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The Benefits of Regional Energy Cooperation in the Eastern Mediterranean and Middle East

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Policy Brief

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The Benefits of Regional Energy Cooperation in the Eastern Mediterranean and Middle East

Improving Environmental Sustainability and Energy Security through Electricity Trade

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KEY INSIGHTS

- Decarbonization is faster and cheaper in Cyprus and the entire Eastern Mediterranean and Middle East (EMME) if investments in enhanced electricity interconnections are implemented.
- Savings of up to 35 billion USD are estimated for the entire EMME region until 2050 if increased electricity trade is enabled.
- Besides lowering costs and improving environmental sustainability, interconnections and electricity trade improve energy security of EMME countries.
- Despite political challenges, a regional action plan from interested countries about relevant infrastructure investments can enable a proper strategy with multiple benefits.

Introduction

A decade has already passed from the Paris Agreement to combat climate change, but the world is not on track to achieve the required decarbonisation. To reverse this situation, investments at an unprecedented pace and scale are needed. At the same time, European Union member states are required to formulate their National Energy and Climate Plans (NECPs), having in mind the long-term goal of net-zero emissions by 2050. The Republic of Cyprus is gradually making progress, as indicated in its latest National Energy and Climate Plan.

One of the measures envisioned in the NECP of Cyprus is the development of the Great Sea Interconnector (GSI), which will link the electricity grid of Cyprus with that of Greece, and eventually of Israel. This project would end the energy isolation of Cyprus, which currently has no grid interlinkages with neighbouring countries. Similarly, an expansion of electricity interconnections is discussed in several countries in the broader Eastern Mediterranean and Middle East (EMME) region, in an effort to untap the vast unexploited renewable energy potential.

The EMME region is defined here to consist of Bahrain, Cyprus, Egypt, Greece, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Palestine, Qatar, Saudi Arabia, Syria, Turkey, and United Arab Emirates – see Figure 1. It comprises countries of various sizes and population levels, at different stages of economic development, with a significant variety in natural, human and financial resources, and facing diverse political and economic challenges. They share, however, a common future. They are located in a hotspot of climate change, with a high likelihood to experience serious adverse impacts on their welfare.

Figure 1. The EMME region.

The importance of an interconnection for Cyprus has been briefly assessed in the past, but not with an outlook to 2050 along with the adoption a carbon neutrality target. Similarly, it has not been assessed against outputs from a regional model that explicitly represents the surrounding countries.

This Brief provides insights on the benefits of grid interconnection deployment for the decarbonisation of the energy system of Cyprus and the EMME region. For this purpose, we developed and used two energy system models: one representing the national energy system of Cyprus and one representing the electricity supply system of the seventeen EMME countries including grid interconnector representation. Our work demonstrates that regional energy cooperation is critical to ensure that the region is on path to meet the goals of the Paris Agreement and to avoid investments in infrastructure that may become stranded assets in the future.

Methodology

Both the national energy systems model of Cyprus and the EMME electricity supply model used for the present analysis are developed within the OSeMOSYS cost-optimization modelling framework. OSeMOSYS adopts an open-source approach to ensure transparency in the input data and assumptions. This enables and encourages future collaboration between researchers, policy makers, and other stakeholders across the relevant geographies. The model's objective is to minimize the cost of satisfying externally defined demand for energy services while considering a range of assumptions, such as technology cost projections, fuel price projections, fossil fuel reserves, and renewable energy availability. It has been used in the past to conduct analyses at global, regional, national, and sub-national level.

The OSeMOSYS-Cyprus model is coupled with an energy demand forecast model to arrive at energy projections of the entire energy system (i.e. electricity, transport, heating & cooling). It is populated with national statistics and data from relevant national authorities and is used to inform the country's official NECP. OSeMOSYS-Cyprus decides on whether to import or export electricity via a comparison of the internally calculated marginal electricity cost and externally defined import and export prices.

On the other hand, the OSeMOSYS-EMME model focuses solely on electricity supply. The seventeen countries of the region are represented in the model as separate systems that can trade electricity with their neighbouring systems either through existing or future grid interconnections. The model is populated with information from publicly available sources. This includes data on existing and planned generation and grid interconnection capacity, electricity demand projections, fuel price projections, and technoeconomic assumptions on electricity generation and storage technologies. OSeMOSYS-EMME internally calculates the marginal cost of electricity at any given time in each country and decides on the volume and direction of electricity trade based on potential cross-border differences. Thus, it is more suited to project electricity trade than a standalone national model.

Scenarios

We developed a set of scenarios to generate insights at a regional and national level, highlighting the advantages of enhanced interconnectivity for pathways that align with the goals of the Paris Agreement. The present analysis assessed the following scenarios:

A. **Reference Trade**: Electricity interconnections are limited to existing projects. Trade is allowed to occur if deemed cost-effective using this infrastructure. In the case of Cyprus, it is assumed that development of the GSI is not successful.

B. **Enhanced Trade**: Investment in grid interconnections under discussion is allowed, thus enabling a higher volume of electricity exchange across the region. In the case of Cyprus, the GSI is developed and trade with Greece and Israel can occur by the end of 2029 and 2032 respectively.

C. **Late GSI**: The third scenario, which is only developed for the OSeMOSYS-Cyprus model, examines the impact of a delayed development of the GSI, pushing the project's completion to the end of 2039.

All above scenarios enforce a net-zero greenhouse gas emissions constraint on each country's electricity system by 2050.

Results and Discussion

Driven by a continuous increase in electricity demand and the need to meet the decarbonisation target by 2050, renewable energy deployment is projected to increase substantially in all scenarios. The scenario runs with OSeMOSYS-Cyprus indicate a renewable energy share by 2050 of 66% without interconnection and 73% with the GSI development. These scenarios foresee that natural gas with Carbon Capture and Storage (CCS) will also contribute to the generation mix. On the other hand, if no gas-fired CCS technologies are developed, electricity generation in Cyprus will be based 100% on renewable energy technologies in 2050.

The variability in renewable energy shares and the availability of interconnections in the aforementioned scenarios leads to differences in the necessity for storage technologies. Specifically, in the OSeMOSYS-Cyprus model scenarios, the total electricity storage in 2050 amounts to 1,124 Megawatts (MW) and 4,460 Megawatt-hours (MWh) without interconnection, and 80-326 MW / 640-1,172 MWh with interconnection. The scenarios of OSeMOSYS-EMME, which foresee 100% renewable energy in Cyprus by 2050 necessitate a much higher storage capacity, reaching 958 MW/3,832 MWh with interconnection and 1,966 MW/7,864 MWh without interconnection.

An interesting observation can be made through the comparison of the electricity trade direction in each scenario for Cyprus (*Figure 2*). The OSeMOSYS-Cyprus scenario, which treats neighbouring country electricity prices as static, projects a high volume of electricity exports as indicated in both scenarios with GSI development. On the other hand, the OSeMOSYS-EMME model endogenously calculates the marginal price of electricity for each country at each point in time; in this case, Cyprus is a net importer of electricity for the majority of the model horizon and only becomes a net exporter towards the end of the outlook. This illustrates the price sensitivity of the projections on the volume and direction of electricity trade.

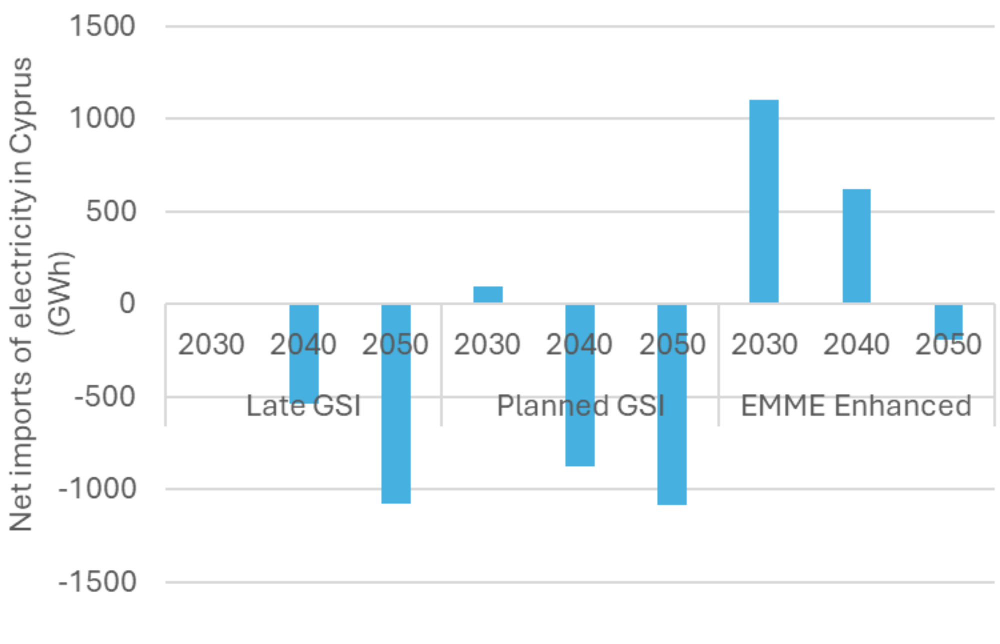
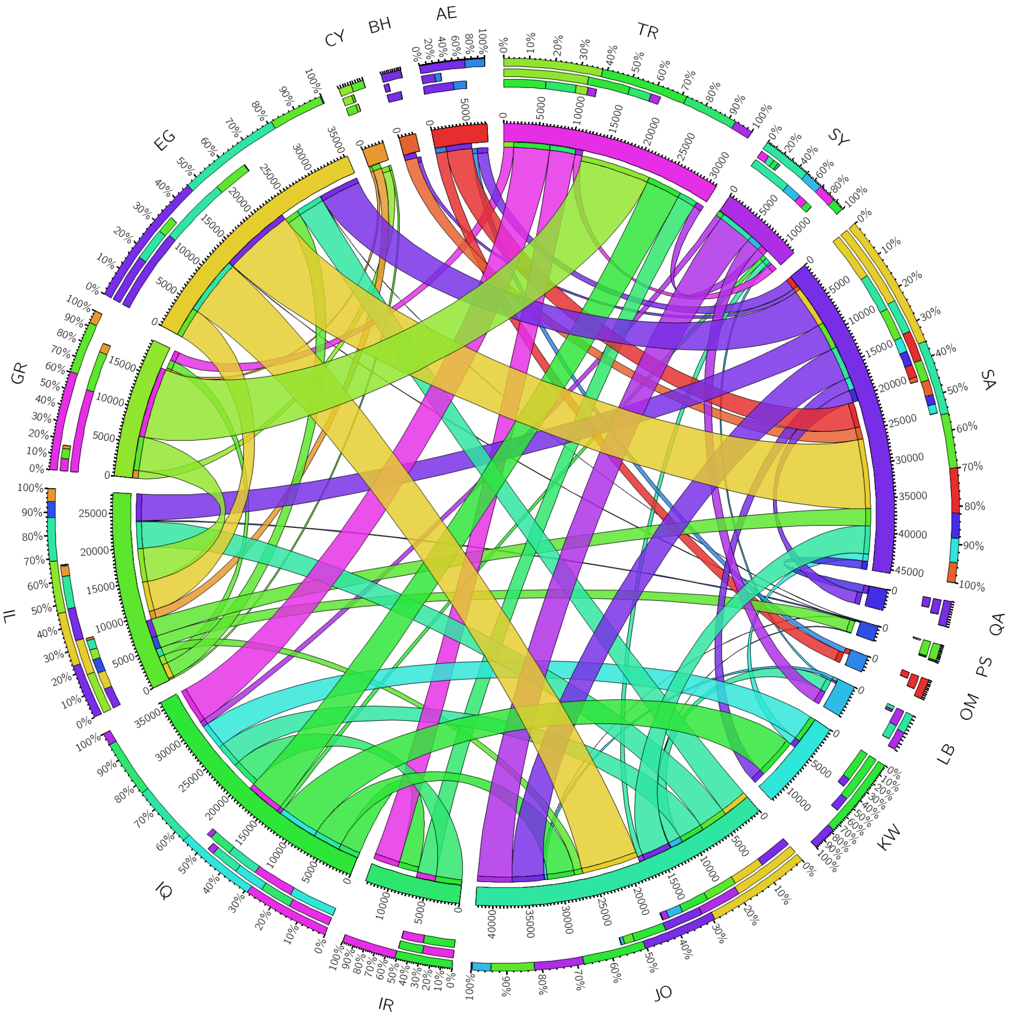


Figure 2. Volume of net imports of electricity in Cyprus in each scenario in the OSeMOSYS-Cyprus model (Late GSI, Planned GSI) and in the OSeMOSYS-EMME model (EMME Enhanced). Scenarios without interconnection are not shown, as no electricity can be traded.

Furthermore, this inconsistency between the two models brings to surface an important limitation. The authors have observed that standalone national models tend to underestimate the need for electricity imports and overestimate the potential for exports. This finding is supported by a comparison of the NECPs of EU member states with official European Commission projections; whereas the latter foresees net electricity exports of the order of 8 TWh by 2030 across the EU, individual national projections lead to an approximate total of 155 TWh. This is an important caveat that national planners need to bear in mind.

Another interesting aspect of our results is the outlook of regional electricity trade volumes. For instance, by 2050 in the Enhanced Trade scenario, Egypt becomes a major electricity exporter with annual net exports exceeding 11 TWh, while Israel with annual net imports of 9.5 TWh is the biggest importer of electricity in the region (*Figure 3*).

The benefit of enhanced interconnectivity is highlighted by a comparison of the system costs of the Reference Trade and Enhanced Trade scenarios. Savings of up to 35 billion USD are estimated for the entire EMME region until 2050, if increased electricity trade is enabled.



AE - United Arab Emirates; BH - Bahrain; CY - Cyprus; EG - Egypt; GR - Greece; IL - Israel; IQ - Iraq; IR - Iran; JO - Jordan; KW - Kuwait; LB - Lebanon; OM - Oman; PS - Palestine; QA - Qatar; SA - Saudi Arabia; SY - Syria; TR - Turkey

Figure 3. Electricity exchange between EMME countries in the Enhanced Trade scenario in 2050, assuming that electricity interconnections will be utilized according to a cost-optimal solution for the entire region. The inner ribbon of the visualisation shows the volume of electricity traded in GWh; for instance, in Egypt (identified by a yellow colour) the total electricity trade is approximately 35,000 GWh. A gap between the ribbon and associated colour segment indicates that electricity is being imported, and electricity flows from a country without this discontinuity. The colour of the band is identical to that of the country of origin (e.g. yellow in the case of Egypt). As such, Egypt imports from Israel, Jordan and Saudi Arabia. Exports are identified by the flows with the equivalent country colour. In the outer part of the graph, three bars show the percentages of electricity traded with each country of the region, identified by their respective colour. The first bar indicates the percentages of the total volume of traded electricity, the middle bar corresponds to electricity imports and the last bar corresponds to electricity exports.

Policy Recommendations

Electricity trade across the EMME region offers multiple benefits as it can lead to a decrease in greenhouse gas emissions, while reducing the financial requirements for investments in power generation technologies. Therefore, in addition to national energy and climate plans, cooperation for the formulation of a **regional energy action plan** can promote coordinated efforts in this front. Regional cooperation should be particularly pursued to identify the most cost-effective grid interconnection projects that can unlock major renewable energy potential.

Operation of a regional electricity market requires the existence of a level playing field across all EMME countries. Since direct or indirect fuel subsidies distort the market, this is an area that requires further policy action in many EMME countries, where **electricity and fuel subsidies should be phased out**.

Especially as far as Cyprus is concerned, **electricity trade between Cyprus and the neighbouring countries offers multiple benefits.** It can lead to an earlier and smoother deployment of renewable energy technologies, facilitate decarbonisation efforts, and reduce the investment requirements for power generation and energy storage.

Irrespective of interconnections, as renewable energy investments continue to increase, the **regulatory framework needs to facilitate the timely deployment of storage technologies**, whether or not (and whenever) the GSI is developed in Cyprus. This will help limit the curtailment of renewable energy at much lower levels than currently practised.

Finally, **uncertainty in the volume and direction of electricity trade has to be considered in the long-term planning of the Cypriot energy system**. Investments in power generation with a supplementary aim to export electricity to neighbouring countries may be faced with inadequate demand, as an interconnected EMME region will be a competitive market for electricity exports. Similarly, in case electricity generation costs are much lower in neighbouring grid systems, electricity imports may increase considerably. If investments decisions are not planned correctly, this might pose a threat to the financial viability of domestic generation and to the long-term security of supply of the national grid.

It must be noted that the discussion in this Brief has focused on the **energy and environmental benefits** of electricity interconnections for Cyprus and the entire region. **Challenges with regard to financing of these investments and geopolitical issues were out of the scope of this research.**

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