1. Past BWR Development in Japan

- Step by step improvement of BWR plant technology since introducing a first commercial BWR plant in 1970
  - Pursuit of Scale Economics
  - Cost Reduction and Shorten Construction Period by Standardization and modularization
  - Improvement of Reliability and Safety
- Development of ABWR based on a lot of accumulated construction and operation experiences
  - Kashiwazaki-Kariwa Unit 6 and 7
- Continuous construction and improvement of ABWR
  - Shika -2 and Hamaoka-5 (under operation)
  - Shimane-3 and Ohma-1(under construction)
  - Higashidori-1 and UK (under planning)

HGNE's Construction Experience in Japan

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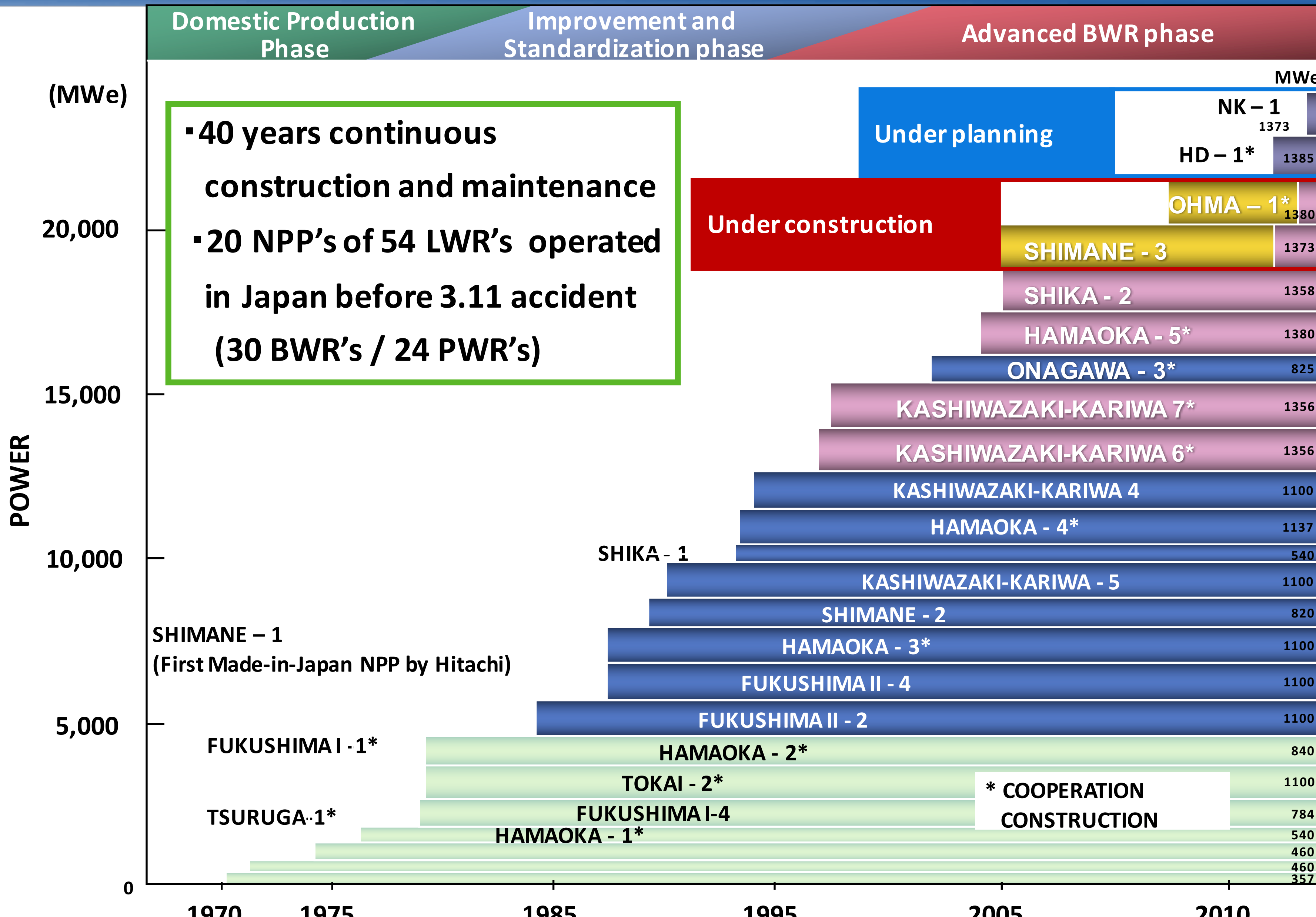
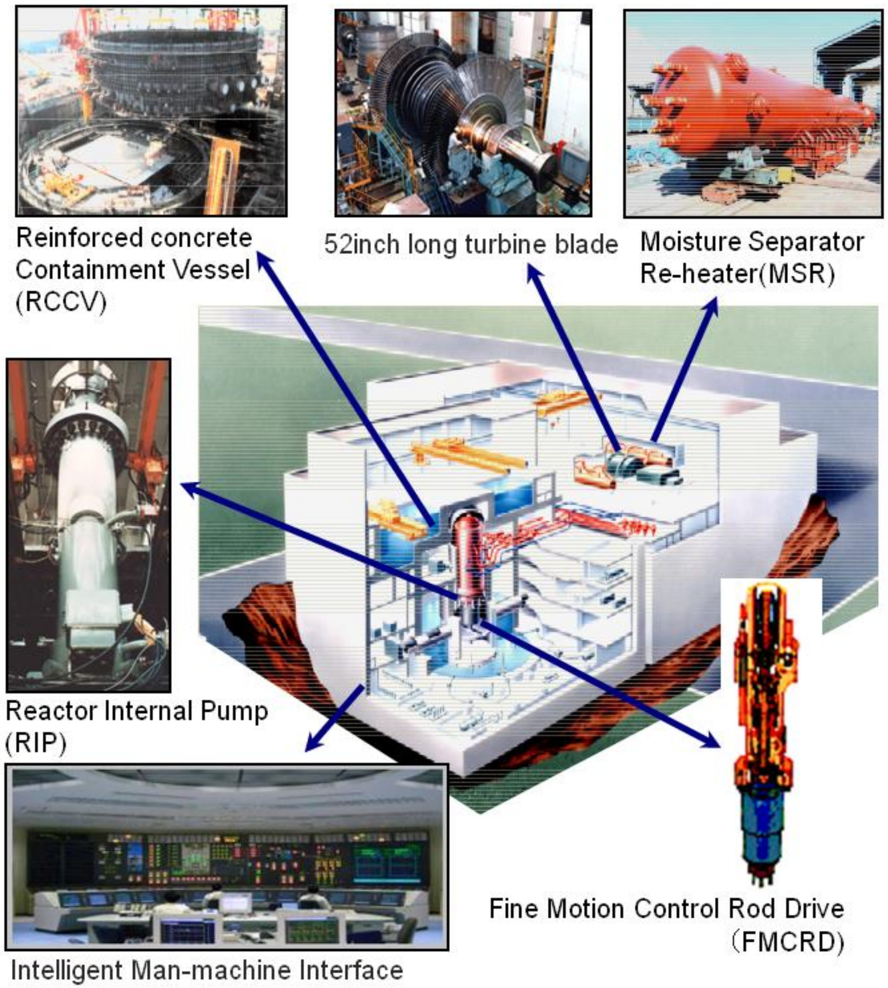


Major Features of ABWR



□Improvement of Safety

- Elimination of Large Pipe by RIP
- 3 Divisions ECCS Systems

□Improvement of Economy

- High Burn-up Fuel and High Flexibility Core
- Compact Containment and Reactor Building by RCCV
- Improvement of Thermal Efficiency by 52" Turbine and MSR

□Improvement of Operation

- Precise Power Control by FMCRD and RIP
- Intelligent of Man-machine Interface

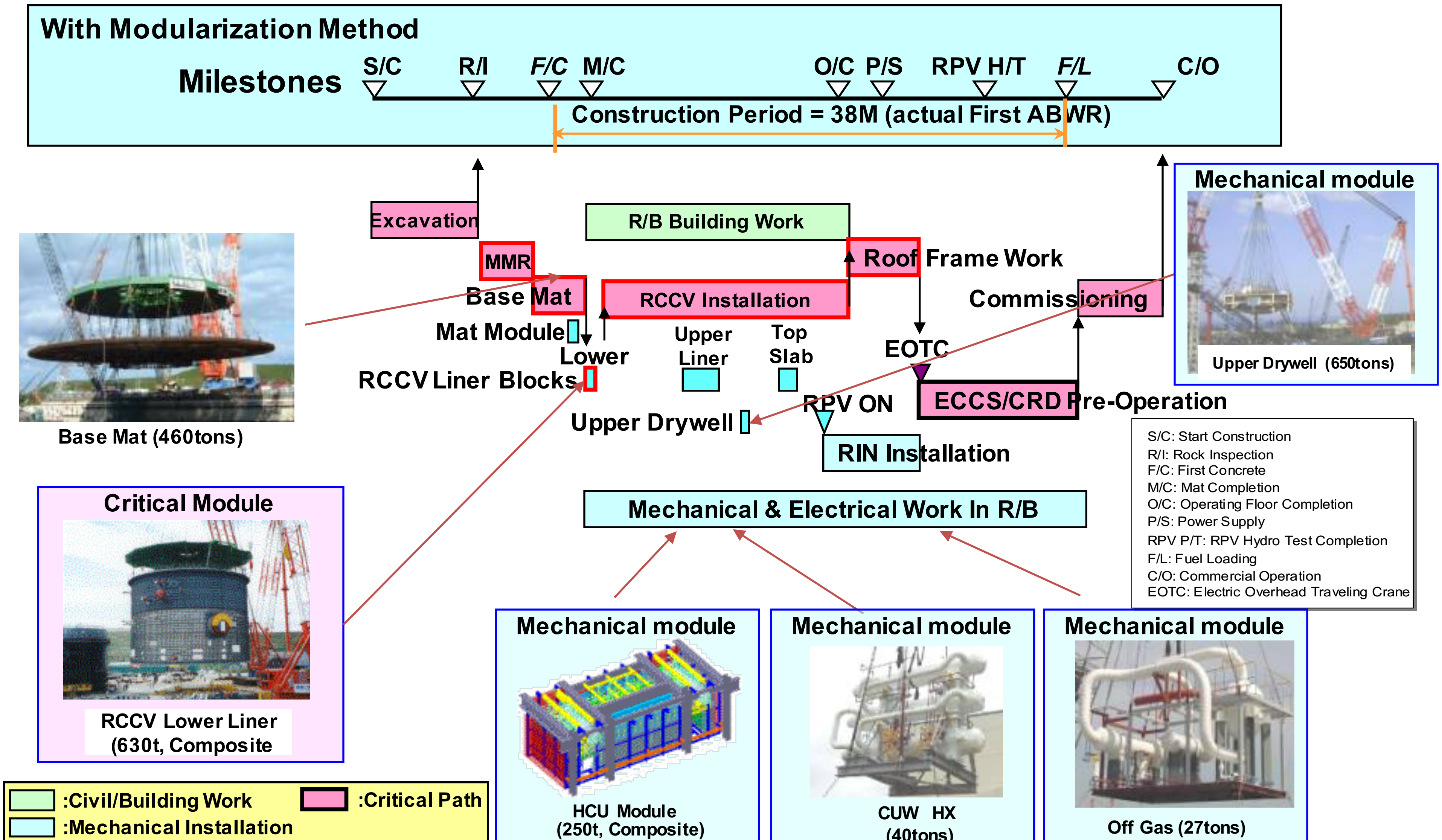
□Improvement of Maintenance

- Reduction of Worker Dose Rate and Radioactive Waste Material by RIP and Advanced technology of Material and Water Chemistry

□Improvement of Reliability

- Redundant Diverse System
- Digital Instrument and Control System

Modular Construction Standardization to shorten Schedule



Construction Experience

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Operating ABWRs

- Tokyo Electric Power CO.
  Kashiwazaki-Kariwa-6/7 (1996/1997)
  (H/G/T Joint Construction)

- Chubu Electric Power CO.
  Hamaoka-5 (2005)
  (BOP)

- Hokuriku Electric Power CO.
  Shika-2 (2006)
  (NSSS and BOP)

ABWR Projects under construction

- Taiwan Power Company
  Lungmen units #1 & #2

- Chugoku Electric Power CO.
  Shimane-3

- J-Power Ohma
  Full MOX ABWR

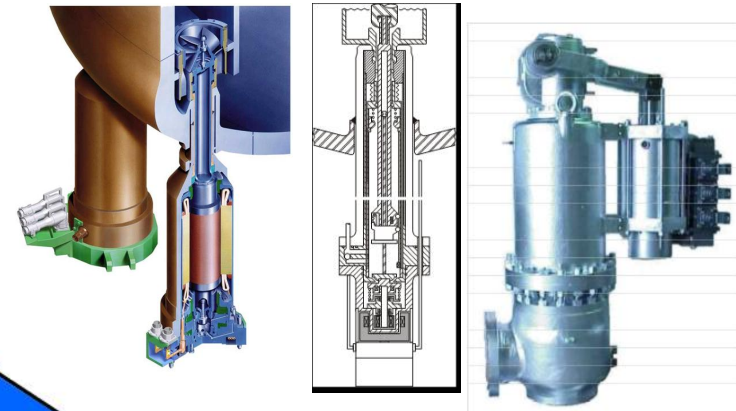
- Tokyo Electric Power CO.
  Higashidori-1

NSSS: Nuclear Steam Supply System BOP: Balance of Plant MOX: Mixed-Oxide Fuel

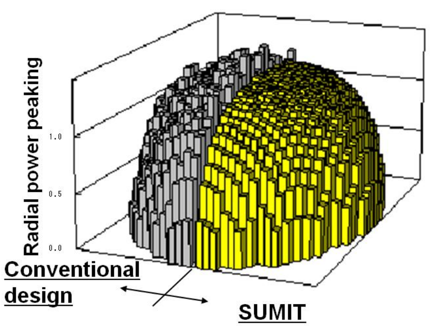
Improvement and Evolution of ABWR

Always evolving ABWR technologies incorporating various customer requirements, site conditions and improvements from earlier plant experience and technological advancements.

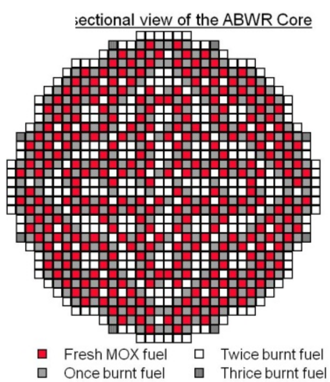
1990
1995
2000
2005
2010
2015
・KK-6&7
First Standardized Design.
・Hamaoka-5
First 60Hz Turbine- Generator
・Shika-2
High Seismic Requirement
High Performance Initial Core Design
・Shimane-3
Rationalization of NSSS
・Ohma-1
Full MOX ABWR
・UK-ABWR
Fukushima Countermeasure



Improved Equipments



High Performance Initial Core



Full MOX Core

Development Strategy of Future BWRs in HGNE

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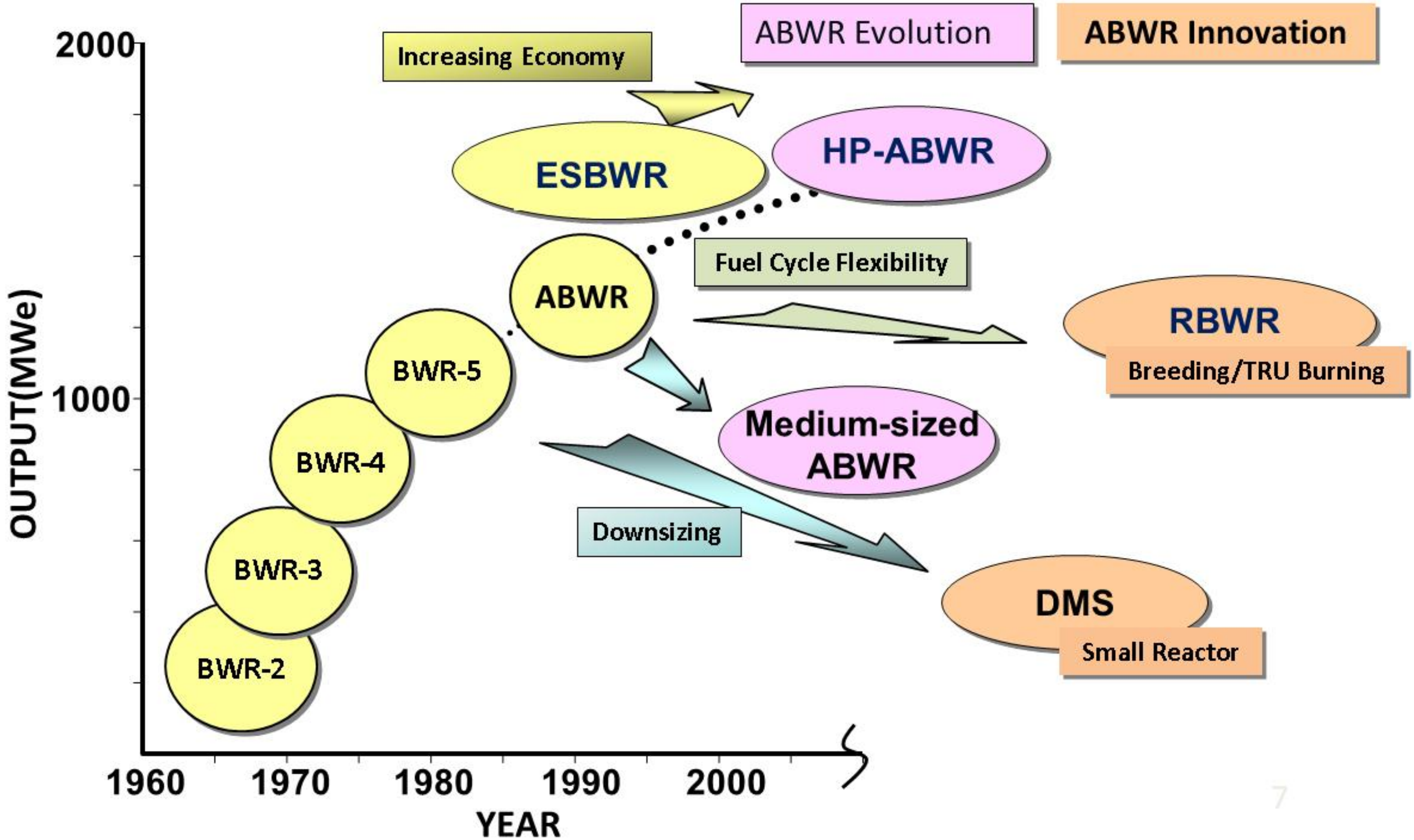
■ Our basic strategy of future reactor development is to utilize the good experiences learned in the ABWR development.

■Our development strategy is composed of two approaches, “Evolution of ABWR design” and “ Innovation of ABWR design”.

- ◆ The evolution of ABWR is to expand the ABWR plant design to various needs and requirements such as downsizing or globalization.
- ◆ The innovation of ABWR design is to apply the innovative technologies to break through the limit of ABWR design concept.

Development Strategy of Future BWR

Not only "Economy of scale", but also "Simplification of System" to meet a variety of customer needs

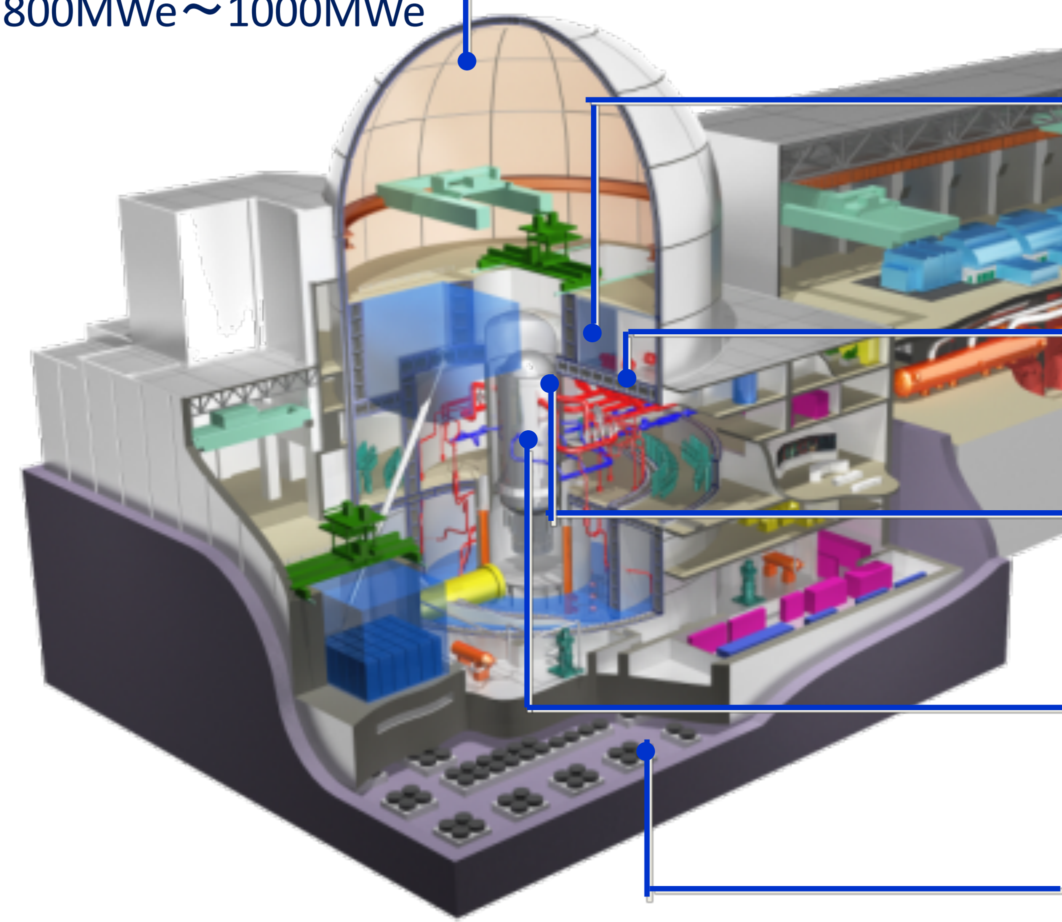


HP-ABWR

HITACHI

HP-ABWR
high performance ABWR

1800MWe～1000MWe



Stronger reactor building
- withstands aircraft crashes

Heat sink diversity and hybrid safety system
- increase safety margin under severe accidents

SC structure containment vessel
- enhances safety margin and shortens construction period

Advanced materials for major components
- realize 80-year plant life

Longer operation cycle, higher burn-up and innovative spectrum shift rods
- realize lower power generation costs

Seismic isolation technology
- ensures safety against earthquakes

Medium-sized ABWR

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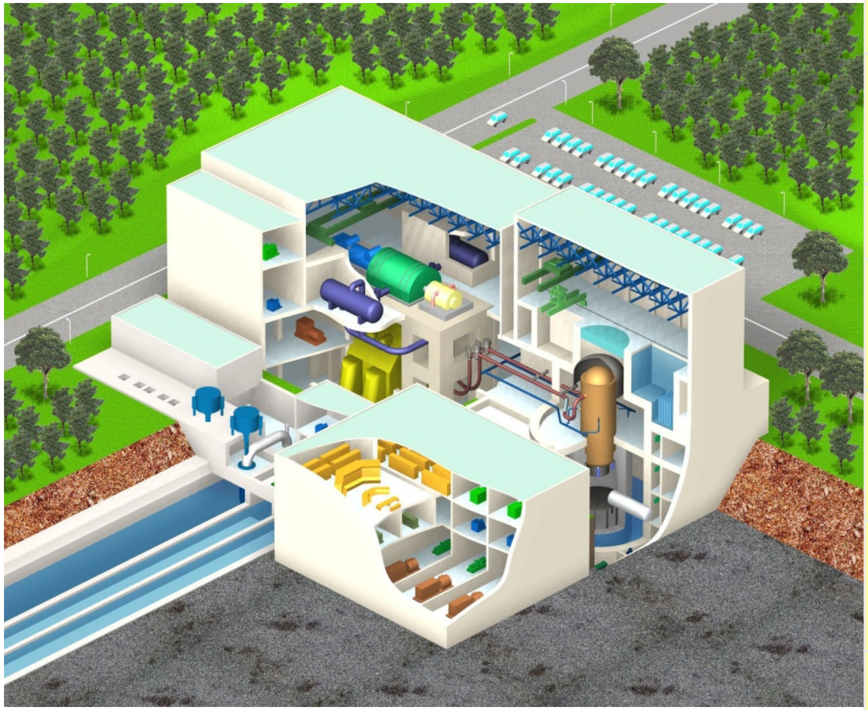
- ***Utilizing ABWR Design***
  for superior experiences in construction & operation
- ***Utilizing Conventional Equipment such as Standard BWR Fuel***
  for minimizing R&D
- ***Utilizing the Large Components Developed for Large Size Reactor***
  for minimizing the system and the amount of equipment



Parameter	ABWR-600	ABWR
Electrical Power	**650 MWe**	1356 MWe
Fuel Bundles	**376**	872
Power Density (kW/l)	**55.6**	50.6
Main Steam Lines	**700A x2 lines**	700A x4 line
RIPs* (number)	**4**	10
Safety system	**4 active**	6 active

*) RIPs: Reactor Internal Pumps

Innovative Small BWR (DMS)

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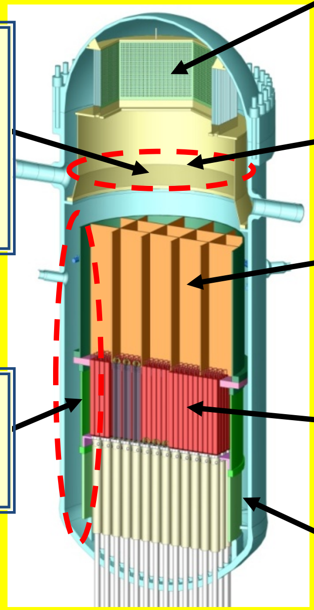
- Designed by using almost proven technologies utilized in ABWR.
- Overcomes scale disadvantage by simplification of system.

Simple and compact RPV

Technologies

Free Surface Separation (FSS)
DMS can separate steam from water by gravity force

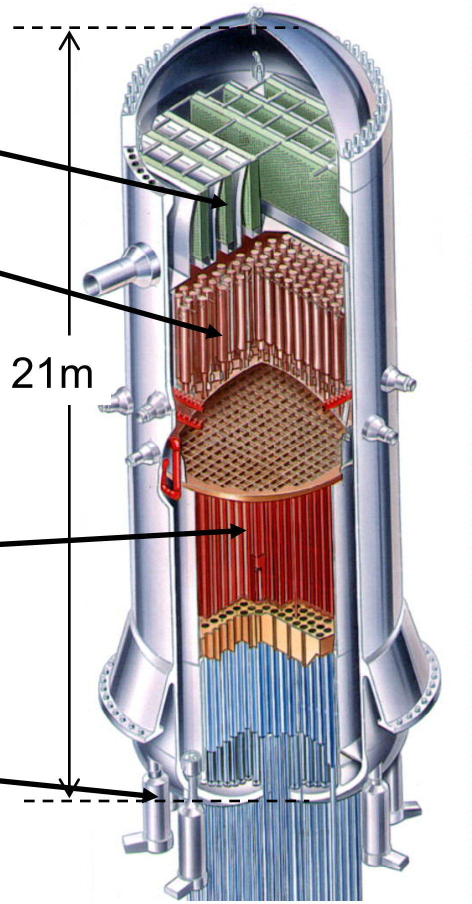
Natural Circulation
No reactor internal pumps (RIPs)



DMS(<428MWe)

Equipment

Equipment
Dryer
Separators → **Eliminated**
Chimney
Fuels → **Short length** fuels
RIPs → **Eliminated**



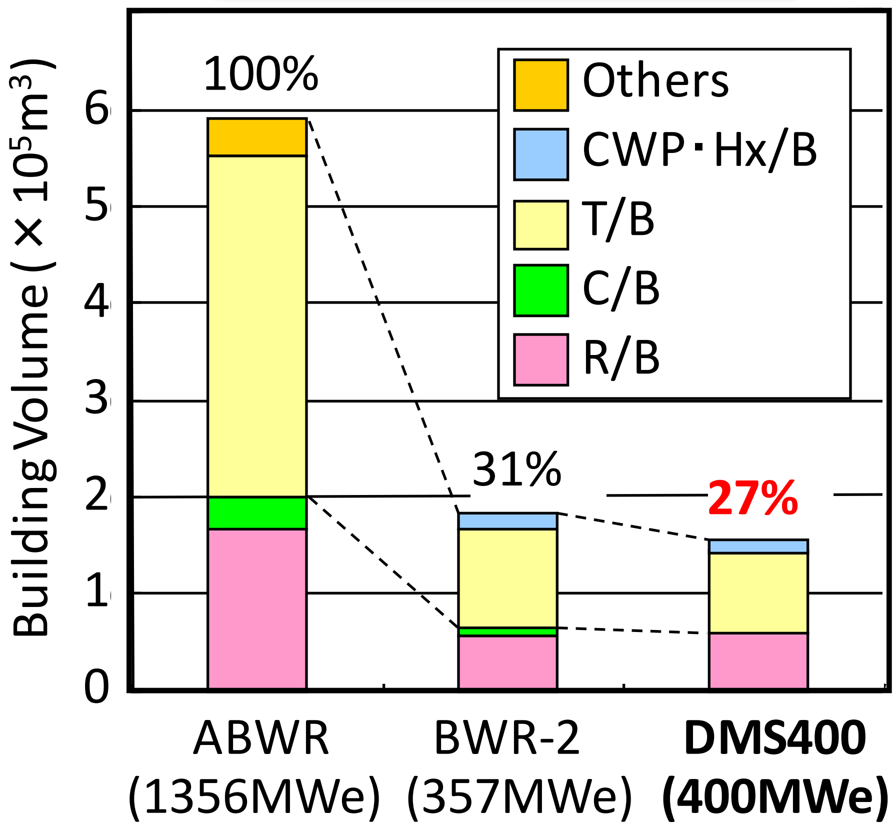
ABWR(1356MWe)

DMS: Double MS (Modular Simplified & Medium Small) Reactor

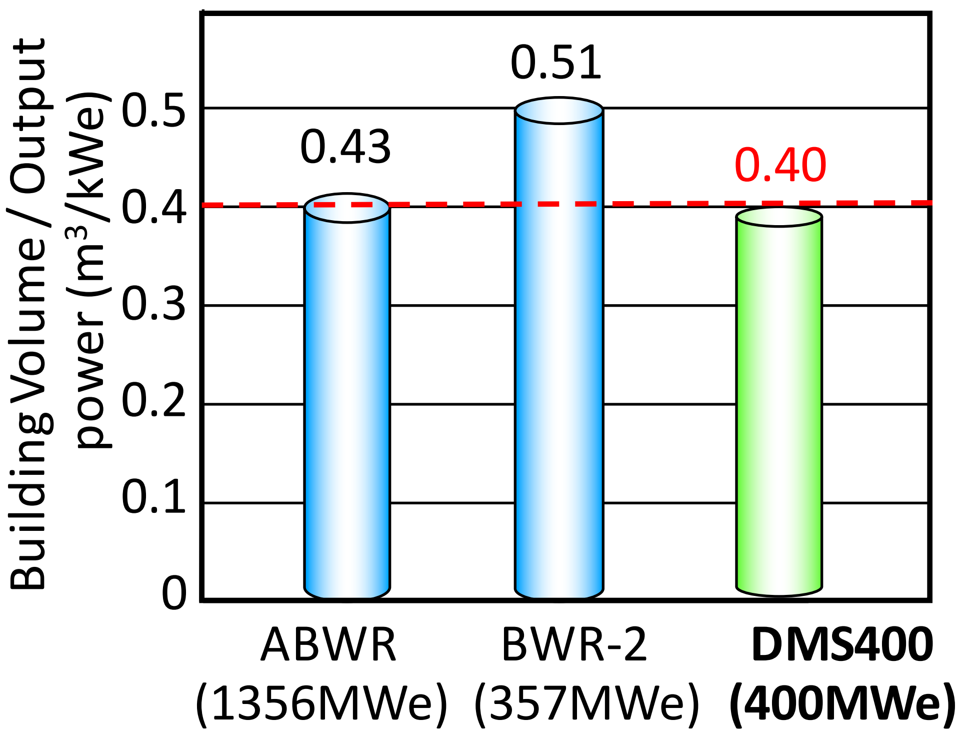
Cost Reduction Estimation in DMS

■ Building volume per unit power of the DMS400 (400MWe class) is almost the same as ABWR.

Building volume



Building volume / Output power



CWP･Hx/B: CWP･Hx building, CWP: Circulating water pump, Hx: Heat exchanger,
T/B: Turbine building,C/B: Control building, R/B: Reactor building

Multi- purpose Thermal Utilization System in DMS

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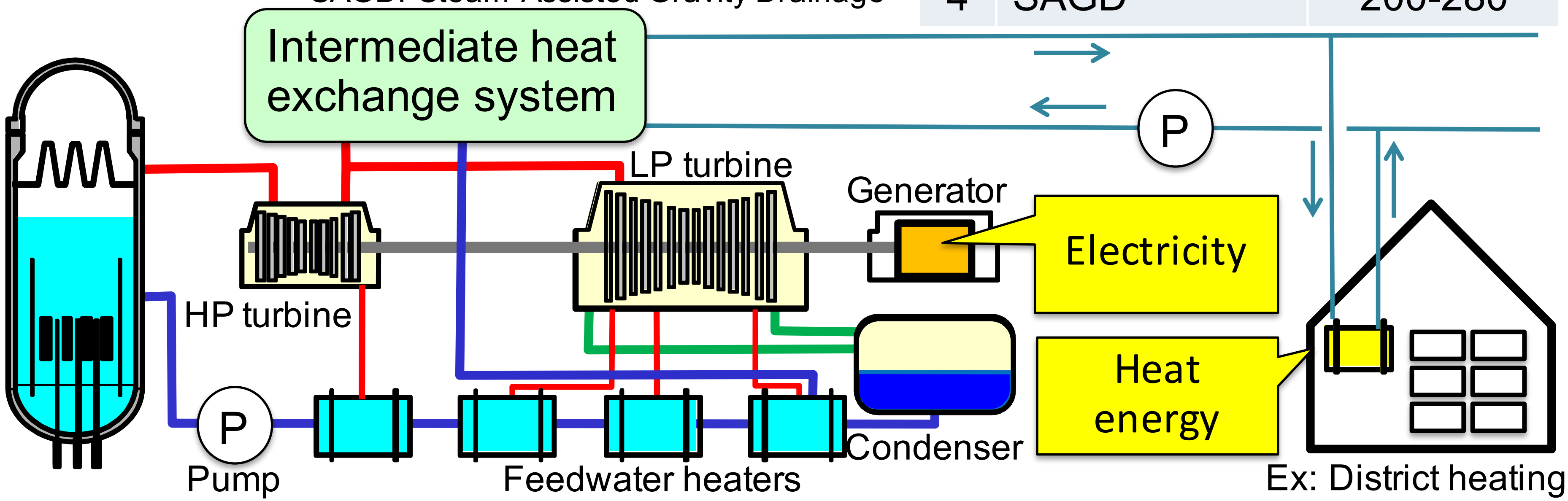
Hitachi-GE, Hitachi, and the University of Saskatchewan in Canada have collaborated on a joint R&D initiative.

Thermal utilization (TU), intermediate heat exchange, and BOP systems is being studied on the basis of Saskatchewan needs.

These study results can be applied in other locations around the world having similar TU application needs.

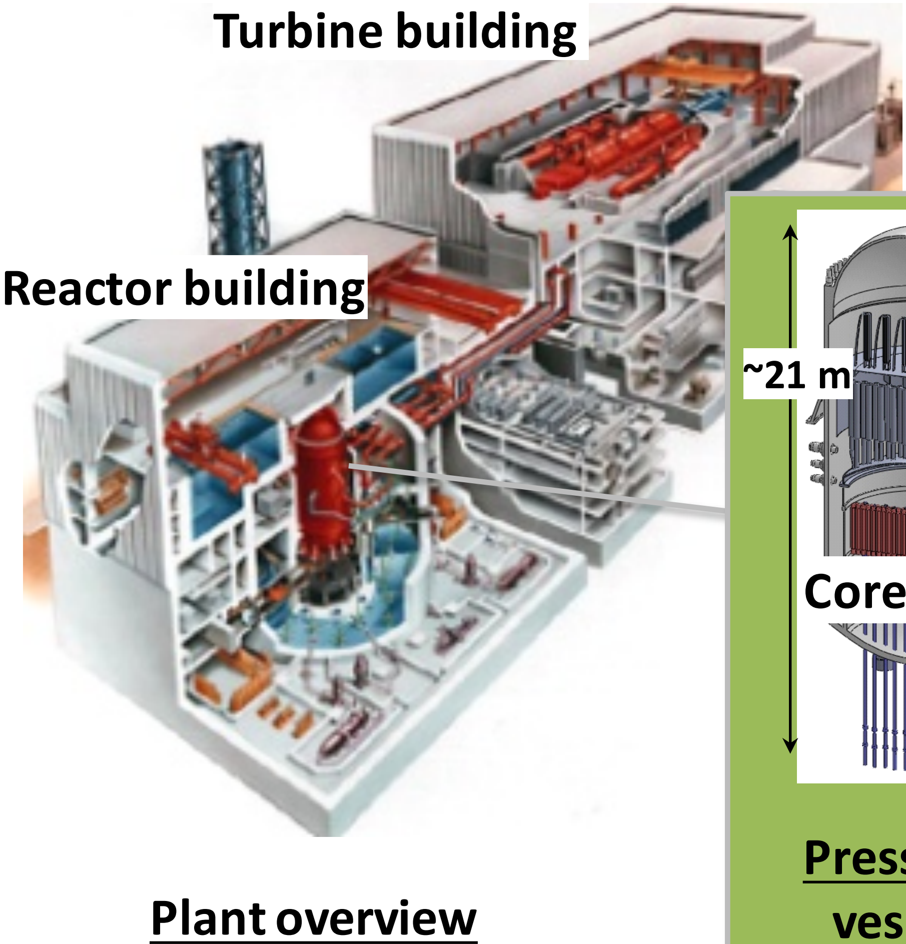
	TU Application	Temp. (°C)
1	Greenhouse	<100
2	District heating	100-200
3	Desalination	
4	SAGD*	200-280

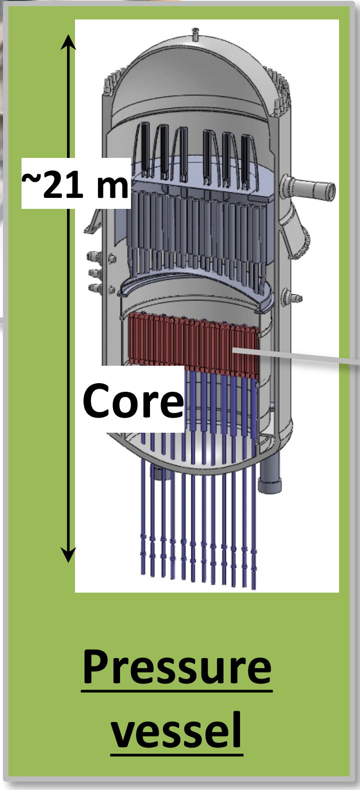
SAGD: Steam-Assisted Gravity Drainage

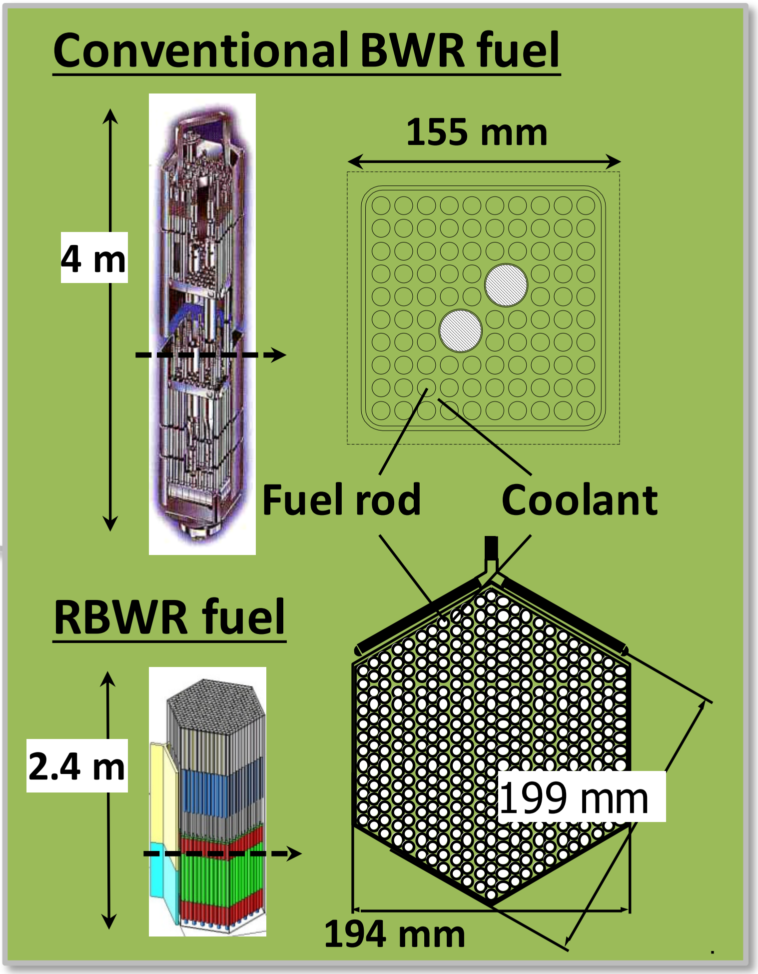


Development of RBWR

- RBWR is developed for Pu Breeding or for TRU burning by optimizing fuel configuration.
- Safety system, BOP, etc. are almost same as conventional BWR.







Feature: inherent safety

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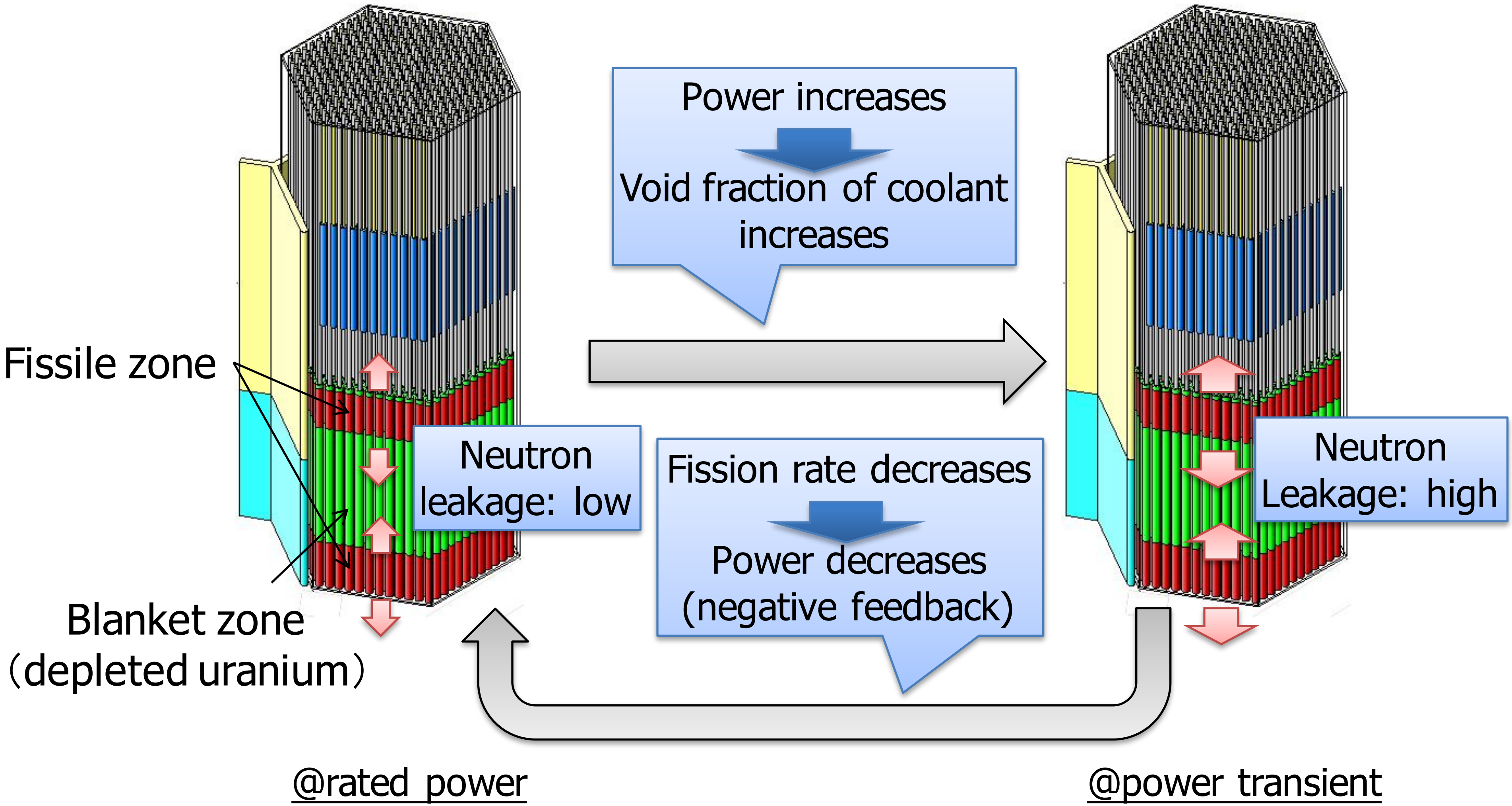
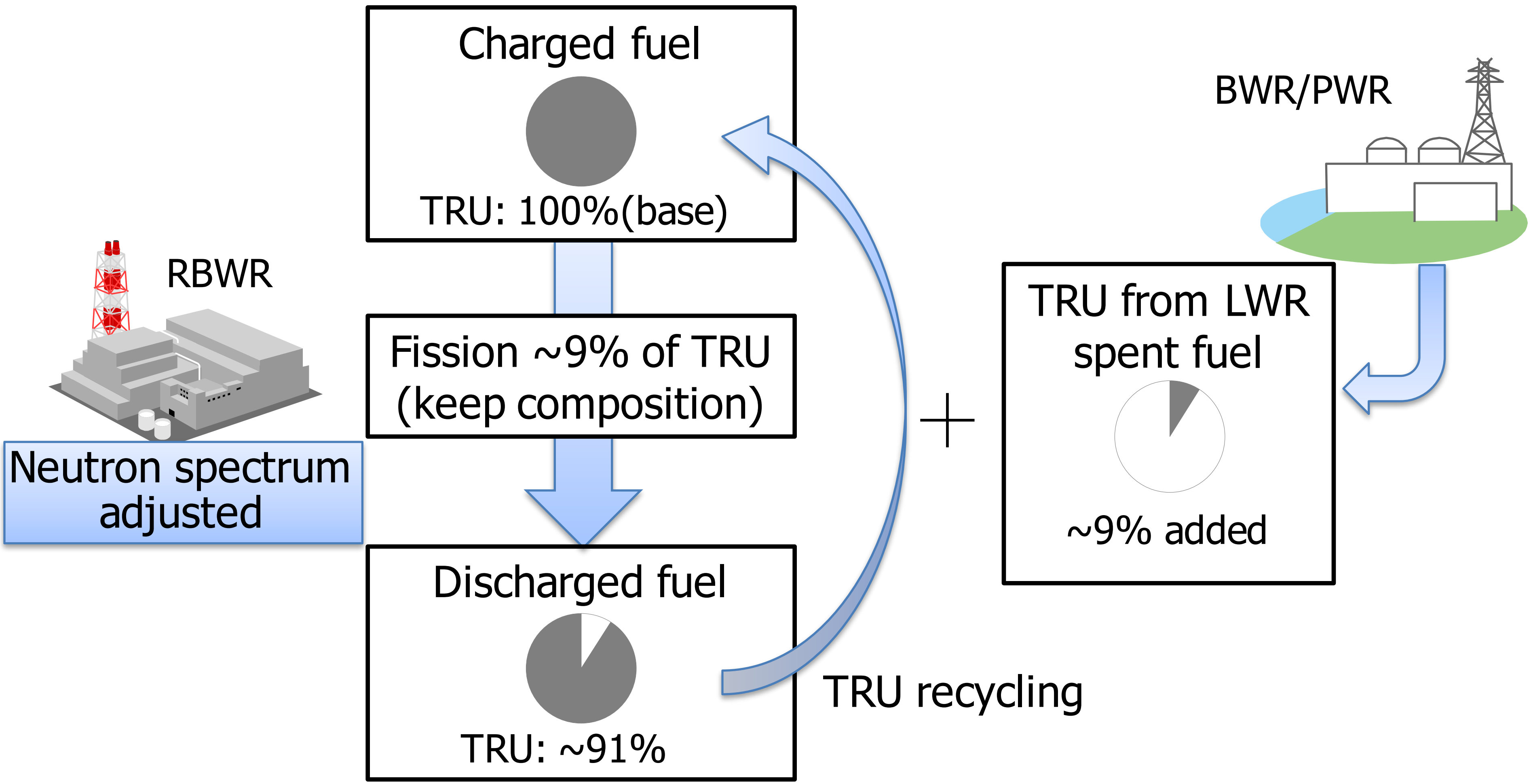
- Void reactivity coefficient, which is one of the crucial safety parameters of LWR, is kept negative by two fissile zone core.



Feature: multi-recycling of TRU

- Recycling of TRU is continued with filling various constraints* by keeping TRU isotopic composition preserved.

* Such as criticality, negative void reactivity coefficient, etc.



Summary

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- HGNE is improving and enhancing the performance of ABWR while continuously constructing it.

- HGNE is developing various types of BWR for future needs such as large, medium and small reactors and a RBWR for fuel cycle flexibility.