Strategic Sectors | **Economy & Territory**

Nuclear Energy Prospects in the Mediterranean Countries

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While European Mediterranean countries are moving towards reducing the share of nuclear electricity in their energy mix, nuclear energy seems to have found new ground in the Middle East and Turkey. In France, where nuclear power contributes around 70 percent of the total generated electricity, officials have committed to a reduction of this contribution to 50 percent by 2035. In Spain, nuclear power's share of the energy mix is a little over 20 percent, but the Spanish government announced in February 2019 its intention to phase out nuclear energy completely by 2035.[1] In this context, it is also worth noting that in the wake of the 1986 Chernobyl nuclear accident in Ukraine, Italy shut down its four nuclear power reactors in 1987, following a referendum that reflected strong public opposition to maintaining a nuclear programme.

However, the decline of the role of nuclear energy on the European side is counteracted by a push for nuclear new build in Turkey, Egypt, and Jordan. As shown in Table 4, Turkey is currently constructing its first nuclear power plant in Akkuyu, on Turkey's Mediterranean coast, with a total capacity of 4,800 MW. Similarly, Egypt is conducting pre-construction work at the Dabaa site on the country's Mediterranean coastline. Once finished, the Dabaa nuclear power plant will also have a total capacity of 4,800 MW. Both the nuclear projects in Turkey and Egypt are being developed by Rosatom, the Russian state-owned company. However, the two projects have different financing and contractual mechanisms. Turkey's Akkuyu project is built under a build-own-operate arrangement, while the Dabaa one is built under a joint venture model.

Rosatom was also linked to Jordan's nuclear power programme, where in 2014 it signed an agreement to build two 1,000 MW reactor units under a joint venture mechanism. According to the agreement, Jordan was responsible for raising 50 percent of the total project cost (estimated at $10 billion). However, the project did not progress and was cancelled in 2018 due to financial difficulties.[2] Since then, Jordan has shifted its attention to small modular reactors (SMR), but it is not yet known what capacity, technology or supplier it is targeting.

TABLE 4 **Status and Nuclear Power Capacity**

	France	Spain	Turkey	Egypt	Jordan
Operating nuclear capacity (MW)	64,960	7,416	0	0	0
Under construction capacity (MW)	1,650	0	1,200	0	0
Committed Capacity (MW)	0	0	3,600	4,800	Unknown

Source: IAEA PRIS and WNA.

Policy Drivers and Challenges

The rationale to invest in (or continue to operate) nuclear power plants differs from one country to another. However, once again, there is a major difference

[1] Reuters, "Spain plans to close all nuclear plants by 2035," *Reuters*, 13 February 2019, see www.reuters.com/article/us-spain-energy-idUSKCN1Q212W, accessed 25 May 2020.
[2] "Jordan to replace planned nuclear plant with smaller, cheaper facility," *Jordan Times*, 26 May 2018, see www.jordantimes.com/news/local/jordan-replace-planned-nuclear-plant-smaller-cheaper-facility, accessed 25 May 2020.

in the narratives under which nuclear power is considered in the Mediterranean countries. In France and Spain, it would be safe to say that nuclear power is largely seen through historical and climate change prisms. For example, France, which originally planned to reduce its nuclear energy share to 50 percent by 2025, delayed the target by 10 years to comply with climate change targets and policies. A delayed reduction of France's nuclear share means avoiding the need to close more reactors in the short term.

Although France has started to look beyond nuclear energy, it still has one reactor under construction (Flamanville-3). The construction of Flamanville-3 started in 2007 and was expected to be completed in 2012. According to the latest information available, *Électricité de France* (EDF) is now expecting the reactor to be connected to the grid in 2022, 10 years behind schedule. The reason behind the delay is the reactor's first-of-a-kind technology, which encountered numerous design issues and quality control problems.[3]

In Egypt, Jordan and Turkey, the policy to invest in nuclear power is not strongly related to climate commitments, if at all. Although the interest in nuclear power in each of these countries has its own historical track and factors, there are some notable commonalities. First, the three countries regard their policy of building nuclear power plants as a means to promote energy security. Second, the three countries entered into agreements with Russia's Rosatom because of two main selling points: help with financing and takeback of nuclear spent fuel. However, in the case of Jordan, the 50 percent financing share still proved to be too much for the economically strained kingdom. Third, unlike European electricity markets, regional electricity markets in the Middle East and Turkey are regulated. In principle, regulated electricity markets are a better environment for nuclear power than liberal markets, which would naturally prioritize dispatching low-cost renewables and natural gas. The downside of such a market structure is that it is not economically efficient and poses a high opportunity cost risk. Given that nuclear power plants are notoriously known for their long construction time (~8-10 years on average), and the dynamism of the renewable energy and energy storage sectors, the risk of being locked into high cost energy generation for decades is serious.

The decline of the role of nuclear energy on the European side is counteracted by a push for nuclear new build in Turkey, Egypt, and Jordan

In terms of nuclear power targets, Turkey has the most ambitious plans. Besides the Akkuyu project, which is currently under construction, Turkey is also planning two other projects, in Sinop (4.4 GW) and İğneada. However, there is a high degree of uncertainty as to whether these two projects will materialize or not due to a lack of interested developers and investors (in the case of Sinop)[4] and the weakness of the Turkish economy, which was strained even before the Covid-19 pandemic.

Turkey's nuclear energy programme has been challenged by widespread public opposition. The public disapproval of nuclear energy has its roots in Turkey's environmental movement, and the opposition has been strengthened by nuclear disasters such as Chernobyl and Fukushima. Additionally, the Akkuyu site has been scrutinized for its seismic risks, which also fuel public fear. In a 2018 survey, two thirds of the respondents opposed the nuclear energy option.[5] Egypt and Jordan have also witnessed public protests against their nuclear power projects, but to a lesser extent.

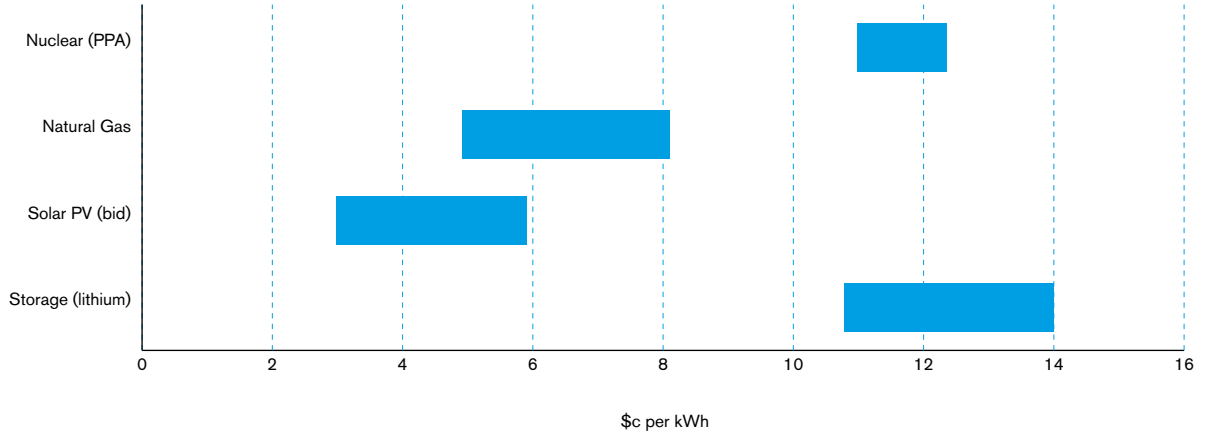
As mentioned above, Jordan has shifted its policy focus to SMR. On paper, SMR seems to be a better fit for Jordan's small power grid (~5GW) and limited financing capabilities compared to the large reactor option. However, small reactors also pose their own challenges such as a lack of operational experience in the marketed SMR designs and higher per kilo-

[3] WNISR, *World Nuclear Industry Status Report*, 2019, see www.worldnuclearreport.org/, accessed 30 May 2020.

[4] The SINOP development agreement between Turkey and the Japanese consortium led by Mitsubishi Heavy Industries collapsed in 2018 after negotiations failed because the cost of the project had doubled

[5] Euronews, "Türkiye'de halkın üçte ikisi nükleer santrallere karşı," 18 March 2019, see https://tr.euronews.com/2019/03/18/turkiye-halkin-ucte-ikisi-nukleer-santrallere-karsi-ak-partililerde-destek-orani-yuzde-50, accessed 15 May 2020.

CHART 14 **Comparative Cost of Different Energy Sources**



watt-hour costs due to the loss of economies of scale.[6] Despite entering discussions with several nuclear vendors, Jordan's SMR venture remains limited to the signing of MoUs and conducting feasibility studies.

Economic Considerations

From an economic perspective, nuclear power projects are characterized by three features: (1) high capital requirement, (2) long lead and construction time, and (3) limited potential for cost savings. While renewables are also capital intensive sources of energy, utility-scale projects can be built in one to two years. Additionally, renewables (and energy storage) are undergoing a cost revolution, which will eventually improve the dispatchability of intermittent renewables such as solar PV and wind. In fact, in recent years the economic viability of nuclear power has witnessed a further decline in most OECD countries, including France, as the cost of alternatives (renewables and natural gas) became cheaper than the marginal cost of nuclear power plants. With the huge cost and time overruns in France's Flamanville project in mind,[7] the outlook for future investments in Europe's nuclear industry appears grim.

In the Middle East and Turkey, economic considerations do not seem to be taking a central role in the decision making on nuclear power. However, the lack of cost competitiveness of nuclear energy vis-à-vis other energy sources, especially the mix of natural gas and renewables, is evident. As shown in Chart 14, the cost range of power purchasing agreements for nuclear electricity is between 11 cents/kWh in Egypt and 12.35 cents in Turkey. On the other hand, the cost of natural gas ranges from 5 to 8 cents per kwh (at $5 and 10 per mmBTU, respectively); and the cost of solar PV bids in 2019 ranged from below 3 cents per kWh in Egypt to 5.9 in Jordan's 50 MW solar power plant. Energy storage costs remain relatively high, but significant cost reductions are expected in the coming few years.

The favorable economics of renewables and natural gas have been reflected in regional government plans. For example, in Jordan, the government has doubled its renewable energy targets in 2018 to 20 percent of the energy mix, and in 2019, the target was raised again to 30 percent by 2030.[8] Jordan now has one of the fastest growing renewable energy markets in the whole Mediterranean region.

In Egypt, the government has launched the "2035 Integrated Sustainable Energy Strategy," according

[6] Ramana, M. V. and Ali Ahmad, "Wishful thinking and real problems: Small modular reactors, planning constraints, and nuclear power in Jordan," *Energy Policy*, 1 June 2016, see www.sciencedirect.com/science/article/pii/S0301421516301136, accessed 26 May 2020.
[7] The cost of Flamanville's project has more than tripled since its inception in 2007. Latest cost estimate is around US$ 13.6 billion.
[8] "Gov't to increase renewable energy contribution in 2020-2030 strategy," *Jordan Times*, 24 December 2019, see www.jordantimes.com/news/local/govt-increase-renewable-energy-contribution-2020-2030-strategy, accessed 11 April 2020.

to which it plans to generate 37 percent of the country's electricity through renewable energy sources, compared to only 3 percent allocated to nuclear.

In the Middle East and Turkey, economic considerations do not seem to be taking a central role in the decision making on nuclear power

In parallel to its expansive renewable energy policy, Egypt has ambitions to become a regional hub for the natural gas trade, following the discovery of massive offshore gas reserves, and is developing its gas import and export infrastructure.

Impact of Covid-19

Globally, the Covid-19 pandemic has significantly slowed down energy generation and investments.[9] In France, power utility EDF, which operates the second largest nuclear power reactor fleet in the world, has scrapped its nuclear generation target for 2020, stating that "maintenance schedule for reactors had been interrupted by the order from authorities for workers to remain at home."[10] EDF nuclear output is expected to fall by more than 20 percent compared to last year.

In Turkey, where a large nuclear project is currently under construction by Russia's Rosatom, there has been no formal announcement of any impact of the pandemic on the project's progress. However, Rosatom's overseas operations have been impacted by the company's Covid-19 measures, which include allowing some of its staff who are based aboard to return home.[11] These measures may have also impacted Egypt's pre-construction work, which is being conducted by Rosatom's personnel at the Dabaa site.

Beyond these direct economic effects, the Covid-19 pandemic is expected to induce significant economic pain in the Mediterranean countries. Some of these countries – like Turkey, Egypt and Jordan – already had economic troubles even before the Covid-19 outbreak. One possible outcome of such increased economic strain is that countries like Jordan may start to dial down their infrastructure spending, including in capital-intensive projects such as nuclear power.

Conclusion

The prospects and drivers of nuclear energy in the Mediterranean countries differ from one region to another. In France and Spain, where nuclear energy is a mature component of the energy mix, climate change commitments seem to be the main rationale to keep nuclear power reactors running. Despite this, by 2035, France aims to reduce its current 70 percent nuclear share to 50 percent; and Spain is planning a complete phaseout. On the other hand, Egypt, Jordan, and Turkey are newcomer countries with aspirations of build nuclear power bases in the coming years. In the Middle East, the deployment of nuclear power seems to be driven by a more complex web of covert and overt reasons that span across the themes of energy security and internal and external political posturing.

The economic competitiveness of nuclear power across all markets, regulated and deregulated, is weak. In the strained economies of the Middle East, the high upfront capital cost of nuclear power plants is a major challenge, especially during and after the Covid-19 pandemic. This justifies Rosatom's leading position as a nuclear vendor in the region, thanks to its ability to either fully or partially finance nuclear projects, as in Turkey and Egypt. However, financing is only one part of the economic impact of these projects, which are being developed in parallel to a powerful energy transition in the region, geared towards the more cost-effective coupling between renewables and natural gas.

[9] Roger Harrabin, "Record drop in energy investment, warns IEA," *BBC News*, 27 May 2020, see www.bbc.com/news/business-52812709, accessed 27 May 2020.
[10] World Nuclear News, "EDF, Orano prepare for COVID-19 impact," *World Nuclear News* see https://world-nuclear-news.org/Articles/French-nuclear-industry-anticipates-COVID-19-impac, accessed 27 May 2020.
[11] Rosatom, "Rosatom arranged the return of 178 employees from construction site of Roopur NPP (Bangladesh) to Russia," 7 April 2020, www.rosatom.ru/en/press-centre/news/rosatom-arranged-the-return-of-178-employees-from-construction-site-of-rooppur-npp-bangladesh-to-rus/, accessed 17 May 2020.