Updates on Saudi National Atomic Energy Project (SNAEP)

Second Meeting of the Technical Working Group for Small and Medium-sized or Modular Reactor (TWG-SMR), 8 – 11 July 2019
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In July 24th 2017, Saudi Government approved the SNAEP to implement a civil nuclear program focusing on three business lines:

1. **Large Nuclear Power Reactor Program**
   - Infrastructure Development
   - Site Preparation
   - Large Nuclear Power Plant (LNPP)

2. **Small Modular Reactors**
   - System-Integrated Modular Advanced Reactor (SMART)
   - High Temperature Gas Cooled Reactor (HTGR)

3. **Nuclear Fuel Cycle**
   - Exploration and Assessment of Uranium & Thorium in Saudi Arabia
   - Localization of Nuclear Fuel Cycle in Uranium production and achieve investment returns

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**How will the national atomic energy program contribute to Saudi Arabia’s energy mix?**

Saudi Arabia is increasing its efforts in meeting the growing demands by incorporating alternative sources of energy in its energy mix to reduce the dependence on fossil fuel. Nuclear energy is one of the alternative energy which can assist in the electricity power generation and water desalination.

**Notes:**

KSA will be establishing a Nuclear Holding Company which will create the future Owner/Operator. A Charter approved on 13 March 2018 established the Nuclear & Radiological Regulatory Commission (NRRC).
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Component 1/1: Large Nuclear Power Plant

- K.A.CARE continues the Project Preparatory Phase, and currently undertaking the review of the received five Supplier Candidates’ responses on 11 deliverables—expecting to finish the evaluation by end of July, 2019.

- K.A.CARE has also commenced development of the following elements with support of its PMO Consultant (WorleyParsons);
  - Integrated Time Schedule
  - LNPP Bid Invitation Specifications (BIS)/RFP
  - Program Master Plan using supplier candidates’ inputs
Component 1/2: Large NPP Site Preparation

- **Progress of Technical Field Works**
  Complete Geophysical Investigations & Drilling Program for the primary LNPP site.

- **Approval of Method Statements & Work Plans**
  K.A.CARE with the help of VTT & WP reviewed 58 method statements and work plans for both sites activities as part of the quality control process.

- **1st Senior Seismic Hazard Association Committee Meeting**
  K.A.CARE Conducted the 1st Senior Seismic Hazard Association Committee (SSHAC) Meeting with more than 23 Seismic Hazard Analysis Experts.

- **Approval of Environmental Impact Assessment Road Map**
  K.A.CARE conducted the 1st Factory Acceptance Test (FAT) at Germany for the Metrological towers.
Component 1/3: Infrastructure Development

- Determined the main components (including SEC scope) of the project and commence development of the Front End Planning and Execution Strategies

1) Infrastructure Support Facilities;
   - Site Development (transportation road network from site area to main road, site layout and allocation of facilities, water and sewage network, etc.)
   - Waste water treatment
   - Water desalination plant
   - Training and simulation center
   - Temporary power network and power generation for the construction phase
   - Security system specialized for nuclear power plants
   - Communication and information system
   - Facility protection safety systems (fire protection system and equipment's, etc.)

2) Temporary Facilities (Non Nuclear Facilities Related), Constructing then Operation & Maintenance such as:
   - Fabrication facilities and warehouses for material storage
   - Laboratories for sampling, measurements and quality control
   - Initial stage Power Generation and networks.
   - Catering & Accommodation
   - Housekeeping, landfill and waste management works

- Designated team was assigned to the project on April

- The project team has approached consultancy company to prepare RFP for Master Plan and Design Services. The RFP will help to define SOW for the Consultancy Engineering Company to develop detail master plan and concept infrastructure design.
Establishment of Saudi Nuclear Energy Holding Company

Review and Revise all previous studies on NHC

Conduct Several Meetings with Governmental Companies to capitalize on their lessons learnt

Conduct a national workshop with including Governmental Companies to overview their experience in establishing and operating

Developing the working scope of the NHC Advisor

Finalizing the bylaws for approval in order to issue the required legal framework

Prepare and review the Administration and Financial Policies for NHC

Develop the Org. structure and Governance Model

The Saudi Nuclear Energy Holding Company establishment is expected soon
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Component 2: SMR for KSA

Small Modular Reactor (SMR) FOR SAUDI ARABIA

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<td>1. Nuclear Cogeneration for Remote cities, Electricity, Water Desalination &amp; Industrial Application</td>
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<td>2. Human Capability Building on key Nuclear technology</td>
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<td>3. Desire for IP ownership of NSSS (Nuclear Steam Supply System) technology</td>
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<td>4. High potential for localization to promote economic growth and job creation in Saudi.</td>
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<td>5. Significant greenhouse gas emission reductions</td>
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<td>6. Future SMR export market in MENA</td>
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Component 2: Small Modular Reactor (SMR)

Methodology for Forming a Strategic Partnership

In keeping with the strategic objective of the KSA, K.A.CARE with regard SMR deployment for electrical power and other non-power applications.

Six Evaluation Criteria have been identified:

1. **SMR Mix**: Commercial deployment (Technology Readiness) and ways of contribution in the national energy mix.

2. **IP Ownership and Tech Transfer**: Identify key issues associated with intellectual property (IP) ownership, technology transfer, and joint development in the Kingdom as well as the potential for export market.

3. **Human Capacity Development and SMR Value Chain (localization)**:
   - Consider the long-term human capacity development of SMR technologies in the Kingdom.
   - Consider localization opportunities of SMR value-chain (manufacturing and services)
Component 2: Small Modular Reactor (SMR)

Methodology for Forming a Strategic Partnership

4. **SMR Licensing**: Examine SMR technologies in light of being licensable in the country of origin as well as meeting the highest international regulatory standards.

5. **SMR Deployment**: Address the unique siting aspects (i.e., limited cooling water availability, integration with non-power applications) for LWR based SMR designs for deployment in KSA.

6. **SMR Economics**: Examine the economics and business model for SMR deployment including the Levelized Cost of Energy (LCOE), CAPital EXpenditure (CAPEX) and OPerational EXpenditure (OPEX).
Component 2: Small Modular Reactor (SMR)

KSA will own and operate small modular reactors for power, water desalination and thermal applications

- A complete accomplishment of the SMART PPE design.
- The joint team (K.A.CARE-KAERI) have produced the Preliminary Safety Analysis Report (PSAR).
- There is an IP joint technology ownership between the Kingdom of Saudi Arabia and South Korea.

- The Joint Preliminary Feasibility Study was concluded with CNNC in December 2017.
- The key target of this study is to explore long-term strategic partnership with China to own and localize the technology and to support petrochemical and oil refinery industries in KSA.
Component 2: SMART Development

Project Milestone

MOU KACARE and KAERI
- 02/14

MOU (JFS Publication Ceremony)
- 03/15

PPE Contraction KACARE and MSIT
- 09/15

Launch of HCB Program & Saudi Team mobilization
- 06/16

Start JFS (Joint Feasibility Study)
- 12/13

MOU KACARE & MSIT SMART Development and Partnership HCB
- 03/15

SMART PPE Started
- 12/15

Saudi Arabia National Atomic Energy Project Approval
- 07/17

End of FOAK construction – KSA owns 43% of Integrated SMART IP
- 11/18

Saudi Arabia

MOU KACARE and MSIT
- 03/15

SMART PPE Ended
- 2023-2029

Component 2: SMART Development

Saudi National Atomic Energy Project
January, 2016, • K.A.CARE and CNEC has signed a MOU to cooperate on the construction of High Temperature Gas Cooled Reactor Project in Saudi Arabia.

March, 2017, • K.A.CARE and CNEC has signed agreement to contact a feasibility study.

May, 2017, • K.A.CARE and CNEC has conducted the kickoff meeting in Beijing

December, 2017, • K.A.CARE and CNEC Concluded the preliminary Feasibility Study
Component 2: Small Modular Reactor (SMR)

Localization of SMR technology in KSA is aligned with Vision 2030 and will support the Kingdom in achieving its long term targets and goals.

SMR’s support to vision 2030

- Maximize value captured from the energy sector
- Unlock potential of non-oil sectors & grow non-oil exports
- Develop human capital in line with labor market needs
- Grow the public investment fund’s assets and role as a growth engine
- Grow contribution of the private sector to the economy

SMR program potential contribution

- SMR technology allows KSA to better utilize its energy resources in the long run and meet its local energy demand without exhausting its oil reserves
- Knowledge transfer & training agreements will enhance local expertise
- SMR value-chain will increase public & private investment and FDI opportunities, and will help developing potential local capabilities

Saudi National Atomic Energy Project
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Component 3: Nuclear Fuel Cycle

3/1. Assessment of Uranium and Thorium in KSA
- K.A.CARE is playing the role of quality assurance for all exploration works that is conducted by Saudi Geological Survey (SGS) in collaboration with CNNC across the Kingdom of Saudi Arabia.
- The 1st phase of this national project will be concluded by satisfying the inferred resources of Uranium and Thorium.
- It was mandated by the Royal Decree to cover all suggested exploration areas that is about 27900 Km²
- The 1st phase of Uranium and Thorium exploration in KSA will be concluded by September 2019

3/2. Uranium (yellow cake) production with Jordan
- K.A.CARE has sent 13 members to Jordan to work on this project on 17th Feb 2019.
- A certain technical committee was formulated by Board of K.A.CARE including all related local stakeholders to oversight the progress of this project.
## Component 4: Saudi Nuclear Regulator

Several Decisions were released and announced by Saudi Cabinet of Ministers for followings:

1. **Decision number (333) Dated 13\textsuperscript{th} March 2018** approving the National Policy for Atomic Energy in Kingdom of Saudi Arabia
2. **Decision number (334) Dated 13\textsuperscript{th} March 2018** approving the establishment of Saudi Nuclear Radiological and Regulatory Authority
3. **Decision number (405) Dated 10\textsuperscript{th} April 2018** approving the Law of Civil Liability from Nuclear Damages
4. **Decision number (406) Dated 10\textsuperscript{th} April 2018** approving the Law of Regulating the Nuclear and Radiological Uses
5. **Royal Order (14/A) Dated 2nd October 2018** appointing H.E. Eng. Khalid Alfalih as the Board’s Chair of Saudi Nuclear Radiological and Regulatory Commission
6. **Royal Order (27318) Dated 24\textsuperscript{th} January 2019** appointing Dr. Khalid Aleissa as the CEO of Saudi Nuclear Radiological and Regulatory Commission
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PPE Project Status

• SMART Preliminary Safety Analysis Report (PSAR) was completed.
• SMART PPE deliverables which contain 4378 design documents were issued.
• Human Capacity Building (HCB) program was completed and 36 KACARE engineers were qualified for NSSS design and have contributed in the design document generation.
• KACARE have reviewed and checked all SMART PPE deliverables. VTT have worked to support KACARE in SMART – Safety Confirmatory Analysis and HCB program quality as an independent reviewer
• SMART PPE is in the final closing stage
VTT Engagement in SMART - Confirmatory Analysis to ensure design safety

- Develop SMART simulation model using Apros & Serpent
- Review essential design documentations
- Review Licensing Documents: Preliminary Safety Analysis Report (PSAR) and Preliminary Accident Management Program (PAMP)
- Licensing Workshop with Saudi regulator at STUK in Finland (Mar. 2018) – discussed licensing plan, SDCA, PSAR and Site

**VTT final report on confirmatory analysis has been drafted with conclusion that Safety confirmatory was assured**
Path Forward

• KACARE & KAERI plan for SMART technology licensing agreement.
• KHNP & VTT recommendations are important tool for the future of SMART technology validation and commercialization.
• Currently KACARE is conducting review on SMR project strategy. A committee has been formed to review SMR projects and give recommendation on path forward.
SMR over all development

• Challenges are almost well known: Licensing, sitting, etc..
• All of these challenges best addressed with a decision for FOAK.
• Country to take advantage of FOAK
• OR through IAEA a multi-country effort to build FOAK.
Thank You