THE PLACE OF THE MENA REGION IN THE INTERNATIONAL HYDROGEN TRADE, A TECHNICAL-ECONOMIC ANALYSIS BASED ON TIAM-FR

Charlène BARNET, Mines Paris, PSL University, CMA - Centre for Applied Mathematics, charlene.barnet@minesparis.psl.eu
Sandrine SELOSSE, Mines Paris, PSL University, CMA - Centre for Applied Mathematics, sandrine.selosse@minesparis.psl.eu
Nadia MAÏZI, Mines Paris, PSL University, CMA - Centre for Applied Mathematics, nadia.maizi@minesparis.psl.eu

Overview

Since the discovery of the Dammam oil field in Saudi Arabia in1938, “black gold” has played a fundamental role for hydrocarbons-rich countries, both as an important – or as the major – component of the State’s budgets and exports revenues and as a resource that has enabled them to position themselves geopolitically and commercially on the international scene. The Middle East North Africa (MENA) zone is unique in several respects in terms of energy and economics. First of all, it encompasses several historically producing and exporting hydrocarbons countries such as the emblematic Saudi Arabia. By the end of 2020, eight of the top 20 oil producers and seven of the top 20 gas producers in the world were in the MENA region. This area accounted for 52% and 43.5% of proven oil and gas reserves and 33.8% and 21.8% of global oil and gas production, respectively [1]. Secondly, it is a region strongly marked by inequalities, which are reflected by the carbon footprint of the countries. While the region's average is below the global average in terms of CO2 emissions per capita, some states have some of the highest per capita carbon footprints in the world [2]. The reason for this is that these countries have relied on abundant and cheap hydrocarbons to develop. As a result, their energy systems are highly, if not almost entirely, carbon-intensive. Finally, this already very arid region will be among the most affected by global warming, with a reduced level of rainfall, increased desertification and coastal areas threatened by rising sea levels.

Because of its high energy density, ease of transport and relatively low cost, oil has become the main source of energy and remains difficult to substitute. But in the face of global warming, this incredible source of energy has now become a problem. In order to meet the objectives of the Paris Agreement to contain the average global temperature increase compared to the pre-industrial period to below 2°C and if possible to 1.5°C, the path identified as the safest is to aim for carbon neutrality by 2050. The "Net Zero Emissions" scenarios have been multiplied to shed light on the energy futures compatible with the announced climate objectives. They all point to a drastic reduction in oil, gas and coal use in the coming decades. This uncertainty about the level of future hydrocarbon consumption is a real challenge for the MENA region and can be a source of instability. The hydrocarbon-producing countries must indeed find a new model of economic development allowing them both to enhance their oil and gas assets, to be part of the new global economy of energy transition [3], and to participate in the global fight against global warming on which their future sustainability is closely dependent; all in an energy world whose geopolitics has been shaken by the Ukrainian conflict. For non-hydrocarbon-producing countries, the energy transition is an opportunity to enter the global energy game and improve their energy security. Despite the magnitude of the challenge, the MENA countries seem determined to take advantage of this new paradigm. Thus, far from gradually withdrawing from the world energy chessboard, many of them are implementing energy strategies geared towards economic diversification and foreign trade. Hydrogen, natural gas and electricity exchanges are at the heart of their energy policies.

In recent years, hydrogen has experienced an unprecedented craze, both among public decision-makers and the private sector. This energy vector could indeed contribute to reducing the carbon footprint of heavy mobility (road, sea or air transport) and that of industries that are difficult to decarbonize (steel industry, chemicals, etc.). In 2022, more than 30 countries worldwide had published or were about to release their national hydrogen strategies [4]. According to Bloomberg NEF, hydrogen could cover up to 24% of the world's energy needs and represent $700 billion in annual sales by 2050 [5]. We should therefore see large-scale hydrogen production and trade in the medium term. In such a context, some countries could emerge as key players in this growing market [6]. Many MENA countries have already expressed their ambition to position themselves as hydrogen suppliers for the European and the southeast Asian markets. We therefore propose here to rely on a bottom-up type optimization model to explore the future place of North African and Middle Eastern countries in the global hydrogen trade as well as the impact of these strategies on water demand linked in particular to electrolyzers.

Methods

We propose here to mobilize a mathematical tool for long-term planning in order to study the possible energy futures for the regions of Africa and the Middle East as well as their future integration into the world energy markets. To do this, we will use the TIAM-FR prospective optimization model, based on the TIMES model generator (The Integrated MARKAL-EFOM System), a standard for long-term prospective modelling developed within the framework of the IEA's Energy Technology Systems Analysis Program (ETSAP). This type of model makes it possible to explore possible energy futures on the basis of contrasting scenarios defined by different constraints, in particular environmental ones. It also allows a great exhaustiveness in the representation of the technologies and the final end-uses composing the studied energy system. Finally, the geographical disaggregation made there is adaptable. TIAM-FR has 15 regions, including the Middle East (MEA) and Africa (AFR) regions that interest us. The underlying objective function is to minimize the overall cost of the system. TIAM-FR will thus allow us to observe the energy trajectories of the areas of our study perimeter according to different levels of climatic ambitions and to assess their future contribution to the global hydrogen trade. At least two scenarios will be proposed in this sense, one representing the climate ambitions formulated by the States in their Nationally Determined Contributions (NDC) and the other integrating the ambitions formulated by the States (for example "Net Zero Emissions" which would not yet be incorporated into the NDCs). A module devoted to the question of water will also make it possible to assess the impact of energy transition policies on this resource [7].

Results

We will first present the level of climate and energy ambitions of the countries of the MENA zone (we will not be interested in the whole of the AFR region although it is represented as a single block in the TIAM-FR) and we will focus in particular on the hydrogen strategies and the announced export objectives. The results of the modeling will give us valuable indications on the new capacities to be installed, the level of investments required and the technological choices to be made for the production of green and blue hydrogen. We will thus be able to have an overview of the articulation between the production of blue hydrogen and green hydrogen. The region studied has the particularity of having gas reserves as well as know-how in the management of network infrastructures on which it can rely to quickly enter the hydrogen market thanks to blue hydrogen. Emphasis will also be placed on exchanges of hydrogen and its derivatives between the regions of our scope and Europe, which is already positioned as a net exporter of hydrogen by 2050 and for which the MENA region is a partner. privileged due to its geographical location and gas networks. Finally, we will address the issue of water, an essential resource for the production of green hydrogen via the electrolysis of water and yet rare in this arid region of the world. Through this work, we wish to obtain a first idea of the water consumption generated by the implementation of the hydrogen strategies announced in the studied area.

Conclusions

This research work aims to explore the place of the Middle East and North Africa region in the global hydrogen trade as well as the impact of these industrial and commercial strategies on water resources. To do this, it relies on a long-term prospective modeling tool allowing the study of contrasting climate scenarios. This subject is at the crossroads of economics, a technical approach, geopolitics and public policies. Last link in "Net Zero Emission" strategies, hydrogen indeed offers the promise of a new vector of commercial power for hydrocarbon-exporting countries, while highlighting the region's weaknesses (the scarcity of water resources).

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