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SEE ENERGY BRIEF

Monthly Analysis

Electricity Interconnections in SE Europe Pave the Way for An Integrated Regional Market

Introduction

The energy sector constitutes a major economic activity for most countries in SE Europe with a significant contribution to infrastructure investment and market activity. Even more important is the geopolitical role often associated with energy issues as they normally involve bilateral or even trilateral cooperation. A number of major cross-border energy projects are currently under development in the region, including gas and electricity interconnections, renewable energy applications (e.g. wind farms, photovoltaic plants, geothermal plants, biomass units, etc.) and large-scale energy efficiency interventions, especially in the building sector.

The SE European region is in need of more and better electricity interconnections, something which is especially visible in island regions, such as Greece and Cyprus. Advancing international electricity interconnections especially between Italy and Western Balkans and between mainland Greece and the Israel-Cyprus-Crete axis is becoming a priority in view of the fast advancing electricity market integration in the region.

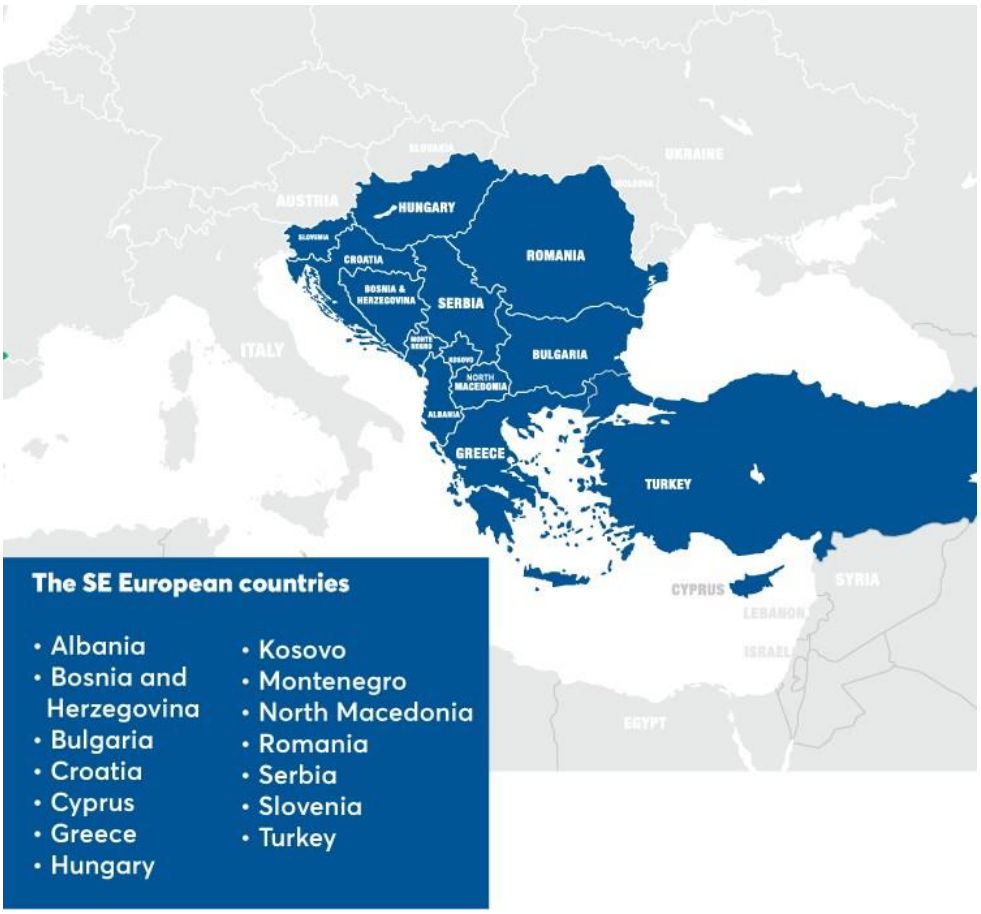
This Monthly Analysis focuses on the latest developments concerning the ongoing and planned electricity interconnections in the wider SE European region, highlighting their importance, in parallel with the increasing RES penetration, for achieving the goal of an integrated regional market.

The SE European Region

In order to facilitate our approach, we need to define and understand the geography of the SE European region. Thus, we consider the broader region as consisting of four main blocks, as follows: (a) West Balkans, (b) EU member countries - which include the Eastern Balkans (Romania, Bulgaria, Greece, Hungary) and the north of West Balkans (Croatia, Slovenia), (c) Turkey and (d) the East Mediterranean (Cyprus, Egypt and Israel), as also analysed in IENE's reference study "SE Europe Energy Outlook 2021/2022". **(1)**

Although strictly not part of SE Europe, Israel and Egypt, located in the East Mediterranean, are developing increasingly close energy ties with the broader region and hence, it was decided to include them in the current Monthly Analysis.

Map 1: The SE European Region as Defined by IENE



Source: IENE

Planned Electricity Interconnections in SE Europe

A key area of focus for SE Europe and an opportunity for bilateral or trilateral energy partnerships would be to facilitate regional cooperation in the Eastern Mediterranean to address supply concerns by building electricity interconnectors between Europe, Asia, and Africa. These can transmit electricity produced by a growing RES share, thus spearheading the green recovery in a region that is particularly impacted by climate change and can provide a "synergistic alternative" to gas interconnectors that allow for real-time energy transfer to markets.

One such project, the EuroAsia Interconnector, which was first conceived in 2010, already enjoys European financing, while another, the Greece-Egypt Power Interconnector, is approved by EU regulatory authorities and is part of the ten-year development plan of the European Network of Transmission System Operators for Electricity (ENTSO-E)[1]. A third one, the EuroAfrica Interconnector, has also been approved by EU regulatory

[1] The project, whose subsea route lays within the officially demarked Greece-Egypt Exclusive Economic Zone, was successfully included in ENTSOE TYNDP 2022 as project number 1048, 1048 – Greece - Africa Power Interconnector (GAP Interconnector) project sheet, Entsoe,

authorities and has received political support from Egypt, Cyprus, and Greece. All the above interconnectors have the benefit of creating new important corridors to transmit sizeable electricity volumes, produced from various energy sources, to Europe. Greece and Egypt have already signed an MOU for a direct subsea cable interconnection **(2)**, building on recent technological progress in alternating current (AC) interconnections **(3)** and Greece's experience with building one of the longest interconnectors in the world to the island of Crete.

Map 2: EuroAsia Electricity Interconnector

Source: EuroAsia Interconnector Ltd.

As a new corridor that helps link Israel and other US allies to Europe, the EuroAsia Interconnector is also supported by the US administration. "We are supportive of connecting the distribution grids of mainland Europe to Cyprus and Israel via the EuroAsia Interconnector", a State Department Official recently mentioned **(4)**. "It is a cost-effective and flexible route that can be used not only for electricity but as a platform to deploy other renewable energy sources".

These transmission lines between countries require a great level of trust and cooperation, but once this is achieved, they are faster and easier to build than pipelines. Since they will be carrying electrons rather than hydrocarbon molecules, they may face fewer security complications than has been evident in the exploration of the region's hydrocarbon resources. Still, for these interconnectors to proceed swiftly and smoothly, it is particularly important that the US government, which is concerned with regional security, energy integration

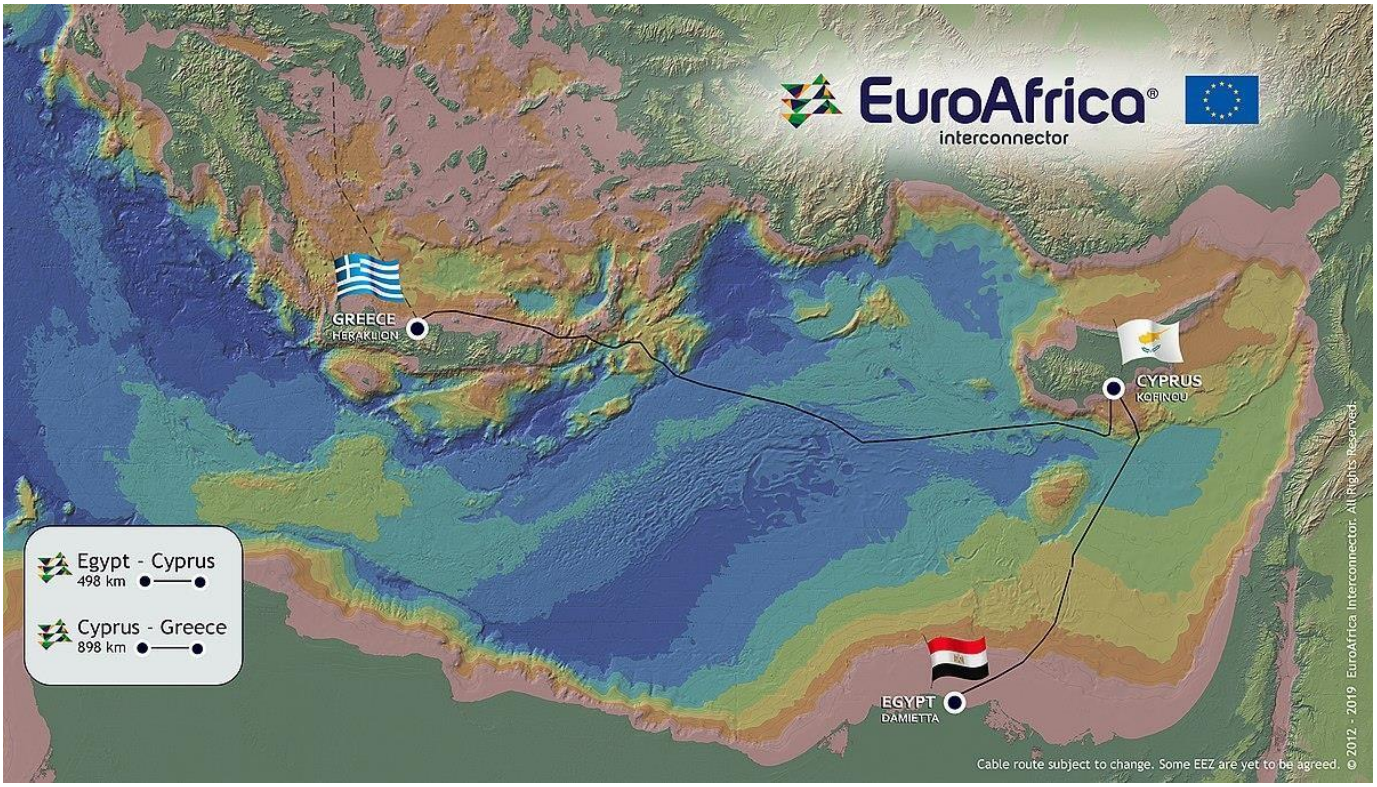
https://tyndp2020-project-platform.azurewebsites.net/projectsheets/transmission/1048

and economic stability, continues to signal to everyone in the region for its support for these projects which are seen as vital for the energy transition.

In any event, electricity interconnectors will facilitate the flow of green sources of energy to SE Europe and beyond to Central and Eastern Europe. As Europe and the global energy system transitions to green alternatives, low-carbon electricity produced in the Eastern Mediterranean may help to provide, among others, green energy to more European nations.

According to EuroAsia Interconnector, the company undertaking the endeavor, 50% of the electricity to be carried by this interconnector is projected to be from RES by 2028-2030, and eventually this percentage will rise to more than 70%. It may also increase the security of supply for Israel and allow it to take advantage of its own RES export potential while supplying electricity in case of need in Europe.

Map 3: EuroAfrica Electricity Interconnector



Source: EuroAfrica Interconnector Ltd.

As Professor John Maniatis noted at a workshop[2], broadening the international interconnectors to bring green energy to Northern Europe would be a great geopolitical opportunity. This could also take the form of a new electric highway: a South-North highway starting from Greece and crossing Bulgaria and Romania toward Germany. As he put it, "besides the pipeline diplomacy, we need a new 'electric cable diplomacy' that will account for the geopolitical instability of the energy transition". **(5)**

[2] Maniatis, J. (2021), General comments, (closed) Atlantic Council workshop on US-Greece energy policy cooperation.

These projects increase the green energy ambitions of a region that is still very dependent on hydrocarbons by creating hubs that help the countries concerned realize their RES potential and reduce their carbon footprint. They may also facilitate the transition to green energy for the countries involved. Combining interconnections with other technological innovations, such as creating an electricity highway and linking them to energy storage projects and RES investment in the region, would allow for optimal trade in energy across the European system, given the time differences between countries.

Map 4: Electricity Interconnections in SE Europe

Source: IPTO

Still, energy experts note that completing the integration of electricity networks in SE Europe will require sufficient long-term electricity storage projects and adequate cross-border and internal electricity interconnections.

The Case of Greece

In view of the fact that Greece's electricity grid has to support several island networks, of great significance are the developments regarding the electricity interconnections of the islands with the power grid in mainland Greece, and improved cross-border interconnections that will enable the national electricity transmission

system to cover the requirements of the new targets for RES penetration and the incorporation of energy storage systems by 2030.

Indicatively, Greece's power grid operator IPTO has incorporated in its ten-year plan for the years 2023-2032 **(6)** the electricity interconnections of the North Aegean islands, the Cyclades and the Dodecanese. It is worth noting that Greece has electricity interconnections to Albania, North Macedonia, Bulgaria, Turkey and Italy through a 400 KV connection. IPTO is now taking initiatives to upgrade Greece's interconnections with neighboring countries, acknowledging transboundary grid link insufficiencies are having a negative impact whose consequences include market functional disorders and higher electricity prices.

IPTO has formed working groups with all of Greece's neighboring countries to examine the prospect of constructing and reinforcing existing interconnections. More specifically, **Italian** operator Terna has signed a terms of reference agreement with IPTO for a new interconnection, with four development phases. The goal is to increase capacity with a 1 GW high-voltage direct current cable under the Ionian Sea from 500 MW currently to 1,500 MW. The length of the new line is expected to reach 220 kilometers in the underwater segment plus another 55 kilometers on land. The existing Greek-Italian electricity grid interconnection, a 163 km subsea cable with a 500 MW capacity in operation since 2002, was useful in facilitating the Target Model's next stage, i.e. market coupling, beginning on December 15, 2020, with the aim of harmonizing the energy markets of the two countries. Now, an expansion and upgrade of the electricity interconnection between the two countries has become a top priority.

In addition, Greece and **Bulgaria** intend to expand their existing interconnection through the construction of a second line between Nea Santa and Maritsa East with a capacity of 2 GW and a length of 151 kilometers. The new 400 kV line is envisaged to increase the total capacity to 1.4 GW in the direction toward Bulgaria and to 1.7 GW from Bulgaria toward Greece. Construction has been completed on the Bulgarian side, while on the Greek part of the border it is expected to be completed by the end of the year.

Another regional project is the second 400 kV interconnection between Greece and **Turkey** to be completed by 2029. The 130-kilometer line will have a capacity of 2 GW, running parallel to the existing one. According to IPTO, the new interconnection will increase capacity by 600 MW in both directions and together with other new lines it will allow for increased renewable energy penetration in the systems. With the forthcoming operation of Turkey's new nuclear power plant in Akkuyu, the 1.1 GW first unit of which will go on stream later this year, Turkey will be in a position to export higher volumes to Europe.

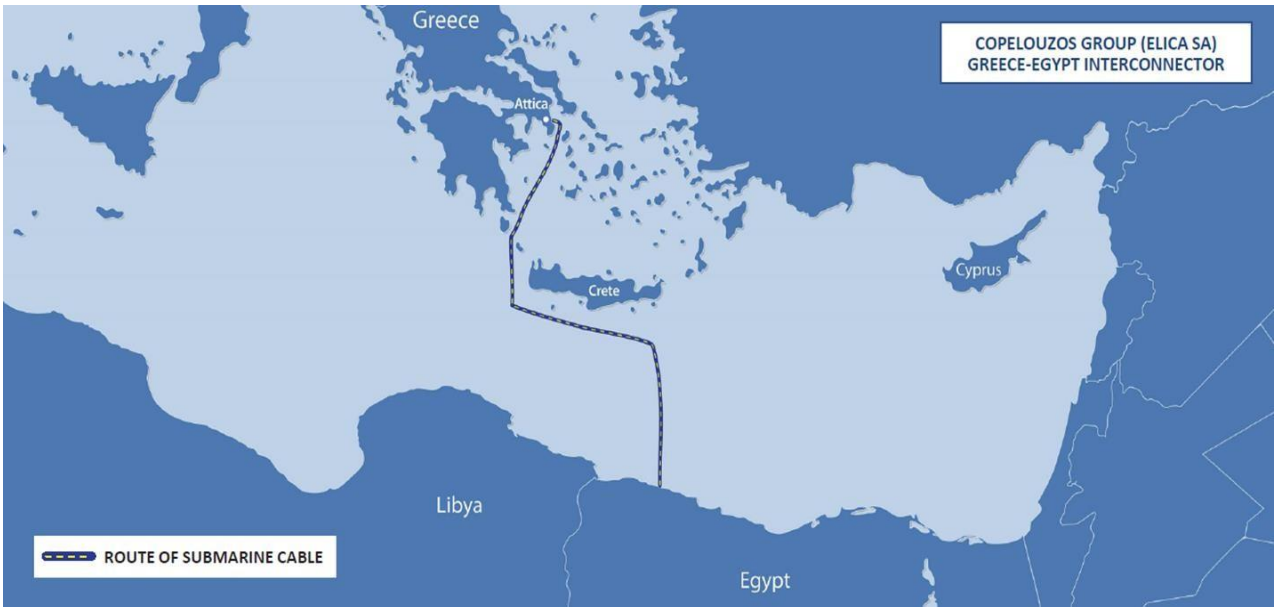
IPTO and **North Macedonia**'s transmission operator MEPSO intend to upgrade their interconnection after 2030. More detailed studies on the project are expected in the next few years, according to IPTO. Furthermore, IPTO and its **Albanian** counterpart OST have been in talks since 2020 on the possibility of

building a second 400 kV interconnection. In February 2022, a working group was formed to examine the technical aspects of the project. The goal is to connect Arachtos in Greece with Fier in Albania with a 145-kilometer cable. The line would increase capacity by at least 200 MW in both directions. **(7)**

It is worth mentioning that construction work has started on the **EuroAsia Interconnector**, a project with a length of 1,208 kilometers between Greece, Cyprus and Israel. The €2.4 billion endeavor is planned with a capacity of 2 GW and is expected to be completed by 2027. The project has so far received €100 million in support from the EU through the Recovery and Resilience Facility and a grant of €657 million through the "Connecting Europe Facility" for the construction phase.

In addition, ELICA, a subsidiary of Copelouzos Group, has proposed to construct **Greece-Egypt electricity interconnector** to enable importing green electricity from Africa. IPTO supports the project, which is currently in the planning stage. In 2022, the working groups from the two countries met and a memorandum of understanding has already been signed with Egypt's transmission operator EETC. This double subsea cable is to stretch 954 kilometers from El Sallum to coastal Nea Makri, northeast of Athens. It is envisaged to transmit low-cost green energy with 3 GW in capacity, of which one third would be provided to local industries and the other two thirds exported to other EU member states.

Map 5: Greece-Egypt Electricity Interconnector

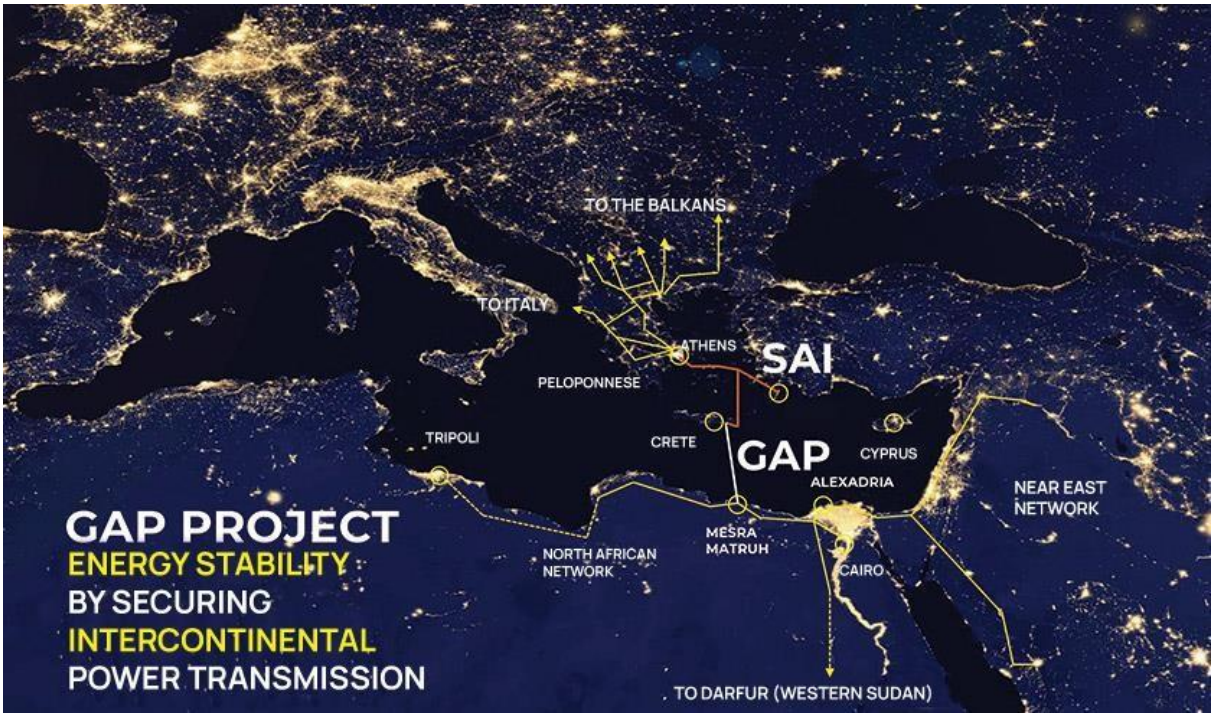


Source: Copelouzos Group

Another important electricity interconnection is the **Greece-Africa Power Interconnector**. The project, a proposal of the Eunice Group, includes the connection of South-Eastern Crete with Egypt and the extension of this interconnection to Attica as the most suitable option for the power interconnection of the two continents. The Greece-Africa power interconnector project is among the projects that are gathering strong

support from both sides of the Mediterranean and is included in the 2022 ten-year development plan of the ENTSO-E. The planned cable (2,000 MW) is characterised by significant advantages in terms of construction, geopolitical value, energy efficiency, economic viability, and potential for exploitation for the production of clean green energy. The project is expected to cost €1.3 billion, with a completion date of 2030, and will enable the bi-directional supply of electricity to Greece and Egypt.

Map 6: Greece-Africa Power Interconnector



Source: Eunice Group

Moreover, Greece has proposed building a cable that will carry electricity mainly produced by RES to Austria and southern Germany where energy infrastructure is curbed by nature protection laws in the Black Forest region. According to Greek officials, the cable, which would have an initial capacity of 3 GW that could be ramped up to 9 GW, would run through Albania. The cable would then run through Montenegro, Croatia and Slovenia before reaching Austria and southern Germany. Alternatively, a subsea cable would connect Albania to Slovenia and then travel to Austria and southern Germany. **(8)**

New interconnections in the Balkans are considered by the European Union and countries in the region as a vital step in order to ensure the security of supply in the future. It becomes even more urgent given the recent supply issues and the results of the energy crisis and expensive power and gas. Furthermore, both IPTO and other operators in the Balkans are focusing on the role of energy storage as a way to stabilize supply-demand and lead to an efficient power system in the years after 2030 within an environment of high RES penetration.

Table: Planned Electricity Interconnections in SE Europe, Including Greece

Project	Distance (km)	Capacity (MW)	Cost (€ million)	Company
EuroAsia Interconnector	1,208	2,000	2,400	EuroAsia Interconnector Ltd
EuroAfrica Interconnector	1,396	2,000	2,500	EuroAfrica Interconnector Ltd
Greece-Egypt Power Interconnector	954	3,000	4,200	ELICA SA
Greece-Africa Power Interconnector	420	2,000	1,300	GAP Interconnector S.M.S.A
Interconnector Greece-Italy	275	1,000	606	IPTO, TERNA
Interconnector Greece-Bulgaria	151	2,000	66	IPTO, ESO EAD
Interconnector Greece-Albania	145	2,000	15.3	IPTO, OST
Interconnector Greece-North Macedonia*	-	-	-	IPTO, MEPSO
Interconnector Greece-Turkey	130	2,000	24.2	IPTO, TEIAS
Green Energy Corridor*	Through Albania, Montenegro, Croatia, Slovenia, Austria and southern Germany	3,000-9,000	-	-

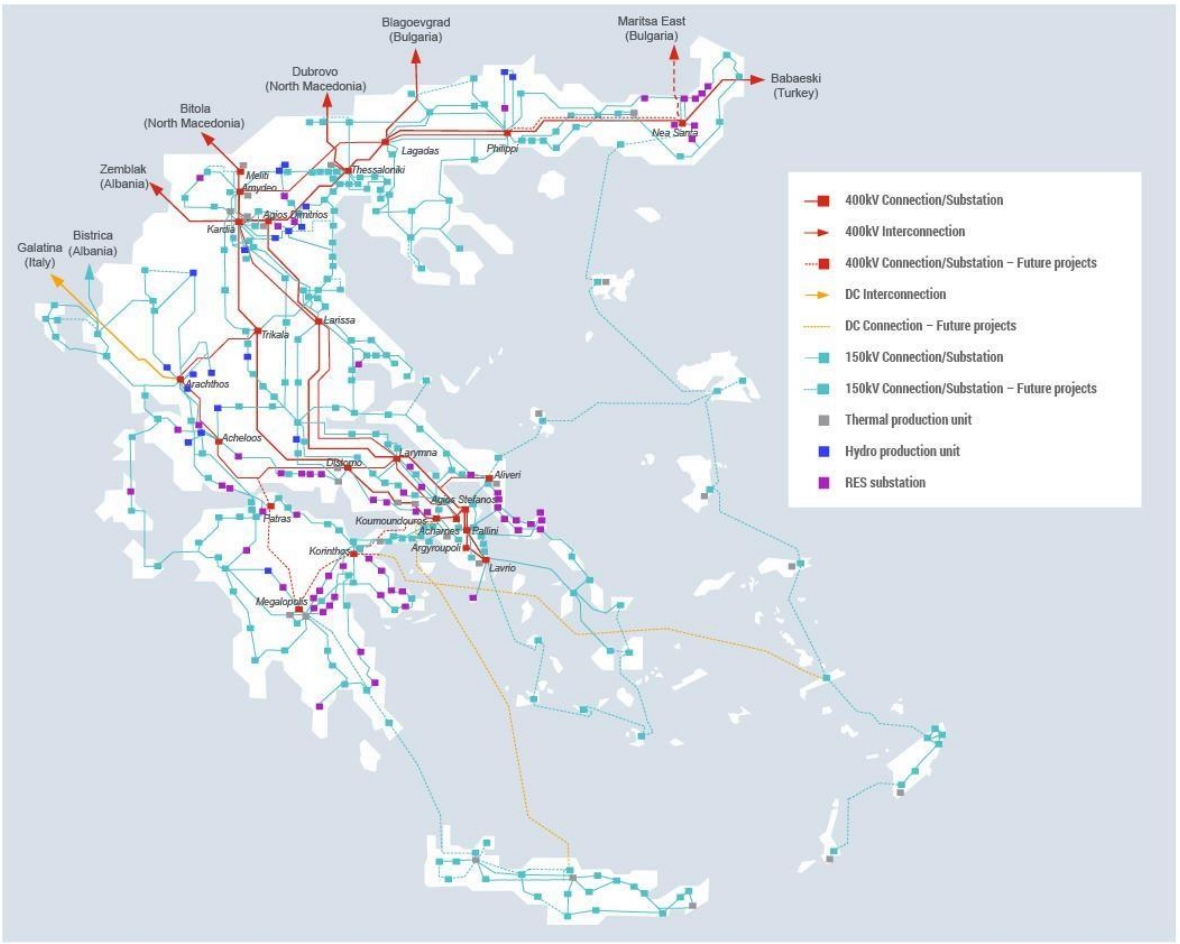
Note: *No more information and data are available.

Sources: Various websites, IENE

IPTO also continues to invest in the underwater connections of non-interconnected Greek islands. Currently, the fourth stage of the Cyclades interconnection is under way, while the operator also focuses on offshore wind planning in order to take advantage of the new connections and connect future wind farms in the Aegean. The Dodecanese (Kos-Rhodes-Karpathos-Samos) will be interconnected with the mainland system by 2028, while the Northeast Aegean islands (1st-3rd phase) are anticipated to be interconnected by 2029.

Regarding Crete's electricity interconnections, one of the most important milestones in the electricity interconnection project of Crete-Attica, i.e. the laying and installation of all the 500 kV direct current technology submarine cables, was successfully completed recently by IPTO's subsidiary company Ariadne Interconnection. With the completion of the cable protection works, expected in the second quarter of 2023, 640 km will have been laid below the seabed surface for maximum safety. The electricity interconnection of Crete with Attica is the largest energy investment, amounting to €1 billion, currently being carried out in the country, with which IPTO will fully integrate Crete into the continental electricity transmission system by the end of 2024. The small-scale grid interconnection to link Crete with the Peloponnese, with the longest in the world AC cable interconnection of 174 km, was completed in July 2021.

Map 7: Domestic and Cross Border Electricity Interconnections in Greece



Source: IPTO

Discussion

As electricity interconnections increase in SE Europe, it is estimated that the RES penetration and hence the energy storage needs will rise. Combining interconnections with other technological innovations, such as creating an electricity highway and linking them to energy storage projects and investment in RES in the region, would allow for optimal trade in energy across the European system, given the time differences between countries.

Completing the integration of electricity networks in SE Europe will require both sufficient long-term electricity storage projects and adequate cross-border and internal electricity interconnections. Of great significance are the developments regarding the electricity interconnections of the islands with the mainland grid, such as in Greece, and improved cross-border interconnections that will enable the national electricity transmission system to cover the requirements of the new targets for RES penetration and the incorporation of energy storage systems by 2030.

Currently, planned and under construction projects for cross-border electricity connections in SE Europe are critical both to prevent market congestion and to enable the integration of electricity from RES and other sources, but their impact will become more visible after 2028. In the case of islands, the use of hybrid stations with RES, i.e. RES and storage, is another solution in cases where the electricity interconnection to the mainland grid is not economically viable, but such stations will have to be assessed as to their technical and economic viability. Furthermore, they must be compared to the existing situation, and their installation and operation to be promoted only if it is ensured that power generation costs are reduced.

The construction of new electricity lines and interconnections, along with new gas pipelines, will enhance Greece's position as an important energy transit country and regional energy player. Such expanded energy network, including most of the islands, will undoubtedly help Greece to strengthen its sovereignty over its land and sea areas.

References

1. IENE (2022), "SE Europe Energy Outlook 2021/2022", https://www.iene.eu/en/congress/47/iene-study-see-energy-outlook-2021-2022
2. Reuters (2021), "Greece, Egypt Sign Deal for First Subsea Power Link between Europe and Africa", https://www.reuters.com/business/energy/greece-egypt-sign-deal-first-subsea-power-link-between-europe-africa-2021-10-14/
3. Hojckova, K. et al. (2022), "A global super-grid: sociotechnical drivers and barriers", *Energy Sustainability and Society*, Volume 12, Article number: 42 (2022), https://energsustainsoc.biomedcentral.com/articles/10.1186/s13705-022-00368-y
4. State Department Official (2021), Response to Media Questions (via email); also reported elsewhere including by Patricia Claus, "US Throws Support Behind Greece in EuroAsia Interconnector Row", https://greekreporter.com/2021/03/19/us-throws-supportbehind-greece-in-euroasia-interconnector-row/
5. Sokou, K. (2022), "Squaring the Energy Transition Circle in Southeast Europe and the Eastern Mediterranean", https://www.atlanticcouncil.org/wp-content/uploads/2022/05/Squaring_the_energy_transition_circle.pdf
6. IPTO (2023), "Ten Year Development Plan of HETS for the period 2023-2032", *in Greek*, https://www.admie.gr/sites/default/files/users/dssas/DPA%202023-2032/%CE%94%CE%A0%CE%91%202023-2032%20%CE%9A%CF%8D%CF%81%CE%B9%CE%BF%20%CE%A4%CE%B5%CF%8D%CF%87%CE%BF%CF%82.pdf

7. OT (2023), "Independent Power Transmission Operator (IPTO): Projects of 550 million euros for electrical interconnections in 2024-2033", https://www.ot.gr/2023/02/07/english-edition/independent-power-transmission-operator-ipto-projects-of-550-million-euros-for-electrical-interconnections-in-2024-2033/
8. Liaggou, C. (2023), "Greece eyes green energy corridor status", https://www.ekathimerini.com/economy/1197094/greece-eyes-green-energy-corridor-status/

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