i-SMR

Innovative Small Modular Reactor

KHNP
KOREA HYDRO & NUCLEAR POWER CO., LTD

i-SMR

Overview

Design Characteristics

The i-SMR™ is a 170MWe integrated pressurized water reactor with enhanced safety, economy and flexibility compared to various SMRs around the world.

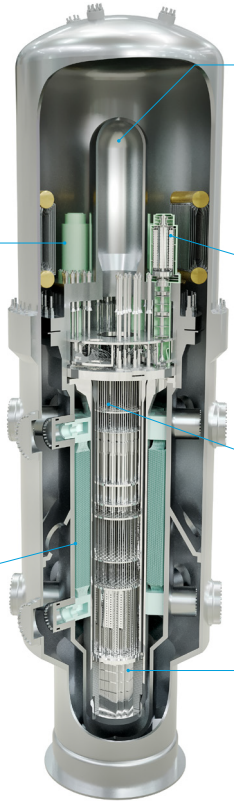
Modular Manufacturing and Installation

Canned Motor Pump

Removes the possibility of a RCP seal LOCA

Helical Type Steam Generator

Integrated SG within the RV minimizes space requirement and amplifies modular fabrication benefits



Integrated Reactor

Eliminates the possibility of a large break loss-of-coolant accident

PCCS Heat Exchanger

Maintains pressure and removes heat in containment vessel

In-Vessel CEDM

Removes the possibility of a control rod ejection accident

Boron-Free Reactor Core

Simplifies the system and alleviates maintenance burdens

Electric power	170 MWe (per Module)	Steam generator	Helical type
Total Electric power	680 MWe (4 Modules)	Reactor coolant pump	4 (per Module)
Fuel assembly	UO_2 17 x 17	Safety system	Fully passive
Core damage frequency	≤ 1.0e-9 / MY	DC power	Non-safety
Construction cost	≤ $3,500 / kWe	Design life	80 years
Neutron absorber	boron-free	Seismic design	0.5g
CEDM	In-vessel type	Construction time	24 months (Single Module)

R&D goals and key technologies

R&D Goals and Status

SAFETY GOALS

Core damage frequency ≤ 1.0e-9/MY
Radiation emergency planning area ≤ Site boundary

Safety system

- Integrated reactor excludes loss of coolant accidents
- Passive safety system design and natural circulation cooling

Beneath the reactor building

- Improved seismic design (0.2~0.3g → 0.5g)
- Enhanced radiation and physical protection against aircraft crashes

Reduced radioactive material leakage

- Lower probability of accidents and a sense of the magnitude of the impact of accidents
- Reduced radioactive material leakage with steel containment vessels aircraft crash

ECONOMIC GOALS

Construction costs ≤ $3,500/kWe
Generation costs ≤ $65/MWh

Significant reduction in construction volume

- Grid simplification and integrated deployment of multiple modules
- Shared auxiliary grids, equipment, etc.

Modularization and factory fabrication

- Modularization of reactor and mechanical systems
- Significant reduction of site work and construction time

Optimization of operating personnel

- An integrated main control room staffed by three operators (20 → 3 persons)
- Automated operation and operational support system

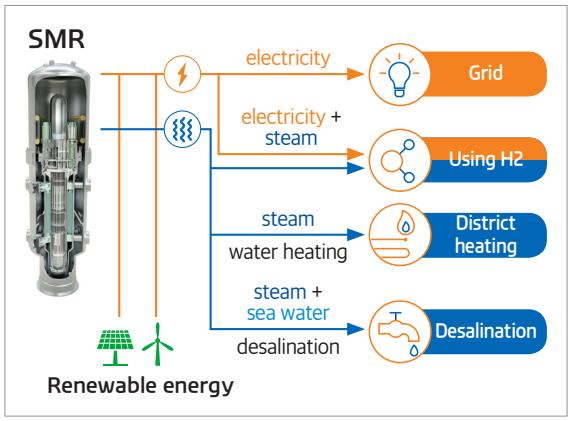
FLEXIBILITY GOALS | Versatile Applications(hydrogen, fresh water, heat production)
100%-20%-100% Load-following operation

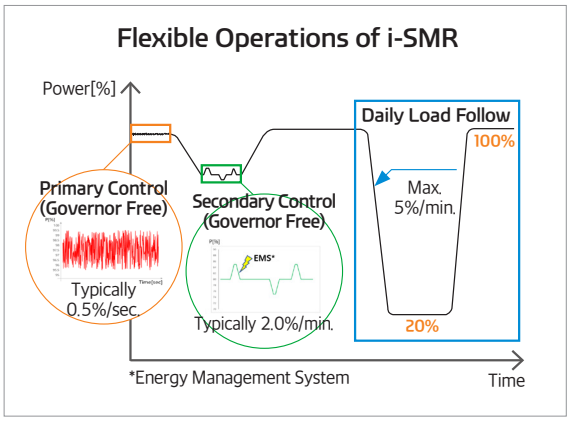
Versatile Applications

- Replacement of aged coal-fired power plants with decentralized power source
- Hydrogen production and process heat, residential heating supply, desalination, etc.

Load-following Operation

- Challenges with time-of-day demand-supply mismatches and grid loading amidst rising renewables
- The i-SMR offers load-following capabilities to mitigate the intermittency.





10 KEY TECHNOLOGIES OF THE i-SMR

Infinite cooling
Passive safety system that does not require operator action or external power supply

In-vessel CEDM
Eliminating the possibilityies of a control rod ejection accidents

Innovative nuclear fuel
A passive safety system that does not require operator action or external power supply

Modularization
Reducing construction time and enhancing economics

Predictive diagnosis
Boosting plant availability with improved O&M performance

Integrated control room
Reducing operational costs through multi-module integrated control technology

Innovative manufacturing technology
Optimizing manufacturing time with cutting-edge technologies such as EBW

Boron-free operation
Simplifying the system and lleviating maintenance burdens by eliminating the boron control system

Compatibility with renewable energy
Enabling flexible operation for compatibility with renewable energy

Automation
Enhancing operational automation levels

i-SMR Key Design Features

Design Characteristics

PCCS test facility

A nuclear reactor with a fully passive safety system

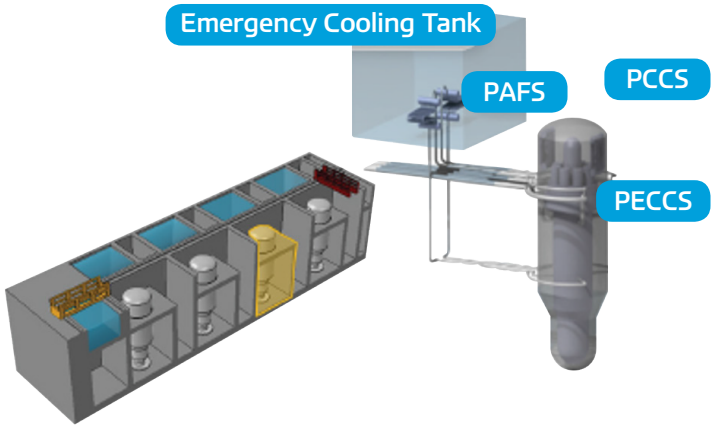
The i-SMR™ achieves inherent safety with a simplified design by applying passive safety systems using natural circulation.

- Under all accident conditions, including severe ones, the reactor can be safely shut down and maintain long-term cooling indefinitely without requiring operator intervention or external power supply.

Containment vessel facilitating easier maintenance

An i-SMR™ reactor module is installed and maintained in a dry reactor builing, thus removing problems associated with systems submersed during long-term power plant operation.

PAFS test facility



- The dry reactor building reduces operating delays and costs by eliminating the time-consuming process of charging and draining water for maintenance.
- The production costs of the containment vessel is reduced as material corrosion caused by cooling water is eliminated. This allows for the removal of the stainless steel cladding from the vessel.

Simplifying systems and enhancing O&M performance (boron-free operation)

Boron-free operation employed in the i-SMR™ can simplify chemical volume and control systems (CVCS) and improve O&M performance.

- The simplification leads to reduced system volume and components.
- Maintenance burdens are reduced due to the absence of equipment corrosion caused by boron.

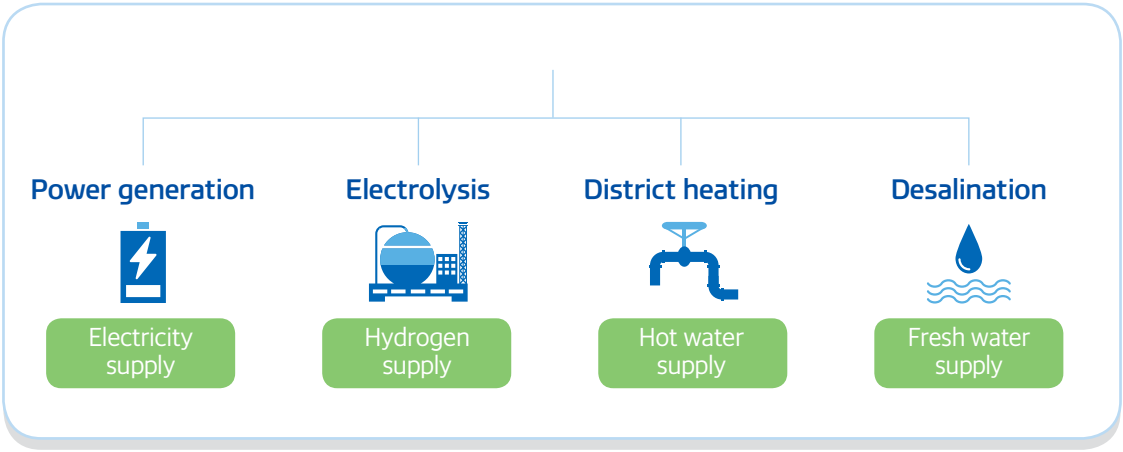
Economic efficiency comparable to large NPPs

The i-SMR boasts economic efficiency competitive with the existing legacy reactors.

- The completion of an i-SMR™ module takes 24 months, a timeframe shorter than that of large reactors. This efficiency is made possible by modularization of components and structures combined with innovative manufacturing technologies.
- Through simplified design and multi-module deployment, the unit cost for construction is less than $3,500/kWe, and the levelized cost estimate (LCOE) is estimated at $65/MWh.

Excellent compatibility with renewables and hybrid systems

The load following capabilities of i-SMR™ ensures stable supply of electricity by supplementing the intermittency of renewable energy such as solar, wind, and hydropower.

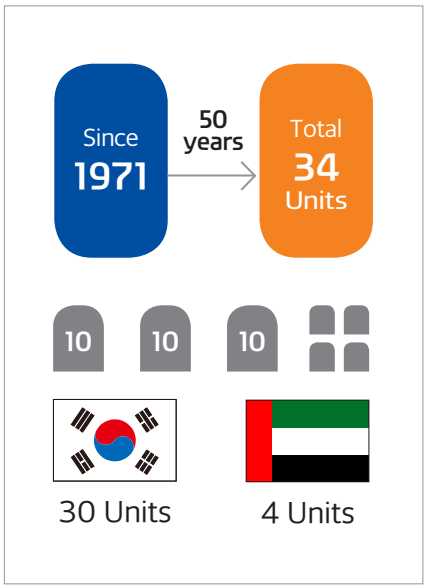


- In addition to power generation, i-SMR™ offers versatile applications such as near-demand district heating, desalination, and hydrogen production.
- The i-SMR™ can produce 680MWe (4 Modules) with its modular design and provide flexible power options from 170MWe (1 Module) to 1,360MWe (8 Modules).

KHNP's Business Capabilities

Competitiveness of Team Korea

- Since 1971, Korea Hydro & Nuclear Power has built and operated a total of 34 nuclear power plants (30 in Korea and 4 in the UAE).
- KHNP possesses the capability to spearhead the successful deployment of SMRs, aiming to enter the global market by 2030, solidifying its position as the core of the Korean nuclear ecosystem.



The Latest Proven Nuclear Technology

- In 2012, SMART achieved a significant milestone by acquiring world's first Standard Design Approval by the Korean regulator, thereby securing an original technology for SMRs.
- KHNP boasts top-notch nuclear technologies, excelling not only in reactor design but also in manufacturing and construction. This expertise has been validated through its extensive experience with both large and small reactors.

2011~

- World's first Standard Design Approval granted by the NSSC to SMART
- Completion of Shin-Kori #3
- EU-APR EUR Certification
- NRC Design Certification granted for APR1400
- Ground Breaking of Barakah #1
- MOU signed for SMART cooperation between ROK-Saudi KOR-Saudi

2021~

- Completion of Barakah #1 (Apr 2021) / #2 (Mar 2022) / #3 (Feb 2023), #4 completion expected by 2024

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