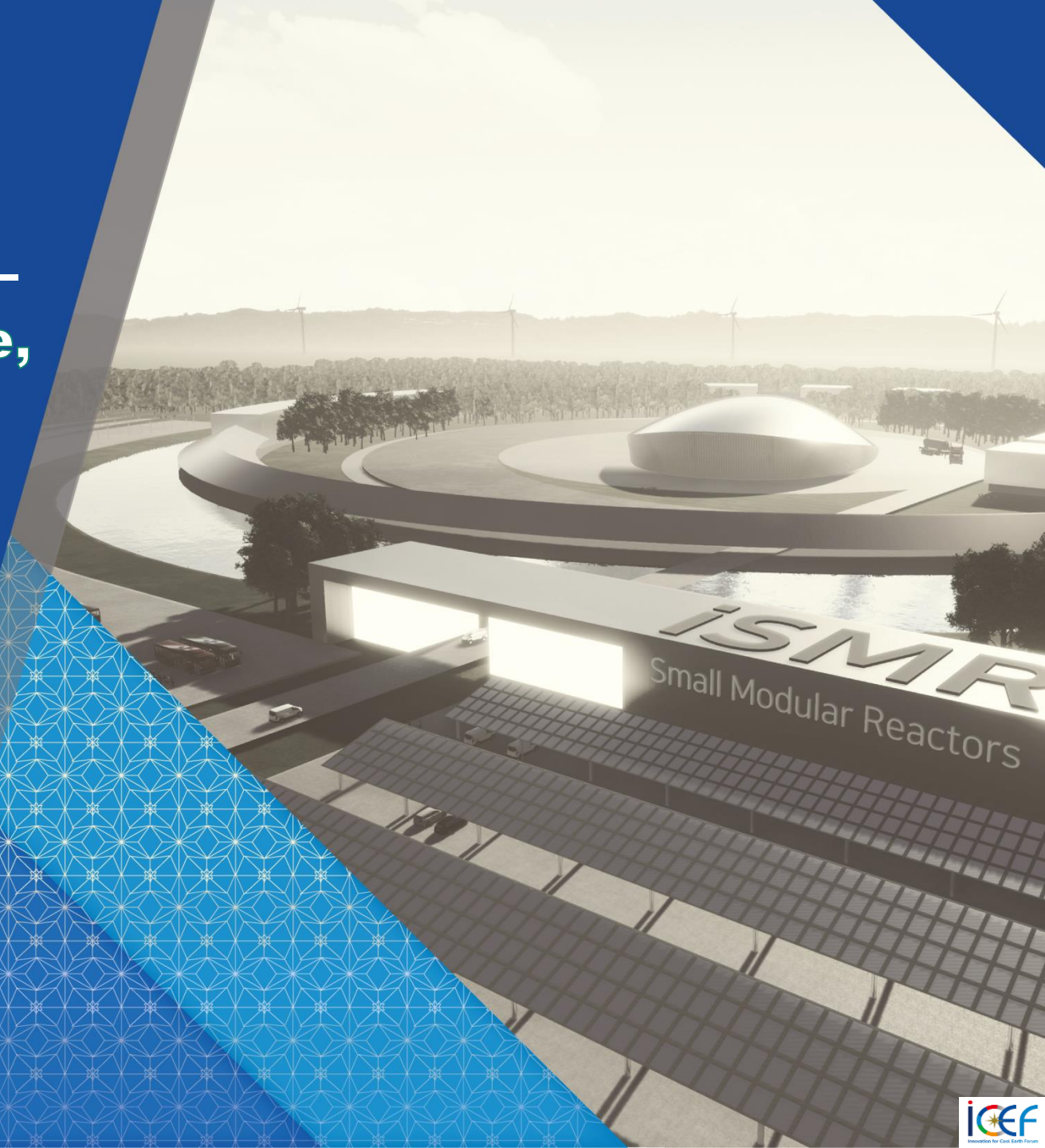
Powering a CARBON-FREE Future,

Together with
i-SMR & SMART NET ZERO CITY



10. October, 2024

Ho Cheol Shin,
A Head of KHNP Central Research Institute

KOREA HYDRO & NUCLEAR POWER CO.,LTD

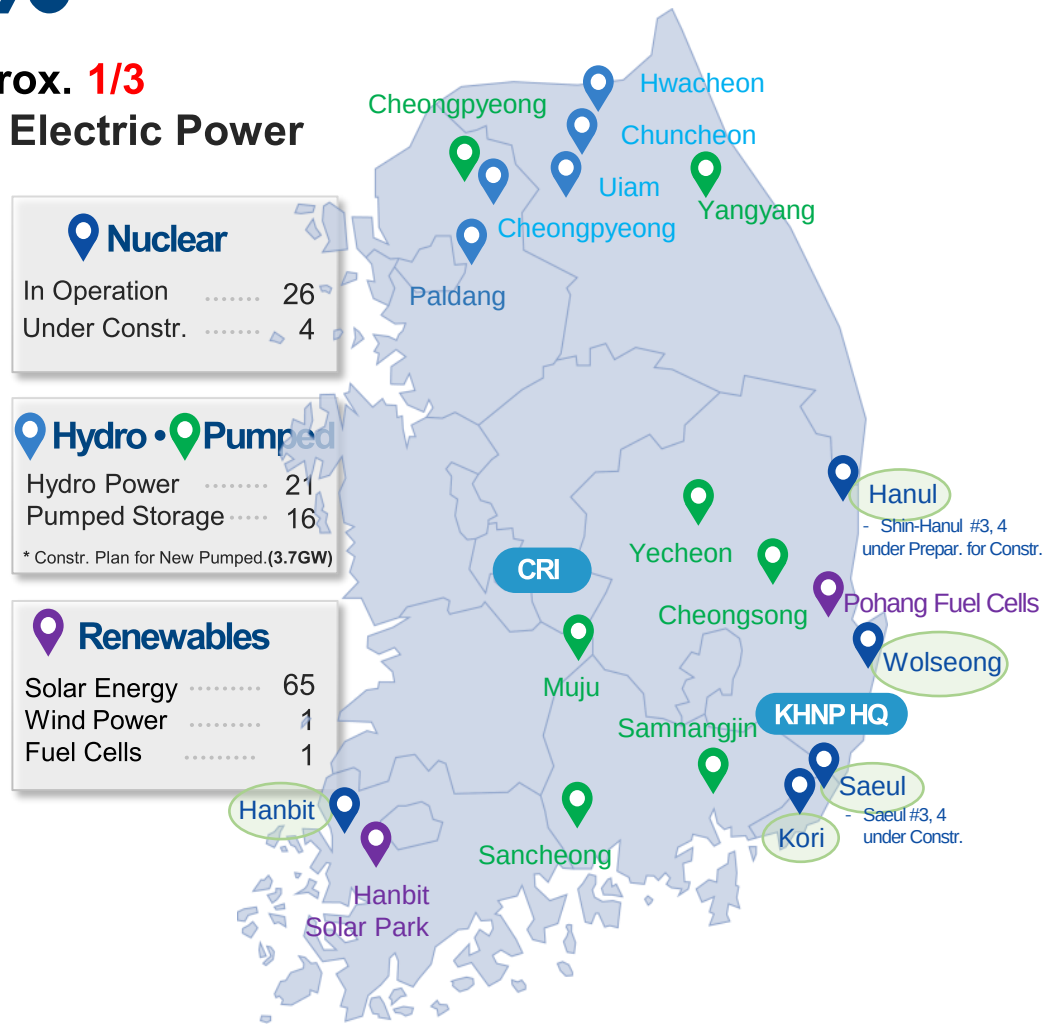
I. Introduction – Overview of KHNP

‘31.5%’

Generating Approx. 1/3 of the Domestic Electric Power

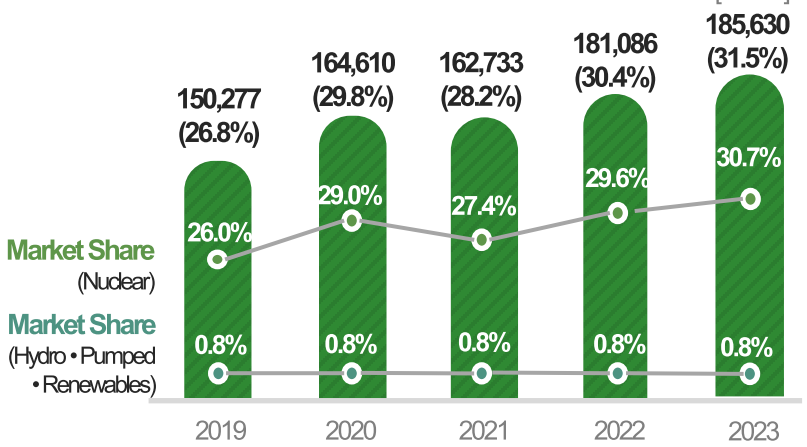
Major Power Plants Location

(as of ’24. 6.)



KHNP’s Power Generation Capacity

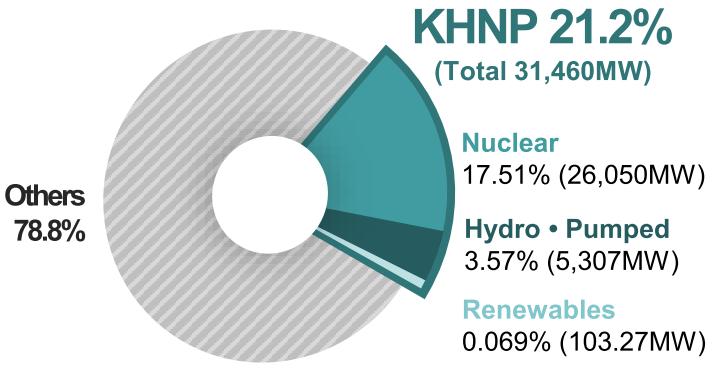
(as of ’23.12.31.) [GWh]



- Domestic Power Generation Capacity: 588,047 GWh (’23.12.31.)

Power Plants Installed Capacity

(as of ’24. 6.)



- Domestic Total Power Plants Installed Capacity: 148,709 MW (’24.6.)

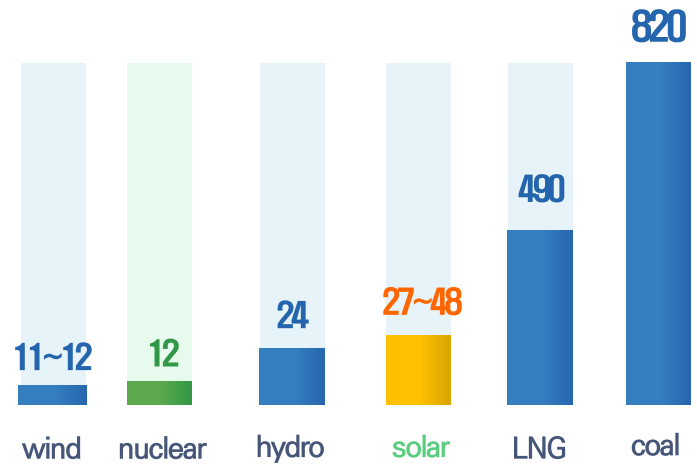
I. Introduction – Energy Trends

❖ Global Trends in Energy Sector

Decarbonization

Importance of environment

IPCC* Life cycle emission factor(2014)



SMR "Lowest carbon footprint"

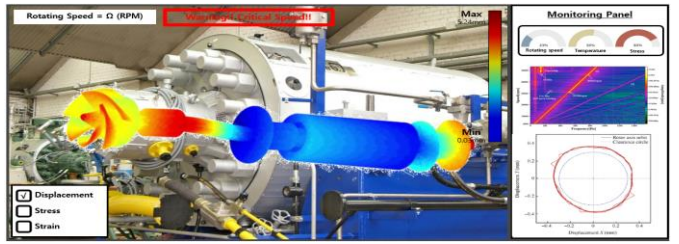
Decentralization

Paradigm shift to small scale

"Small independent grid"

Digitalization

4IR technologies



"Cutting-edge digital technologies"

I. Introduction – Chanllenges of Large NPP

Challenges of Large Scale NPPs

SMR has Strength that conventional (large) NPPs doesn't have

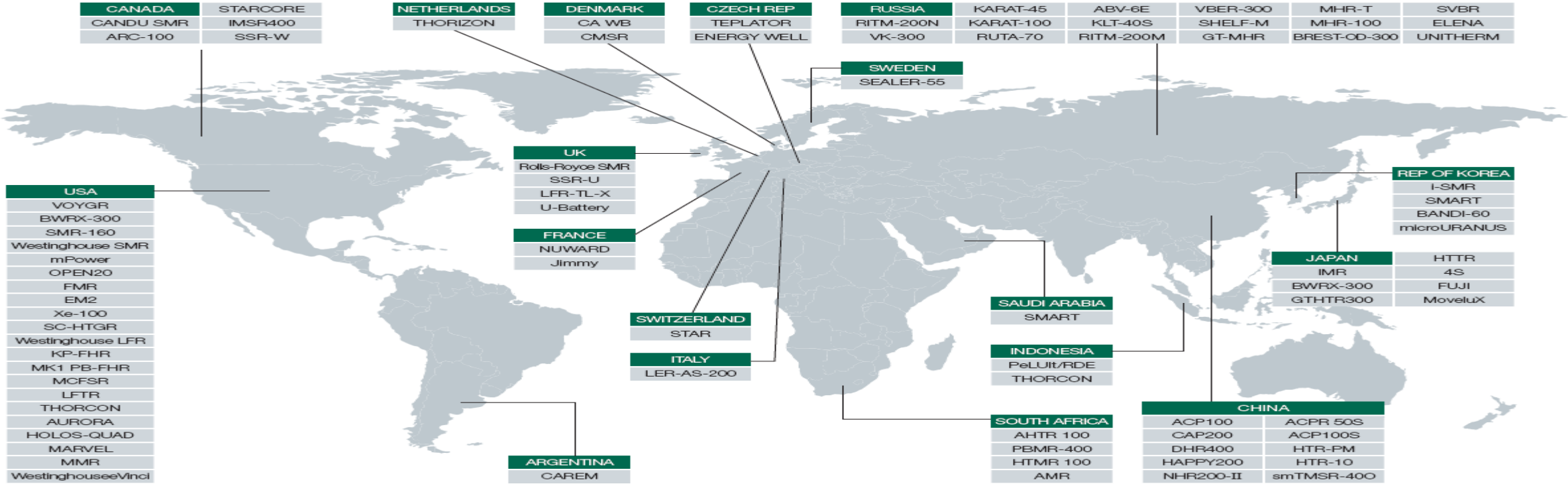
Advantages of SMR	
Safety	• Effective in alleviating accidents due to its inherent **safety characteristics** • **Reduced radioactive** release due to small number of nuclear fuel bundles
Economics	• Reduced initial **investment** • Reduced construction delay risk by factory manufacturing and equipment modularization
Flexibility	• Applicable to smaller power grids • Easy control to supplement renewable energy intermittency • Ease to overcome siting constraints • Suitable for wide application (desalination, process heat, hydrogen)

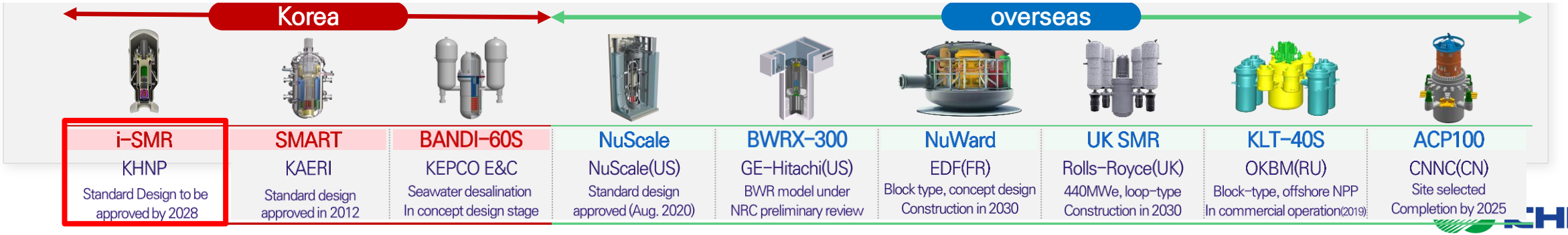
Reference

- **13th INPRO Dialogue Forum**
  "Small Modular Reactors Update on International Technology Development Activities"
- **OECD NEA 2021**
  "Small Modular Reactors: Challenges and Opportunities"

I. Introduction – SMR Development Status

❖ Over 80 types of SMRs under developed Worldwide





II. i-SMR Development Goals

❖ 3 Major Goals : Higher Safety, Economic Feasibility, Flexibility

Higher Safety

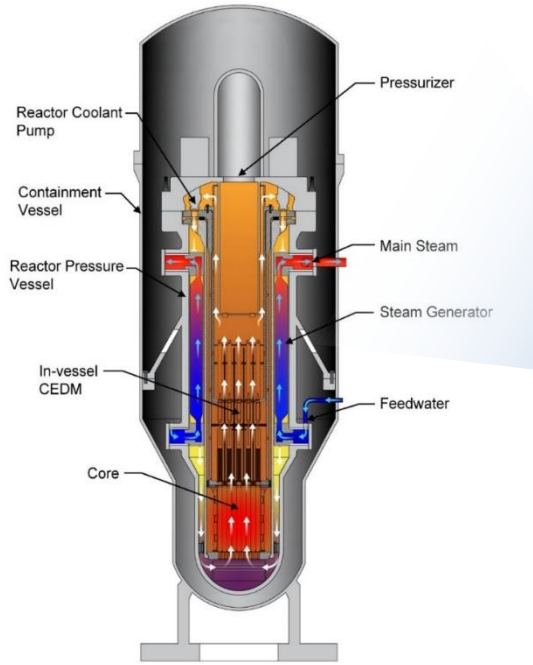
Core Damage Frequency : 1.0×10-9/M·Y

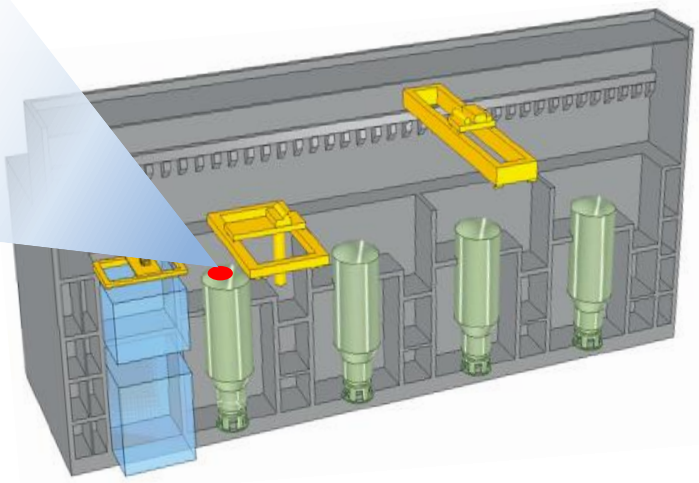
Economic Feasibility

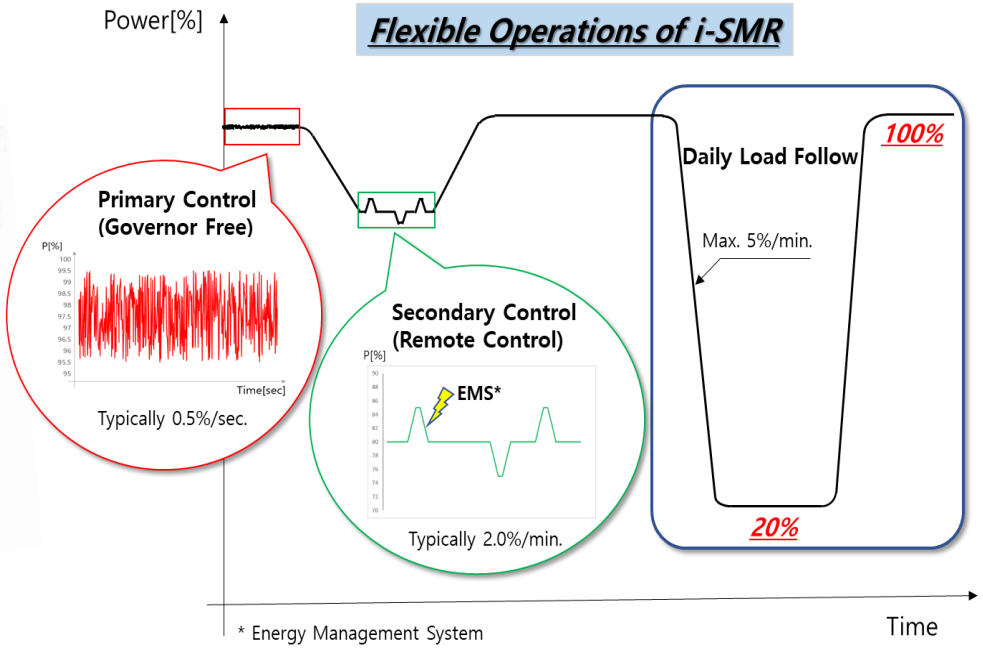
- Construction cost : $3,500 /kWe
- Generation cost : $65 /MWh

Flexibility

- Power range : 100%-20%-100%
- Linear power variation rate: 5%/min





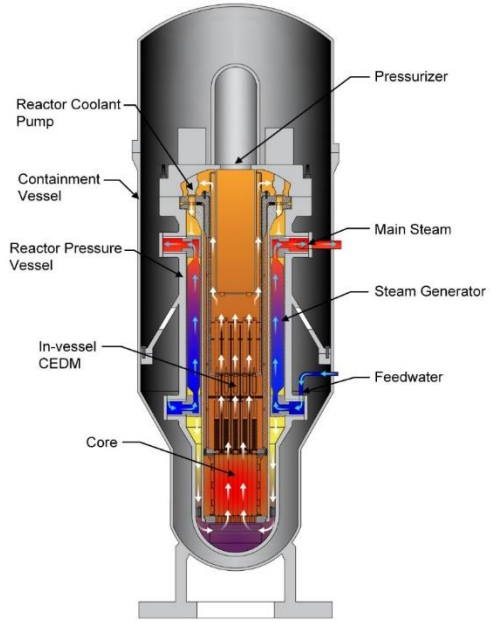


II. i-SMR Development Goals

❖ Higher Safety (1/2)

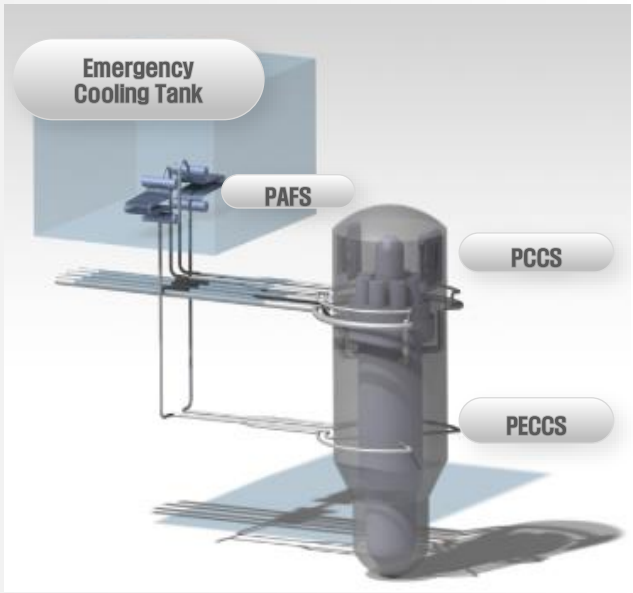
Integral Reactor Design

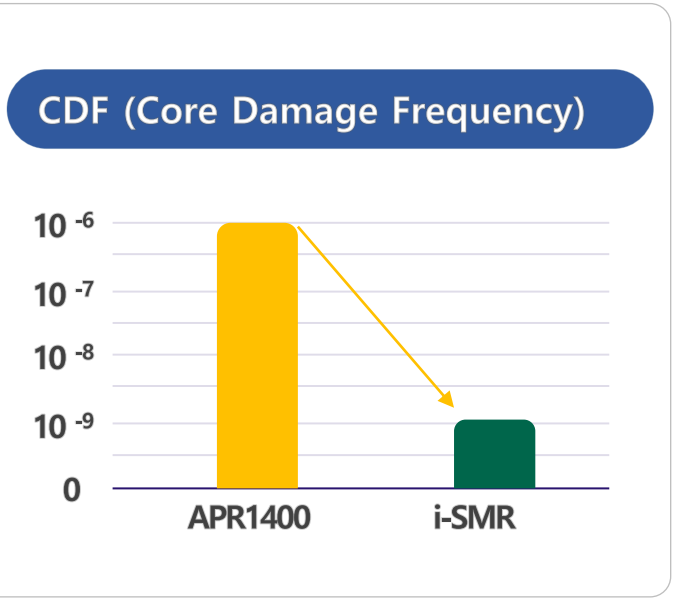
- Integrating main equipment into RCS
- No large pipe : LB-LOCA elimination
- IV-CEDM : Preventing rod ejection accident



Fully Passive Safety System Design

- Passive safety system with natural circulation
- Safety system without safety-class Electric power
- Station Blackout response time : ≥ 72 hours





1,000 times higher safety than large NPPs

II. i-SMR Development Goals

❖ Higher Safety (2/2)

Underground reactor building

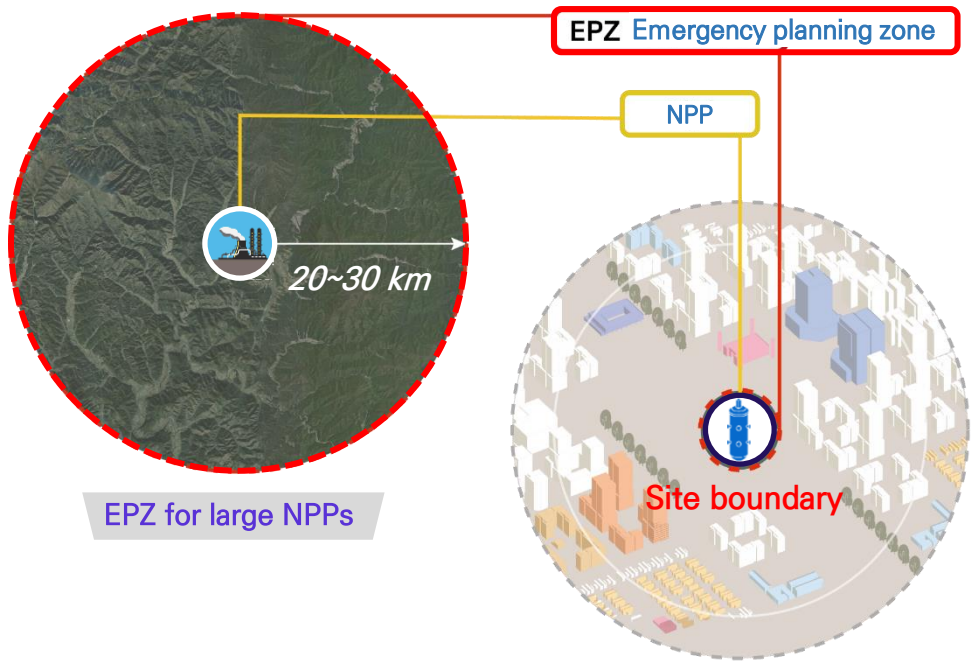
- Seismic Design 0.5g
- Underground reactor
- Seismic design of major equipment
- Aircraft crash protection

Reduction of radioactive leakage

- Small reactor
- Low accident probability
- Steel containment

EPZ within the site boundary

While large NPPs need EPZ of 20~30㎞ radius,
SMR can be installed near cities, residential/remote areas



II. i-SMR Development Goals

❖ Economic Feasibility

Reduction in construction volume

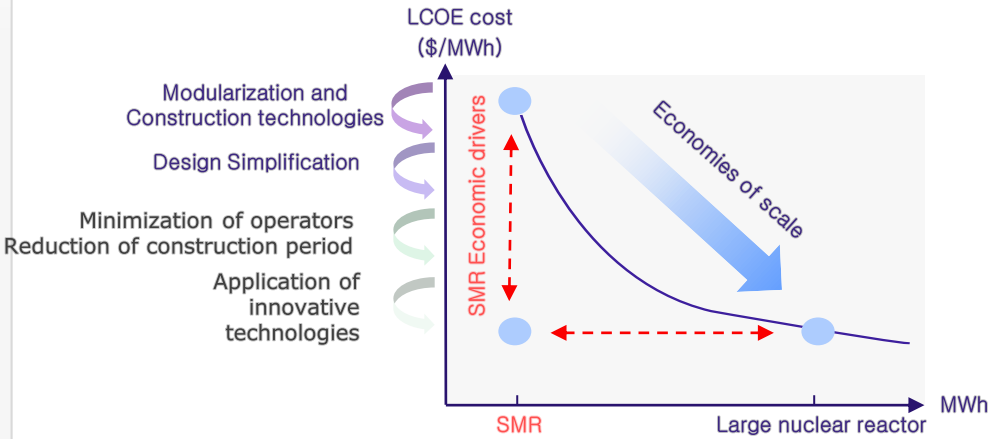
- Design simplification of system
- Multiple modules in a single reactor building

Modularization and factory manufacturing

- Design optimization for inland transportation
- Reduced construction time and cost with innovative technologies

Significant reduction in operators

- 3 operators in one integrated MCR for multiple modules
- Autonomous/Automatic operation and operate support system
- Predictive/preventive maintenance



II. i-SMR Development Goals

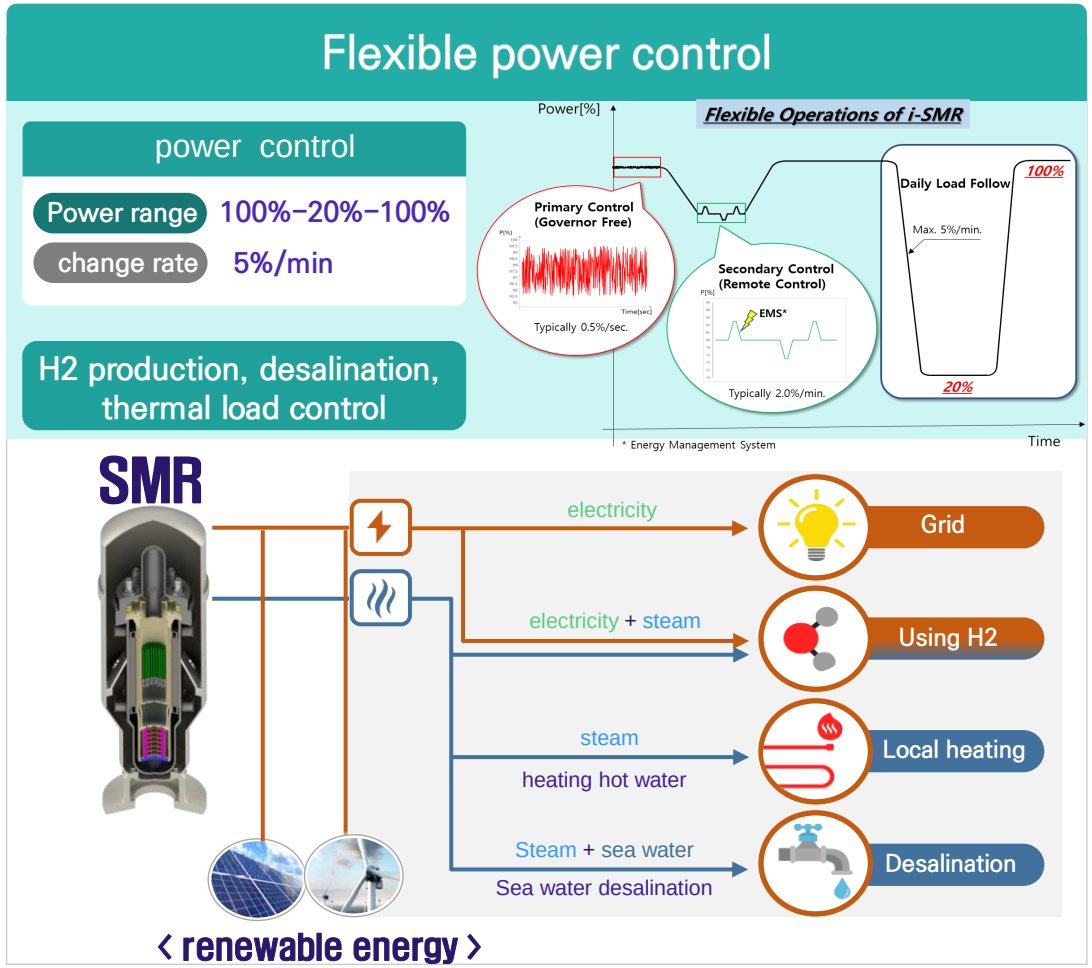
❖ Flexibility

Multipurpose utilization

- Replacement of aging coal-fired power plant
- Distributed power supply
- Hydrogen production (HTSE)
- Process heat, district heat, desalination, etc.

Harmonization with Renewable Energy

- Easy flexible operation by Load following operation
- Carbon-free auxiliary power is required to complement intermittent of renewable energy



III. Future Plan

❖ Future Plan

Preliminary Design led by KHNP

- KHNP project (KAERI, KEPCO E&C, KNF, Doosan, Academic)
  - Period : '21 ~ '23 (3years)
  - Budget : $40 Million

National R&D Projects Supported by the Government

- MSIT* /MOTIE* project
  - Period : '23 ~ '28 (6years)
  - Budget : $300 Million

* MSIT : Ministry of Science and ICT / MOTIE : Ministry of Trade, Industry and Energy

Basic Design by 2023 (KHNP) | **SDA approval by 2028 (Government)** | **FOAK operation in 2031**

2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031

- Top-Tier Requirements and Conceptual Design
- Basic Design (2.5yrs)
- Standard Design (2yrs)
- Licensing (3yrs)
- Commercialization
- Confirmation of Business Plan (Industries)
- Construction started
- First construction completed

KHNP

IV. SSNC(i-SMR Smart Net-zero City)

Combining i-SMR & Smart city to materialize advantages and visualize model

→ Carbon-neutral city design & Feasibility evaluation centered on i-SMR

i-SMR Smart Net-zero City "SSNC" Vision

Carbon neutrality

Energy Innovation Platform to Accelerate Carbon Neutrality

SMR SMART NET-ZERO CITY

Eco-friendly

01 Net-zero energy based on i-SMR

- Stable energy supply & management
- Short-term construction (24months/module)
- Construction near demand areas
- Harmony with renewable energy

02 Innovation of city & Industrial competitiveness

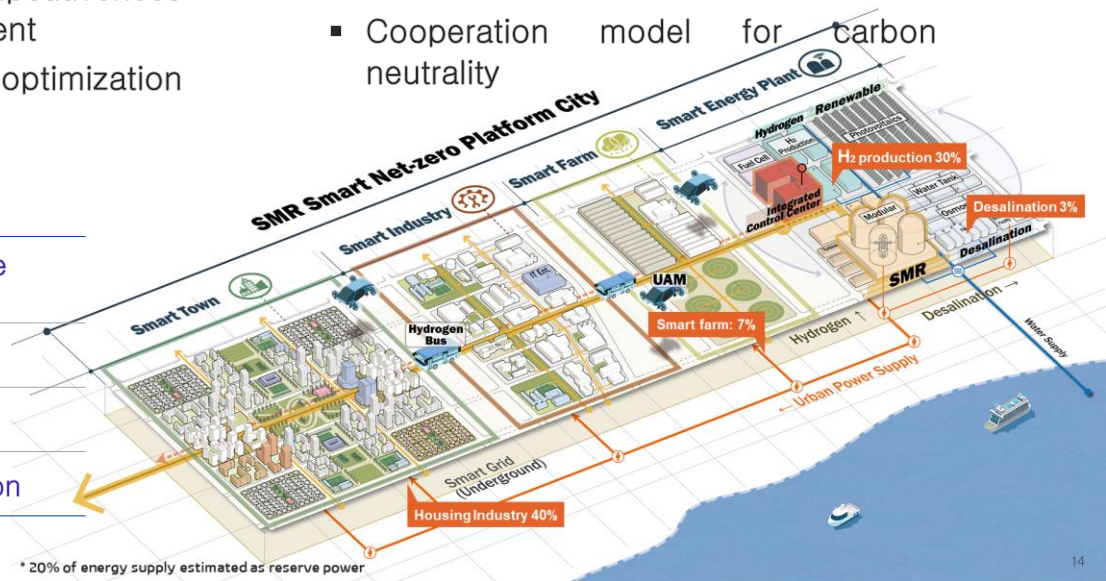
- Achieve Carbon neutrality
- Securing industrial competitiveness for sustainable development
- Providing energy optimization solutions

03 Co-prosperity for carbon neutrality

- Maximize synergy through cooperation
- Cooperation model for carbon neutrality

SSNC Platform

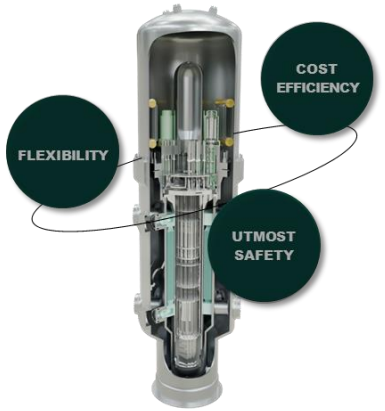
Smart Energy Plant	Stable supply simulation of CF100 energy through harmony of i-SMR & renewable energy
Smart Industry	Optimizing energy efficiency for industrial facilities with high energy demand
Smart Town	Provision of smart life through appropriate energy management
Smart Control	Autonomous control solution for efficient energy production, distribution, utilization



V. Conclusion and Suggestion

1. Sustainable Energy Solutions for CARBON NEUTRALITY

i-SMR & SSNC

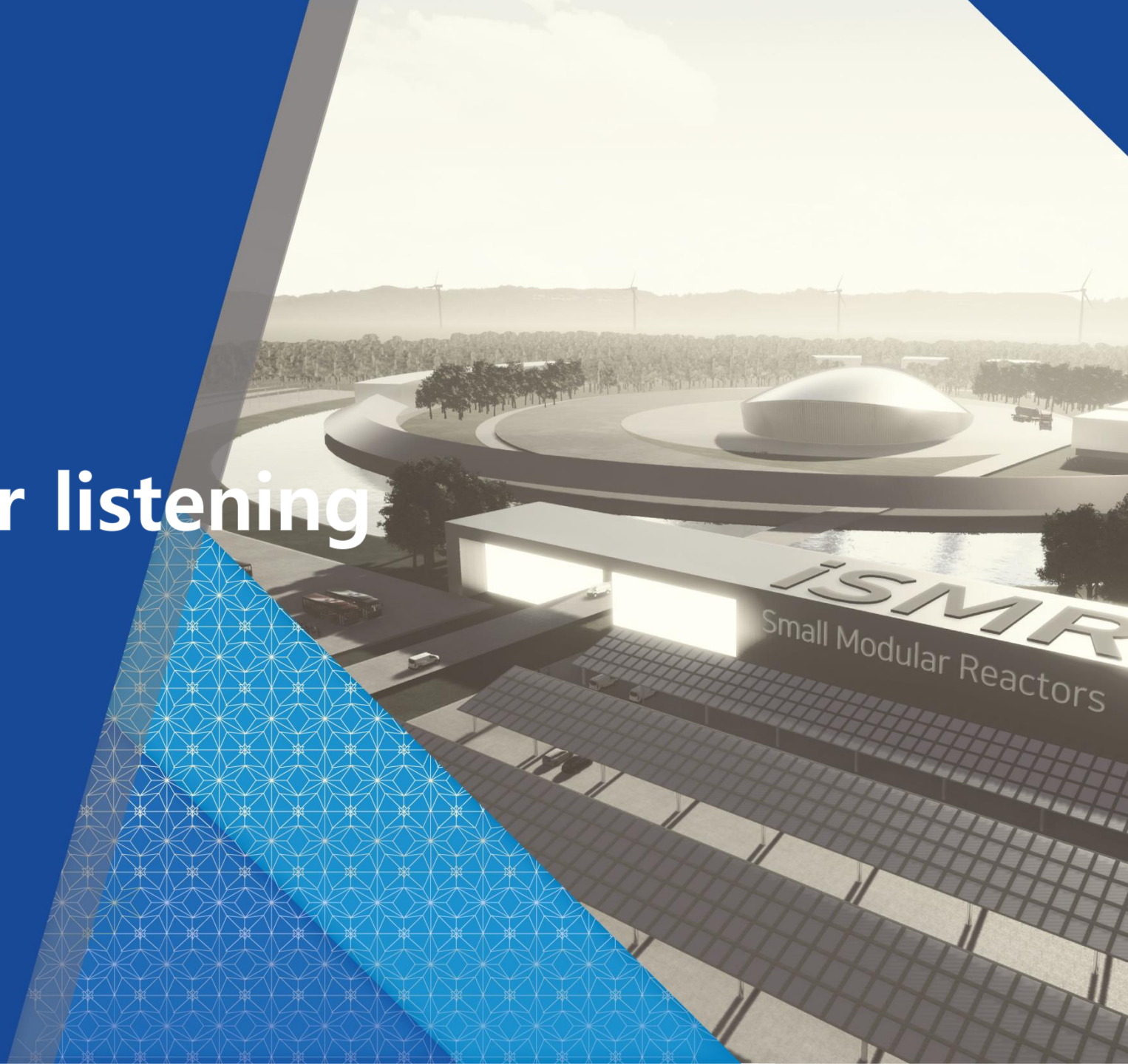


2. What should we do to accelerate the commercialization of SMR?

1) Need to build efficient regulations framework

2) Need to expand various non-electric applications

Thank You for your listening



Korea Hydro & Nuclear Power Co., Ltd.