# Business Briefing on Nuclear Energy Systems

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**MITSUBISHI HEAVY INDUSTRIES, LTD.**

# Business Domains in MHI

| Business domain | Customers / Markets | Segment | | | | | |
|---|---|---|---|---|---|---|---|
| | | Shipbuilding & Ocean Development | Power Systems | Machinery & Steel Infrastructure Systems | Aerospace Systems | General Machinery & Special Vehicles | Others (Air-Conditioning/ Machine Tool) |
| Energy & Environment | • Power companies<br>• Gas companies<br>• Resource companies (oil, chemicals, steel) | | • GTCC<br>• Large-size thermal power plants<br>• Nuclear energy | • Environmental plants<br>• Chemical plants | | | |
| Machinery, Equipment Systems | • Core industries (steel, etc.)<br>• Automotive industry<br>• Logistics, etc. | | • Stationary engines | • Compressors<br>• Metals machinery<br>• Crane & material handling systems | | • Turbo-chargers<br>• Forklift trucks<br>• Engines | • Air-conditioning equipment<br>• Machine tools |
| Transportation | • Airlines (air)<br>• Shipping companies (sea)<br>• Railways (land), etc. | • Commercial Ships | | • Transportation system | • Commercial aircraft | | |
| Defense & Aerospace | • Ministry of Defense (land, sea, air)<br>• JAXA | • Destroyers & submarines for the Ministry of Defense | | | • Defense aircraft<br>• Missiles<br>• Space Systems | • Special vehicles | |

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# 1. Summary of FY 2011

# (1) FY 2011 Highlights

## Domestic Business

### Devoted all our resources to restarting existing plants

- **Full support to operators for emergency safety countermeasures, stress test, and medium- and long-term countermeasures**
- **Delivery of radioactive waste storage facility equipment for restoration of TEPCO's Fukushima Daiichi Nuclear Power Station**

Stress test by MHI

Radioactive waste storage facility equipment (sludge storage tank)

## Global Business

### EU-APWR and ATMEA1 acclaimed, following US-APWR

- **Finland** (March 2012)
  **Order for engineering study of EU-APWR for Olkiluoto unit 4**
- **Jordan** (April 2012)
  **ATMEA1 shortlisted**


A meeting with TVO

Bidding for a Jordan project

# (2) Orders Received in FY 2011

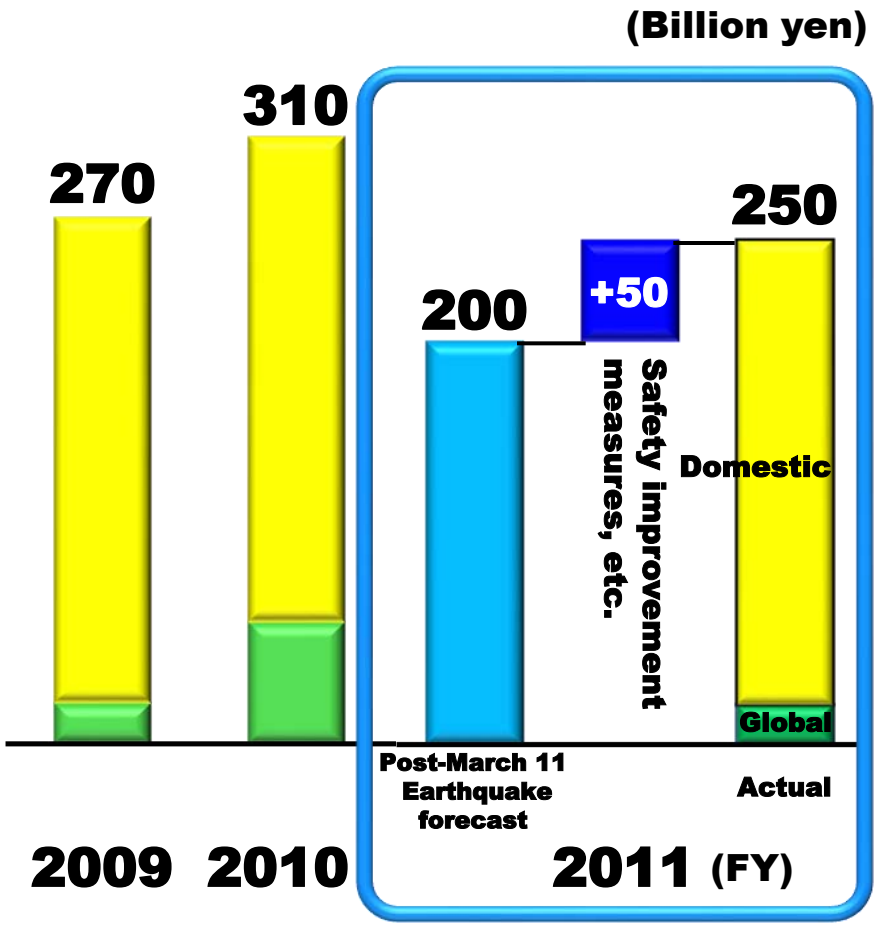
**Secured 250 Billion Yen by safety improvement measures, etc.**

## Domestic

- **Secured orders that exceeded post-March 11 Earthquake forecast by 50 billion yen.**

## Global

- **Received an order for engineering study of EU-APWR in Finland, etc.**



# 2. Outline of 2012 Mid Term Business Plan (2012 Plan)

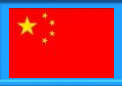
# A Leading Company in the Global Nuclear Energy Field

**Contribute to stable power supply with world's highest level of safety technologies.**

## Strategies

- **Promote domestic business by establishing new safety technologies**
- **Deploy resources to restore TEPCO's Fukushima Daiichi Nuclear Power Station and its future decommissioning**
- **"Selection & concentration" and alliance to accelerate the development of global business**

# (2) Business Environment

| | Right after the earthquake (2011) | Now (2012) | Long term outlook (2020 - 30) |
|---|---|---|---|
| Domestic Business | Secure stable power with operation of existing plants | Delay in restart of existing plants | **Domestic**<br>Retain a Position in Energy Mix Policy |
| Domestic Business | Close watch required for trends on LWR new build and nuclear fuel cycle | Japanese energy policy to be determined by the Energy and Environment Council in the coming summer | |
| Domestic Business / Global Business | Prompt stabilization of TEPCO's Fukushima Daiichi Nuclear Power Station, and deployment of lessons learned | TEPCO's mid-and-long-term roadmap announced<br>Revision of IAEA safety standards started | |
| Global Business | Commitment to continuous promotion of nuclear energy supported by most nations, except Germany, Switzerland, and some other countries |  Impact of the shale gas revolution. In the medium and long term, nuclear energy is an important power source.<br>  Finland is promoting nuclear energy. New French President Francois Hollande intends to maintain nuclear energy.<br>  Increase the electrical capacity of nuclear power stations to 70GW by 2020<br>  Vietnam, Turkey, and Saudi Arabia, etc. are promoting nuclear energy. | **Global**<br>Power Demand will increase by approx. 25% between 2010 and 2020<br>World Energy Outlook Nov. 2011 |

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# The Advisory Committee for Natural Resources and Energy has presented options on the power source ratio in 2030.

## Issues to be considered

| | |
|---|---|
| Stable power supply | ● Electricity Shortage<br>- Operators requested to save power this summer |
| Global warming countermeasures | ● Increase of $CO_2$<br>- Up 2.4% year on year in 2011 |
| Energy security | ● Increase in geopolitical risk<br>- Import dependence on the Middle East: 87% for Crude Oil, 27% for Natural Gas |
| National economy | ● Increase in cost for alternative fuels (Up Y3.1 trillion )<br>● Industrial slow-down |

## Enhancing safety and steps for recovery of public acceptance

| | |
|---|---|
| Improvement and reevaluation of facility | ● Safety improvement measures<br>● Implementation of stress tests |
| For emergency event | ● Implementation of nuclear disaster drills<br>● Allocation of disaster prevention engineers |
| Social acceptability | ● Nuclear Regulatory Agency to be established<br>● Ensuring transparency of activities |

## Energy Policy to be formulated by the Energy and Environment Council (August 2012)

## Proposals presented by the Advisory Committee (May 2012)

| Option | Fundamental idea for nuclear energy | Ratio of nuclear energy (Renewable energy) |
|---|---|---|
| 1) | All forced decommission | 0% (35%) |
| 2) | No new build existing plants with 40-year lifetime | 15% (30%) |
| 3) | Some of new build existing plants with more than 40-year lifetime | 20 - 25% (30 - 25%) |
| 4) (Reference) | Some of new build existing Plants with more than 40-year lifetime | 35% (25%) |
| 5) | Electricity users' choice | - |

(Note) Current ratios:
Nuclear: 26%, Renewable: 11%

## Assumption in 2012 Plan

- Restart of existing plants step by step
- No new build plan in the range of 2012 Plan (by 2014)

## Outlook

- Uncertainties in future:
  - Geopolitical risks including those related to the Middle East
  - Energy system reform
  - Impacts on the economy and employment, etc.
- It is important to review the option appropriately depending on circumstances

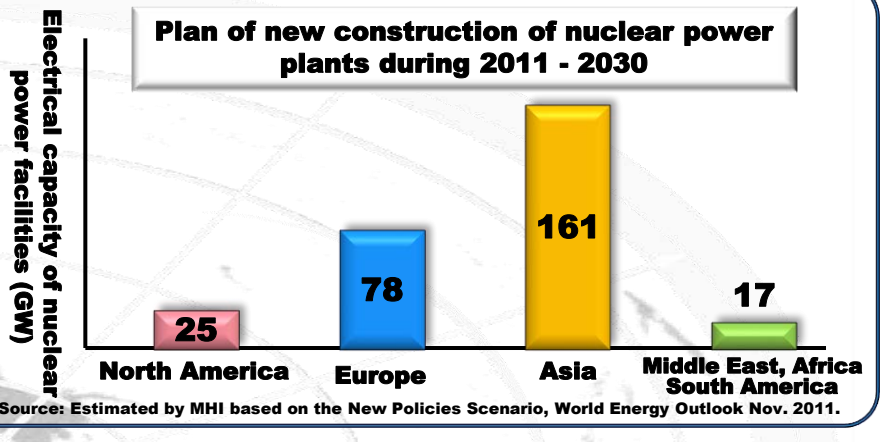
(Data from the Committee, May 28)

# (4) Global Trends on Nuclear Energy



**Nuclear energy regarded as an important power source by developed countries in nuclear field such as United States and France as well as emerging countries.**

- "[Nuclear power provides] electricity without adding carbon dioxide to the atmosphere." "We'll incorporate those conclusions and lessons from Japan in designing and building the next generation of [nuclear] plants." (US President Barack Obama)
- "Nuclear energy's role grows more valuable as we confront a changing climate, increasing energy demand and a struggling economy." (US Energy Secretary Steven Chu)




Source: Estimated by MHI based on the New Policies Scenario, World Energy Outlook Nov. 2011.

- "I do think that nuclear power should be part of the mix in future as it is part of the mix right now." (British Prime Minister David Cameron)
- The UK expects Japan to continue to play an important role in nuclear safety and the peaceful use of nuclear energy globally. (Attachment to the Joint Statement following a UK/Japan summit on nuclear energy)
- I have trust in the nuclear power industry of France. Our policy is to complete the Flamanville EPR, which is a third-generation reactor. (French President Francois Hollande)
- We want to increase the ratio of nuclear power generation from the current 30% to 60% in 20 years. (Jyri Häkämies, Minister of Economic Affairs of Finland)

- The peaceful use of nuclear energy has important meaning as the international community grapples with the energy crisis and climate change. Therefore, the peaceful use of nuclear energy should be promoted. (NPT delegation of China)
- I expect Japan to construct "the safest nuclear reactors using its cutting-edge technology." (Vietnamese Prime Minister Nguyen Tan Dung)
- Given the country's growing energy demands, nuclear energy was "an essential component of our energy mix" (Indian Prime Minister Manmohan Singh)

# (5) Strategic Roadmap and Plan for Orders



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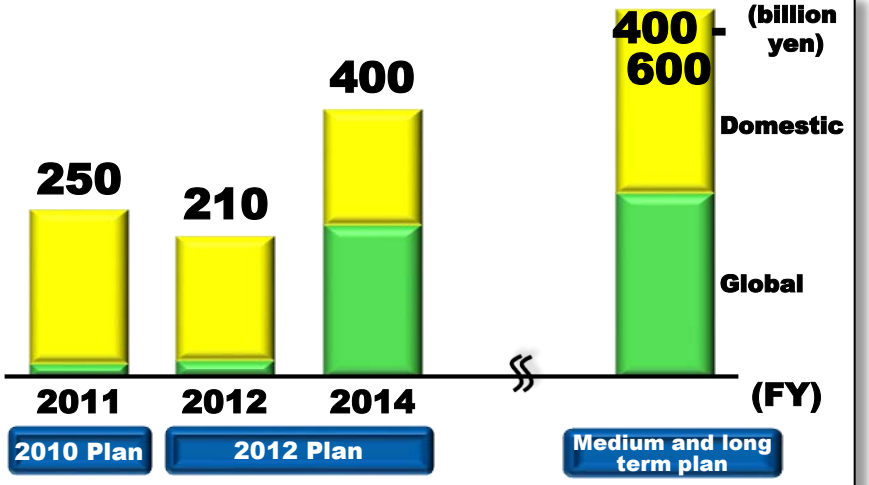
**Maintain the business size and technical capability with domestic AS in the short term and with new construction in overseas countries in the medium term**

## Strategic roadmap

| | 2012 Short term | 2014 | Medium term | 2020 | Long term | 2030 |
|---|---|---|---|---|---|---|
| | Focus on restart and safety improvement of existing plants | | Establish concept of new plant with world's highest level of safety | | | |
| | Full support to TEPCO's mid-and-long-term roadmap with our comprehensive technical capability | | | | | |
| | Obtain DC/COL for US-APWR and U.S. NA3 and CP3/4 | | | | For plant replacement needs in the U.S. | |
| | Obtain EUR certificate for EU-APWR, OL4 in Finland | | | | For forthcoming opportunities in Europe | |
| | Develop ATMEA1 jointly by Japan and France | | First plant in Jordan | | For expansion in global market | |
| | Improve design of the state-of-the-art Tomari Unit3 | | Phase II in Vietna | | Expand domestic business model | |
| | Phase of entry to post-operational services | | Phase of full-scale launch to post-operational services | | Phase of growth and maturity to Post-operational services | |

## Plan for Orders

- In FY 2012, decrease of orders due to decrease of regular outages in Japan and 210 billion yen to be secured mainly from domestic post-operational services including safety improvement measures
- In FY2014, increase of orders to 400 billion yen through overseas new build and alliances
- In the medium and long term, increase of orders to 600 billion yen level through applying our domestic business model to overseas countries




NA3: North Anna Unit 3, CP3/4: Comanche Peak units 3&4,
OL4: Olkiluoto unit 4, DC: Design Certification, COL: Combined License for Construction and Operation

# (6) Tasks and Primary Actions

| | Tasks | Primary Actions |
|---|---|---|
| Domestic business | Timely restart of existing plants | • Apply our best knowledge from the events at TEPCO's Fukushima Daiichi Nuclear Power Station to safety improvement measures for PWR plants<br>• Offer full support to operators for stress test with all our strength |
| | Promotion of new build, nuclear fuel cycle and FBR | • Continue to take measures for achieving energy independence, securing energy over a long term and ensuring safe and stable power supply<br>• Establish PWR plant concept with the world's highest level of safety technologies |
| | Restoration of TEPCO's Fukushima Daiichi Nuclear Power Station and future decommissioning | • Support to TEPCO's mid-and-long-term roadmap with our comprehensive technical capability<br>• Establish decommissioning technologies for future by participation in national research and development projects |
| Global business | Implementation of large-scaled projects | • Selection & Concentration on promising projects to secure orders<br>• Collaborate with MHI Engineering Headquarters for EPC |
| | Enhancement of post-operational services in global market | • Apply the domestic business model to overseas countries<br>• Increase orders through alliances |

# 3. Domestic Business Strategy

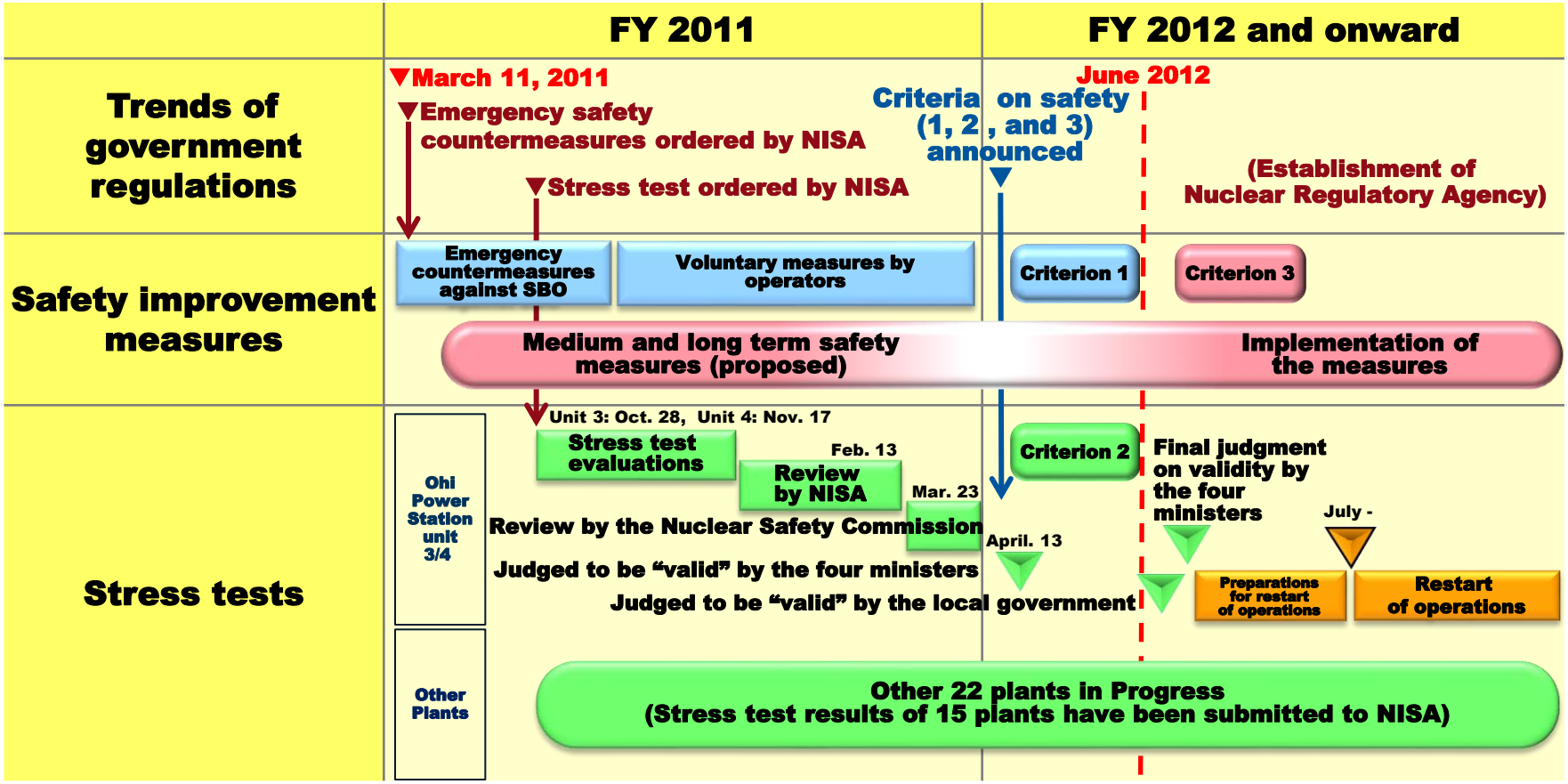
# (1) Approach to Restart Existing Plants (1/2)

## Respond quickly to government's criteria on safety

**Criterion 1: Safety measures to prevent even worse situation after Station Black Out (SBO) (emergency countermeasures for SBO)**

**Criterion 2: Confirming that earthquake or tsunami of unexpected severity do not result in fuel damage (stress tests)**

**Criterion 3: Developing a plan for further safety improvement measures (medium- and long-term measures)**




SBO: Station Black Out
NISA: Nuclear and Industrial Safety Agency

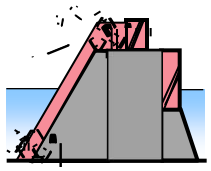
# (2) Approach to Restart Existing Plants (2/2)

**Emergency countermeasures for SBO (Criterion 1) completed for all plants. Stress tests is in progress (Criterion 2). Medium- and long-term safety improvement measures have been proposed (Criterion 3).**

## Emergency countermeasures for SBO (Criterion 1)

- Securing power source and cooling source
- Water tightening

### Nuclear disaster drills

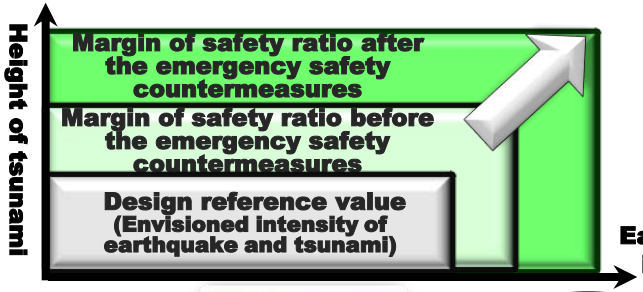


Increase height of Storm surge barrier


Pump for cooling reactor cores


Large capacity pump

## Stress tests (Criterion 2)

- Checking the margins of safety ratio before and after the emergency measures compared to the design reference value

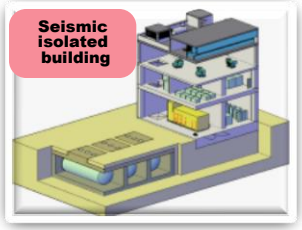






## Medium- and long-term safety improvement measures (Criterion 3)

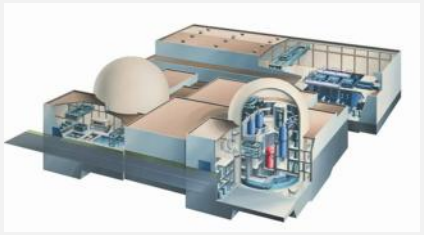
- Further safety improvement



# (3) Measures on Newly Built Plants and Nuclear Fuel Cycle

**Continuing projects for energy independence (securing energy over the long term and ensuring a safe, stable energy supply)**

## New plant



APWR

Next-generation LWR

**Establishing the concept of world's highest level of PWR plant**
(Pursue safety taking countermeasures for severe accident into consideration )

## Interim storage

Cask (drop test of real equipment)

Facility for storing transport/ storage containers (casks)

**Providing highly safe casks and storage facilities**
(Appropriate storage management of spent fuel)

## FBR

Demonstration reactor
(demonstrating innovative technologies)

Commercial reactor
(practical application of FBR)

**Contribute international cooperation in FBR development as a core company**
(Establishing international standards for safety and applying them to commercial reactors)

## Nuclear fuel cycle

Rokkasho Reprocessing Plant

MOX fuel plant

**Support for early completion of the Rokkasho Reprocessing Plant**
(Contributing to energy independence)

FBR: Fast Breeder Reactor

# (4) Activities for TEPCO's Fukushima Daiichi Nuclear Power Station



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## Responding to TEPCO's medium and long term roadmap with commitment and our comprehensive technical capability

▼Mar. 11, 2011 - Dec. 2012

▼Dec. 2011 - ▼Cold shutdown

▼Jan. 2014 - ▼Removing fuels from spent fuel pool ▼Opening RV

▼Jan. 2022 - ▼Removing fuel debris

2041-2050▼ Completion of decommissioning▼

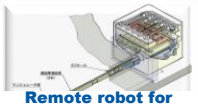
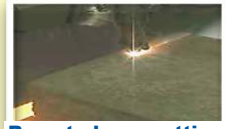
**Step 1 and 2**

**Measures for stabilization (completed)**

Liquid waste storage (Mega-Float)

Forklift with radiation shield cabin

**Decommissioning**

| | | Phase 1 (Within two years of the completion of Step 2) | Phase 2 (Within 10 years) | Phase 3 (30 - 40 years later) |
|---|---|---|---|---|
| Inside the power plant premises | Cooling nuclear reactors and processing accumulated water (Maintain stable state) |  Sludge storage tank;  Multi-purpose tank;  Cylindrical blockers for cesium adsorption tower | Reliability improvement | |
| | Removing fuel from spent fuel pool | National project | Preparation for work/ removal | |
| | Removing fuel debris | Developing methods and devices;  Robot |  Remote robot for inspecting the inside of reactor vessel;  Debris removal method | Removal |
| | Dismantling reactor facilities |  Laser cutting of thick plates;  Remote laser cutting of thick plates | Development of remote dismantling technologies | Making dismantling equipment; Disman-tlement |
| | Treatment and disposal of radioactive waste | Researches and development | Actual works | |
| Outside | Monitoring – final disposal of radioactive waste | Monitoring, decontamination, and disposal (continued) | Interim storage and final disposal | |

Vehicle mounted decontamination water treatment system

Dredging robot (collection of sludge from rivers and sea)


Unmanned Undersea survey tool (marine monitoring)

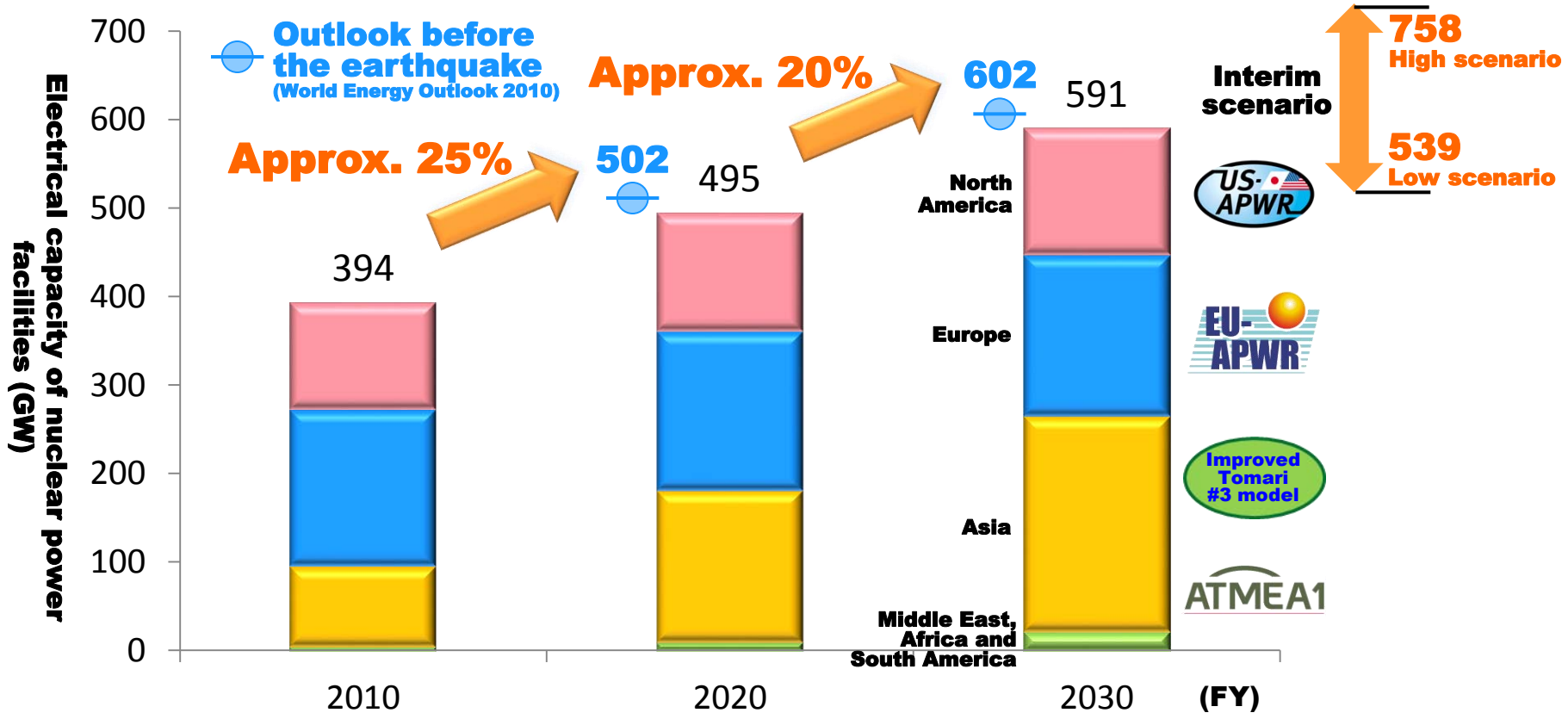
Airborne measurement system (atmosphere monitoring)

(Note) Red: Delivered/To be delivered
Blue: Under consideration/ development

# 4. Global Business Strategy

# Nuclear Plants Continuously Promoted Globally

- **No major change in the demand outlook after the earthquake**
- **Increase by approx. 25% until 2020 and then by approx. 20% until 2030**




Source : World Energy Outlook Nov. 2011 Interim Scenario (New Policies Scenario)

# (2) Large-Size Reactors

## Engineering studies for large-scale projects in the United States and Europe underway

### Dominion: North Anna unit 3
### Luminant: Comanche Peak units 3&4

- DC of US-APWR being accelerated towards completion in 2015, with resolving an impact related to the seismic issue
- For NA3, an MNES engineering center established in North Carolina for licensing and engineering work in progress
- For CP3/4, R-COL licensing work in progress.

**Chairman Farrell of Dominion (1Q 2012 earning call)**

- "I believe NA3 will be built by our Company. Existing units will have to retire in 2030, through that decade. We are going to need to have nuclear power in the state to keep a balanced portfolio."

NA3 (artist rendering)

CP3/4 (artist rendering)

### TVO: Olkiluoto unit 4

**2010**
- Project plan approved by the government of Finland
- EU-APWR selected as one of the candidate reactors

**2012**
- Sponsor and supporter electric company for EUR review determined
- Received order for preliminary engineering study, preparation for bidding underway

**2015**
- TVO's application for a construction license


OL4 (artist rendering)

NA3: North Anna Unit 3, CP3/4: Comanche Peak units 3&4, OL4: Olkiluoto unit 4
NC: State of North Carolina, DC: Design Certification, COL: Combined License for Construction and Operation, EUR: European Utility Requirements

# (3) Medium-Size Reactors

## Global deployment in progress, with projects in Jordan and Vietnam leading the way.

### The first plant in Jordan

ATMEA1

**2011:** Bidding
**Feb., 2012:** Japan-Jordan bilateral agreement came into force.
**Apr.:** ATMEA1 of Japan and France and a Russian PWR (VVER) were shortlisted as candidate reactors
**Dec.:** Reactor to be selected

Candidate site

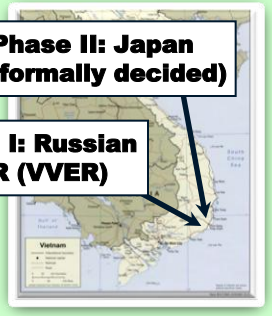

Planned construction site

### Vietnam, Phase II, Unit 1 and 2 at Binhai

Improved Tomari #3 model

**Sept. 2011:**
Concluded an MOU concerning cooperation to construction of a nuclear power plant on the second site of Ninh Thuan province by JINED and EVN
**Jan. 2012:**
Japan-Vietnam bilateral agreement came into force.
**Sept. 2013 or later:**
Reactor to be selected after parliamentary approval

Meeting of JINED and Vietnamese government




Planned construction site

## Global deployment of ATMEA1

**Dec. 2009:** Basic design completed

**Feb. 2012:** Compliance with French safety requirements confirmed by ASN.
Promotion in progress to Hungary, Slovenia, Malaysia, Indonesia, Canada, Brazil, and others.


ATMEA


ATMEA1

JINED: International Nuclear Energy Development of Japan Co., Ltd.
EVN: Electricity of Vietnam
ASN: Nuclear Safety Authority of France

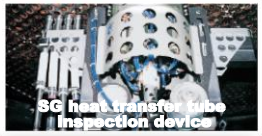
# (4) Post-Operational Services

## Business expansion through advanced maintenance technologies and alliances

## Our core competence

### Accumulated advanced maintenance technologies with all the 24 PWRs in Japan.

- Robotic technologies
- Inspection technologies
- Maintenance and repair technologies






- Improvement of equipment reliability
- Shortening work periods, reducing radiation dosage
- Countermeasures for material degradation

### The first place in component exports in Japan

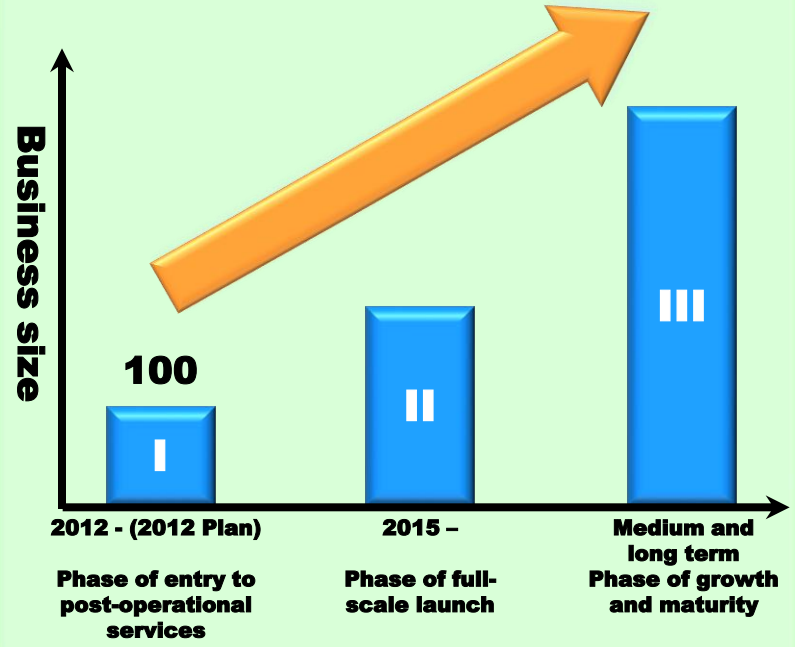
- Manufacturing technologies


- Reactor vessel head: 19 units
- Control rod drive mechanism: 597 units
- Steam generator: 31 units
- Nuclear turbine: 10 units, and others

**Alliances with overseas companies**

## Business growth scenario

I: Establish sales network and organization for on-site work
II: Apply our advanced maintenance technologies
III: Establish post-operational service business



# Enhancing customer services by allocating domestic and global bases

## Domestic bases

### Advanced Plant Safety Department (Aug. 2011)

Improving safety of existing PWR plants

Morning meeting

### Mitsubishi Wakasa Nuclear Plant Technical Support Office (Feb. 2012)

Technical support during normal operation
Support for initial responses to emergencies

The Center's opening ceremony

### Decommissioning Planning Department (Feb. 2012)

Restoration of TEPCO's Fukushima Daiichi Nuclear Power Station and future decommissioning business

Regular meeting

## Global bases

### U.S. MNES NC engineering center (May 2012)

Designing, licensing, and engineering for US-APWR

Opening ceremony of the engineering center

### Liaison Office in Helsinki, Finland (Feb. 2012)

Promotion of EU-APWR

Helsinki office

### COMIA, France (Apr. 2011)

Promotion of maintenance service business in Europe

Regular meeting of the steering committee

### MHI Engineering Headquarters (January 2012)

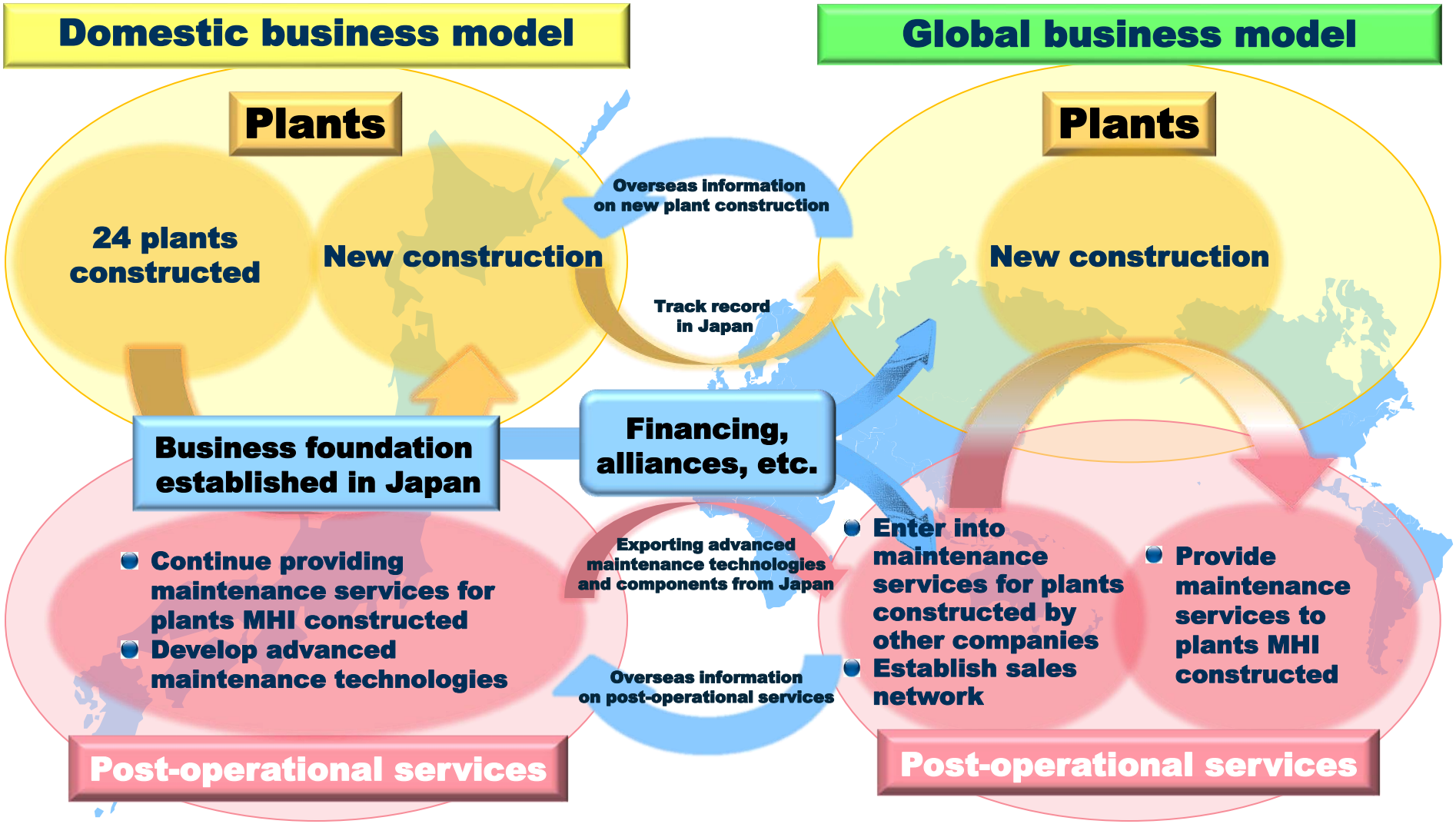
Internal cooperation with the Nuclear Energy Plant Project Management Department being the axis

Nuclear Energy Plant Project Management Department

NC: State of North Carolina

# 6. Evolution of Business Model

## Establishment of domestic-overseas, biaxial structure



# A Leading Company in the Global Nuclear Energy Field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