INTERSESSIONAL PANEL OF THE UNITED NATIONS COMMISSION ON SCIENCE AND TECHNOLOGY FOR DEVELOPMENT (CSTD)

Geneva, Switzerland
6-8 November 2017

Contribution of Japan

to the CSTD 2017-18 priority theme on 'The role of science, technology and innovation to increase substantially the share of renewable energy by 2030'

The role of science, technology and innovation to increase substantially the share of renewable energy by 2030

Regarding the renewable energy policy of Japan, please refer to the FY2016 Annual Report on Energy (Energy White Paper 2017).

In particular, there are Feed-In Tariff systems (FIT) (Energy White Paper 2017 outline slides 17 to 18) and "Fukushima New Energy-Oriented Society Scheme" (Energy White Paper 2017 outline slide 8) as the efforts to disseminate renewable energy.

■Energy White Paper 2017
http://www.meti.go.jp/english/report/downloadfiles/2017_outline.pdf

■Fukushima New Energy-Oriented Society Scheme
http://www.enecho.meti.go.jp/category/saving_and_new/fukushima_vision/pdf/fukushima_plan_en.pdf

経済産業省

FY2016 Annual Report on Energy (Energy White Paper)

June 2017

Agency for Natural Resources and Energy

FY 2016 Annual Report on Energy (Energy White Paper 2016)

- The Energy White Paper is an annual report based on the Basic Act on Energy Policy.* It has been published annually since June 2004.

FY2016 Annual Report on Energy (Energy White Paper 2016) Outline

Part 1 Current Energy Situation and Key Measures (Topics)

Chapter 1 Progress in Fukusima's Reconstruction
- Efforts towards the Decommissioning of TEPCO's Fukushima Daiichi Nuclear Power Station Units 1-4
- Basic Policy for Accelerating Fukushima's Reconstruction from the Nuclear Disaster Revisions of the Act on Special Measures for the Reconstruction and Revitalization of Fukushima and the Act on Nuclear Damage Compensation and Decommissioning Facilitation Corporation, etc.

Describing the progress in Fukushima's reconstruction, which marks a turning point in energy policy

Chapter 2 New Direction of Energy Policy
- Enhancement of energy security (e.g. revision of the JOGMEC Act)
- Energy conservation policy and new energy policy that strike a balance between environmental restrictions and growth (e.g. enforcement of the revised FIT Act)
- Response to problems related to the public interest under Invigoration of competition and liberalization on energy supply (e.g. thorough pursuit of the electricity system reform)

Explaining the backgrounds and ideals of the broad framework of the current energy policy

Chapter 3 Energy System Reform in Japan and Abroad and Trends in the Energy Industry
- Changes in the business environment surrounding overseas energy industries (changes in the market and systems, and technological innovations)
- Trends in the response of overseas energy industries to changes in the business environment (example cases in the United States and Europe)
- Trends in the Japanese energy industry

Describing example cases in the United States and Europe as a reference for strengthening the competitiveness of the Japanese energy industry

Part 2 Energy Trends (Data)

Part 3 Measures Taken in FY2016 concerning Energy Supply and Demand (Measures)

* Article 11 of the Basic Act on Energy Policy:
The Government is required to submit to the Diet an annual report outlining measures taken in the previous fiscal year concerning energy supply and demand.

【Reference】Energy White Papers in Recent Years Concerning Topics in Part I

	Chapter 1	Chapter 2	Chapter 3
FY2015 Annual Report on Energy (Energy White Paper 2016) <Cabinet decision on May 17, 2016>	**Contributions to energy security in the era of low crude oil prices** • Recent crude oil prices and forecast • Need for investment in upstream development and measures • Responses to oil price fluctuation risks (LNG) • Reduction of dependence on crude oil on the demand side (energy conservation)	**Responses to the Great East Japan Earthquake and the Accident at Tokyo Electric Power Company's (TEPCO) Fukushima Daiichi Nuclear Power Station and the Nuclear Energy Policy Based on the Lessons thereof** • Efforts towards the Decommissioning • Support for nuclear disaster victims and the New Energy-Oriented Society Scheme • New nuclear power policy	**Changes in energy policy based on the Paris Agreement** • Influence of the Paris Agreement • Innovative Energy Strategy • New mechanism in the electricity sector
FY 2014 Annual Report on Energy (Energy White Paper 2015) <Cabinet decision on July 14, 2015>	**The Shale Revolution and changes in the global energy situation** • Changes brought about by the Shale Revolution • Impact on and changes in energy security • Future changes in the global energy situation	**Responses to the Great East Japan Earthquake and the Accident at TEPCO's Fukushima Daiichi Nuclear Power Station** • Activities related to decommissioning, support for accident victims, compensation and regulation	**Dealing with energy costs** • Changes in energy and electricity prices • Impact on households and industries • Measures to deal with energy costs
FY2013 Annual Report on Energy (Energy White Paper 2014) <Cabinet decision on June 17, 2014>	**Various Background Factors of the Strategic Energy Plan** • Structural Issues related to the energy situation in Japan • Issues raised after the nuclear accident (safety and cost) • Changes in the geopolitical structure (Shale Revolution, global expansion of nuclear power, and country risks)	**The Great East Japan Earthquake and the review of Japan's energy policies** • Responses to the accident • Measures taken after the accident (resource strategy, promotion of energy conservation, and acceleration of the introduction of renewable energy)	—
FY2012 Annual Report on Energy (Energy White Paper 2013) <Cabinet decision on June 14, 2013>	**Consideration of global experiences related to energy** • Human history and energy • Potential risks behind the complex energy supply chain (case studies of past crises) • Perspectives on the establishment of Japan's future energy policy	**The Great East Japan Earthquake and zero-based review of Japan's energy policies** • Nuclear power regulations and status of support for accident victims • Status of measures taken after the accident (renewable energy, coal-fired thermal power generation, acquisition of resources, electricity system reform, and energy conservation) • Various meetings and deliberations on the Basic Energy Plan	—

Chapter 1 Progress in Fukushima’s Reconstruction

Measures to Deal with the Aftermath of the Accident at Fukushima Daiichi Nuclear Power Station (Measures for decommissioning)

- Concerning measures for decommissioning, **progress was made in activities such as the removal of fuels from the spent fuel pools and the retrieval of fuel debris** based on the Mid-and-Long-Term Roadmap

Measures		FY2015	2016	2017	2018	2019	2020	2021	2022
Fuel removal	Unit 1	Started removal of the covers of the reactor building after implementation of measures to prevent scattering of dust【All roof panels were removed by October 2015.】	Completed removal of the covers of the building【November 2016】	<Image of the building at the time of the start of removal (FY2020)>					
	Unit 2	Decided which portions of the upper part of the Unit 2 building should be dismantled before the selection of removal plans【November 2015】	Started installation of a platform for access to the operating floor【September 2016】	<Image of the removal plans (decided in FY2017)>					
	Unit 3	(Reference) The condition of the operating floor immediately after the accident Completed removal of the largest piece of rubble (appox. 25 tons) in the spent fuel pool【August 2015】	Started installation of removal equipment【January 2017】 Completed decontamination of the operating floor【June 2016】 Completed installation of shields【December 2016】	<Image of the building at the time of start of removal (around the middle of FY2018)>					
		Dismantling of the building covers → Removal of rubble, decontamination, etc. → Installation of covers used for removal of fuels						Removal of fuels (FY2020)	
		Preliminary construction		Dismantling of the upper part of the building, etc.				Removal of fuels (FY2020)	
		Removal of rubble and decontamination → Installation of shields → Installation of covers used for removal of fuels, etc.							Removal of fuels (around the middle of FY2018)
Fuel debris retrieval	Unit 1	Examination of the inside using cosmic ray muon【May 2015】 Examination of the inside using a snake-shaped robot【April 2015】	Started full-fledged operation of Naraha Remote Technology Development Center【April 2016】 Implemented detailed examination of the inside based on the result of the previous examination【March 2017】	Decide the policy for debris retrieval (around summer)	Finally decide the method of debris retrieval (first half)	Continue to conduct R&D based on knowledge and wisdom collected from within and outside Japan			
	Unit 2		Examination of the inside using cosmic ray muon【July 2016】 Examination of the inside using a scorpion-shaped robot【February 2017】						
	Unit 3	Conducted a preliminary survey in preparation for examination of the inside using robots【October 2015】	Scheduled to develop an underwater robot and conduct examination of the inside						
		Grasp of the situation in the nuclear reactor container and consideration of the method of debris retrieval		Engineering work, etc.	Preparation for debris retrieval				Start of debris retrieval for the first unit

Measures to Deal with the Aftermath of the Accident at Fukushima Daiichi Nuclear Power Station (Progress in Contaminated Water Management)

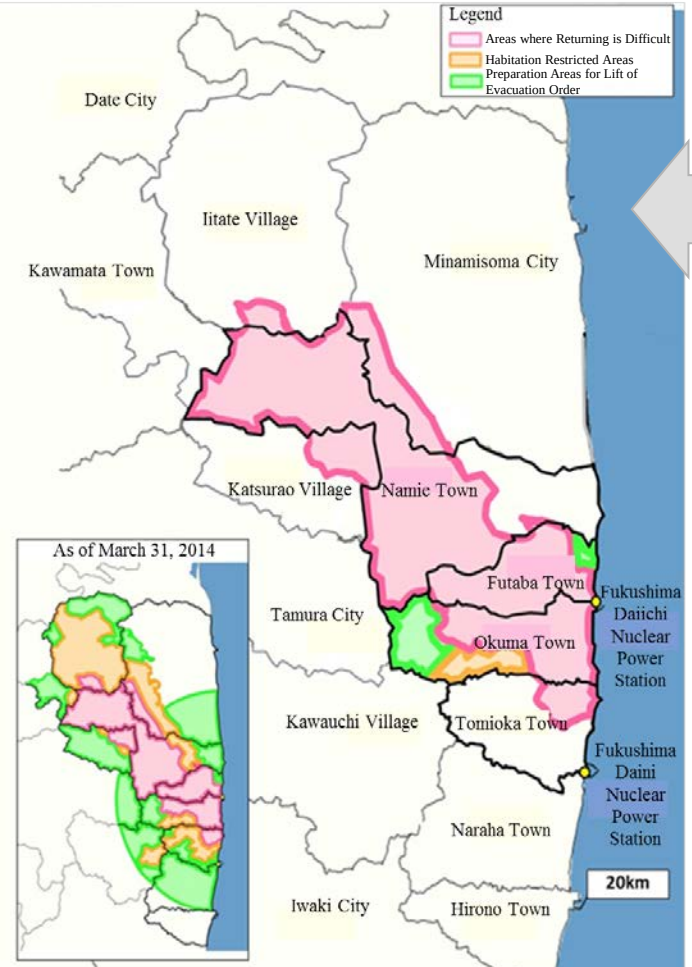
- Concerning contaminated water, measures were implemented in accordance with three principles—**(i) isolating water from the contamination source, (ii) preventing leakage of contaminated water, and (iii) removing contaminated water**—based on the basic policy for the contaminated water issue.

		Measures and the results (until March 2017)	Future outlook
Isolating	Volume of inflow of groundwater into the buildings **Approx. 400 m³/day (From June 2011 to May 2014)**	Operation of the groundwater bypass【From May 2014】Discharged approx. 270,000 tons of water by Mar. 2017 Operation of the sub-drains【From Sept. 2015】Discharged approx. 300,000 tons of water by Mar. 2017 Completion of paving of 92% of the ground of the site【As of Feb. 2017】 **Approx. 300 m³/day (From May 2014 to Sept. 2015)** **Approx. 120m³/day (The target (100 m³/day) was almost achieved) (Mar. 2017)**	Closure of Frozen soil wall (landside impermeable wall) 【Mar. 2016 Start of freezing】【Oct. 2016 Completion of freezing on the sea side】 【Mar. 2017 Freezing process continuing except for one frozen section on the mountain side】Volume of water pumped through the bank area: reduced from around 400 m3/day (before measures were implemented) to the latest average of around 120 m3/day in March 2017 Enhancement of the sub-drain【From Oct. 2016】Expansion of purification facility to two systems, restoration and enhancement of pumping wells and an increase in the number of tanks
Preventing leakage	Concentration of radioactive materials in the surrounding sea area *The value of cesium 137 in waters around the south discharge channel **Approx. 10,000 Bq /L (Mar. 2011)** (Monthly average)	Ground improvement using water glass【Mar. 2014】 Closure of the seaside impermeable wall【Oct. 2015】Start of pumping of water through the groundwater drains following the closure【Nov. 2015】 Installation of more welded tanks【As of Jan. 2017】Welded tanks with combined capacity of approx. 850,000 tons (around 90% of the total capacity of approx. 980,000 tons) **Lower than the detection limit value (0.7 Bq／L) (Mar. 2017)**	Plan for installation of more tanks Additional capacity of approx. 550,000 tons will be created through such measures as installation of new tanks and replacement of flange-type tanks, increasing the total installed capacity of welded tanks to approx. 1.37 million tons by 2020. Treatment of flange-type tanks Various measures will be taken to continue the use of flange-type tanks until 2018, including leak prevention measures such as installation of double dykes, preemptive security measures such as waterproof sealing of side flanges, and four-times-a-day patrol.
Removing	Additional effective doses at the site boundary **Approx. 11 mSv/year (Mar. 2012)**	Treatment of contaminated water in the tanks almost completed【May 2015】→ Cumulative total of approx. 760,000 m³ Treatment by ALPS will be continued to further reduce the risk. Treatment of contaminated water in the trenches wholly completed【Dec. 2015】→ Cumulative total of approx. 10,000 m³ **Less than 1 m Sv/year (Achieved in March 2016)**	Consideration of long-term handling of contaminated water treated by ALPS 【Sept. 2016 Establishment of a subcommittee concerning contaminated water treated by Advanced Liquid Processing System (ALPS)】
Treatment of stagnant water in the buildings		Separation of the Unit 1 turbine building from the circulation water injection line【Mar. 2016】 Exposure of the floor in the Unit 1 turbine building【Mar. 2017】 Treatment of high concentration contaminated water in the condenser Start of removal for Unit 1【Oct. 2016】 Halving of radioactive materials in stagnant water in the building compared with level at the end of FY2014【Jan. 2017】	Completion of treatment of stagnant water in the building【within 2020】

Lifting of Evacuation Orders and Decontamination Activities to Prepare for Return of Evacuees

- By April 1, 2017, evacuation orders were lifted for Tamura City, Naraha Town, Kawauchi Village, Katsurao Village, Minamisoma City, Iitate Village, Kawamata Town, Namie Town and Tomioka Town, which are Preparation areas for lift of evacuation order and Habitation restricted areas.
- **Decontamination was completed by the end of March 2017** based on the decontamination implementation plan in all of the 11 municipalities in Fukushima Prefecture which have been designated as special decontamination areas **except for areas where returning is difficult.**

■Conceptual diagram of areas under evacuation orders (As of April 1, 2017)



[Municipalities where evacuation orders were lifted]

Municipalities	Date of the lifting of the evacuation order
Tamura City	April 1, 2014
Kawauchi Village (areas formerly designated as areas where evacuation orders are ready to be lifted) (areas formerly designated as areas where residents are not permitted to live)	October 1, 2014 June 14, 2016
Naraha Town	September 5, 2015
Katsurao Village	June 12, 2016
Minamisoma City	July 12, 2016
Iitate Village	March 31, 2017*
Kawamata Town	March 31, 2017**
Namie Town	March 31, 2017***
Tomioka Town	April 1, 2017***

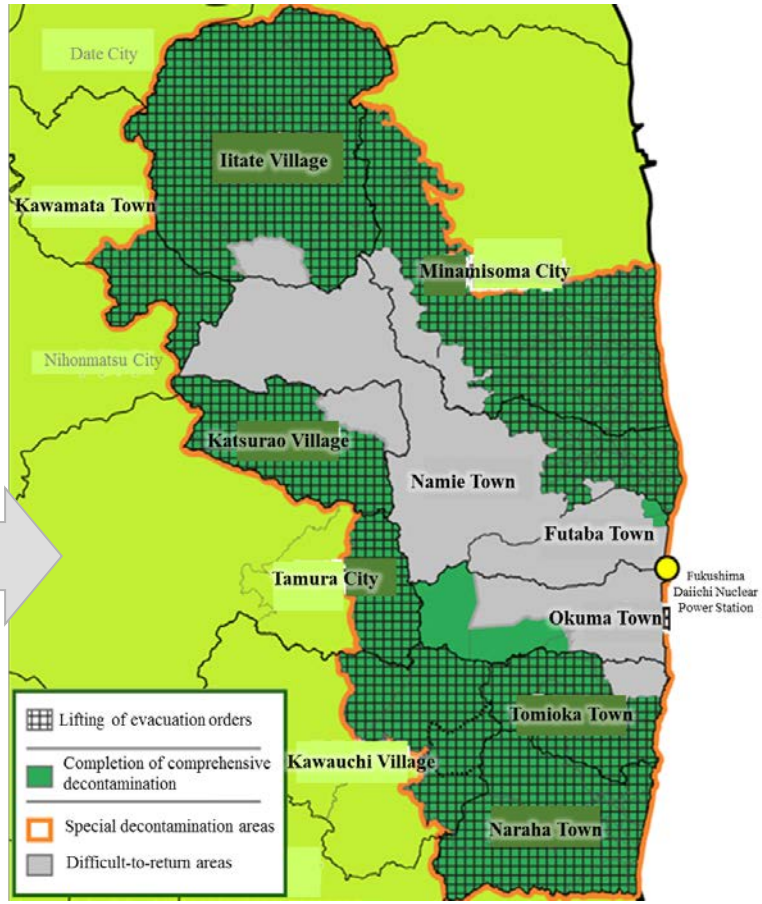
Decided by the Nuclear Emergency Response Headquarters on June 17, 2016 (*), on October 28, 2016 (**) and on March 10, 2017 (***)

[Municipalities where comprehensive decontamination was completed]

Municipalities	Date of the completion of decontamination*
Tamura City	June, 2013
Naraha Town	March, 2014
Kawauchi Village	March, 2014
Okuma Town	March, 2014
Katsurao Village	December, 2015
Kawamata Town	December, 2015
Futaba Town	March, 2016
Iitate Village	December, 2016
Tomioka Town	January, 2017
Minamisoma City	March, 2017
Namie Town	March, 2017

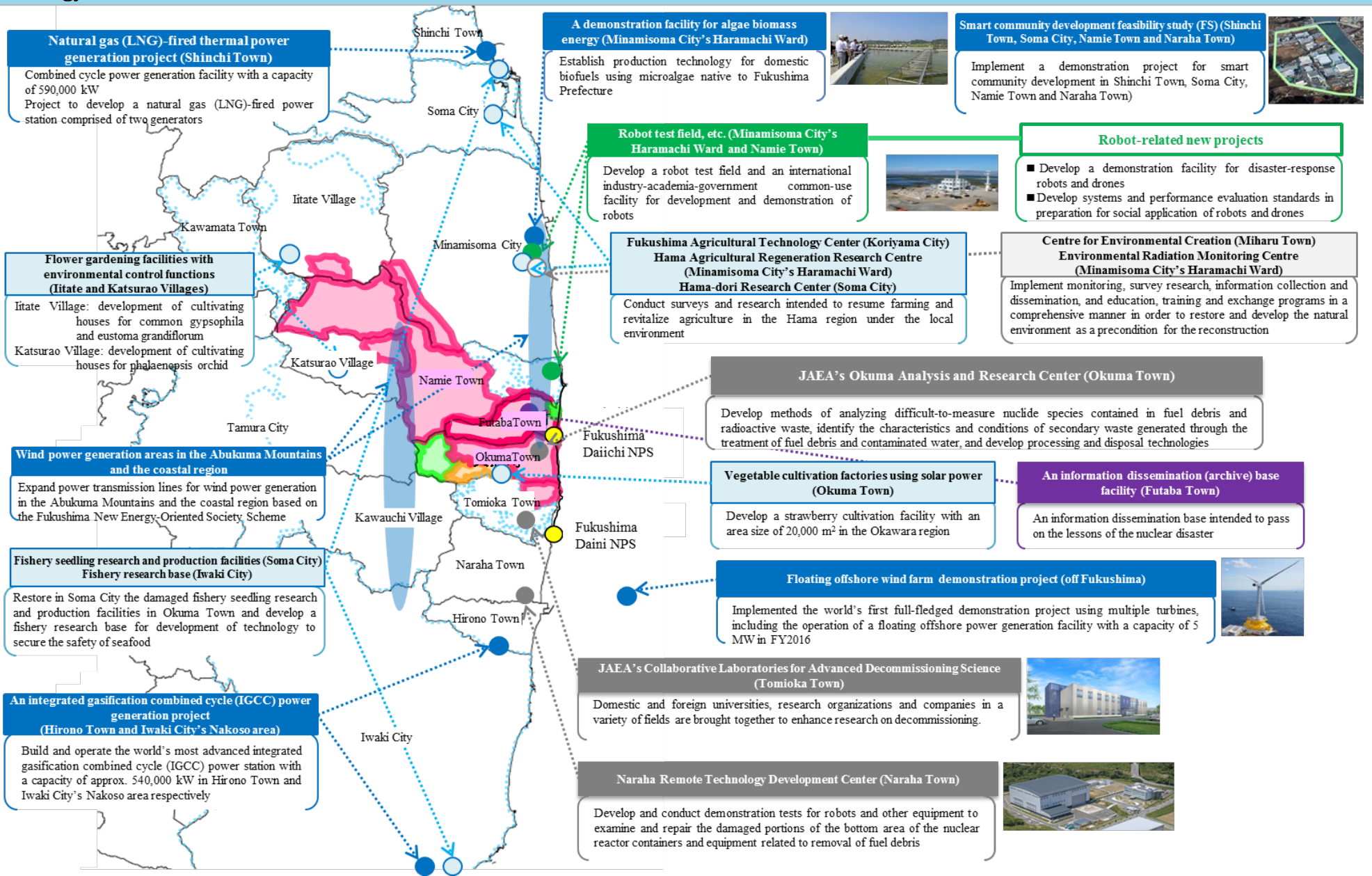
*The dates of completion of decontamination indicated above are the dates when comprehensive decontamination was completed in the areas designated for decontamination under the municipalities' decontamination plans for which consent was obtained.

■Progress in decontamination directly implemented by the national government (April 2017)



Promotion of the Fukushima Innovation Coast Framework

- Realize **the Fukushima Innovation Coast Framework** as the pillar of Fukushima's reconstruction by creating world-leading new technologies and industries through the technical innovations and the establishment of technology development bases in such fields as **robotics, decommissioning and energy**.



Natural gas (LNG)-fired thermal power generation project (Shinchi Town)

Combined cycle power generation facility with a capacity of 590,000 kW
Project to develop a natural gas (LNG)-fired power station comprised of two generators

A demonstration facility for algae biomass energy (Minamisoma City's Haramachi Ward)

Establish production technology for domestic biofuels using microalgae native to Fukushima Prefecture

Smart community development feasibility study (FS) (Shinchi Town, Soma City, Namie Town and Naraha Town)

Implement a demonstration project for smart community development in Shinchi Town, Soma City, Namie Town and Naraha Town)

Robot test field, etc. (Minamisoma City's Haramachi Ward and Namie Town)

Develop a robot test field and an international industry-academia-government common-use facility for development and demonstration of robots

Robot-related new projects

- Develop a demonstration facility for disaster-response robots and drones
- Develop systems and performance evaluation standards in preparation for social application of robots and drones

Flower gardening facilities with environmental control functions (Iitate and Katsurao Villages)

Iitate Village: development of cultivating houses for common gypsophila and eustoma grandiflorum
Katsurao Village: development of cultivating houses for phalaenopsis orchid

Fukushima Agricultural Technology Center (Koriyama City)
Hama Agricultural Regeneration Research Centre (Minamisoma City's Haramachi Ward)
Hama-dori Research Center (Soma City)

Conduct surveys and research intended to resume farming and revitalize agriculture in the Hama region under the local environment

Centre for Environmental Creation (Miharu Town)
Environmental Radiation Monitoring Centre (Minamisoma City's Haramachi Ward)

Implement monitoring, survey research, information collection and dissemination, and education, training and exchange programs in a comprehensive manner in order to restore and develop the natural environment as a precondition for the reconstruction

JAEA's Okuma Analysis and Research Center (Okuma Town)

Develop methods of analyzing difficult-to-measure nuclide species contained in fuel debris and radioactive waste, identify the characteristics and conditions of secondary waste generated through the treatment of fuel debris and contaminated water, and develop processing and disposal technologies

Wind power generation areas in the Abukuma Mountains and the coastal region

Expand power transmission lines for wind power generation in the Abukuma Mountains and the coastal region based on the Fukushima New Energy-Oriented Society Scheme

Vegetable cultivation factories using solar power (Okuma Town)

Develop a strawberry cultivation facility with an area size of 20,000 m² in the Okawara region

An information dissemination (archive) base facility (Futaba Town)

An information dissemination base intended to pass on the lessons of the nuclear disaster

Fishery seedling research and production facilities (Soma City)
Fishery research base (Iwaki City)

Restore in Soma City the damaged fishery seedling research and production facilities in Okuma Town and develop a fishery research base for development of technology to secure the safety of seafood

Floating offshore wind farm demonstration project (off Fukushima)

Implemented the world's first full-fledged demonstration project using multiple turbines, including the operation of a floating offshore power generation facility with a capacity of 5 MW in FY2016

JAEA's Collaborative Laboratories for Advanced Decommissioning Science (Tomioka Town)

Domestic and foreign universities, research organizations and companies in a variety of fields are brought together to enhance research on decommissioning.

An integrated gasification combined cycle (IGCC) power generation project (Hirono Town and Iwaki City's Nakoso area)

Build and operate the world's most advanced integrated gasification combined cycle (IGCC) power station with a capacity of approx. 540,000 kW in Hirono Town and Iwaki City's Nakoso area respectively

Naraha Remote Technology Development Center (Naraha Town)

Develop and conduct demonstration tests for robots and other equipment to examine and repair the damaged portions of the bottom area of the nuclear reactor containers and equipment related to removal of fuel debris

Fukushima New Energy-Oriented Society Scheme

● Aiming to **turn the whole of Fukushima Prefecture into a base for the creation of a pioneering model of a future new energy-oriented society** in order to further strengthen support for Fukushima's reconstruction while **accelerating renewable energy and other initiatives in the energy sector** under the Fukushima Innovation Coast Framework and using the results (September 7, 2016: Council for Realizing the Fukushima New Energy-Oriented Society Scheme)

Fukushima Innovation Coast Framework
Energy-related industrial projects

Expansion of introduction of renewable energy

○ Fukushima Renewable Energy Institute, AIST
- Opened in Koriyama City in April 2014

○ Fukushima Floating Offshore Wind Farm
- A turbine with a capacity of 2MW was installed and started operation in 2013, a turbine with a capacity of 7MW was installed and started operation in 2015, and a turbine with a capacity of 5MW was installed in 2016.

○ Support for introduction of renewable energy
- Support introduction of equipment in addition to support through the FIT system (FY2014 supplementary budget: 9.2 billion yen)

○ Demonstration of a large storage battery for power grids
- Tohoku Electric Power's power substation in Minamisoma (started operation in February 2016)

Development of a model for realizing a hydrogen society

○ Basic technology research concerning a hydrogen energy carrier (MCH: methylcyclohexane)
- Fukushima Renewable Energy Institute, AIST (from 2014)

Development of a smart community

○ Implement a project to build smart communities for community reconstruction

Accelerate activities

Use the results

Start new activities

Turn the whole of Fukushima into a pioneering model base of a future new energy-oriented society

○ Intensively implement projects under various ministries' budgets in Fukushima
○ Disseminate technologies and models developed in Fukushima to other regions in Japan and abroad
- Organize inspection tours by diplomatic missions in Tokyo and hydrogen-related international conferences

Expansion of introduction of renewable energy
~Expand the power transmission network in order to further expand introduction~

○ Expand power transmission lines for wind power generation in the Abukuma and Futaba areas
→ **A power transmission company was established in March 2017.**
Detailed design work and installation of a power transmission network will start in FY2017.

Development of a model for realizing a hydrogen society
~Creation of an integrated model for realizing a cycle of generating hydrogen from renewable energy and storing, transporting and using it~

○ Large-scale production of hydrogen using renewable energy (capacity of 10,000 kW, the largest in the world)
→ **Selected a candidate company for implementing a demonstration in late September 2016. Currently, the candidate company is conducting a FS (the study to be concluded around summer)**
○ Demonstration of next-generation technologies to transport and store hydrogen (to be used during the 2020 Olympic and Paralympic Games in Tokyo)
○ Expansion of hydrogen use
- Support development of hydrogen stations and expand introduction of FCVs, FC buses and FC forklifts

Building of smart communities
~Support community reconstruction based on the use of renewable energy and hydrogen~

○ Create a model of a CO_2-free hydrogen town
○ Extend the initiative throughout the prefecture (conduct FS)
→ **Naraha and Shinchi Towns and Soma City have formulated master plans.**
Namie Town will formulate a master plan by around the summer of 2017.

Outline of the Act on Nuclear Damage Compensation and Decommissioning Facilitation Corporation【Nuclear Damage Compensation Act】

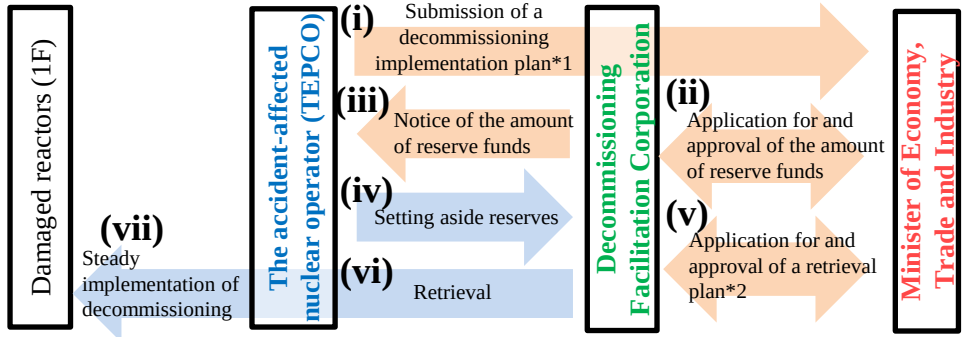
- To further accelerate Fukushima's reconstruction and revitalization, a cabinet decision on the "Basic Policy for Accelerating Fukushima's Reconstruction from the Nuclear Disaster" was made in December in 2016 for the purpose of implementing additional measures and expanding existing measures as necessary. In particular, the decommissioning of 1F will enter a new process of removing fuel debris (melted fuel rods), so the necessary amount of funds is expected to increase, requiring appropriate countermeasures.
- **To secure decommissioning of the damaged reactors**, measures based on the Basic Policy for Accelerating Fukushima's Reconstruction from the Nuclear Disaster will be implemented with respect to the nuclear operator engaging in the decommissioning work, including **obligating the operator to set aside reserve funds necessary for the decommissioning at the Nuclear Damage Compensation and Decommissioning Facilitation Corporation (Decommissioning Facilitation Corporation)**.

Outline of the measures to be implemented

(1) Establishment of a reserve fund system

The accident-affected nuclear operator is obligated to set aside reserve funds necessary for decommissioning of the damaged reactors at the Decommissioning Facilitation Corporation every year and obtain approval for funding plans (retrieval plans) for steadily implementing decommissioning.

- **The accident-affected nuclear operator** is obligated to submit a decommissioning implementation plan to **the Minister of Economy, Trade and Industry** through **the Decommissioning Facilitation Corporation**. ((i))
- Based on the implementation plan, **the Decommissioning Facilitation Corporation** is obligated to determine the amount of reserve funds every year subject to approval from **the Minister of Economy, Trade and Industry**, while **the accident-affected nuclear operator** is obligated to set aside the determined amount of reserve funds at the corporation. ((ii), (iii) and (iv))
- When retrieving funds necessary for decommissioning, **the accident-affected nuclear operator** is obligated to formulate a retrieval plan together with **the Decommissioning Facilitation Corporation** and obtain approval from **the Minister of Economy, Trade and Industry**. ((v))
- Based on the approved retrieval plan, **the accident-affected nuclear operator** retrieves funds necessary for decommissioning and steadily implements the decommissioning. ((vi) and (vii))



*1 Implementation plan for decommissioning: plan for concrete actions based on the Mid-and-Long-Term Roadmap

*2 Retrieval plan: formulated jointly by the accident-affected operator and Decommissioning Facilitation Corporation
Describes a multi-year funding plan

(2) Onsite inspection of the accident-affected nuclear operator

Employees of the Ministry of Economy, Trade and Industry or the Decommissioning Facilitation Corporation are empowered to conduct onsite inspection of the headquarters of the accident-affected nuclear operator and the accident site when necessary to do so in order to approve the amount of reserve funds, for example.

* Five years after the entry-into-force, the managed reserve fund system will be reviewed as necessary, and necessary measures will be taken based on the results.

Outline of the Act on Special Measures for the Reconstruction and Revitalization of Fukushima【Fukushima Special Measures】

● Implement measures necessary for **developing institutional systems to reconstruct and revitalize Specified Reconstruction and Revitalization hubs, strengthening organizations responsible for reconstructing and revitalizing** businesses of disaster-affected business operators, **establishing new industrial bases** in the Hama-dori region and **restoring reputational damage done by rumors** to agricultural, forestry and fishery products produced in Fukushima Prefecture

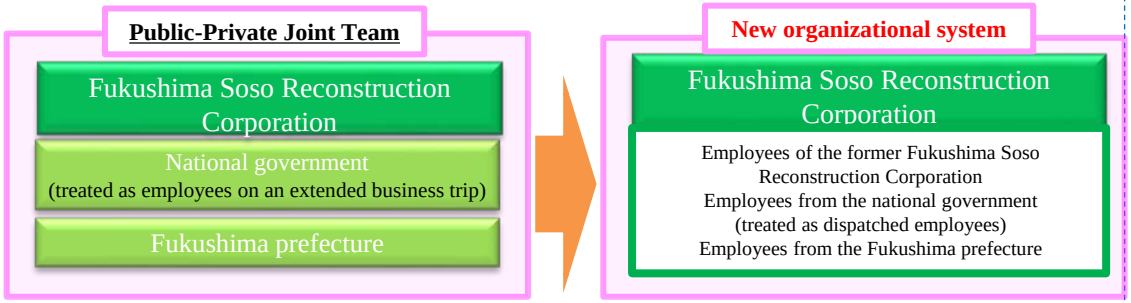
1. Establishment of plans and programs to promote reconstruction and revitalization of Specified Reconstruction and Revitalization hubs

Mayors will formulate plans for promoting reconstruction and revitalization of Specified Reconstruction and Revitalization hubs in parts of the difficult-to-return areas for which the goal is lifting the evacuation order and enabling returnees to live there. If the plans are approved, the following programs can be used.

- ○ The national government will implement decontamination and disposal of waste in accordance with the approved plans. (the cost will be borne by the national government)
- ○ The national government will implement infrastructure projects, including building new roads, on behalf of the municipalities.
- ○ Special cases of taxation related to capital investment necessary for resumption of business by disaster-affected business operators and promotion of business location by new business operators
- ○ Application of a program to develop a reconstruction and revitalization base in a housing complex zone in order to develop a new urban area through a comprehensive purchase method

2. Enhancement of the organizational system of the Public-Private Joint Team

To achieve organizational integration of the Public-Private Joint Team (comprised of the national government, Fukushima prefecture, Fukushima Soso Reconstruction Corporation, etc.) that is responsible for supporting the business reconstruction of disaster-affected business operators, Fukushima Soso Reconstruction Corporation (public corporation), which is the core of the team, acquired a legal status such that national government officials can be dispatched while retaining the original employee status.



3. Legislation for Promoting the Fukushima Innovation Coast Framework

To further promote the Fukushima Innovation Coast Framework in the Hama-dori region, the areas where activities related to the Framework and the activities will be specified in the legally prescribed priority promotion plan in order to grant patent fee waivers or reductions related to research results for small and medium-size enterprises and to enable low-cost use of government-owned test and research facilities for the purpose of promoting the development of new robot products and technologies. In addition, a working group will be established under the Council for the Reconstruction and Revitalization of Fukushima Following the Nuclear Disaster to develop a system for relevant organizations to cooperate in promoting the Innovation Coast Framework.

4. Measures to eliminate reputation damage

To eliminate reputation damage on agricultural, forestry and fishery products produced in Fukushima Prefecture, the implementation of surveys on the sales status and measures based on the survey results, such as provision of guidance and advice, was legally prescribed.

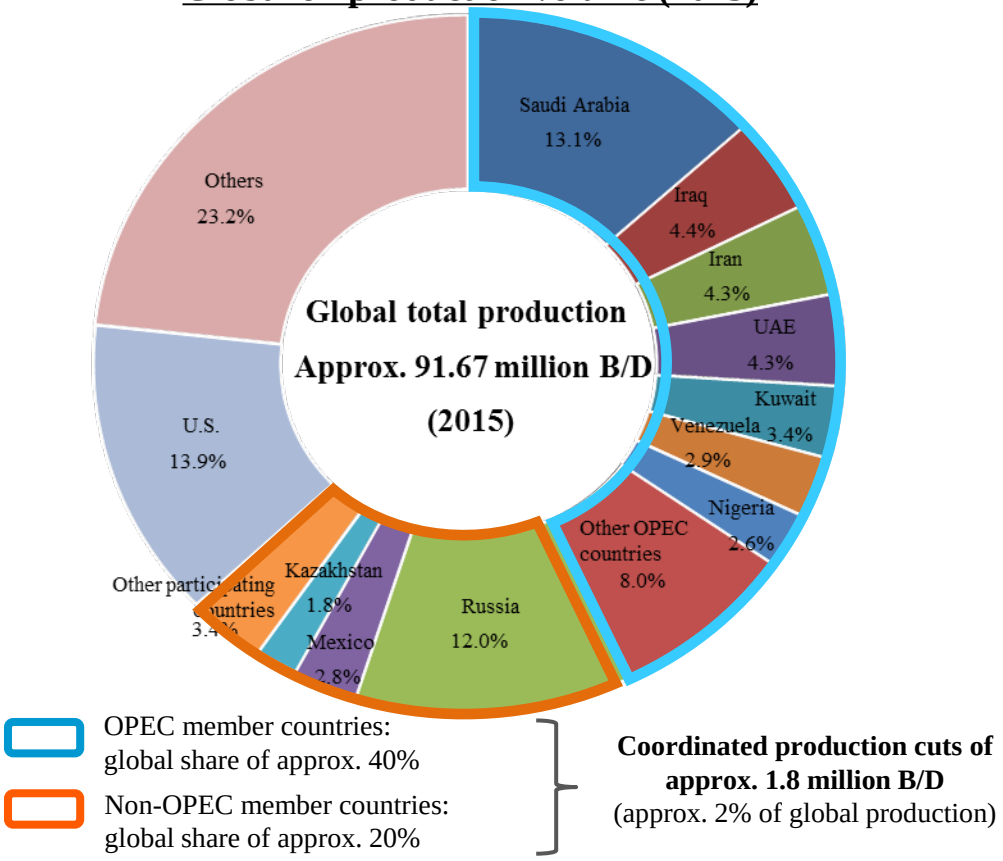
*In addition, the following measures will be legally prescribed in order to promote them: (i) establishment of companies which engage in community building to develop an environment for the return of evacuees in the disaster-affected 12 municipalities; (ii) measures to prevent bullying of children; and (iii) securing of means of transportation for local residents.

Chapter 2 New Direction of Energy Policy

Enhancement of Energy Security: Trends in the International Crude Oil Market

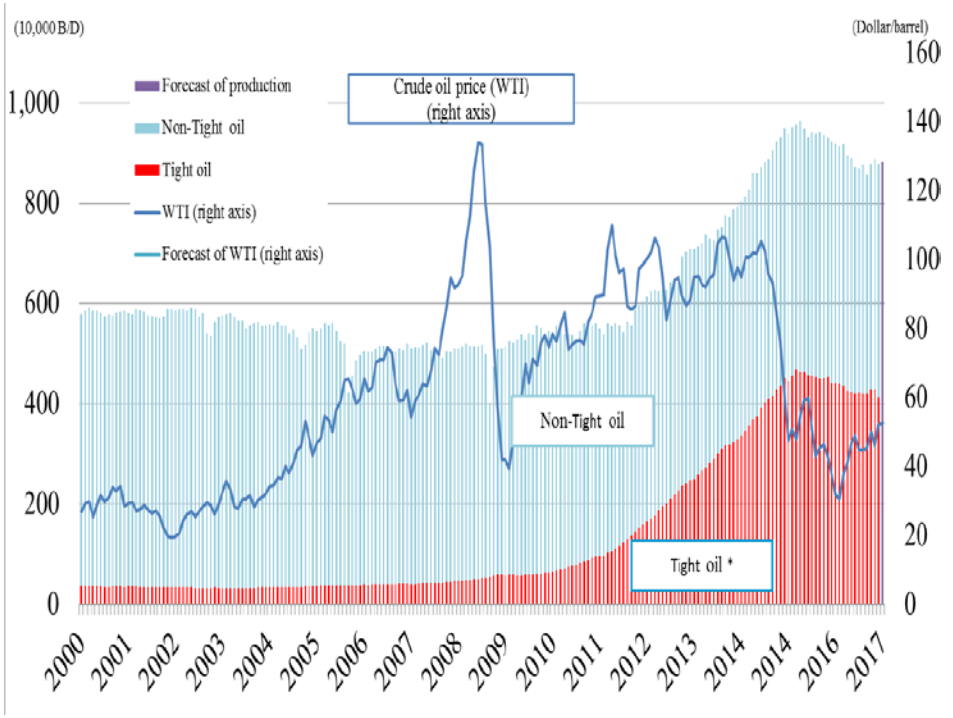
- Since July 2014, the international crude oil price has rapidly dropped due to factors such as the economic slowdown of emerging countries, an increase in U.S. shale oil and the high level of production volume in OPEC countries**. <u>In February 2016, the price fell to 26.21 dollars/barrel, the lowest level since 2003.</u>**
- At a **<u>regular OPEC conference</u> in November 2016**, OPEC countries, which until then maintained the strategy of retaining market share, **<u>agreed to reduce production</u>** following a prolonged slump in the crude oil price. In December, OPEC countries **<u>agreed</u>** with Russia and other **<u>major non-OPEC oil-producing countries on coordinated production</u>**.
- In response to these moves, the crude oil price rose somewhat and has recently stayed at around 50 dollars/barrel. On the other hand, the possibility was pointed out that the crude oil price may decline again depending on **the status of compliance with the agreement on production cuts and the trend in U.S. shale oil production.**

<u>Global oil production volume (2015)</u>



Source: Prepared by the Agency for Natural Resources and Energy based on BP Statistics (2016)

<u>Changes in U.S. crude oil production volume, etc.</u>



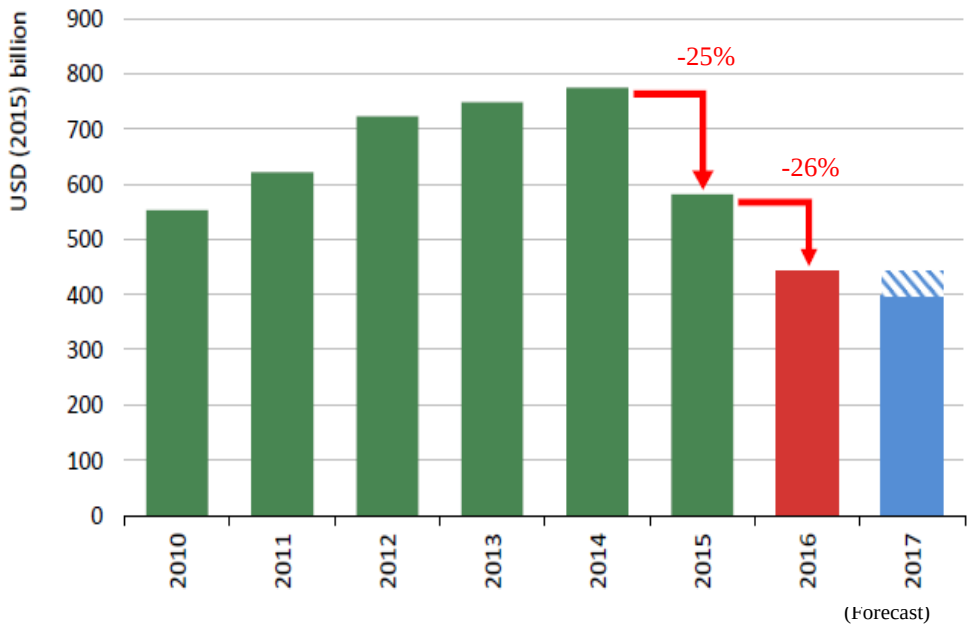
※Include Tight oil

Source: Prepared by the Agency for Natural Resources and Energy based on statistical data published by the U.S. Energy Information Administration

Enhancement of Energy Security: Resource Strategy amid the Oil Price Slump

- Because of the oil price slump, the fundamental strength of oil and natural gas development companies has declined steeply, **leading to a sharp fall in investments in oil and natural gas upstream development.** (a fall of 25% in 2015 and of 26% in 2016 compared with the previous year)
- On the other hand, the oil price hit bottom at around 25 dollars/barrel, and U.S. and European oil majors and, the Chinese and Indian governments and state-owned oil companies **have stepped up acquisitions of resource rights and companies since 2016** because of expectations for a future crude oil price rise.
- In Japan, too, the JOGMEC Act was revised in November 2016 to provide strong support for **the enhancement of international competitiveness through corporate acquisitions by companies engaging in upstream development.** The goal is to create core companies with a daily production volume of more than 1 million barrels.

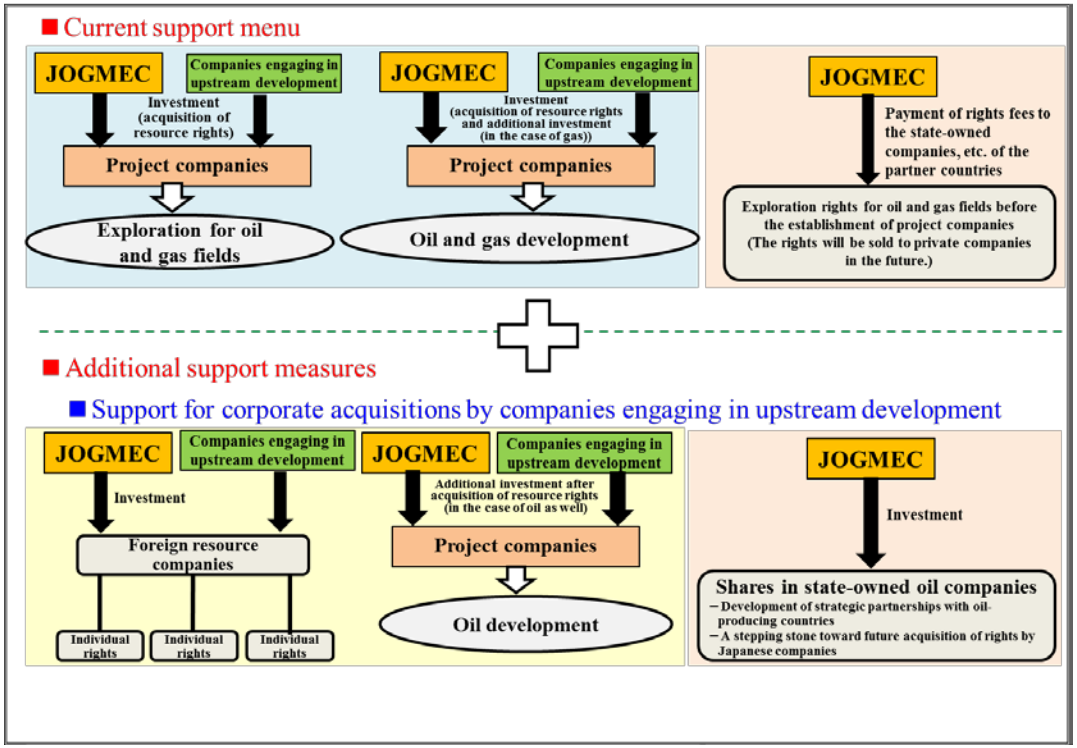
A fall in global investments in upstream development



Source: World Energy Investment 2016, IEA

Outline of the revision of the JOGMEC Act

(JOGMEC: Japan Oil, Gas and Metals National Corporation)



Source: Prepared by the Agency for Natural Resources and Energy

Enhancement of Energy Security: Realization of an LNG Market with High Liquidity

- LNG contracts concluded by Japanese companies are mainly **long-term ones** to which **destination clauses** are attached and under which **the LNG price is tied to the crude oil price**, making it difficult to flexibly buy or sell LNG depending on the supply-demand relationship.
- The market environment surrounding LNG in Japan and abroad is changing drastically, as exemplified by the U.S. Shale Revolution and the electricity and gas market liberalization in Japan. **For Japan, which is the world's largest LNG importing country, to play the leading role in realizing a transparent and highly flexible international LNG market**, the government announced the Strategy for LNG Market Development in May 2016.
- The public and private sectors will work together to realize the following three elements: improvement in the ease of trade, development of an appropriate price discovery mechanism, and open and adequate infrastructure.

Vision of ideal LNG transactions

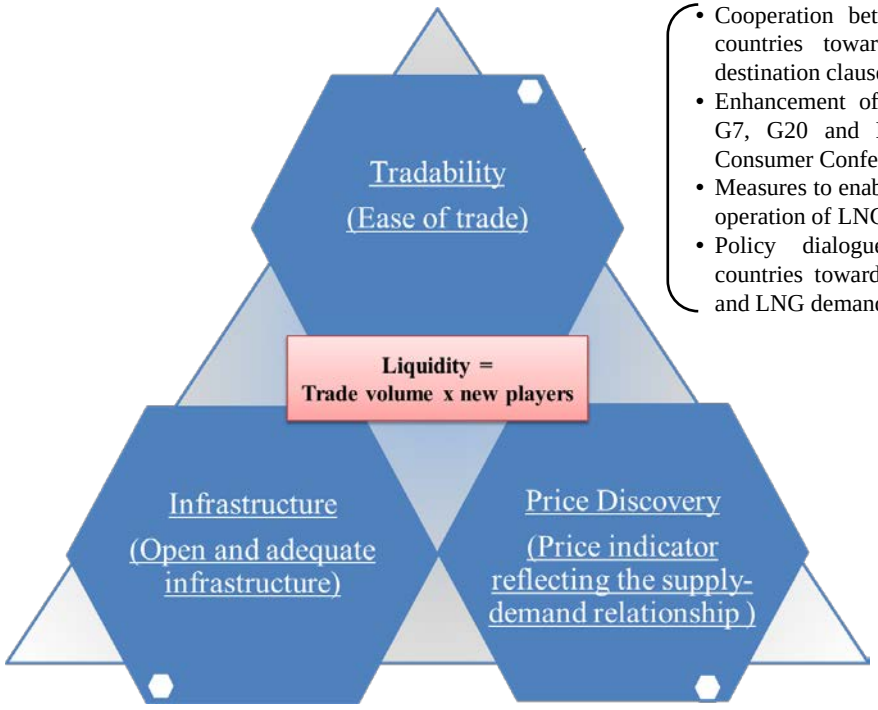
Existing LNG transactions

- Long-term contracts are the mainstay.
- Resale is restricted under destination clauses.
- The LNG price is tied to the oil price.

Future LNG transactions

- Long-term transactions will be limited to a necessary minimum, while short-term contracts and spot transactions will be actively used.
  → **Stabilize the supply-demand relationship**
- Destination clauses will be abolished or relaxed so that resale and arbitrage trade can be used.
  → **Curb the price**
- Set the price in a way that reflects the supply-demand relationship
  → **Stabilize and enhance the transparency of pricing**

Three basic elements for realizing an LNG market with high liquidity



- Cooperation between consumer countries toward abolition of destination clauses
- Enhancement of cooperation at G7, G20 and LNG Producer-Consumer Conference
- Measures to enable more flexible operation of LNG ships
- Policy dialogue with Asian countries toward expanding gas and LNG demand

Development of adequate domestic infrastructure, including new LNG terminals

Establishment of an LNG price indicator reflecting the supply-demand relationship in Japan

【Reference】Enhancement of Energy Security: Development of Domestic Energy and Mineral Resources

- Domestic energy and mineral resources are more stable than energy supply sources that rely on imports from overseas.
- In order to promote the development of domestic resources, the government is engaging in research and development activities, including the development of production technology intended to conduct survey and exploration activities concerning conventional resources such as oil and natural gas, and commercialize non-conventional resources, such as methane hydrate and seafloor hydrothermal deposits.

	Oil and natural gas	Methane hydrate	Seafloor hydrothermal deposits, etc.
			
Status of development	<Resource volume surveys> ○ The Shigen 3D geophysical exploration ship will be used to conduct basic geophysical exploration of areas totaling around 62,000 km^2 by fiscal 2018. ○ By fiscal 2016, areas totaling 48,000 km^2 have been explored. At more than 70 locations in the explored areas, the presence of strata that may contain oil or gas reserves were confirmed. <A drilling survey> ○ From June to October 2016, a drilling survey was conducted in the seas off Shimane and Yamaguchi. Various geological data were obtained, and signs indicating the presence of a thin gas layer and gas were confirmed in the target stratum. At the deepest point, a strong gas seepage indicating the presence of a high-pressure gas layer was found. ○ In the future, detailed analysis and evaluation of geological data obtained through the drilling survey will be conducted and the oil and natural gas potentials around the surveyed sea area will be estimated.	<Sand layer pore-filling type of methane hydrate> ○ In April-May 2016, preliminary drilling was conducted in the test sea area in preparation for the second offshore production test. The offshore production test was conducted in April-June 2017. ○ After the test, technology development will be conducted based on the test results toward the launch of a commercialization project led by private companies in consideration of the international situation. <Shallow-type methane hydrate> ○ The results of examination of a resource volume survey conducted mainly in the Sea of Japan in fiscal 2013 to 2015 were announced in September 2016. ○ In the future, the government will conduct survey and research activities concerning recovery technology and surveys intended to examine the distribution of shallow-type methane hydrate, the notable surface features of the deposits and the characteristics of the subsurface.	＜Resource volume surveys＞ ○ Four new promising deposits were discovered in the Okinawa sea area. Efforts will be continued to discover additional promising deposits. ○ In fiscal 2016, the resource volume in the Izena cauldron in the Okinawa sea area was confirmed to be 7.4 million tons. In the future, boring surveys will be conducted in order to identify the resource volume of the deposits already known. <Development of extracting and lifting technology> ○ Concerning the extracting technology to drill for seabed ore, Japan succeeded in the sea trial of a drilling test machine in fiscal 2012 for the first time in the world. ○ In fiscal 2016, an underwater pump to lift ore and water up to a ship from 1,600 meters deep under the sea was manufactured. ○ In fiscal 2017, the world's first extracting and lifting pilot test is scheduled to be conducted.

Balancing the Environment and Economy: Balancing Thorough Energy Conservation and Economic Growth

- Under the energy mix plan, final energy consumption is estimated to be reduced by approx. 50.3 million kl in crude oil equivalents in FY2030 through energy conservation based on the assumption of annual economic growth of 1.7%.
- To balance thorough energy conservation and economic growth, Japan aims to create a virtuous circle in which energy conservation activities by companies lead to profit growth.

Measures to encourage proactive energy conservation activities by companies

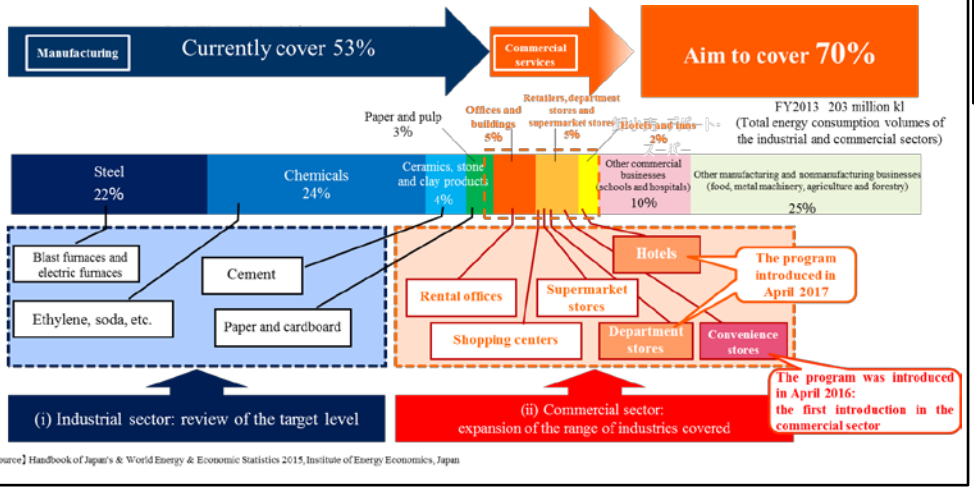
(i) **Enhance incentives** to encourage voluntary activities on a company-by-company basis

Example: The Top Runner Program, which is intended to encourage energy conservation activities on an industry-by-industry basis by setting targets, was introduced in April 2016 for convenience stores and in April 2017 for hotels and department stores.

→ Cover 70% of energy consumption on an all-industry basis by the end of FY2018

Evaluation system under which business operators are classified

(Reference) Introduction and expansion of the Top Runner Program



(ii) Develop regulations and subsidy programs to **encourage energy conservation activities that improve productivity** in light of the actual status of energy management and business management policy

Example: Energy conservation activities that improve productivity through cooperation between multiple business operators on an industry-by-industry basis or a supply chain-by-supply chain basis

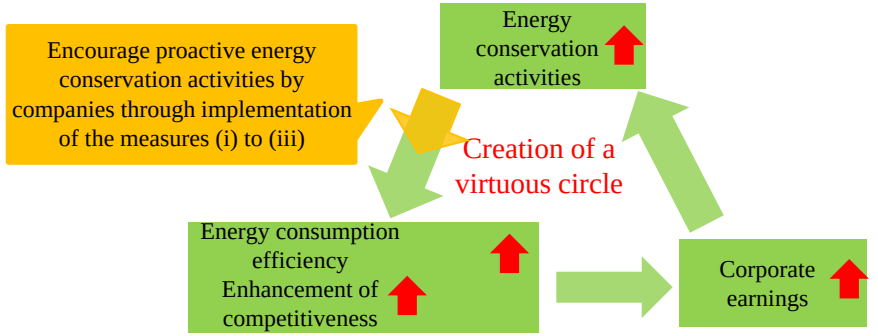
(iii) **Invigorate private-sector energy conservation businesses** that encourage activities by small and medium-sized enterprises (SMEs) and households that lack energy conservation knowhow

Example: Regional platforms for consultations concerning energy conservation (support for activities by SMEs)

ZEH builder (dissemination of houses with high energy conservation performance)

Energy management business operators (advice on improving energy management and facility operation)

Sustainable energy conservation encouraged through participation in energy conservation activities



Balancing the Economy and the Environment: Review of the FIT (Feed-In Tariff) System

July 2012: Start of the Feed-In-Tariff system

(Introduced capacity volume increased by 2.5-fold in four years after the start of the system)

Emerging problems

Capacity introduction tilted heavily toward solar power

- ✓ Approved volume for solar power accounts for approx. 90%
- ✓ Non-implemented solar power projects (310,000 projects)

An increasing burden on the people

- ✓ Acquisition cost at approx. 2.3 trillion yen in FY2016
- ✓ Estimated at 3.7 trillion to 4.0 trillion yen in FY2030 under the energy mix plan

Electricity system reform

- ✓ A system that strikes the balance with retail sale liberalization and broad-area sharing

Revised FIT Act: enacted in May 2016 and put into force in April 2017

1. Establishment of a new approval system

- Elimination of non-implemented projects and a system to prevent the occurrence of new non-implemented projects
- A system to ensure appropriate project implementation

2. Cost-efficient introduction

- Auction system for large-scale solar power generation
- Setting of mid- and long-term acquisition price targets

3. Introduction of power sources with a long lead time

Indicate multi-year acquisition prices in advance in order to promote expansion of introduction of geothermal, wind, hydroelectric and other power sources.

4. Review of the fee reduction system

- Revise the reduction rate based on the confirmation of efforts to maintain or enhance international competitiveness and promote energy conservation

5. Shift to purchase by power transmission business operators

- Change business operators obligated to purchase FIT electricity from retail business operators to power transmission and distribution business operators
- Expand introduction through broad-area sharing of electricity

Introduce renewable energy to the maximum extent and curb the burden on the people at the same time

Energy mix: toward achieving 22 to 24% (FY2030)

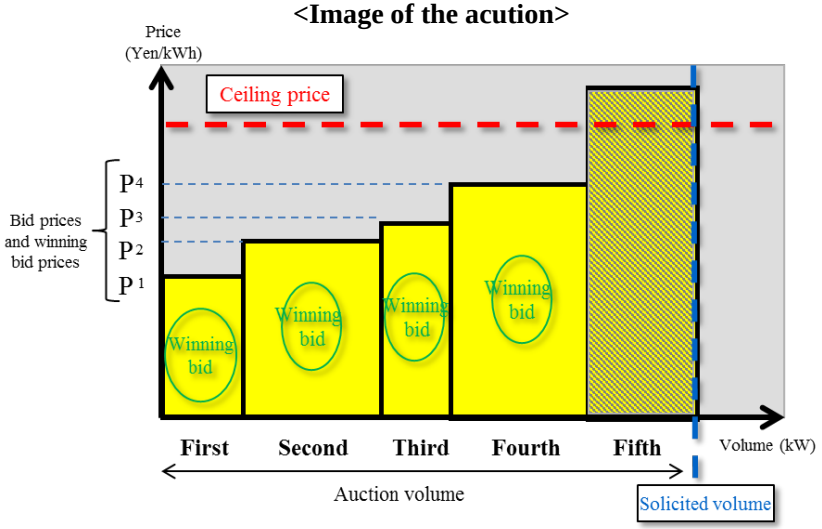
Balance the Economy and the Environment: Efficient Introduction of Renewable Energy Taking Account of the Burden on the People

- Under the energy mix plan, the introduction level of renewable energy in FY2030 is set at 22 to 24% and the acquisition cost is set at 3.7 trillion to 4.0 trillion yen.
- While the introduced capacity volume of renewable energy increased by 2.5-fold in four years after the start of the FIT system, the acquisition cost is estimated to reach 2.7 trillion yen in FY2017. To introduce renewable energy to the maximum extent and curb the burden on the people at the same time, it is necessary to promote cost-efficient introduction. Thus the FIT Act was revised in May 2016 and the revised act was put into force in April 2017.

Overview and concept of the auction system

- Applicable to power generation for business use with capacity of 2MW or more
  Hold three auctions over the next two years (FY2017 and 2018) on a trial basis
  The auction volume is estimated at 1 to 1.5 GW.
- The ceiling on the auction price is set at 21 yen/kWh for the first auction. The ceiling for the second and third auctions will be set based on the examination of the results of the first auction.
- In the first to third auctions, the bid price will be adopted as the purchase price (pay as bid method). The purchase period is 20 years.

<Image of the acution>



Setting of price targets

<Solar power>

- Achieve the following level with the aim of realizing independence from the FIT system
- Solar power for non-household use: power generation cost of 14 yen/kWh in 2020 and of 7 yen/kWh in 2030
- Solar power for household use: lower the purchase price to a level similar to the household-use electricity price in 2019 and the electricity sale price to a level similar to the electricity market price at an early time after 2020

<Wind power>

- Onshore wind power with capacity of 20 kW or more: reduce the power generation cost to 8-9 yen/kWh by 2030
  Aim to realize introduction independent from the FIT system
- Small wind power with a capacity of less than 20 kW: realize independence from the FIT system over the mid to long term by promoting cost reduction while watching the introduction trend
- Offshore wind power: aim to realize independence from the FIT system over the mid to long term while improving the environment for introduction

*Concerning other power sources as well, price targets have been set in order to realize independence from the FIT system over the mid to long term.

Balance the Economy and the Environment: Activities to Establish a Negawatt Trading Market and VPP

- Existing smart community-related technologies will be further developed in order to (i) create a negawatt trading market and to (ii) conduct demonstration of the establishment of a virtual power plant, which uses energy resources (e.g. storage batteries) owned by users for supply demand adjustment.

Major smart community-related technologies	Establishment of communication interface	Demand response (negawatt trading)	Technology for group control of storage batteries

Development

Use of negawatt trading

Negawatt trading market

Results so far achieved

- **Formulation of trading rules between business operators**
- **Establishment of relevant ministerial ordinances**
- **Revision of the operational rules of Japan Electric Power Exchange**

Future activities

Commercialization from April 2017

Adjustment capacity (response to low-frequency risks)

Results so far achieved

- **Advanced control negawatt demonstration project**
- **Public solicitation of adjustment capacity**
  - **About 1 million kW of Negawatt was traded through the auction.**

Establishment of VPP

Adjustment capacity (supply-demand adjustment in normal times, etc.)

Results so far achieved

- **VPP establishment demonstration project**
  - Establish a basic control system and check its operation
- **Improvement of the environment for expansion and use of energy resources**
  - **Indicate targets for reduction of storage battery prices**
  - Develop communication standards and consider cybersecurity guidelines

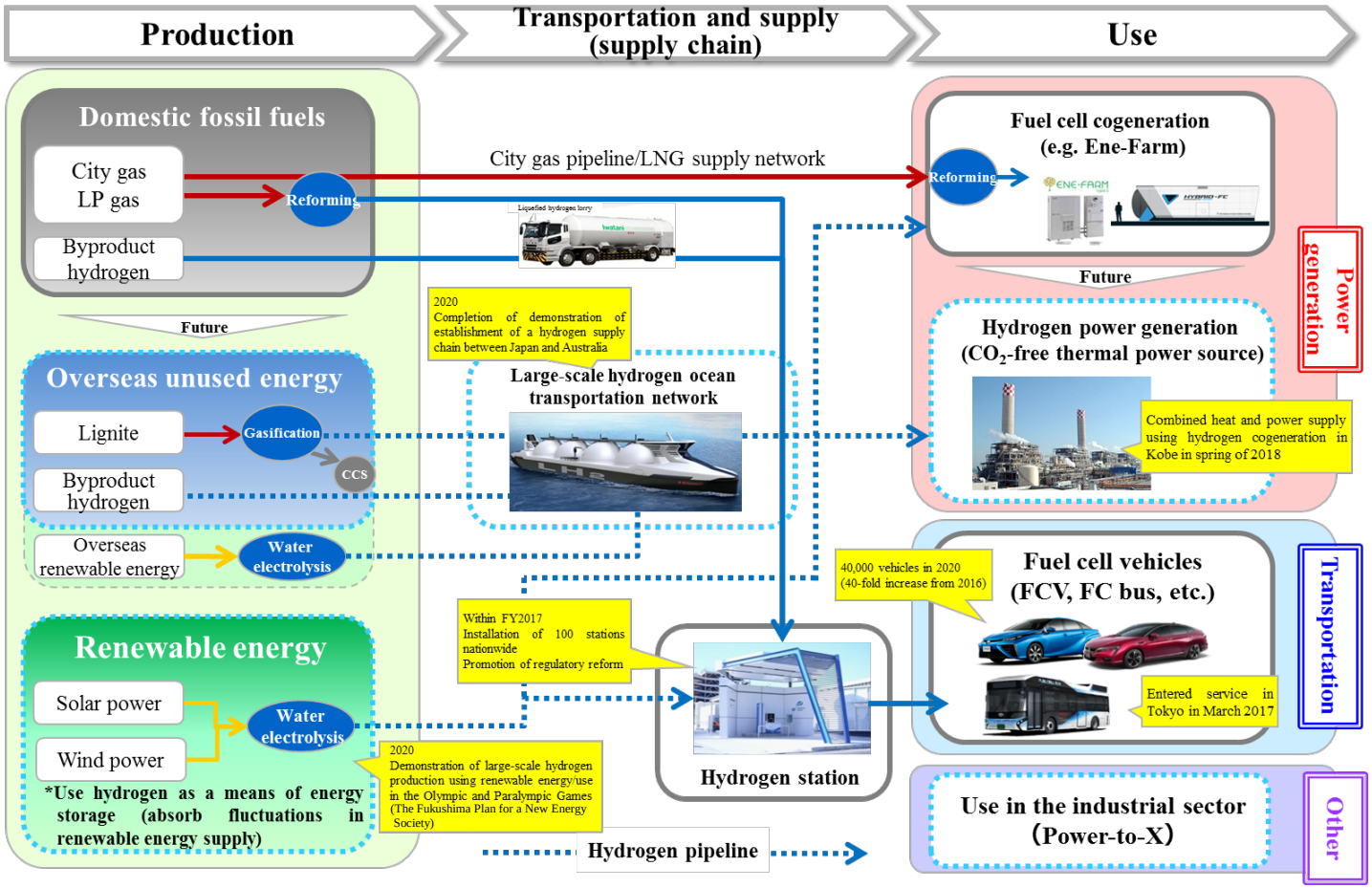
Future activities

- **VPP establishment demonstration project**
  - Demonstration concerning more precise control
  - **Conduct demonstration of demand-creating DR (upward DR) in order to expand renewable energy**
- **Further improvements of the environment**
  - Expand the scope of equipment to which the communication standard is applicable
  - Expand the scope of application of cybersecurity guidelines
  - Consider the method of evaluating VPP resources, etc.

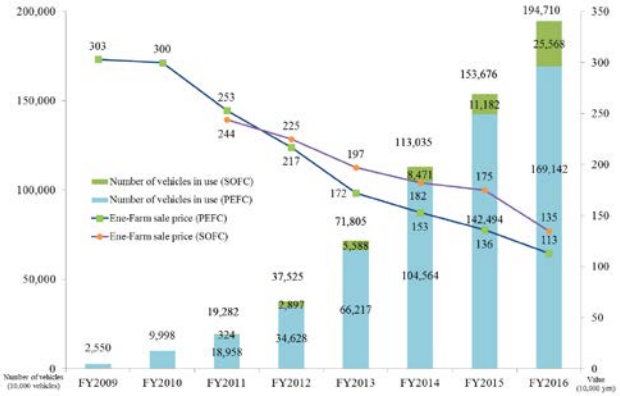
Continue to promote activities to disseminate negawatt trading and VPP

Balancing the Economy and the Environment: Direction of Activities to Realize a Hydrogen Society

- Hydrogen is the key to energy security and the fight against global warming.
- To realize a hydrogen society, activities will be conducted in the following three phases.
  Phase 1: Expand use of FCVs, hydrogen stations, Ene-Farm, etc. (from now onward)
  Phase 2: Introduce hydrogen power generation in earnest and establish a large-scale hydrogen supply system (around 2030)
  Phase 3. Establish a CO_2-free hydrogen supply system on a net basis (around 2040)

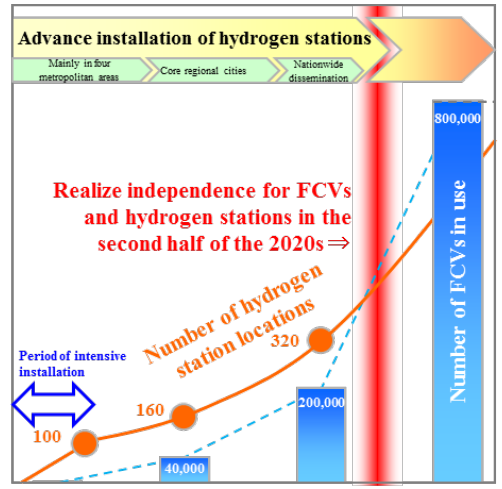


Dissemination of Ene-Farm



【Source】 Prepared by the Agency for National Resources and Energy

Dissemination of FCVs and hydrogen stations



Invigoration of Competition and Challenges related to Public Interests under Liberalization (Thorough Implementation of Electricity System Reform)

- An interim report prepared by the council (December 2016) presented measures to further invigorate competition and measures to overcome challenges related to public interests that are difficult to overcome through market principles alone.

1. Further invigoration of competition

(1) Creation of a base load power source market

- Create a market to facilitate access to base load power sources (coal-fired thermal power, large-scale hydroelectric power, nuclear power, etc.) by new power companies and also further invigorate competition by requiring major power companies to provide their base load power sources to the market through institutional measures

(2) Review rules on use of interconnected power lines (introduction of an indirect auction)

- Achieve broad-area merit order and invigorate competition by revising the rules on the use of cross-regional power lines (interconnected power lines) to shift from the first come first served principle to an indirect auction, which enables the use of power sources in order of increasing cost

2. Response to challenges related to public interests under liberalization

I. The environment, introduction of renewable energy and stable supply

(1) Introduction of capacity mechanism

- Introduce a system to secure supply and adjustment capacity necessary in the medium and long term in a situation where wholesale electricity trade is invigorated and introduction of renewable energy is expanded

(2) Establishment of non-fossil value trading market

- Establish a market where retailers can procure non-fossil values in order to achieve the target (a non-fossil power source share of 44%) under the Act on the Promotion of Use of Non-fossil Energy Sources and Effective Use of Fossil Energy Materials by Energy Suppliers and to reduce the burden of the FIT system on the people

II. Decommissioning, compensation, safety, disaster management, etc.

(1) Measures related to finance and accounting under liberalization

- Recover the shortage of reserve funds for compensation for damage done by the nuclear accident in a fair manner
- Establish a “managed reserve fund system” for decommissioning of 1F
- Use the system of wheeling fees in order to maintain the decommissioning accounting system, which is intended to reduce dependence and smoothly implement decommissioning

(2) Acceleration of voluntary safety initiatives and disaster management cooperation

- Activities to establish an autonomous system in order to continuously enhance the safety of nuclear power

Invigoration of Competition and Challenges related to Public Interests under Liberalization (Gas System Reform)

- In the small-lot trade sector, which covers households, retail sales were fully liberalized on April 1, 2017.
- Retail price regulation was abolished in principle. However, from the perspective of protecting users, the provision of a regulated price menu is obligated in regions where competition is insufficient as a provisional measure.
- As a result of the full liberalization of retail sales, a gas market worth approx. **2.4 trillion yen**, including households, shops, offices, etc., has been opened (**the number of users is approx. 26 million**).
- Consequently, in a gas market worth **a total of 5 trillion yen**, including the large-lot trade sector, which had already been liberalized, it is expected that costs will decline due to vigorous competition and consumer convenience will improve.

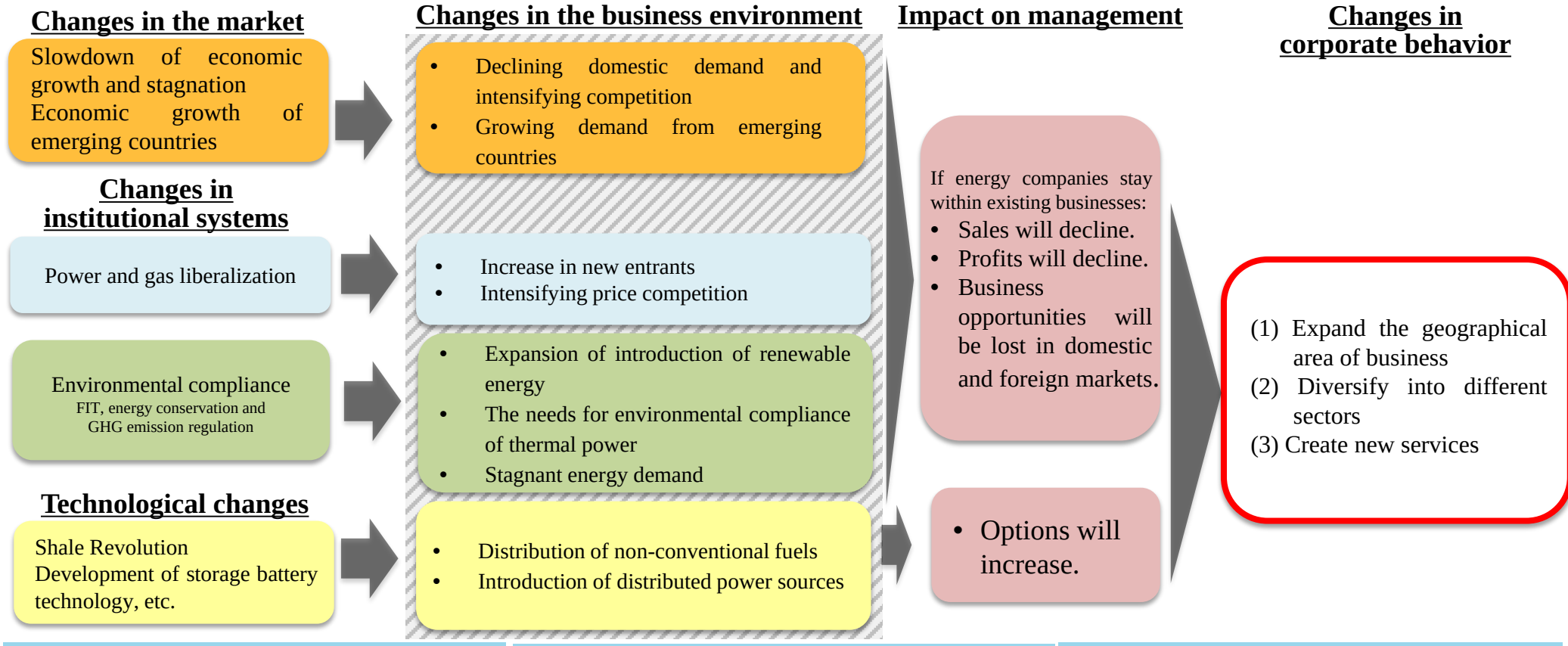
<Current status of the full liberalization of retail gas sales>

- The Ministry of Economy, Trade and Industry started accepting applications for prior registration for retail sales on August 1, 2016, and **45 companies** have obtained registration. Of the 45 companies, **12** plan to supply gas to households (as of March 31).
- The number of applications for contract switching came to **approx. 130,000** nationwide (as of April 7).
- In the Kansai region, vigorous competition is occurring. For example, new entrants and existing gas companies are competing with each other through such measures as offering discounts for combined purchase of electric power and gas or making counter price offers.

Chapter 3 Energy System Reform in Japan and Abroad and Trends in the Energy Industry

Structural Changes Surrounding Energy Companies and Response (Pioneering Cases in the U.S. and Europe)

- Japan's traditional energy market was rigid due to the presence of barriers between electricity, gas and other sectors.
- However, the barriers have been removed as a result of liberalization carried out through the reform of the electricity and gas systems, resulting in invigorated competition. At the same time, the source of competitiveness is changing due to the needs for environmental compliance and the arrival of innovative technologies.
- In response to those changes, energy business operators need to take more flexible and comprehensive actions as players responsible for stable supply, including expanding the geographical area of business, diversifying into different sectors and creating new services.



(1) Expand the geographical area of business

- Expand abroad in pursuit of new demand

(e.g.) In the case of European companies
Expansion within the domestic market → Expansion within the EU → Expansion outside the EU

(2) Diversify into different sectors

- Diversification intended to expand profits and disperse risks (e.g. integrated provision of power and gas)
- Entry into or concentration of resources in highly profitable businesses (e.g. investment in renewable energy)

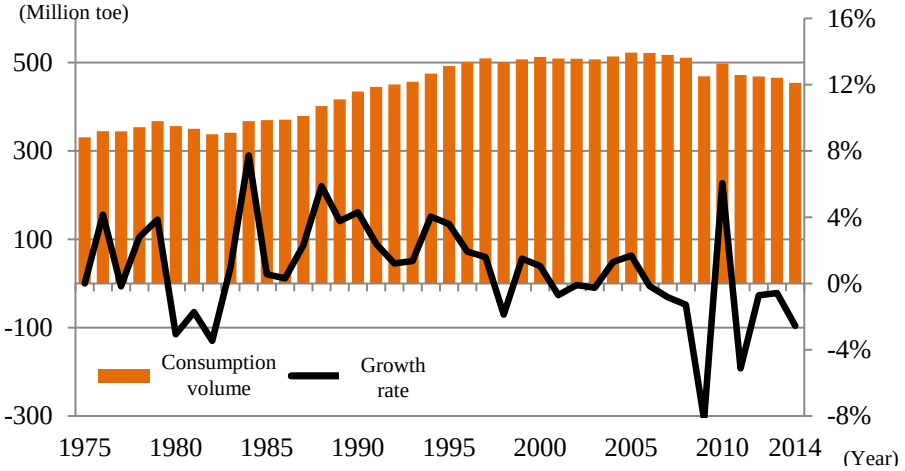
(3) Create new services

- Arrival of companies which provide new services using new technology or business model, and active investment in or acquisition of such companies

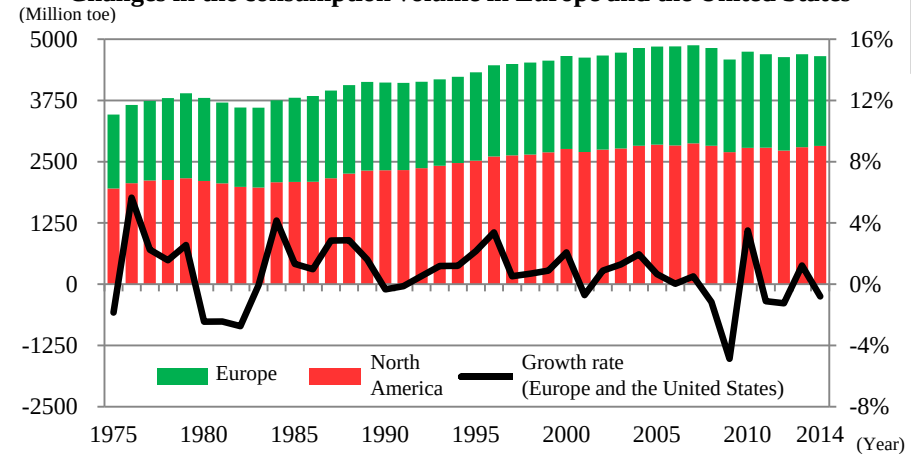
Changes in Energy Demand

- The energy consumption volume in Japan has been on a downtrend since 2005 and has remained flat in Europe and the United States.
- On the other hand, demand has been growing in emerging countries, mainly in Asia.
- The key to the prosperity of the energy industry is expanding into foreign markets, mainly Asia, where demand is expected to grow, rather than staying within the domestic market.

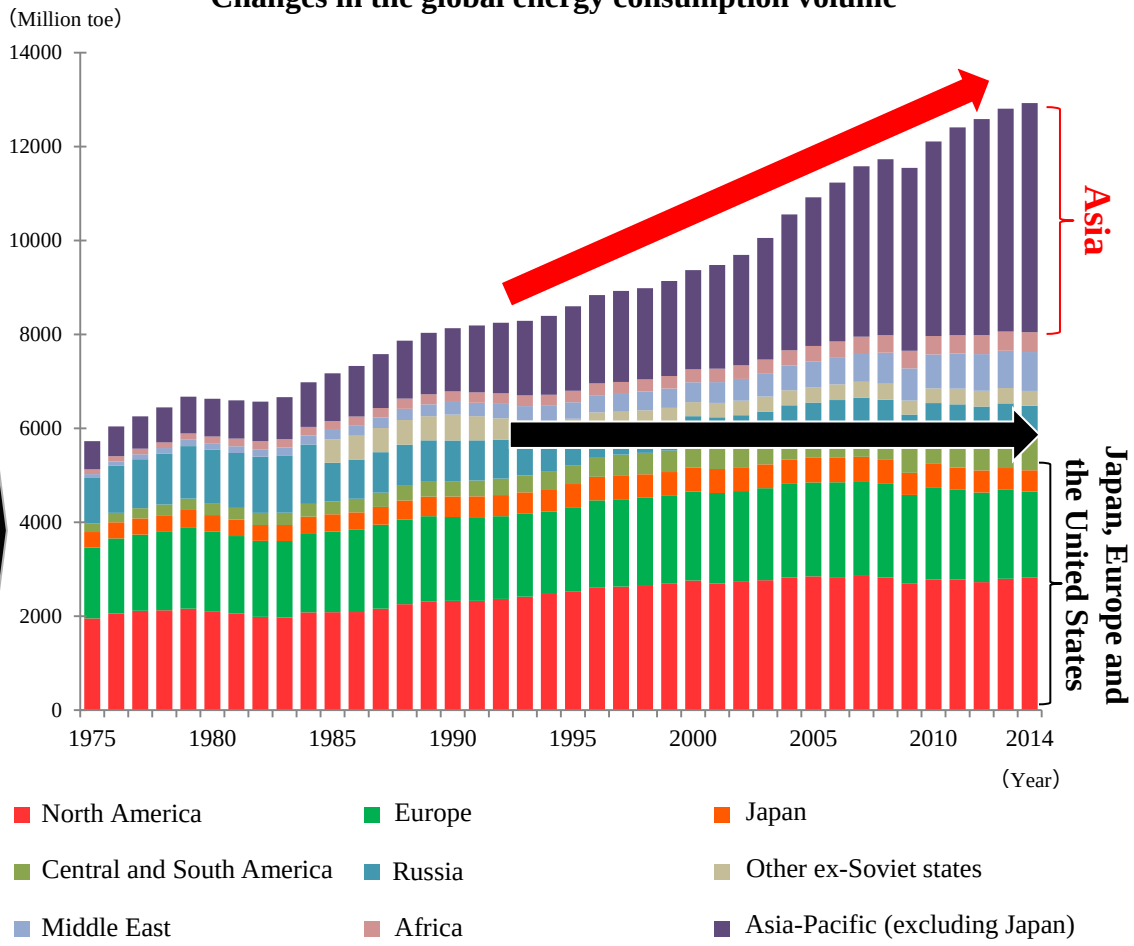
Changes in the energy consumption volume in Japan



Changes in the consumption volume in Europe and the United States



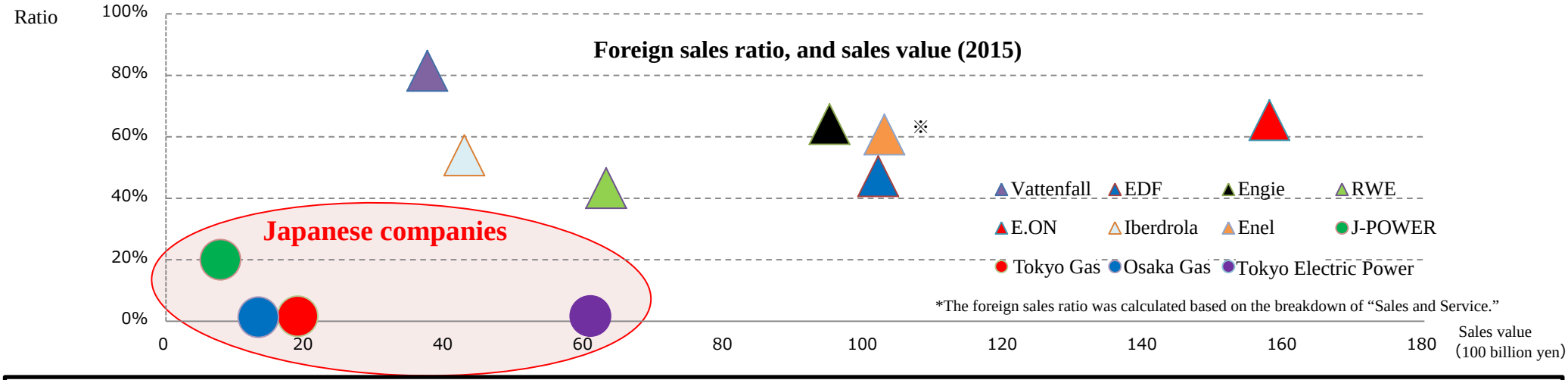
Changes in the global energy consumption volume



Source: Prepared by the Agency for Natural Resources and Energy based on Statistical Review of World Energy 2015, BP

Activities of Foreign Companies (1) Expansion of the Geographical Area of Business

- In Europe, where liberalization started earlier, competition is intensifying and risks are growing in domestic markets due to the effects of liberalization in and outside the region, while opportunities to expand shares in newly opened foreign markets are increasing.
- In response to the changes in the situation, European energy companies, regardless of their size, are actively expanding abroad without being content with doing business only in domestic markets.



● E.ON (Germany)
Starting with the entry into the U.K. market with the acquisition of PowerGen, a major U.K. power company, made full-fledged entry into 15 foreign markets around the world, including Hungary and Russia

● RWE (Germany)
Expanded mainly into European countries, including the U.K., the Netherlands, the Czech Republic and Turkey, and also into Dubai

● Vattenfall (Sweden)
Engaging in thermal power generation business mainly in Germany (Planning to allocate 90% of all investments to renewable energy in the future in pursuit of low-carbon business)

● EDF (France)
Engaging in power generation business, including nuclear power, in Europe, the United States, Brazil and China

● Engie (France)
Established 24 regional business units and five support divisions with a view to overseas expansion and strengthened locally-tailored services

● Iberdrola (Spain)
Expanded mainly into North and South America, with a particular focus on wind power generation

● ENEL (Italy)
Engaging in thermal and hydroelectric power generation business, mainly in Eastern Europe and South America

Source: Prepared by the Agency for Natural Resources and Energy based on annual reports

Activities of Foreign Companies (2) Diversification into Different Sectors

- In Europe, the entry by power companies into the gas market—German electricity company E.ON is an example—and the entry by gas companies into the electricity market—U.K. gas company Centrica is an example—has proceeded, resulting in the arrival of comprehensive energy companies.
- In addition, while the competitiveness of power sources is changing due to the need for environmental compliance, Iberdrola (Spain) is growing by rebalancing its power source mix through an increase in renewable energy investment.
- DONG Energy, a state-owned energy company in Denmark, has achieved a dramatic business shift from oil and gas production to power generation using renewable energy (offshore wind power).

E.ON (Germany) — Electricity→gas

Acquired Ruhrgas, a domestic gas company.
→Currently, gas business accounts for around 50% of overall sales.

- Concentrating on the energy business after selling the chemicals business inherited from the conglomerate that was its predecessor (sale of a non-strategic business)
- Also engaging in gas business in Norway and Russia after acquiring Ruhrgas (2003), which was the largest gas company in the world
- Gas business accounts for around 50% of overall sales (2015).

Centrica (U.K.) — Gas→electricity

Acquired U.S. and European energy companies
→Currently making active investment in electricity business

- Entered the domestic power retail sector following the full liberalization of power retail sales in 1999
- Acquired major foreign energy companies, including DirectEnergy in North America and ATCO in Canada
- ATCO is actively engaging in electricity business as well, allocating more than 50% of its capital investment to the electricity sector (2015).

Iberdrola (Spain) — Conventional power sources→renewable energy

Rebalanced the power source mix
→Currently, renewable energy accounts for 32% of the power source mix.

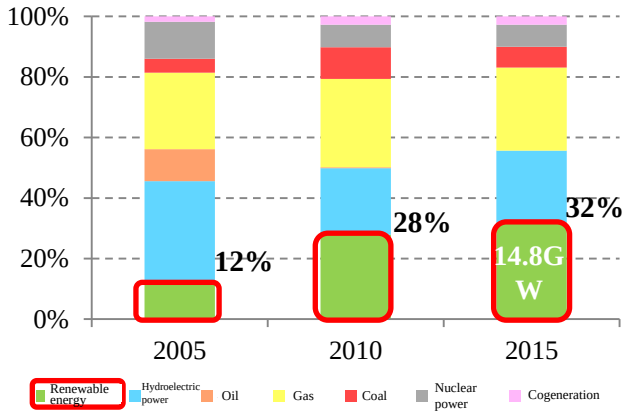
- Acquired Scottish Power in the United Kingdom, resulting in an increase of around 50% in renewable facility capacity (2007)
- Opened Whitelee Windfarm (capacity grew from 322MW to the current level of 539MW), which was the largest onshore wind power generation facility (the second largest now) in Europe, in 2009.
- Signed an agreement with Areva, a French nuclear power company, to jointly engage in offshore wind power business with a capacity of 350MW in the Baltic Sea (2014)

DONG Energy (Denmark) — Oil and gas production →renewable energy

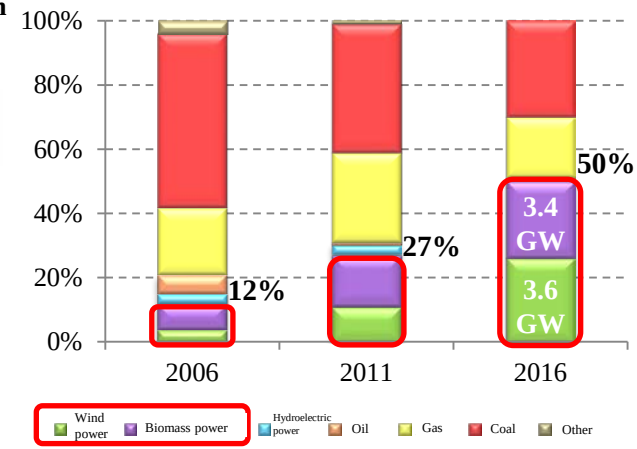
A business shift from oil and gas production to renewable energy
→ The largest offshore wind power generation company in the world now

- Announced a plan to withdraw from oil and gas businesses and concentrate on renewable energy business (2016)
- Became the largest offshore wind power generation company in the world with more than 1,000 offshore wind turbines (2016)
- Planning to introduce offshore wind power generation facilities with a total capacity of 11-12GW (the current capacity at 3.6 GW, or a quarter of the global total, as of 2016) by 2025.

Iberdrola's power source mix



DONG Energy's power source mix



Source: Prepared by the Agency for Natural Resources and Energy based on references materials published by the Institute of Energy Economics, Japan

Activities of Foreign Companies (3) Creation of New Services (Venture Investment and M&A)

- As a result of the progress in liberalization, some companies are more actively exploring new profit sources than before.
- It is impossible to develop all capabilities internally because new value is created through a variety of technological innovations, including renewable energy, storage batteries, technology to control distributed power sources and stored electricity, demand control technology, and big data analysis.
- Indeed, companies in Europe and the United States, where liberalization started earlier, are seeking to acquire these new technologies through venture capital investment and M&A activity (open innovation).

Venture investment activities

*The value of investment made by energy companies in venture capital companies
The figures in parentheses indicate the ratio to the overall venture capital amount
Converted into yen terms based on the following exchange rates: €1=120; $1=110 yen.

Energy companies	Venture capital companies, etc.	Investment value*	Investee companies, example projects	Investment target technologies
Engie (France)	Engie New Ventures	13.8 billion yen (100%)	・AMS (energy storage) ・Powerdale (EV infrastructure) and 12 other projects	Distributed power source, energy storage, mobility, etc.
RWE (Germany)	Innogy Venture Capital	At least 9 billion yen (75%)	・Mantex (biomass) and five other projects	Renewable energy, carbon neutral, etc.
Iberdrola (Spain)	Iberdrola Ventures - PERSEO	8.4 billion yen (100%)	・Oceantec (wave power generation), etc.	Renewable energy, distributed power source, efficiency improvement, etc.
Exelon (U.S.)	Constellation Technology Ventures	0.11 to 1.1 billion yen/project (100%) 5.6 billion yen in 2015	・C3 Energy (smart grid) and 13 other projects	Energy-related venture companies
EDF (France)	ELECTRANOVA CAPITAL	3.6 billion yen (33%)	・Seatower (deep water offshore wind power generation) ・Firstfuel (BEMS) and 10 other projects	Smart city, mobility, etc.
E.ON (Germany)	Strategic Co-Investments	0.36～0.6 billion yen/project (100%)	・Green Smith (energy storage) ・Bidgely (energy management) and 13 other projects	Smart grid, distributed power sources, enhancement of renewable energy, etc.
ENEL (Italy)	INCENSe	0.72 billion yen (74%)	・80 projects, including I-EM (energy management using big data) are ongoing.	Energy storage, data analysis, IoT, etc.
Tokyo Electric Power	Energy Impact Fund	0.55 billion yen (data not available)	・Spark Fund (energy service) ・opus one (smart grid) and three other projects	Companies contributing to a shift to low carbon, distributed power and digitization, etc.

Source: Prepared based on annual reports and websites of individual companies and media reports

M&A activities

Acquirers	Year of acquisition/observation	M&A targets	Company outline
Engie (France)	2017	EV-Box (Netherlands)	A major provider of EV recharging service owning more than 40,000 recharging stations
Iberdrola (Spain)	2017 (observation)	New Jersey Resources Corporation (U.S.)	A U.S. gas distribution and retail sales company
ENEL (Italy)	2016 (observation)	ELECTROPAULO (Brazil)	A Brazilian power company engaging in power distribution and retail sales in urban areas
Engie (France)	2016	SIRADEL (France)	Conduct simulations using 3D city models
E.ON (Germany)	2013	Enerji SA (Turkey)	A Turkish power company affiliated with a conglomerate engaging in a broad range of businesses, including power generation, distribution and retail sales.

Source: Prepared based on annual reports and websites of individual companies and media reports

Number of M&As (January, 2010 to March, 2017)

Company name	Number of projects
Engie (France)	36
EDF (France)	19
ENEL (Italy)	10
E.ON (Germany)	9
Iberdrola (Spain)	8
RWE (Germany)	6
Exelon (U.S.)	6
Tokyo Gas	5
Kansai Electric Power	3

*From information published by SPEEDA
Period: January 1, 2010 to March 1, 2017
Projects: including acquisitions announced, completed or reported during the above period but excluding joint ventures and mergers on an equal footing
Limited to acquisition deals under which 50% or more of all shares were eventually acquired.

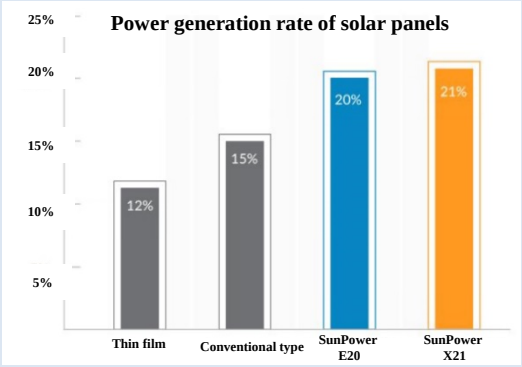
Activities of Foreign Companies (3) Creation of New Services (Technological Innovations)

- New services are being created through a variety of technological innovations, including efficiency improvement of solar power generation, development storage battery systems with high extensibility, an improvement in the operating rate of wind turbines using big data and commercialization of small nuclear reactors.

Sun Power

【Efficiency improvement of solar power generation】

- Achieved the world's highest power generation efficiency (module conversion rate) through the back-contact method (technology to eliminate the need for an electrode on the light-receiving side)
- Improved the conversion efficiency to more than 20% from 15% for existing products



Source: Sun Power's website

Vestas

【Improvement in the operating rate through data analysis】

- A wind turbine maker planning to introduce wind power generation facilities with global combined capacity of more than 81GW (a global share of 16% as of 2016)
- Providing maintenance service that guarantees a high operating rate through the use of a vast volume of data concerning wind turbine operation
- Reducing the operation suspension time by predicting problems with wind turbines through monitoring using accumulated big data collected from customers

* ClearSight
A software program that provides analysis concerning the operation status and advice on efficiency improvement based on information collected from a large number of wind turbines

Source: Vestas' website

AES Energy Storage

【Development of storage battery systems with high extensibility】

- Developed a battery unit which can be flexibly expanded to a capacity of several hundred thousand kilowatts, with 40 kW as a minimum unit
- Can be used for a wide range of applications as it has become possible to change the capacity after introduction, which was previously difficult to do
- Advanced into South America and Europe as well and also planning to move into Asia and Oceania as well

Source: AES Energy Storage's website

NuScale

【Small Modular Reactor: SMR】

- Developing a small nuclear reactor with a diameter of 4.5 m and a height of 23 m
- The small reactor under development is easy to cool because of its small output capacity and is reputed to have a high level of safety.
- Shorten the construction period and reduce the manufacturing cost by locally assembling pre-fabricated units
- Planning to achieve output capacity of 600,000 kW by combining 12 reactors, each of which has a capacity of 50,000 kW
- Aiming to start commercial operation in 2026

Source: NuScale's website

Activities of Foreign Companies (3) Creation of New Services (Renewable Energy-Related Companies)

- Around the world, renewable energy-related industries are transforming their business models and expanding the scope of their businesses amid changes in the business environment.
- Foreign energy companies are not only seeking to acquire world-class generation capacity but also advancing into new businesses. For example, First Solar (U.S.) has expanded into the power generation sector, while Solar City (U.S.) has launched a new business known as the third-party ownership model.
- In the wind turbine market, where market players are becoming larger and oligopoly is proceeding, Vestas (Denmark) and Siemens (Germany) are providing maintenance service that guarantees a high operating rate using a vast volume of operation data.

< Activities of solar panel makers >

Company name	Business outline	Characteristics of technology and business model
Trina Solar (China)	・Panel maker	・Although the company started up relatively late for a PV panel maker, in 1997, it was the global No. 1 in 2015 with a panel production volume of 5,873 MW and a shipment volume of 5,740 MW. (The top three panel makers in the world in terms of production volume in 2015 were Chinese companies.)
First Solar (U.S.)	・Panel maker	・Realized low-cost production of PV panels using CdTe (cadmium telluride) ・Not only engaging in panel assembly but also expanding into the power generation sector
Solar City (U.S.)	・Panel maker ・Third-party ownership model	・Accelerating introduction of household-use solar power generation with zero initial investment under the third-party ownership model ・Not only engaging in panel assembly but also expanding into the power generation sector (Acquired by Tesla (U.S.) in 2016)

<Activities of wind turbine makers>

Company name	Business outline	Characteristics of technology and business model
Vestas (Denmark)	・Wind turbine maker	・Providing maintenance service that guarantees a high operating rate using a vast volume of data ・Integrated with Mitsubishi Heavy Industries' offshore wind power generation business in 2013
Siemens (Germany)	・A comprehensive heavy electric machinery maker engaging in production of wind turbines	・Providing maintenance service that guarantees a high operating rate using a vast volume of data ・Integrated its wind power business with Gamesa (Spain), a major wind power company, in 2016

【Comparison between makers in the world and in Japan】

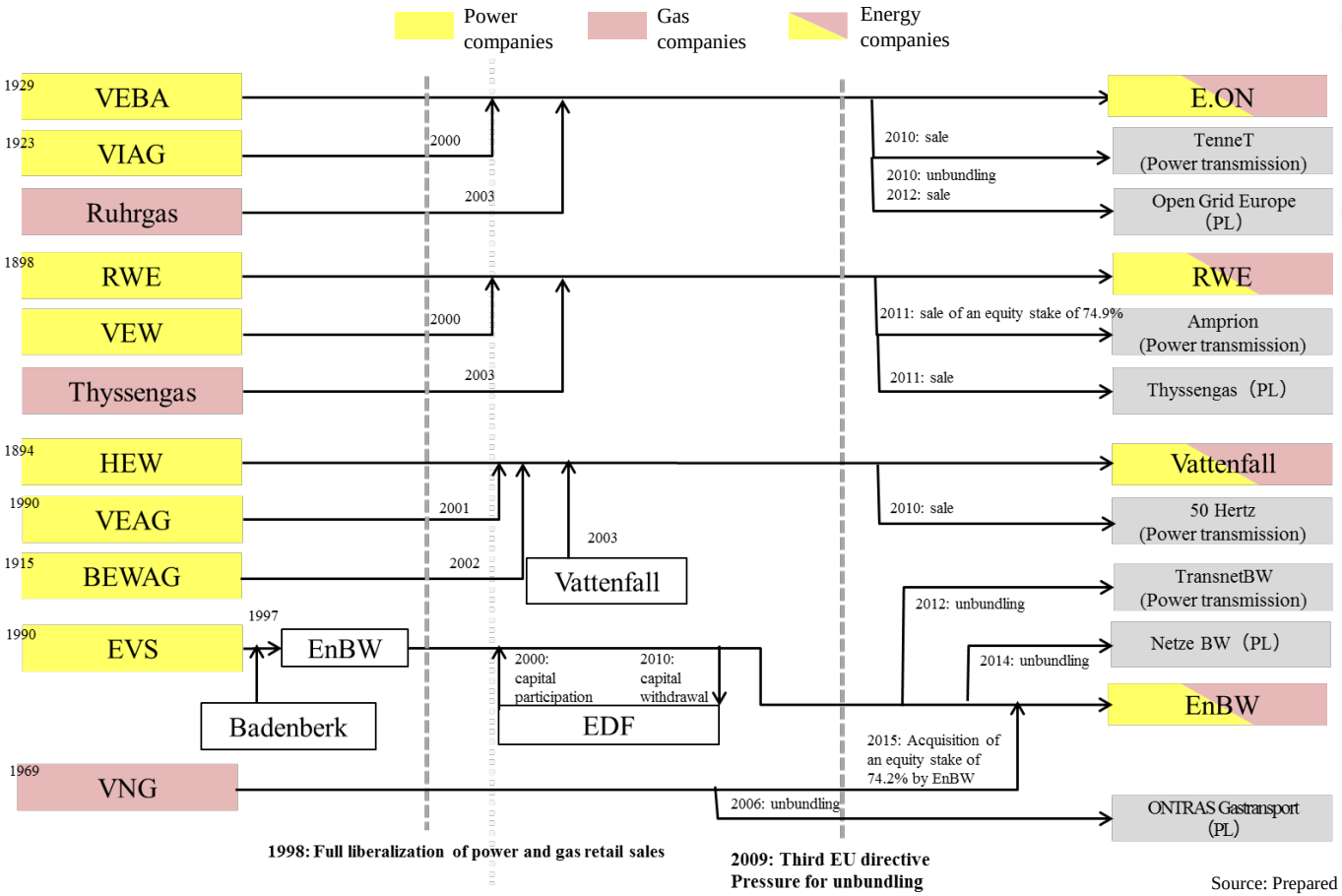
	Solar power generation (production volume/year)	Wind power generation (introduction volume/year)
Japan	Company A Approx. 1,250MW	Company B Approx. 74MW
	Five-fold	Eighty-fold
World	Trina Solar (China) Approx. 5,900MW	Vestas (Denmark) Approx. 6,300MW

Source: Prepared by the Agency for Natural Resources and Energy based on various reference materials

【Reference】 History of German Power and Gas Companies

- Before the liberalization, there were eight major power companies known as the “Big 8” and multiple gas companies.
- After the full liberalization of retail sales of power and gas in 1998, integration proceeded. E.ON and RWE entered the gas business sector in earnest through the acquisition of Ruhrgas and Thyssengas, respectively.
- In the 2000s, the power companies were consolidated into the Big 4 (E.ON, RWE, Vattenfall and EnBW) (vertical integration system at that point).
- Under pressure from the European Commission to unbundle power transmission and transportation divisions, unbundling has proceeded since 2010. Currently, ownership of these divisions has been unbundled with respect to all four except EnBW.

History of power and gas companies*



Examples of spinoff in recent years (2016-)

E.ON (Germany)

Parent
- Renewable energy
- Power distribution
- Retail sales
- Nuclear power (only in Germany)

Uniper
- Thermal power
- Hydroelectric power
- Trading
- Nuclear power (outside Germany)

Unbundling

RWE (Germany)

Parent
- Nuclear power
- Thermal power
- Hydroelectric power
- Trading

Innogy
- Renewable energy
- Power distribution
- Retail sales

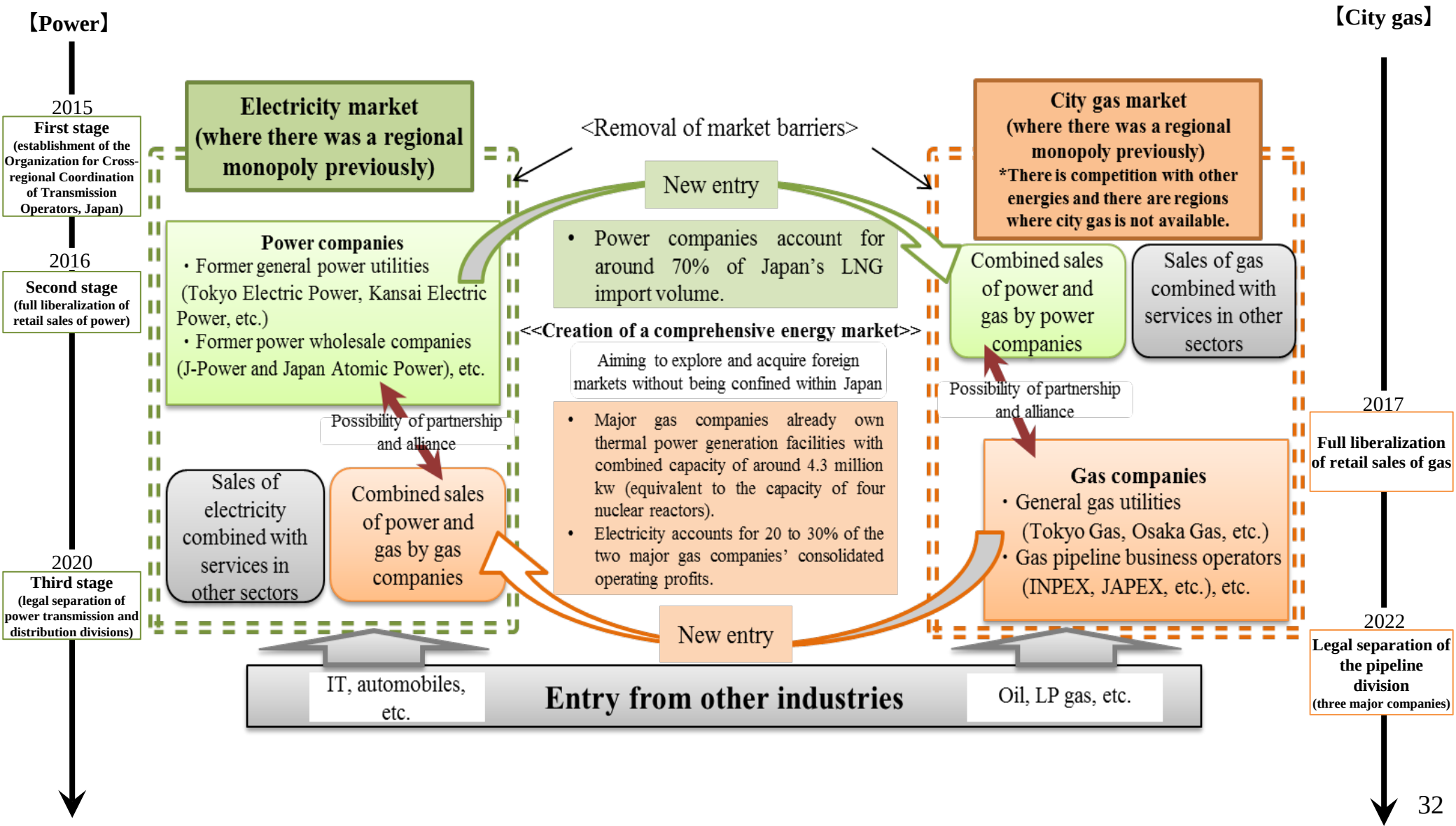
Unbundling

Source: Prepared by the Agency for Natural Resources and Energy based on various reference materials

*This chart shows only representative energy companies, rather than all power and gas companies.

【Japan】Changes in the Environment Surrounding Japan's Energy Industry

- Market barriers have been removed due to the full liberalization of retail sales of power and gas, so competition is expected to intensify due to mutual entry by energy companies into each other's sectors and new entries from different industries.

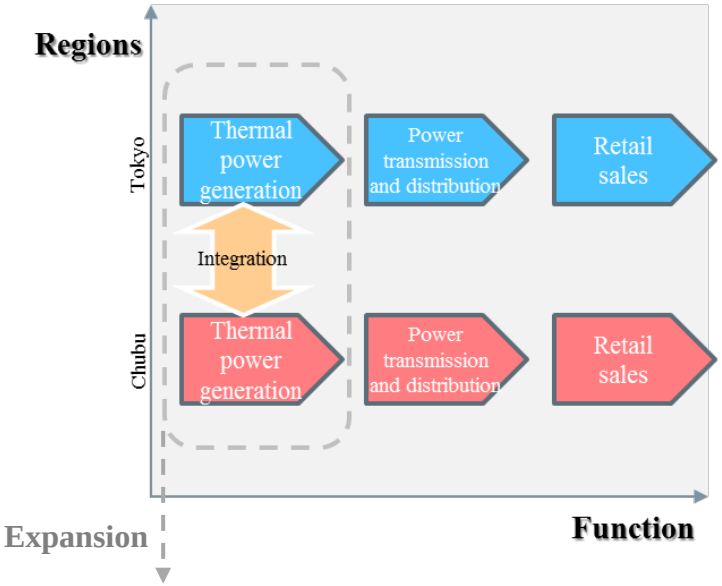


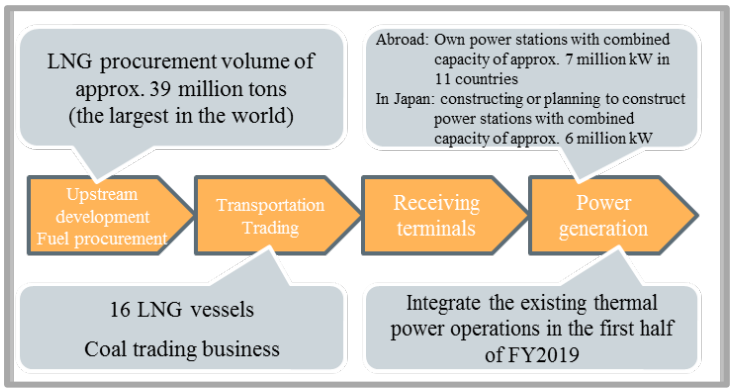
【Japan】JERA's Challenges (i)

- TEPCO Fuel & Power and Chubu Electric Power established an alliance company called JERA in 2015.
- JERA expects to become the global No. 1 in terms of both LNG procurement volume and thermal power generation capacity by integrating existing thermal power operations in the first half of FY2019 with the aim of reorganizing the thermal power generation business along the lines of different functions (when the existing thermal power operations are integrated in the first half of FY2019).

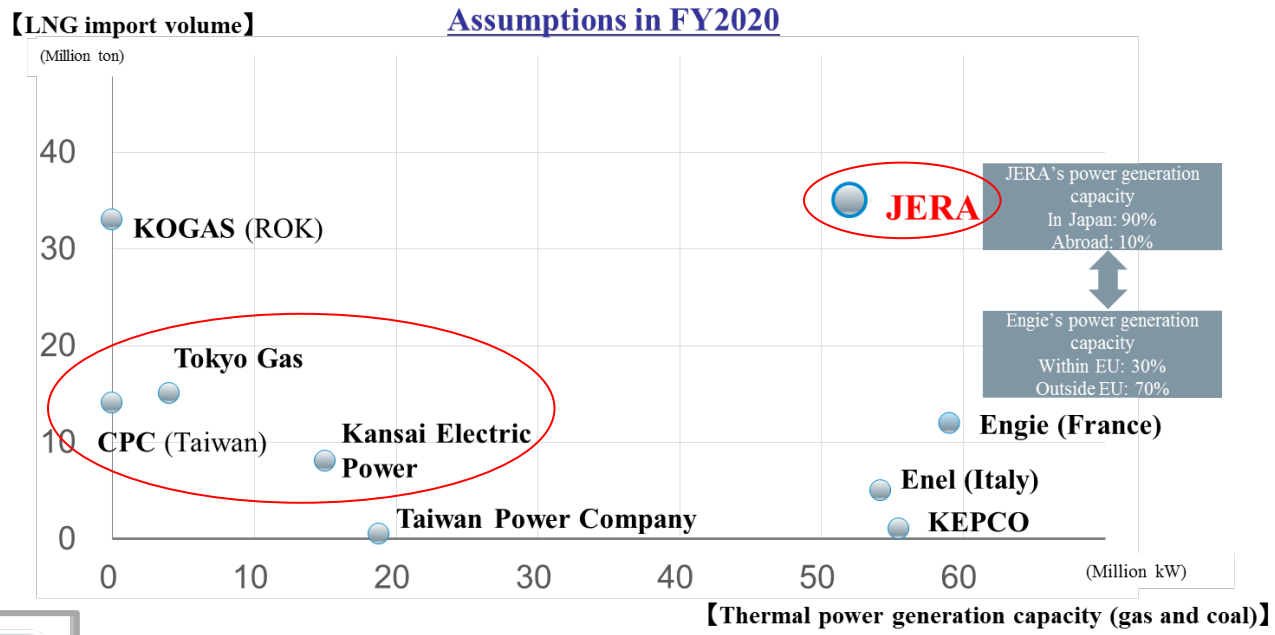
JERA's scope of businesses

Reorganization of the thermal power business
⇒ from region-by-region to function-by-function





JERA's global position (assumed position in FY2020)



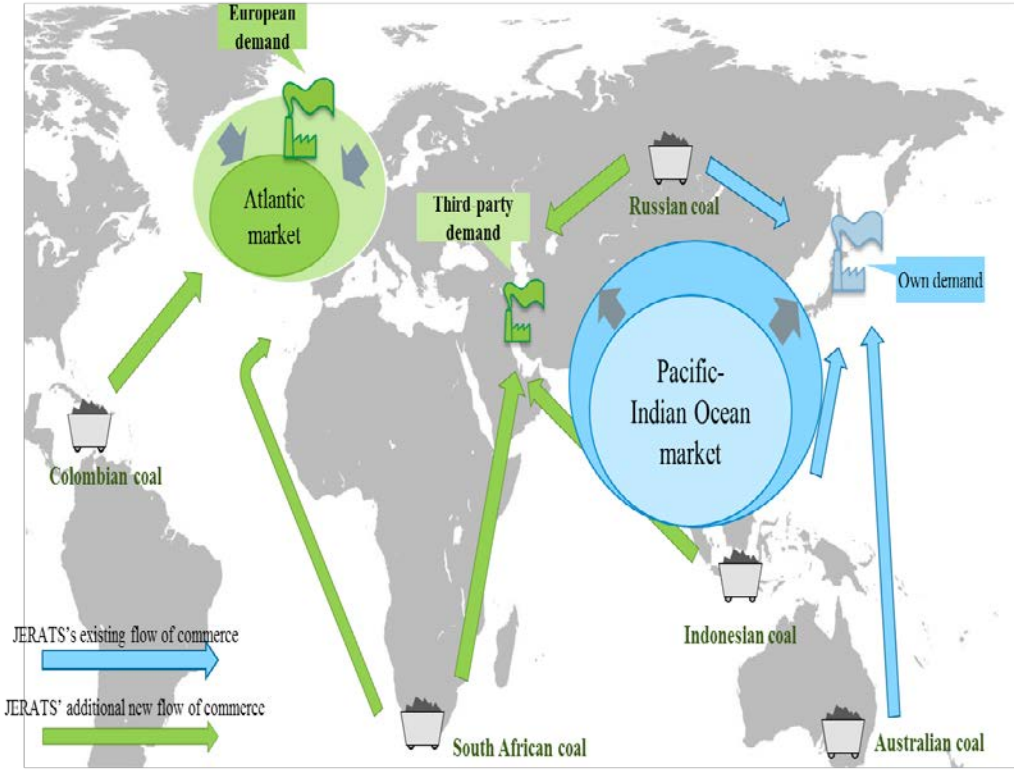
Source: Prepared by the Agency for Natural Resources and Energy based on reference materials provided by JERA

【Japan】JERA's Challenges (ii)

- Acquired the coal trading division of EDF Trading, a subsidiary of EDF, a global energy company, by taking advantage of its LNG trading volume, the largest in the world
- Aiming to lead Japan in upstream development, fuel trading and power generation

Flow of commerce of JERA's coal trading (after the acquisition of the coal trading division from EDF Trading)

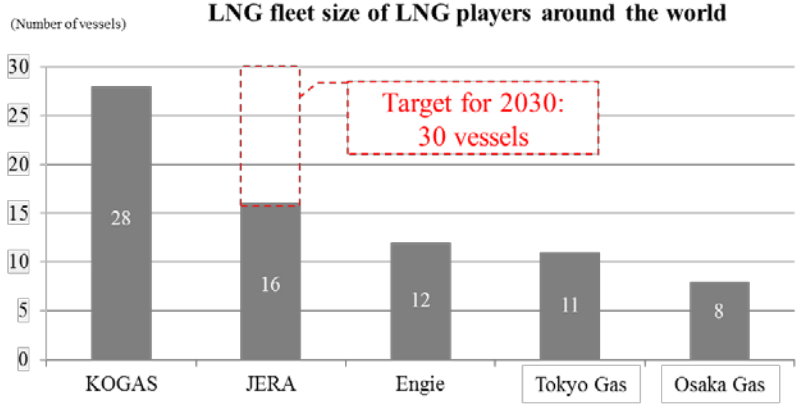
⇒ JERA's large size made it possible to acquire EDF Trading's coal trading division.



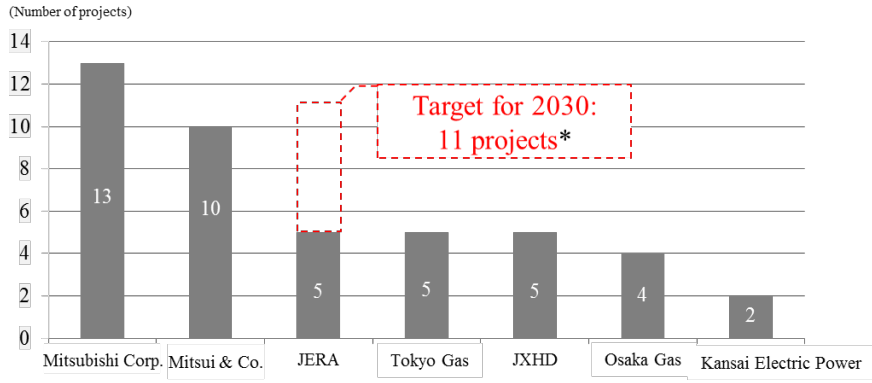
JERA's targets (upstream development, transportation and power generation (abroad))

	2016	2030
Power generation abroad	Approx. 6 million kW	Approx. 20 million kW
Fuel trading	16 LNG vessels	30 LNG vessels
LNG projects	5 projects	Around 11 projects

LNG fleet size of LNG players around the world



Status of participation in LNG projects by major domestic LNG players



*The target for 2030 may include coal projects depending on future developments.

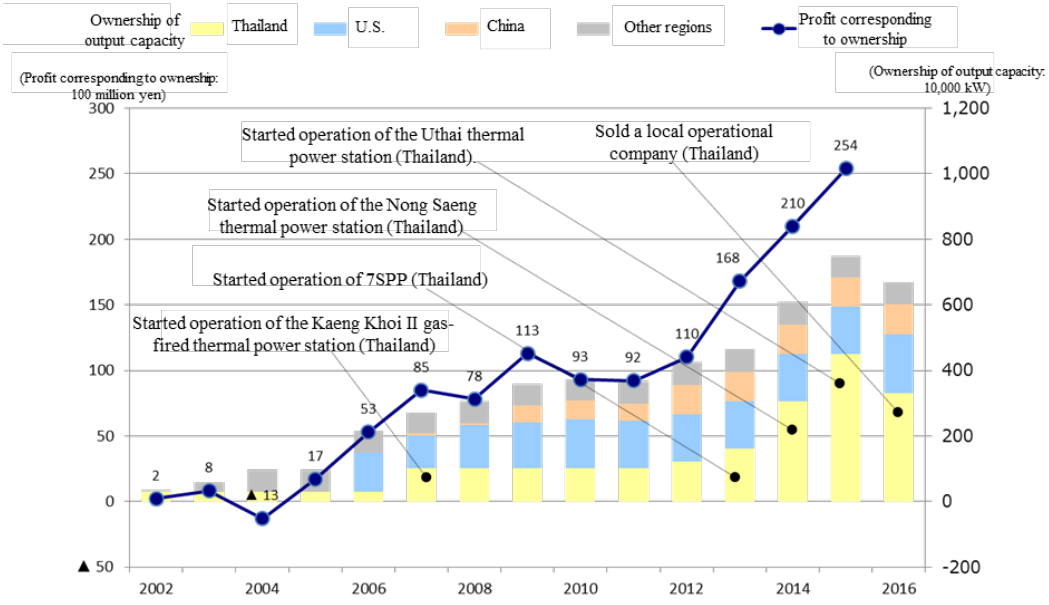
Source: Prepared by the Agency for Natural Resources and Energy based on reference materials provided by JERA

【Japan】 Companies Pursuing Active Overseas Expansion

- Companies which have been preparing for overseas expansion in a strategic manner in anticipation of liberalization have been steadily increasing their overseas business.
- There are plans for future overseas expansion, mainly in Asia and North America.

J-Power's ownership of output capacity of overseas power generation business (in commercial operation)

*Profit corresponding to ownership for FY2016 has not yet been finalized.



Source: Reference materials provided by J-Power

Position of the overseas business

	Tokyo Gas	Osaka Gas
Current status	**The foreign ratio: 10%** Profit base: average for 2009-2011	**The foreign ratio: 5%** Profit base: forecast for 2017
Business plan	**The foreign ratio: 25%** Target for 2020: 2011 medium-term business plan	**Foreign ratio: a third** Target for 2030: 2017 medium to long-term business plan
Notable features (extracted from the business plan)	Aiming to expand the resource business and develop an LNG value chain in the upstream sector Seeking to expand abroad in energy service and engineering businesses in the mid and downstream sectors	Aiming to expand business in all of the upstream, midstream and downstream sectors, mainly in North America, Asia and Oceania (i) Concentrating business resources on priority areas of activity; (ii) promoting partnerships and M&As; and (iii) improving the business implementation capability by increasing involvement in businesses

	JERA (Tokyo Electric Power and Chubu Electric Power)	Kansai Electric Power	J-Power
Current status	**5.9GW*** As of February 2017	**1.4 GW *** As of February 2017	**6.7 GW*** As of March 2017
Business plan	**20 GW** Source: Reference materials provided by J-Power	**10-12 GW** Target for 2025: 2016-2018 medium-term business plan	**10 GW** Target for 2025: 2015 medium-term business plan
Notable features (extracted from the business plan)	Actively expanding into overseas energy businesses, mainly in Asia, the Middle East and North America, including merchant business and renewable energy business in North America Also engaging in fuel business	Aiming to obtain stakes in projects by strengthening local networks through the establishment of foreign offices and expanding the scope of target investment regions and businesses to cover Europe and the United States and renewable and other energy sources	Advancing mainly into Asia by taking advantage of clean coal-fired power generation technology with high heat efficiency Aiming to expand business in the United States through various sales methods

*Overseas power generation capacity excluding facilities under development and construction
Prepared by the Agency for Natural Resources and Energy based on individual companies' websites

【Japan】Activities to Expand the Geographical Area of Business, Diversify into Different Sectors and Create New Services

- Japanese energy companies are expanding their business operations beyond the existing sectorial barriers by moving into domestic and foreign regions where demand is expected to grow, by diversifying into different sectors adjacent to their existing businesses and by creating new services based on technological evolution.

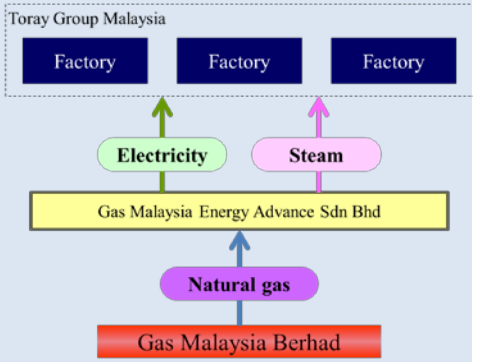
Expansion of the geographical area of business

【Kobelco Power: the first inland thermal power station in Japan (Tochigi Prefecture)】

- Kobe Steel signed a mutual power and gas supply contract with Tokyo Gas as an activity to enter the electricity sector and established a new power company called Kobelco Power Moka in order to build a GTCC with a capacity of 1.25 million kW.
- This will be the first full-fledged inland thermal power station in Japan and is expected to contribute to the enhancement of energy infrastructure and the development of the region through distributed location of power sources.

【Tokyo Gas: provision of energy service in Malaysia】

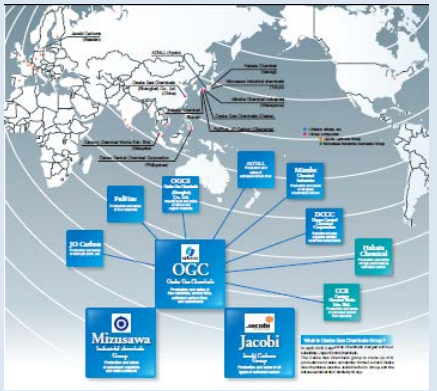
- Through a subsidiary, Tokyo Gas provides a service to efficiently supply a combination of heat and electricity generated by a gas cogeneration system, boilers, air conditioners and water treatment facilities.
- Striving to contribute to the development of local energy infrastructure and to establish a value chain



Diversification into different sectors

【Osaka Gas: diversification into chemicals business (diversification into an adjacent business)】

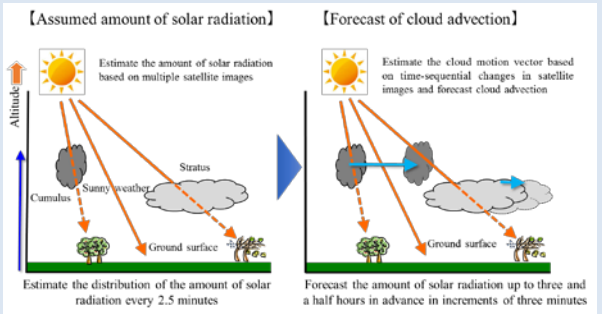
- Osaka Gas acquired Jacobi Carbons AB, a world-leading company in the business of activated carbons used for water and air purification, for approx. 38.3 billion yen through a subsidiary called Osaka Gas Chemicals.
- In 2015, Osaka Gas became the global No. 2 in the activated carbon business and captured the world's largest share regarding high-value added activated carbon from coconut shells.



Creation of new services

【Kansai Electric Power: short-term forecasting system for the amount of solar radiation Apollon】

- Kansai Electric Power developed Apollon, a short-term forecasting system for the amount of solar radiation that can forecast the amount of solar radiation per 1 square km up to 3.5 hours in advance in increments of three minutes through the use of satellite images provided by the Japan Meteorological Agency.
- Apollon has achieved an overall error rate of 9% or less with respect to the 60-minute forecast. The introduction of this system at a central load dispatching office reduces cost related to supply-demand control (2016).



Source: Prepared by the Agency for Natural Resources and Energy based on reference materials provided by individual companies

【Japan】Energy Companies Engaging in Locally-Focused Businesses

- In Germany, there have traditionally been locally-focused entities known as Stadtwerke, which provide everyday life services, including energy supply. Currently, there are around 1,400 such entities.
- In Japan as well, there are business operators providing locally-focused services.

Concerning Stadtwerke in Germany

(i) Use of local resources
- Operate local hydroelectric and biomass power stations
- Use heat generated from waste treatment and cogeneration systems

(ii) Creation of local jobs
- Create jobs, including direct, indirect and induced jobs

(iii) Examples of locally-focused services
- Dispatch engineers to do household electrical wiring work
- Seek compensation for losses when foods stored in refrigerators are damaged due to power failure

Economic size of stadtwerke as a whole (total)

Business type	Sales (100 million yen)	Number of employees (persons)
Power	70,049	63,019
Gas	35,846	33,643
Heat	5,446	9,638
Total	111,341	106,300

(The above are figures as of 2013; 1 euro=140 yen)

Examples of locally-focused Japanese energy companies

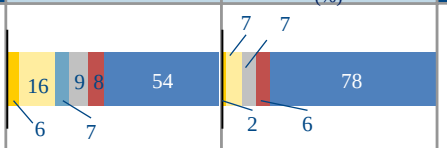
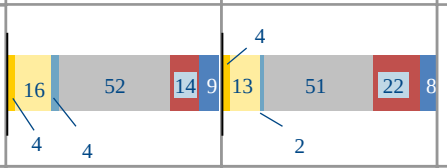
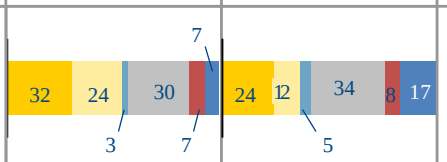
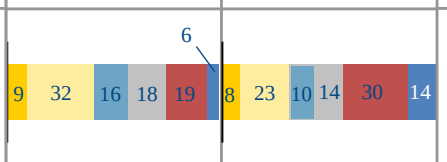
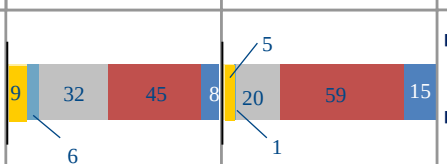
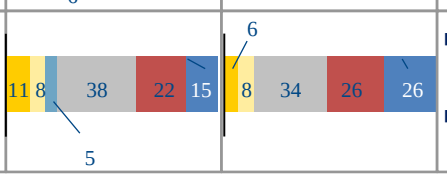
Company name	Specifics of business
Miyama Smart Energy (Miyama City, Fukuoka Prefecture)	• Aim for local production, local consumption of power by purchasing electricity generated by solar power within the city at 1 yen/kWh higher than the normal price and selling it to users • Offer various discounts, including a 50-yen/month discount for users purchasing a combination of electricity and tap water and a 300-yen refund/month for users subscribing to comprehensive living support service (such as daily life monitoring for elderly people)
Local Energy (Yonago City, Tottori Prefecture)	• Established jointly by Yonago City and five local companies; Purchase electricity generated by waste incineration and solar power generation facilities in the city, sources accounting for 80% of the electricity sold by the company
Tottori Gas Group (Tottori City, Tottori Prefecture)	• Established jointly by Tottori City and Tottori Gas in order to create a virtuous economic cycle and achieve regional revitalization by promoting local production and local consumption of energy
Sala Corporation (Toyohashi City, Aichi Prefecture)	• Sala Group, which centers around Chubu Gas, provides locally-focused general daily life services: including sales of houses and automobiles and operation of adult learning classes, in addition to supplying energy.

Source: Prepared by the Agency for Natural Resources and Energy based on reference materials provided by individual companies

Reference

【Europe】 Outline of European Power and Gas Companies

- In Europe, liberalization proceeded following EU directives issued in the 1990s. Later, the introduction of renewable energy made progress through the development of institutional systems.
- Measures taken by individual energy companies in response included mutual entry by power and gas companies into each other's sector, intensive investment in renewable energy sources and overseas expansion.
- In recent years in particular, E.ON and RWE have been seeking to change their core businesses.

	Sales size/operating profit rate (%)	Foreign sales ratio (%)	Power source mix (2015)		Outline	Strategy
			Installed capacity (%)	Power generation volume (%)		
EDF **Electricity→**	€75 billion (6.0%)	47%			■ Was originally a French state-run electricity company Still engaging in vertically integrated power business*1 in France Also engaging in the gas business ■ Has a large proportion of nuclear power generation and is exporting nuclear reactors	■ CAP 2030: Provide customer-tailored solutions – Renewable energy development intended to achieve power source competitiveness and low carbon at the same time – Accelerating international business (ratio of profits earned outside Europe: 5% → 15%)
Engie **Gas →**	€69.9 billion (-4.4%)	64%			■ Was originally a French state-run gas company Still engaging in vertically integrated gas business*1 in France Also engaging in power business ■ Promoting overseas expansion focusing on local needs and shifting to low carbon	■ 3-year strategic transformation plan – Shifting to low carbon business – Providing comprehensive solutions for customers – Devoting efforts to non-commodity businesses
Iber. **Electricity→**	€31.4 billion (12.5%)	54%			■ A Spanish electricity company also engaging in the gas business ■ Actively increasing renewable energy power capacity, mainly in overseas markets Renewable energy accounts for more than half of the company's installed capacity (including capacity of hydroelectric power generation).	■ Strategic Plan 2016-2020 – Leading energy conversion by devoting efforts to business with high foreseeability – Devoting efforts to renewable energy, network, and long-term contract power generation business
ENEL **Electricity→**	€75.7 billion (9.7%)	61%			■ Was originally an Italian state-run power company Also engaging in the gas business ■ Expanding overseas, mainly in South America and Eastern Europe, and increasing renewable energy power capacity	■ Strategic Plan 2017-2019 – Digitization and customer focus are the pillars of the strategy – Investment in digitization: €4.7 billion – Providing new services, including demand response, e-home, e-mobility, and mini utility
RWE **Electricity→**	€46.4 billion (0.9%)	43%			■ Established through the merger of major German power companies Also engaging in gas business ■ The proportion of coal-fired thermal power generation is large.	■ Established Innogy, a new company centering on renewable energy, network and retail sales, with the aim of shifting away from the traditional business model – The parent company is continuing traditional power generation and trading businesses.
E.ON **Electricity→**	€116.2 billion (-4.4%)	65%			■ Established through the merger of major German power companies Also engaging in the gas business ■ The proportion of gas-fired thermal power generation is large.	■ Devoting efforts to renewable energy, network and customer solutions with the aim of shifting away from the traditional business model – Spun off traditional power generation, trading and resource development businesses

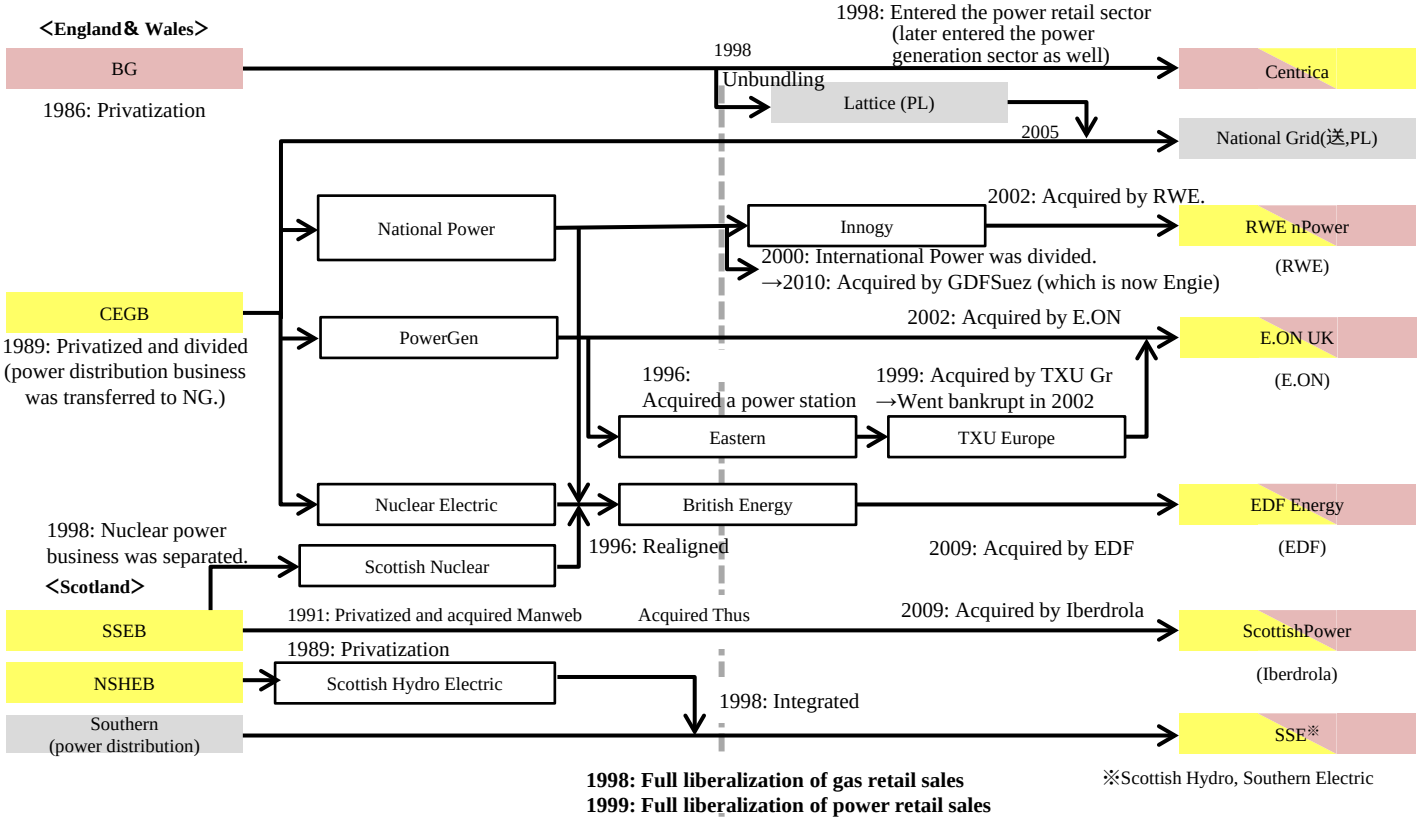
Renewable energy / Hydroelectric power / Oil / Gas / Coal / Nuclear power (renewable energy includes hydroelectric power in the case of RWE)

*1: EDF and Engie have legally unbundled their transmission and distribution divisions.

【Europe】U.K. power and gas companies

- Before the liberalization, CEGB and BG, both of which were state-run companies, were engaging in vertically-integrated power and gas businesses, respectively.
- In line with the liberalization, the two companies were privatized and disbanded and their businesses were realigned and consolidated, resulting in intensified competition among companies including foreign ones.
- RWE (Germany), E.ON (Germany), EDF (France) and Iberdrola (Spain) entered the U.K. market in earnest through acquisitions.
- Currently, the companies have been consolidated into the Big 6 (Centrica, RWE nPower, E.ON UK, EDF Energy, Scottish Power and SSE). Four of the six are foreign companies.

History of power and gas companies



* This chart shows only representative energy companies, rather than all power and gas companies.

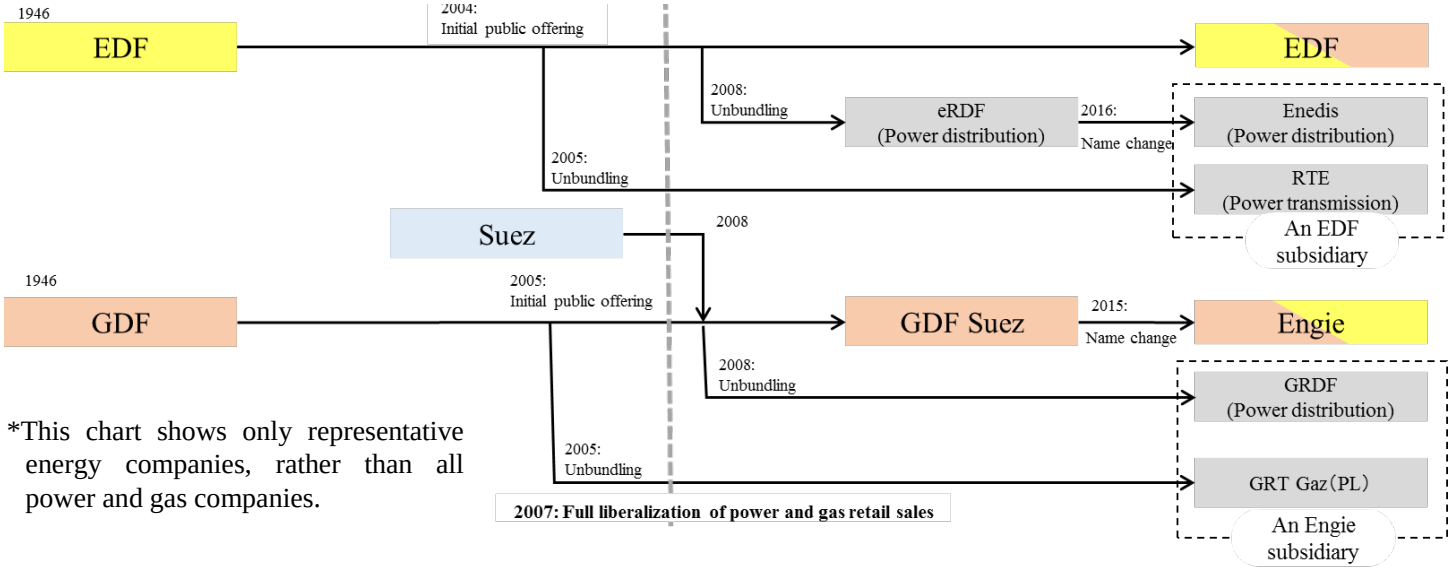
Source: Prepared by the Agency for Natural Resources and Energy based on various reference materials

【Europe】French, Spanish and Italian Power and Gas Companies

France

- Before the liberalization, EDF and GDF, which were state-run companies, dominated power and gas businesses through vertically integrated operation.
- After partial privatization of these two companies, power and gas retail sales were fully liberalized in 2007.
- Following the liberalization, EDF and Engie (former GDF Suez) have continued to dominate the power and gas sectors through vertically integrated operation.
- EDF is actively expanding abroad, particularly in the nuclear power generation sector, backed by solid domestic business.

History of power and gas companies*



*This chart shows only representative energy companies, rather than all power and gas companies.

<Concerning Suez>
Before the merger with GDF:
○A major global water business operator
○Dominant power and gas company in Belgium
○ Engaged in power business in France, Italy and Germany.
After the merger, GDF became GDF Suez, with the water business separated into an independent company.

Source: Prepared by the Agency for Natural Resources and Energy based on various reference materials

Spain

- Electricity and gas retail sales were fully liberalized in 2003.
- Iberdrola shifted emphasis in the power source mix to renewable energy and is actively expanding abroad following the revision of Spain's policy on support for introduction of renewable energy.

Italy

- Gas and power retail sales were fully liberalized in 2003 and 2007, respectively.
- ENEL is actively expanding abroad because it has become difficult to expand domestic share due to regulation.

【United States】 Major U.S. Companies

- In the United States, liberalization started in the 1990s. However, liberalization was temporarily suspended due to the power crisis in California in 2000-2001. Afterwards, the progress in liberalization has varied from state to state.

  (The electricity sector has been fully liberalized in 13 states and Washington D.C. (as of March 2017))

- Some major energy companies have classified businesses into regulated and liberalized businesses and are operating them separately, while others are actively rebalancing their portfolios and accelerating the introduction of renewable energy in particular.

<U.S. energy companies>

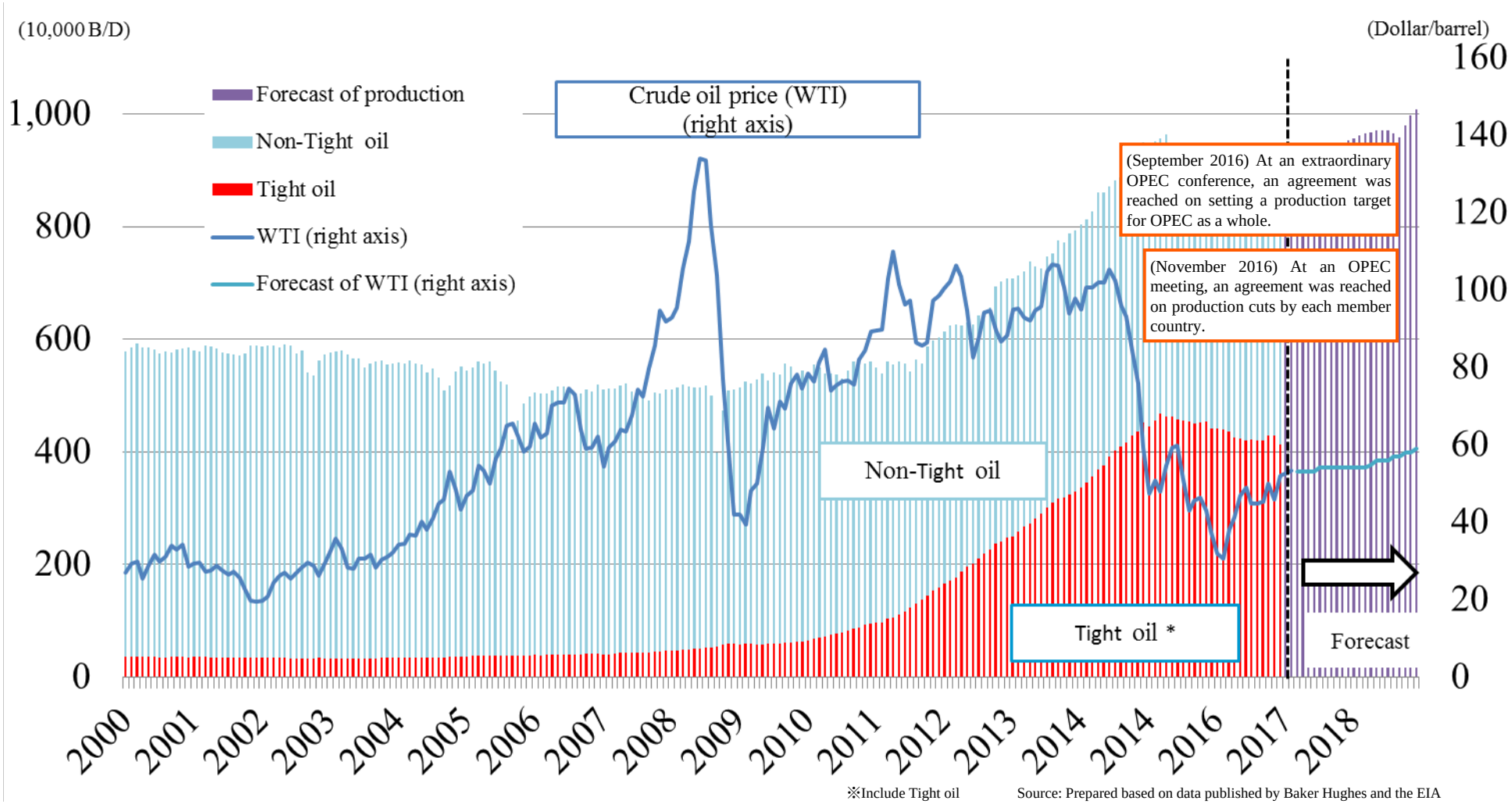
Company name	Headquarters/states where business is conducted	Power source mix	Business strategy, etc.
Exelon	・Illinois (liberalized state) ・Expanded into 48 states and Washington D.C.	Nuclear power: 59%; Thermal power (mainly gas and oil): 29%; Renewal energy: 11%	・The largest power company in the United States ・Expanded from the power generation business into retail business in liberalized sectors, thereby striking the balance in the value chain (actively investing in smart grid, etc.)
NextEra Energy	・Florida (partially liberalized state) ・Expanded into 26 states	(Subsidiary FPL: power generation volume) Natural gas: 69%; Nuclear power: 22%; Coal: 4%; Purchased power: 5% (Subsidiary NEER: power generation volume) Wind power: 42%: Nuclear power: 27%; Natural gas: 27%; Solar power: 3%	・Owns two subsidiaries: FPL, a subsidiary which supplies to Florida electricity mainly generated through natural gas-fired thermal power, and NEER, a subsidiary which mainly engages in renewable energy business across the United States, including in liberalized markets
Southern Company	・Georgia (partially liberalized state) ・Expanded into 17 states, mainly in the South	Natural gas: 46%; coal: 34%; Nuclear power: 16%; Hydroelectric power: 3%	・Not only engaging in power business but also actively expanding in the gas business, as exemplified by the acquisition of AGL Resources, a gas sales company, in 2016
Duke Energy	・North Carolina (regulated state) ・Expanded into five states	Fossil fuel power: 74.7%; Nuclear power 17.9%; Hydroelectric power: 7.2%; Renewable energy: 0.2%	・Sold hydroelectric and gas-fired thermal power stations in South and Central America for a total of 2.4 billion dollars and is planning to invest 11 billion dollars in renewable energy over the next 10 years

Source: Prepared by the Agency for Natural Resources and Energy based on various reference materials

【World】 Changes in the Environment Surrounding the Oil Industry

- The global supply-demand structure has changed dramatically due to an expansion of U.S. shale oil production. Due to the uncertainty over the Chinese economy and OPEC's decision to maintain the production target, the crude oil price has fallen steeply since July 2014.
- As shale oil production volume has been kept at a certain level even during the period of an oil price slump, the rise in the crude oil price has been curbed despite OPEC's coordinated production cuts.

Changes in and forecast of crude oil price and U.S. crude oil production volume



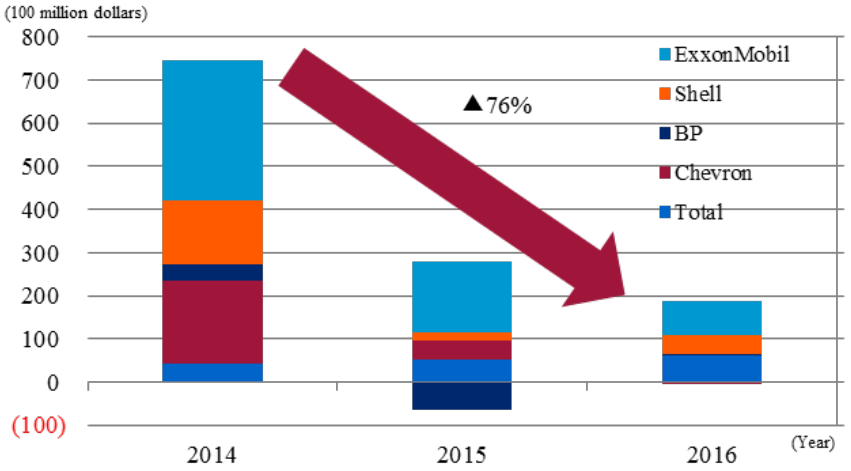
※Include Tight oil

Source: Prepared based on data published by Baker Hughes and the EIA

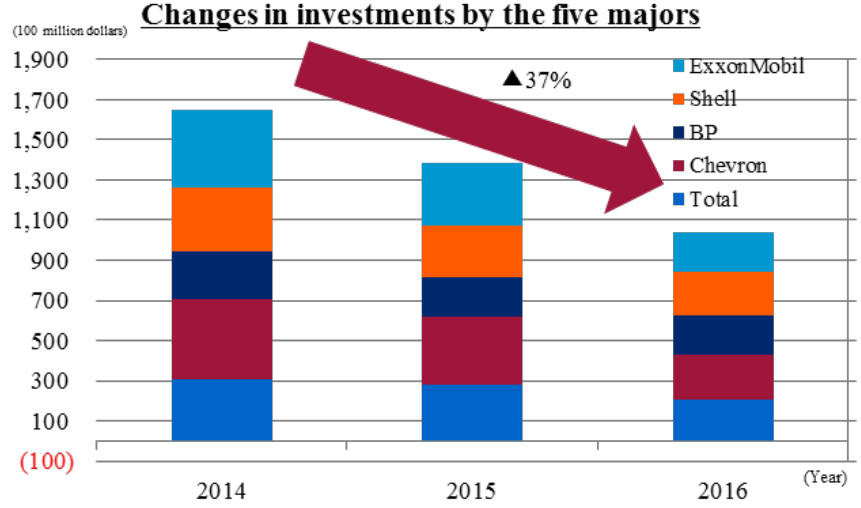
【World】 Activities of Oil Majors (Upstream Development)

- Oil majors, confronted with the deterioration of their financial condition due to the slumping oil price, implemented strategic acquisition of upstream assets while reducing investment and selling off non-strategic assets (portfolio rebalancing).
- Due to the oil price slump since 2014, oil-producing countries' state finances deteriorated. Moves to obtain foreign currency funds accelerated, including an initial public offering by Saudi Aramco and the sale of government-owned shares in Russia's state-run oil company.

Changes in the five majors' net profits



Changes in investments by the five majors



(Note) U.S. accounting standards;
The value of investments includes investments in assets other than upstream assets.
Source: Estimated by the Agency for Natural Resources and Energy based on earning information published by individual companies

Examples of acquisition of high-quality assets by European and U.S. oil majors

Date	Acquirer	Target company	Outline
October 2015	ExxonMobil	Mozambique	Acquired a deepwater mining area in Mozambique
February 2016	Shell	BG (U.K.)	Completed the procedures for acquisition at the equivalent of 54 billion dollars (Acquisition of LNG assets in Australia and rights to a deepwater oil field in Brazil)
October 2016	ExxonMobil	Cyprus	Acquired a deepwater mining area in Cyprus
December 2016	BP	UAE	Acquired a 10% stake in the ADCO mining area in Abu Dhabi through a share exchange
December 2016	BP	Egypt	Acquired a 10% stake in the Zohr gas field and other assets from Eni
January 2017	ExxonMobil	U.S.	Acquired the Permian shale assets for 6.6 billion dollars
February 2017	ExxonMobil	Inter Oil (Papua New Guinea)	In July 2016, proposed a counter bid for a project which another company had already agreed to acquire. Acquired rights to a gas field in Papua New Guinea

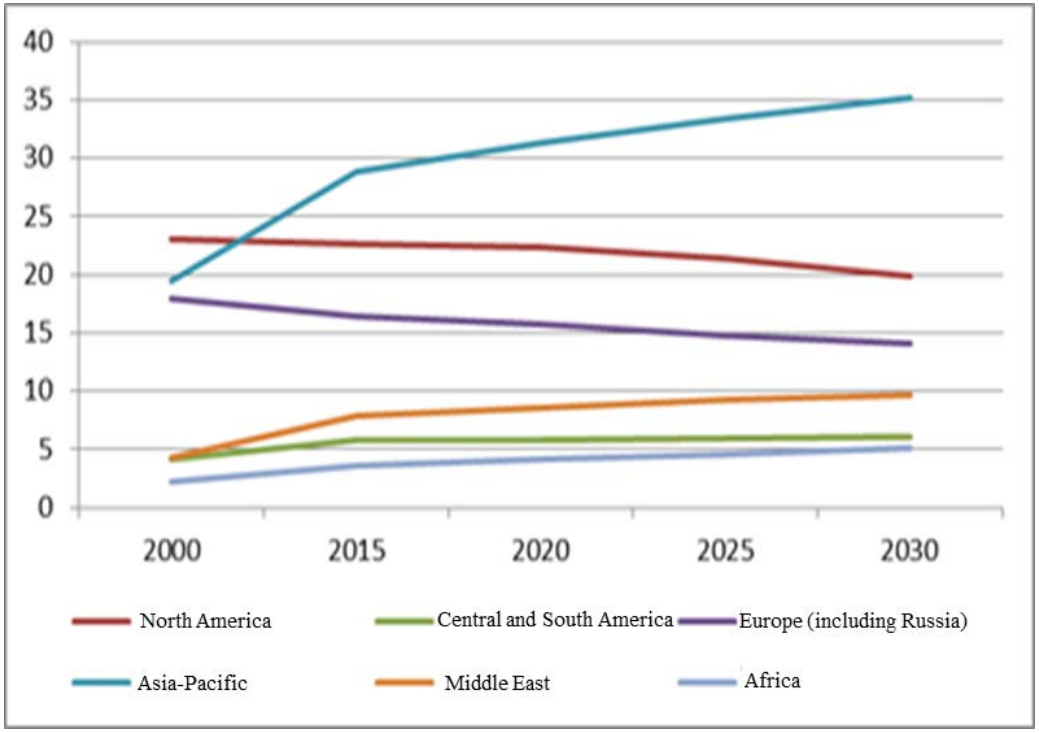
Initial public offering by state-run companies

- **SaudiAramco (Saudi Arabian state-run company): planning initial public offering**
- **Rosneft (Russian state-run company): sold government-owned shares**
- **Kazmunaigas (Kazakh state-run company): considering partial privatization**
- **Petrobras (Brazil): considering selling shares in a subsidiary**

【World】 Activities of Oil Majors (Downstream)

- In accordance with changes in the supply-demand structure of oil products, oil majors are reviewing their refining business in developed countries and are seeking to optimize the global supply-demand balance through oil product trading.
- In recent years, Chinese oil companies, in the same manner as oil majors, are actively expanding abroad, particularly in Asia, with the aim of building a global oil supply network.

Trend in demand for oil products by region (1 million BD)



Source: Prepared by the Agency for Natural Resources and Energy based on World Energy Outlook 2016, IEA

Examples of closure and sale of oil refineries in developed countries by oil majors

Country	Outline
U.K.	In 2011, Chevron sold the Pembroke oil refinery to Valero, a U.S. oil refining company.
France	Since 2010, four refineries, including Total's Dunkirn refinery, have been closed.
Australia	Since 2003, a total of four refineries, including ones owned by Exxon Mobil, Shell and BP, have been closed.

Source: Prepared by the Agency for Natural Resources and Energy based on data published by the Institute of Energy Economics, Japan

Examples of expansion into Southeast Asia by Chinese oil companies

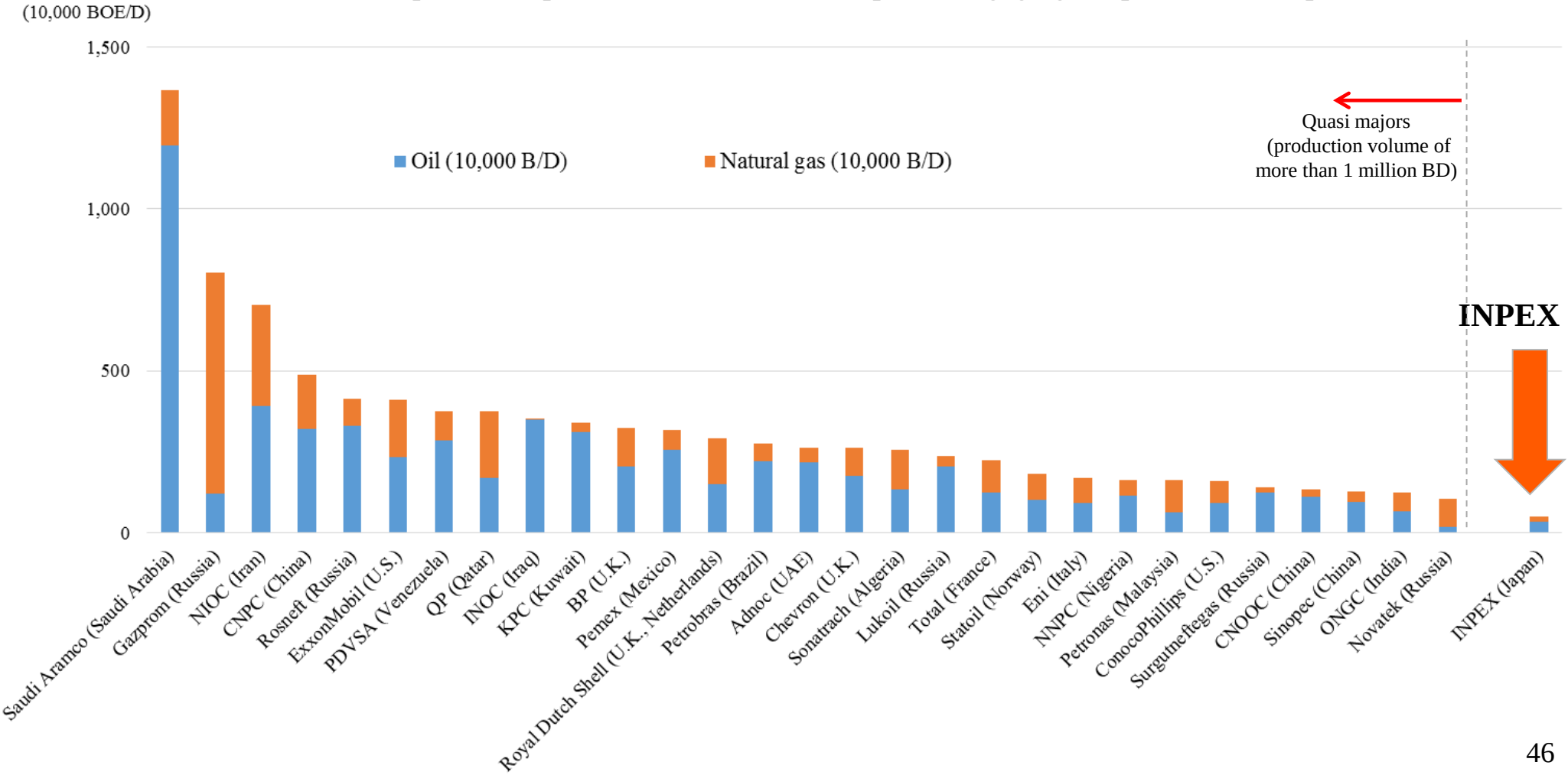
Country	Project outline
Myanmar	In Myanmar's Dawei special economic zone, Guangdong Zhenrong Energy obtained approval from the government for a plan to build a refinery with a capacity of 100,000 BD.
Cambodia	A subsidiary of CNPC is building a refinery with a capacity of 40,000 BD. Scheduled to be completed in late 2018
Malaysia	In December 2016, Shandong Hengyuan Petrochemical, an independent energy company, acquired a 51% stake in Shell's Port Dickson refinery (capacity of 156,000 BD).
Singapore	In 2009, CNPC acquired a 50% stake in Singapore Refining Company (capacity of 290,000 BD) through a subsidiary.

Source: Prepared by the Agency for Natural Resources and Energy based on data published by the Institute of Energy Economics, Japan

【Japan】 Activities of Companies Engaging in Oil and Natural Gas Upstream Development

- Concerning Japanese companies engaging in upstream development, the public and private sectors are conducting activities to create “core companies,” aiming for a production scale of around 1 million barrels per day as a benchmark.
- Although the industry realignment has made a certain amount of progress in Japan, Japanese energy companies are still small by international standards. There are expectations for invigoration of corporate acquisition activities following the revision of the JOGMEC Act in November 2016.

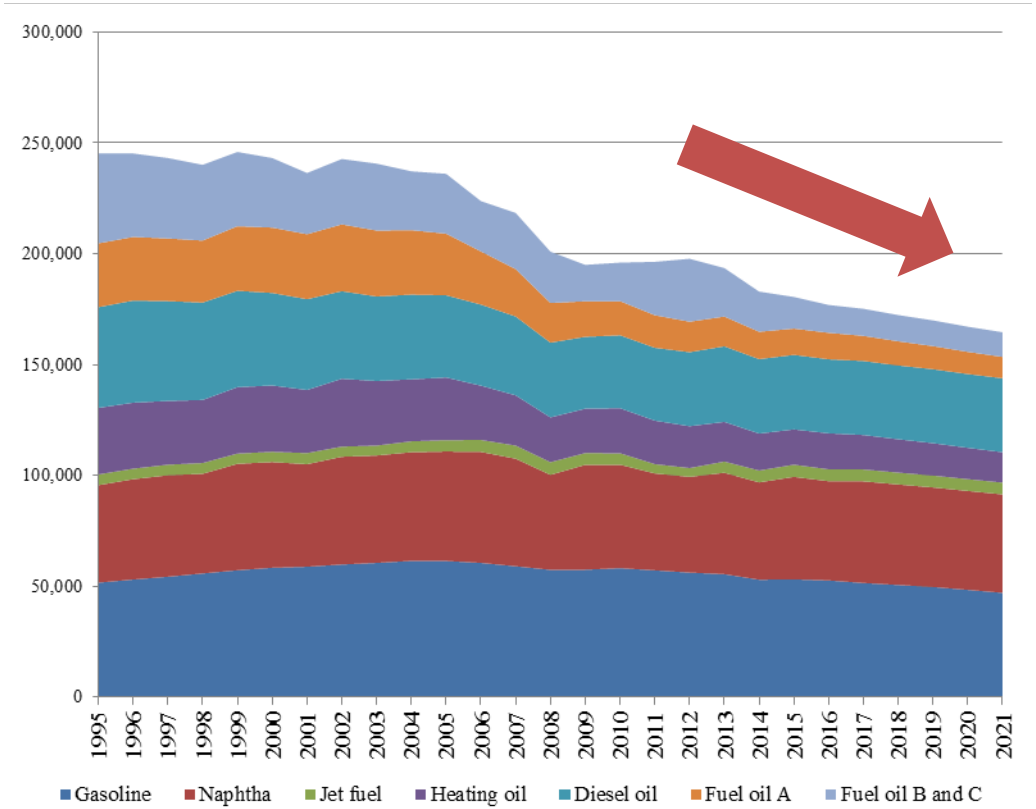
International comparison of production volumes of companies engaging in upstream development



【Japan】 Environment Surrounding Japan's Oil Refining Industry

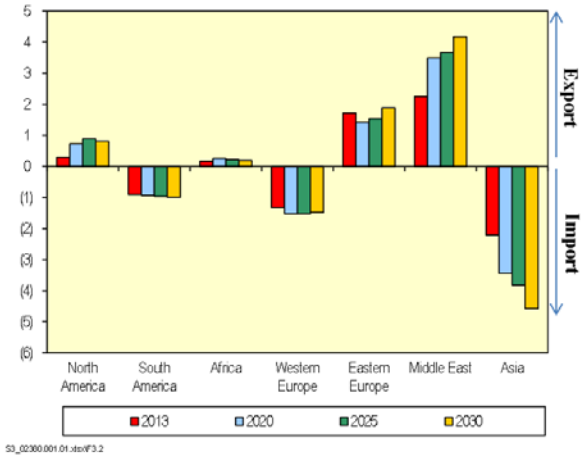
- Although oil product demand is expected to continue declining in Japan, demand is expected to grow in neighboring Asian countries and supply capacity is also expected to increase accordingly.
- In Asia, environmental regulation is expected to be tightened, resulting in the narrowing of the quality gap with developed countries. It is possible that international oil product transactions will become more vigorous than the current situation.

Fuel oil demand by type in Japan (Unit: 1,000 kl)



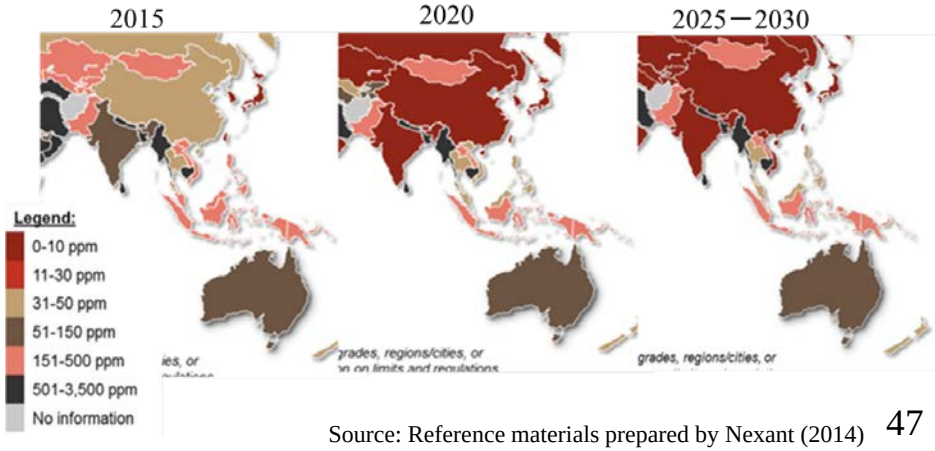
Source: Data for the period until 2016 are based on the Mineral Resources and Petroleum Products Statistics Data for the period since 2017 are cited from the Forecast for Oil Product Demand from 2017 to 2021 , the Petroleum Market Trends Working Group. However, the portion of the estimated demand for fuel oil C that is used for power generation is a figure for 2016 provisionally adopted due to the absence of an estimate.

Oil product trading volume by region (Unit: million BD)



Source: Reference materials prepared by Nexant (2014)

Sulphur content regulation concerning gasoline in Asia

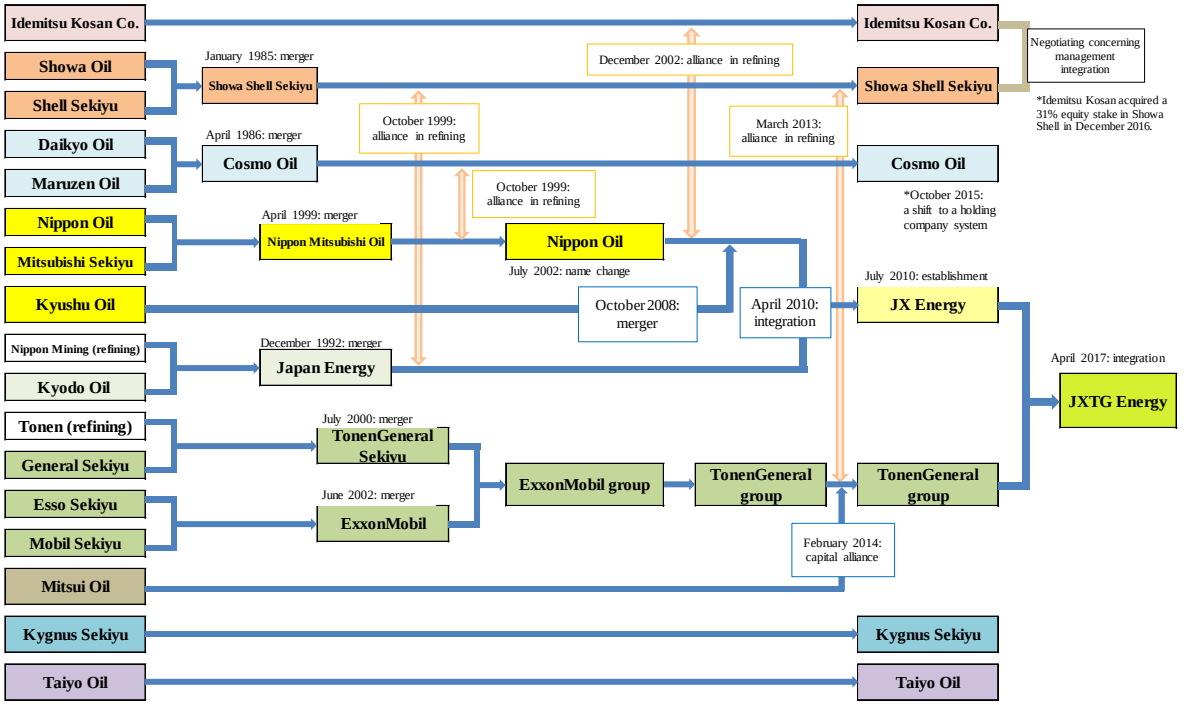


Source: Reference materials prepared by Nexant (2014)

【Japan】 Future outlook of the mid and downstream sectors of the oil industry

- Amid the shrinkage of the domestic market, the realignment of the oil industry has proceeded in Japan. Progress has been made in activities toward management integration, integration of refinery operation, and business efficiency improvement and rationalization.
- In the future, the challenge will be further expansion into growth sectors through activities such as the acquisition of foreign market shares in Asian and other regions in addition to rationalizing domestic businesses. Amid the ongoing expansion into Asian markets by oil majors and Chinese companies, Japanese companies also need to step up expansion activities.

History of the realignment of the oil industry



Source: Prepared by the Petroleum Association of Japan

Examples of overseas expansion by Japanese oil companies

Oil company	Sector	Country of operation	Joint venture company (joint venture partners)	Remarks
Idemitsu Cosmo	Oil refining	Qatar	Laffan Refinery 2 (Qatar Petroleum, Total, Marubeni and Mitsui and Co.)	2009: Laffan Refinery 1 (capacity of 146,000 B/D) started operation. December 2016: Laffan Refinery 2 (capacity of 146,000 B/D) started production.
Idemitsu		Viet Nam	Nghi Son Refinery &. Petrochemical Ltd. (Kuwait Petroleum International, PetroVietnam and Mitsui Chemicals Inc.)	2013: Construction of the refinery started. By the end of 2017: Commercial operation is scheduled to start (capacity of 200,000 B/D).
JX		Viet Nam	VIETNAM NATIONAL PETROLEUM GROUP *Commonly known as Petrolimex (partnership with the company)	December 2014: Signed a memorandum of understanding on consideration of acquisition of shares and construction of a new oil refinery April 2016: Signed a contract to purchase shares and a strategic partnership contract
TonenGeneral	Oil sales and terminals	Australia	TQ Holdings Australia Pty Limited (Qube Holdings Limited)	【Specifics of the project】 Oil products sales and terminal operation From the middle to the end of 2017: Scheduled to construct an oil product storage facility (maximum capacity of 230,000 KL).
JX	Petrochemicals	ROK	Ulsan Aromatics (SK Innovation)	August 2011: Established a joint venture November 2012: Started construction June 2014: Started commercial operation
Cosmo			Hyundai Cosmo Petrochemical (Hyundai Oilbank)	November 2009: Established a joint venture November 2012: Installed additional production equipment (annual PX production: 380,000 tons → 1.18 million tons) January 2013: Started commercial operation (additional equipment)
Showa Shell Taiyo			GS Caltex (participated in a project implemented by the company)	April 2012: Signed a memorandum of understanding on increasing annual PX production from 1.35 million tons to 2.35 million tons

Source: Prepared based on information available on individual companies' websites