Jordan

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Jordan, as of 2007, has set its course on energy diversification. The dependence on more than 95% on a single and mostly imported energy has proven catastrophic at instances to the economy. After the Arab Spring and the repeated interruptions of gas supply, renewable energy (primarily PV) power plants were constructed at an accelerated pace. Today, Jordan is one of the regional leaders in the share of renewables as part of total electricity generation. Nuclear energy has been considered as part of its future energy mix since 2007, and it is envisioned that a plant (primarily SMR) will be operational by 2030. Energy source diversification draws the issue of flexibility to the forefront.

Flexible operation of a nuclear power plant on the Jordanian power grid is subject to technical and economic hurdles. In our review of different technologies, we see that most of the nuclear technologies safely operate when ramping power up and down upon demand, within defined technical specifications. Economics of operational flexibility, however, is a different issue to be considered, particularly for a small grid as is the case for Jordan. Nuclear energy is capital-intensive, so it may prove overly expensive if the plant is operated below its nominal power level, particularly in the first years (debt repayment years), rendering it infeasible.

Table 1. Key Energy Metrics for Jordan

National Clean Energy goal (All numbers in 2018 values)	31% of electricity generation from renewables by 2030
Total Primary Energy Consumption	9.712 Mtoe
Electricity Consumption	17.5 TWh
Total CO2 Emissions	26 million tons
Renewables Generation	2188 GWh
Renewables Energy Percent of Electricity Generation	11%
Nuclear Energy Policy	Deployment of SMR nuclear power plant by 2030

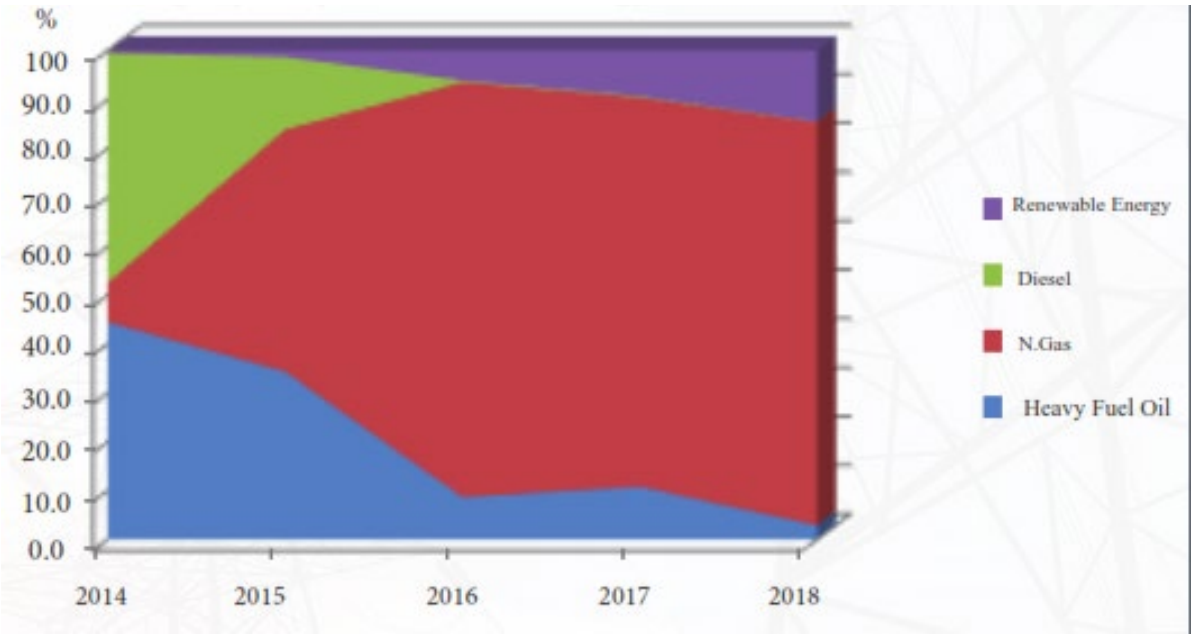

Figure 1. Contribution of primary and renewable energy sources in electricity generation

For Jordan's small grid, emerging SMR options excel over large nuclear power plants. Most SMRs are modular in nature and are included in plants with modular expansion in mind. With this said, the plant can initially operate as a base load generator and, as it becomes economically viable, move into the second phase (debt has been paid off for the first units), these first units can go into load following operation. At this point in time, more SMR modules would have been added and can be presumed to be operating at nominal power levels. SMRs offer the opportunity to meet the objective of achieving true energy diversification, while doing so with an amount of flexibility offered by balancing how demand is met via operation of the deployed units. Gradual SMR plant expansion and flexibility in operation of each unit will offer significant ability to work with other clean energy systems on the grid.

The economic challenges of nuclear energy are not specific to nuclear alone. The introduction of renewable generators into the Jordanian energy mix, coupled with a slowdown in demand, has caused grid imbalances in which conventional power plants had to be operated with low loading factors which increases the price of electricity and reduces the efficiency. This periodic overproduction and grid imbalance occurred during times of expedited planning and PV expansion. Lack of proper planning coupled with unforeseen circumstances, will usher in unwanted surprises. Introduction of flexible nuclear technologies, such as an SMR plant that can support both base load and flexible demand, can support Jordan's goals relative to energy diversification.