Prospects, Impediments and Expectations from SMRs Design & Technology

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## Prospects and Expectations from SMRs

### Integral design
- Incorporation of primary system components into single vessel
- Elimination of large break LOCA by design
- Elimination of Rod Ejection Accident (in case of in-vessel CRDMs)
- Improved axial and radial shielding
- Increased passivity of decay heat removal

### Modular design
- Compact and simplified layout
- Fewer structures, systems and components
- Lower on-site construction time
- Factory fabrication, assembling and testing
- Multi-module NPPs offering scalability
- Transportable NPPs
### Prospects and Expectations from SMRs (Contd..)

<table>
<thead>
<tr>
<th>Safety aspects</th>
<th>Facility size and deployment aspects</th>
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<tr>
<td>• Elimination of some severe accidents by design</td>
<td>• Smaller plant footprint</td>
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<td>• Passive core cooling and residual heat removal systems</td>
<td>• Smaller EPZ</td>
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<td>• Elimination of some failure modes by passivity</td>
<td>• Reduced plant cooling requirements</td>
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<td>• Longer grace periods due to inherent safety features</td>
<td>• Underground placement of containment</td>
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<td>• Low core damage frequency ($\sim 10^{-8}$-$10^{-10}$/year)</td>
<td>• Higher Seismic resistance</td>
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<td>• Moveable or sea based deployment</td>
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<td>• Deployment in regions lacking essential infrastructure</td>
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## Prospects and Expectations from SMRs (Contd..)

| Flexible applications | • Load following capability enabling cogeneration applications such as desalination, district heating, hydrogen production etc.  
|                       | • Independent power source for energy critical facilities  
|                       | • Suitability for remote regions having small grids  
|                       | • Integration with renewables in hybrid energy systems  
| Economic aspects      | • Lower upfront capital cost  
|                       | • Improved on-site economics  
|                       | • Economy of serial production  
|                       | • Higher learning rate |
Challenges in SMRs Development

### Demonstration of technology
- ‘Proven’ technology is seen as risk-free option
- Demonstration or Prototype SMR NPPs need to be developed
- Comprehensive testing and qualification requirements of SMR components and systems

### Complex engineering
- Contain to some extent of “first-of-a-kind” engineering systems and components
- Updating of codes and standards
- Integrated and modular design
- Long-term reliability may be a major technological and material challenge
- Interfacing with cogeneration and non-electric applications
## Challenges in SMRs Development (Contd..)

### Economic viability
- Challenges in entering established energy markets
- Large initial orders required for securing economy of factory fabrication
- Economic competitiveness is not proven yet
- Varying estimations of $/kWe values
- Demonstration and prototype SMR plants are going through major delays in schedules and cost overruns

### Public acceptance
- SMRs deployment and nuclear renaissance is linked with public acceptance
- Public advocacy and lobbying are required
- Successful public-private partnerships are essential
Challenges in SMRs Development (Contd..)

| Licensing & regulatory framework | • Updating of regulatory framework  
|                                  | • Legal and institutional framework  
|                                  | • Development of pathways to licensing  
|                                  | • Lack of human resource with skills and capacity  
|                                  | • Long lead-time for regulatory review |

| Concepts of operation | • Control room’s designs for multi-module SMRs  
|                      | • Control room staffing  
|                      | • Design of human-system interfaces  
|                      | • I&C requirements and interfaces |
Concluding Remarks

- For successful business plan of SMRs to work, large orders would be necessary
- SMRs are good option to support innovation in nuclear energy technologies and to extend nuclear energy benefits to newcomers
- Regulatory oversight is necessary for maintaining the required level of safety and facilitating effective management of SMR technologies
- Comprehensive work on risk analysis and hazard analysis of systems shared among modules and with cogeneration plants is necessary
- International partnerships would be very beneficial in successful development and deployment of SMRs
- IAEA could materialize the postulated SMRs deployment by actively engaging the developers and potential users and maintaining public advocacy of SMR benefits
Thanks