Report on Results of IAEA Technical Meeting
on “Technology Assessment of SMRs for Near Term Deployment”
hosted by STEG, Tunis, Tunisia, 2 – 5 October 2017

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Division of Nuclear Power, Department of Nuclear Energy
Purpose and Specific Objectives

• **Purpose:**
  – Provide a Forum for Member States to discuss in an integrated manner the status of SMR designs and technologies that are already commercially available or expected to become available for near term deployment, as well as approaches for the assessment of these technologies
  – Identify common technology issues and siting requirements of countries in the Middle East and North Africa Region

• **Specific Objectives:**
  – Enable Member States to conduct an assessment of SMR technologies by enhancing their understanding of design and safety fundamentals
  – Discuss specific areas of SMR technology assessment including unit size, proven technologies, standardization, constructability & their supply chains
Outcome

• Increased capacity of Member States to make knowledgeable decisions in their national nuclear energy programme

• Increased understanding among Member States for the identification of various SMR designs for near term deployment, aiming to harness the benefit of advanced reactor technologies
Workshop Features

- Jointly chaired by CNSC – Canada and IAEA/NPTDS-SH, supported by IAEA/NSNI/RAS
- 26 Nominated Participants from 14 Member States
- 7 embarking countries in MENA region
- 15 participants from STEG and CNSTN
- 6 SMR technology holders from:
  - China, France, Republic of Korea, Russian Federation, United Kingdom and the United States of America
- 20 Technical Sessions in 4-days:
  - 3 IAEA staff technical presentations
  - Breakout Sessions
  - Embarking countries presentations to report the results of Breakout Session
- Scientific Visit to CNSTN
# Status of Deployment Timeline

<table>
<thead>
<tr>
<th>Year</th>
<th>Q1</th>
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### KLT-40S
- **Q1, 2017**: Barge Prep, Fuel Loading
- **Q4, 2019**: Operation → 2060

### HTR-PM
- **Q3, 2019**: Graphite, Pebble Loadings
- **Q1, 2022**: Operation → 2060

### CAREM
- **Q1, 2023**: Construction
- **Q1, 2024**: Fuel loading
- **Q4, 2024**: Operation → 2060

### ACP100
- **Q4, 2025**: Construction
- **Q4, 2026**: Fuel loading
- **Q4, 2027**: Operation → 2060

### SMART
- **Q1, 2026**: Post SDA Licensing
- **Q4, 2026**: Construction
- **Q1, 2027**: Fuel loading
- **Q4, 2028**: Operation → 2085

### NuScale
- **Q3, 2028**: Design Certification Review (42 months)
- **Q4, 2029**: Construction
- **Q1, 2030**: Fuel loading
- **Q4, 2030**: Operation → 2085
Salient Design Characteristics

Simplification by Modularization and System Integration

Multi-module Plant Layout Configuration

Underground construction for enhanced security and seismic

Enhanced Safety Performance through Passive System

- Enhanced severe accident features
- Passive containment cooling system
- Pressure suppression containment

Image courtesy of IRIS 7.

Image courtesy of BWX Technology, Inc.

Image courtesy of BWX Technology, Inc.

Image courtesy of NUSSC Power Inc.
### Status and major accomplishment in Technology Developer Countries

<table>
<thead>
<tr>
<th>Countries</th>
<th>Recent Milestone</th>
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<tbody>
<tr>
<td>Argentina</td>
<td><strong>CAREM25</strong> is in advanced stage of construction. Aiming for fuel loading &amp; start-up commissioning in 2019.</td>
</tr>
<tr>
<td>Canada</td>
<td><strong>CNSC</strong> is performing design reviews for several innovative SMR designs, mostly non-water cooled, including molten salt reactors (MSR).</td>
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<tr>
<td>China</td>
<td>• <strong>HTR-PM</strong> is in advanced stage of construction. Commissioning expected in 2018.</td>
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<td>• <strong>ACP100</strong> completed IAEA generic reactor safety review. CNNC plans to build <strong>ACP100</strong> demo-plant in <strong>Hainan Provence</strong> in the site where NPPs are already in operation.</td>
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<td>• China has 3 floating SMR designs (<strong>ACP100S</strong>, <strong>ACPR50S</strong> and <strong>CAP-F</strong>).</td>
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<td>France</td>
<td>• <strong>CEA</strong> presented SMR Technology, the French approach for a <strong>170 MW(e)</strong> integral-PWR design. Combining the skills of <strong>CEA, EDF, Naval Group and TechnicAtome</strong>.</td>
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<tr>
<td>Republic of Korea</td>
<td><strong>SMART (100 MWe)</strong> by KAERI certified in 2012, shared IP with <strong>K.A.CARE, Saudi Arabia</strong>. A pre-project engineering for SMART on-going for near-term construction of 2 units.</td>
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<tr>
<td>Russian Federation</td>
<td>• Akademik Lomonosov floating NPP with 2 modules of <strong>KLT40S</strong> is in advanced stage of construction. Aiming for commissioning in 2019.</td>
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<td>• AKME Engineering will develop a deployment plan for <strong>SVBR100</strong>, a eutectic lead bismuth cooled, fast reactor.</td>
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<tr>
<td>United Kingdom</td>
<td>• <strong>Rolls-Royce</strong> recently introduced <strong>UK-SMR</strong>, a <strong>450 MW(e)</strong> PWR-based design; many organizations in the UK work on SMR design, manufacturing &amp; supply chain preparation.</td>
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<td>• Identifying <em>potential</em> sites for future deployment of SMR</td>
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<tr>
<td>United States of America</td>
<td>• The US-NRC has started design review for <strong>NuScale (600 MW(e) from 12 modules)</strong> from April 2017, aiming for FOAK plant deployment in Idaho Falls.</td>
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<td>• <strong>TVA</strong> submitted early site permit (ESP) for Clinch River site, design is still open.</td>
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</tbody>
</table>
### Status and major accomplishment in Embarking/ non vendor Countries

<table>
<thead>
<tr>
<th>Countries</th>
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| **Algeria**   | • Performs technology readiness level assessment for water-cooled SMRs  
• Participation in IAEA-INPRO's SYNERGIES and RISK projects and so forth.                                                                                                                                   |
| **Egypt**     | • Performs fundamental technology assessment on HTGR technology using Multi-Attribute Utility Theory (MAUT)  
• Case study on the feasibility of small and medium nuclear power plants in Egypt                                                                                                                           |
| **Jordan**    | • Jordan, Saudi Arabia and Republic of Korea is to conduct a feasibility study for a deployment of SMART in Jordan  
• Jordan to conduct feasibility study of SMR deployment with Rolls-Royce                                                                                                                                  |
| **Kenya**     | • Requested support on human capacity building for Reactor Technology Assessment that covers SMRs through IAEA-TC Project, to be implemented in Q1-2018                                                                 |
| **Pakistan**  | • Interest in participation and design development of the ACP100 of CNNC/NPIC                                                                                                                                 |
| **Saudi Arabia** | • Vision 2030 → National Transformation Program 2020: Saudi National Atomic Energy Project:  
  • K.A.CARE takes joint design ownership of SMART with KAERI. A pre project engineering is on going for construction of 2 units of SMART  
  • An MOU between K.A.CARE and CNNC on HTGR development/deployment in KSA                                                                                                                                     |
| **Tunisia**  | • STEG, the National Electricity and Gas Company is active in performing technology assessment for near-term deployable water-cooled SMRs                                                                                                                                 |

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Current Challenge: Construction Management

Reasons for delayed are varied, including to incorporate safety lessons learned.

Technology alone does not shorten construction time.

Chart showing construction times for different countries:
- CHINA
- JAPAN
- Republic of KOREA
- RUSSIA

Large Reactors connected to Grid since 1990
Group A: Design, Technology, Economic and Advanced Applications of SMR

Presented by:
Mr. Zouhire Boumazza
COMENA, Algeria
Topic A-1: Proven Design / Technology

• **Description:**
  – The level of experience through operation of a certain component or a certain nuclear power plant design for a certain length of time demonstrating the capabilities of those technologies.

• **Importance factor rationale:**
  – Verification of proven technology is important for a complex system for long term safe, economical and reliable operation

• **To be discussed by Group-A:**
  – Comparison with utility requirements.
  – Operational experience and/or experimental validation on the proposed design or on a similar design
  – To what extent are the major components standardized?
Two (2) deployment cases were considered:

1. SMR with proven design, i.e. the technology being/has been built and/or operated
2. First of a Kind (FOAK):
   - Algeria and Tunisia prefer not to adopt FOAK designs. FOAK designs shall first be deployed in the vendor’s country,
   - Current technology with water-cooled
   - advanced Gen-IV type reactors too challenging for embarking countries
   - Saudi Arabia, however, is confident to adopt FOAK design, certified by the country of origin: offers transfer of technology, IP ownership and export to neighbouring countries in the region
Expectations of embarking countries on SMR Deployment

• Security of energy with proven design
• Optimization of enhanced safety with economic competitiveness
• Viable financing scheme for SMR
• Development of national nuclear infrastructure
• Explore localization, national industry participation for nuclear and non-nuclear works and system/component productions
• Marketing and expansion to neighbouring countries
• Potential for transfer of technology
Operational experience and/or experimental validation on the proposed design or on a similar design

– Operational experience is highly preferred in introduction of SMRs, although some embarking countries have rationale to adopt FOAK designs

– Reference/prototype designs:
  - Similar/experimental facilities
  - Simulators
  - Shadowing experience
  - Technical support from vendors

– Regulatory framework
  - Standardization/unification of regulations
Topic A-2: Design Simplification

• Description:
  – The minimization of the number of types of systems and components, without adverse impacts on the plant economics, performance and safety, while improving ease of operation and maintenance

• Importance factor rationale:
  – Simplification is a key approach adopted by all SMR designs, particularly integral-PWR type SMRs. It could have a significant effect on economics of construction, operation costs for replacement parts, and labour requirements for operation and maintenance support.
Topic A-2: Design Simplification

• Discussed by Group-A:
  – Comparative design simplification for nuclear steam supply systems (NSSS), components, operations and safety systems
    • Simplification without causing additional problems in both safety and regulation
  – Maintenance procedure affected by design simplification
    • Simplification without causing detrimental effects on maintainability & inspection
  – Estimated significance of plant cost reduction due to design simplification, e.g. integrated versus loop-type NSSS of PWR-type SMRs
    • Multi module approach should reduce cost
    • Passive systems
    • Transportability/construction
Description:

- Nuclear power have also been promoted for (1) cogeneration of electricity and industrial-process heats (2) hybrid energy system of renewables and nuclear to mitigate the climate change; SMRs to contribute in near future

Importance factor rationale:

- Nuclear power for cogeneration will provide many economic, environmental and efficiency related benefits. However, the applications are not the same; they depend on the technology, type of reactor and fuel, and temperature of the cogeneration system.
- Renewables are intermittent power sources; while nuclear powers are traditionally based-load with embedded load-follow capability
Advanced applications are

- Cogeneration
- Desalination
- High temperature applications (petrochemical applications, ammonia, hydrogen production...)

Economic benefits of SMRs for cogeneration and integrating with renewables

- Integration (in petrochemical industry for example in KSA): even if kWth cost is higher, the quality of final products will increase and their cost reduces
- Diversification of use of the SMR (multipurpose)
- Improvement of the plant efficiency
- Possibility of integration with renewables energies: complementary and maneuverability / flexibility
- SMR considered as a backup for intermittent energies
Topic A-3: SMR for Advanced Applications

– Management of waste products
  • Decommissioning easier and cheaper (less components, less pipes).
  • Less wastes, less costs due to the size (but the same quantity by kWh produced than large NPPs)
  • Waste heat from cogeneration
  • HTGR : waste storage in dry conditions
  • Opportunity of reducing the costs thanks to high availability

– Safety and regulatory frameworks of collocating nuclear power plant with non-nuclear industries using heats from nuclear
  • Compliance of nuclear regulations with other industries regulations
  • Problems : implications of nuclear on industrial installations; Emergency Preparadness Zone
  • Security
  • Initiating events of accidents (external events)
Group B: Constructability, Maintainability, Operation Engineering and Supply Chain issues in SMR Deployment

Presented by:
Mr. Rashad Abuaish
K.A.CARE, Saudi Arabia
Topic B-1: Constructability

• **Description:**
  - The technologies and methods that will be used during the construction of the nuclear power plant.

• **Importance factor rationale:**
  - The term ‘modular’ in SMR could signify shop fabricated modules of system, structure and components also the use of modular construction technology which is also applied for large reactors

• **To be discussed by Group-B:**
  - Issues in transporting the reactor vessel and other major components; the size and weight transport requirements
  - For construction in the Middle East and North Africa region, what land area and water source and supply are required for construction, including layout and temporary use land areas?
  - Construction management and the use of user’s countries labour force; human capacity building issues.
Group Statement / Key Findings

• Constructability

  o Reactor internals assembly in factory versus on site are possible options, however welding of the primary circuits of reactor is strongly recommended to be done at the factory.
  o Considering the MENA region, land availability might not be an issue whereas water and other main supplies, for construction activities, must be carefully identified and considered.
  o Preparation of adequate infrastructure (harbours, roads, bridges, etc.) must be made for transportation of large and heavy modules.
  o FOAK SMRs will come with certain construction risks which will need to be minimized by vendors.
Group Statement / Key Findings

• Constructability
  
  o Keeping in mind the modularization nature of SMRs, interaction between the embarking country and technology provider should result in minimizing the impact on local infrastructure through specific design and construction solutions.

  o Vendors are recommended to provide different options to enhance constructability to address potential infrastructure limitations.

  o The number of onsite construction labour for SMRs is expected to be significantly reduced compared to large NPPs due to the modularization. However, onsite needs should be identified and addressed.
Topic B-2: Operation & Maintainability

• Description:
  – The methods, technologies and experience involved in maintaining the nuclear power plant for safe and reliable operation

• Importance factor rationale:
  – The actual operating performance of the 3 SMRs of different design & technology currently in final-stage of construction will only be known after 2019 – 2020.

• To be discussed by Group-B:
  – Available support after plant commissioning, including plant operation and maintenance for deployment in embarking countries
  – The need of full-scope simulators and operator training programme
  – Issues, challenges and new approach for on-line and off-line maintenance programme for near-term deployable SMR with new design features, e.g. in-vessel steam generators, underground construction, and so forth.
Group Statement / Key Findings

• Operation and Maintainability
  o Proper training must be provided to the embarking countries by the vendor for operation and maintenance specially for the passive safety systems.
  o The lack of operating experience in SMRs can be a critical point for launching some of the advanced designs in the embarking countries.
  o Accessibility for maintenance could pose an issue specially for underground and heavily integrated reactors
  o Some of the current designs have shared systems, such as one turbine for multiple modules, and solutions must be proposed by the vendors in scenarios such as turbine maintenance.
Group Statement / Key Findings

• Operation and Maintainability
  o Integrated reactors pose difficulties for maintenance accessibility for components such as steam generator.
  o Very compact SMR may have higher radiation fields which in turn will require more operation staff resulting in higher costs. New shielding options might be a solution.
  o Full-scope simulators are key to provide comprehensive training for operators (operation and maintenance).
Topic B-3: Supply Chain

- **Description:**
  - Strength of the relationship between the technology holder and its suppliers, including assessment of the capabilities and history of the suppliers, the duration of the relationship, and any quality or schedule issues or advantages based upon current data or relevant experience record.

- **Importance factor rationale:**
  - Is industrial supply chain for SMR fully established?
  - This will determine the degree of involvement of the owner. The lack of clear definition of interfaces can lead to significant issues.
  - The ability of the technology holder to deliver the plant as specified and the assurance of manufacturing of key nuclear components and systems.

- **To be discussed by Group-B:**
  - Who will handle QA/QC for lower level/domestic components in user’s countries, particularly those embarking?
  - Supply chain arrangement for sensitive technology, export control issues.
Group Statement / Key Findings

• Industrial Supply Chain
  o The general responsibility of the QA/QC is on the main contractor. However, **embarking country’s aiming to localize the supply chain should take part** in performing such activities and promote the upgrading of the local industries to meet the nuclear standards.
  o The approach is depending on the embarking country’s nuclear program objectives (Electricity generation only or also industry localization). The evolution of a robust local supply chain will eventually lead to a regional manufacturing facility in the case of a large nuclear program.
Group Statement / Key Findings

• Industrial Supply Chain
  - Countries with industrial infrastructure (oil and gas, heavy industries, etc.) are in a better position to contribute to the supply chain starting with the BOP and gradually to the nuclear island after acquiring required experience.
  - Export control should be addressed for the dual use components, fuel and transportable reactors.
Group C: SMR Siting, Licensing and Regulatory Frameworks

Presented by:
Mr. Joseph Nduma Ruwah,
Kenya Nuclear Electricity Board
Topic C-1: Siting

• **Description:**
  – Site specific parameters affecting the plant design.

• **Importance factor rationale:**
  – Interaction between site characteristics and the features of the proposed SMR design may be a strong differentiator; for example, design features that have been included in a certified design in country origin to be deployed in user countries with significantly different site characteristics and external events/hazards.

• **To be discussed by Group-C:**
  – Site size requirements, boundary conditions, site structure plan: single or multi-unit SMR plant.
  – Heat sink temperature, condenser cooling water source and extent of water resources
  – Specific natural hazards in MENA region: seismic, flooding, sand storms; dry/wetlands.
Topic C-2: Licensing

• Description:
  – The official process of authorization granted by the regulatory body to the applicant to have the responsibility for the siting, design, construction, commissioning, operation or decommissioning of a nuclear installation.

• Importance factor rationale:
  – The actual operating performance of the 3 SMRs of different design & technology currently in final-stage of construction will only be known after 2019 – 2020.

• To be discussed by Group-C:
  – Available support after plant commissioning, including plant operation and maintenance for deployment in embarking countries
  – The need of full-scope simulators and operator training programme
  – Issues, challenges and new approach for on-line and off-line maintenance programme for near-term deployable SMR with new design features, e.g. in-vessel steam generators, underground construction, and so forth.
Topic C-3: Regulatory Framework

• **Description:**
  – Framework of system of authorities designated by the government of a State as having legal authority for conducting the regulatory process, including issuing authorizations, and thereby regulating nuclear, radiation, radioactive waste and transport safety.

• **Importance factor rationale:**
  – Considering specific design, technology and siting features of SMR: Emergency Planning Zone (EPZ) size, Graded Approach and Defence-in-Depth were identified as the key enabling issues/challenges for deploying an SMR currently being addressed in the SMR Regulators Forum
  – Sharing regulatory experience amongst nuclear power countries preparing to license SMRs and capacity building for embarking countries interested in SMR are crucial for successful deployment

• **To be discussed by Group-C:**
  – Region-specific, i.e. MENA’s potential safety case for SMRs
  – Additional safety requirements due to regional site characteristics
  – Participating countries’ current and near-future activities on emergency preparedness and response, particularly EPZ size determination
Key Findings - Siting considerations

• Public opinion and politics is key
  – Environmental and site conditions are seemingly secondary considerations – at this point of time

• Main drivers for site selection:
  – Regional access to water – coastal sites preferred
  – Security
  – Proximity to protected areas (e.g., heritage sites, holy places, tourist areas, fishing zones)
  – Proximity to hazards (e.g., shipping lanes, oil fields)

• Site considerations in embarking countries are already helping to substantiate FOAK designs
Key Findings - Licensing

- Embarking countries are considering legal and regulatory framework development at the same time they are selecting sites
  - No licensing experience in embarking countries
- FOAK SMR challenges
  - New technologies have not been validated in experienced nuclear countries
  - Challenge with public acceptance if unanticipated problems or delays occur
  - Multiple uses and types of SMRs require coordination among ministries/countries
- Recognize importance of training and spent fuel management
Key Findings - Regulatory framework

• Embarking countries have regulations for controlled nuclear materials but these don’t include nuclear power

• Governments are considering establishing the regulator for NPPs

• Regulatory framework may be imported alongside the vendor technology – needs to accommodate research reactors and SMRs

• Opportunity and challenge for nuclear to set the standard for regulating other industries
SMR: definition & rationale of developments

Advanced Reactors to produce up to 300 MW(e), built in factories and transported as modules to sites for installation as demand arises.

A nuclear option to meet the need for flexible power generation for wider range of users and applications

**Economic**
- Lower Upfront capital cost
- Economy of serial production

**Modularization**
- Multi-module
- Modular Construction

**Flexible Application**
- Remote regions
- Small grids

**Smaller footprint**
- Reduced Emergency planning zone

**Replacement for aging fossil-fired plants**

**Better Affordability**

Shorter construction time

Wider range of Users

Site flexibility

Reduced CO₂ production

Integration with Renewables

Potential Hybrid Energy System
Other Generation IV SMRs (Examples)

**PRISM**
- Power Reactor Innovative Small Modular
- Liquid Sodium-cooled Fast Breeder Reactor
  - 311 MW(e) / 840 MW(th)
  - Core Outlet Temp: 485°C
  - Fuel Enrichment: 26% Pu, 10% Zr
  - Underground containment on seismic isolators
  - For complete recycling of plutonium and spent nuclear fuel

**4S**
- Super Safe Small Simple Sodium-cooled Fast Reactor
  - Fuel Cycle: 30 years
  - 10 MW(e) / 30 MW(th)
  - Core Outlet Temp: 510°C
  - Fuel Enrichment < 20%
  - Negative sodium void reactivity
  - Hybrid of active and passive safety features
  - Designed for remote locations and isolated islands, close to towns

**SVBR100**
- Heavy Metal Liquid Cooled Fast Reactor 100 MW
  - Lead Bismuth Eutectic cooled Fast Reactor
    - 101 MW(e) / 280 MW(th)
    - Core Outlet Temp: 490°C
    - Fuel Enrichment 16.5%
    - Fuel Cycle: 8 years
    - Hybrid of active and passive safety features
    - Prototype nuclear cogeneration plant to be built in Dimitrovgrad, Ulyanovsk

**IMSR**
- Integral Molten Salt Reactor
  - Molten Salt Reactor
    - 80, 300 and 600 MW(th)
    - Core Outlet Temp: 700°C
    - Fuel Cycle: 7 years
    - MSR-Burner: Efficient burner of LEU
    - MSR-breeder: Thorium breeder
    - Ideal system for consuming existing transuranic wastes (Long lived waste)
    - Passive decay heat removal in situ without dump tanks
SMR for Non-Electric Applications

District heating
Seawater desalination
Pulp & paper manufacture
Methanol production
Heavy oil desulfurization
Petroleum refining
Methane reforming hydrogen production
Thermochemical hydrogen production
Coal gasification
Blast furnace steel making
Advantages, Issues & Challenges

**Technology Issues**
- Shorter construction period (modularization)
- Potential for enhanced safety and reliability
- Design simplicity
- Suitability for non-electric application (desalination, etc.).
- Replacement for aging fossil plants, reducing GHG emissions

**Non-Techno Issues**
- Fitness for smaller electricity grids
- Options to match demand growth by incremental capacity increase
- Site flexibility
- Reduced emergency planning zone
- Lower upfront capital cost (better affordability)
- Easier financing scheme

**Technology Issues**
- Licensability (FOAK designs)
- Non-LWR technologies
- Operability and Maintainability
- Staffing for multi-module plant; Human factor engineering;
- Supply Chain for multi-modules
- Advanced R&D needs

**Non-Techno Issues**
- Economic competitiveness
- Plant cost estimate
- Regulatory infrastructure
- Availability of design for newcomers
- Physical Security
- Post Fukushima action items on institutional issues and public acceptance
### Roadmap for Technology Developer

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<tr>
<th>Phase</th>
<th>Milestones</th>
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<tbody>
<tr>
<td><strong>(1) Project Creation, Conceptual Design, Funding &amp; Economic Studies</strong></td>
<td>- Project Charter&lt;br&gt;- Conceptual Design &amp; Econ Studies&lt;br&gt;- Establish QA Programme</td>
</tr>
<tr>
<td><strong>(2) Basic Design &amp; Engineering Development</strong></td>
<td>- Submit Preliminary Licensing Package&lt;br&gt;- Test Plans Finalized&lt;br&gt;- Submit Final Licensing Package&lt;br&gt;- Final Design Package</td>
</tr>
<tr>
<td><strong>(3) Detailed Design, Testing, &amp; Validation</strong> (Owner Participation in FOAK)</td>
<td>- Issue Fuel Qualification Plan&lt;br&gt;- Fuel Design Data&lt;br&gt;- Supplier Qualification Plans&lt;br&gt;- Qualified Suppliers List</td>
</tr>
<tr>
<td><strong>(4) Fuel Design Assessment &amp; Qualification</strong></td>
<td>- Fuel Design Assessment&lt;br&gt;- Issue Fuel Qualification Plan&lt;br&gt;- Fuel Design Data</td>
</tr>
<tr>
<td><strong>(5) Supplier Development &amp; Qualification</strong></td>
<td>- Supplier Qualification Plans&lt;br&gt;- Qualified Suppliers List</td>
</tr>
<tr>
<td><strong>(6) Pre-Licensing Discussions and/or Design Certification Activities</strong></td>
<td>- Preliminary Regulatory Response&lt;br&gt;- Obtain Regulatory Acceptance</td>
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<tr>
<td><strong>(7) Owner/Licensee and International Interactions</strong></td>
<td>- Owner Requirements&lt;br&gt;- IAEA Generic Reactor Safety Review (GRSR)&lt;br&gt;- Owner Acceptance of Designer QA Programme&lt;br&gt;- Agreement of Cooperation (FOAK)&lt;br&gt;- IAEA Safeguards Review</td>
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Roadmap for Technology User

**PHASE 2**

(1) **PROJECT CREATION**
- EPC Contract Signed
- Site Application Submitted
- Early Site Preps Completed

(2) **PLANNING, FINANCING, CONTRACTING, & SITING**
- Submit Application for Construction License

(3) **SITE SPECIFIC DESIGN & ENGINEERING SUPPORT**

**PHASE 3**

(4) **LICENSING & REGULATORY OVERSIGHT**
- Site Permit Approved
- Construction License Issued
- Operator Licenses Issued

(5) **Procurement, Supplier Development & Qualification**
- Award Reactor Module Contract
- Reactor Modules Ready
- Reactor Fuel Ready

(6) **CONSTRUCTION**
- 3 Years (NOAK)
- First Concrete
- Fuel Loading

(7) **TRAINING & INITIAL STARTUP**
- Commercial Operation Date (C0D)

(8) **OPERATIONS, SPENT FUEL & WASTE MANAGEMENT, DECOMMISSIONING**
- Dry Spent Fuel Storage Site Approved
Summary

- IAEA is engaged to support Member States in SMR Technology Development and has started addressing challenges in applying Design Safety Requirements for NPPs to SMRs.

- SMR is an attractive option to enhance energy supply security:
  - In newcomer countries with smaller grids and less-developed infrastructure
  - In advanced countries for power supplies in remote areas and/or specific applications

- Innovative SMR concepts have common technology development challenges, including regulatory and licensing frameworks.

- Studies needed to evaluate the potential benefits of deploying SMRs in grid systems that contain large percentages of renewable energy.

- Studies needed to assess “design standardization” and “target costs” in cogeneration markets, the benefits from coupling with renewables to stabilize the power grid, and impacts on sustainability measures from deployment.
Thank you!

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