Development of Next-Generation LWR in JAPAN

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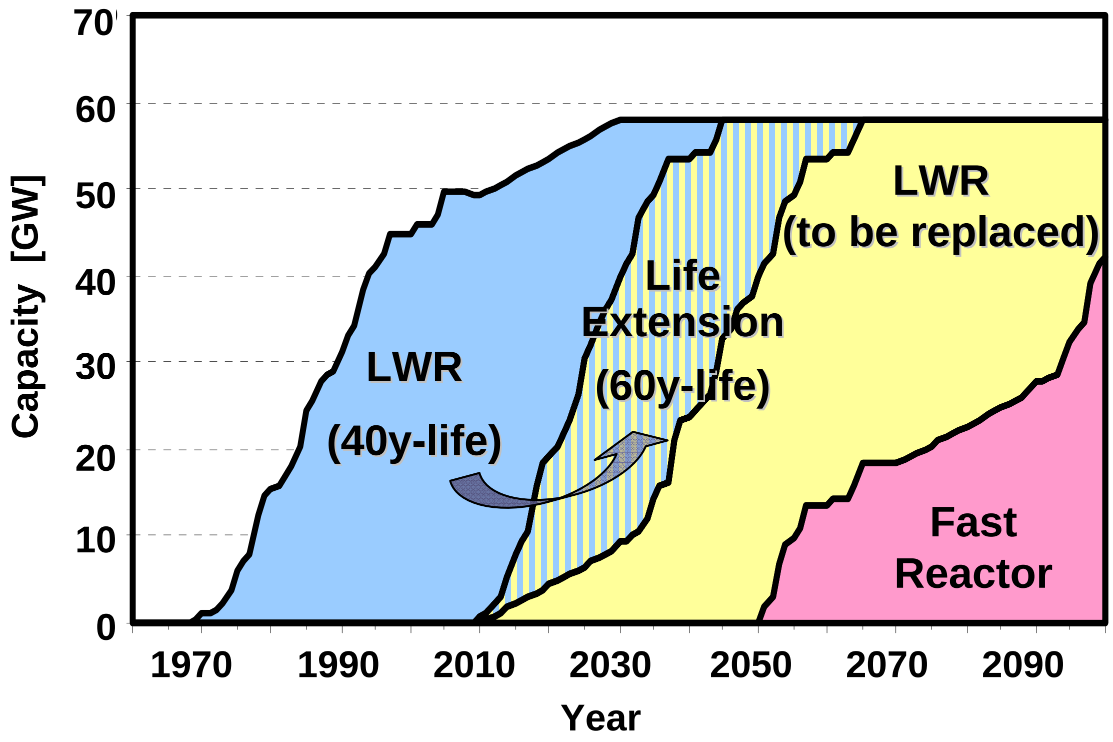
Background

- Trend in the world - ***Nuclear Renaissance***
  - Dramatic expansion of nuclear energy
- Trend in Japan
  - Contribute to large reduction of greenhouse gas emissions
  - Nuclear energy is the only clean base-load energy source
    - 53 commercial reactors are in operation, meeting approximately 30% of the country's electricity demand
    - Maintain the share of nuclear power in the total electricity supply at about 30-40%

      (The Nuclear Energy National Plan, Oct. 2006)

Background (cont.)

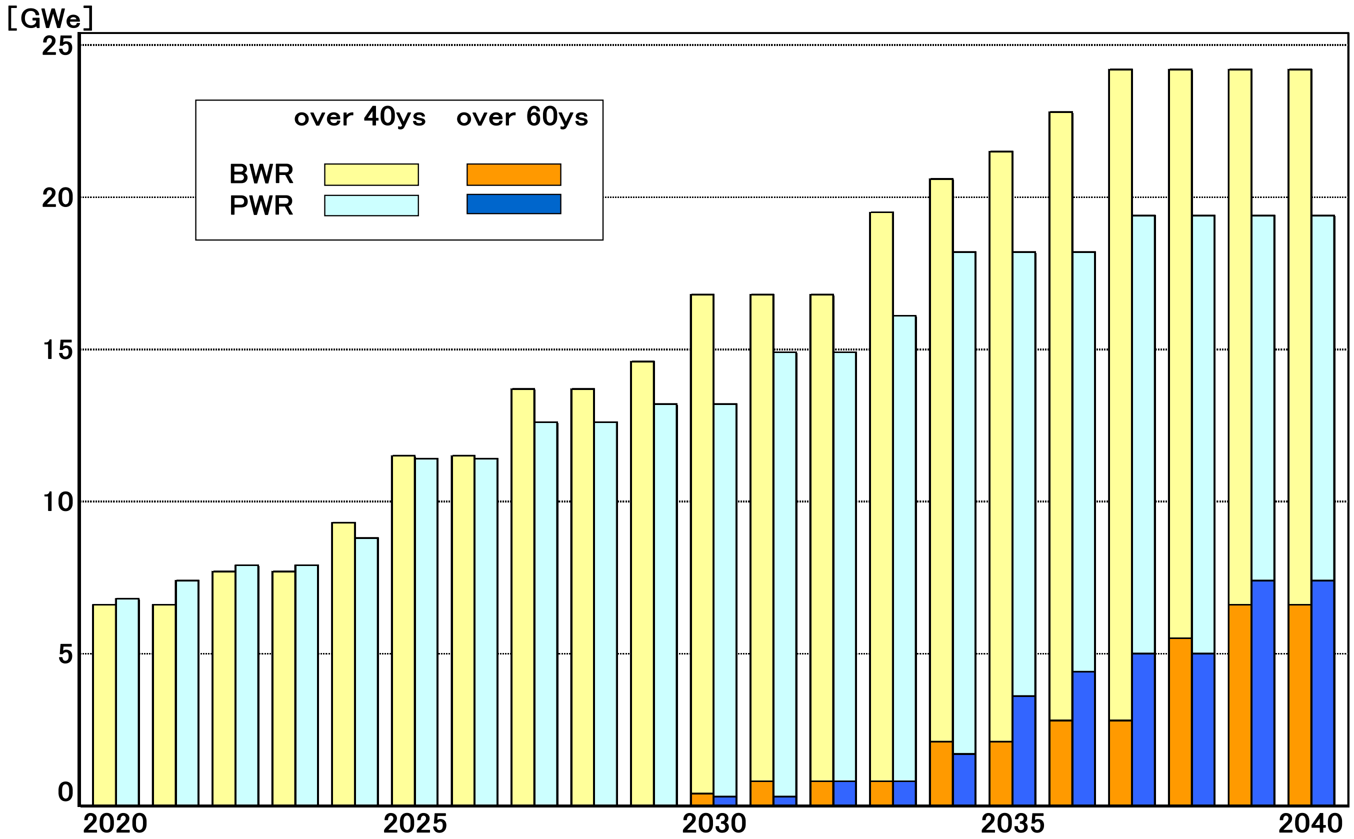
- Long-term framework for nuclear energy



[Note] The capacity is assumed to be saturated at 58GWe for illustrative purpose.

Background (cont.)

- It is anticipated that many reactors will need replacement needs starting in the 2030's.



Major target

Items	User requirements in Japan	
Safety	core damage frequency containment failure f. countermeasures against SA	$\leq 10^{-5}$ /ry $\leq 10^{-6}$ /ry Yes
Economy	construction cost capacity factor operating cycle plant life construction period	TBD 97 % (average throughout lifetime) 24 months 80 ys ≤ 30 months
Public acceptance	evacuation frequency external hazards	$\leq 10^{-6}$ /ry (short-term) $\leq 10^{-7}$ /ry (long-term) earthquake, tsunami, airplane crush
Operation & Maintenance	core design maintainability maintenance work	70 GWd/t (ave. assembly discharge) high reliability & easy maintenance 50 % reduction

Concept of next-generation LWR

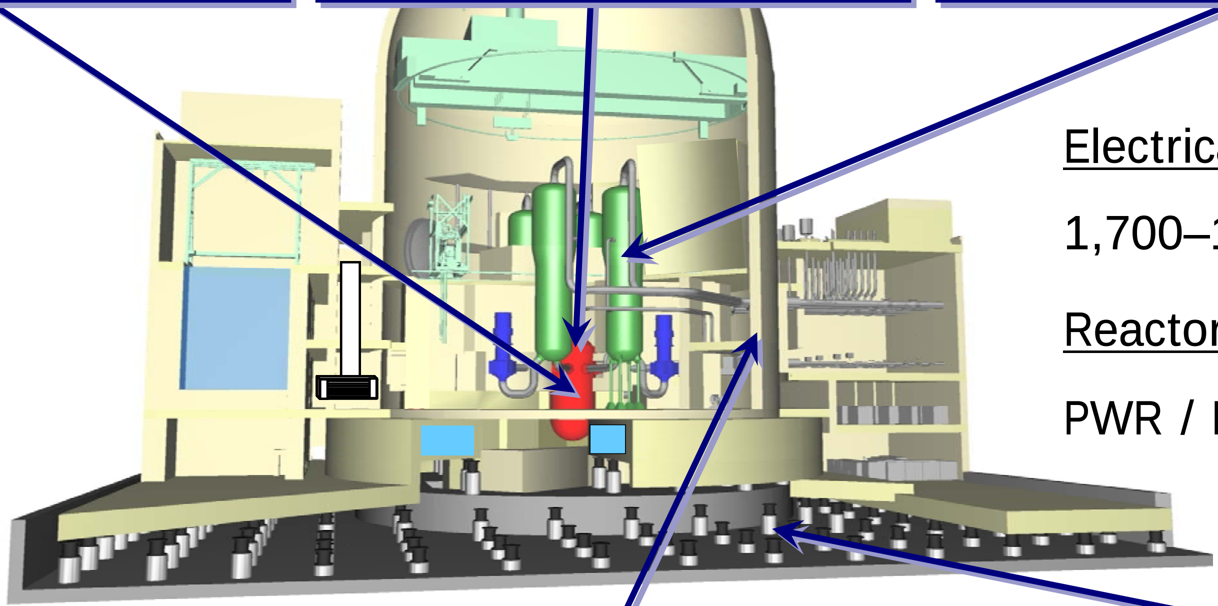
- Concept for the next-generation LWR
  - World's best level of safety and economy in the 2030 timeframe
  - Global standard
  - Simplifying their operation and maintenance
  - High public acceptability
- Reactor Types
  - One PWR design and one BWR design
- Electric output
  - 1,700 to 1,800 MWe class
    - Key technologies should be developed for 800 to 1,000 MWe class plants within the framework of the standardization of designs for the 1,700 to 1,800 MWe class

Outline of technology development

Reactor core system with very high burn-up fuel

Advanced safety system [passive and active]

Long-lived materials & innovative water chemistry technologies



Electrical Output

1,700–1,800 MWe

Reactor Type

PWR / BWR

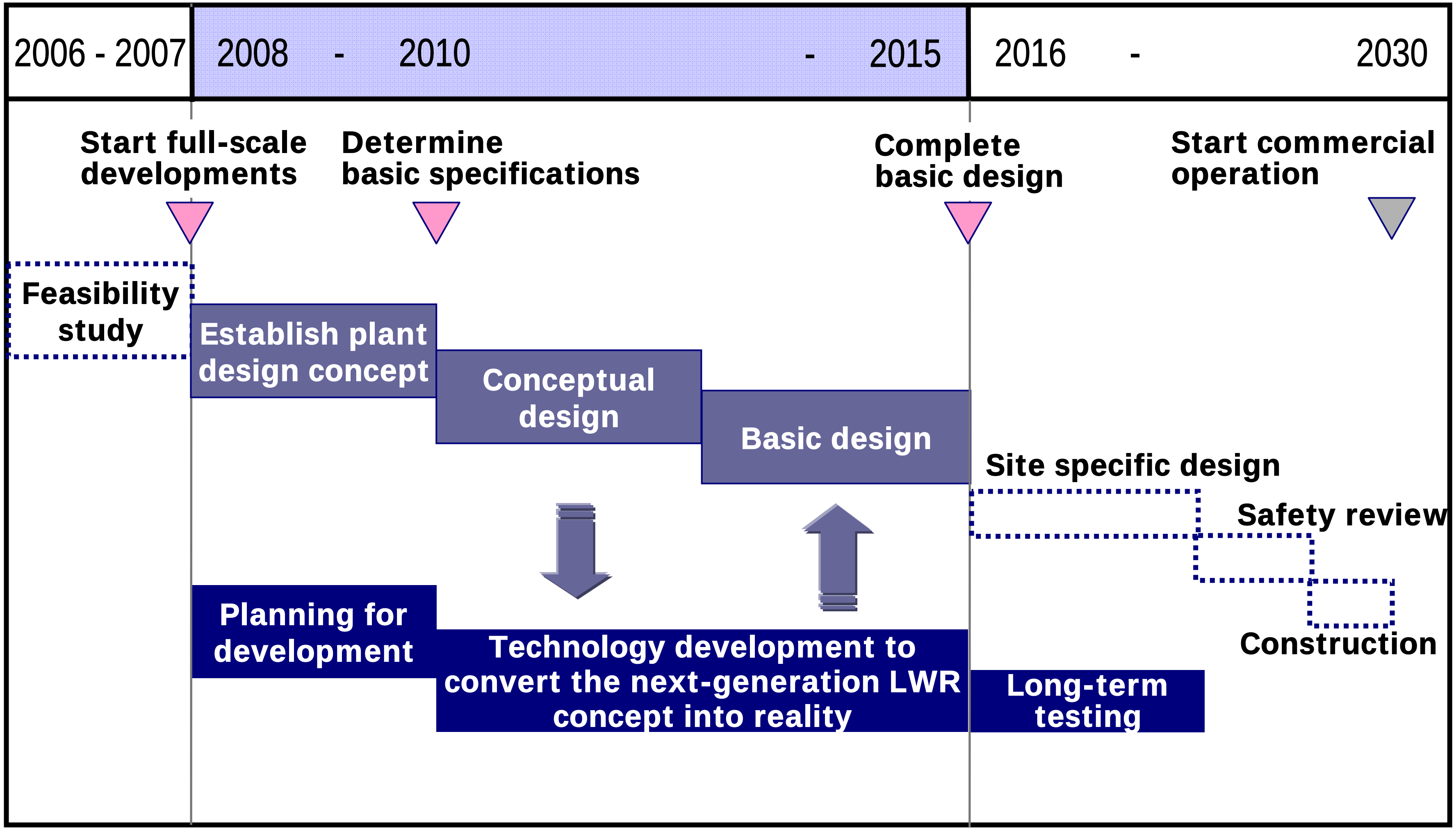
World leading digital technology

Innovative construction technology

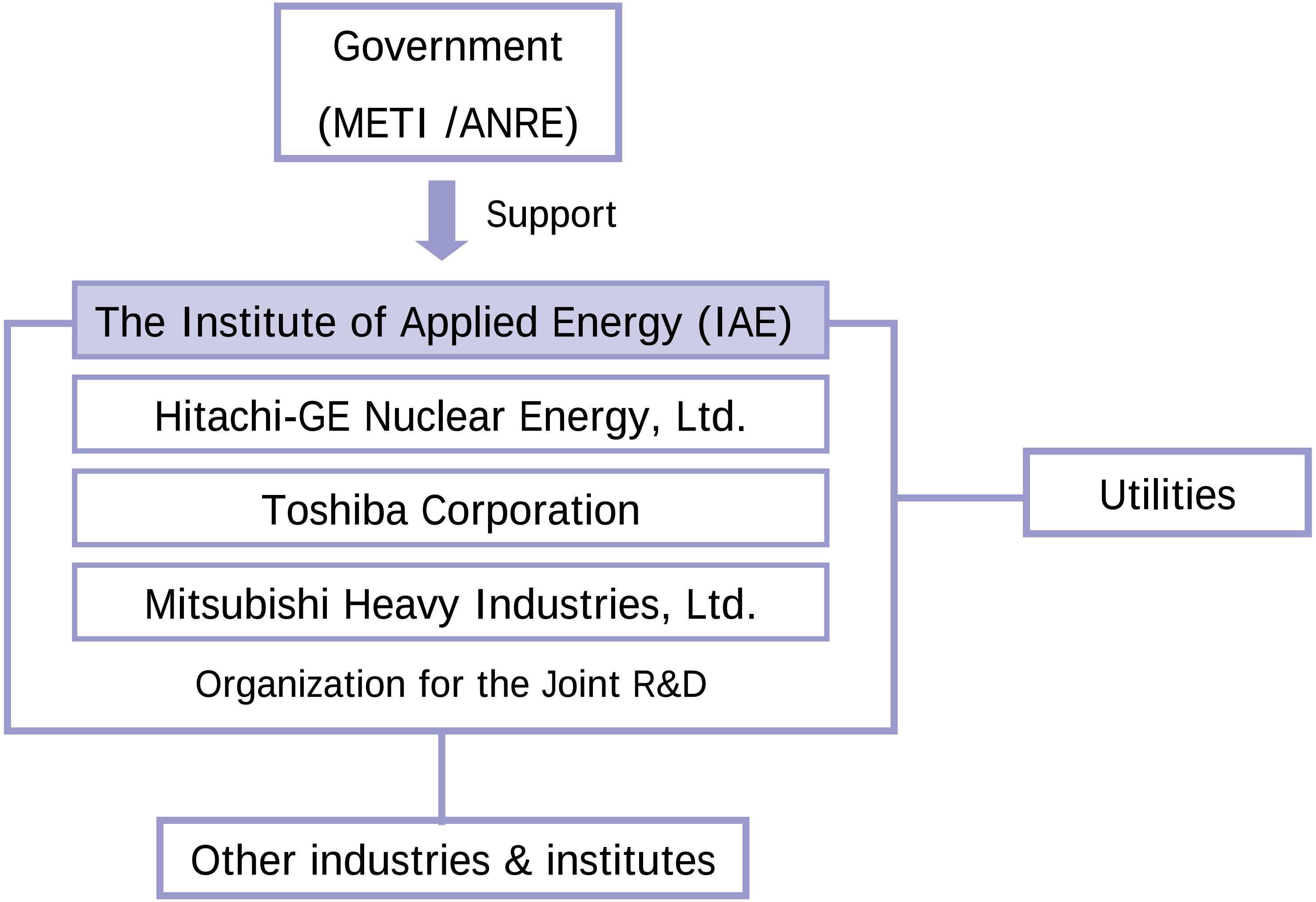
Seismic isolation system

[Note] The figure shows an example of PWR

Schedule


2006 - 2007
2008 - 2010 - 2015
2016 - 2030
Start full-scale developments
Determine basic specifications
Complete basic design
Start commercial operation
Feasibility study
Establish plant design concept
Conceptual design
Basic design
Site specific design
Safety review
Construction
Planning for development
Technology development to convert the next-generation LWR concept into reality
Long-term testing

Organization



Technology development

Reactor core system with very high burn-up fuel

Goals

- Capacity factor of up to 97%
- spent fuel discharge reduced by 30~40%

Developments

- Very high burn-up fuel
  - Up to 100GWd/t* burn-up fuel
    with uranium enrichment over 5%
    (average discharge burn-up 70–90GWd/t)
- Cladding materials for very high burn-up fuel
  - e.g. new zirconium alloys, stainless steels
- Advanced reactor core system

*.Maximum fuel assembly burn-up of PWR

Reactor core system with very high burn-up fuel (cont.)

Phase I (fy2008-2010)

- Evaluation of technical impacts of 5%-10% uranium enrichment on the current fuel cycle facilities and fuel cycle cost competitiveness
- Preliminary evaluation of cladding materials for very high burn-up fuel

Phase II (fy2011-2015)

- Demonstration of fuel integrity through experimental irradiation tests
- Promote practical use of over 5% enriched-U fuel including associated regulatory development
- Develop advanced reactor core system

Advanced safety system
[best combination of passive and active safety system]

Goals

- Safe, reliable and simplified system
- Reduction of equipments and maintenance work in safety system

Developments

- Best combination of passive and active concepts
- Demonstration tests for the advanced safety system

Advanced safety system

[best combination of passive and active safety system] (cont.)

Phase I (fy2008-2010)

- Establish conceptual design of safety system
- Estimate core damage frequency (CDF) and containment failure frequency (CFF)

Phase II (fy2011-2015)

- Perform evaluation tests for advanced safety system
- Establish safety analysis method

Long-lived materials and Innovative water chemistry technologies

Goals

- Eighty-year plant lifetime
- Large reduction of occupational dose

Developments

- Nickel-based alloy for steam generator tube
  - High resistance to intergranular corrosion (IGA) and primary water stress corrosion cracking (PWSCC)
- Stainless steel for BWR reactor internals
  - High resistance to irradiation-assisted stress corrosion cracking (IASCC)
- Innovative coolant chemistry control technology

Long-lived materials and Innovative water chemistry technologies (cont.)

Phase I (fy2008-2010)

- Material design and screening tests
  - state-of-the-art molecular design tool and broad investigation into existing knowledge-base
- Survey of applicability of water chemistry control technologies

Phase II (fy2011-2015)

- Establishment of production process and Long-term verification tests for new materials
- Large-scale and long-term tests to verify applicability of water chemistry technologies

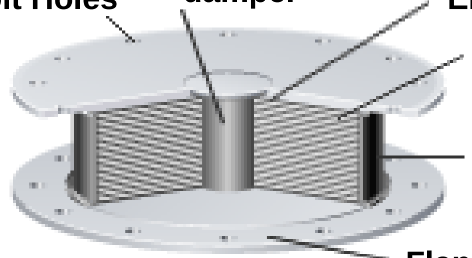
Seismic isolation system

Goals

- Standardized structural design
- Plant design independent from site specific conditions

Developments

- Large-scale seismic isolation system
- Establishment of codes and standards for seismic isolation design



Seismic isolation system

Seismic isolation system (cont.)

Phase I (fy2008-2010)

- Feasibility analysis for seismic isolation system for next-generation LWR plot plan
- Basic characteristic tests for seismic isolation system

Phase II (fy2011-2015)

- Full-scale or large-scale model tests
  - Ultimate characteristics for seismic isolation system
  - Piping integrity between seismic isolation building and non-seismic isolation building, etc.
- Establish evaluation method and standards for LWR plant with seismic isolation system

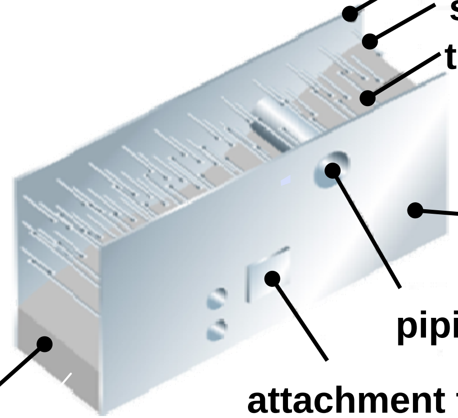
Innovative construction technologies

Goals

- Shortening of construction period to 30 months
  (from 1st concrete to start of commercial operation)

Developments

- Large modularization technologies
  - Application of steel plate reinforced concrete (SC) structure to PCV*, etc.



* Primary containment vessel of BWR

Innovative construction technologies (cont.)

Phase I (fy2008-2010)

- Preliminary examination on SC structured PCV
  - Elementary tests for SC structure: buckling, shearing, horizontal load tests for cylindrical wall

Phase II (fy2011-2015)

- Large-scale SC structured PCV structure tests
- Develop other techniques to allow assembly of large modular blocks
- Establish analysis method and standards

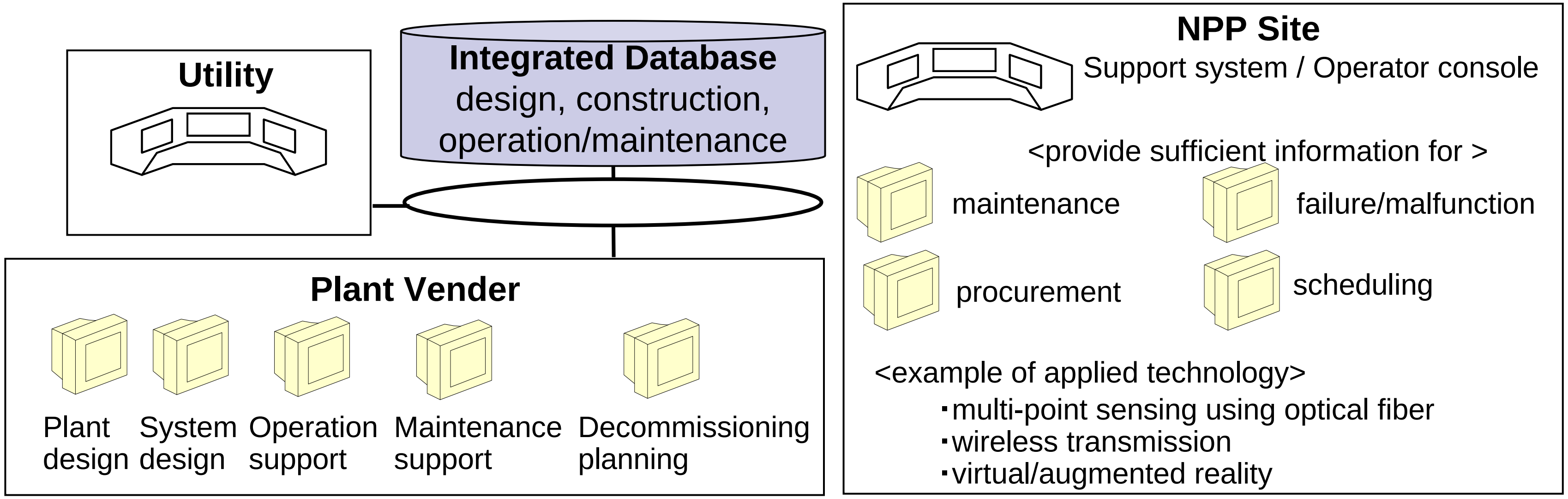
World leading digital technology

Goals

- Improve plant operability, maintainability and availability

Developments

- Plant management system adopting innovative digital technologies and devices



World leading digital technology (cont.)

Phase I (fy2008-2010)

- Comprehensive job and data analysis from plant design stage to decommissioning stage
- Establish concept of total management system
- Investigate innovative seed technologies related to the total management system

Phase II (fy2010-2015)

- Design major management systems
- Develop and/or verify basic digital technologies
  - e.g. sensor or monitor for equipments, data transmission technology, etc.

Regulatory development

- Propose appropriate regulation for the next-generation LWR plant design
- Develop codes and standards from technology development stage
- Promote international harmonization of regulations, codes and standards for smooth introduction of the plants into the international market
- Collaborate with the international organization (IAEA, OECD/NEA, MDEP), foreign standards development organizations (SDOs)

Summary

- Development of next-generation LWR started April 2008 with consortium of consisting of three major plant vender, utilities and IAE.
- Basic design and major R&D will be completed in 2015 and the 1st commercial operation will start around 2030.
- Evaluation of innovative technologies including preliminary tests is now ongoing.
- In June 2010, all the activities associated with this program will be reevaluated in order to proceed to the next development step