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New SMR Design, innovative-SMR (i-SMR)

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CONTENTS

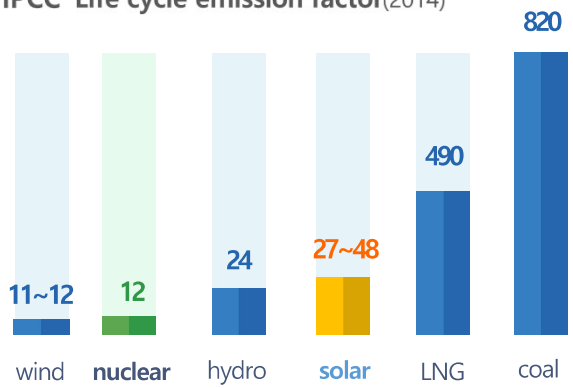
1-1 Global Trends in Energy Sector

☑ **SMR(Small Modular Reactor)** as optimal model for global energy trends : **Decarbonization, Decentralization, Digitalization**

Decarbonization

Importance of environment

IPCC* Life cycle emission factor(2014)



IPCC(Intergovernmental Panel on Climate Change)

SMR "Lowest carbon footprint"

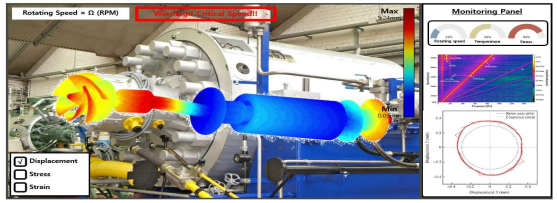
Decentralization

Paradigm shift to small scale

"Small independent grid"

Digitalization

4IR technologies

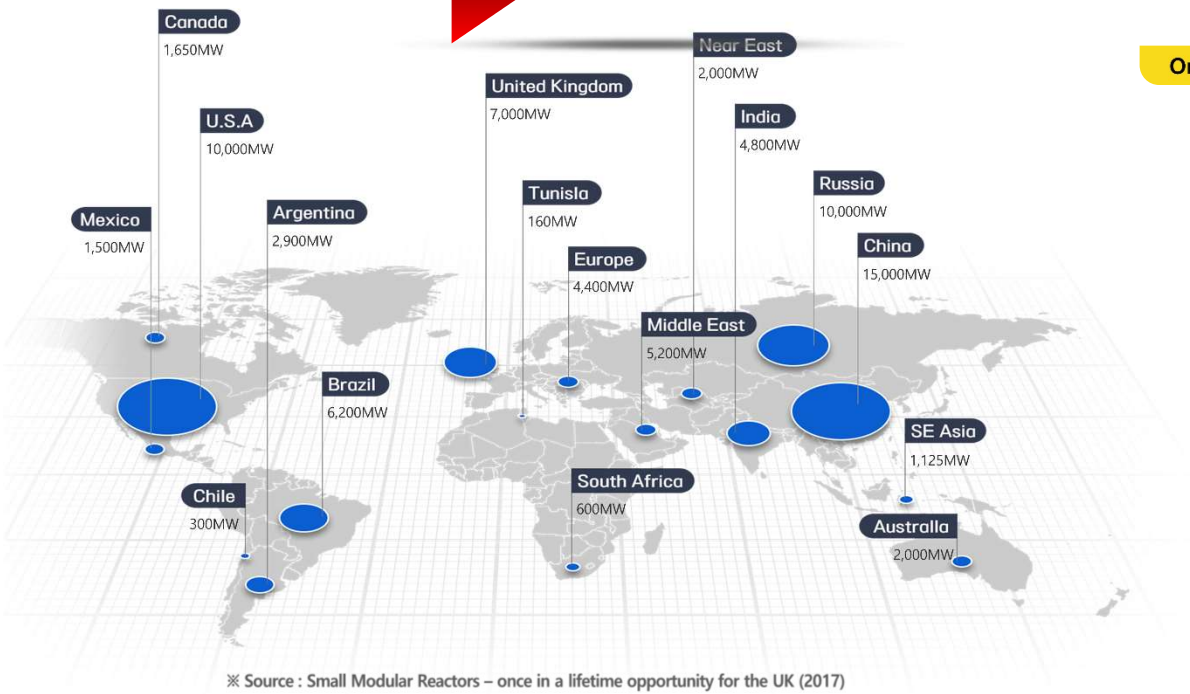


"Cutting-edge digital technologies"

1-2 SMR Market Outlook

☑ Global SMR Market potential : Increased demand for SMR by 2030s

Market growth 65~85GW until 2035



※ Source : Small Modular Reactors – once in a lifetime opportunity for the UK (2017)

$116 Billon by 2030

	Market	Benchmark
On-grid Coal-Fired Power	$80B	Natural Gas

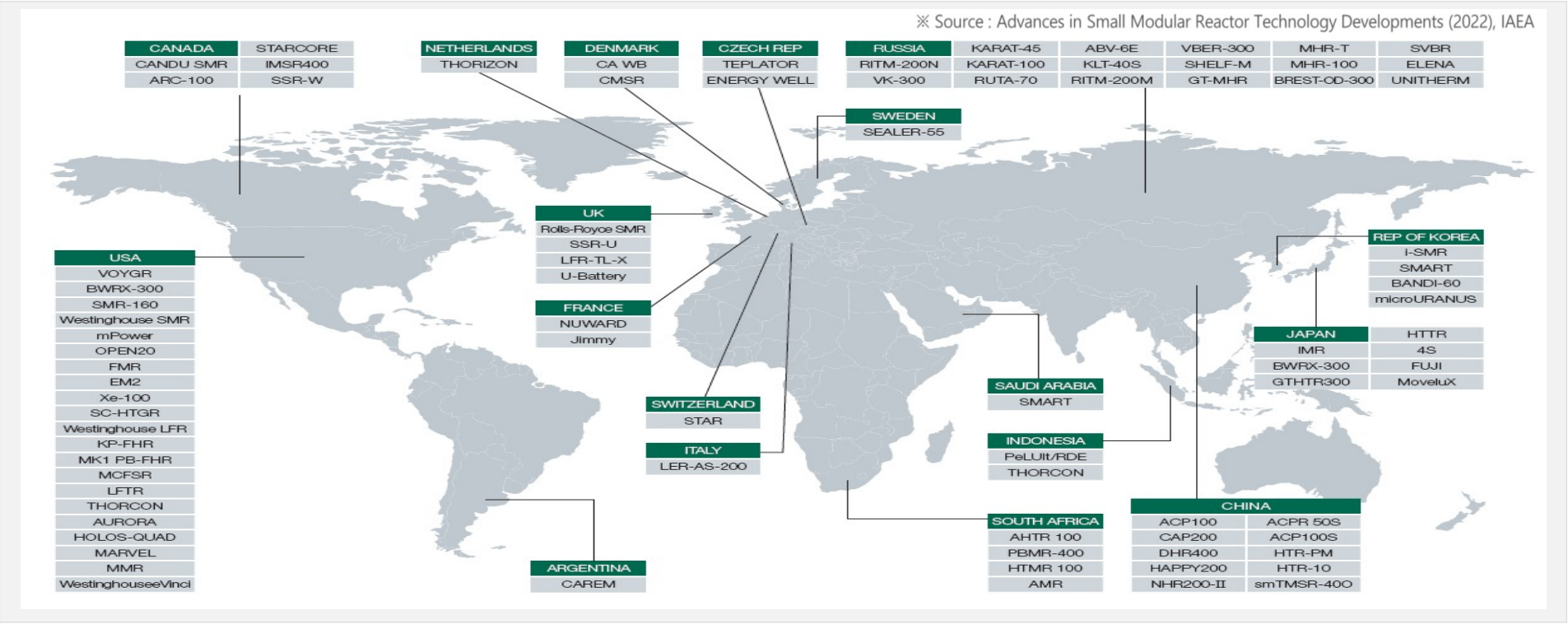
	Market	Competitor
Off-grid Remote Island	$24B	Diesel
Off-grid Heavy Industries	$9.6B	Natural Gas
Off-grid Mines	$2.8B	Diesel

※ Source : Canadian SMR Roadmap: Economic and Finance Working Group Report (2018)

1-3 Global SMR Development Status

☑ **Fierce competition for SMR development** to **achieve commercialization by 2030s**

"Over 80 types of SMRs under development worldwide"



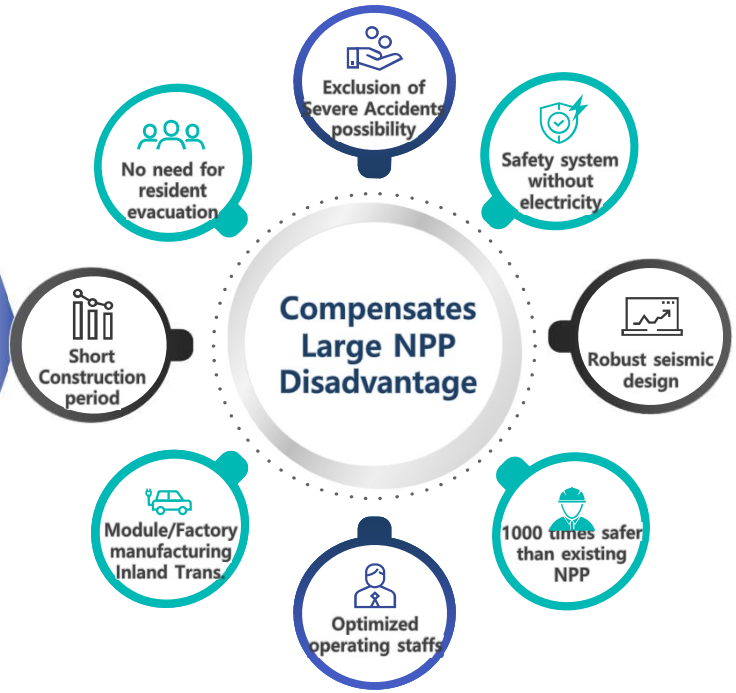
1-4 Characteristics of SMRs

☑ SMR has strength that conventional (large) NPPs doesn't have : Safety, Economics, Flexibility

Definition	SMR (Small Modular Reactor) : A reactor with an electric power of less than 300MW capable of factory production of a reactor module

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"

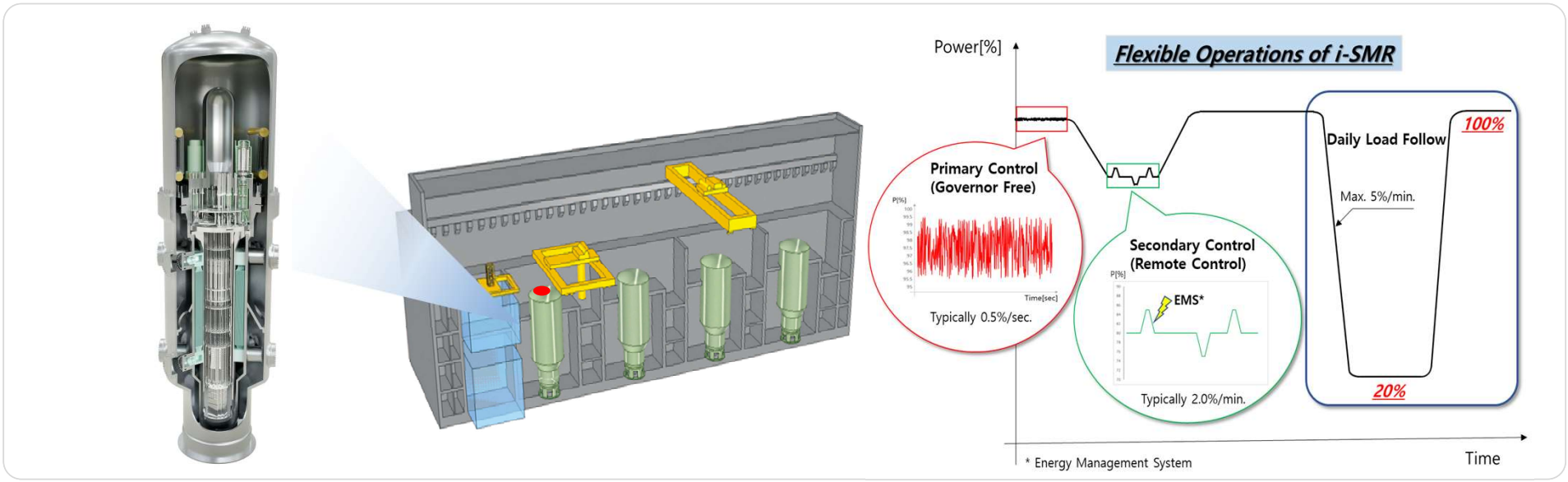
2-1 i-SMR Development Goals

☑ **Innovative SMR(i-SMR)** to lead **global SMR market in 2030s**

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

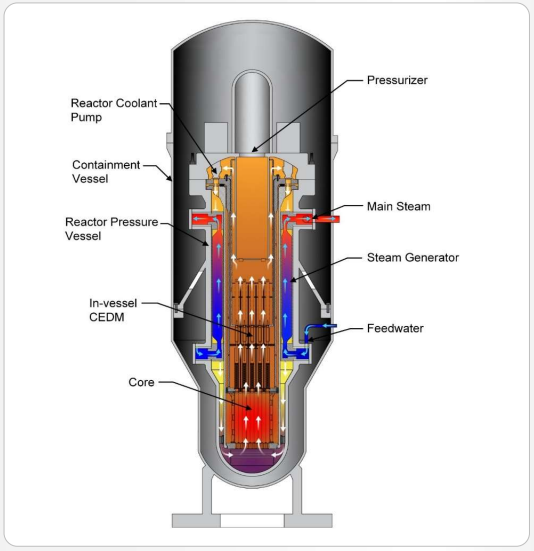


2-2 Design characteristics of i-SMR : Safety

Safety : Enhanced safety by Passive safety system without safety-class DC power and operator's actions

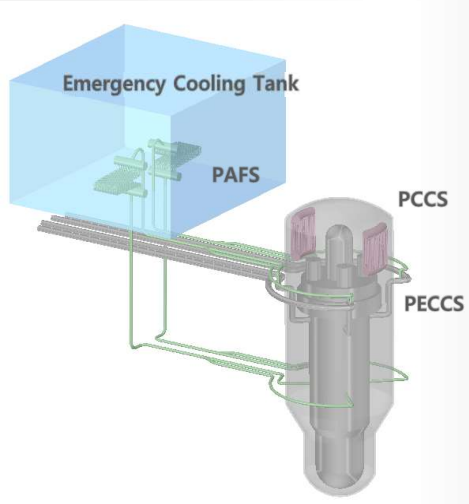
Integrated Reactor Design

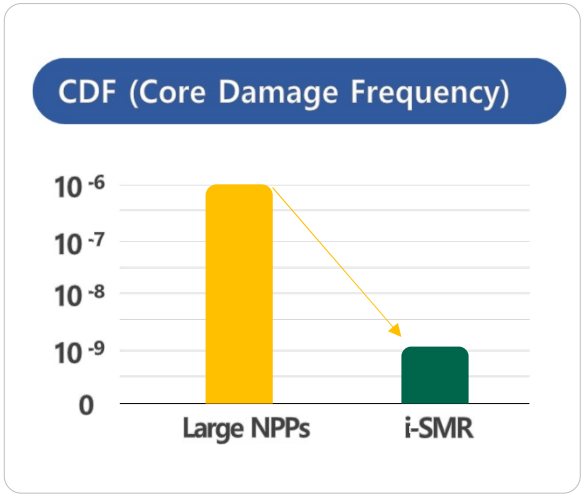
- Integrating main equipment of reactor system
- LB-LOCA exclusion (pipeless)
- [IV-CEDM] Preventing a rod ejection accident



Fully Passive Safety System Design

- Passive safety system with natural circulation
- Safety system without safety-class DC power and operator's action
- Station Blackout (SBO) response time : ≥ 72 hours





1,000 times safer than large NPPs

2-3 Design characteristics of i-SMR : Safety

Safety : Enhanced safety allows construction near cities, residential areas

Underground reactor building/Enhanced seismic performance

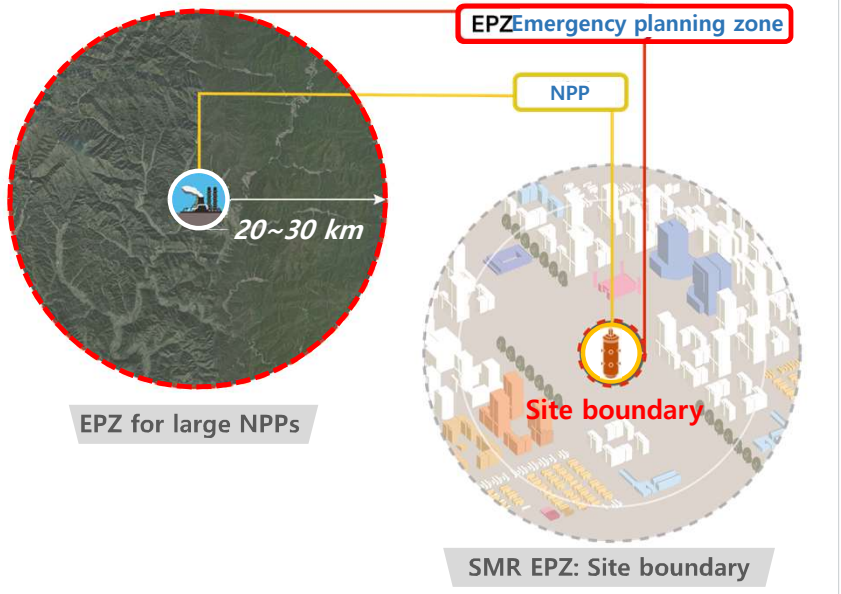
- Seismic Design 0.5g
- Underground reactor
- Seismic design of major equipment
- Aircraft crash protection

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



2-4 Design characteristics of i-SMR : Economics

Economics: Enhanced Economics by Simplification, Modularization, Standardization and application of Innovative technologies

Reduction in construction volume

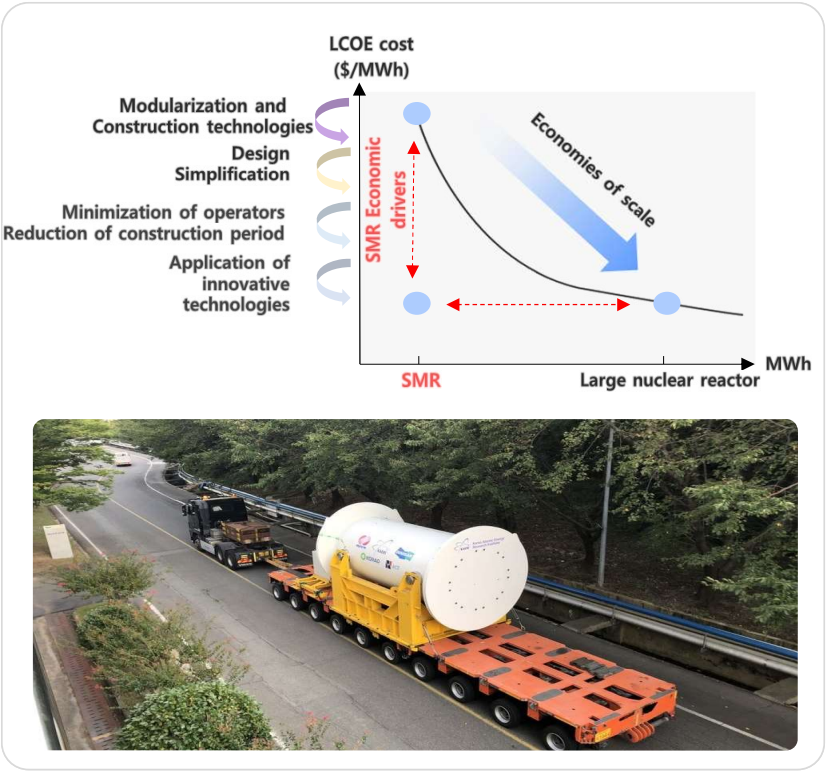
- Design simplification of system
- Multiple modules in a single reactor building

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



2-5 Design characteristics of i-SMR : Flexibility

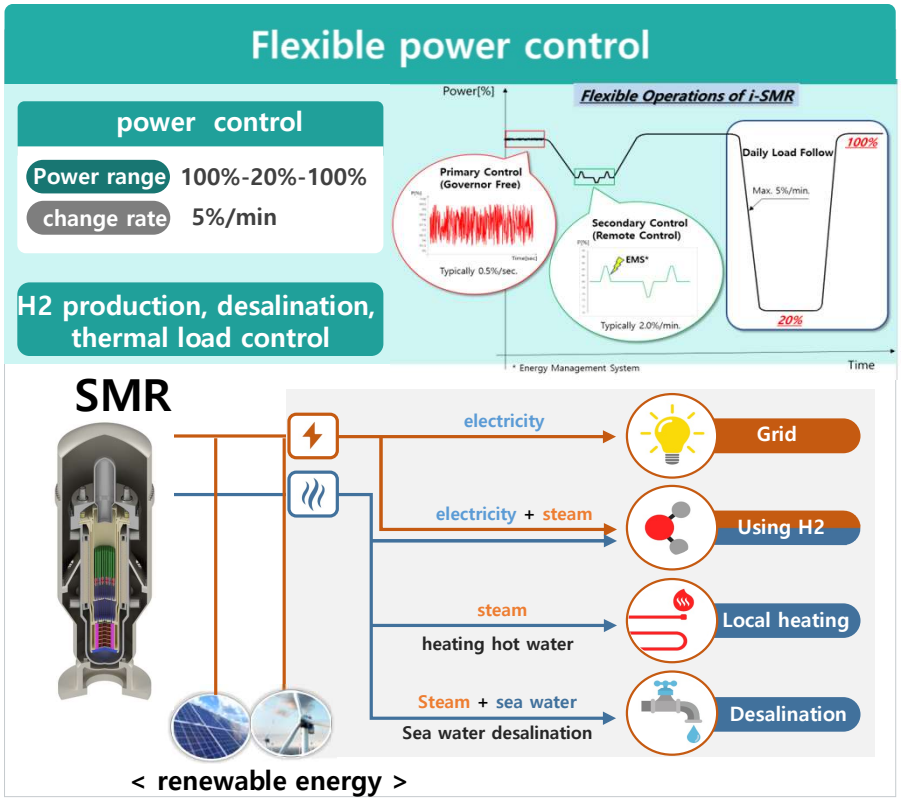
Flexibility: Flexible power control complements volatility of renewable energy

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



3-1 Development Status and Future Plans of i-SMR

☑ Target Goal : SDA approval by 2028, FOAK operation in 2031

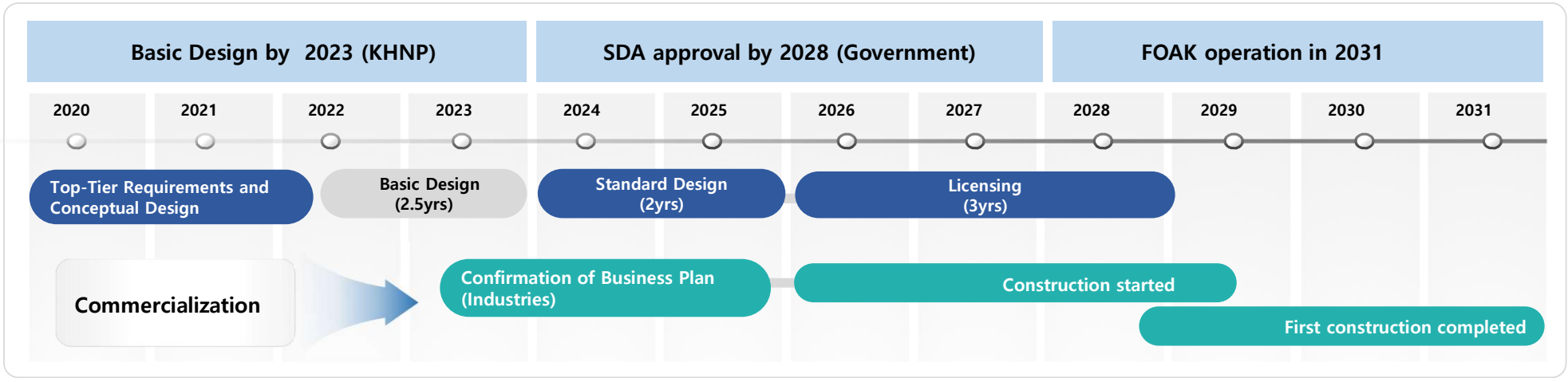
Preliminary Design led by KHNP

- 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

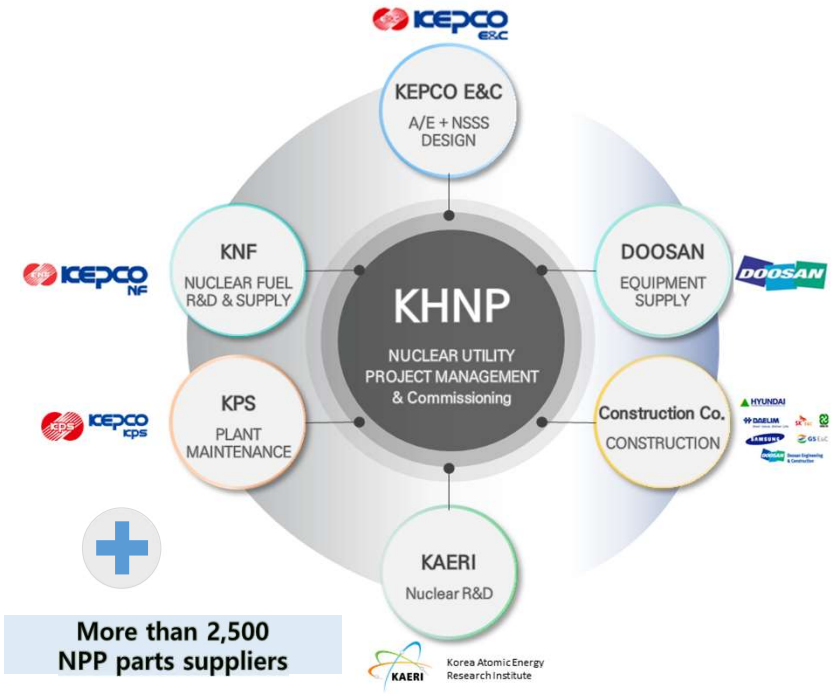
* MSIT : Ministry of Science and ICT / MOTIE : Ministry of Trade, Industry and Energy



3-2 Competitiveness of i-SMR

☑ **i-SMR boasts the highest competitiveness based on strong solidarity and experience of nuclear industry**

World's best value chain



More than 2,500 NPP parts suppliers

Proven global competence from 50 years of experience

APR 1400

Life	60 Years
Output	1,400MWe
Seismic	SSE 0.3g

EU - APR

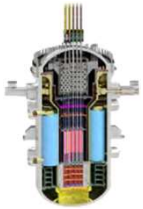
Life	60 Years
Output	1,400MWe
Seismic	SSE 0.25g

→ EUR certification 2017

US - APR

→ NRC Design Certification 2019

SMART



→ World`s 1st SDA approval SMR

Model (Country of development)	AP1000 (USA)		APR1400 (Korea)		EPR (France)	
Country in Construction (Start of construction)	China ('09~)	USA ('13~)	Korea ('08~)	UAE ('11~)	Finland ('05~)	France ('07~)
Capital cost ($/kWe)	3,154	8,600	2,410	3,275	5,723	8,620

Source: Projected Costs of Generating Electricity (NEA, 2020 Edition)

Since 1971 — 50 years → Total 34 Units by Korea

30 Units

4 Units

3-3 SMR Smart Net-Zero City (SSNC)

Sustainable energy innovation

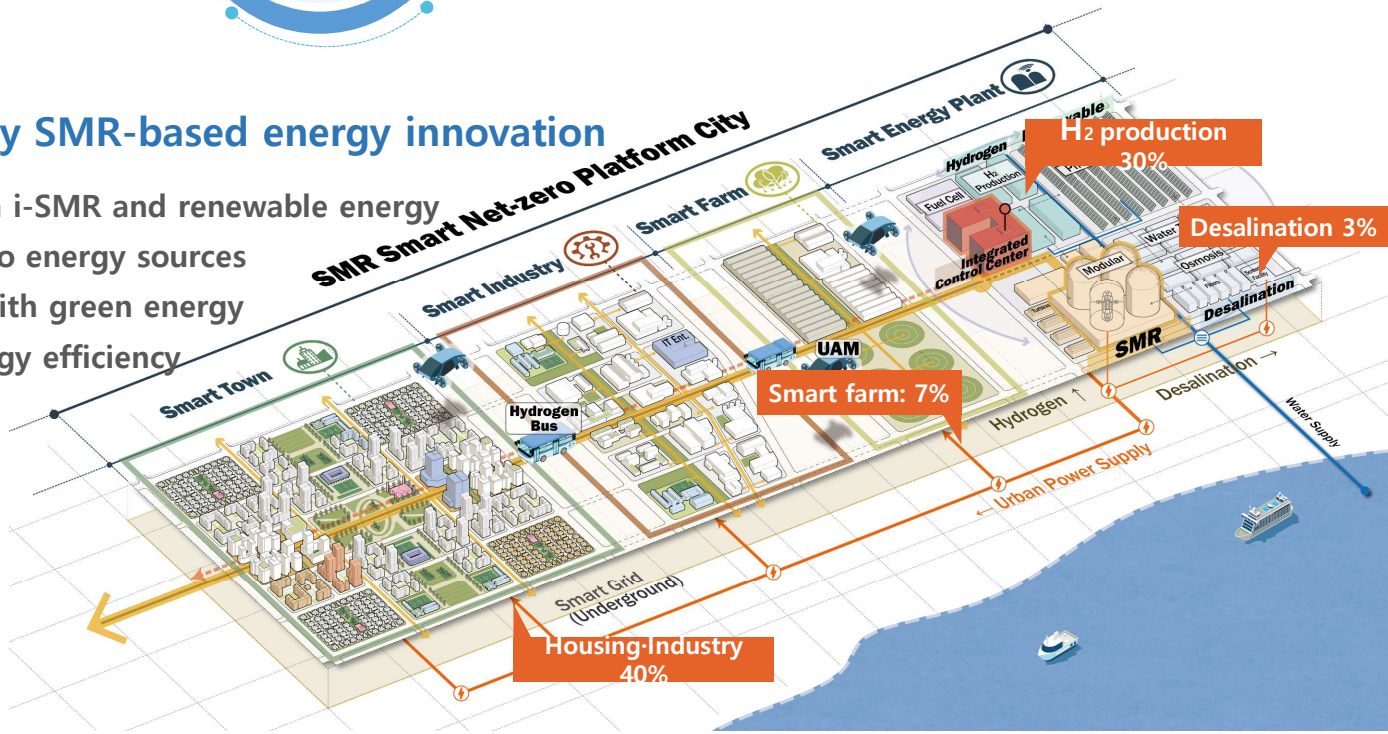
Energy innovation platform for carbon neutrality

SMR SMART NET ZERO CITY(SSNC)

Green energy-based city economy innovation

Net-Zero City Platform enabled by SMR-based energy innovation

- **Smart Energy Plant:** achieve Net-Zero with i-SMR and renewable energy
- **Smart Industry:** promote 4IR with Net-Zero energy sources
- **Smart Town:** build Net Zero smart town with green energy
- **Smart Control:** integrated control for energy efficiency



ALL in i-SMR,
i-SMR for ALL

ALL innovative technologies and components
are encapsulated in i-SMR,
i-SMR runs for ALL purposes to address climate crisis.