Innovative Light-Water Reactor

HITACHI

HI-ABWR

Highly Innovative ABWR

Hitachi-GE Nuclear Energy, Ltd.

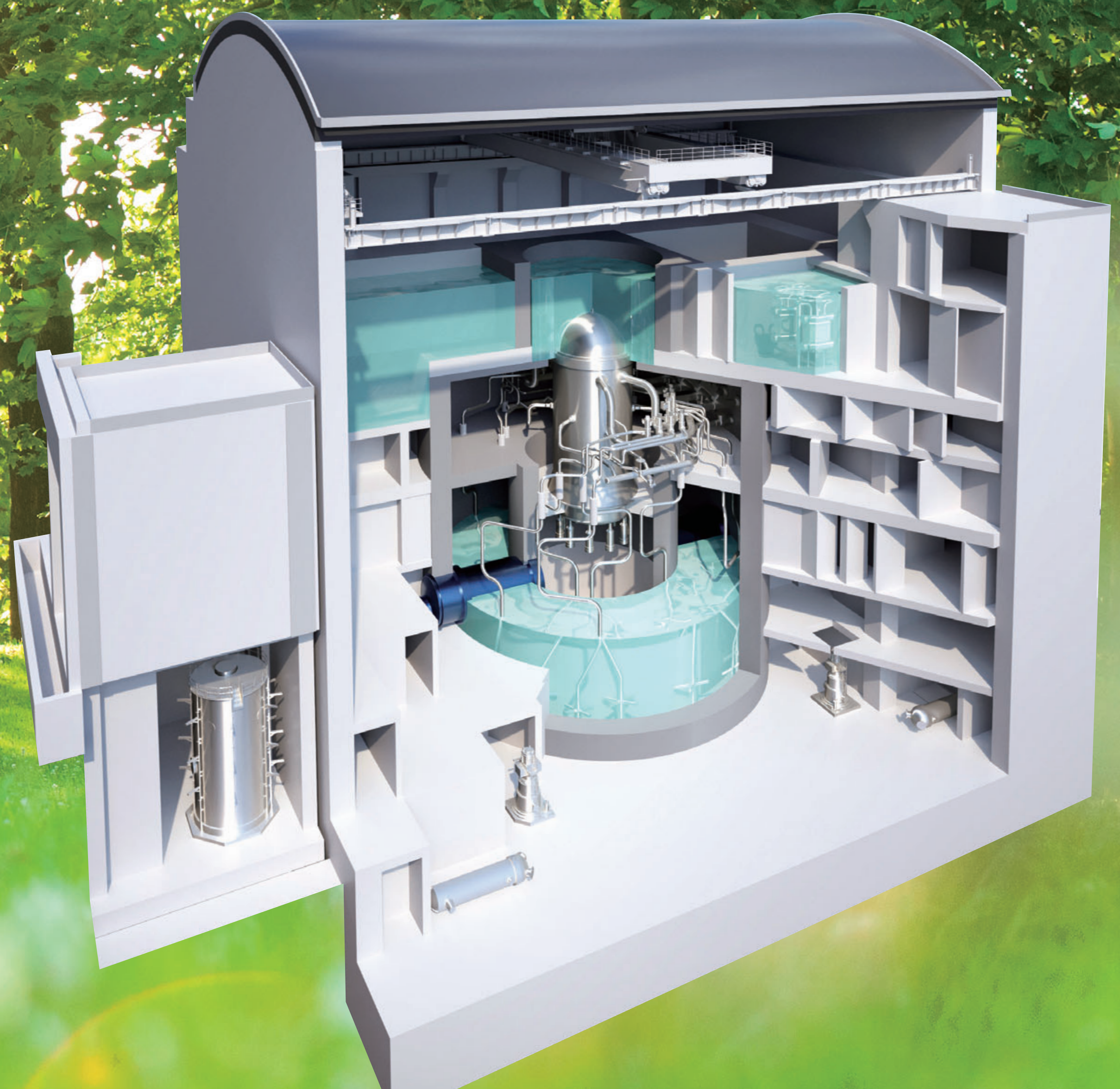
Innovating to protect the future

The highly Innovative ABWR (HI-ABWR) is based on an international standard of ABWR design that meets the regulatory requirements of the UK and Europe has received design acceptance confirmation from the UK, reflecting lessons learned from the Fukushima Daiichi Nuclear Power Station accident. The HI-ABWR is a next-generation light water reactor that incorporates new safety mechanisms.

It is equipped with innovative safety features, such as disaster countermeasures, control of unexpected accident escalation and reduce the reactor's impact on the environment.

In addition, it contributes to the realization of carbon neutrality through the reduction of spent fuel using high burnup fuels and the stabilization of electric power systems by load following operations.

HI-ABWR
Highly Innovative ABWR



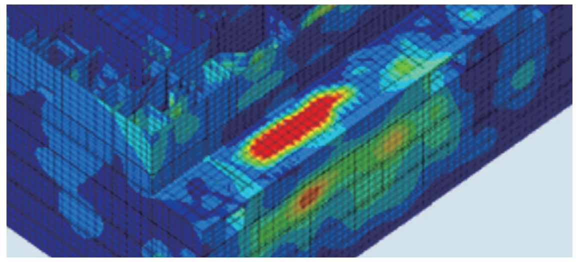
Protecting from disasters

The HI-ABWR is designed to address various disasters including earthquakes and tsunamis and physical impacts due to airplane crashes, internal fires and floods. The HI-ABWR minimizes the impact of disasters by strengthening the exterior wall and safety-divisional separation barrier.

Strengthening robustness against impacts and disasters

Strengthening buildings against airplane crashes

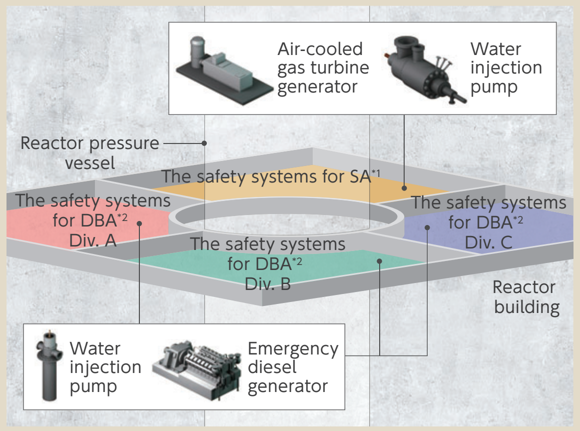
The exterior wall of the reactor building is designed to withstand airplane crashes and minimizes not only the area of physical impacts but also the range of vibration propagation after an airplane crashes.



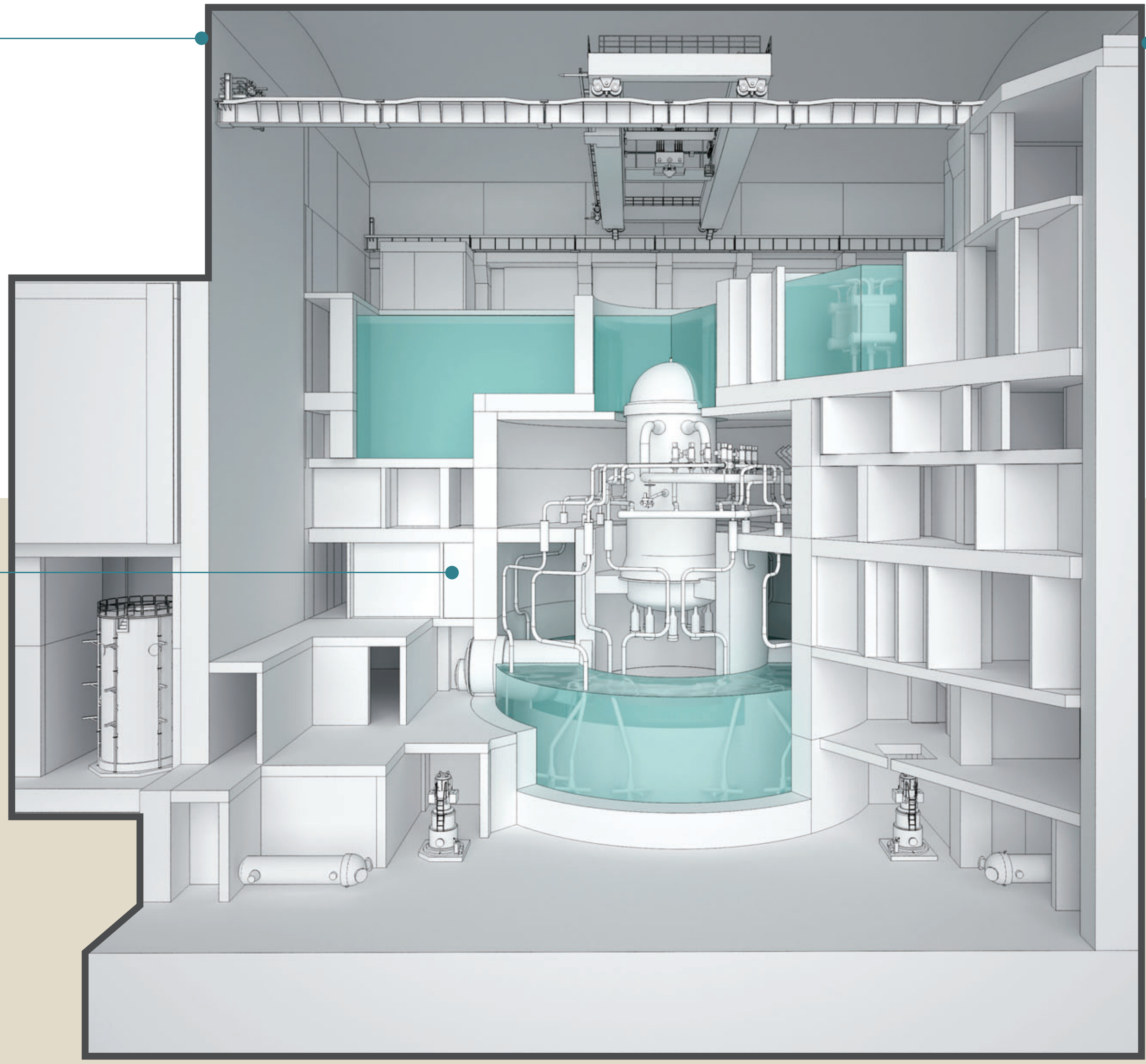
Simulation of an airplane crash into the reactor building

Minimizing the area of the impact of disasters

In order to prevent significant damage to the reactor core during an accident, the safety systems for design basis accidents and the safety systems for severe accidents, are located in four areas separated using fire-resistant, water shut-off walls to minimize the impact of internal fires and flooding caused by pipe breaks to each area.



*1 The safety systems for SA···The safety systems for severe accidents
*2 The safety systems for DBA···The safety systems for design basis accidents



Pursuing resilience of buildings and equipment

Toughening buildings

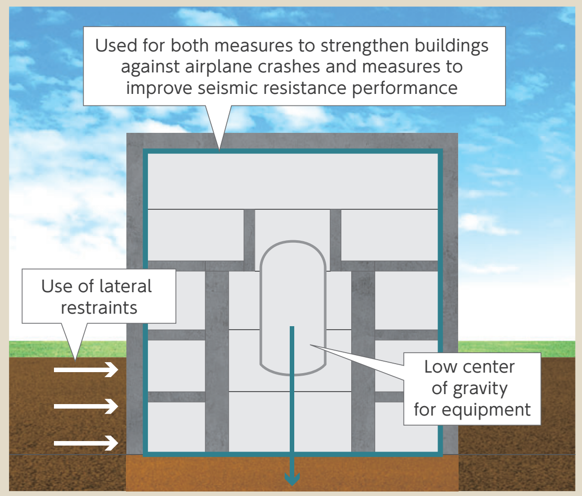
The robust exterior wall is built to be robust in the event of a physical impact due to airplane crash, etc. and is also seismic resistant, protecting the building from physical damage and earthquake-caused damage. Maintaining safety and limiting the increase in building materials improves economic efficiency.

Seismic-resistant construction based on lateral restraint

In addition to the reinforced concrete constituting the building, lateral restraint using rocks and backfilling earth around the building strengthen its anti-seismic capabilities.

Improving seismic-resistance performance by lowering the center of gravity and highly aseismic design

The center of gravity of the overall building is lowered by installing heavy equipment on the lower floors and reducing the slab above to upgrade aseismic capabilities. Highly aseismic design is adopted in equipment as well as the building to improve the seismic resistance of the entire power plant.



Highly Innovative Guard

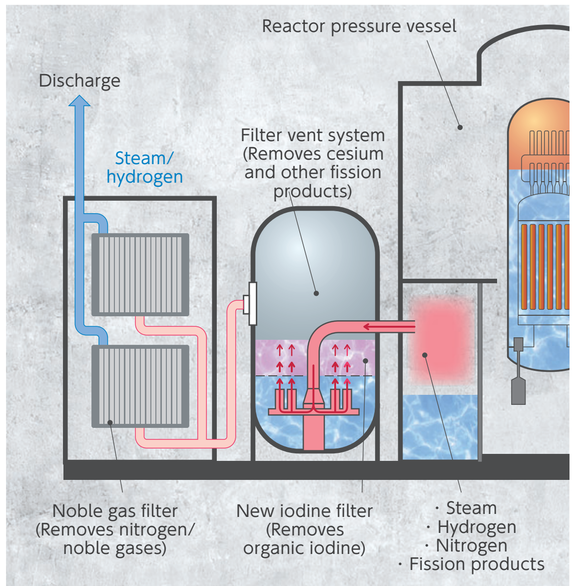
Preventing accidents escalation

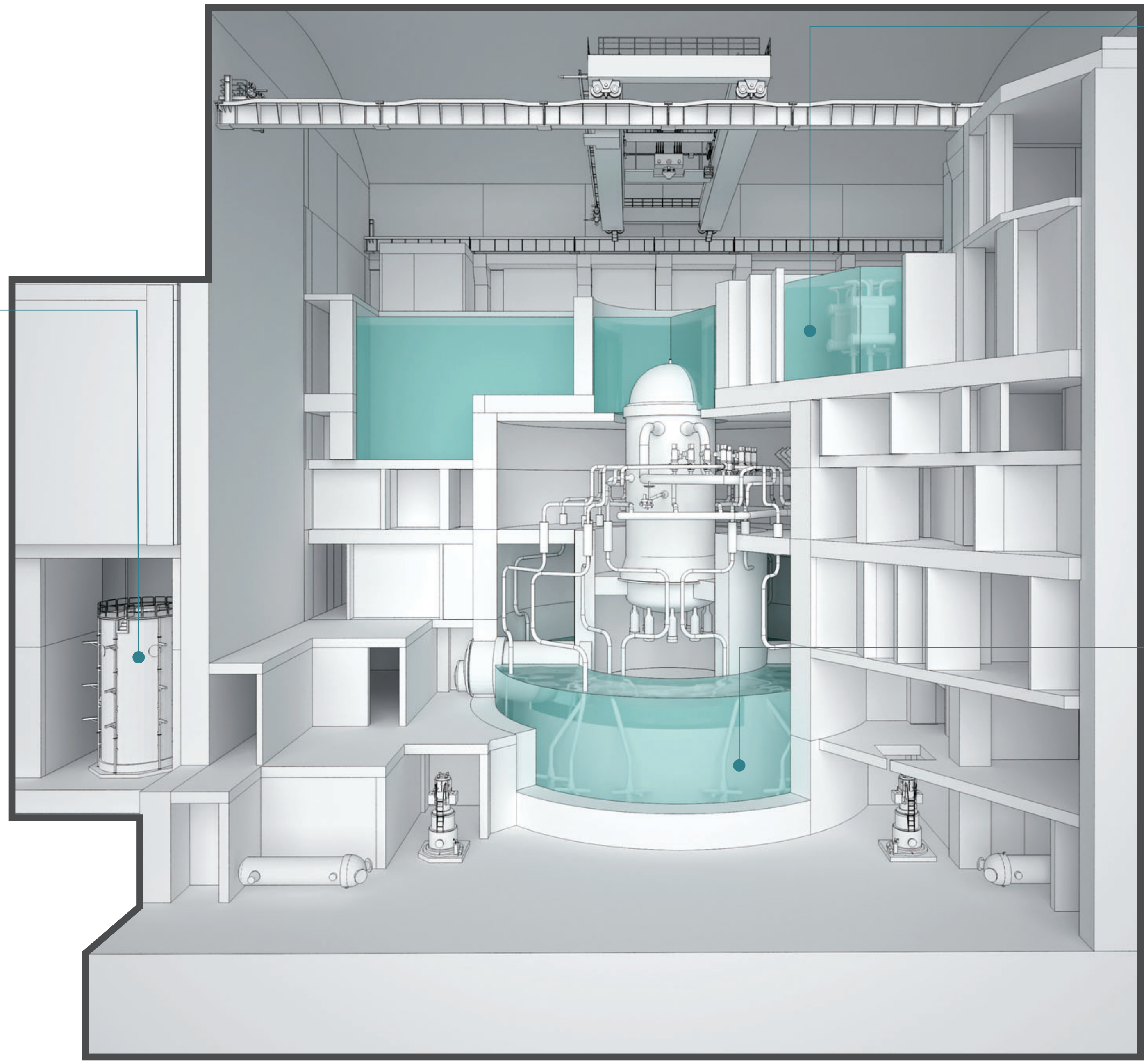
A passive safety system is a system that incorporates mechanisms driven using natural force without relying on an external power supply or the actions of operators to mitigate the impact incurred should an accident occur.
The HI-ABWR introduces a passive core cooling system, lower drywell flooder, containment system for radioactive substances (filter vent system + noble gas filter + new iodine filter etc.) to suppress the accident escalation and reduce the impact on the environment.

Confining radioactive substances to reduce their impact on the environment

Containment system for radioactive substances, which reduces their impact on the environment

In addition to the conventional filter vent system for reducing emissions of radioactive substances into the environment, a noble gas filter and a new iodine filter--the latter capable of removing organic iodine, traditionally difficult to remove--have been installed to remove radioactive noble gases and organic iodine from the steam and hydrogen emitted into the air. This helps reduce the need for resident evacuation even if a severe accident were to occur.

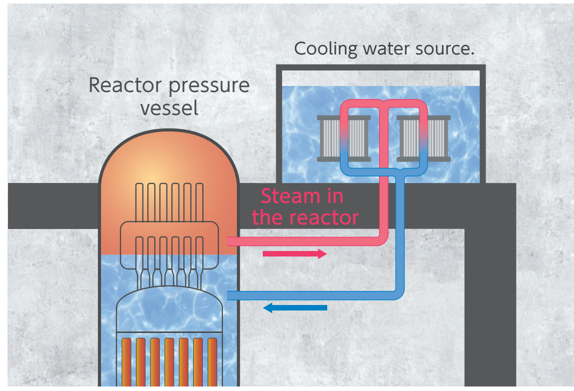




Suppressing the accident escalation without an external power supply

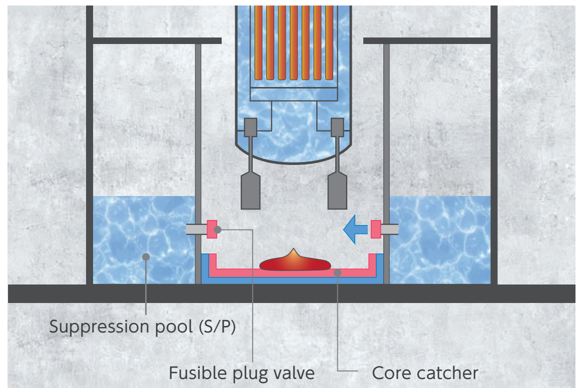
Passive reactor cooling system driven by the difference in the density of water and steam and the height difference with the reactor pressure vessel

The cooling water source, which is installed at a higher elevation than the reactor pressure vessel, cools the steam from the reactor and circulates it to cool the core. Due to automatic activation, 24-hour operation by operator actions are not required.



Lower drywell flooder that does not require operator actions

Should a core be damaged and molten fuel (debris) fall from the reactor pressure vessel, the fusible plug valve is activated by the radiation heat of the debris and other attributes, causing coolant to be injected using gravity. The coolant is able to cool the debris for three days. Furthermore, a core catcher is provided to prevent floor erosion caused by the debris.



Highly Innovative Safety

Protection using digital technology

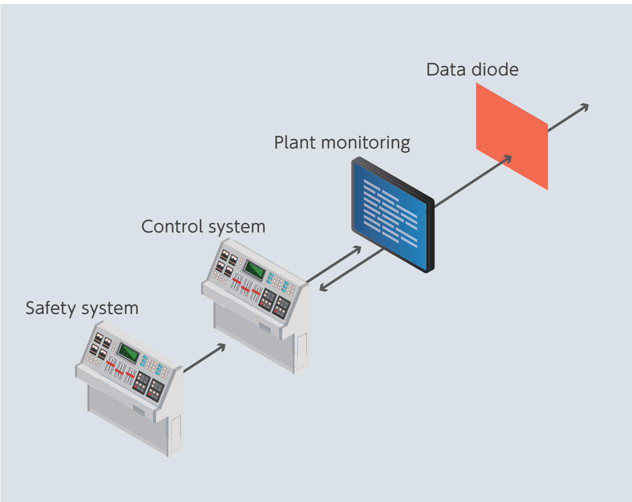
Hitachi's Lumada is a new approach that connects humans, digital technology and other technologies.
Plant monitoring and operation, as well as maintenance are enhanced by utilizing knowledge of the latest digital technologies. In addition, the instrument and control equipment is arranged in multiple locations to ensure safety against a single failure, and prepared for accidents in various ways as necessary.

Next-generation central control room based on the harmony of human and machine

Central control room (for illustrative purposes)

With the consideration of factors affecting human performance that have been implemented in the past and the digital innovation focused on the accumulated know-how and data, monitoring and operations are ensured in normal operations and during accidents. For equipment management, a digital twin is created, combining equipment management and Lumada. The migration from construction management to equipment management will be seamless.

Instrument and control equipment for risk management



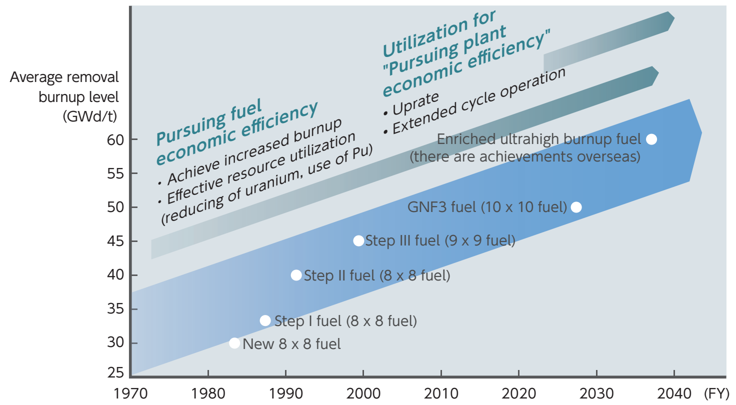
For instrument and control equipment exposed to a harsh environment, set up equipment whose performance against severe accidents has been confirmed in environment testing.
Defense against cyberattacks is provided using one-way communication, and backups by diversified equipment is addressed to the risk of failure due to co-factors in digital systems.

Highly Innovative Security

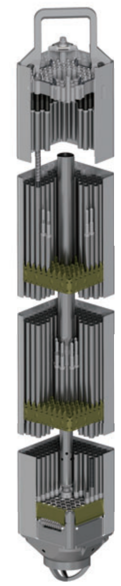
Sustainably protecting society

In order to realize a sustainable society, stable supply of electricity is required while reducing environmental impact, realizing carbon neutrality, and utilizing renewable sources of energy. We are making further improvements such as development of new fuels, operations that stabilize electric power systems and the improvement of capacity factor through maintenance.

Improving operation costs using high burnup fuels



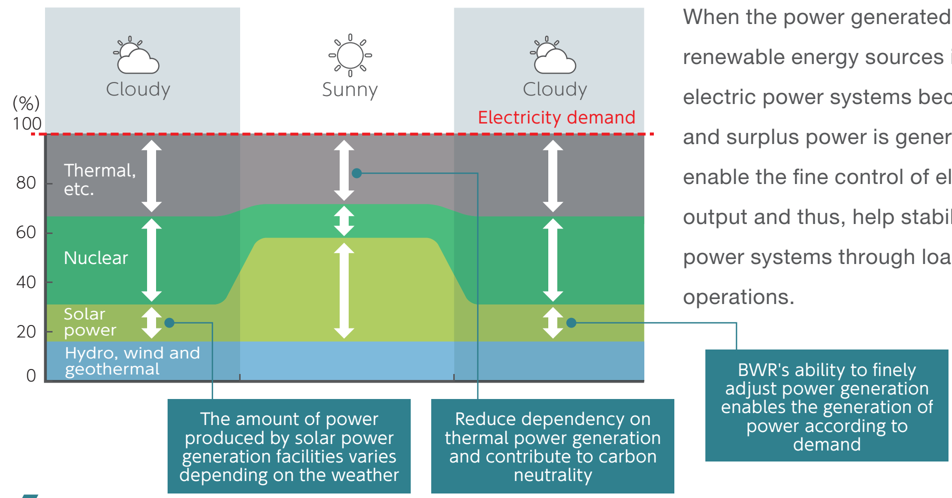
Since BWR fuels are backwards-compatible, the most recently designed fuels can always be used. High-performance high burnup fuels enable extended cycle operation, reducing operating costs and spent fuel.



GNF3 fuel*

* GNF3 fuel: Next-generation fuel assembly developed by Global Nuclear Fuel (GNF)

Stabilizing electric power systems through load following operations



When the power generated from renewable energy sources increases, electric power systems become unstable and surplus power is generated. BWRs enable the fine control of electric power output and thus, help stabilize electric power systems through load following operations.

Realizing stable operation through the consideration of maintenance

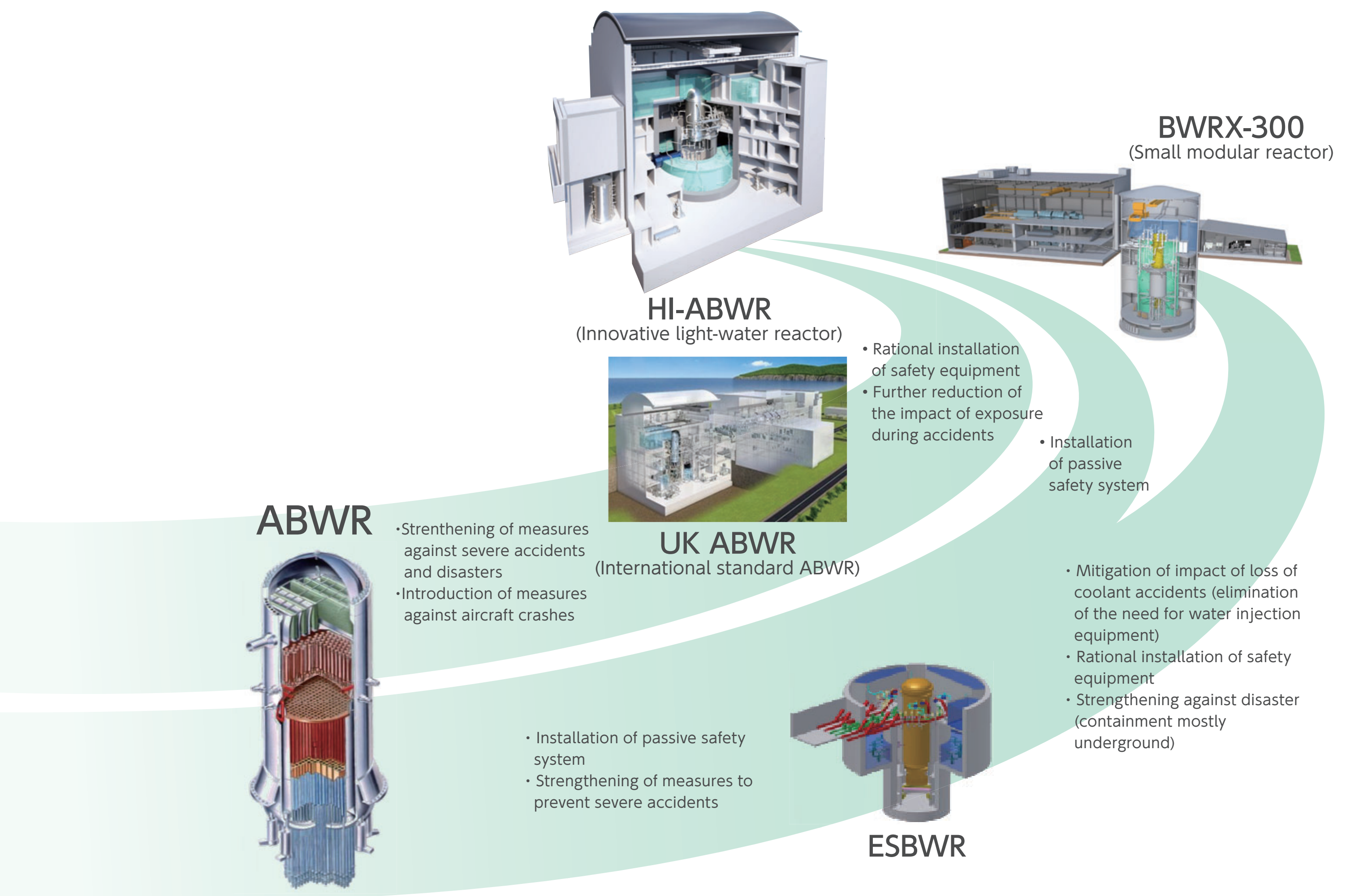
Designed to streamline maintenance and reduce downtime required for plant maintenance, helping to improve capacity factor.

Highly Innovative Sustainability

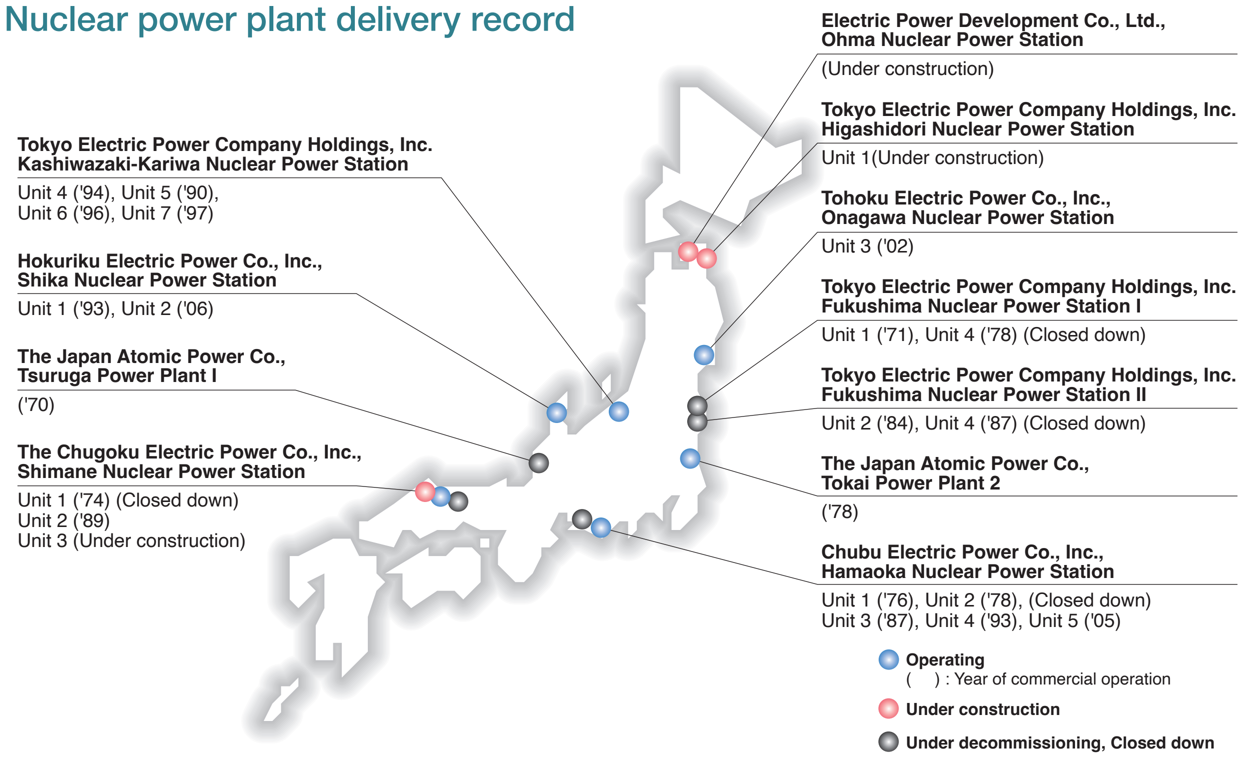
Hitachi's evolving BWR technologies

Hitachi's BWR technologies continue to evolve.
Hitachi's initiatives in the nuclear power business began with a research reactor which started operating in 1957.
Since we started commercial operation of the Japan's first commercial light-water reactor in 1970, we have supplied many nuclear plants.
Incorporating the experience from the Fukushima Daiichi Nuclear Power Station accident, we will promote reliability improvement activities and the development of preventive maintenance technology and pursue increased safety.

History of BWR reactor development and innovative light-water reactors



Nuclear power plant delivery record



HI-ABWR basic specifications

Item				Specifications
Basic design	Electric power			1350 to 1500 MWe
	Thermal power			3926 to 4300 MWt
	Reactor pressure			Approx. 7.17 MPa [abs]
	Rated core flow rate			Approx. 52.2 x 10^3 t/h
	Reactor core	Height		Approx. 3.8 m
		Diameter		Approx. 5.2 m
	Fuels	Model		10 x 10 fuel (employs the latest fuel at the time of operation)
		Level of enrichment		Approx. 4% (adjust based on the reactor cycle length and fuel discharge burnup)
		Number of assemblies		872
	Reactor pressure vessel	Internal diameter x overall height		Internal diameter: Approx. 7.1 m, Height: Approx. 21 m
	Control rod	Number of rods		205
		Drive system	At output control	Finely adjusted electromotive drive
			At scram	Hydraulic-driven high-speed scram
		Control material		Boron carbide (partially hafnium)
	Nuclear reactor recirculation system	Recirculation method		Internal pump
		Number of pumps		10
	Emergency core cooling system	High-pressure water injection		High-pressure core injection system (2 lines)
				Reactor core isolation cooling system (1 line)
		Low-pressure water injection		Low-pressure core injection system (3 lines)
		Reactor pressure vessel depressurization		Auto-depressurization system
	Residual heat removal system			3 lines
	Containment			Made of reinforced concrete integrated into the building
The safety system for severe accidents	The safety system for preventing reactor core damage			Passive reactor cooling system (1 line)
				Substitute low-pressure core injection system (1 line)
	The safety system for preventing containment vessel damage			Fusible plug valve
				Core catcher
				Containment over pressure protection system
				Filter vent system
				Noble gas filter

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See the following for more information about the HI-ABWR:
www.hitachi-hgne.co.jp/en/abwr

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https://www.hitachi-hgne.co.jp/en/

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