# Business case for BWRX-300

June 2022

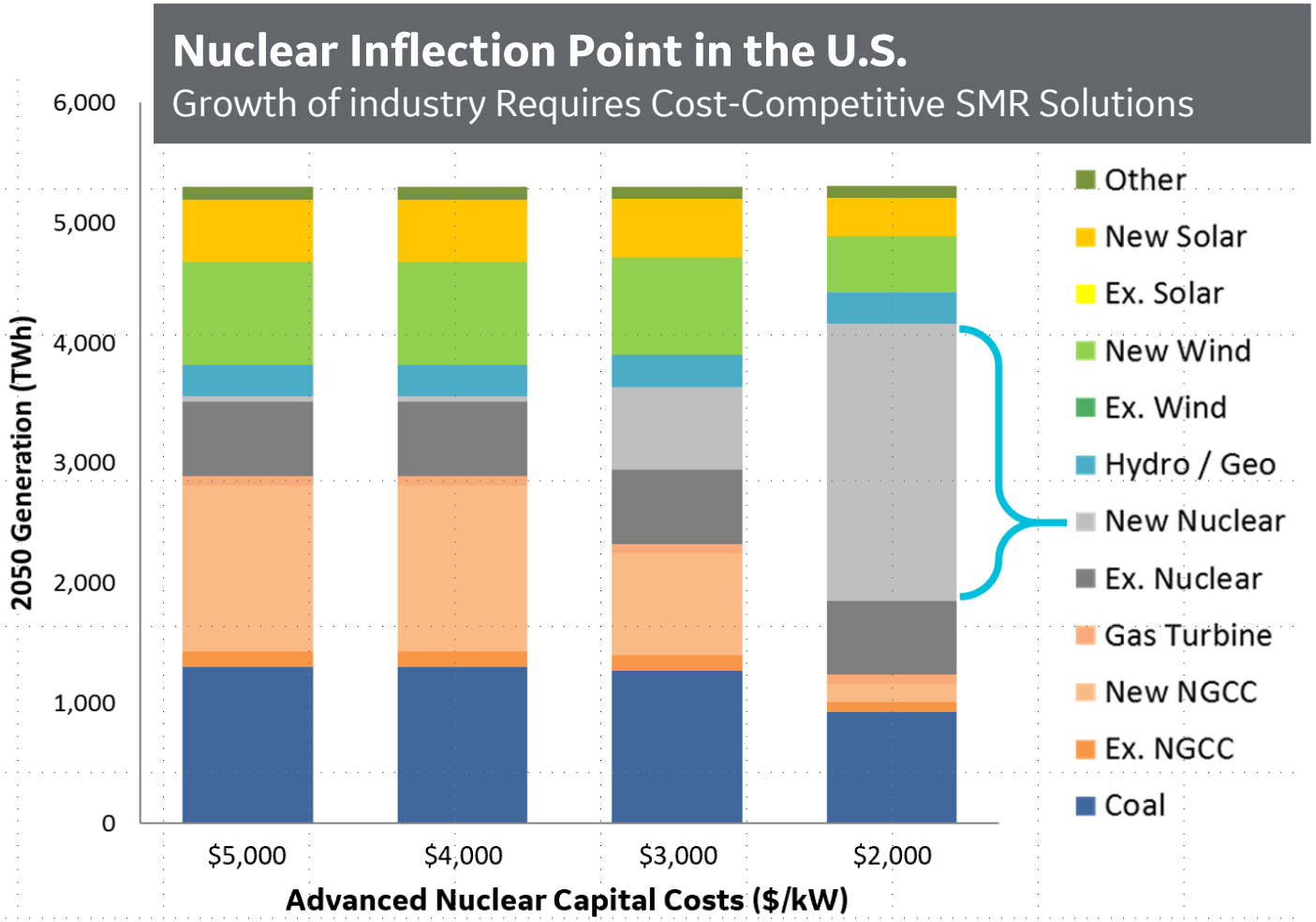
Fredrik Vitabäck

**GE Hitachi Nuclear Energy**

BWRX-300 Small Modular Reactor

*“Without cost reductions, nuclear energy will not play a significant role.”*

# Future of Nuclear – What is needed?




*Source: Figure 3.2 from EPRI Report 3002011803: Exploring the Role of Advanced Nuclear in Future Energy Markets*

EPRI ELECTRIC POWER RESEARCH INSTITUTE

**Exploring the Role of Advanced Nuclear in Future Energy Markets**

A combination of **reduced capital costs**, favorable policy conditions, and additional revenue streams for other services and products is more likely to create conditions under which significant new deployment of advanced nuclear reactor technology will occur.

MITei MIT Energy Initiative

**The Future of Nuclear Energy in a Carbon-Constrained World**

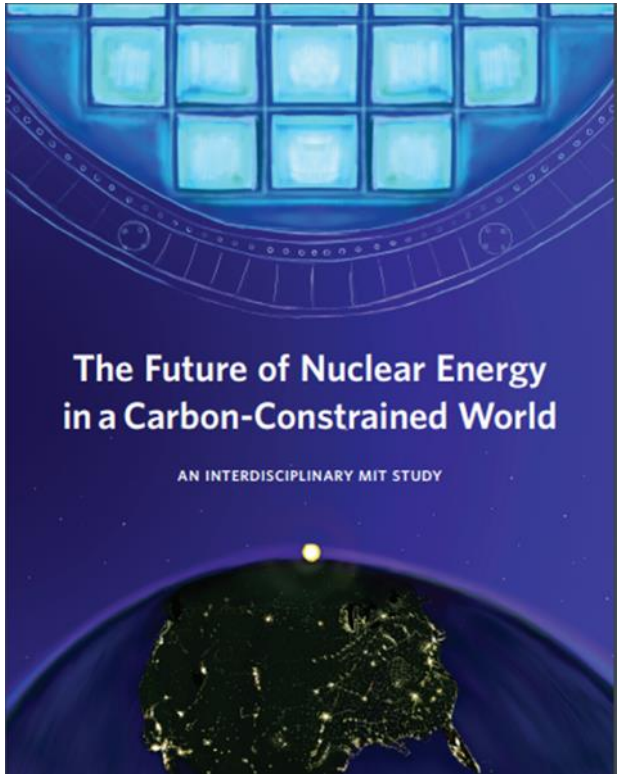
"Based on the findings that emerged from this study, we contend that, as of today and for decades to come, the main value of nuclear energy lies in its potential contribution to decarbonizing the power sector. Further, we conclude that **cost is the main barrier** to realizing this value. Without cost reductions, nuclear energy will not play a significant role."

**International Energy Agency**

**Nuclear Power in a Clean Energy System**

Support innovative new reactor designs: Accelerate innovation in new reactor designs, such as small modular reactors (SMRs), with **lower capital costs** and shorter lead times and technologies that improve the operating flexibility of nuclear power plants to facilitate the integration of growing wind and solar capacity into the electricity system.

# How Can Nuclear Be Economically Competitive?




http://energy.mit.edu/research/future-nuclear-energy-carbon-constrained-world/

*<u>Select findings to reduce cost</u>:*

- **Optimize** new reactor buildings and **structures** … both the amount of material and the amount of labor
- **Cost reduction** efforts need to be **focused on construction** improvements and processes
  - Standardization
  - Embedment
  - Modularization
- Successful nuclear builds have **proven supply chains** for NSSS

*Economy of many > Economy of scale*

[Rethinking Nuclear]

# Leveraging the history - evolution by innovation

## Proven success turning vision into commercial-scale reality, on time and on budget







OVER 80 YEARS OF NUCLEAR EXPERIENCE AND INNOVATION

| 1939 | 1955 | 1957 | 1962 | 1974 | 1986 | 1990 | 1996 | 2014 | 2017 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|
| First GE involvement in nuclear physics | GE Atomic Division established | Vallecitos BWR AEC License #1 | NPD achieves full power | 25th BWR Peach Bottom 3 | 50th BWR River Bend | Laguna Verde 1 | 1st ABWR built on time on budget | ESBWR NRC License | BWRX-300 launched | BWRX-300 down selected by OPG |

67 reactors licensed in 10 countries

# BWRX-300 Innovation

## Not reducing - enhancing

- 10th generation Boiling Water Reactor
- Continued World class safety
- Leverages U.S. NRC licensed ESBWR
- Design-to-cost approach
- Significant capital cost reduction per MW
- Capable of load following
- Ideal for electricity generation and industrial applications, including hydrogen production
- Small footprint
- Initiated licensing in the U.S. and Canada
- Operational as early as 2028

**MOST**
COMPETITIVE SMR

BWRX-300 Small Modular Reactor

**300 MW Water Cooled SMR**

Designed to Mitigate LOCA

Reduced Staff

$

Competitive LCOE

# Utilizing proven technology

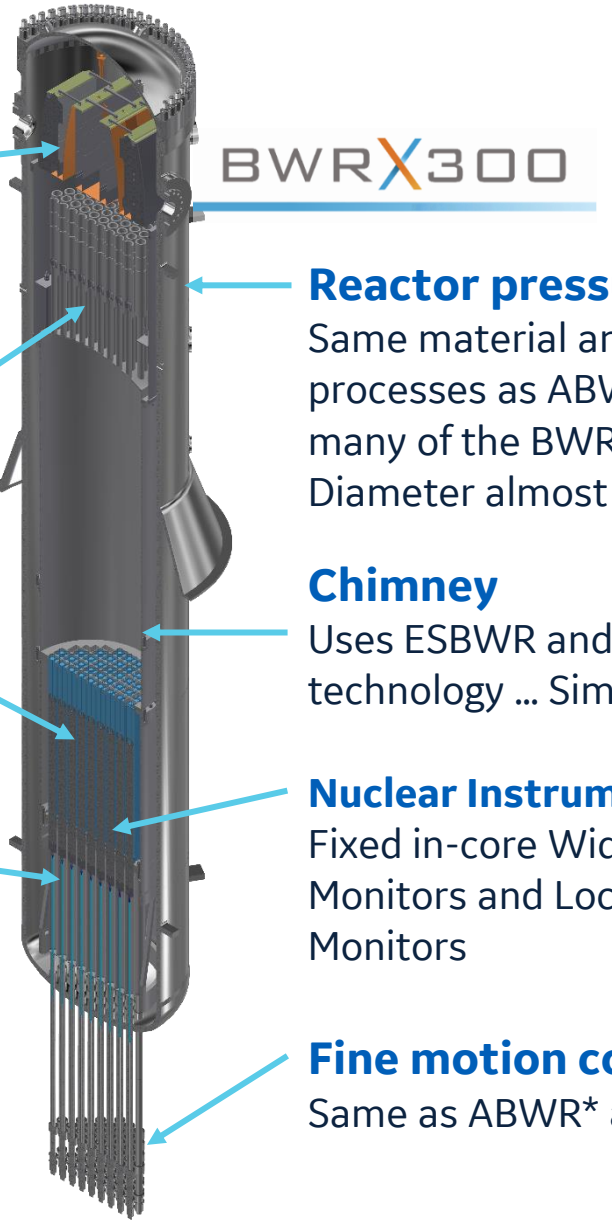
PROVEN COMPONENTS, PRIOR TESTING, AND OPERATIONAL HISTORY GREATLY ACCELERATE DEPLOYMENT

**Dryer**
Same features as ABWR* and ESBWR ...
Same as upgrades for existing fleet ...
Size nearly identical to KKM**

**Steam separators**
Same as ABWR* and ESBWR ...
Similar to the BWR fleet

**GNF2 fuel**
>19,000 bundles delivered ...
Utilized by ~70% of BWR fleet

**Control rod blades**
Same as ABWR* ...
Longer than ESBWR ...
Almost identical to latest design for BWR fleet




**Reactor pressure vessel**
Same material and fabrication processes as ABWR*, ESBWR and many of the BWR fleet ...
Diameter almost identical to KKM**

**Chimney**
Uses ESBWR and Dodewaard*** technology ... Simplified

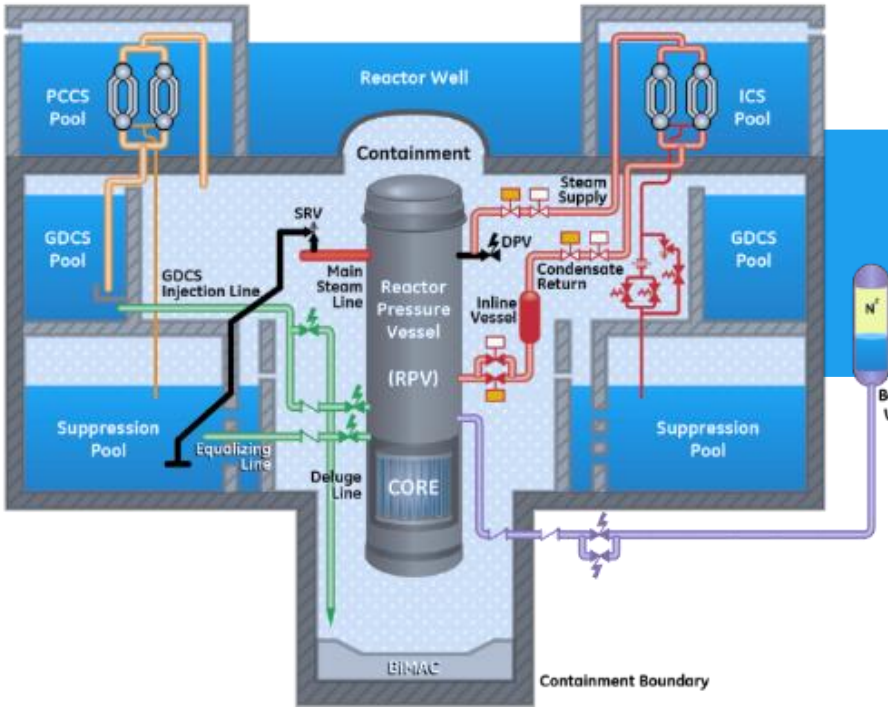
**Nuclear Instrumentation:**
Fixed in-core Wide Range Neutron Monitors and Local Power Range Monitors

**Fine motion control rod drives**
Same as ABWR* and ESBWR

* ABWR fleet has combined 22+ years of operating experience | ** Kernkraftwerk Mühleberg (KKM): 355 MWe BWR/4, 1972 ~ 2019 | *** Dodewaard: 58MWe natural circulation BWR, 1969 ~ 1997

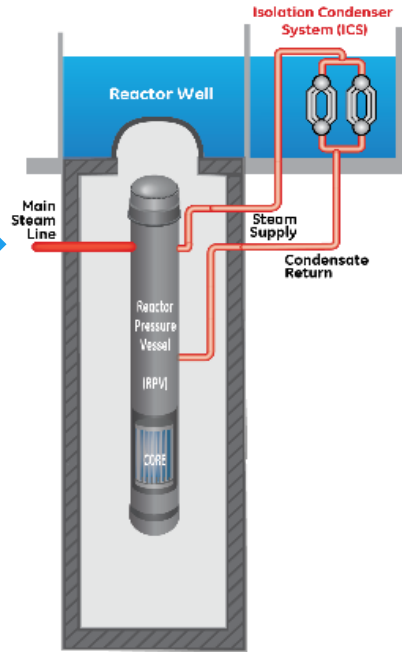
# The power of innovation

## ESBWR



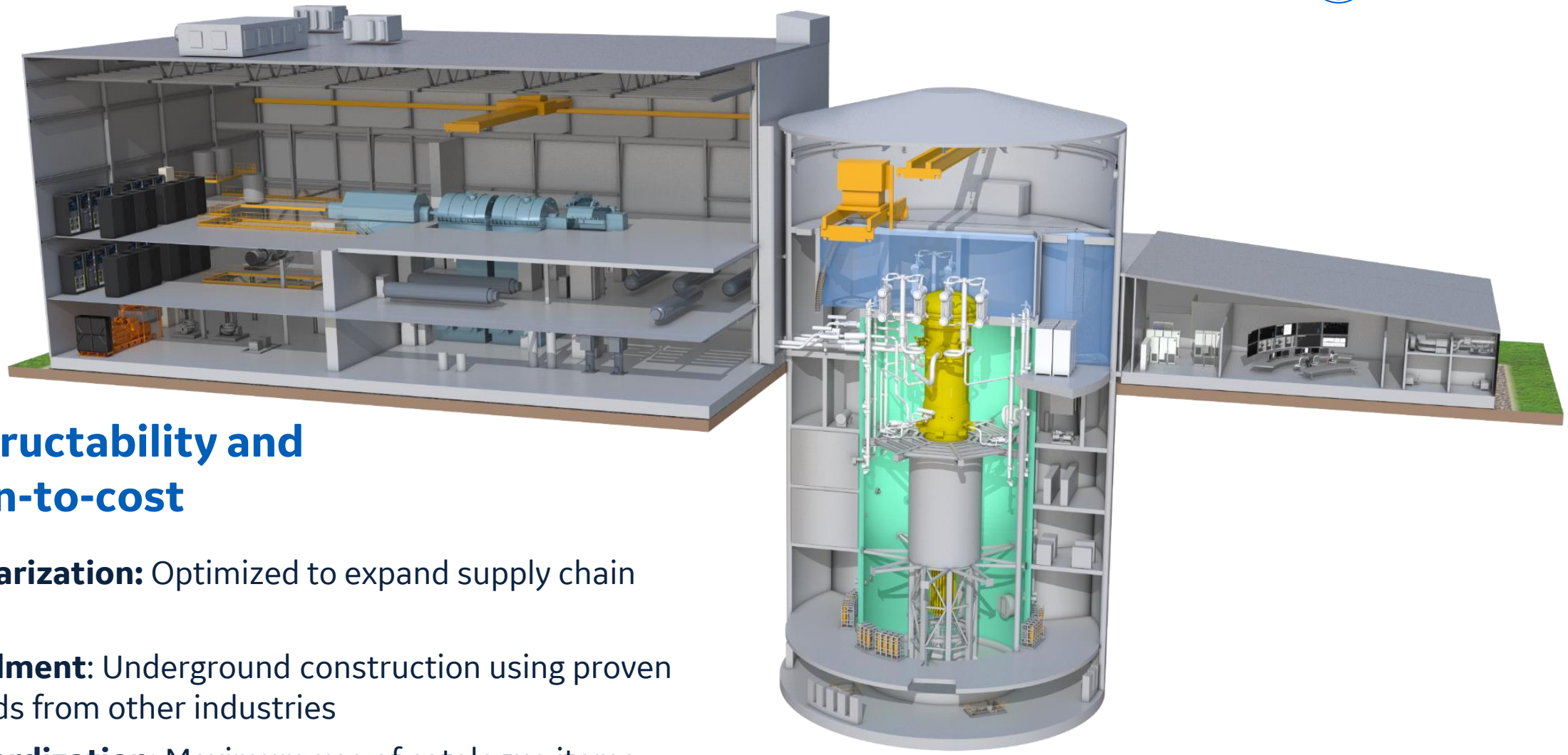

**90%** volume reduction

## BWRX300




**>50% building volume reduction/MW**
**>50% less concrete/MW**

# Optimized for cost and ease of construction



## Constructability and Design-to-cost

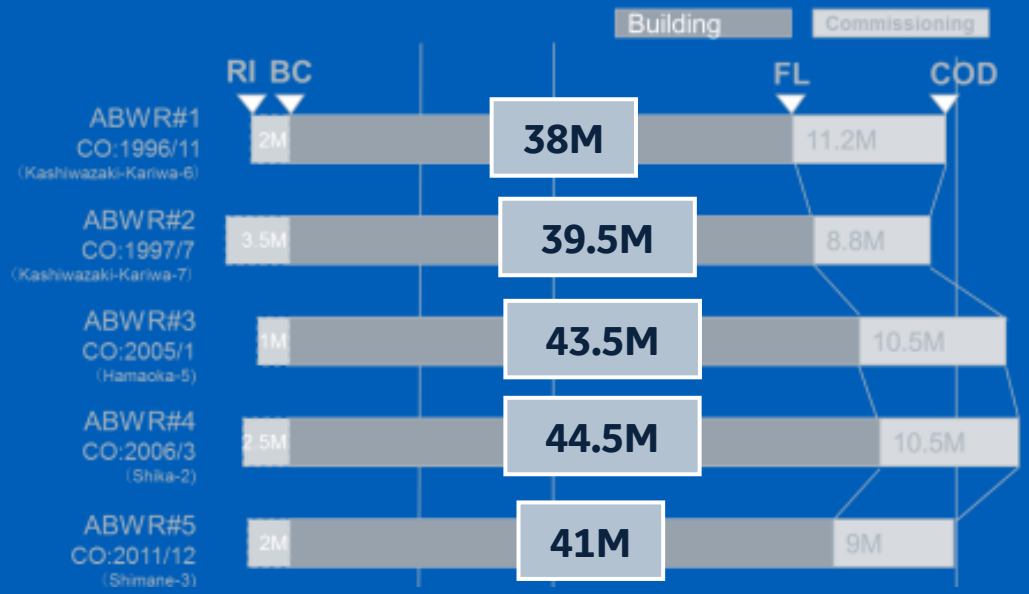
- **Modularization:** Optimized to expand supply chain locally
- **Embedment**: Underground construction using proven methods from other industries
- **Standardization**: Maximum use of catalogue items
- **Standardization** :“Off the shelf” turbine/generator

# Time to market

## Building on ABWR experience

**Kashiwazaki-Kariwa 6/7 ABWRs**

### Efficient, repeatable model




M - months

FIRST-OF-A-KIND GEN III PLANT BUILT ON 38-MONTH CONSTRUCTION SCHEDULE

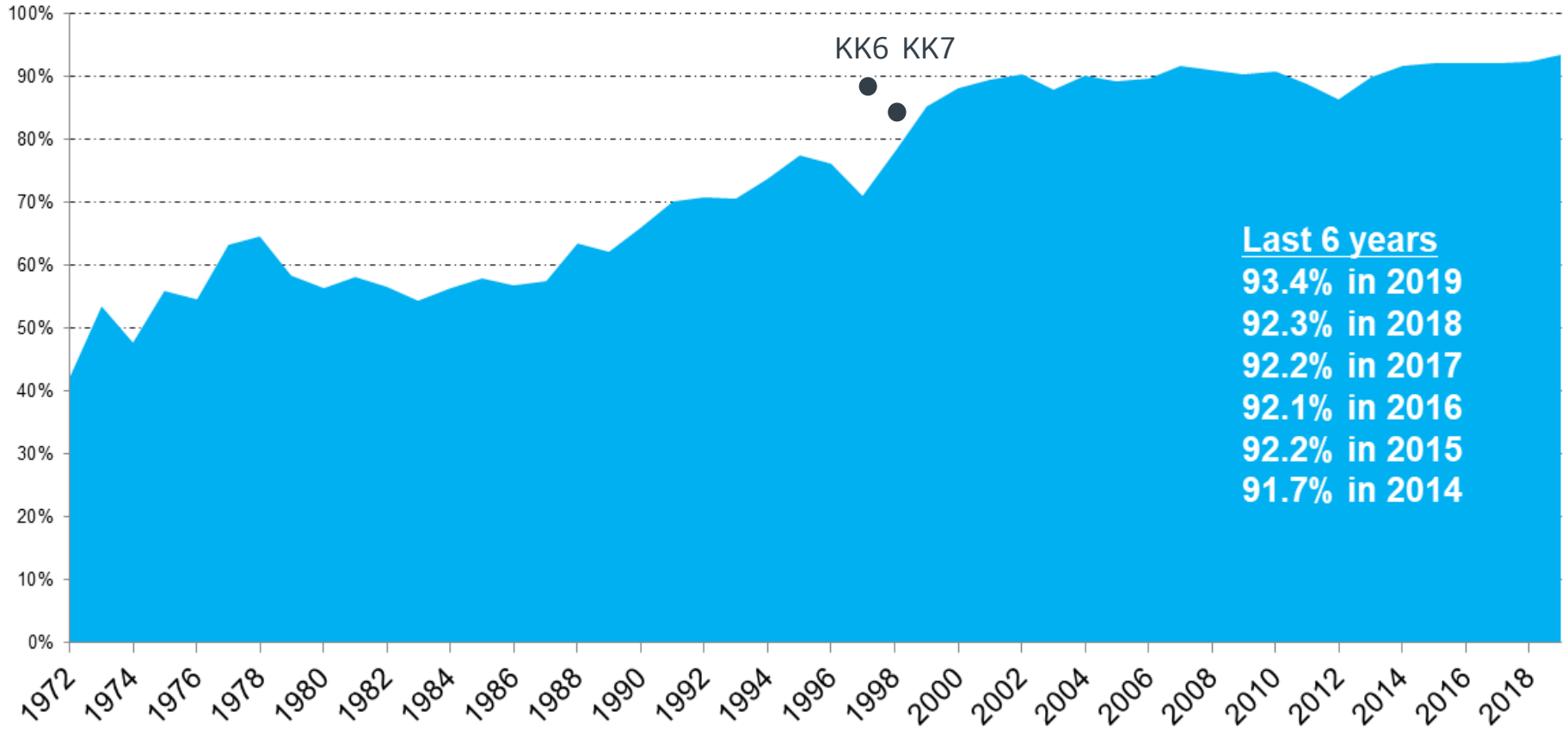
~1.2GWe/3year

*Proven technology + innovation + experience*

[Performance focus]

# Proven record in increasing reliability over evolutions

US fleet Capacity Factor (CF)




BWRX-300 designed to operate at the highest performance levels on Day 1 of operation, leveraging decades of learnings