductors and replacement of 400k V 2-bundle Birecik HES – Birecik).

The overall investment cost is about 248 MEUR, 10% of which represents investment for internal reinforcements in Turkey and Syria related to the project.

THE COST BENEFIT ANALYSIS (CBA)

The main objective of the CBA methodology is to provide a common and uniform basis for the assessment of the 14 Clusters.

The applied CBA methodology derives from the ENTSO-E proposal submitted to ACER in July 2016 and based on Regulation (EU) 347/2013 on guidelines for trans-European energy infrastructure. It sets out the Med-TSO criteria for the assessment of costs and benefits of a transmission Cluster, all of which stem from ENTSO-E practice based on European policies on market integration, security of supply and sustainability.

The goal of Cluster assessment is to characterize the impact of transmission Clusters, 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 CO2 or GWh). A general overview of the indicators used for Cluster assessment is included in the Figure 13 below.

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

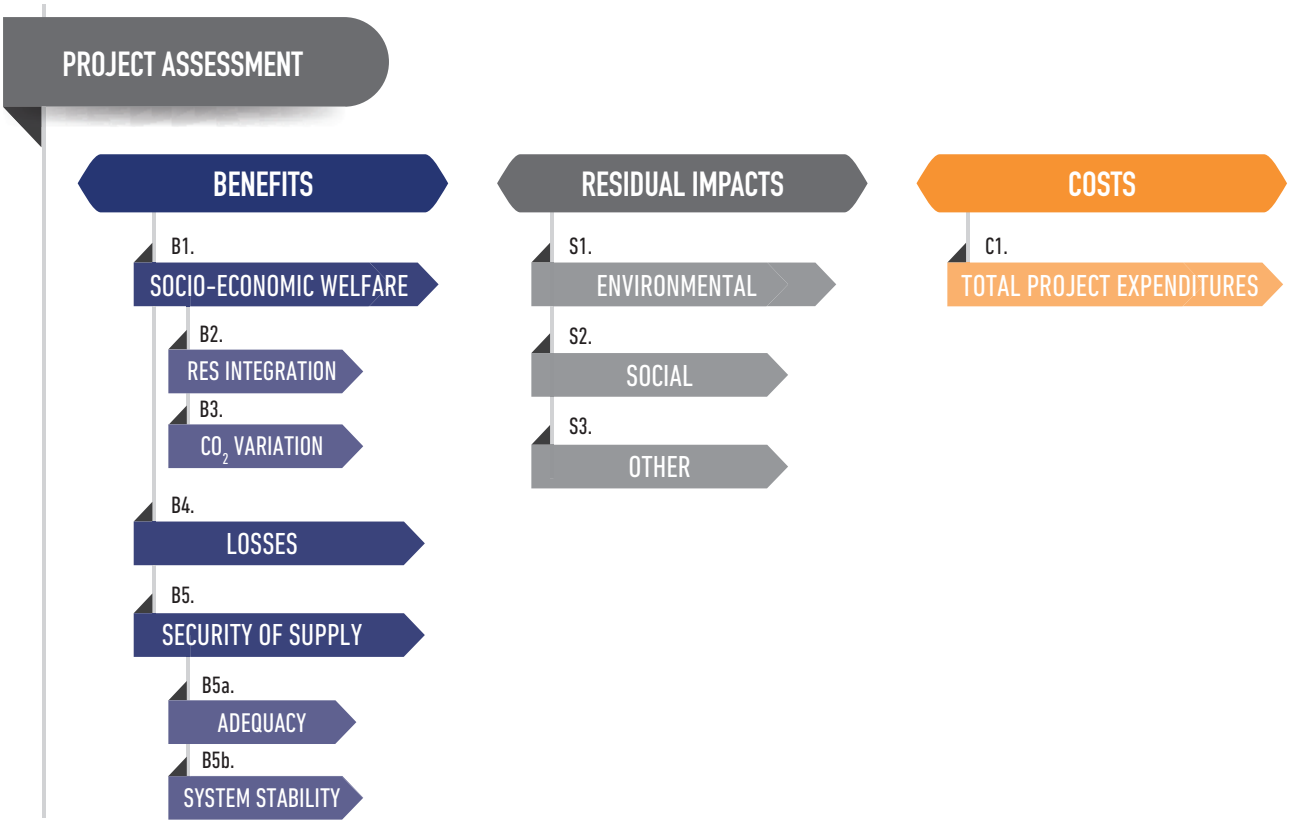


Figure 13. Components of CBA

A COMMON SET OF RULES FOR THE MEDITERRANEAN POWER SYSTEM AND TRANSMISSION GRID CODE

The harmonization of principles and practices is the prerequisite to transparency and real cooperation, as well as the ultimate scope of the Mediterranean Project. Common rules are the practical result of the willingness to cooperate and a guarantee for investors.

This topic has been addressed in a specific task of the Mediterranean Project developed by Med-TSO Technical Committee 2. This task deals with i) the analysis of the existing and foreseen regulatory framework in the different Mediterranean power systems; ii) the identification of areas, aspects and issues that should be harmonised in the future for the entire Mediterranean region, mainly focusing on the TSOs responsibilities and functions. The work has enabled to develop a common set of basic rules, together with a tentative roadmap for its adoption and compliance, associated to the following 4 areas:

- Legal and regulatory (transversal aspects where further coordination with regulators is needed).
- Connection of users (generation, distribution and consumption units) to the grid.
- Operation of the interconnected systems.
- Markets within system operation; particularly those associated to the system services management.

The work has been performed, based on a proactive approach of the Members, both in the provision of information and in the contribution to the definition of the common target, via general and specific surveys and the distribution of responsibilities.

Starting Regulatory Framework in the Mediterranean Region

In the first step, particular surveys and discussions among TSOs enabled the elaboration of a “List of issues potentially considered for a common regulatory framework” within the 4 above-mentioned areas. The analysis performed enabled to identify 34 aspects and 135 issues as those which **could be harmonized** for the Mediterranean region.

Proposal of Common Target Regulatory Framework

From the abovementioned reference, an additional survey was launched in order to get the priority estimation by TSOs of the 135 technical issues already pre-selected and further discussions were carried out. This enabled to identify the 24 aspects and 66 issues that **should be harmonized** for the Mediterranean region.

Figure 14 summarises the aspects and issues[6] included in both Starting and Target Regulatory Frameworks (in bold/italic, aspects proposed at the highest priority to be harmonised in the Mediterranean region and included in the Target).

STARTING REGULATORY FRAMEWORK (SRF): 34 Aspects ➧ 135 Issues		
1 Regulatory Aspect (11 Issues). REE &STEG		
13 Connection Aspects (41 Issues)	**14 Operation Aspects (57 Issues)**	**6 System Services Markets Aspects (26 Issues)**
• ***Connection procedure (2)***	• ***System states (1)***	• ***Legal issues (5)***
• ***Frequency requirements (3)***	• ***Technical requirements (5)***	• ***Capacity calculation (3)***
• ***Voltage requirements (2)***	• ***Information exchange (3)***	• ***Capacity allocation (5)***
• ***Reactive power requirements (1)***	• ***Contingency analysis (5)***	• ***Dispatching and balancing (1)***
• Short circuit requirements (IPTO)	• Dynamic stability	• Settlement and metering
• **Protection requirements *(1)***	• ***Management of international exchange programs (1)***	• ***Transparency (2)***
• **Control requirements *(4)***	• HVDC technologies	
• Power quality	• ***Outage coordination (1)***	
• ***Demand disconnection schemes (1)***	• ***Load frequency control (6)***	
• System restoration capabilities	• ***Reserve management (1)***	
• Demand side response services	• ***Defence plan (6)***	
• ***HVDC requirements (1)***	• ***Restoration plan (1)***	
• Compliance and monitoring	• ***Training (2)***	
	• Dispatch priority	
COMMON TARGET REGULATORY FRAMEWORK (CTRF): 24 Aspects ➧ 66 Issues		
1 Regulatory Aspect (3 Issues)		
8 Connection Aspects (15 Issues)	**11 Operation Aspects (32 Issues)**	**4 System Services Markets Aspects (16 Issues)**

Figure 14 Starting and Common Target Regulatory Framework in the Mediterranean Region

Figure 15 shows for the different areas the selection ratios by which those issues present in the Starting Regulatory Framework have been included within the Target Proposal. As a result, 49% of the initial reference of 135 issues have been selected. On the other hand, Figure 16 shows how the different areas are present in the Target Proposal, being the operation area that concentrating the majority of selected issues to be harmonised (32 operation issues represent 48% of the total selected).

6 Issues refer to every particular topic which is currently regulated in the national context and are candidate for regional harmonization while aspects refer to a group of related issues (i.e., acceptable voltage ranges or low-voltage-though-capability are issues within the aspect called Voltage Requirements)..

SELECTION RATIO

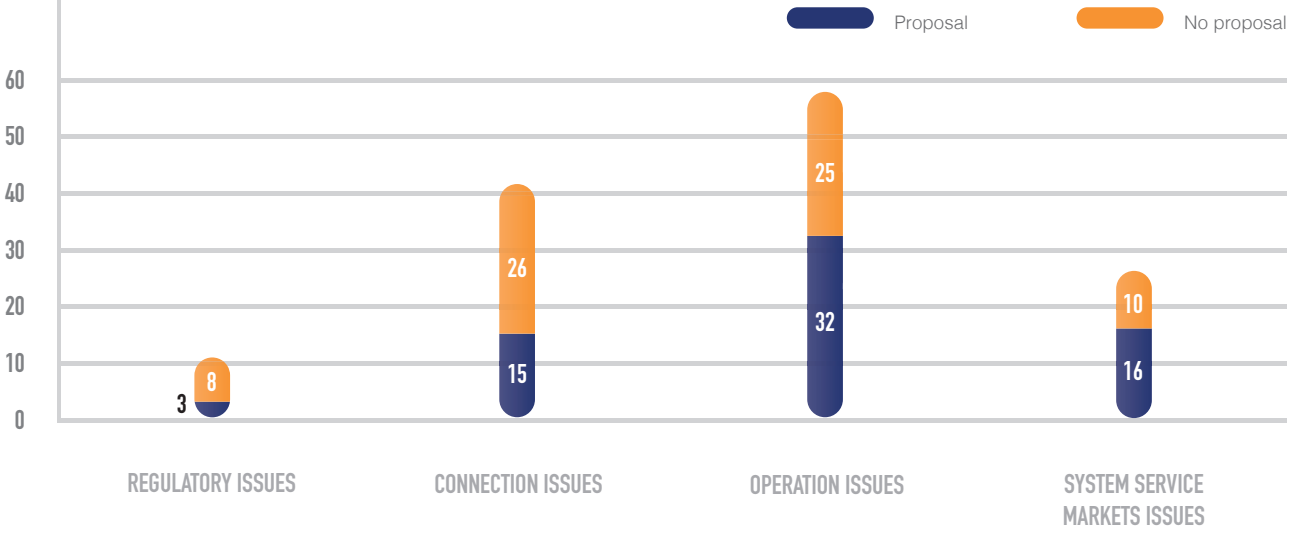


Figure 15 Selection ratios of issues in SRF included in CTRF for every area

PROPOSAL ISSUES

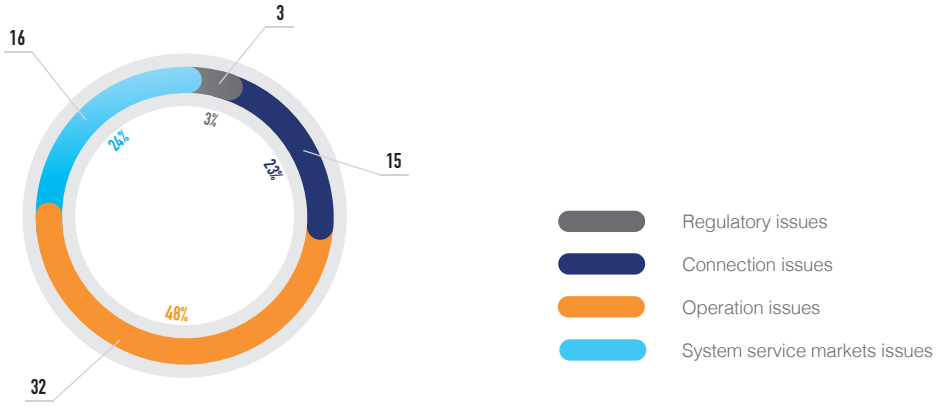


Figure 16 Relative proportion of issues included in CTRF for every area

For each of the 66 selected issues, TC2 worked also in the identification of the most suitable "rule format" for regulatory implementation, considering the following general classification:

- External Rules: Where TSOs are not generally autonomous and need to be approved by competent authorities at national or regional level; this without prejudice that these rules might be proposed by TSOs –e.g. Grid Codes-, or higher regulation.
- Internal Rules: Where TSOs are generally autonomous in adopting agreements or contracts, either between TSOs or between TSOs and other stakeholders (users and service providers); this without prejudice that these may need to be based on external rules as mentioned above.

Proposal of Common Tentative Road Map. Furthermore, for anticipating how the practical regulatory implementation of the 66 selected issues could be realized, additional work was carried out in order to incorporate the TSOs views on estimating which prioritization and which temporal horizon should be applied. This has allowed to elaborate a Road Map where classifying the issues according to their potential regulatory harmonisation considering 3 tentative time-horizons: short-term (2018-2020), medium-term (2021-2025) and long-term (>2025). As a result of this process, the proposal has been

elaborated considering both dimensions previously mentioned: the degree of importance for an issue to be harmonized and the temporal estimation as explained above. Figure 17 graphically represents the combined prioritization for the 66 selected issues in the 3 different time horizons (colors correspond to areas, as segregated in priority ranges).

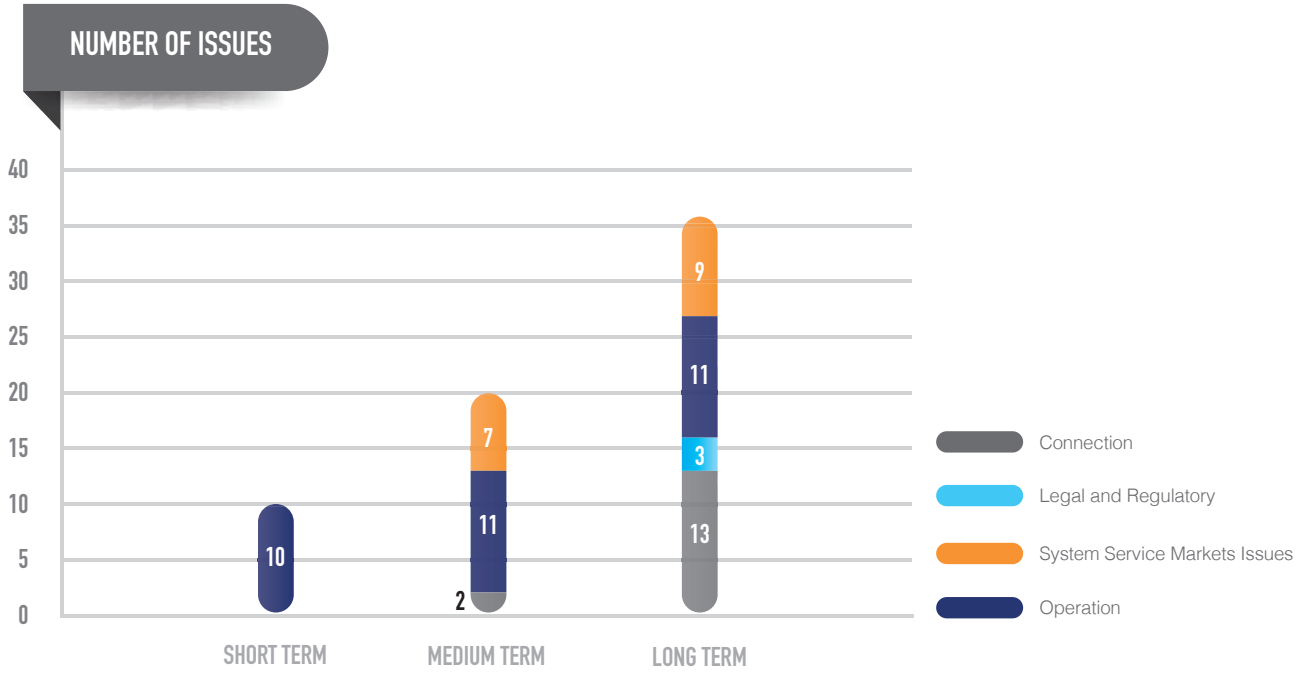


Figure 17 Time prioritization for the 66 issues included in the CTRF by technical area

Based on the analysis performed, the correlation between the 66 technical issues, their level of degree of prioritisation and their temporal prioritisation, the technical issues have been finally grouped in the following 6 categories:

Frequency/voltage management and control in different system states. In the short-term horizon this category includes issues only from the operation and connection areas. In particular, operation area issues focus on system states and coordination of relevant actions and procedures, such as rules and types of restoration plans, inter-TSO assistance and coordination, frequency ranges and deviation management procedure and setting of demand disconnection schemes. Connection area issues are related to certain frequency requirements which are considered of major and urgent importance for harmonisation, such as frequency/time range limits for users to withstand without damage, overfrequency and underfrequency schemes and rate of change of frequency withstand capability.

In the medium term horizon this category mainly includes issues from the operation area and few from the connection area. In particular, operation area issues focus on aspects related to load frequency control, as well as on the procedures for demand disconnection and for management of power flow and voltage deviation. Connection area issues are related to demand disconnection schemes and voltage/time range limits for users to withstand without damage.

Management of international interconnections. In the short-term horizon this category includes issues only from the operation and SSM areas focussing on the management of international interconnections, in particular, international exchange programs, protection coordination criteria, type of contingencies to be considered and joint remedial actions following contingencies and operational security limits. Furthermore, issues with reference to the NTC are considered, such as, security criteria, processes and different time horizons used for NTC calculation, as well as criteria and procedure for outage coordination if it affects NTC. In general, the duration of both regulatory and practical implementation for the issues of this category vary, depending on the proposed rule format, nevertheless it is important to underline that harmonisation is concluded within the short-term horizon.

In the medium-term this category includes mostly issues from the SSM, focussing mainly on:

- dispatching & balancing aspects (such as actions for guaranteeing exchange programs, management of unintentional deviations),
- legal aspects (such as rules for exchange of cross-border electricity, contractual requirements for participation on cross-border electricity trade and technical requirements for using the interconnections), and also

- some issues related to capacity allocation (such as kinds of capacity products, methods and procedures applied for capacity allocation and responsible for the management of the procedure, mechanisms for the use of the allocated capacity, system of liabilities, guarantees and penalties).

There are also few issues from the operation area, such as contingency list and periodicity of state estimation calculations, measures and mechanisms of reactive power and reserves management with focus on the international interconnections. In this category, the harmonisation of specific HVDC requirements or criteria is included, prioritised for the medium term horizon, taking into consideration also the harmonization process in ENTSO-E countries.

Transparency and information exchange platform. In the short-term horizon, this category includes issues only from the operation and SSM areas, in particular all data (real-time, structural and scheduled) and public information to be exchanged between the TSOs. In general, for this category both regulatory and practical implementation of the harmonization process are expected to be rather short, particularly in cases of TSOs interconnected, where this exchange of information is already coordinated based on inter TSO agreements.

In the medium and long-term horizons this category includes issues only from the connection area, such as global architecture and schemes, controllability and observability threshold and magnitudes of non-transmission facilities to be provided to TSO control centres, as well as telecommunication and protection schemes. In general, for this category regulatory implementation should be rather short, since these issues are already mature for harmonisation within the Mediterranean area, but certain technical issues and limitations can be challenging during implementation phase. It should be noted that, based on the results of the Survey, the issue of observability of non-transmission facilities is proposed to be moved to the short term horizon, since its harmonisation is considered of major and urgent importance.

Criteria for connection. This category includes issues only from the connection area with temporal prioritisation in the medium term horizon, such as criteria for access capacity calculation, studies for access and connection, limits of reactive power contribution and fault ride through capability. For those issues, regulatory implementation should be coordinated taking into consideration also the harmonization process in ENTSO-E countries. Practical implementation is expected to be rather short, since based on the results of the Survey, these connection issues are rather mature for harmonisation within the Mediterranean area, particularly in cases of TSOs already interconnected, who already implement common procedures based on inter TSO agreements.

Legal and regulatory. This category includes issues from the legal and regulatory area with temporal prioritisation in the medium term horizon, such as unbundling of activities (regulated and non-regulated), coordinated regulation for feasible and viable international interconnections, as well as presence of a Market Operator and responsible authority for settlement of disputes. Based on the existing experience of harmonisation within ENTO-E, for this category of issues both regulatory and practical implementation are expected to be time consuming, mainly due to the current lack of regulatory framework in certain Mediterranean countries. It is proposed that for all issues at least the regulatory implementation should start within the medium term horizon.

Training and certification. This category includes only 2 issues from the operation area with temporal prioritisation in the medium term horizon, namely language requirements and certification of the operators in charge of real time operation, which are considered already mature for harmonisation within the Mediterranean area, thus both regulatory and practical implementation phases should be rather short.

Models of Rules: Contracts and Grid Code. As a final stage of this task, work has been carried out in order to identify which rules could be tackled and first developed in terms of achieving common models due to their priority in the regulatory harmonization process for the Mediterranean region. With this purpose, a combination of priority areas/aspects/issues involved and potential rule formats have been considered in order to select the 3 following regulations:

- Connection Contract TSO-User for users to connect to the grid.
- Operation Agreement TSO-TSO between neighbouring TSOs.
- Grid Code with the chapters about requirements for connection and about system operation.

The model of rules includes the technical arguments for the mentioned selection, as well as theconceptual proposal guidelines which should be included in the rules and a basic

simplified model which to be further developed and used in the entire Mediterranean region in order to regulate both TSO-TSO and TSO-User relation.

In practical terms, this constitutes a first proposal considering the TSOs perspective for the core priority issues in a medium-long term scenario of global harmonisation in the Mediterranean region. Consequently, further work will be needed in order to coordinate with other perspectives, advance in the implementation details of priority rules, and enlarge the harmonisation perimeter to other issues beyond the priority level and articulate potential intermediate stages where partial harmonization might be achieved.

Coordination mainly refer to Regulators, both at national and regional levels, since practical implementation of new rules is in many cases beyond TSOs possibilities, but also to the implication of involved stakeholders; both are vital for contributing to maintain the security of power supply while accomplishing the ambitious objectives of increasing energy sustainability and markets integration.

INTERNATIONAL ELECTRICITY EXCHANGES

Sharing resources and taking advantage from complementarities are the main reasons why interconnection is beneficial for the power Systems. The Mediterranean Project includes an appraisal of such aspects in the framework of harmonization / integration.

Focusing on methodologies, procedures and mechanisms for sharing resources through cross border exchanges, based on inter-grid complementarities and efficient use of generation infrastructures, are key for interconnected systems evolving towards more interconnection. More specifically, the following targets have been addressed to TC3:

- Assessment of regional cross border exchanges potential development: cross borders exchanges regulation, procedures and rules for coordinated dispatching and operation in presence of international exchanges
- Schemes of Auxiliary applications and Services of Regulations and RES integration
- Application of the CBA methodology defined by ESS as reported in previous sections of this document

Assessment of regional cross border exchanges potential development in Mediterranean region

On the base of the outcome of a comprehensive questionnaire (more than 100 questions) have been investigated: data of existing and planned interconnections between Med-TSO Countries, transfer capacity(criteria and process to evaluate the NTC), methods of capacity allocation, publication of data - information and transparency, balancing and volume – price of involuntary exchanges, procedures and rules to guarantee exchanges programs and balancing services, market issues, legal issues, nomination of exchanges in the interconnections, network services providing, system operation and settlement and metering.

The main conclusions of the enquiry are summarized in the following:

- The situation of the Mediterranean power systems is heterogeneous with a wide variety of advances regarding the integration of national electric systems and electricity markets: in the North bank, European countries belong to an integrated area advancing towards a real internal energy market, while in the Southern and Eastern part of the Mediterranean area, exchanges are very low, mainly due to the absence of electricity market mechanisms, while interconnections are mainly used to improve the security of supply and not for market purpose. Thus, a large part of transfer capacity is available for further electricity market development. So given the complementarity of supply and demand (growth and profile), increasing exchanges even without using an integrated electricity market would enhance the development of more technical coordination in terms of network operations and sharing information which are essential for the development of the electricity market at the sub regional and regional levels.

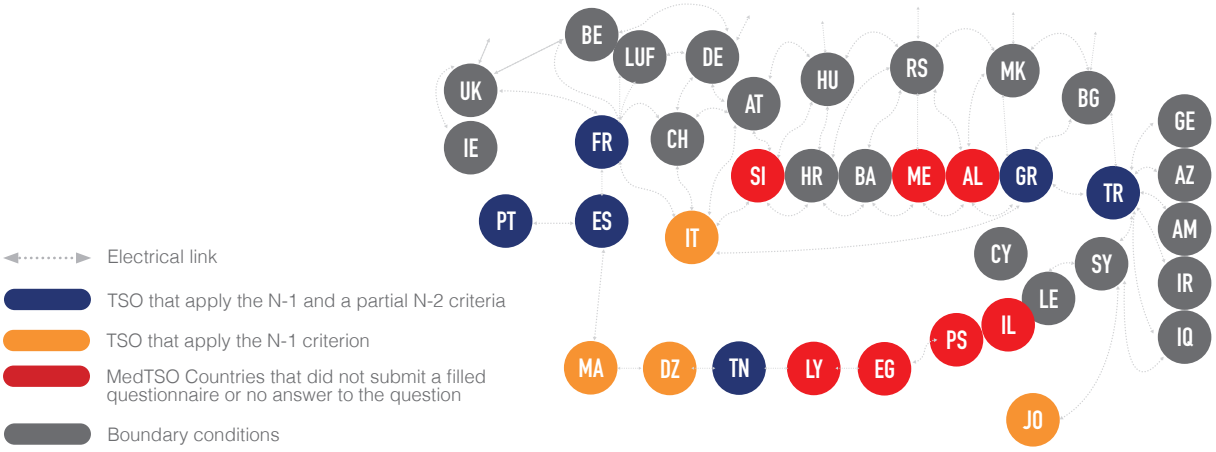


Figure 18 Security criteria used in NTC calculation within Med-TSO countries

- In terms of transfer capacity, the 'N-1'security criterion is considered by all TSOs, which consists mainly in load flow calculations considering the tripping of any line or transformer of the grid with respects to technical requirements, while some TSO also consider partial 'N-2' criterion.
- For most TSOs of the Southern shore, capacity allocation considerations are not applicable, while most of the European TSOs apply all or some of the allocation methods.
- In the South shore countries, most of the electrical data are not published, with the exception of few data like actual loads in Morocco and Jordan, grid development plan in Algeria and installed generation capacity in Jordan. The situation is completely different for ENTSO-E countries where almost all data are published.

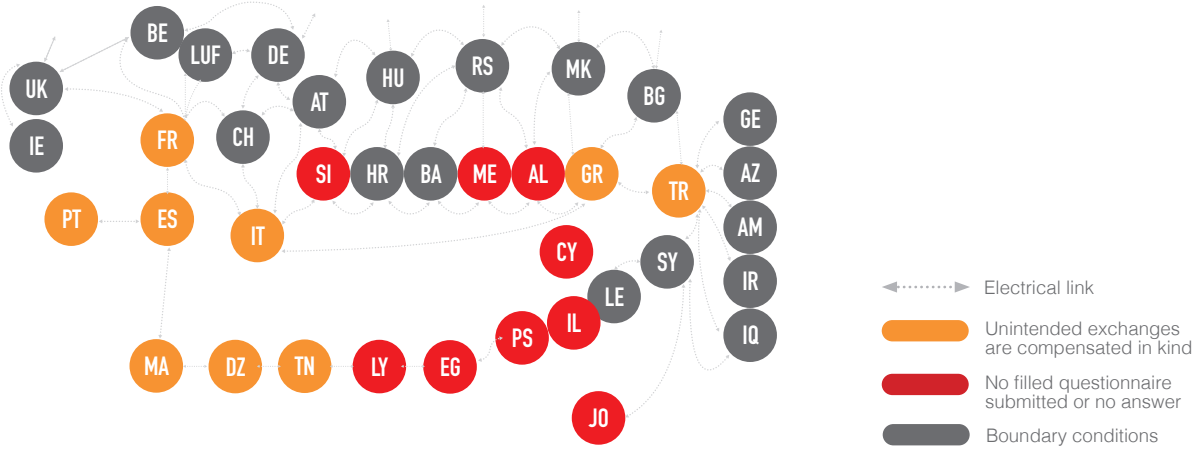


Figure 19 Treatment of unintended deviation exchanges within Med-TSO countries

- Unintended deviation exchanges are not treated commercially by most of the TSOs but through compensation mechanisms, such as compensation in kind for energy consumed by a neighboring country, so that a zero balance is achieved.
- HVDC technology, is present in almost half of the countries, among which, only Spain and France have both LCC and VSC technologies installed, while in the rest of the countries only LCC technology exists. In all countries where HVDC technology applies, no special regulation for HVDC has yet been established, with the exception of France and Italy that have already developed national HVDC regulation in this aspect.
- Concerning the experience from the operation of the HVDC interconnectors, the need for management of inverse flows and voltage deviations has been identified for the LCC link between France and the UK, while the LCC link between Greece and Italy in the past withstood major disturbances in the South East Europe without being affected. The experience from the operation of the VSC link between France and Spain and of the LCC link between Turkey and Georgia is rather short to provide currently any feedback. The HVDC interconnectors of France with the UK and Spain are in fact the only HVDC links in the Mediterranean Region operating in parallel with AC lines and until today no special operational problems or unexpected behavior have been identified.
- Studies about dynamic stability are performed occasionally in more than half of the countries in specific situations identified as possible risk for the system or upon request.
- Programming and management of scheduled international exchanges is performed in all the European countries including Turkey in accordance with coordinated rules and mechanisms. In the countries of the Maghreb and Mashrek area that have provided information, the energy trading is performed according to bilateral contracts and mainly in cases of emergency. Exchange limitations exist for all TSOs in case of emergency.
- In what concerns the criteria and procedures for outage coordination between TSOs or TSO and users, particularly when outage operations affect the NTC, all countries perform corrective or predictive outages in accordance with coordinated rules or mutual agreements between the relevant parties. Few TSOs provided information concerning the remuneration of the affected traders.
- TSO is the party responsible for the settlement and metering in international interconnections in all countries.

These are the main conclusions on what could be called generic questions selected from each of the chapters constituting the questionnaire. Of course, as mentioned above, other

information on many issues were provided when applicable, in particular information on system operation such as voltage management with neighbors, limitation of the power flow through the interconnection in case of emergency, defense plan coordination, restoration plans, selectivity protection on interconnection lines to avoid propagation of incidents, description of the system states, parameters that are monitored on line, frequency requirements, voltage ranges in internal networks and on interconnections, reactive management, limit criteria for short-circuit, system protection coordination, data exchanges between TSO, load-frequency control, reserve management, training and certification of employees in charge of real time operation, power generation dispatching priority, etc..

Schemes for sharing system services with RES integration

In this sub-task an extensive questionnaire was elaborated for the assessment of the present reserves sharing possibilities jointly with the expected RES development programs in the Mediterranean region, making it possible to indicate some quantitative results mainly in the area of new generation and infrastructures. The questionnaire gathered more than 180 questions organized in 6 thematic areas: Regulating Reserves, Imbalance Settlement, Load Participation, Voltage Control, Renewable Energy Sources and Regulatory Issues.

The main conclusions of the analysis are summarized in the following:

- In addition to sharing of ancillary services to facilitate RES development, trans border interconnections are necessary for achieving such sharing, since interconnectors are intended for capacity and energy exchanges as well as for providing capacity reserve security support between TSO's. These three "ingredients", RES, sharing and interconnectors, appear to be instrumental for supporting significant infrastructural, economic and social developments in both interconnected countries, this being even more relevant for the developing countries of the Southern Mediterranean shore.
- In most ENTSO-E countries, sharing services is currently possible, but not widely deployed except for emergency support among them, since most of them opt to relay on their own reserves to compensate for grid disturbances. The present contribution of RES to sharing of services is relatively small, but is expected to increase in the near future, with the aim to mitigate the impact of large RES development programs.
- In countries of the Southern Mediterranean shore where market is not yet in place, sharing services can also be achieved by replacing the market related features with appropriate inter TSOs agreements, covering the technical requirements and the financial compensations necessary for a real application of this platform. In this case, TSO's may assume the role of Balance Responsible Party and be instrumental in setting up Balance Service Providers organizations.

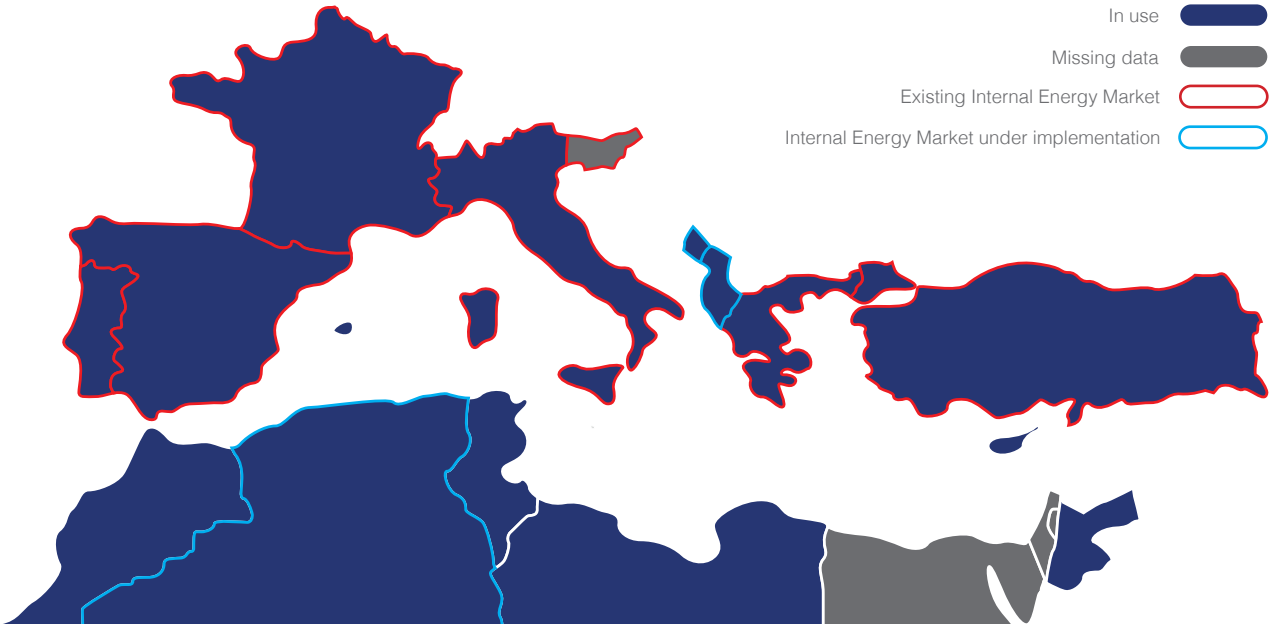


Figure 20 Countries where FCR is in use

- Some Southern shore Countries have ambitious goals on RES growth, but limited electricity markets and less conventional generation to support such growth. Sharing services is a key element to facilitate such RES integration. More specifically, without sharing services, the maximum admissible level for RES deployment depends on the parallel growth and the fast response of conventional generation. In addition to the relatively small present contribution of RES themselves, system's FCR can be achieved by increasing generators' statism and improving ramping capabilities. This would require significant hardware retrofitting for existing RES, while for future at the design level, the cost of this option should be evaluated against the benefit of increasing RES deployment. FRR and RR, slower in response, appear to be a less important issue but still require adequate attention for determining the size of the necessary reserves to accommodate RES growth.

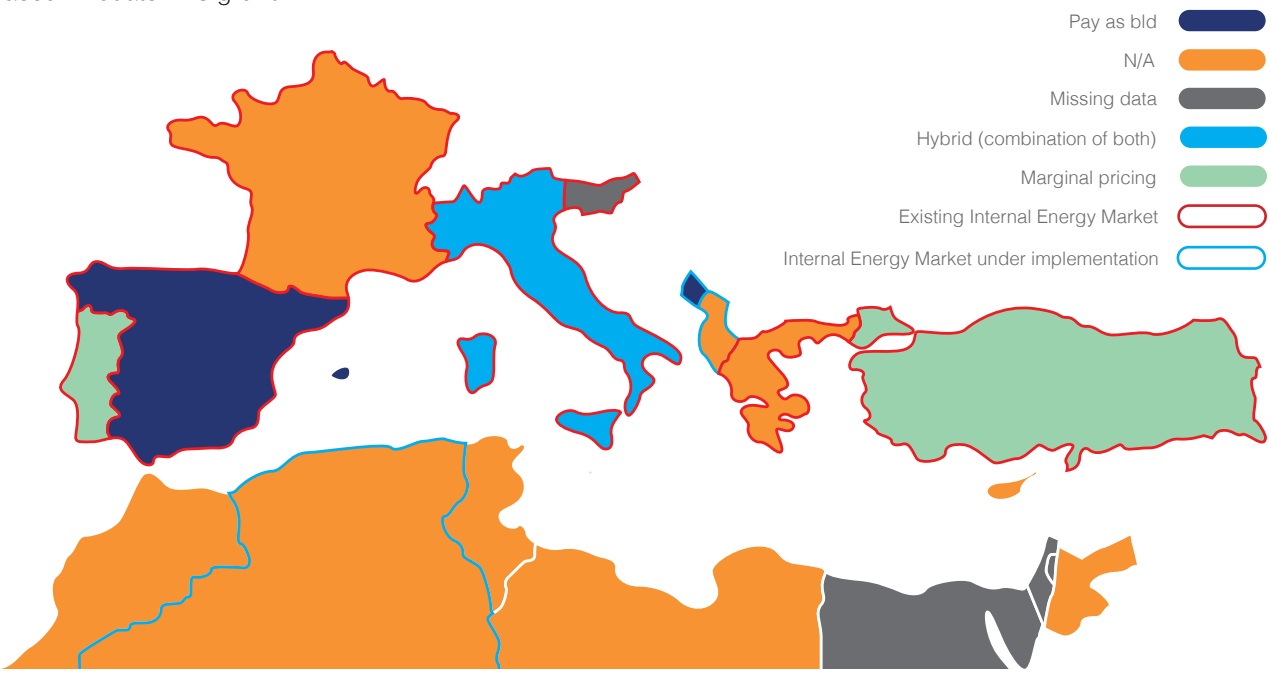


Figure 21 Settlement rule for load providers of balancing services

- Flexibility is a prized characteristic in power systems with significant RES. How this flexibility is procured is strongly shaped by the regulatory context. Vertically integrated utilities typically can use contractual or policy mechanisms to extract flexibility from generators. In contrast, in partially or wholly restructured power markets, like in some ENTSO-E countries, system operators use market designs—with clear definitions of performance requirements—to incentivize the provision of power system flexibility. Through interconnections, flexible resources can be pooled by market coupling and cooperation on reserve/balancing, pooling response, ramping capabilities and system services. **BALIT (Balancing Inter TSO's) platform** between Portugal and Spain is a good example of a very beneficial practice allowing cross-border exchanges of balancing services among countries and entailing the trading of unused balancing services in a control area. In this platform, each TSO keeps its own reserves and its own procurement mechanisms and may elect to bid its surplus of balancing energy into the other TSO's mechanism next to real time using the remaining NTC available at that moment. To apply this concept in market oriented countries, services can be bid into neighbouring control areas, thus resulting in increasing reliability and efficiency, fostering competition and mitigating balancing costs.
- The final goal of coordination is to achieve consolidated operation for maximum economic benefit and least cost RES integration. Consolidated operation consists in merging of two or more balancing areas run by a joint single operating organization. Similar results can be achieved by a virtual or partial consolidated operation based on specific cooperative agreements creating a new operating entity responsible for running both balancing areas. To achieve such long term coordination target shall require:
    - institutional consensus between interconnected countries
    - interconnected systems stakeholders support, including generators and IPPs (if present)

- harmonization of the regulatory framework (rules and statutory codes focusing on reserves sharing) between interconnected TSOs
- harmonization and strict coordination of technical parameters between interconnected TSOs
- coordination of Development Plans, for both conventional and RES generation, between interconnected systems

MED-TSO DATA BASE (DBMED)

A repository of data needed to feed the basic activities of interconnected systems is a prescription of the Mediterranean Project. This is is also a prerequisite to make enduring and sustainable the activities described in the previous sections.

TASK

DBMED will be used as a structured repository for storing, country by country, historical data on adequacy and related parameters like generation, NTC values, demand evolution, other statistics, but also complete information on the Transmission Systems components in the form of full grid models, provided, validated and updated on a regular basis by Med-TSO members. A key feature, rendering DBMED a unique exchange tool between Med-TSO members, is the possibility to collaborate with all the different commercial software for network analysis used by the TSOs, thus enabling exchange of data and information in a more flexible, accurate, quick and effective manner.

DBMED ARCHITECTURE

DBMED is developed as a web-based database with a dedicated server for storing and exchanging of data. It operates on a multi-user platform, considering possible different authorization levels and ensuring safe access to DBMED information stored and exchanged by the Med-TSO Members.

DBMED access and use is independent of the software used by the Med-TSO Members: import and export of data and network models is possible in the different software formats used by the TSOs for network analysis.

Since the users of the application are located in different countries, a web application based on a three-tier architecture was adopted for DBMED, where presentation, application processing, and data management functions are physically separated. Three-tier architecture is composed of a presentation tier (web client), a domain logic tier (application server), and a data storage tier (data server). The solution requires that the users are provided with Internet access.

The DBMED implementation was developed with Extjs framework and Java for the frontend application, while for the backend database Oracle is used, a worldwide leader in database application, with highest performance, scalability and encryption options. The DBMED application runs on Tomcat webserver. For the infrastructure solution, cloud IAAS is used with the application being installed on virtualized hardware maintained by the cloud provider. Using the computer and a browser, DBMED user connects via Internet with the application. The application provides secure access by requiring user authentication, using traffic encryption (https protocols) and digital certificate to ensure the security and reliability of the connection.

Different user categories with different credentials and roles are defined within the DBMED and assigned to the TSO users, enabling them to access and manage data, as follows:

- Administrative Controller;
- TSO administrators;
- Viewer;
- Guest.

DBMED MAIN STRUCTURE, ACTIVITIES AND FEATURES

DBMED is organized into three sections,

A. **Network**: network data for load flow analysis

B. **Market**: data necessary for market studies

C. **Adequacy**: historical and statistical data, for adequacy studies and reporting purposes

In the present implementation of DBMED only Network section is fully implemented, while Market and Adequacy sections are being developed.

DBMED features comply connection with DBMED with the best practices, as depicted in Fig. 22.

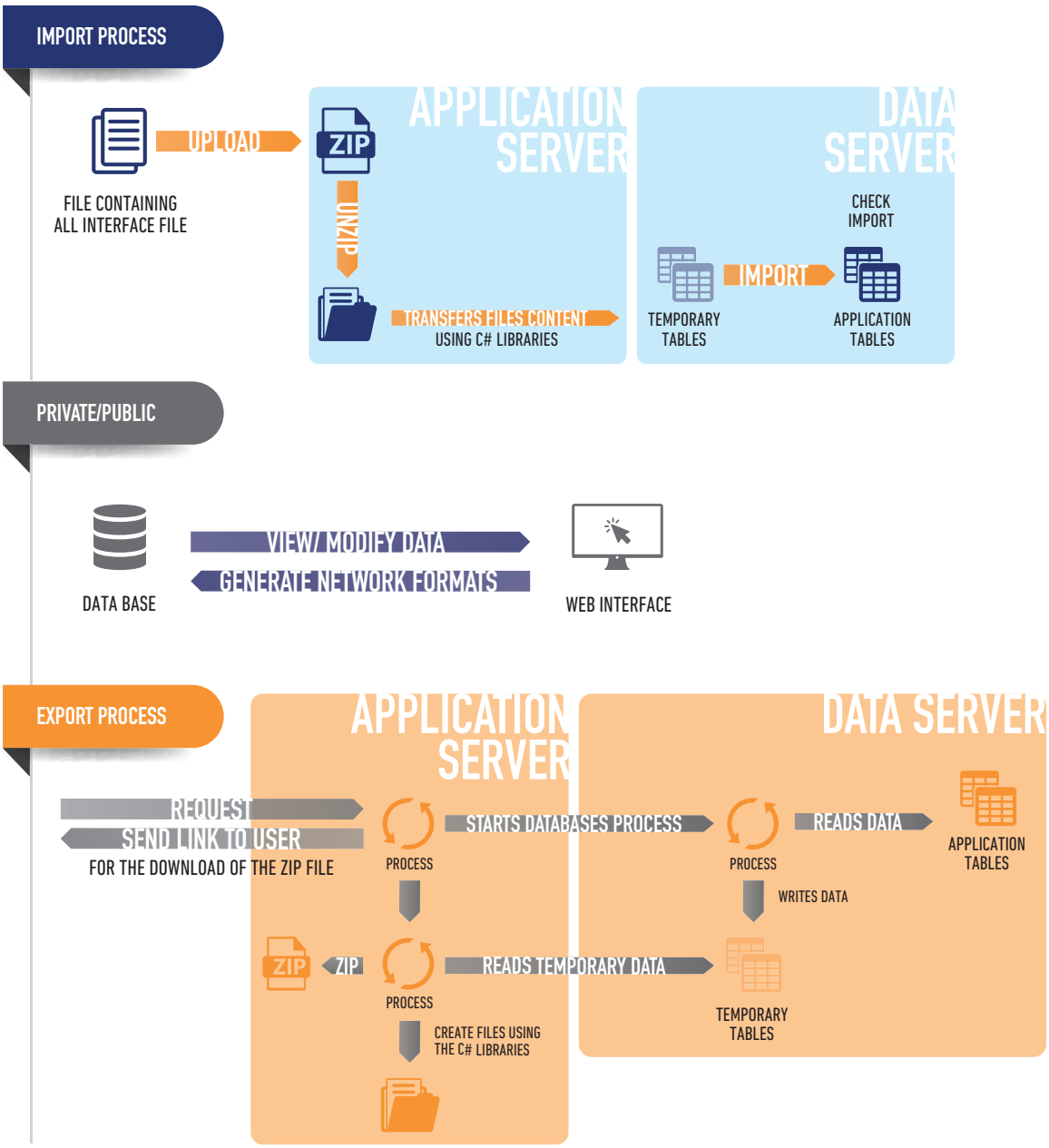


Figure 22. Maine features of DBMED

THE GRID MAP

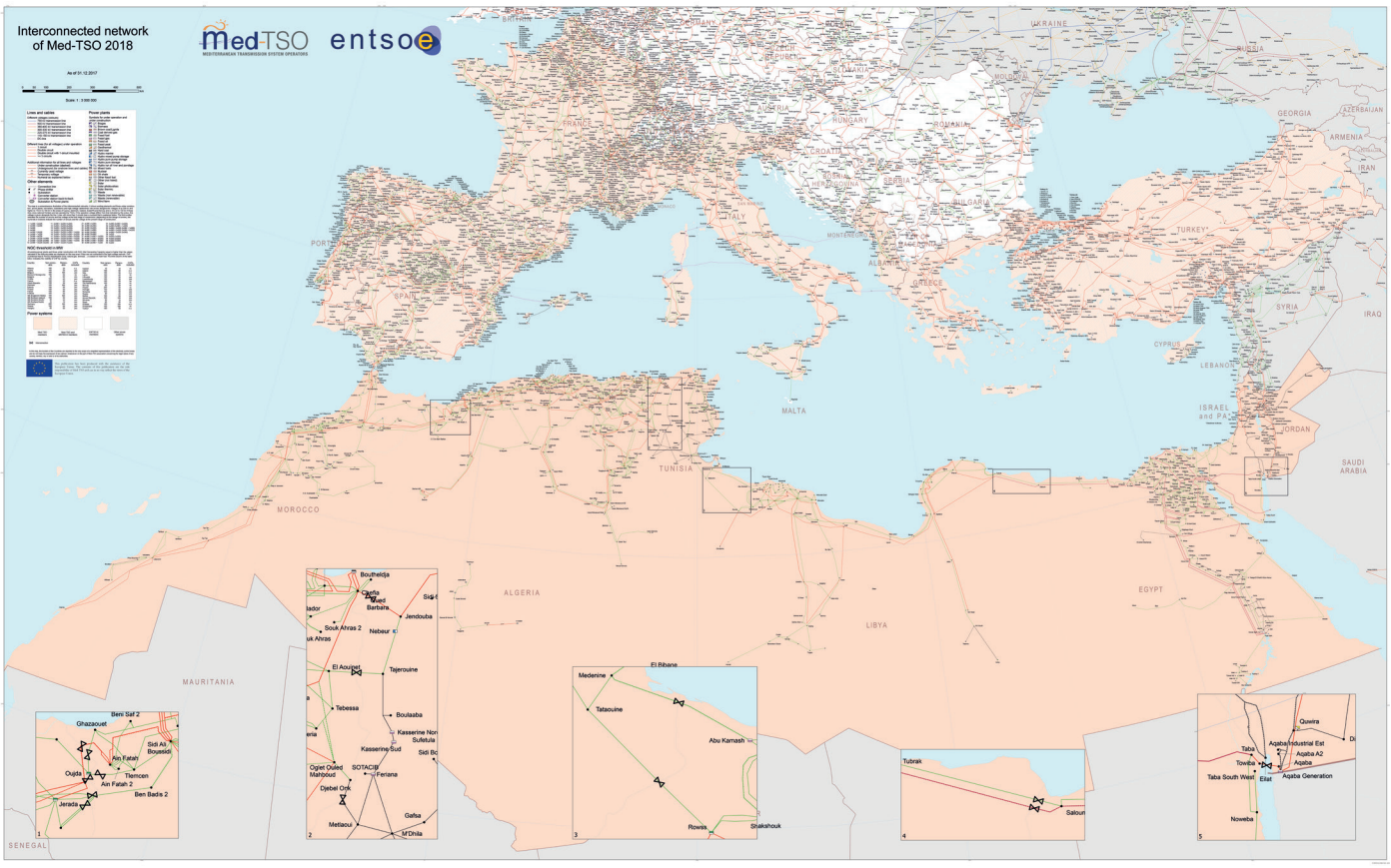
This map is a comprehensive illustration of the transmission system network operated by members of the Med-TSO, and it has been developed in cooperation with the European Network of Transmission System Operators (ENTSO-E).

The map represents some 400 000 km of high voltage lines in the Med-TSO region as per the end of year 2016, and it is the first of its genre to give a comprehensive picture of the status of the electric interconnections within the Mediterranean region, an area that groups three different synchronous zones:

- ENTSO-E synchronous Continental Europe zone,
- South Western Mediterranean Block, which is synchronous with the ENTSO-E's synchronous Continental Europe zone;
- South Eastern Mediterranean Block

The lines represented, constitute the relevant electricity grid, i.e. the portion of the grid that can affect the interconnections between the power systems.

In general, the map depicts all transmission lines designed for 220kV voltage and higher and generation stations with net generation capacity of more than 100 MW. It is important to note that the map takes into account also the also the lines between 110 and 150 kV given the peculiarities of the power systems of the members of Med-TSO. Moreover, the map includes five zooms in order to highlight the existing interconnections within the Mena region.



KNOWLEDGE SHARING

Knowledge sharing has the very important objective of establishing a forum among the relevant professionals from the Members working in the technical activities carried out by Med-TSO through its Technical bodies (Committees, Working Groups and Task Forces) and making the main results available for the external stakeholders.

Three workshops have been held in the frame of the Mediterranean Project for sharing the experience and disseminating the results of the 3-year activities.

In order to coordinate the dissemination and knowledge sharing activities, a network of Single Point of Contact (SPOCs) has been set up. This network has also the aim to inform all the members of the Association about the news related to activities designed to improve the exchange of technical information between the various TSOs.

Furthermore, several initiatives are going to be launched in the next months, in the frame of the future activities that will be carried out as a continuation of the Mediterranean Project, to address a list of topics considered of relevant interest for Med-TSO and its Members. Among them, HVDC theory and practice sessions have been scheduled, to meet the needs of sharing knowledge about this technology, envisaged to be the most used for crossing the Mediterranean Sea.

WORKSHOP OVERVIEW

A Common Target Regulatory Framework for the Mediterranean TSOs - Harmonization of Technical Rules

The workshop took place in Madrid hosted by Red Eléctrica de España (REE) at its headquarters in Madrid, on 15 March 2017.

This initiative was promoted by Med-TSO's Technical Committee "Regulation and Institutions" (TC2) to share views on the Common Target Regulatory Framework and the Tentative Road Map, as well as to interchange experiences and challenges in the different fields of practical implementation at national level and multinational harmonization of rules concerning TSOs functions.

TC members presented the proposal of common target regulatory framework in different field: Legal and Regulatory, Connection, Operation and System service market, as well as the proposal of a common tentative road map.

Some of other issues explained during this workshop: national implementation of Network Codes and the implementation of the System Operation Guidelines and their impact in managing renewables, with the implementation of Market codes, the implementation of European network codes in Albania, the ongoing regulatory harmonization in the Maghreb countries and the regulatory challenges in an isolated system.

Renewable Energy Development and Integration in the Mediterranean Region

This initiative took place for two days in Algiers (24-25 October 2017). The workshop was organized by the Technical Committee "International exchanges of electricity" (TC3) and the Working Group "Economic Studies and Scenarios" of Med-TSO, with the support of Sonelgaz, the Algerian TSO.

The workshop focused on some of the results achieved by the Association in the framework of the Mediterranean Project , aiming at improving the integration of the Mediterranean Power Systems through the definition of a common framework of rules and procedures shared by all Med-TSO Members.

The target of TC3 within the Mediterranean Project is to define methodologies, procedures and operational mechanisms for sharing resources through the cross-border exchange of electricity, based on the complementarities between the Members' systems and the effective use of the already existing and planned transmission infrastructure.

Six are the drivers calculated by the scenarios studies: Economy and population; Renewable energy development; Technology development; New load (water de-salinization, electric cars, public transportation, energy efficiency); Market integration (internal market, regional market, or global market); Thermal carbon free technologies.

The workshop was also an opportunity to exchange different best practices for facilitating Renewable Energy Sources integration in the Mediterranean countries.

Network Analysis – Sharing Knowledge and experience on coordinated planning

The workshop was organized by the Technical Committee "Planning" (TC1) of Med-TSO and hosted by Terna (20 March 2018 , in Rome at Terna Campus). The worldwide Energy transition and the evolution of the Energy Sector involve the northern and southern banks of the Mediterranean basin in the same direction but with different peculiarities. 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 potentiality of renewable generation and by a fairly high rate of growth of the demand, supported by concrete examples of plans and deployment of RES. In the frame of the Mediterranean Project, TSOs worked, among the others, to setting up a development plan of the interconnection.

During this workshop it was possible to learn about the Master Plan delivered by the application of the agreed Planning Process, based on the following activities: Scenario Building definition; integration of national generation adequacy plans; set up of a regional Market model and relevant studies, results of the network studies performed for 14 projects classified along three corridors (Western, Central and Eastern).

NEXT STEPS

Med-TSO Association has successfully performed the Mediterranean Project (MP I), and it is fully committed to continue the consolidation of a more secure and sustainable electricity infrastructure in the Mediterranean region with a focus on increasing the interconnection capacity in the region. A new Action, called “Mediterranean Project II” [8] (MP II) is going to be launched, again with the support of the European Commission, with the aim of continuing and, where it is possible, consolidating and improving the activities carried out by the previous Mediterranean Project. Med-TSO will develop the proposed Action according to its Action Plan 2018-2020, aimed at extending and integrating the Mediterranean electricity systems, in line with the objectives of EU's Neighbourhood policy on Energy and Climate Change.

Med-TSO has identified the need for **strengthening TSOs cooperation in both system operation and system development**, structuring its new Action Plan along the following streams of activity: Planning of infrastructures; Regulation & Power System Rules; Scenarios Adequacy and Market Studies; Operation of Power Systems; Training and Knowledge sharing.

The key expected objectives of the **proposed new Action** are:

- **Consolidating the Planning process**, by updating and improving the Mediterranean Master Plan, with the perspective of making it as a standard delivery of the Association;
- Continuing the **harmonization of regulation and technical rules** in the Mediterranean region, possibly by implementing a zonal approach in selected priority areas, taking into account national diversities and promoting faster harmonisation where possible;
- Improve Med-TSO capabilities for elaborating **Adequacy reports** and carrying out **Market Studies**;
- Starting cooperation in the Operation area, by setting up a **Common Web-Platform for** TSOs members to gather information on cross-border interconnections; and drafting **periodical reports** on the behavior of the regional electricity system in normal and critical conditions;
- Launch an intensive **exchange of expertise** between the Members of the Association and towards both the main stakeholders in the region (MEDREG, Arab Union for Electricity, ENTSO-E) and Academia, throughout training, workshops and events for knowledge dissemination, both internal and external.

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