The Prospects of Nuclear Development in the Future

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Presentation topics

1. Outline of Hitachi-GE Nuclear Energy
2. World Nuclear New Build – Future trend
3. Key Issues for Sustainable Nuclear Development in the Future
1. Outline of Hitachi-GE: Alliance of Hitachi and GE

Hitachi-GE Nuclear Energy
(Established on July 1, 2007)

GE Hitachi Nuclear Energy
(Established on June 4, 2007)

Hitachi equity share: 80.01%
GE equity share: 19.99%
Hitachi equity share: 40%
GE equity share: 60%

Hitachi GE nuclear business collaboration for more than 50 years
First alliance for comprehensive BWR technology in 1967
Committed to develop and promote latest BWR technologies and services
1. Outline of Hitachi-GE: Company profile

**Hitachi-GE**
Approx. 1,500 employees

**Fuel Cycle**
- Components supply for Monju / Rokkasho
- Interim Storage Casks

**New Builds**
- ABWRs under construction in Japan and Taiwan
- UK GDA application for Horizon Project

**Maintenance Services**
- Safety enhancement work for plant restart
- Fukushima Decommissioning etc.

**Rokkasho Reprocessing Plant**

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Provide wide range of products and services covering design, manufacturing, construction, fuel supply and maintenance services.

Integrated services provided by Hitachi Group Companies.
1. Outline of Hitachi-GE: Key products

**ABWR**
- The only advanced Gen III technology in operation today
- Licensed in 3 countries
- 4 ABWRs in operation today
- 4 ABWRs under construction
- GDA review in UK underway

**ESBWR**
- The latest BWR design pursuing further simplicity and economy
- Natural circulation principles
- Passive safety design
- NRC certification completed

Reference: Nuclear Energy Today @OECD/NEA 2012
Targeting countries proceeding with plans to construct new nuclear power plants

【Europe】
UK (Horizon project),
Lithuania,
Poland, etc.

【North America】
Canada
USA
Mexico

【Asia】
Taiwan, Vietnam, Malaysia,
India, Thailand, etc.

【Middle East and Africa】
Saudi Arabia
UAE
South Africa, etc.

【South America】
Brazil
Argentina, etc.
Development plan unchanged in many countries after Fukushima Accident

- Growing electricity demand
- Measures to reduce CO₂ emission
- Energy security concern

Source: World Nuclear Association website (July 2012)
Demand for new build will be driven by countries of high economic growth, especially by China.

2. World Nuclear New Build – Future trend

- Stable new build in the countries with clear nuclear development policy and strong nuclear industry.

- Capacity of installed base in developed countries tends to decrease (more decommissioning than new build)

### Current Installed Base
- **Country of stable new build** (China, Russia, Korea, India)
  - Current Installed Base: 95
  - No. of units in operation in 2030 (WNA reference scenario): 251
  - No. of units in operation in 2030 (WNA lower scenario): 179

### Developed Countries
- **Developed Countries** (North America, Western Europe, etc.)
  - Current Installed Base: 241
  - No. of units in operation in 2030 (WNA reference scenario): 218
  - No. of units in operation in 2030 (WNA lower scenario): 110

### Emerging Countries
- **Emerging Countries**
  - Current Installed Base: 47
  - No. of units in operation in 2030 (WNA reference scenario): 89
  - No. of units in operation in 2030 (WNA lower scenario): 47

Source: World Nuclear Association
“Building new nuclear power plant” has to be “economically feasible” project.

- **Construction Risk**
  - Cost over run
  - Schedule delay

- **Licensing Risk**
  - Requirement well known?
  - Requirement changes?

- **Operating Risk**
  - Long term PPA?
  - Operating performance

Economically feasible ROI? IRR?
3. Key Issues for Sustainable Nuclear Development

- Proper risk allocation among stakeholders

**Government (incl. Independent Regulatory Body)**
- Stable long term nuclear development policy
- Clear and foreseeable rule making
- Political measures to mitigate overall risks

**Intelligent Owner/Operator**
- Capital Investment plan
- Licensing applicant
- Construction oversight
- Power Purchase Agreement
- O&M management

**Financial Sector**
- Long term loan with preferable conditions
- Equity participation

**Supplier / Nuclear Technology Provider**
- Proven and licensable technology
- Design completion
- EPC execution
- Maintenance Services
3.1 The case of the countries of stable new build

Why “Building new nuclear power plant” can be a “feasible project” in the countries of stable new build?

- Stable long term nuclear development policy
- Rules are clear for domestic players
  - Nuclear related laws and regulation
  - Applicable codes and standards
- Owner/Operator responsible for long term power generation and distribution
  - Capable of planning and managing new build
- Cost and schedule certainty
  - Series of construction with standardized design
  - Experienced supply chain / construction labors
3.2 The case of the developed countries

Why nuclear installed base in the developed countries tend to decrease?

- Low electricity demand growth
- “Lack of new build for long years” increases construction risk
- Competition with low gas price under the deregulated market
- Competition with renewables (wind and solar)

- The issue of desirable “energy mix” for long years future
- Ability of private sector of taking long range risk is limited
- Governmental role seems to be necessary

To be the end of 60 years life in 2025-2040

Example of UK Horizon Project: Overview

- Two to three Advanced Boiling Water Reactors (ABWR; 1,350MW class) per site, Wylfa and Oldbury.
- Primary focus is to secure all key licences, permits, and commercial agreements for Wylfa by 2018.
- Plan is to start commercial operation of the 1st unit at Wylfa in the first half of the 2020s.
- Developing business structure and operational organisation for Horizon to become a licenced nuclear power plant operator.

Pictures: Existing Magnox stations at Wylfa (Top) and Oldbury (Bottom), adjacent to Horizon’s sites
3.2 The case of the developed countries

Example of UK Horizon Project: Project Scheme

- **Investors**
- **Hitachi, Ltd.** (Investor)
- **HHNPD UK** (Investment Company)
- **HM Treasury** (Lenders)
- **O&M Partners**

**Horizon Nuclear Power**

- **DECC**
- **CfD Counterparty**
- **Power Sales**
- **Power Suppliers**

**Hitachi-GE Nuclear Energy**

- **Supply Chain Companies** (Babcock International, Rolls-Royce, etc.)
- **GEH** (Technology Partner)
- **GNF** (Nuclear Fuels)
- **Constructors**

**EPC Contract**

**CfD**

**Sub-contracts**

**Site License Company and operator**

**Export Credit Agencies**

CfD provides long-term revenue stability, lowering risk to investors and costs to consumers.

Generator sells power as normal, but receives variable top-up to the “strike price.”

If market reference price goes above the strike price - generator must pay back the difference.

Source: UK Department of Energy and Climate Change
3.3 The case of the emerging countries

What are the difficulties of nuclear development projects in the emerging countries?

[Typical issues]

- Possible change of Government policy
- Rules and Organizations under development
  - Unclear identification of responsible organization
  - Unclear mechanism to resolve conflicts among stakeholders
  - Who’s responsible for key milestone control and proper program change decision
- Difficulty of financial arrangement
  - “A certainty of the project required for lenders” vs “Upfront funding necessary for increasing a certainty”
- Expanding expectation for the role of suppliers and suppliers’ country
3.3 The case of the emerging countries

- Expanding expected role of supplier
  - Licensing (cooperation with regulatory authority of the country of origin)
  - O&M support (necessary resource development)
  - Long term Fuel supply
  - Financial support (including equity participation)
3.3 The case of the emerging countries

- **Expected level of maturity of the emerging country**

  - **State level Infrastructure**
    - National policy on nuclear development
    - International commitments on Safety/Security/Safeguards, etc.
    - Public acceptance
    - Legal framework establishment
    - Bilateral agreement

  - **Organizational maturity**
    - Identification of stakeholders
    - Division of responsibility among stakeholders
    - Management system / execution capability

  - **Project level maturity**
    - Project model (including financing structure)
    - Project planning (high level)
    - Project management capability

  - **Capacity building and enhancement of maturity in the course of project execution**
3.3 The case of the emerging countries

What’s necessary for the future projects

- Reducing overall risks
  - Experience of “Success Project”
  - Accumulate experiences and share the best practice
    - Mechanism of sharing best practices
  - Minimize “FOAK” nature of the project
    - Common regulatory requirement
    - International codes and standards
    - Utilization of reliable global supply chain

- Proper risk allocation and Sharing risks among stakeholders
  - Bi and/or Multi national cooperation on infrastructure development, human resource development, etc.
  - Cooperation among experienced intelligent owner/operators
  - Multi source of funding
  - EPC execution by a consortium of experienced companies
Example of Activity for sharing best practice

Outline of “Nuclear Power Plant and Reactor Exporter’s Principles of Conduct (NuPoC)”

What’s NuPoC?     (See Web site in detail : www.nuclearprinciples.org.)

- An industry code of conduct resulting from a three-year initiative to develop norms of corporate self-management in the exportation of nuclear power plants.
- The nuclear power plant industry’s shared high standards in the areas of safety, security, environmental protection and spent fuel management, compensation for nuclear damage, nonproliferation and ethics.
- Addressing not only what exporters should consider in designing the plant but also i) exporter’s expectation for customer countries’ readiness of introducing nuclear, and ii) encouraging exporters’ efforts to help customer to develop its infrastructure

Who participate into the NuPoC?
AREVA, ATMEA, GE Hitachi, Hitachi-GE, KEPCO, MHI, MNES, Rusatom Overseas, Toshiba, Westinghouse, INVAP
4. Summary

- Sure for the future demand of nuclear new build
- The future increase of nuclear installed base is driven by a certain limited countries with stable new build
- The current nuclear installed base of developed countries tends to decrease and more Governmental action seems to be necessary to realize a desirable “energy mix” for the future
- Nuclear new build projects in emerging countries are facing difficulties. The accumulation of success experiences, mechanism of sharing the best practice to mitigate overall risks and proper allocation of remaining risks would be the key for sustainable nuclear new build in the future
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