Chairpersons’ Summary

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The 22nd INPRO Dialogue Forum on Successful Development and Sustainable Deployment of SMRs
22nd INPRO Dialogue Forum

• **Main objectives:**
  - Facilitate the rapid development and deployment of SMRs by promoting the exchange of knowledge, experiences, and best practices
  - Promote sharing of R&D efforts aimed at advancing SMR technologies in safety, efficiency, and cost-effectiveness
  - Discuss common safety standards, licensing procedures, and guidelines to streamline the regulatory framework and infrastructure to support a consistent approach to SMR deployment across different regions
  - Analyse the specific requirements and needs of SMR vendors and Member States and Recommendations for the IAEA

• **Participation and structure:**
  - Over 170 participants from 31 Member States and 1 International Organization (WNAO)
  - 5 Plenary Sessions, 4 MSs sessions, and a Technical tour in 5 Days

• **Strong support from Republic of Korea**
Highlights from a keynote session

Key IAEA Activities on SMRs (Mr Hahn, IAEA)

Key IAEA Activities on SMR

- Technology Development and Deployment
  - TWG-SMR/GCR
  - ARIS Database
  - SMR Booklet

- Reactor Technology Assessment
  - Updated Method incorporates SMR

- Fuel, Safe management of Spent Fuel, Radioactive Waste and Decommissioning

- Approaches to Commissioning and Operation
  - Issues on the conduct of operation, OLC and MCR for multi-unit plant

- Economics
  - Economic Appraisal of SMR Projects: Methodologies and Applications

Technical Cooperation for MS Capacity Building

- Legal Frameworks for safety, security, safeguards and civil liability for nuclear damage

- Safety & Security
  - Applicability of Safety Standards and Security Guides
  - Emergency Preparedness and Response

- Nuclear Harmonization and Standardization Initiative
  - Industry Track
  - Regulatory Track

- Safeguards-by-Design
  - Facilitation of safeguards inspection early in reactor design stage

- Infrastructure Development
  - IAEA Milestones Approach applicable to SMR
  - New deployment models
Highlights from Panel Session

Strategic Partnerships and Collaboration to Support SMRs

Pan-Canadian
- COG SMR Program
  - De-risks plans for all partners
  - Provides Supports to new entrants

International
- Technical collaboration agreement between GEH, OPG, TVA and SGE to develop BWRX-300 standard design

Regulatory
- MOC between CNSC and US NRC to collaborate AR and SMR technologies
- Charter to find regulatory efficiencies to support BWRX-300 design

Small & Medium Size Reactor Technology Forum (SMRTF)
- Fuel Supply, Enrichment & Recycling TTs
- Radioactive Waste Management TT
- Nuclear Security TT
- Nuclear Liability TT

SMR Vendor Participant Program (VPP)
- SMR Industry Regulatory TT
Highlights from Panel Session

- **Integrated PWR**
- Electric Power: 170 MWe/Module
  - 680 MWe in case of 4 modules
- Core: UO₂, 69 FAs, (active length: 2.4 m)
- Boron Free Operation
  - No Chemical concerns
  - No Boron Precipitation during Accident
- Canned Motor RCP
  - Enhancing economics & Instability free
- Dry type Passive Safety Systems
  - No Failure, Easy Maintenance
  - PAFS, PECCS, PCCS
- Module Fabrication & Construction
- LCOE < 65 $ / MWe
Success of SMR Deployment

- Manufacturers
- Constructor
- Operating Organization
- Regulatory Body
- R&D Organizations
- Designer
- Public
- Government
- International organizations
Highlights from Panel Session

Regulatory Experiences on SMR & Large NPPs

**Abbreviations**
- **RR**: Research Reactor
- **KSNP**: Korea Standard Nuclear Power Plant
- **JRTR**: Jordan Research and Training Reactor
- **OPR 1000**: Optimized Power Reactor
- **APR1400**: Advanced Power Reactor
- **SMART**: System-integrated Modular Advanced Reactor

**Timeline**
- **HANARO** 1995
- **KSNP (Hanul-3)** 1998
- **Export of JRTR to Jordan, APR1400 to UAE** 2009
- **Development of Future Reactor**
- **Development of Advanced Reactor**
- **SMART-P, SMART**
- **OPR1000 (SKN-1)** 2011
- **APR1400 (SKN-3)** 2016

**Key Events**
- **The First RR (TRIGA) 1962**
- **Introduction of Nuclear Power**
- **The first NPP (Kori-1) 1978**
- **Technology Self-Reliance**
- **Promotion of localization**

**SMRT**
- **SMART (7/2012)**
- **SDA Approve**
- **SMART100 (12/2020)**
- **SDA Review (in progress)**

**Applications**
- **(Application scheduled)**
- **the SDA of i-SMR (’26.1)**

**Timeline Years**
- **2010 2012 2019 2024 2026**
To be a reliable SMR manufacturer, seamless efforts are required, going beyond the role of a mere "build-to-print" manufacturer.

- Extensive experience in nuclear component design and manufacturing
- In-depth understanding in nuclear regulation and Code/Standard

Differentiated Manufacturing Expertise
- Development of innovative manufacturing technologies
- Proactive investment in facilities
- Co-work with manufacturing equipment supplier

Robust Supply Chain
- Collaboration with government and financial investors
- Establishing win-win strategies with subcontractors
Highlights from Panel Session

Challenges of deploying floating power units

01 Approval of safety for transportation between countries

02 Legal and regulatory support for projects, unique business schemes of implementation

03 The necessity of international cooperation based on transparent and non-discriminatory approaches

THE WAY FORWARD:

Cooperations between IAEA and IMO

Forming working groups to develop specific standards

Analyzing the experience of pilot projects and successful practiceties of international cooperations
Highlights from Panel Session

- Development partners of advanced small modular reactor for marine applications
Highlights from Panel Session

- Site selection and Characterisation
- Planning/Preparation/Development of Related Nuclear Project Infrastructure
- NPG Approach Nuclear Power Project
- Selection of Vendor / Strategic Partner
- Community Engagement & Stakeholder Management
### Pros and Cons of Competing Options

#### Hydrogen and ammonia co-firing
- The utility can partially utilize existing technologies.
- The utility can maintain the current supply chain (and employment).
- Hydrogen and ammonia are still relatively expensive.

#### CCUS
- Thailand can still rely on stable supply of fossil fuel-based electricity.
- CCS is based on proven technology and is now economically competitive.
- The technology readiness level of most CCU technologies are still low.
- Hydrocarbon is still being combusted.

#### SMR
- The industry can rely on clean and stable supply of electricity by SMR.
- SMR can complement the nature intermittency of renewable energy.
- The public is still concerned about the safety and the radioactive waste.
Application of INPRO methodology and tools

- Applying the ASENES tools and INPRO methodology to address and assess the sustainability of advanced LWRs and SMRs and possible deployment scenarios to Vietnam (being planned)
  - Possibility to introduce advanced LWRs and SMRs into the electricity mix after 2030 to replace coal and support renewable energy
  - Nuclear energy sustainability assessment (NESA) for Vietnam Seaborg CMSR technology (Joint-work of PECC2, Seaborg and VINATOM with support from the INPRO Section)
Kenya’s NPP is Based on Milestone Approach

**Highlight from MSs Session**

**Milestone 1**
- Nuclear power option included in national energy strategy
- First nuclear power plant project

**Phase 1**
- Considerations before a decision to launch a nuclear power programme is taken

**Phase 2**
- Preparatory work for the construction of a nuclear power plant after a policy decision has been taken

**Phase 3**
- Activities to implement a first nuclear power plant

**Milestone 2**
- Ready to make a knowledgeable commitment to a nuclear programme

**Milestone 3**
- Ready to invite bids for the first nuclear power plant

**Milestone 4**
- Ready to commission and operate the first nuclear power plant

**Operation of the First Nuclear Power Plant**

**Pre-Project**
- Feasibility Study

**Project Decision Making**
- Bidding Process

**Construction**
- Commissioning

**Timeline**
- 10 – 25 years

**We are here**
Participants’ survey revealed that Economics, Licensing, Public acceptance, Supply chain are the main challenges to deploy SMRs, while Economics and Harmonized licensing regime, and a standardized design are the most important aspects for global SMR deployment.
Participants’ survey revealed that affordability, small size fit to the grid, and flexible operation are the important features to deploy SMRs in embarking countries, while HRD and collaboration are the main ways to actively involve those countries in SMR deployment.
SMRs will create many new opportunities, but there are also challenges ahead

- When integrated with renewable energy sources, SMRs can support electrical grid stability, reducing greenhouse gas emissions, and advancing energy security initiatives.
- For embarking countries, SMRs offer a pathway to reliable, low-carbon energy production, while simultaneously reducing reliance on fossil fuels and stimulating economic growth.
- Early and strategic international cooperation, IAEA’s assistance to Member States given the plethora of information and options, engagement of the SMR industry in tandem with government efforts, and R&D in ensuring continued innovation are critical to overcome various challenges.
To demonstrate safety and operating performance for early SMR deployment,

- Regulatory predictability, international harmonization and standardization, and the graded approach are emphasized.
- Regulations for SMRs should be flexible to accommodate innovative aspects in design, manufacturing, construction, and operation.
- Newcomer countries can overcome challenges with the support of international organizations, exporting countries, and other advanced countries.

✓ For the informed decision by the policy maker, data driven evaluation of SMR Safety & Performance is necessary. IAEA and established countries should provide the detailed data.
To demonstrate economic competitiveness of SMRs and ensure the sustainability of their supply chain,

- The relevant issues should be considered from the early beginning of the project, even at the design and R&D stages
- To benefit from innovative solutions, the design should be manufacturable and it requires cooperation between designers and manufacturers
- International cooperation may serve as an instrument to mitigate possible disruptions in the supply chain
- To become a supplier, a new entrant should be engaged asap and prove it has a framework in place, including QA programmes and capacity.
- To create a pull of reliable suppliers the support from government and transparent regulation are required.
To tackle challenges facing deployment of FNPP,

- Effective collaboration among industry stakeholders, regulatory bodies, and international organizations is essential to address the complex regulatory landscape.
- Continued investment in technological innovation, such as advanced reactor designs, modular methods, and robust safety systems, is critical to enhancing the safety, reliability, and cost-effectiveness.
- Leveraging international collaboration, knowledge sharing, and lessons learned from pilot projects can accelerate its deployment.
- Efficient integration of the nuclear power system with the current shipyard workplace, technology, and HRs can strengthen competitiveness of FNPP.
Main challenges to develop necessary infrastructures for deployment of SMRs are

- Developing the human resource on SMRs
- Developing the nuclear industry infrastructure to support
- Economic viability
- International collaboration with the IAEA on SMR related activities

Covered Key factors that were assessed to determine the viability of SMR projects implementation include

- License
- Financing
- Localization
Recommendations to expedite SMR deployment

- The IAEA should more actively organize regularly dedicated events for SMRs including INPRO Dialogue Forums to share best practices, and HRD programs such as SMR school.
- The IAEA should provide more information on SMR safety and operation, and progress of global SMR development.
- Training on INPRO methodologies should be offered to support MSs for their informed decision.
- The IAEA should organize a high-level event to strengthen international collaborations for accelerating SMR deployment.
Impressions on the 22nd DF are surveyed as **Informative, engaging, insightful**. We need to make a step forward.
Chairpersons’ Conclusion

- 22\textsuperscript{nd} INPRO DF has been a great success.
- Invaluable SMR knowledge and experiences have been shared and discussed, and recommendations made through;
  - Active participation of distinguished participants
  - Excellent panel discussions and presentations
  - Well-designed programs cooperated with KNS
- Excellent support from Korean government.
Thank you for your attention