JORDAN'S SMR RTA EXPERIENCE

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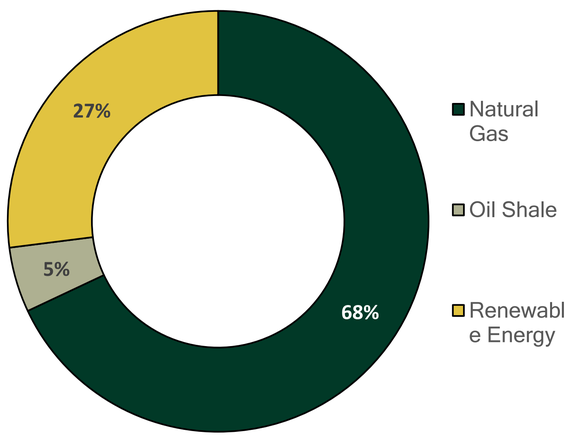
INTRODUCTION

The Jordan Atomic Energy Commission (JAEC), based on the updated electricity demand forecast study conducted on the Electricity Market in Jordan, initiated studies on the feasibility of deployment of Small Modular Reactors (SMRs) in Jordan. This paper discusses selecting and evaluating reactor vendors to align with Jordan's nuclear power project requirements emphasizing the critical Energy and water state in Jordan, and justifying the need for such a program. It explains the rationale behind the requirements. The IAEA RTA methodology was used as a reference to build the process with some modifications to accommodate the special nature of the SMR technology. Throughout this framework, the paper navigates the process, it presents the results of the RTA offering insight into the SMR RTA experience and its implications for the country's energy/water future.

ENERGY AND WATER SECURITY

- Water sector consumed **16%** of the total electricity produced in 2020(2)
  - Natural water resources challenges:
    - High depth of ground water, long distances from population centers, and very low quantity of surface water
  - Energy intensity of total supplied water is **3.4 kWh/m^3**
- Energy demand is expected to increase due to the predicted increase in **water desalination** and the **longer pumping distances** by the National Conveyance Project
    - The Energy intensity is **9 kWh/m^3** for freshwater delivered to Amman(4)
    - **2.6 times higher** than the current energy intensity



2022 Electricity Generation Mix(1)

Natural Gas (340 million cubic feet per day)
- **1.8%** sourced from *Risha Gas Field*
- **300 million cubic feet per day (88%)** from Israel over a period of 15 years ends in 2031

Oil shale (235 MW x 2 Units)
- First unit commenced operations on Oct. 25, 2022
- Second unit to start in Q2 2023
- Expected to meet up to **15%** of the annual electricity demand
- Capital investment of **2.1 Billion USD**(2)
- **30-year** power purchase agreement was signed.

LARGE REACTOR EVALUATION

In 2009, JAEC received expressions of interest from four reactor technology vendors.

On January 26, 2010, JAEC issued a questionnaire to each interested technology vendor requesting technical and preliminary financial information.

On March 21, 2010, JAEC received vendors' responses offering JAEC seven different plant technologies.

during the process, Jordan performed various technical studies:

- Water cooling studies;
- Electric/grid studies;
- Stakeholder involvement strategies;
- National infrastructure surveys and studies;
  - •Localization/national industry;
  - •Transportation.
- Siting studies.
  - •Country Wide Survey (CWS) and site selection studies;
  - •Full site characterization studies are still not performed;
  - •Meteorological data collection at the selected site was started in 2017.

But this track was paused due to several reasons, the most hindering were
- Economics of the project
- Grid Compatibility
- Cooling water

SMR EVALUATION

Preliminary Assessment of different SMR technologies was conducted in three main phases.

Suitable technologies that are potentially viable for Jordan will be assessed in this phase.

- JAEC contacts vendors (IAEA SMR booklet, Attraction by news or achievements)
- declaration of interest of some vendors (Vendors contact JAEC)
- - References: IAEA SMR booklet, OCED, ANS

Even without getting into deep details with some vendors the immaturity of the technology was very apparent with some reactors from the get-go.

- General
- Design
  - Questions about Turbine configurations (multi-unit plants sharing a single turbine).
- Operation and maintenance
  - No experience; maintenance and staffing still under development
- Construction
  - No experience or reference plant (at the time)
- Reactor performance
  - Availability, efficiency, load following capability, etc.)
- Nuclear Safety
  - Experience with Non-water-cooled reactors
  - Safety Classifications
  - Changing of major parameters such as CDF and LRF
- Fuel cycle, waste management, and non-proliferation
  - Sustainable Fuel Supply
  - Manufacturing experience
- Licensing and operating experience
  - None of the designs were licensed (at the time)
- Vendor long-term commitment
  - Long-term commitment couldn't be proven

RESULTS

Evaluation Methodology	A	E	B	D
Evaluation Matrix	81	78	75	71
Key Factors	83	85	83	81
Best-In-Class	81	80	73	66
Average	**82**	**81**	**77**	**73**
Rank	**1**	**2**	**3**	**4**

CONCLUSION

- Jordan has completed the evaluation of 6 reactors and as a result has a clear understanding of the challenges and obstacles coming ahead;
- Using SMR for both power and non-power applications would help Jordan to have energy and water security while having a domestic alternative to imported sources;
- Although not discussed in this paper, the economic evaluation plays a major role in the technology assessment and, when combined with the technical assessment, would change the ranking results;
- The evaluation process is not final and is open to additional reactor technologies if merit is shown.