



Mediterranean Electricity Interconnection Perspective

2025 edition

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The drafting team which realized this document was composed of:

Charalampos PITAS IPTO - Greece

Francisco REIS REN - Portugal

Emmanuel BUÉ RTE - France

Andrea CIANFANELLI TERNA - Italy

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Abbreviations

AC	Alternative current
CBA	Cost Benefits Analysis
CCGT	Combine Cycle Gas Turbine
DBMED	Mediterranean Database
DC	Direct current
EC	European Commission
EENS	Expected Energy Not Supplied
ENS	Energy Not Served
ENTSO-E	European Network of Transmission System Operators for Electricity
EU	European Union
GDP	Gross domestic product
GHGs	Greenhouse gases
GWh	Gigawatt hour
HVAC	High voltage alternating current transmission
HVDC	High voltage direct current transmission
IN	Inertial scenario
kV	kilovolt
LCC	Line-commutated current-sourced converters
LOLE	Loss of Load Expectation
MA	Mediterranean Ambition scenario
MEDREG	Mediterranean Energy Regulators
Med-TSO	Association of the Mediterranean Transmission System Operators (TSOs)
MENA	Middle East and North Africa
MW	Megawatt
MWh	Megawatt hour
MMP	Mediterranean Masterplan
NDP	National Development Plan
NTC	Net Transfer Capacity
OCGT	Open Cycle Gas Turbine
PCI	Project of Common Interest
PINT	Put IN one at a Time
PiTs	Points in Time
PMI	Project of Mutual Interest
PR	Proactive scenario
PV	Photovoltaics
RES	Renewable Energy Sources
SEW	Socio-economic welfare

SoS	Security of supply
TEASIMED	Towards an Efficient, Adequate, Sustainable and Interconnected MEDiterranean power system
TOOT	Take One Out at a Time
TSO	Transmission System Operator
TYMNDP	Ten-Year Mediterranean Network Development Plan
UNFCCC	United Nations Framework Convention on Climate Change
VSC	Voltage source converters
VOLL	Value of Lost Load

1

Executive Summary

The present edition of the Mediterranean Electricity Interconnection Perspective (MEIP) represents the result of the collaboration between the 20 Transmission System Operators (TSOs)¹ of Med-TSO, aimed at exploring the opportunities to strengthen the electrical integration across the Mediterranean region.

Together with the updated Master Plan of Interconnection, this document is one of the key deliverables of TEASIMED 2 (Towards an Efficient, Adequate, Sustainable and Interconnected MEDiterranean Power System 2), the fourth consecutive project co-funded by the European Commission to sustain the development of the region.

The report includes the assessment of 11 interconnection projects promoted by Mediterranean TSO members from 13 different countries, spanning five different corridors characterised by common geographical particularities and challenges. It also includes seven exploratory projects, analysed to assess the potential benefits of increasing transmission capacity across borders currently not directly investigated by Med-TSO members. Including these exploratory projects, the total number of involved countries rises to 18 in total.

Projects are assessed for the first time with a view to the 2040 time-horizon and considering three different energy scenarios developed by Med-TSO members, in alignment with the scenarios developed by ENTSO-E, the Association of European TSOs, in the framework of the 2024 Ten-Year Network Development Plan (TYNDP).

¹ <https://med-tso.org/en/members/>

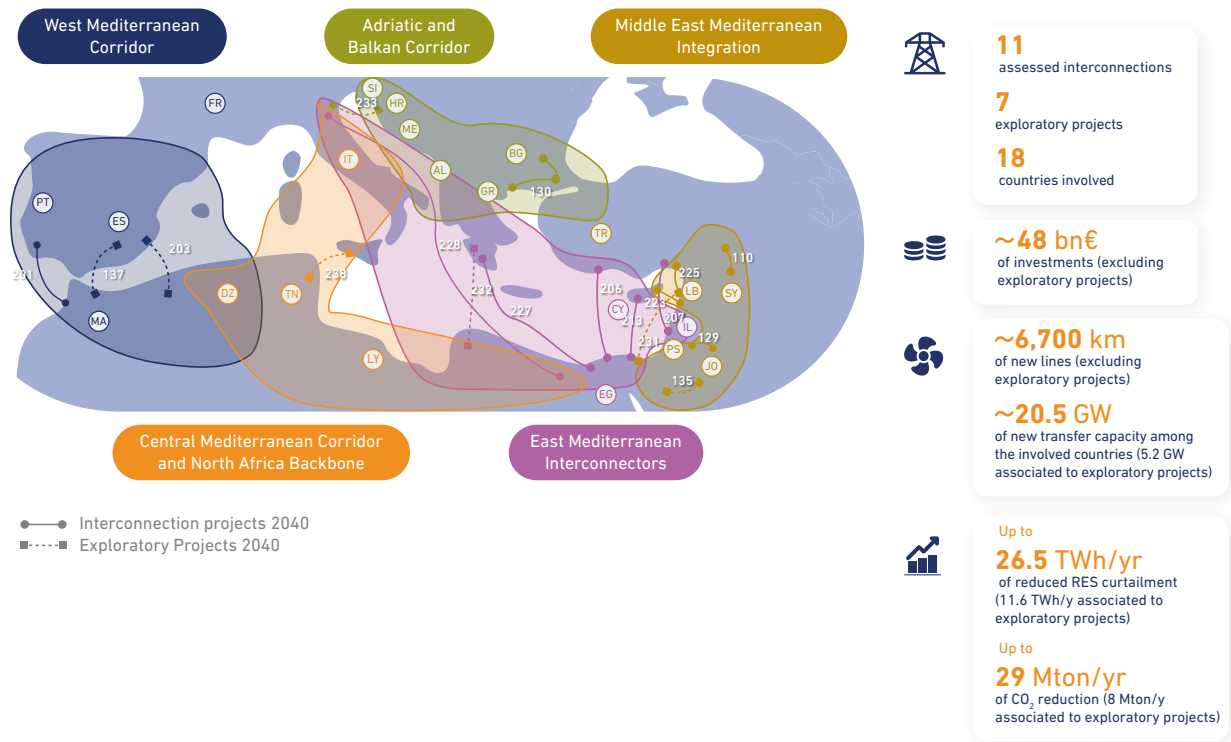


Figure 1: MEIP 2025 Main Results

Within the framework of the MEIP, TSOs were given the opportunity and the tools to identify the possible evolution trends for the whole Mediterranean region, identify the associated system and network needs, and assess the benefits of interconnection projects to cover them.

Observing at the results and the overall indicators resulting from the MEIP as depicted in Figure 1, the following key considerations could be extracted:

- Globally, the execution of all 18 interconnection projects, including exploratory ones, would result in around 20.5 GW of additional transfer capacity, involving investments up to €48bn. This would significantly contribute to the development of the Mediterranean region in the medium term from economic, social and environmental perspectives.
- While the updated Master Plan provides useful insights on projects currently under development or currently included in TSOs' National Development Plans (NDPs), the MEIP predominantly focuses on future interconnections subject to preliminary assessment, and even exploratory interconnection projects.
- Developing new interconnection capacity is crucial for leveraging the complementarities among Mediterranean countries, supporting renewable energy integration and contributing to the reduction of CO₂ emissions.

- In certain cases, interconnections help reduce the energy isolation of specific countries or regions, significantly enhancing their security of supply (SoS), while also contributing to system stability.
- Building interconnections looking at both the 2030 and 2040 horizons represents a fundamental step towards the progressive, long-term energy integration of the Mediterranean region. This process will require continued development to ensure efficient operational use of the available transmission capacity.

2

Introduction and context of the MEIP

2.1 The Climate Agenda & the Mediterranean

Climate change remains one of the most pressing and complex challenges of our era, shaping both the global political discourse and economic priorities. Since the landmark adoption of the Paris Agreement in 2015 under the United Nations Framework Convention on Climate Change (UNFCCC), nations have intensified their collective efforts to limit the rise in global average temperature to well below 2°C, and ideally to just 1.5°C above pre-industrial levels.

In this context, the European Union has progressively asserted its climate leadership. The European Green Deal, unveiled in 2019, serves as the foundation of the EU's strategy to achieve climate neutrality by 2050. It promotes a transformative model of sustainable growth that decouples economic development from greenhouse gas emissions. This ambition was further solidified in 2021 with the Fit-for-55 package, which establishes the legally binding target of reducing EU emissions by at least 55% by 2030 compared to 1990 levels.

The energy crisis precipitated by the Russian invasion of Ukraine in 2022 underscored the strategic urgency of accelerating the clean energy transition. In response, the European Commission launched the REPowerEU Plan, emphasising that reducing reliance on fossil fuel

imports and investing in renewables, energy efficiency, and resilient infrastructure are not only environmental imperatives but also critical to energy security and economic stability. As a result, the global climate agenda has evolved to integrate security, industrial competitiveness, and resilience into the broader decarbonisation framework.

Meeting the objectives of the Paris Agreement and the EU's long-term climate vision demands a profound transformation of the global energy system across both supply and demand. On the supply side, rapid deployment of renewable and low-carbon technologies is essential, supported by flexible assets such as battery energy storage systems (BESS), enhanced grid interconnections, and demand-side response mechanisms to manage the variability of renewable generation. On the demand side, improvements in energy efficiency, widespread electrification, and shifts in consumption behaviour are vital to aligning energy use with climate targets.

Within this broader transformation, the Mediterranean region holds a unique and strategic position. Although its total greenhouse gas emissions account for only around 6% of the global total², the region is disproportionately affected by climate impacts, including intensifying heatwaves, droughts, and water scarcity. These phenomena threaten ecosystems, food systems, and economic stability. At the same time, the region's energy and demographic dynamics are highly heterogeneous. Southern and eastern Mediterranean countries are experiencing rapid population growth, urbanisation, and industrialisation, driving a steady rise in electricity demand. In contrast, northern Mediterranean countries are advancing in energy efficiency and renewable integration but face growing challenges related to grid flexibility and system stability as the share of variable renewables increases.

Importantly, Mediterranean non-EU countries have also joined the global climate effort by formulating and updating their Nationally Determined Contributions (NDCs) under the Paris Agreement. These commitments reflect growing political will to reduce emissions, enhance climate resilience, and promote sustainable development. Many of these countries are now designing national policies and strategies that align with their NDC targets, including renewable energy deployment, energy efficiency measures, and climate adaptation initiatives. This convergence of ambition across the Mediterranean Basin reinforces the potential for coordinated regional action.

The southern and eastern Mediterranean countries are naturally equipped with abundant Renewable Energy Resources (RES), particularly solar and wind. These resources offer the potential not only to meet rising domestic demand but also to support regional energy integration and the development of green hydrogen markets. However, the deployment remains slower than the region's technical and economic potential would suggest. Despite falling technology costs and increasingly supportive policy environments, barriers such as limited grid infrastructure and financing constraints continue to impede large-scale implementation.

The contrasting realities across the Mediterranean Basin present significant complementarities

² Carbon Emissions - Global Carbon Atlas

that could be leveraged through enhanced regional cooperation. Developing robust electricity interconnections is central to unlocking these synergies. Strengthened cross-border infrastructure would enable more efficient resource sharing, bolster system flexibility, enhance energy security, and facilitate greater renewable energy integration. Moreover, interconnected grids lay the groundwork for integrated electricity markets, facilitating optimal resource dispatch and supporting the transition to a sustainable and resilient energy system.

Looking ahead, the success of the climate and energy transition in the Mediterranean will depend on coordinated action across national, regional, and European levels. The region's vast renewable potential, rising energy demand, and strategic location linking Europe, North-Africa, and the Middle East, position it as a pivotal actor in the global energy transition. Fulfilling this potential will require sustained political commitment, targeted infrastructure investment, innovation in grid technologies, and the establishment of clear and stable regulatory frameworks. By aligning climate ambition with regional cooperation and economic opportunity, the Mediterranean can play a decisive role in advancing global decarbonisation and fostering regional stability.

2.2 Med-TSO's vision

Med-TSO is the leading strategic and technical association driving the evolution of the electricity sector across the Mediterranean, a hub region that connects Europe, Africa, and Asia.

This report is a direct product of that vision, demonstrating Med-TSO's role as a platform for the multilateral cooperation of its 20 member TSOs, and reflecting the Association's commitment to shaping the Mediterranean into a model of integrated, resilient, and sustainable power systems.

Through policy alignment, technical cooperation, and strategic infrastructure planning, Med-TSO supports its members in leading the transition toward a reliable and climate-resilient energy future for this diverse and interconnected region.

The Association aims to become a key instrument for the integration and development of the region's electricity transmission systems, a goal pursued through the projects assessed in this document, which focus on interconnection development and the large-scale integration of RES. By providing proactive support to its members in planning of new interconnections and facilitating a harmonised assessment framework, Med-TSO works to represent the collective needs of the region's TSOs and improve relations with all stakeholders in order to build a more integrated, sustainable, and secure energy future.

2.3 Aim and scope of Mediterranean projects

The Mediterranean Interconnection projects promoted by Med-TSO members, planned for the 2040 time-horizon and beyond, along with the exploratory initiatives, are assessed to evaluate their potential to enhance regional energy security, address the challenges of the energy transition, facilitate widespread RES integration, and support market harmonisation in line with long-term climate objectives. This assessment aims to provide strategic guidance for investment prioritisation by fostering regional cooperation, aligning infrastructure development with shared goals, and ensuring these projects can effectively accelerate decarbonisation, increase system flexibility, and promote long-term energy independence across the region.

Interconnection projects are organised into five corridors, or project clusters: the West Mediterranean Corridor, Central Mediterranean & North Africa Backbone, East Mediterranean Interconnectors, Adriatic and Balkan Corridor, and Middle East Mediterranean Integration, to better capture common drivers, regional needs, and shared geographic and network characteristics. The evaluation includes an in-depth analysis of the techno-economic feasibility of these interconnections, considering future capacity requirements, technical standards, and grid integration challenges associated with rising renewable generation, as well as the integration of advanced technologies such as green hydrogen and electric mobility. The assessment explores three long-term scenarios that account for evolving demand patterns, generation mixes, and regional market integration, supported by detailed technical studies including 8,760-hour network simulations and market studies through a comprehensive cost-benefit analysis (CBA). The results are summarised in concise technical descriptions, outlining necessary grid reinforcements, estimated project investment costs, and key CBA indicators such as socio-economic welfare (SEW), RES integration potential, and CO₂ reduction benefits. Additionally, the analysis highlights each project's overall merits. These assessments aim to confirm that prioritised projects are technically robust, economically viable, and environmentally sustainable.

2.4 Why a 2040 Mediterranean Perspective document?

The Mediterranean region stands at a pivotal juncture in its energy transition. While the 2030 Master Plan of Interconnection developed by Med-TSO provides a robust framework for short-term infrastructure development, the rapidly evolving energy landscape demands a complementary 2040 Mediterranean Electricity Interconnection Perspective document. This medium-term strategic outlook is essential to anticipate future challenges, guide investment decisions, and ensure the resilience and integration of the Mediterranean Power System.

The 2030 Master Plan focuses on mature interconnection projects and near-term market analyses. However, the energy transition is not a linear process. The 2025 edition aims at updating the report published in 2022 and focuses on 2030 targets, prioritising the most mature

infrastructure projects that are essential for advancing regional decarbonisation, integrating renewable energy sources, and enhancing cross-border interconnections. These projects strive to improve energy security, boost market efficiency, and reduce the environmental impact of electricity generation.

However, by 2040, the Mediterranean region will face new technological, geopolitical, and environmental dynamics that cannot be fully captured within a 2030 horizon. Examples include the rapid growth of Renewable Generation Sources (RES) and the evolutions around green hydrogen and electric Mobility. The 2040 Perspective document serves as a bridge between the tactical 2030 goals and the visionary 2050 decarbonisation targets, offering a coherent roadmap that aligns infrastructure development with long-term climate commitments.

Infrastructure investments require long lead times and substantial capital. The 2040 Perspective document assesses priority projects promoted by Med-TSO members, defines technical requirements and evaluates economic viability. This transparency is crucial for attracting funding from public and private sources, including EU instruments and international financial institutions. It also helps mitigate risks by aligning investments with long-term demand forecasts and policy trends.

It is important to emphasise that the 2040 Perspective document is not a substitute for the 2030 Master Plan; it is a complementary tool. While the Master Plan focuses on mature projects and immediate needs, the 2040 document explores long-term opportunities, emerging technologies, and strategic reinforcements. Together, they form a comprehensive planning suite that equips Med-TSO to navigate the complexities of the energy transition. Moreover, they ensure a strategic, phased approach to regional energy development, balancing immediate priorities with long-term ambitions.

The prospects for the evolution of Mediterranean Power Systems are presented in detail in another deliverable of the TEASIMED 2 project: the Med-TSO Scenario Report for the 2030 and 2040 horizons.

3

Elaboration of the MEIP

The 2025 edition of the Mediterranean Electrical Interconnection Perspectives (MEIP) report builds on the consolidated planning methodology developed and refined by Med-TSO through its previous study projects, aimed at the coordinated study and development of interconnection projects across the Mediterranean. This methodology is designed to support the energy transition and the evolution of power grids in a cost-effective, secure, and regionally integrated manner.

The interconnection projects are evaluated against a set of long-term energy scenarios that reflect potential evolutions in electricity demand and generation. These scenarios provide a robust analytical foundation for grid planning studies, allowing for a comprehensive assessment of project impacts from both technical and economic perspectives. The evaluation process integrates results from market simulations and network analyses to inform investment decisions.

The methodology includes the following key steps:

- Definition of Mediterranean energy scenarios.
- Identification of future interconnection projects.
- Development of regional power system models for market studies.
- Load flow analysis and assessment of infrastructure requirements to meet security

standards.

- Cost-Benefit Analysis (CBA) of proposed investments.

While the MEIP 2025 report maintains the core methodological framework of the Med-TSO Master Plan, it introduces updated scenario assumptions and revised CBA results. The projects analysed in this edition are expected to be implemented by 2040, extending the planning horizon beyond that of the Master Plan report published earlier in 2025, which focused on projects targeted for implementation by 2030.

MEIP 2025 therefore complements the Master Plan by identifying and assessing additional interconnection projects necessary to meet the evolving energy needs of the region over the next two decades. These projects reflect a long-term vision for regional integration and system flexibility, aligned with the broader goals of decarbonisation, energy security, and market development across the Mediterranean.

In addition, MEIP 2025 includes the preliminary market assessment of a set of exploratory projects, primarily focused on market analysis. These are conceptual interconnections rather than committed projects, designed to explore the potential evolution of cross-border exchanges beyond 2040. This forward-looking exercise ensures that all plausible future developments in regional connectivity are considered, providing valuable insights into strategic directions that Mediterranean electricity systems could take under various long-term scenarios.

3.1 Projected evolution of Mediterranean power systems by 2040

The Scenario-Building Process developed by Med-TSO serves as the foundation for assessing future energy needs. It delivers a quantitative basis for infrastructure assessment and network planning by defining a set of plausible futures against which system performance can be tested. In practice, these scenarios are designed to capture the dynamic uncertainties of the energy transition.

The Med-TSO framework includes three long-term scenarios: Inertial, Proactive and Mediterranean Ambition, which represent different levels of interaction among national power systems, ultimately aiming at a more coordinated Mediterranean Power System. These 2040 scenarios outline possible pathways from the present to a range of future trends in energy demand, electricity generation, sector coupling, technological development, policy directions, and decarbonisation goals. They provide a solid foundation for grid development studies.

INERTIAL SCENARIO

No breakthrough in the midterm

Under a scenario of moderate GDP and electricity consumption growth – factors that influence electricity demand more significantly in MENAT countries than in European countries – the Inertial scenario implies the achievement of mid-term energy targets aligned with RePowerEU and Fit-for-55 objectives for Europe. However, international cooperation remains limited beyond the European context.

In the Inertial scenario (IN), energy policies primarily prioritise local and national implementation, largely due to persistent disparities in power sector regulations among Mediterranean regions and countries. The advancement of RES is steadily but moderately progressing, in alignment with national energy policies. Within this context, the development of green hydrogen exhibits only marginal progress, primarily due to the absence of robust regionally coordinated policies and integration. There is no distinct preference towards small-scale, decentralised plants or large, centralised ones. Overall, progress in the adoption of electric vehicles and electrification in other sectors, as well as energy efficiency measures, remains sluggish, except for a select few countries that have implemented strong incentive policies.

PROACTIVE SCENARIO

Bottom-up boost of distributed generation and electrical devices at the consumer level

With a significant increase in GDP and electricity consumption, there is a stronger commitment to achieving a more sustainable energy sector, leading to an intensified development of renewable energy sources in support of EU climate neutrality by 2050. However, international cooperation among MENAT countries remains limited and robust energy policy integration is still lacking.

In the Proactive scenario (PR), the development of RES is primarily driven by local solutions and tailored regulations or incentives that encourage widespread investment at the consumer and prosumer levels. This approach is integrated with smart energy management systems in homes and buildings.

Certain countries are accelerating the integration of green hydrogen strategies, the adoption of electric vehicles, and promoting electrification in other end-use sectors alongside implementing energy efficiency measures. However, significant disparities persist among countries. The implementation of distributed generation reduces reliance on grids and minimises energy losses, although interconnections remain crucial due to the higher penetration of RES.

MEDITERRANEAN AMBITION SCENARIO

Top-down boost for supra-national cooperation and utility-scale developments

With a notable increase in GDP and electricity consumption, there is a heightened aspiration for a more sustainable energy sector, resulting in an intensified development of renewable energy sources and a stronger commitment to achieving climate neutrality by 2050. Moreover, there is an improved level of cooperation in the Green Transition, encompassing policy integration, financing, industry collaboration, and technology transfer.

This collaborative effort extends across the Mediterranean region, with a multilateral and regional approach that emphasises significant advancements in energy policy integration, regulatory harmonisation, and technical cooperation among grid operators.

In the Mediterranean Ambition scenario (MA), the significant growth of renewable energy sources is facilitated mainly through utility-scale projects, supported by institutional agreements and international cooperation, including off-take agreements. The abundance of carbon-free energy sources also fosters the exploration of new applications for electricity, such as green hydrogen, as well as deep electrification of buildings and industrial processes, which are increasingly embraced in national and regional strategies. Additionally, there is a stronger impetus towards energy efficiency. This scenario underscores the complementary nature of diverse countries' approaches in implementing large-scale projects.

Regarding EU-27 countries, both the Proactive and Mediterranean Ambition scenarios aim to reach full decarbonisation in 2050, with two contrasting pathways proposed in the TYNDP2024 approach: Proactive focuses more on renewable development and decentralised options, while Mediterranean Ambition favours a centralised low-carbon option and more electricity interconnections.

The Mediterranean Ambition scenario stands out from the other two due to one particular driver: enhanced regional cooperation between Mediterranean countries. This scenario considers major changes in energy policy integration, regulatory coordination, and technical and financial cooperation.

Among the most essential aspects that this cooperation should encompass, the industrial dimension, for example, could maximise the share of local manufacturing of energy equipment (and thereby boost employment) in the countries concerned. Access to the most favourable credit conditions is also crucial for supporting investments in renewable energy and related technologies.

Most MENAT countries currently perceive the lack of tangible progress in international cooperation as an obstacle to the full implementation of the policies and investments identified to successfully achieve the energy transition.

Overcoming this obstacle will be crucial to unlocking the full potential of the region's energy resources and fostering sustainable development. Enhanced collaboration among Mediterranean nations can pave the way for a more integrated energy market, ultimately benefiting all participating countries.

The table below provides a concise overview of how each of the key parameters influencing long-term electricity consumption trends is selected for the three scenarios.

Drivers	Metrics	Inertial scenario	Proactive scenario	Mediterranean Ambition scenario
Macro-economic trends	GDP/Population growth	+	++	++
	Green Transition and Paris Agreement, decarbonization targets achievement	+	++	+++
Energy transition & integration of energy policies	Mediterranean integration, regional regulation, and Euro-Mediterranean cooperation on energy	+	+	+++
	Renewable hydrogen and derivatives	+	++	+++
Electrification	Electric mobility	+	++	++
	Other electrifications	+	++	++
	RES development rate	++	+++	+++
Power supply, RES development	Distributed vs large scale technologies	+(Large-scale)	+++ (More distributed)	++ (Both with country adaptation)
	Technological progress & energy efficiency (behavior and public polices)	+	++	++

Legend: (one + stands for Low growth, ++ for Moderate growth, and +++ for High growth)

Table 1: Summary of storylines

These elements are presented in detail in another key deliverable of the TEASIMED 2 project: the Med-TSO Scenario Report for the 2030 and 2040 time-horizons. The report outlines how the evolution of power systems will influence the electricity exchanges between Mediterranean countries by 2040.

By 2040, the electricity demand is estimated to be between 2,900 and 3,060 TWh, depending on the scenario, representing an increase of approximately 40% to 50% compared to the reference year 2023, as depicted in Table 2.

Over the decade from 2030 to 2040, the average annual growth rate is expected to range from +1.6 to +2.1%. The higher consumption levels in the Proactive and Mediterranean Ambition scenarios, compared to the Inertial scenario, can be explained by a more favourable economic growth assumption (this factor remains the most decisive factor in North Africa, Middle East countries and Türkiye), as well as stronger electrification of the energy sector (mobility, industry, heating processes, etc.).

	2023	2030	2040		
	Mediterranean countries	Mediterranean countries	Inertial	Proactive	Mediterranean Ambition
Electricity consumption (TWh)	2052	2473	2897	3006	3057
Consumption increase	-	+20%	+41%	+46%	+49%
Compound annual growth rate (CAGR)	-	+2.7%	+1.6%	+2.0%	+2.1%

Table 2: Electricity consumption projections by 2040

In the context of a significant increase in the installed capacity of renewable energy, Figure 2 illustrates the projected evolution of electricity production in the Mediterranean region up to 2040 under the different scenarios.

This increase is driven by the need to meet both the growing electricity consumption and the specific demand for green hydrogen production.

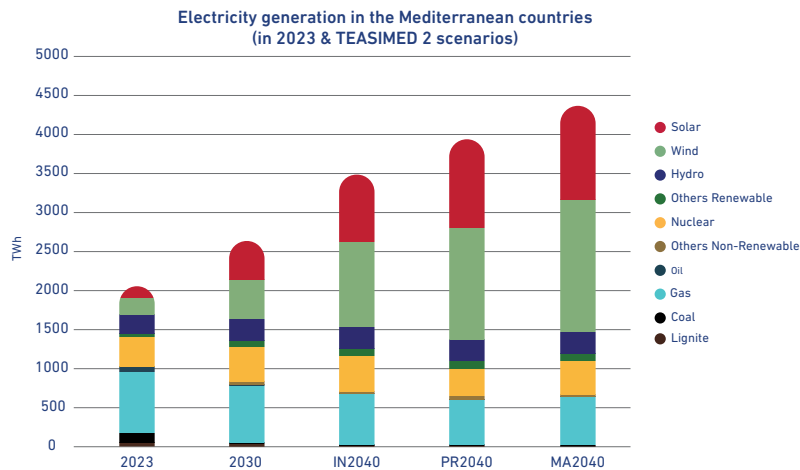


Figure 2: Electricity generation in the Mediterranean countries

While the share of renewable energy production reached about one-third in 2023, it is expected to exceed 50% by 2030 and could account for up to 70% to 80% of the total demand by 2040, depending on the scenarios. Wind energy alone could supply up to 40% of total demand. This represents a major shift in the nature of Mediterranean power systems, which will need to adapt to the widespread integration of these technologies.

Connecting Mediterranean countries through an interconnection network enables electricity exchanges that are justified by the complementarities between the connected countries. These complementarities vary in nature, for example, economics with flows oriented towards the country where the production costs are the lowest compared to the countries where the production of electricity is more expensive. Complementarity can also result from a situation of deficit in a country which can then benefit, if necessary, from generation capacity from interconnected neighbouring countries. It can also result from the massive development of non-dispatchable renewable energies, the surplus of which at certain times of the day will be evacuated through interconnections.


3.2 Proposed investment clusters and project merits

The Mediterranean electricity network covers a large and diversified area, characterised by significant variability in generation mixes, weather conditions, renewable generation potential, demand patterns, etc. This diversity gives rise to a range of needs and opportunities to valori

se throughout the area.

Therefore, to address specific system requirements that differ from one region to another, TSOs propose targeted investment clusters and interconnection projects. They also propose exploratory projects addressing borders currently not covered by promoted interconnection projects. To support the identification of clusters, covered system needs have been therefore classified into categories of project benefits, as summarised in the following table.

Some benefits find a direct quantification through cost-benefit analysis. This is the case, for example, of the merits related to the first macro category: welfare, sustainability and security of supply, which includes the economic welfare generated by the given project, the reduced RES curtailment and associated reduced CO₂ emissions and the reduced energy not supplied (ENS). Other merits are assessed in qualitative terms and associated with projects through symbols and specific descriptions.

Category	Detailed Project Benefits	Associated System Needs	Symbol
Welfare, sustainability and security of supply (SoS)	<p>Reduce high price differentials between different market nodes/ countries.</p> <p>Positively contribute to the reduction of RES curtailment and CO₂ emission levels</p> <p>Contribute to solving adequacy and security of supply issues</p>	<p>By increasing the net transfer capacity between market zones, cross-border interconnections enable additional flows of electricity from countries with lower production costs to countries with higher production costs. This reduces price differentials between zones, thus creating value for the consumer and the whole system.</p> <p>As a result of the additional enabled flow, interconnections do also directly contribute to reducing RES curtailment. Excess of renewable (and typically low-cost) electricity produced in a given zone can be exported to another, thus reducing the overall emission factor of the generation mix.</p> <p>Finally, imported electricity from other countries represents an additional resource during scarcity periods to ensure balancing between demand and supply, thus contributing to security of supply.</p>	



Isolation	<p>Fully or partially contribute to resolving the isolation of countries in terms of power system connectivity or to meeting specific interconnection targets</p>	<p>This benefit specifically addresses security of supply for isolated systems (e.g. islands) and those showing low level of connectivity.</p> <p>It might also be associated with projects which allow countries to reach interconnection targets (e.g., that set by the Clean Energy Package of the European Commission).</p>	
Operation – Flexibility	<p>Introduce additional system restoration mechanisms</p> <p>Improve system flexibility and stability</p> <p>Increase system voltage stability</p> <p>Contribute to the integration of new RES generation capacity</p>	<p>In the coming years, flexibility needs are expected to evolve both in terms of nature and volume as a consequence of the introduction of more weather-dependent generation (in replacement of conventional fossil power generation) and power electronic-based devices. In this context , cross-border interconnections can play a key role in reducing overall flexibility needs and also covering some of them.</p> <p>Cross-border interconnections allow not only the exchange of energy, but also flexibility of services between countries belonging to the same interconnected power system, thus reducing overall flexibility needs.</p> <p>In some cases, interconnections can also provide some flexibility services themselves (e.g., through HVDC converter stations), thus contributing to covering some flexibility needs, including system restoration.</p> <p>The flexibility enabled and provided by interconnections ultimately contributes to the integration of a greater share of RES into the power system.</p>	
Operation – Flows	<p>Enable cross-border flows to overcome internal grid congestions</p> <p>Mitigate loop flows in bordering systems</p>	<p>By enabling new exchanges or increasing existing transfer capacity between market zones, cross-border interconnections could also be particularly effective to countries experiencing internal grid congestion and physical loop flows involving other market zones.</p>	

Table 3: Project merits categories and description.

The benefits listed in Table 3 have been used by TSOs as a foundation for proposing cross-border interconnection projects conceived to answer specific needs, which have been assessed within the framework of the TEASIMED 2 project.

3.3 Market studies approach and CBA methodology

Scenario building provides Med-TSO members with a common framework to quantitatively assess, on a pan-Mediterranean level, national assumptions regarding the evolution of load and generation fleets for Med-TSO 2040 scenarios. Given the weather-dependent nature of renewable energy sources and the varying operating conditions of load and generation, market studies are conducted using a probabilistic approach. These studies focus on the impact of weather conditions, such as wind, temperature and solar irradiance, using available weather databases.

Market simulations involve the economic optimisation of the total generation cost across the entire Euro-Mediterranean Power System, including commercial exchanges between bidding zones. The physical network is taken into account primarily to determine interconnection exchange capacities and, where relevant, minor internal constraints.

The market simulator used is ANTARES3, a sequential Monte-Carlo-based, multi-area, open-source simulator (GNU GPL 3.0) developed by RTE, the French TSO, designed to assess generation adequacy and economic efficiency across interconnected power systems.

The implementation of market models provides a comprehensive and detailed view of the Mediterranean power system's behaviour, using a wide range of indicators and physical quantities at hourly resolution. The output data includes, but is not limited to, power and energy generation by plant type and by country, cross-border exchanges, marginal production prices, national energy balances, expected unsupplied energy, renewable energy curtailment and CO₂ emissions.

The cost-benefit analysis (CBA) methodology is designed to evaluate the benefits and costs of new interconnection projects, offering consistent data and indicators to support their assessment. The primary objective of the CBA methodology used in this Mediterranean Interconnection Perspectives report is to establish a common and uniform framework for evaluating these projects. To do so, each project is assessed through a broad set of benefit indicators, calculated according to two different approaches:

- **TOOT approach** - The Take One Out at a Time (TOOT) method, evaluates each project by removing it individually from the reference case. The benefits are measured by comparing the reference case and the reference case minus the TOOT project. This approach is generally applied to more mature projects that are already included in the reference case.

- **PINT approach** - The Put IN one at a Time (PINT) method, evaluates each candidate project by adding it individually to the reference case. The change in system indicators is measured by comparing the reference case and the reference case plus the PINT project. This approach is generally applied to less mature projects that are still in a preliminary or planning phase, which are not included in the reference case.

Reference case - This serves as the baseline grid configuration for the cost-benefit analysis, representing the most likely future network development based on projects with sufficient maturity and implementation certainty. In this TEASIMED 2 project, a total of 11 interconnection projects are assessed. Two of these (numbers 227 and 213) showing a more advanced level of project maturity are therefore included in the reference case for 2040. They have been assessed using the TOOT methodology, meaning that each of them has been studied by removing it from the reference case grid. The nine others have been evaluated by adding them individually to the reference case grid as per the PINT approach.

The following set of common indicators provides a comprehensive and robust foundation for project assessment across the Mediterranean region within the scope of the Mediterranean Project. The multi-criteria approach highlights the key aspects, advantages and limitations of each project, offering sufficient information to support informed decision-making. The indicators are summarised in Figure 3 and described in subsequent sections.

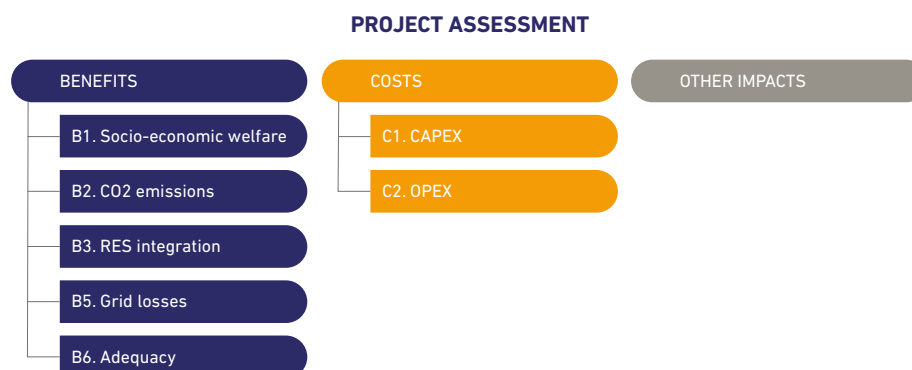


Figure 3: Cost-Benefit Assessment indicators

B1. Socio-economic welfare (SEW), or market integration, measures a project's ability to reduce congestion between bidding zones, thereby increasing transmission capacity and facilitating more efficient electricity trading across markets. SEW quantifies the annual cost savings achieved by the system thanks to the project, including fuel cost savings, monetised savings in CO₂ emissions, and variations in the expected energy not supplied (EENS). It is important to note, however, that SEW does not account for changes in grid losses, which are evaluated separately through a different indicator.

B2. Variation in CO₂ emissions captures the change in power system CO₂ emissions resulting from the implementation of a new project. It is a consequence of the effects measured in B1 (socio-economic welfare) and B3 (RES integration), as the project may enable the use of lower-carbon generation sources. Although the economic impact of CO₂ emission changes is already reflected in the SEW calculation, the CO₂ variation indicator is presented separately due to its strategic importance for the Mediterranean region's decarbonisation goals.

B3. RES integration evaluates the system's ability to connect new RES plants and enable both existing and future "green" generation, while minimising curtailments. Although this indicator is economically included in the calculation of SEW (since changes in RES integration affect energy from conventional sources and, in turn, system costs), RES integration remains a key objective in the Mediterranean region and is therefore presented separately.

B5. Variation in losses in the transmission grid captures changes in energy losses within the transmission grid resulting from the implementation of the new project, serving as a measure of energy efficiency. The variation in losses are determined through network simulations, as explained later in the document, and monetised using the hourly marginal electricity price, as determined in the market studies.

B6. Security of supply assesses the adequacy of the power system to meet electricity demand over an extended period, thus evaluating the impact of the reliability project. It accounts for the variability of weather conditions that influence both electricity demand and renewable energy generation. Monetisation of B6 is based on the value of lost load (VOLL) set at €3,000/MWh. In the SEW assessment, peak generation capacity is adjusted to ensure that the adequacy criterion – loss of load expectation (LOLE) – remains below three hours per year in every Mediterranean country.

Sector coupling

The modelling link between electricity and hydrogen systems via electrolyzers establishes sector coupling. Electrolyzers use surplus electricity from RES and/or nuclear sources to produce low-carbon hydrogen. As a result, the development of new interconnections can influence how electrolyzers operate. In a simplified two-country scenario, increasing electricity export capacity reduces RES curtailment in the exporting country and delivers carbon-free electricity to the importing country. Depending on where the electrolyzers are located, new interconnections may decrease or increase low-carbon hydrogen production.

The calculation of the B1 indicator must account for these mechanisms to capture the full value of SEW. The detailed modelling and calculation method is described in chapter 2.6.2 of the ENTSO-E document Implementation Guidelines for TYNDP 20224, based on 3rd ENTSO-E Guidelines for Cost-Benefit Analysis of Grid Development Projects.

CBA reporting

The calculation of B1, B2, B3 and B6 indicators is performed over 35 climatic years for the Inertial scenario and three climatic years (1995, 2008, and 2009, similarly with TYDNP2024 climatic year selection) for the Proactive and Mediterranean Ambition scenarios. For each project, the average, minimum, and maximum values of the indicators are provided. The geographical scope for calculating those indicators not only covers the Mediterranean countries but the entire interconnected Euro-Mediterranean electricity system.

Indicator B5, Grid losses, is calculated with data corresponding to the climatic year “2000”, the year which presents the closest resemblance in terms of annual exchanges on the Mediterranean interconnections with the average of 35 climatic years.

3.4 Network studies

While market simulations are used to calculate several key benefits of interconnection projects from an energy market perspective, such as socio-economic welfare or CO₂ emissions reduction, network analyses are essential to assess the impact of these projects on the transmission network and identify the required internal reinforcements for a secure system operation. Once the reinforcements have been identified and implemented, the same type of network simulation is used to calculate the variation of network losses associated with the analysed project.

In TEASIMED 2, analyses have been based on a Continuous Load-Flow approach. With respect to more conventional network simulation methodologies based on a set of representative Points in Time (PiT), the approach is based on DC hourly load-flow simulation for a full climatic year, as described in the following section.

3.4.1 General Assumptions

The assessment of the investigated projects through network studies adopted a coherent approach to that illustrated in the previous chapter, and relied on the same TOOT and PINT methodologies. Furthermore, the reference grid (RG) for 2040 is consistent with the reference case previously mentioned for market simulations.

TOOT approach - The Take One Out at a Time (TOOT) method consists of excluding grid element projects from the reference network structure on a one-by-one basis and to evaluate the load flows over the lines with and without the examined network reinforcement (a new line, a new substation, a new PST, ...)

PINT approach - The Put IN one at a Time (PINT) method considers each new item grid element on the given network structure one-by-one and evaluates the network flows over the

lines with and without the examined network reinforcement.

Scenarios

This study covers three scenarios: the Inertial (IN) scenario, the Mediterranean Ambition (MA) scenario and the Proactive (PR) scenario.

For the Inertial scenario and for each project, complete network (N-state) and post-contingency (N-1) static studies have been performed. This in turn led to defining, in cooperation with each TSO, reinforcements to mitigate the violations that might appear. However, for Proactive and Mediterranean Ambition scenarios, only complete network (N) static studies (N) have been performed with the reinforced network emerging from the IN scenario analysis. Consequently, network reinforcements have only been proposed for these solutions.

3.4.2 Fundamentals of load flow analysis

Network studies are needed to verify the physical capability of a given power system to transport electricity in line with the outcomes of market studies while respecting quality and security standards. Running network simulations therefore allows us to:

- Evaluate the performance of the interconnected Mediterranean network by assessing its ability to transfer the bulk power flows resulting from the economic studies while ensuring the secure operation of the system.
- Identify potential criticalities related to the interconnections and the internal grids, in terms, for instance, of bottlenecks and voltage issues.
- Assess the need for internal reinforcements due to the new interconnections.

Network studies mainly involve load flow analyses, which compute the power flows and the bus voltages in an assigned electric system subject to the regulating capability of generators, reactive power sources, and on load tap-changer transformers in different operating conditions and according to specific security criteria, as depicted in Figure 4.

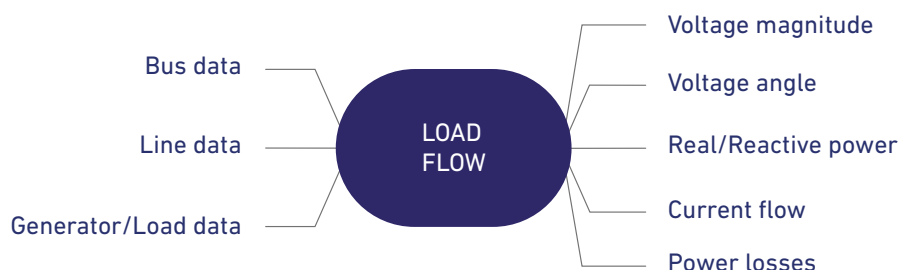


Figure 4: Load flow input & output

A parallel can be drawn with water flow in meshed pipelines with different inflow (generators) and outflow (load). A load flow describes how the water flow is distributed in the pipeline, helping to detect any problems in water distribution (e.g., overloads).

Load flow output is essential for the evaluation of the performance and security of a power system. Load flow analyses typically require the assessment of several cases in both normal and emergency operating conditions. Considering that the network includes a certain number of lines and transformers in normal (N) state, criteria (N-1) and (N-2) are defined to verify the ability of a system to operate even on a contingency with the lack of one element (N-1) or two elements (N-2) respectively, as presented in Figure 5 and Figure 6.

Such ability may depend on the specific system and the faulty elements. The figure below shows a simplistic example of how two different systems may become unstable without one or two elements or may remain stable depending on the elements selected and their spatial distribution. Similar behaviour can be observed in an electric network where the lack of one element can be easily compensated in a well-meshed network while it is not sustainable in weaker parts of the system.

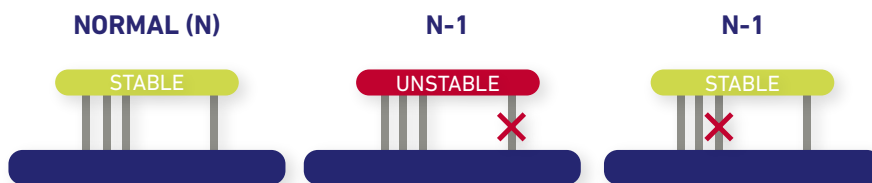


Figure 5: Simplified example of N-1 application

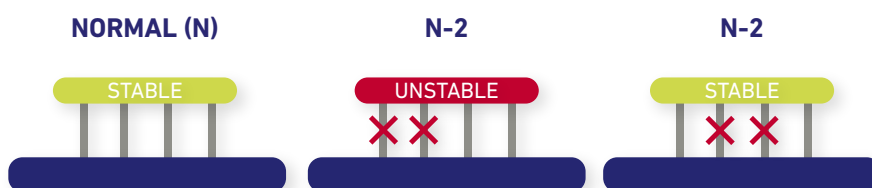


Figure 6: Simplified example of N-2 application

A description of the security criteria includes:

- The acceptable voltage range in normal and contingency situations (i.e., $\pm 5\%$ in normal

and $\pm 10\%$ in contingency or in general for generation buses).

- The threshold for admissible overloads of network elements (i.e., 20% for lines, 5-10% for transformers).
- Contingency criteria (N-1, identification of N-2, loss of a substation, remedial actions).

3.4.3 Continuous load flow methodology

The continuous load flow approach implies the assessment of grid conditions over a full climatic year, for a total of 8,760-hour cases. As shown in the following diagram, the inputs for the calculation module include the market simulation results, the network models, and a set of security criteria needed to define dispatching conditions and verify grid quality standards to run 8,760 load flows. Resulting contingencies are automatically analysed to identify recurrent issues and select a set of most critical cases that require further investigation. The result of the investigation leads to the definition of transmission grid reinforcements needed for a secure operation of the electricity network including the assessed interconnection. The continuous load flow process is depicted in Figure 7.

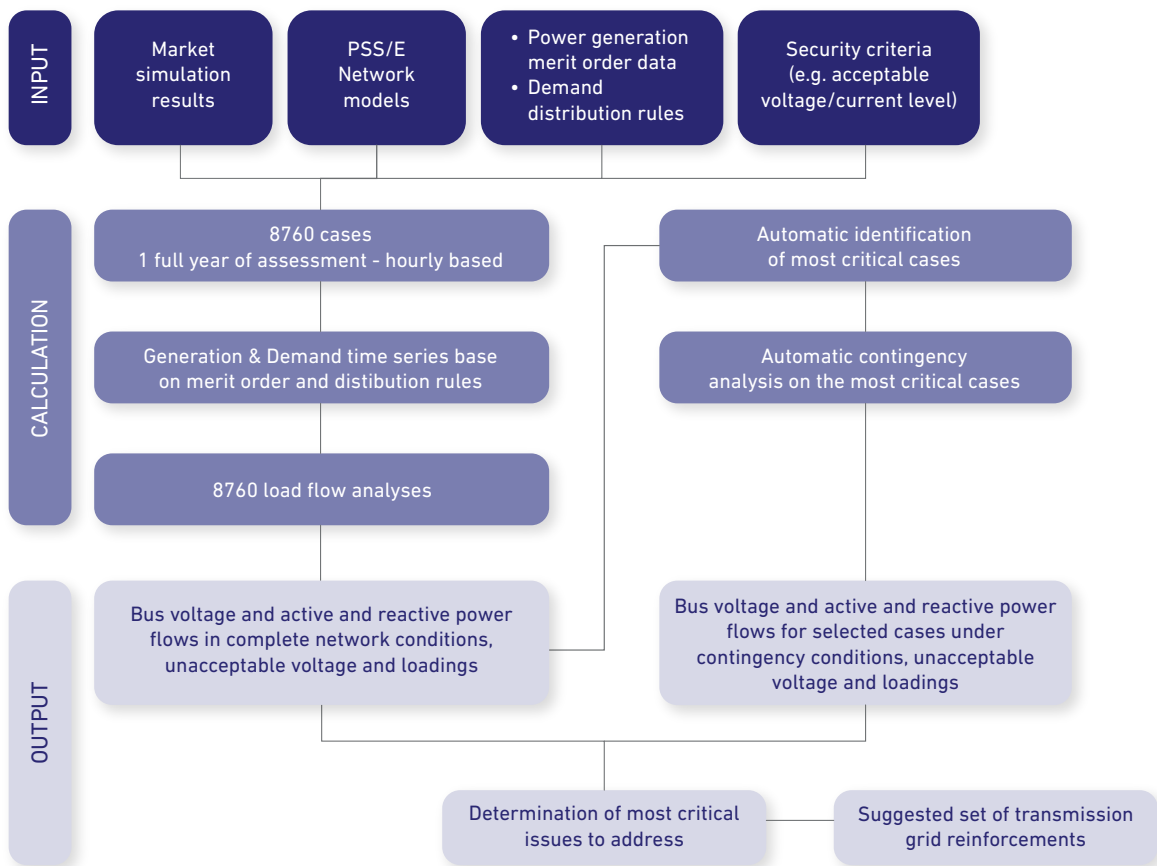


Figure 7: Continuous load flow process

Dispatching conditions for power generation are determined through merit order ranking data, provided by TSOs for each country. The merit order is used to distribute the generation resulting from market simulations for each cluster (CCGT, OCGT, wind, PV, etc., in line with ENTSO-E's classification) among power generation plants belonging to the same cluster and included in the network model. To reflect the typical operation of the electricity network as closely as possible, several power generation criteria are considered, as displayed in the diagram below (Figure 8).

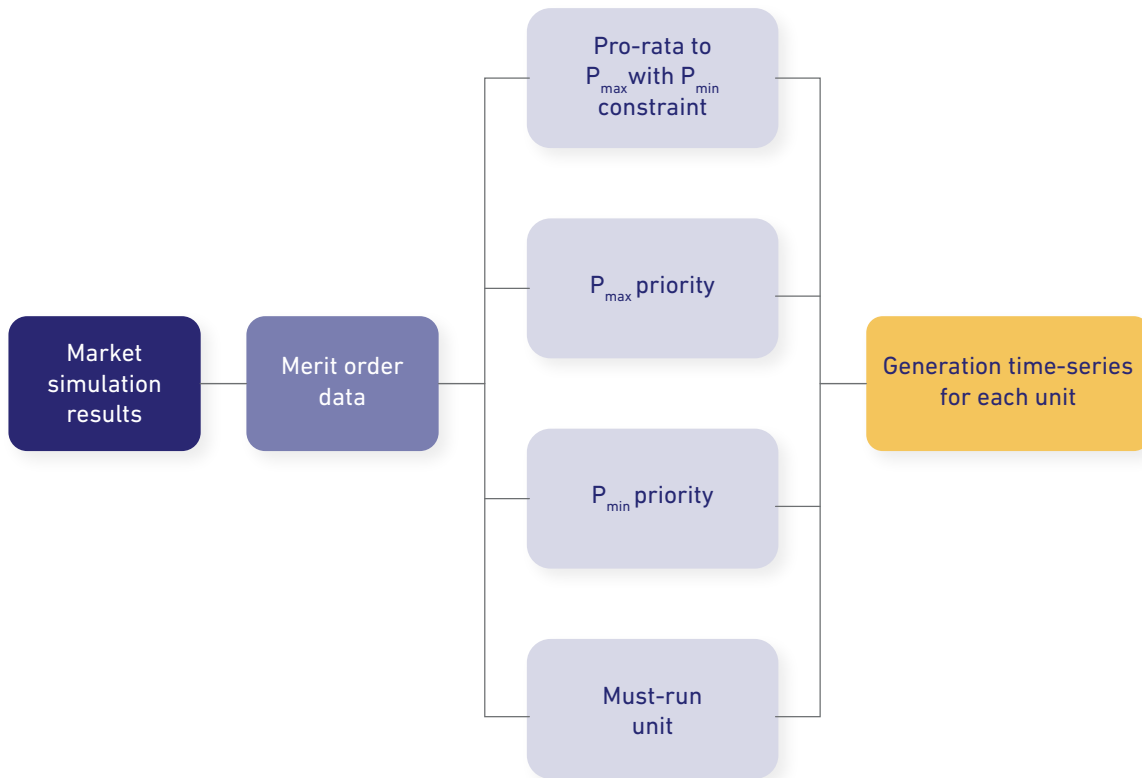


Figure 8: Approach to model dispatching conditions

For demand, there is no notion of merit order. Demand is therefore dispatched only by differentiating fixed and scalable loads.

With respect to PiT-based methodologies, the applied continuous load flow approach assesses a wider number of grid conditions, theoretically enabling more accurate and detailed identification of contingencies for further investigation. It also facilitates statistical analysis while delivering transparency on data calculated at each step.

In the previous TEASIMED project, to limit simulation time, contingency analysis was only performed on the cases that were deemed most critical for each country (between 1% and

5% of the total complete network situations). These critical cases were selected based on a tailored method elaborated by EDF experts to encompass all situations of importance, both within the countries and at their borders.

In TEASIMED 2, the use of a state-of-the-art programming language, and updated and refined automation algorithms, allowed us to unlock the full computation potential of our machines. Contingency analyses were performed not only on the most critical cases, but on all 8,760 cases considered for the complete network analysis⁵. This, in turn, enriched the statistical approach used to assess the criticality of every contingency/violation pair.

The outputs of the contingency analysis included:

- The rate of the element
- The occurrence frequency of a Contingency/Violation pair
- The average violation value
- The maximum violation value

are retrieved and combined into a criticality index defined as follows to highlight the items to address as a priority.

$$\gamma = 1000 \cdot \frac{\text{Rate}}{\text{Installed capacity}} \cdot \frac{\text{Nb of occurrences}}{\text{Nb of cases in } N - 1} \cdot \frac{\sqrt{\text{Max violation} - \text{OverloadingLimit}}}{\sqrt{\text{Max violation}^2 + \text{OverloadingLimit}^2}} \cdot \frac{\text{Average violation} - \text{OverloadingLimit}}{\sqrt{\text{Average violation}^2 + \text{OverloadingLimit}^2}}$$

This dimensionless value provides an order of magnitude of the necessity of either reinforcement or redispatch to address the grid code violations and allows for an intercomparison of otherwise very different events and items.

Based on this numerical assessment, for each country, both contingencies and violations have been evaluated as shown in the table below.

	Violation 1	Violation 2	Violation 3	Violation 4	Total Contingency
Contingency A	-	V_{A2}	V_{A3}	-	V_A
Contingency B	V_{B1}	V_{B2}	-	V_{B4}	V_B
Contingency C	V_{C1}	-	-	V_{C4}	V_C
Contingency D	-	-	V_{D3}	-	V_D
Total Violation	V_1	V_2	V_3	V_4	-

Table 4: Contingences and violations evaluation

3.4.4 Variation and monetisation of network losses

The final step of the network simulations is to compute the variation and monetisation of a network's technical losses. For each project, this is conducted for the reference grid and includes the assessed project and the associated identified reinforcements. Grid losses are calculated directly as part of load-flow simulations for the two conditions, as the difference between the total generation and the total demand in a country. For underwater cables, losses are attributed equally to the countries involved.

Monetisation is then performed considering the marginal price of each market node obtained from market simulations that include the assessed project. The reference equation is the following:

$$\text{Delta losses monetised}_{Px} = \sum_{h=1}^{8736} (\text{Losses after } Px - \text{Losses before } Px)_h \times \text{Marginal cost with } Px_h$$

Where Px is the assessed project.

This approach has the benefit of allowing the assessment of losses on an hourly basis for all 8,760 hours of the year. However, considering that continuous load-flow approach does not involve re-dispatching and relies on fixed power generation merit order information provided by TSOs, calculated losses might not fully reflect the true behaviour of network operation throughout the whole year. This phenomenon is, however, mitigated by the overall monetisation approach, which examines the variation of losses resulting from the assessed interconnection.

3.4.5 Analysis of the results of the network studies and investment costs

Planning an electrical transmission system can involve financial choices from among different technically feasible solutions. Making such decisions requires the quantification of costs of the various system components.

The main components to be considered are transmission lines, transformer substations and conversion stations in the case of HVDC transmission. Additional components might be involved in the case of specific identified reinforcements.

Costs for the design, construction and installation of components have been collected directly from Med-TSO members. When not available, standard costs or costs used in similar projects have been considered. For the scope of this report, the ratio of €1 = \$1,038 between euros and USD has been established.

4

The Mediterranean Electricity Interconnection Perspective

4.1 Presentation of the transmission projects

Interconnection projects have been proposed for updated assessment due to multiple drivers. Interconnectors can provide benefits such as improving market efficiency and reducing cost for end users, integrating more renewables, enhancing security of supply and stability of power networks, etc.

In this edition of the Mediterranean Electricity Interconnection Perspectives Med-TSO members proposed a total of 11 interconnection projects and 7 exploratory projects to be assessed, as presented in Figures 9 to 11.

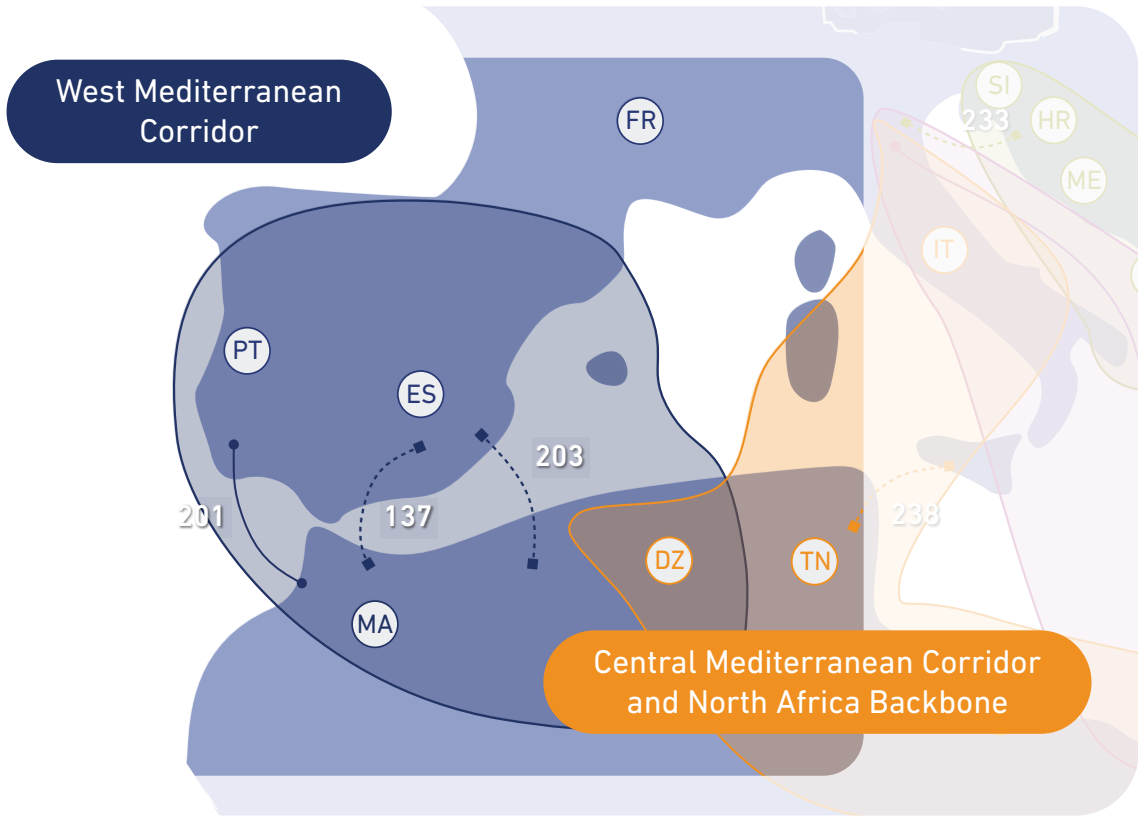


Figure 9: Projects in Western Mediterranean Region

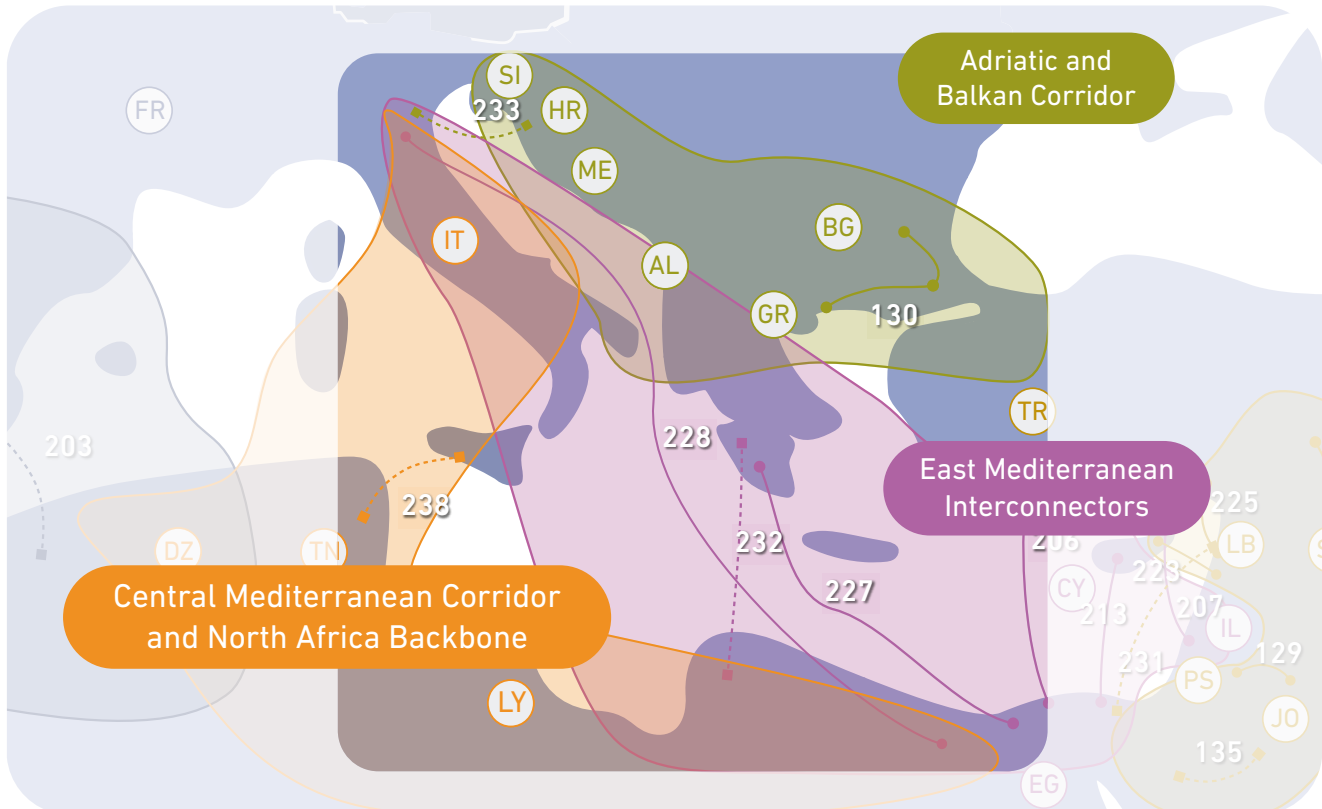
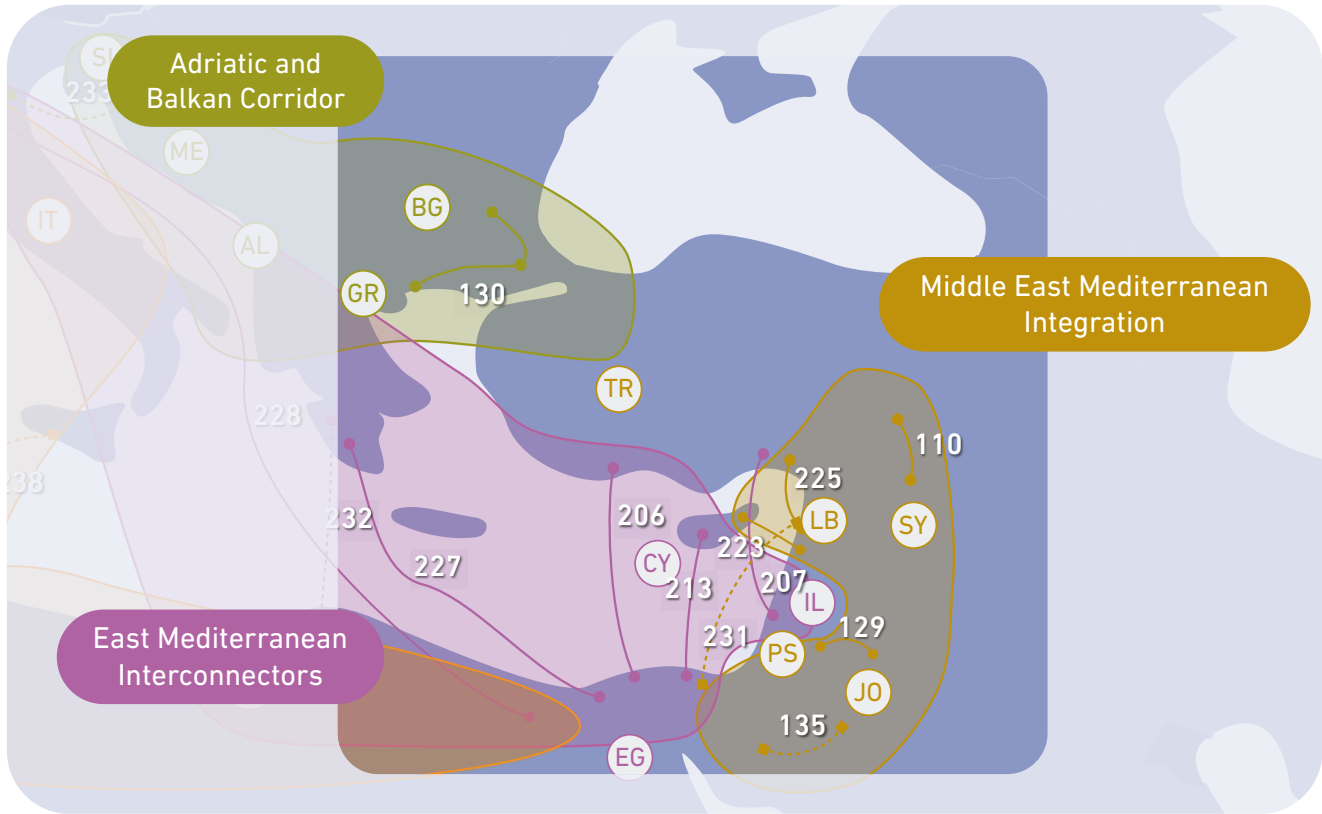










Figure 10: Projects in Central Mediterranean Region



- Interconnection projects 2040
- - - ■ Exploratory Projects 2040

Figure 11: Projects in Eastern Mediterranean Region

Projects have been clustered into the following five corridors or regions to better reflect common drivers and needs while also reflecting common geographic and network characteristics.

Projects Corridor/ Region	Projects covering the Corridor/ Region	Nominal transfer capacity (MW)	Potential expected benefit from the cluster	Detailed benefits
West Mediterranean Corridor	Project 201: Morocco – Portugal	±1000		1.1, 1.2, 2.1, 3.1, 3.2, 3.3, 3.4
	Project 203: Algeria – Spain (Exp)	±1000		1.1, 1.2, 2.1, 3.1, 3.2, 3.3, 3.4
	Project 137: Morocco - Spain (4th link) (Exp)	±700		1.1, 1.2, 2.1, 3.1, 3.2, 3.3, 3.4
Central Mediterranean Corridor and North Africa Backbone	Project 238: Italy – Tunisia (2nd cable) (Exp)	±600		1.1,1.2, 1.3, 3.1, 3.3, 3.4, 4.1
East Mediterranean Interconnectors	Project 228: Egypt – Italy	±3000		1.1,1.2, 1.3, 3.1, 3.2, 3.4, 4.1
	Project 206: Egypt – Türkiye	±3000		1.1, 1.3, 3.1, 3.2
	Project 207: Israel – Türkiye	±2000		1.1, 1.2, 1.3, 2.1, 3.1, 3.2, 3.4
	Project 213: Cyprus – Egypt	±1000		1.1, 1.2, 1.3, 3.1, 3.2, 3.3, 3.4











	Project 227: Egypt – Greece	±3000		1.1, 1.2, 1.3, 2.1, 3.1, 3.2, 3.3, 3.4, 4.1
	Project 232: Greece – Libya (Exp)	±1000		1.1, 1.2, 1.3, 3.1, 3.4, 4.1
Adriatic and Balkan Corridor	Project 233: Croatia – Italy (Exp)	±500		1.1, 1.2, 3.1, 3.2, 3.3, 3.4, 4.1
	Project 130: Bulgaria – Greece – Türkiye	±1000		1.1, 1.2, 3.2, 3.4
Middle East Mediterranean Integration	Project 231: Egypt – Lebanon (Exp)	±500		1.3, 2.1, 3.4, 4.1
	Project 225: Lebanon – Türkiye	±250		1.1, 1.2, 1.3, 2.1, 3.1, 3.2, 3.3, 3.4
	Project 223: Cyprus – Lebanon	±250		1.1, 1.2, 1.3, 3.1, 3.2, 3.3, 3.4
	Project 110: Syria – Türkiye	±600		1.1, 1.3, 3.4
	Project 129: Jordan – Palestine	-200		1.1, 1.2, 1.3, 2.1, 3.1, 3.2, 3.3, 3.4, 4.1, 4.2
	Project 135: Egypt – Jordan (Exp)	±900		1.1, 1.2, 1.3, 3.2, 3.4, 4.1

Table 5: List of projects and main figures





Category	Symbol	Detailed Project Benefits Legend
1. Welfare, Sustainability, and SoS		<p>1.1) Reduce high price differentials between different market nodes/countries</p> <p>1.2) Positively contribute to the reduction of RES curtailment and CO₂ emission levels</p> <p>1.3) Contribute to solving adequacy and security of supply issues</p>
2. Isolation		<p>2.1) Fully or partially contribute to resolving the isolation of countries in terms of power system connectivity or to meeting specific interconnection targets</p>
3. Operation Flexibility		<p>3.1) Introduce additional system restoration mechanisms</p> <p>3.2) Improve system flexibility and stability</p> <p>3.3) Increase system voltage stability</p> <p>3.4) Contribute to the integration of new RES generation capacity</p>
4. Operation Flows		<p>4.1) Enable cross-border flows to overcome internal grid congestions</p> <p>4.2) Mitigate loop flows in bordering systems</p>

Table 6 - Legend of project merits

4.2 The West Mediterranean Corridor

The West Mediterranean Corridor features the assessments of one project involving Morocco and Portugal and two exploratory initiatives concerning, respectively, the fourth interconnection between Morocco and Spain and a submarine link connecting Spain with Algeria. The third AC interconnection cable between Morocco and Spain had already been evaluated in the updated Mediterranean Master Plan.

These projects involve countries that jointly contribute to the further exploitation of the existing integration between the Iberian electricity market and the Maghreb region. As a result, the expected benefits of these projects are aligned and reflect a clear positive contribution in terms of:

- Reducing the electricity price differential between the Iberian market and the Maghreb countries, benefitting from the lower prices observed in Spain and Portugal.
- Increasing the integration of renewables, namely through the avoided curtailment in Spain and Portugal that can be channelled to the Maghreb countries through the envisaged

projects, leading to a reduction in gas-fuelled generation in Morocco and Algeria.

- Meeting specific interconnection targets, which are quantitatively set in the case of the EU Countries; however, it should be noted that projects between EU and non-EU countries do not impact the EU electricity interconnection target in any way.
- Enhancing operational flexibility through the technical characteristics of the technologies at use, namely those associated with VSC-HVDC technology, such as black-start capability and voltage control.

Project n°201: Morocco – Portugal (MA - PT)



*Converted at USD/EUR 1.0389 as of 31/12/24

Morocco and Portugal, two neighbouring countries with growing energy cooperation, are establishing their first electricity interconnection. The project consists of a new HVDC link, based on VSC technology, between the Ben Harchan substation in Morocco and the Tavira substation in Portugal, with an expected NTC of about 1,000 MW and a total length of roughly 300 km, including around 228 km of submarine cable.

In recent years, both TSOs – ONEE and REN – have conducted feasibility studies confirming the mutual benefits of this interconnection. This project is conceived as a joint effort to strengthen cooperation and optimise system operation in the context of increasing renewable energy integration. In this regard, the expected benefits of this initiative are threefold: narrowing the electricity price gap between the Iberian market and the Maghreb countries, enhancing the integration of renewables, particularly by preventing curtailment in both Portugal and Morocco, and reducing Morocco's reliance on gas-fired electricity generation.

Exploratory Project n° 203: Algeria – Spain (DZ - ES)



*Converted at USD/EUR 1.0389 as of 31/12/24

A potential submarine electrical interconnection between Spain and Algeria has been assessed as an exploratory project for the 2040 horizon. This initiative aims to strengthen energy cooperation across the Mediterranean, and the potential benefits are significant in terms of RES integration, power flow optimisation and grid operation, in order to guarantee security and adequacy standards in Algeria.

Economically, the project could offer long-term benefits by diversifying energy sources, improving supply security in Algeria, and fostering regional energy markets. It may also contribute to decarbonisation goals by enabling the exchange of low-carbon electricity.

Exploratory Project n° 137: Morocco – Spain (4th interconnection) (MA - ES)



*Converted at USD/EUR 1.0389 as of 31/12/24

The Morocco–Spain electricity interconnection is a cornerstone of regional energy cooperation, playing a strategic role in bolstering the security of supply for both countries. The existing infrastructure, along with the third interconnection currently in its planning stage, reflects a mutual commitment to enhancing grid resilience and enabling integration of renewable energy sources.

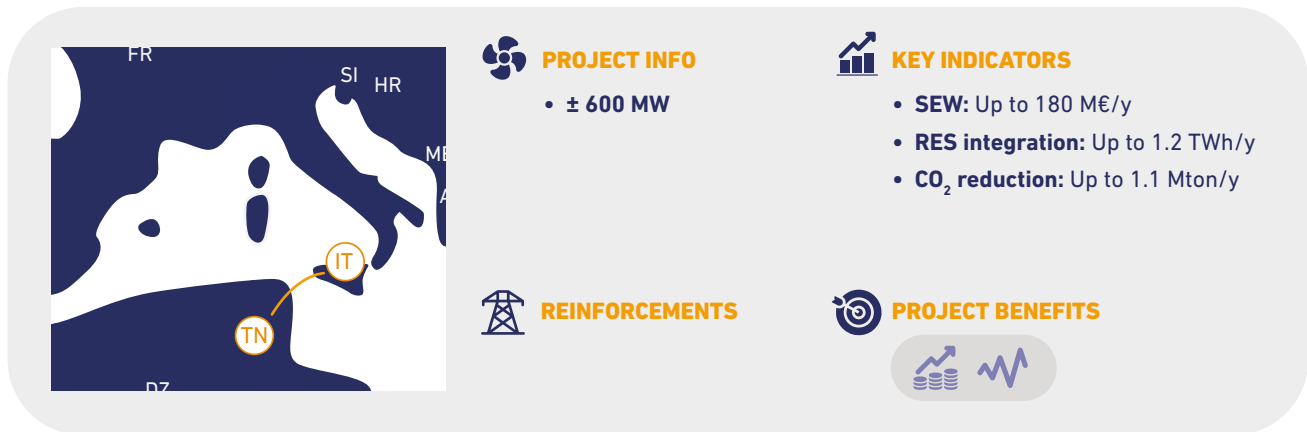
Looking ahead to 2040, the expansion of this interconnection with a fourth cable emerges as a particularly compelling exploratory project. This potential addition could further reinforce system flexibility, facilitate deeper renewable integration, and support the security of the interconnected systems.

4.3 Central Mediterranean Corridor & North Africa Backbone

This group includes a single exploratory project focused on an additional interconnection between Italy and Tunisia. In light of the ongoing progress on the Italy-Tunisia border, there could be a growing rationale for assessing the feasibility of a second link between the two countries. This initiative falls within the broader objective of strengthening interconnections among Maghreb countries and linking them to the Italian network, which presented a high integration rate of renewables in its energy mix together with an overcapacity of the thermal power plants. This exploratory analysis is therefore intended to support long-term strategic reflection and guide future decisions regarding cross-border infrastructure between Italy and Tunisia.

Demand in Tunisia is expected to double over the next decade, while the Italian TSO is expecting demand saturation and is therefore seeking new market opportunities to optimise renewables power flows to and from the islands of Sicily and Sardinia. Furthermore, STEG expects that the reinforcement of this interconnection would reduce the need for continuous investments in power production units and provide access to guaranteed electricity at a lower cost. A new link would also enhance system flexibility and enable a greater integration of renewable energy sources on both shores of the Mediterranean.

Exploratory Project n°238: Italy – Tunisia (2nd project) (IT - TN)



*Converted at USD/EUR 1.0389 as of 31/12/24

The Italy-Tunisia interconnection (Project n° 204, cf. Master Plan 2030), currently under construction, constitutes one of the first electricity infrastructure projects under development along the Europe-North Africa border and the first HVDC link between the continents. This milestone in Euro-Mediterranean energy cooperation will enable greater renewable energy integration while enhancing the security, adequacy, and flexibility of both national power systems. Given Project n° 204's progress, exploring a second Italy-Tunisia link presents an opportunity for forward-looking regional energy planning. This preliminary assessment examines how increased interconnection capacity could address evolving Mediterranean Power System needs without implying development commitments.

This potential interconnection has been studied within the TEASIMED 2 framework as an exploratory project aimed at assessing its behaviour and the potential benefits it may offer. Currently, no formal joint development activities exist between Terna and STEG for a second HVDC link, and this project remains technically and procedurally independent from Project n° 204.

The proposed second submarine interconnection between Sicily and Tunisia would feature 600 MW of transmission capacity, bringing total interconnection capacity between the two countries to 1,200 MW. While detailed specifications remain undefined, the length and maximum depth can be assumed comparable to Project n° 204.

The CBA performed on this project highlights the significant potential benefits that this cross-border connection offers. In fact, despite being studied in the presence of the first interconnection project between Italy and Tunisia (Project n° 204, cf. Master Plan 2030), the benefits remain substantial and compelling.

4.4 The East Mediterranean Interconnectors

This group includes five interconnection projects and one exploratory study. These projects aim to strengthen connections between countries across the two shores of the Eastern Mediterranean region, by creating new electricity corridors in the region and providing mutual benefits, resulting from the complementary characteristics and energy prices of the countries involved. More specifically, this cluster includes:

- two interconnection projects linking the Turkish system to those of Egypt and Israel,
- one interconnection projects linking the system of Cyprus to that of Egypt,
- one interconnection project linking the Greek system to the Egyptian system,
- one interconnection project linking the Egyptian and Italian systems,
- one exploratory project concerning an interconnection between Greece and Libya.

Project n°206: Egypt – Türkiye (EG - TR)



*Converted at USD/EUR 1.0389 as of 31/12/24

The purpose of the project is to establish a connection between northern Egypt and southern Türkiye via the Mediterranean Sea. This interconnection will have a 3 GW capacity and will be implemented as a submarine HVDC link. On the Egyptian side, the implementation horizon and the vast evolution of the Egyptian electrical transmission grid require the addition of a single circuit 500 kV line, with a total length of 100.5 km.

Egypt and Türkiye are currently undergoing profound changes in their electricity sectors. Egypt

continues to rely heavily on natural gas, while Türkiye utilises a more diverse mix that includes coal, natural gas and hydroelectric power. Both countries have set ambitious targets for the integration of intermittent renewable energy sources, which are expected to reshape their electricity landscapes within the next 15 years. Türkiye is adding 5 GW of solar capacity to the grid annually, an amount equivalent to approximately 5% of the country's total installed capacity. Alongside these initiatives, new interconnection projects, such as the Egypt–Greece and Greece–Türkiye link, are also expected to improve regional power exchange and system flexibility.

This project aims to enhance system reliability, strengthen the security of supply, and support the integration of natural gas, solar, and wind energy resources into the regional grid.

Project n°207: Israel – Türkiye (IL - TR)



*Converted at USD/EUR 1.0389 as of 31/12/24

The project consists of a new interconnection between Israel and Türkiye to be executed through an HVDC submarine cable. The new HVDC submarine link is expected to be implemented using VSC technology.

The project seeks to increase the interconnection capacity between Türkiye and Israel to 2000 MW and develop a new Eastern Mediterranean corridor.

Project n°213: Cyprus – Egypt (CY - EG)

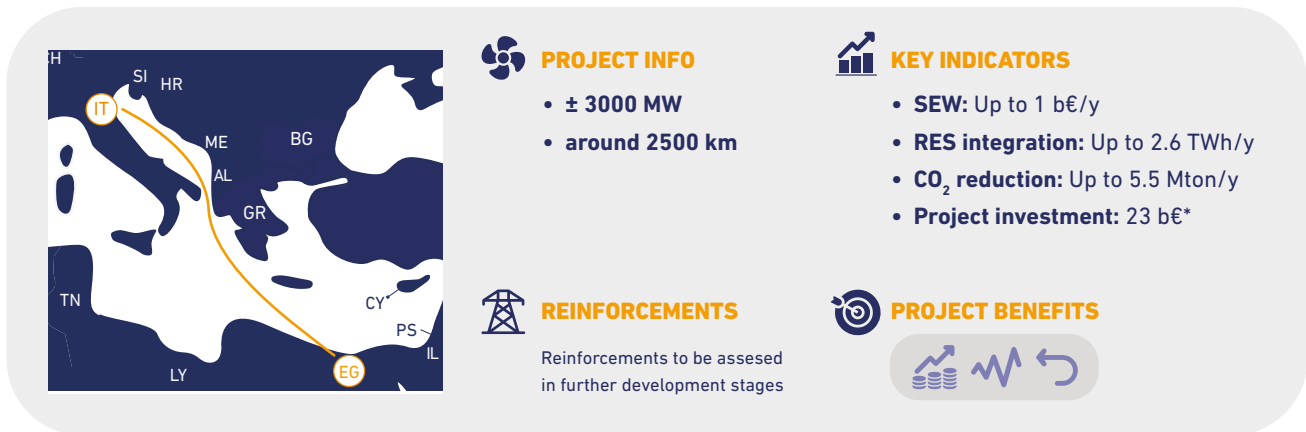


*Converted at USD/EUR 1.0389 as of 31/12/24

The project consists of a new interconnection, which includes two power cables (2×500MW) to be constructed between Egypt and Cyprus together with a new 2 x 500 MW HVDC converter station at Burrulus in Egypt. The HVDC cables will terminate in Cyprus at the HVDC converter station at Kofinou, which will be part of the multi-terminal HVDC interconnection between Israel, Cyprus, and Crete.

The project is included in the reference grid and is studied with the TOOT approach. This interconnection will link the two countries via 521km long HVDC submarine cables and will form a corridor between the northeastern and southeastern banks of the Mediterranean. The benefits of this interconnection are considered strategic for both countries in terms of facilitating RES penetration, and supporting security and adequacy standards.

Project n°228: Egypt – Italy (EG - IT)



*Converted at USD/EUR 1.0389 as of 31/12/24

The analysed Egypt–Italy interconnection, proposed in TEASIMED 2 by the Egyptian TSO, EETC, could represent a transformative opportunity to strengthen energy cooperation across the Mediterranean region. As energy systems adopt more renewables, cross-border links like this one become vital for system resilience, market efficiency, and environmental goals. This ambitious initiative aims to create a more interconnected and adaptable Mediterranean electricity network, supporting present challenges and long-term objectives, with the connection of two geographical extremes of the region.

This HVDC interconnector would enable bi-directional flow of clean electricity, boosting system flexibility and stability. It would help manage surplus renewables during low demand while providing a reliable import route during supply constraints, addressing renewable intermittency and optimising green energy use.

Beyond operational benefits, the project could reduce greenhouse gas emissions by supplying low-carbon electricity to established markets and enhancing competitive pricing through diversified supply sources. It may also spur regional investment, job creation, and energy security, significantly contributing to peak demand coverage and long-term resilience.

The envisioned link would connect western Egypt to northern Italy via an HVDC corridor with 3,000 MW capacity, using a double bi-pole system (each pole approximately 750 MW). The submarine cable would span over 2,500 km beneath the Mediterranean, Ionian, and Adriatic seas, possibly reaching depths of up to 3,000 metres.

Project n°227: Egypt – Greece (EG - GR)

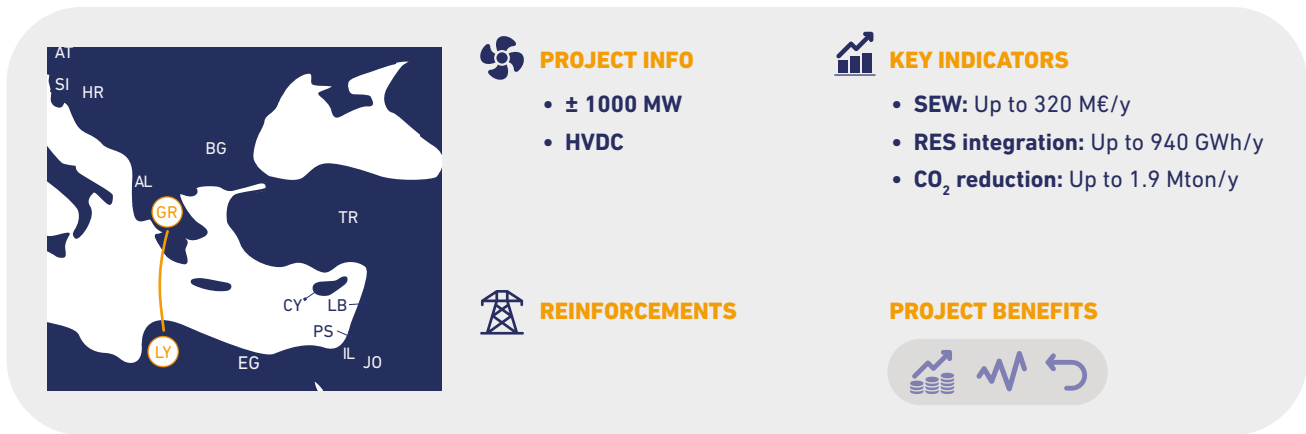


*Converted at USD/EUR 1.0389 as of 31/12/24

The Egypt-Greece interconnection is studied as the first link between the two countries, as well as an electricity corridor between the northern and southern banks of the Eastern Mediterranean region. The benefits of this interconnection are considered deeply strategic for both countries in terms of RES power flow optimisation and grid operation to guarantee security and adequacy standards. The project will also support Europe's efforts to achieve energy security and independence from natural gas.

The submarine HVDC interconnection is planned with a bipolar configuration and a tentative capacity of 3,000 MW, connecting the two national electricity grids via HVDC converter stations located on each side.

Exploratory Project n°232: Greece – Libya (GR - LY)



*Converted at USD/EUR 1.0389 as of 31/12/24

This potential interconnection has been studied within the TEASIMED 2 framework as an exploratory initiative. Within this exploratory context, the project envisions a submarine interconnection between continental Greece and Libya modelled with a transmission capacity of 1,000 MW.

Conducting a preliminary assessment at this stage offers a forward-looking approach to regional energy planning as it allows for a better understanding of how an interconnection could meet the evolving needs of the Mediterranean Power System, without implying any immediate commitment to development. This exploratory analysis is intended to support long-term strategic reflection and guide future decisions on cross-border infrastructure between the two countries.

4.5 The Eastern Adriatic and Balkan Corridor

This corridor includes an interconnection project that involves Bulgaria, Greece and Türkiye and an exploratory project connecting the system of Italy with that of Croatia. The former project aims to increase the existing NTC between Türkiye and Continental Europe Synchronous Area (CESA), which are already synchronously connected. The increased interconnection capacity between Türkiye and CESA via the Bulgaria – Türkiye – Greece project will enable transfer of a large quantity of renewable energy from Balkan region to Türkiye. It will result in reduction of thermal generation and CO₂ emissions in Türkiye.

Project n°130: Bulgaria – Türkiye – Greece (BG - TR - GR)



*Converted at USD/EUR 1.0389 as of 31/12/24

The project consists of two new AC overhead interconnections, one linking Greece and Türkiye, and one connecting Bulgaria and Türkiye. The initiative is jointly promoted by IPTO, TEİAŞ and ESO, and the exploratory study has been conducted by Med-TSO within the framework of the TEASIMED project.

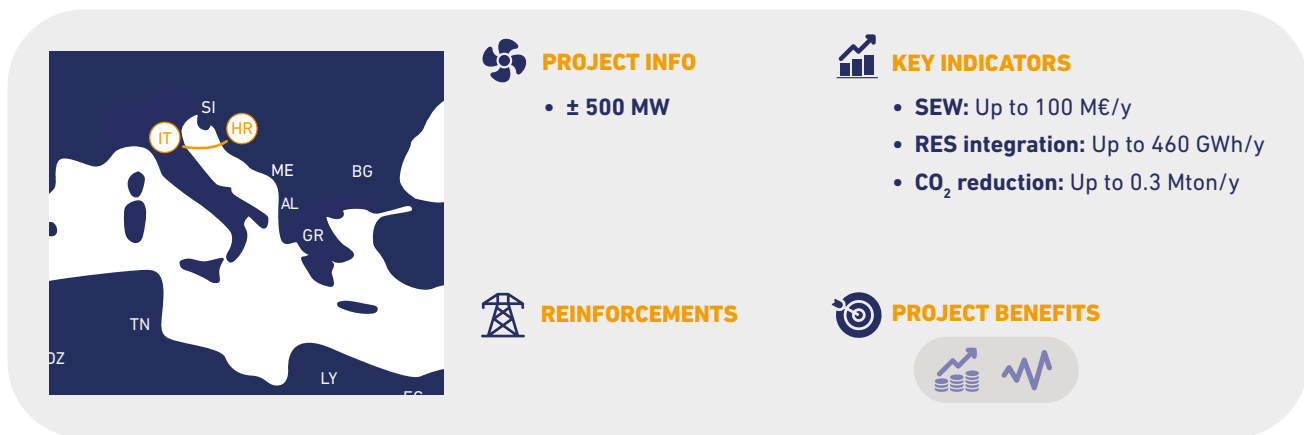
The Turkish power system has been synchronised with the Continental Europe Synchronous Area (CESA) network since September 2010, with Greece and Bulgaria being part of the CESA to Türkiye transmission corridor. Currently, there are five interconnections within this corridor: two linking Greece and Bulgaria, one Greece and Türkiye, and two Bulgaria and Türkiye.

At present, some limiting factors, unrelated to the grid expansion, remain, but are in the process of being resolved. Consequently, the total NTC value is currently limited to 1,560 MW in the CESA to Türkiye direction and 1,080 MW in the opposite direction. Two-thirds of this capacity is allocated to the Bulgaria – Türkiye interconnection while one-third is allocated to the Türkiye – Greece link. The commissioning of the second interconnection between Greece

and Bulgaria (Nea Santa–Maritsa), together with the reinforcement of the 400 KV South-East Bulgaria network, has increased the NTC to 1,350 MW in the Bulgaria to Greece direction and to 800 MW in the opposite one.

Greece is currently well interconnected through one DC and several AC interconnectors. In addition to its links with Türkiye and Bulgaria, Greece is interconnected with North Macedonia, Albania and Italy. The Turkish network, aside from its interconnections with Greece and Bulgaria, is asynchronously interconnected with the grids of Syria, Iraq, Iran, and Georgia.

Exploratory Project n°233: Croatia – Italy (HR - IT)



*Converted at USD/EUR 1.0389 as of 31/12/24

The proposed energy interconnection between Croatia and Italy holds significant potential to strengthen energy security, market integration, and renewable energy utilisation across the Adriatic region. This infrastructure would support the decarbonisation and electrification efforts of both countries while providing broader regional benefits.

Beyond the direct bilateral advantages, the interconnection could serve as a key enabler for the deeper integration of the Balkan Peninsula into the European energy system. It would establish an Italy–Croatia connection and position Italy as a regional energy corridor in conjunction with existing Montenegro and Greece interconnections.

This potential interconnection has been studied within the TEASIMED 2 framework as an exploratory project aimed at assessing its behaviour and the potential benefits it may offer. Currently, there are no formal joint development or study activities in progress between Terna (Italy) and HOPS (Croatia).

This link would represent the first submarine interconnection between Italy and Croatia, and

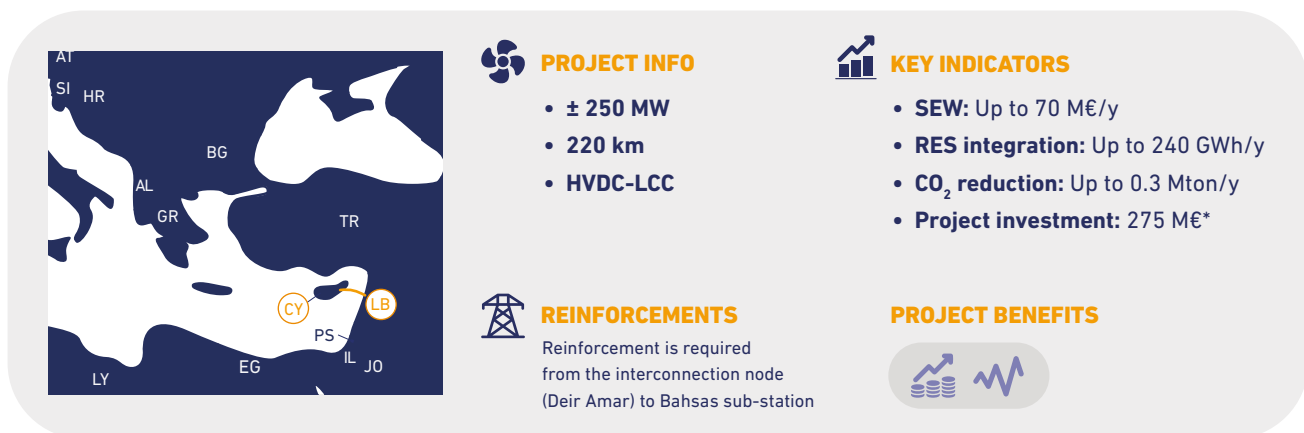
for the scope of this exercise, has been studied with a capacity of 500 MW. Technically, the proposed HVDC submarine cable would traverse the northern Adriatic, where proximity and about 50 metres of sea depth present favourable conditions and lower project challenges.

4.6 Middle East Mediterranean Integration

This cluster includes four interconnection projects, as well as two exploratory studies, as listed below, aimed at reinforcing the connection of the countries of the Eastern Mediterranean region. Specifically, this cluster includes:

- two interconnection projects linking the Lebanon System to those of Türkiye and Cyprus,
- one interconnection projects linking the System of Turkey to that of Syria,
- one interconnection project linking Jordan to Palestine,
- one exploratory project linking the Egyptian and Lebanese systems,
- one exploratory project increasing the transfer capacity between Egypt and Jordan.

Project n° 223: Cyprus – Lebanon (CY - LB)



*Converted at USD/EUR 1.0389 as of 31/12/24

The Cypriot grid is currently isolated since Cyprus is an island. Cyprus is actively pursuing electric grid interconnection projects to overcome its energy isolation and enhance regional energy security. The project is aiming to increase the interconnection capacity between Cyprus and Lebanon to 250 MW and develop a new corridor in the Eastern Mediterranean.

Project n°225: Lebanon – Türkiye (LB - TR)



*Converted at USD/EUR 1.0389 as of 31/12/24

At present, there are no interconnections between Lebanon and Türkiye. The Turkish grid is currently interconnected with the grids of Greece, Bulgaria, Syria, Iraq, Iran, Nakhchivan (Azerbaijan), and Georgia.

Through the interconnections to Greece and Bulgaria, the Turkish grid is interconnected to Continental Europe Synchronous Area (CESA). Due to limiting factors unrelated to the grid expansion, total NTC values are limited to 650 MW in the CESA to Türkiye direction and 500 MW in the opposite direction. The Turkish and Syrian grids are connected via a 400 kV AC overhead line, which remains physically in place but was deactivated following Türkiye's integration into CESA, due to synchronisation issues. Plans to restore its functionality through a back-to-back (B2B) converter station on the Turkish side exist, but the investment is currently on hold pending stabilisation in Syria. The Turkish grid is also connected to Georgia (B2B) and Iran (asynchronously) and through the isolated region method with the grids of Iraq and Iran.

The project aims to increase the interconnection capacity between Türkiye and Lebanon to 250 MW and develop a new corridor in the Eastern Mediterranean.

Project n°110: Syria – Türkiye (SY - TR)



*Converted at USD/EUR 1.0389 as of 31/12/24

The project consists of a new interconnection between Syria and Türkiye, to be implemented through a 400kV AC overhead line and HVDC back-to-back (B2B) station in Türkiye. Its main objective is to further increase the interconnection capacity between the two countries by around 600 MW.

Currently, the Turkish and Syrian grids are linked by a 400 kV AC overhead line, connecting the Aleppo SS on the Syrian side and the Birecik HPP substation on the Turkish side. This interconnection was previously used to connect two units of Birecik HPP in Türkiye, to supply the Syrian network. However, after TEİAŞ synchronously connected to the ENTSO-E network, the line had to be switched off. A back-to-back converter substation is now planned for construction next to the Birecik HPP substation on the Turkish side to enable power exchange through the line. Once operational, it will allow the two grids to be fully connected asynchronously to each other.

Project n°129: Jordan – Palestine (JO - PS)



*Converted at USD/EUR 1.0389 as of 31/12/24

This project consists of a new interconnection between Jordan and Palestine.

Currently, the Palestinian territories (West Bank and Gaza) depend mainly on Israel for electricity supply. In this regard, the interconnection is expected to increase the transfer capacity from Jordan to Palestine by about 200 MW, to support the regional integration of the Palestinian power system and to mitigate dependence on Israeli provision. The West Bank will also be supplied through the first phase of the interconnection expansion, projected for 2030, by 200 MW on 132 kV link with Jordan to Jericho on an isolated-grid basis, according to the assumptions of Med-TSO Inertial scenario.

The project is promoted by NEPCO and PETL, under the framework of the studies conducted by Med-TSO within the TEASIMED project.

Exploratory Project n°135: Egypt – Jordan (EG - JO)



*Converted at USD/EUR 1.0389 as of 31/12/24

Jordan and Egypt have electrically interconnected since 1998 via a 13 km 400 kV, AC submarine cable (3 + 1 spare) submersed at a depth of 850 m across Taba to the Gulf of Aqaba with an exchange capability of 1,100 MW. The 2040 upgrade project involves enhancing the existing HVAC infrastructure to increase the transfer capacity by an additional 900 MW, bringing the total to 2,000 MW. The main drivers for the project are to strengthen regional grid resilience, support greater renewable energy penetration, and unlock further opportunities for energy exchange and market integration, thus contributing to regional decarbonisation goals and enhancing economic and operational synergies among the interconnected systems.

The Egyptian power grid is currently interconnected with the grids of Libya, Jordan, and Sudan via HVAC transmission links. In parallel, Egypt is developing a major 3,000 MW HVDC interconnection with Saudi Arabia, which is expected to become operational by the end of 2025. At the same time, Jordan and Saudi Arabia are progressing with the establishment of their HVAC interconnection. Once operational, the interconnections between Egypt, Jordan, and Saudi Arabia will enable the integration of their national grids into the Gulf Cooperation Council Interconnection Authority (GCCIA) Grid, which already links the power systems of six GCC countries via a 400 kV network.

Exploratory Project 231: Egypt – Lebanon (EG - LB)



*Converted at USD/EUR 1.0389 as of 31/12/24

The Egypt-Lebanon Electricity Interconnection is a regional energy project designed to enhance electricity trade and improve energy security in the Levant. The proposed project involves the construction of a submarine HVDC cable with an approximate length of 500 km and a planned transmission capacity of up to 500 MW. This strategic link will enhance electricity exchange between the two countries, allowing Egypt to export surplus power, particularly from renewable sources, while providing Lebanon with a stable and reliable supply of electricity to support its grid recovery and long-term energy needs.

The project reinforces broader efforts to integrate Arab electricity markets, fostering economic cooperation and sustainable energy exchange across the Middle East and North Africa (MENA) region.

Legal Headquarters

Viale Egidio Galbani, 70
00156 Rome – Italy

Operational Headquarters

Via della Marcigliana, 911
00138 Rome – Italy

www.med-tso.org

info@med-tso.com

@med-tso



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