Climate Compatible Growth

COP27 POLICY BRIEF SERIES

Eastern Mediterranean and the Middle East Region: Enhancing Decarbonization of Power Generation Through Electricity Trade

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Summary

The region of the Eastern Mediterranean and Middle East (EMME) is very diverse, comprising countries with rich fossil fuel reserves, which are net energy exporters, and countries that heavily rely on energy imports. This policy brief aims to highlight the potential benefits offered by a future enhancement in electricity trade across the region. A model representing the national electricity supply system of seventeen EMME countries is developed and used to assess alternative scenarios where trade is limited or enhanced. Relevant implications in terms of renewable energy deployment, greenhouse gas emissions, and overall system costs are then quantified. The scenario results can assist in the identification of potential net exporters of carbon-neutral electricity, markets for electricity imports within the region, as well as key transit countries.

Key Policy Recommendations

- Regional cooperation and the formulation of a regional decarbonization action plan that accounts for the benefits of electricity exchange is needed.
- Identification of the most cost-effective grid interconnection projects can maximize the use of regional renewable energy potential.
- A favourable regulatory environment can encourage investments in electricity generation and storage technologies and grid interconnectors.
- A gradual phase-out of fossil fuel and electricity subsidies will create the necessary level playing field for a regional electricity market that assists in the smooth integration of additional renewable energy capacity.

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Introduction

The climate emergency is one of the most important challenges of modern society. A transition to low-carbon economies can mitigate the impact of climate change but requires investments at an unprecedented pace and scale. However, not all regions in the world are on a path to decarbonization.

Most countries in the Eastern Mediterranean and Middle East (EMME[1]) region **(Figure 1)** are far off the trajectory required to achieve the targets set by the Paris Agreement. An unquestionable indication of this is that the renewable energy share in total electricity generation of the EMME region was limited to 12% in 2019 [1].

Several model-based assessments have been conducted on the topic of increased renewable energy deployment and decarbonization of the region. Examples include national-focused analyses [2–4], but also efforts with a regional perspective [5–7]. Such regional analyses can provide a more holistic overview in regard to regional cooperation and energy commodity trade. However, certain gaps have been identified in existing literature with regional focus in terms of temporal and technological detail.

This brief describes the first attempt to develop a fully open-source EMME energy systems model with grid interconnector representation. It aims to explore the potential for electricity trade across the region and how this can unlock renewable energy resources and assist in cost-effective decarbonization efforts. It provides new insights on the potential environmental and economic benefits offered by increased regional collaboration in the energy sector. As this sector is frequently a driver for regional instability, it is imperative that the alternative of cooperation is examined.

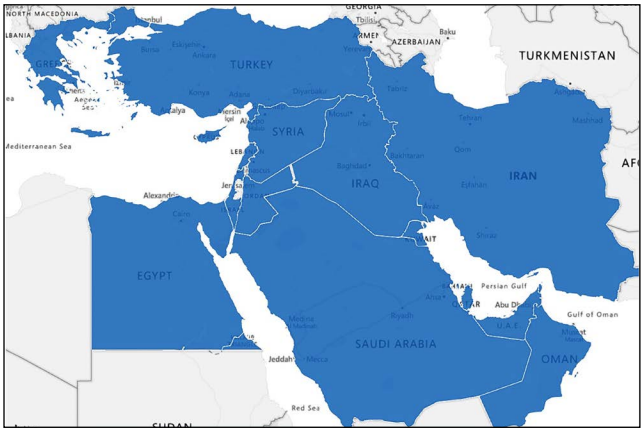


Figure 1. The EMME region.

Methodology

The EMME electricity supply model presented here is developed within the OSeMOSYS modelling framework, which is a cost-optimization model [8]. It adopts an open-source framework, in order to ensure transparency in the input data and assumptions. This also allows for and encourages future collaboration between researchers, policymakers, and other stakeholders across the region.
The model's objective is to minimize the cost of satisfying externally defined demands for energy services while considering a range of assumptions, such as on technology cost projections, fuel price projections, fossil fuel reserve, and renewable energy resource availability. It has been used in the past to conduct analyses at the global, regional, national, and sub-national level [9].

[1] 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.

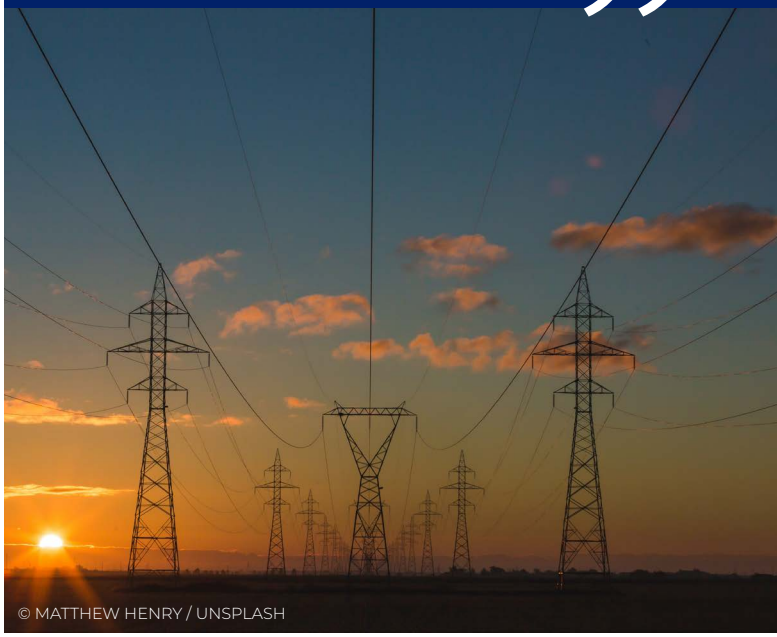
The seventeen countries of the region are represented in the model as separate systems that can trade electricity with their neighbouring systems either through existing or future grid interconnections. The model is populated with information from publicly available sources. This includes data on existing and planned generation [10, 11] and grid interconnection capacity [12–15], electricity demand projections [4, 16–28], international fuel price projections[2] [29], and technoeconomic assumptions on electricity generation [30] and storage technologies [31]. However, data are scarce for some countries. This limitation can be alleviated in future improvements of this work through collaboration with interested national authorities.

Scenarios

A set of scenarios is developed to generate insights at a regional and national level, highlighting the advantages of EMME-wide policies instead of individual national roadmaps. The present analysis assesses the following scenarios:

A. **Reference Trade:** In this scenario, electricity interconnections are limited to existing projects. Trade is allowed to occur if deemed cost-effective using this infrastructure.
B. **Enhanced Trade:** In this scenario, investment in grid interconnections under discussion is allowed, thus enabling a higher volume of electricity exchange across the region.
C. **Net Zero with Reference Trade:** Building on the Reference Trade scenario, this case implements a net-zero carbon dioxide emission target across the EMME region. This scenario shows the additional investments needed to align the region with the Paris Agreement targets and limiting global warming to 1.5°C.

> *"renewable energy deployment is projected to increase substantially in all scenarios."*



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D. **Net Zero with Enhanced Trade:** Similar to above, a net-zero carbon dioxide emissions target is implemented, while allowing for investments in new grid interconnections to occur. A comparison with the Net Zero with Reference Trade case can show potential cost savings enabled by enhanced trade.

Results and Discussion

Driven by an assumed continuous increase in electricity demand, renewable energy deployment is projected to increase substantially in all scenarios. In the cases

[2] Even though some countries may provide fuel to generation facilities at a lower cost, international fuel price projections are used for the entire region. This is done to assess development pathways under perfect market conditions without any market distortions.

where no carbon dioxide emission targets are implemented, the renewable energy share in generation increases to 60% by 2030, 88% by 2040 and 93% by 2050. An increase in variable renewable energy needs to be accompanied by electrical storage capacity, which is projected at 89–93 GWh in 2030, 614–626 GWh in 2040, and 975–1,011 GWh in 2050.

Availability of additional grid interconnection capacity increases the level of trade across the EMME region **(Figure 2)**. The total level of electricity exchange is increased by 37 TWh in 2030, 70 TWh in 2040, and 92 TWh in 2050, when the Reference and Enhanced Trade scenarios are compared. This illustrates the considerable potential for investments in grid interconnections.

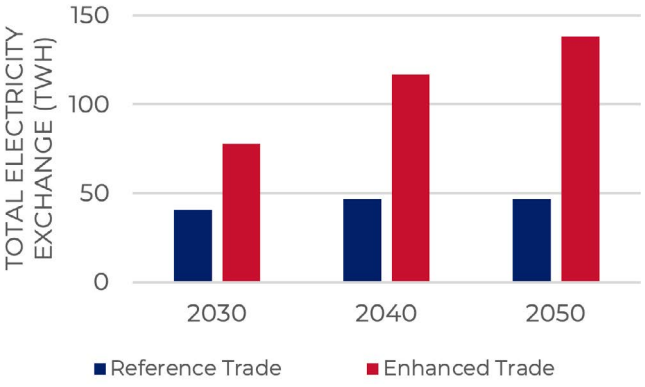


Figure 2. Level of total intraregional electricity exchange projected for the Reference and Enhanced Trade scenarios.

Even though the planned grid interconnection capacity is limited until 2050 to currently identified projects, electricity trade has a direct effect on greenhouse gas emissions. Cumulative carbon dioxide emissions in the period 2021–2050 decrease from 9.9 Gtons in the Reference Trade to 9.7 Gtons in the Enhanced Trade scenario. When the period 2031–2050 is considered, the reduction in emissions is approximately 5%. If further grid interconnections other than those already discussed are considered, the difference between the two cases increases. Specifically, when the regional grid interconnection capacity is allowed to reach up to double its planned capacity for the period 2031–2050, emissions decrease by an additional 3% for the entire period 2031–2050 and 7% in 2041–2050.

The analysis clearly indicates that electricity exchange can assist in a more cost-effective achievement of the Paris Agreement targets. When the two scenarios with net-zero emission targets are compared, the overall system costs decrease when enhanced electricity trade is allowed **(Figure 3)**. Specifically, the total system cost reduces by 6% in the decade 2041–2050; this is the period in which emission targets are implemented.

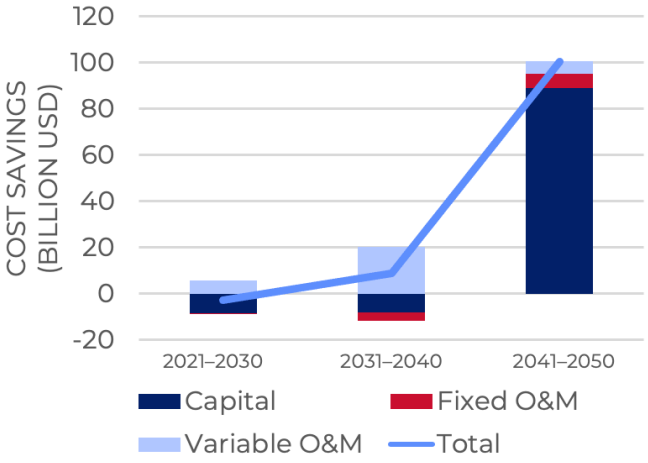
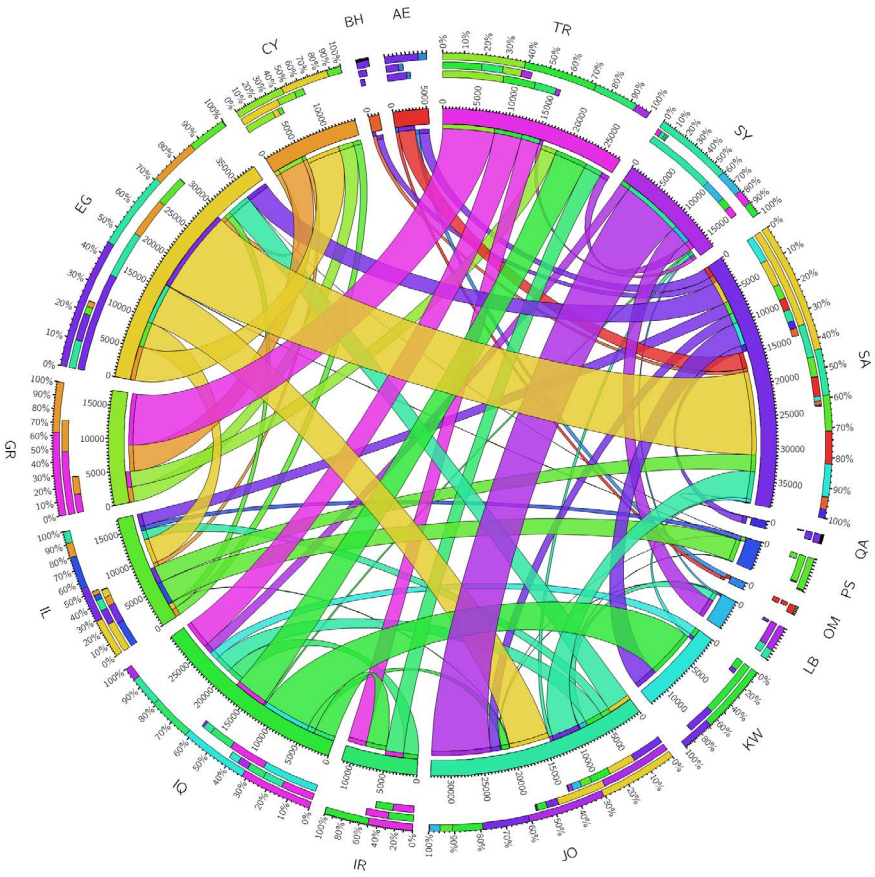


Figure 3. Difference in electricity supply system cost between the Net-Zero variants of the Reference and Enhanced Trade scenarios. Negative values indicate higher cost in the Enhanced Trade compared to the Reference Trade case. O&M = Operation and Maintenance.

The outlook for national economies is also of interest. For instance, by 2050 in the Enhanced Trade scenario, Egypt becomes a major electricity exporter with annual net exports exceeding 20 TWh, while Saudi Arabia with annual net imports of 9.7 TWh is the biggest importer of electricity in the region **(Figure 4)**.



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 4. 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. A gap between the ribbon and associated colour segment indicates that electricity trade is being imported to the respective country. Electricity starts flowing from a country without this discontinuity. The colour of the band is identical to that of the country of origin, which is identified by the colour of the inner-most circle.

Conclusions and Policy Recommendations

Electricity trade across the Eastern Mediterranean and Middle East (EMME) region offers multiple benefits. It can lead to a decrease in greenhouse gas emissions, while reducing the financial requirements for generation technologies. In addition to national energy and climate plans, regional cooperation for the formulation of a regional action plan can promote coordinated efforts on this front.

Regional cooperation in the identification of the most cost-effective grid interconnection projects that can unlock major renewable energy potential should be pursued. Similarly, an increase beyond the planned grid interconnection capacity should be investigated.

Renewable energy investments are projected to increase across the EMME region in all scenarios. These need to be accompanied by investments in storage technologies and increasing the availability of grid interconnections. A favourable regulatory environment that supports investments in these technology options is needed to achieve decarbonization.

Operation of a regional electricity market entails 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 political action in many EMME countries, where electricity and fuel subsidies are still in place.

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ACKNOWLEDGEMENTS:

Dr Stephanie Hirmer (Oxford University) and Prof. Jim Watson (University College London) have led the curation of this policy brief series. The policy briefs underwent an anonymous (double blind) peer-review process. They were edited by Simon Patterson (Loughborough University) and designed by Sarel Greyling (Sarel Greyling Creative).

This material has been produced under the Climate Compatible Growth (CCG) programme, which brings together leading research organizations and is led out of the STEER centre, Loughborough University. CCG is funded by UK aid from the UK government. However, the views expressed herein do not necessarily reflect the UK government's official policies.

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CITATION: Taliotis, C., Karmellos, M., Fylaktos, N., and Zachariadis, T. (2022). Eastern Mediterranean and the Middle East Region: Enhancing Decarbonization of Power Generation Through Electricity Trade. Climate Compatible Growth Programme COP27 Policy Brief Series (Version 1). Available at: https://doi.org/10.5281/zenodo.7056290.