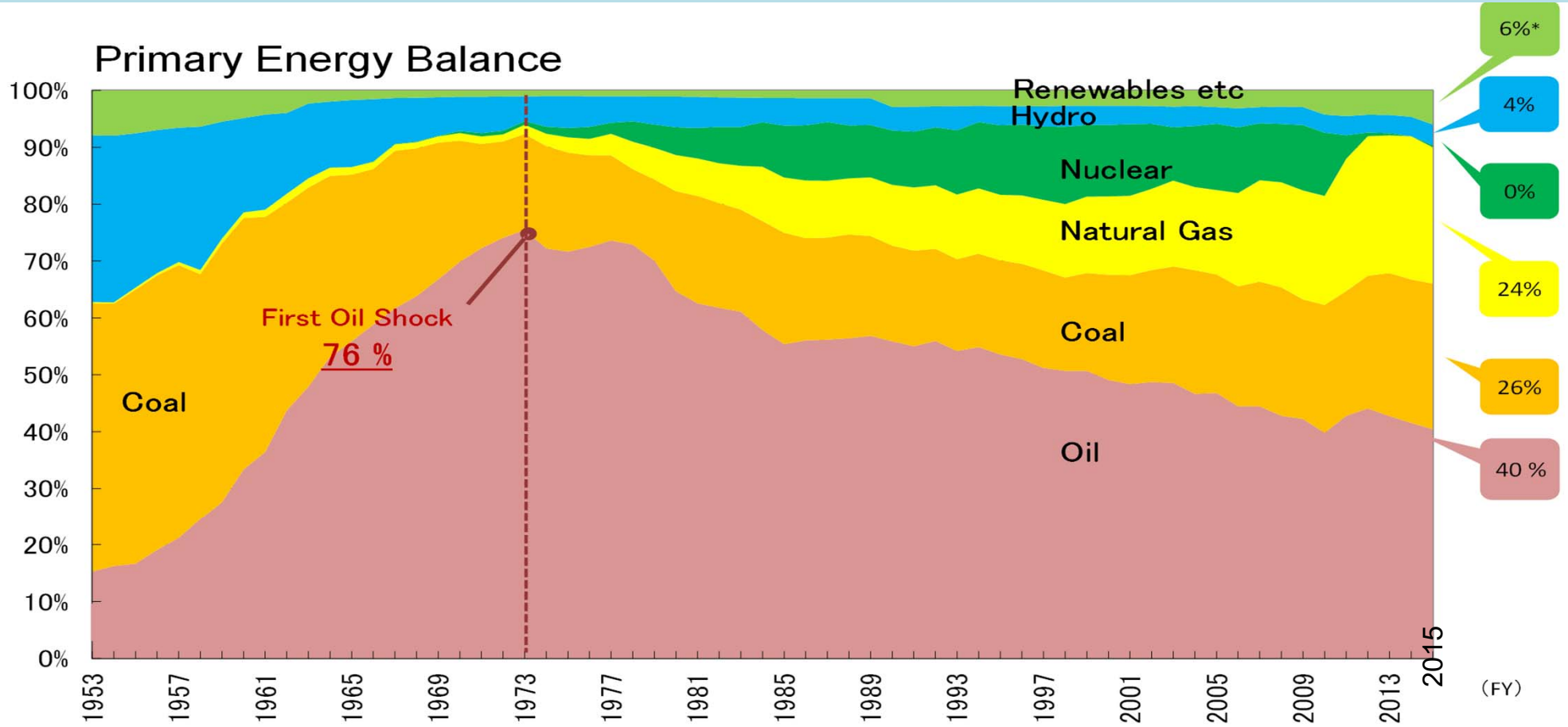
Japan’s Strategic Energy Plan

April 12th, 2018

Agency for Natural Resources and Energies

Japan's Energy Balance in History

- Japan has made decision to secure energy supply to adopt different changes
  - 60's：national coal to oil, 70's：Oil crisis, 90's：Liberalization and global warming, in 2011：the Great East Earthquake and Fukushima Accident
- Toward the goal of Paris Agreement, Japan should make decision



Post war reconstruction (1950s)

Rapid economic growth(1960-)

Two oil crises (1970s)

Liberalization of markets and global warming (1990s-)

Great East Japan Earthquake and 1F accidents (2011-)

From domestic coal to petroleum (1960s)

・From oil to gas and nuclear

・the world's high level of energy efficiency

・Focus of Nuclear ・Focus of Renewable

* "Renewables etc." consists of solar power (1.5%), wind power (0.2%), geothermal heat (0.1%), and biomass (1.9%), effective recovery use of wasted energy(2.2%).

Source: Prepared based on "Comprehensive Energy Statistics 2016" issued by the Agency for Natural Resources and Energy.

Japan's Strategic Energy Plan

- Based on the Strategic Energy Plan, Japan tackles the policy targets related to **Safety, Energy security, Economic efficiency, and Environment** simultaneously. (3E+S)
- The Plan also refers **reducing dependence on nuclear power generation as much as possible** by promoting energy efficiency and conservation, introduction of renewable energy, and introduction of efficient thermal power plants.

<Policy target for 3E+S>

Safety

Safety is the top priority.

Energy security

Self-sufficiency: About 25%, higher than before the earthquake (about 20%)

Economic efficiency

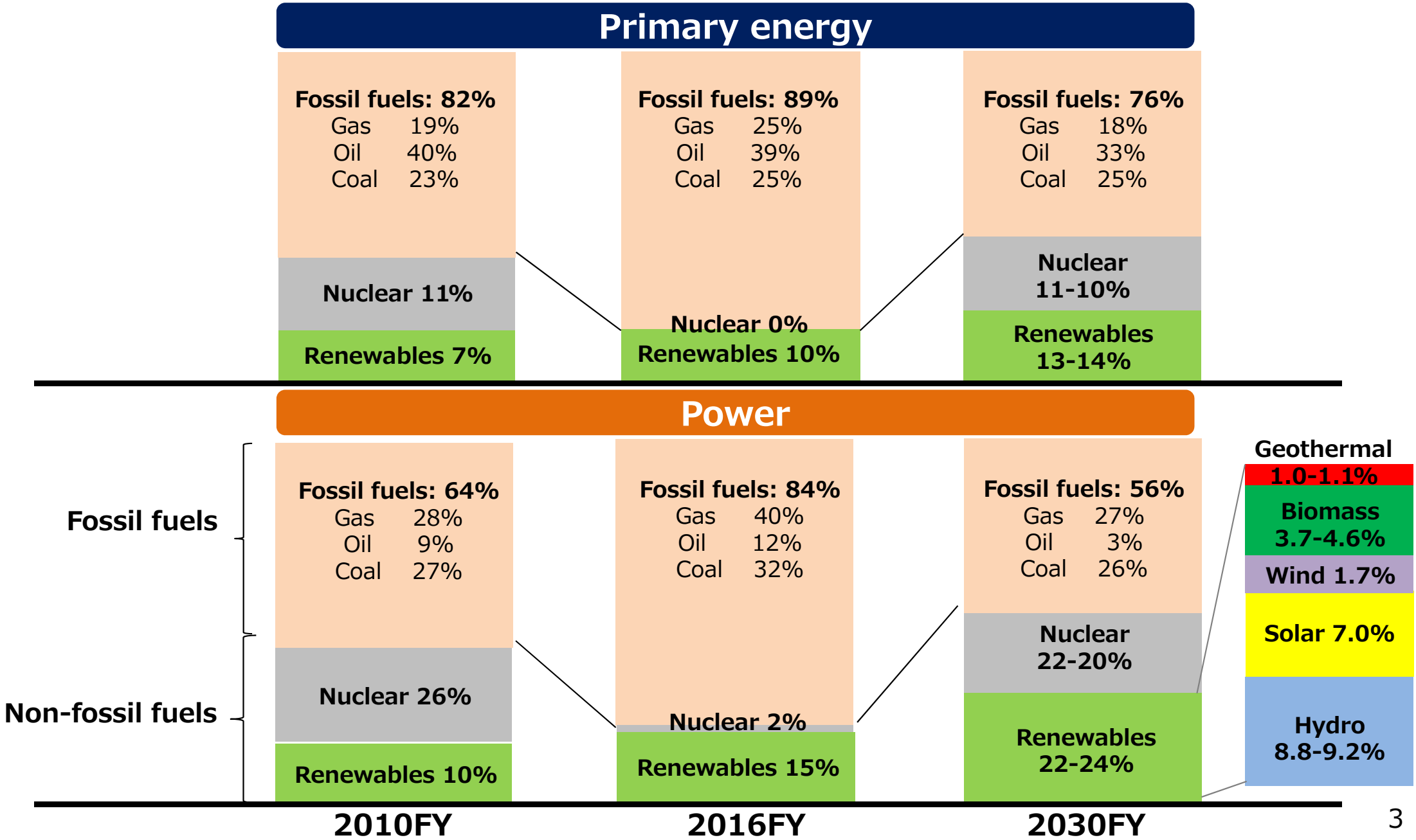
Electricity cost: To lower from the current level
(9.7 trillion yen in FY2013 to 9.5 trillion yen in FY2030)

Environment

Greenhouse gas emission reduction target:
(reduction of 26.0% in FY 2030 compared to FY 2013)

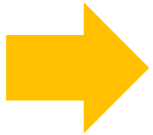
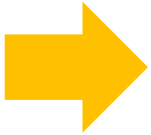
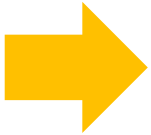
Energy Mix in Japan

- Energy Mix is a forecast and also a vison of a desired energy structure.
  - ➢ the goals of "Energy security", "Economic efficiency" and "Environment" are achieved



Low Self sufficiency Rate

- There are no nationally resources. It's important to improve the self sufficiency rate.

	Self Sufficiency (2000)		Self Sufficiency (2016) *China/India = 2015	Primary Nationally Produced Resources
U.S.	73%		88%	Natural Gas Coal, Petroleum
U.K.	74%		67%	Petroleum
Germany	40%		37%	Coal
France	52%		54%	Nuclear Power
China	98%		84%	Coal
India	80%		65%	Coal
Japan	20%		8%	None

Source: IEA Energy Balances 2017 *Japan's self sufficiency ratios estimated by Agency for Natural Resources and Energy

Japan's imports are particularly reliant on the Middle East. What will be the long-term situation there?

	Petroleum				Gas			
	Import Reliance	% Middle East	Largest Importer		Import Reliance	% Middle East	Largest Importer	
U.S.	41%	8%	15% Canada	Connected via Pipeline	3%	0%	3% Canada	Connected via Pipeline
U.K.	22%	1%	12% Norway	Connected via Pipeline	46%	10%	32% Norway	Connected via Pipeline
Germany	96%	4%	37% Russia	Connected via Pipeline	90%	0%	44% Russia	Connected via Pipeline
France	97%	25%	15% Saudi Arabia	Tanker Transport *Connected via European Pipeline	99%	2%	40% Norway	Connected via Pipeline
China	61%	31%	9% Saudi Arabia	Tanker Transport *Connected via pipeline to Russia etc.	29%	4%	15% Turkmenistan	Connected via Pipeline
India	83%	46%	15% Saudi Arabia	Tanker Transport *No pipeline	40%	25%	22% Qatar	Tanker Transport *No pipeline
Japan	99%	85%	37% Saudi Arabia	Tanker Transport *No pipeline	98%	23%	28% Australia	Tanker Transport *No pipeline

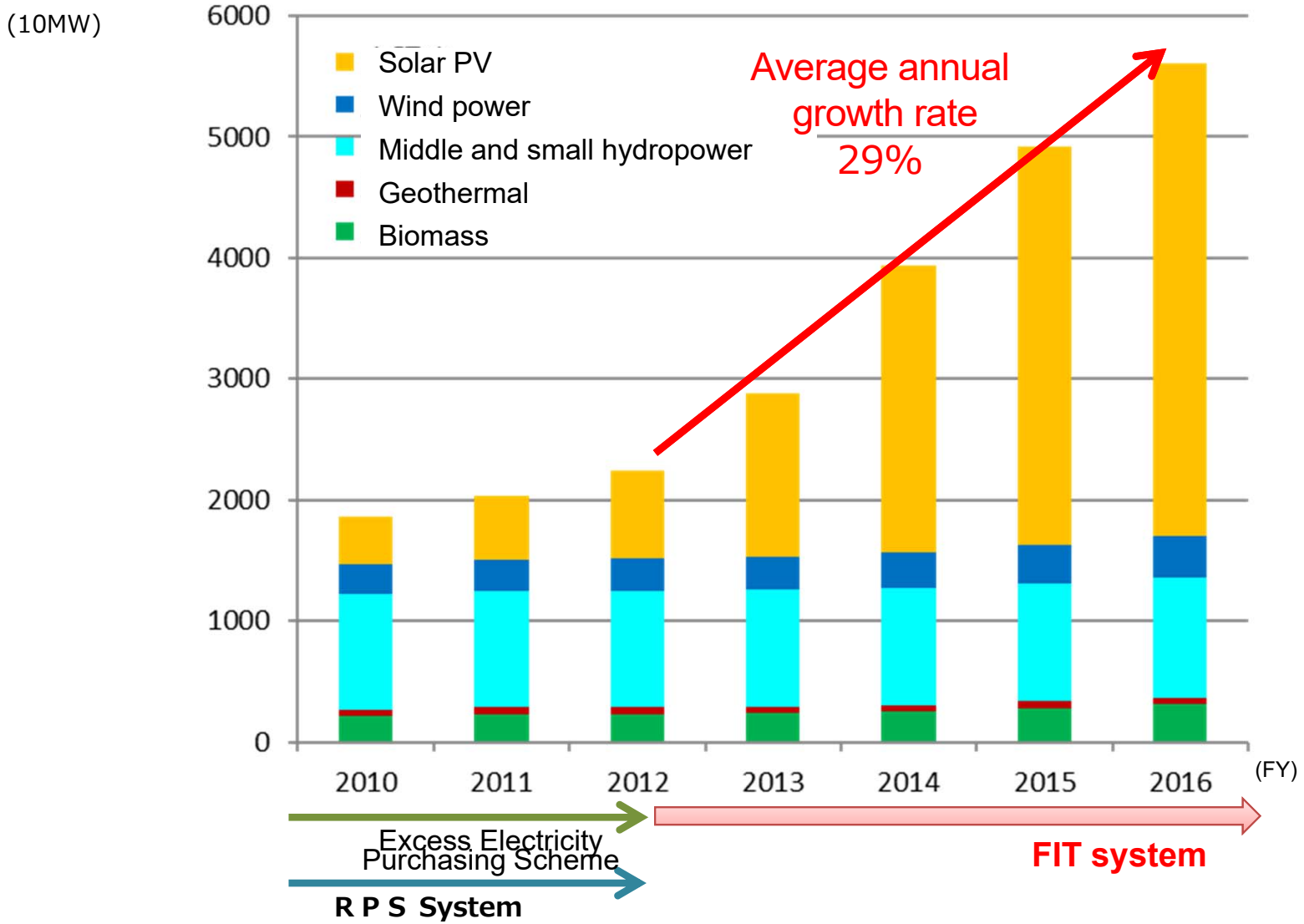
Source: Produced by Agency for Natural Resources and Energy from IEA/Energy balances etc.

*Data for China and India is from 2015

History of Introduction of RES

○FIT system introduced in 2012 causes 2.7 times increase in Renewables.

○The purchase costs reached 2.3 trillion yen (about 20.9 billion US dollars) and the levy burden to average households amount up to 686 yen/month (about 6.1 US dollars/month)

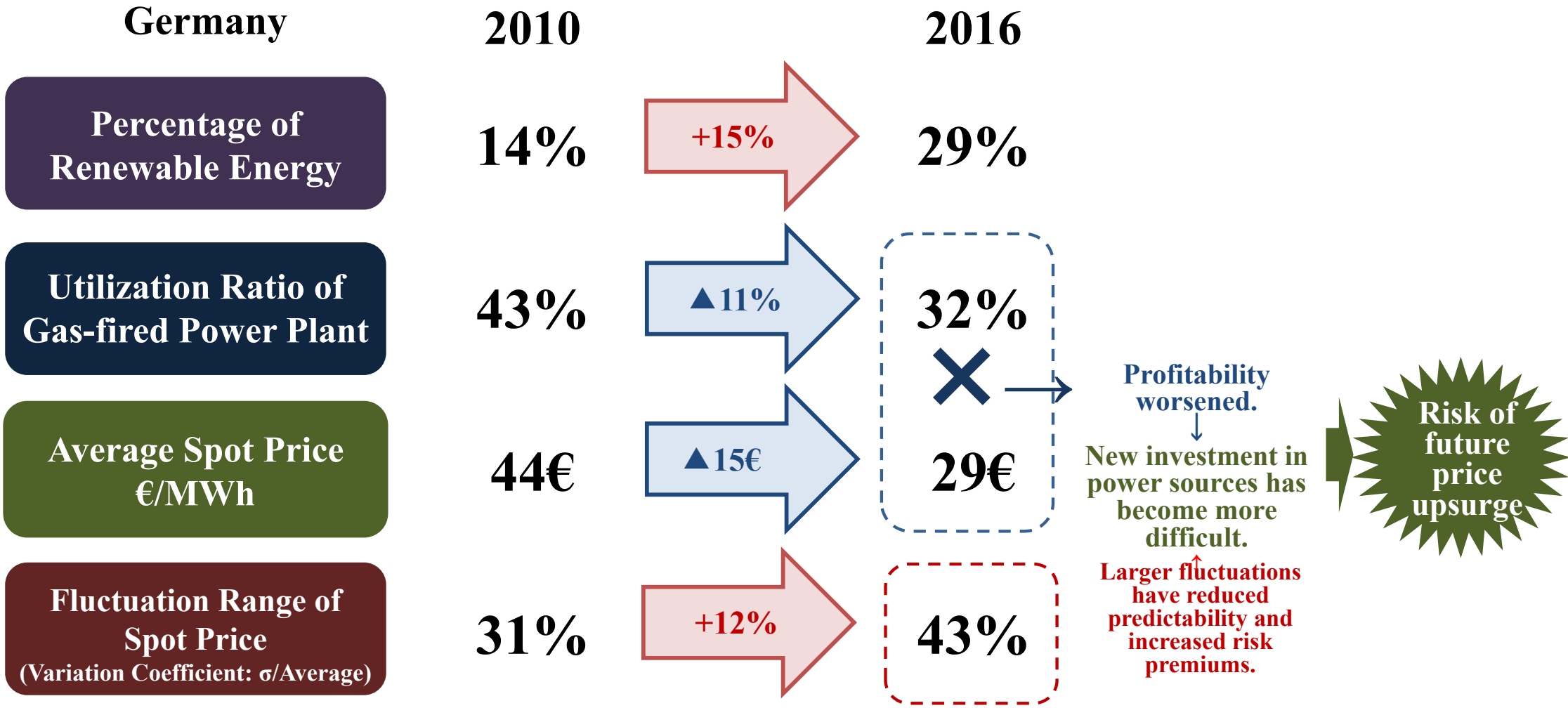


Three challenges to be addressed for renewable energy to be a major power source

Referred example **"Clean energy's dirty secret - Wind and solar power disrupting electricity systems" Economist, Feb 25th 2017**

	(i) Cost	(ii) Operating reserves	(iii) NW
Current	**Significantly declined in foreign countries**	**Depending on thermal power as operating reserves**	**Constructed in accordance with the locations of thermal and nuclear power plants**
Challenges	**Reduce higher cost in Japan**	**Maintain thermal power as operating reserves + Reduce battery cost**	**Restructure NW suitable for renewable energy + Introduce distributed NW**

Dissemination of renewable energy with no marginal cost has decreased the capacity utilization of thermal power plants, which leads to declining profitability of large-scale power sources. Fluctuations in spot prices have reduced predictability in investment.



※2010 and 2016 crude oil prices (WTI) at $79/bbl, $43/bbl respectively

Source: Created by Agency for Natural Resources and Energy from ENTSO-E, AG Energiebilanzen, etc.

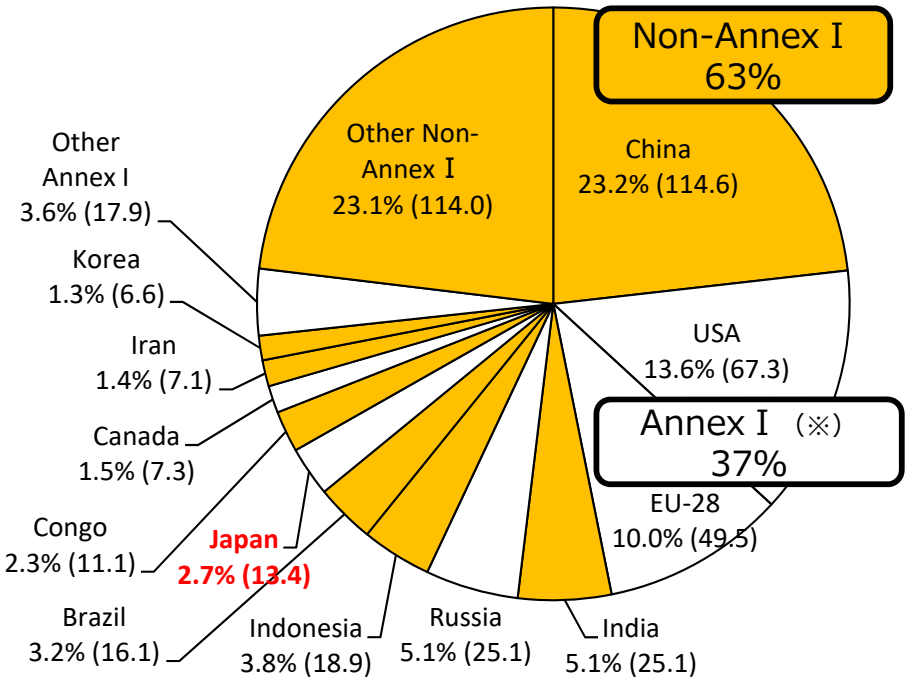
Contributions to Climate Change

- Our nationally determined contributions towards post-2020 GHG emission reduction is at the level of a reduction of 26.0% in FY 2030 compared to FY 2013
- Japan's GHG emission share accounts for only 2.7%. It's important to contribute to the reduction of GHG emission in the world or developing countries.

[Intended Nationally Determined Contributions submitted by major countries]

	Compared with 1990	Compared with 2005	Compared with 2013
Japan	-18.0% (2030)	-25.4% (2030)	-26.0% (2030)
U.S.	-14 to 16% (2025)	-26 to 28% (2025)	-18 to 21% (2025)
EU	-40% (2030)	-35% (2030)	-24% (2030)
China	-60% to -65% of carbon dioxide emissions per unit of GDP by 2030 compared to 2005 achieve the peaking of carbon dioxide emissions around 2030		
South Korea	+81% (2030)	-4% (2030)	-22% (2030)

GHG emission share



(※) : The list of countries which are obliged to reduce GHG emission

【Source】CO2 EMISSIONS FROM FUEL COMBUSTION2016(IEA)

◆ The U.S. submitted emission reduction target compared to 2005 while the EU submitted its target compared to 1990.

◆ South Korea submitted an emission reduction target of -37% in 2030 compared to the business-as-usual (BAU) scenario.

“The Strategic Policy Committee of the Advisory Committee for Natural Resources and Energy” & “Round Table for Studying Energy Situations”

- Periodic review of the plan is necessary and as four years have passed since the formulation of the Strategic Energy Plan, the Strategic Policy Committee of the Advisory Committee for Natural Resources and Energy held the 1st meeting on August 9, 2017 to begin those discussions.
- Under the Plan for Global Warming Countermeasures based on the Paris Agreement, Japan decided to aim at achieving an 80% reduction by 2050 as a long-term goal. However, such an ambitious goal may be difficult to achieve if we only continue current efforts. To overcome this challenge, Japan needs to achieve technological innovations and reduce carbon emissions through international contributions. To this end, METI established a Round Table for Studying Energy Situations.

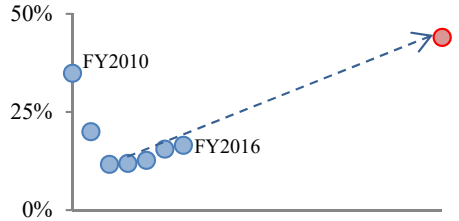
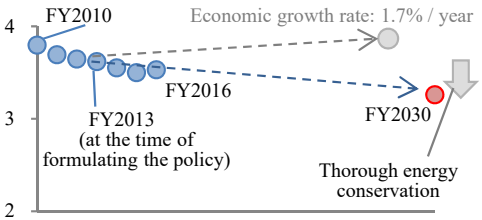
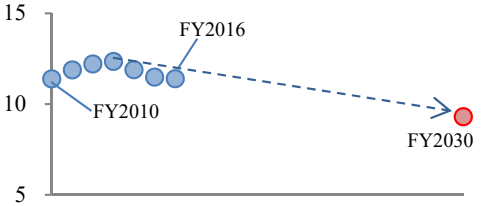
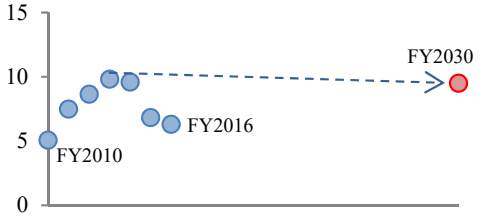
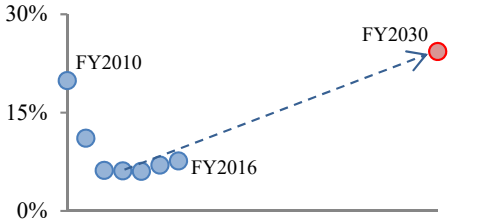
Member of the Strategic Policy Committee of the Advisory Committee for Natural Resources and Energy

Masahiro Sakane	Councilor, Komatsu Ltd.
Keigo Akimoto	Group Leader, Systems Analysis Group, Research Institute of Innovative Technology for the Earth (RITE)
Mami Ito	President＆CEO, NIHON DENTO KOUGYO Co., Ltd.
Takao Kashiwagi	Institute Professor, Tokyo Institute of Technology
Takeo Kikkawa	Professor, Graduate School of Innovation Studies, Tokyo University of Science
Teiko Kudo	Managing Executive Officer, Sumitomo Mitsui Banking Corporation
Yuko Sakita	Journalist /Environmental counselor, Represent of NPO"GENKI Network for Creating a Sustainable Society"
Yoko Takeda	Chief Economist　Deputy General Manager Research Center For Policy And Economy
Kikuko Tatsumi	Standing Advisor, NIPPON ASSOCIATION of CONSUMER SPECIALISTS（NACS） Public Interest Incorporated Association
Jitsuro Terashima	Chairman, Japan Research Institute, Chairman
Masakazu Toyoda	Chairman and CEO The Institute of Energy Economics, Japan
Hidetoshi Nakagami	Jyukankyo Research Institute Inc. CEO and Founder
Issei Nishikawa	Governor, Fukui Prefecture
Hiroya Masuda	Nomura Research Institute, Ltd Adviser THE UNIVERSITY OF TOKYO Visiting Professor
Toshihiro Matsumura	Professor, Institute of Social Science, The University of Tokyo
Nobuko Mizumoto	Managing Executive Officer & General Manager, Procurement Strategy Planning, IHI Corporation
Hirotaka Yamauchi	Professor, Hitotsubashi University, Graduate School of Commerce and Management
Akira Yamaguchi	Professor, The University of Tokyo, Department of Nuclear Engineering

Member of Round Table for Studying Energy Situations

Masami Iijima	Chairman of the Board of Directors, Mitsui & Co., Ltd.
Junko Edahiro	Professor, Tokyo City University Founder and President, e’s Inc.
Makoto Gonokami	President, The University of Tokyo
Masahiro Sakane	Councilor, Komatsu, Ltd.
Takashi Shiraishi	President, Institute of Developing Economies, Japan External Trade Organization
Hiroaki Nakanishi	Executive Chairman, Hitachi, Ltd.
Yoichi Funabashi	Co-founder and Chairman,Asia Pacific Initiative
Naoko Yamazaki	Astronaut

Progress in the Energy Mix Policy by FY2030
- Steady advancement seen while half way through -

	Before the Great East Japan Earthquake (FY2010)	After the Great East Japan Earthquake (FY2013)	Current (FY2016: estimation)	Energy Mix (FY2030)	Progress
Effort indices					
[i] Ratio of zero-emission power source	36 % Renewable energy: 10% Nuclear power: 26%	12 % Renewable energy: 11% Nuclear power: 1%	17 % Renewable energy: 15% Nuclear power: 2%	44 % Renewable energy: 22 to 24% Nuclear power: 22 to 20%	
[ii] Energy conservation (Final energy consumption in crude-oil equivalents)	380 million kl Industries and businesses: 2.4 Households: 0.6 Transport: 0.8	360 million kl Industries and businesses: 2.3 Households: 0.5 Transport: 0.8	350 million kl Industries and businesses: 2.2 Households: 0.5 Transport: 0.8	330 million kl Industries and businesses: 2.3 Households: 0.4 Transport: 0.6	
Achievement indices					
[iii] CO2 emissions amount (energy-oriented)	1.13 billion ton	1.24 billion ton	1.14 billion ton	0.93 billion ton	
[iv] Power cost (fuel cost + FIT purchase cost)	5 trillion yen Fuel cost: 5 trillion yen (Crude-oil price: $84/bbl) FIT purchase: 0 trillion yen	9.8 trillion yen Fuel cost: 9.2 trillion yen (Crude-oil price: $110/bbl) Quantum factor + 1.6 trillion yen Price factor + 2.7 trillion yen FIT purchase: 0.6 trillion yen	6.2 trillion yen Fuel cost: 4.2 trillion yen (Crude-oil price: $48/bbl) Quantum factor - 0.9 trillion yen Price factor - 4.1 trillion yen FIT purchase: 2.0 trillion yen	9.2 to 9.5 trillion yen Fuel cost: 5.3 trillion yen (Crude-oil price: $128/bbl) FIT purchase: 3.7-4.0 trillion yen	
[v] Energy self-sufficiency rate (overall primary energy)	20 %	6 %	8 %	24 %	

* Figures in FY2016 are the results estimated based on the data in the Energy Supply-Demand Outlook in Japan by FY2018 (prepared by the Institute of Energy Economics, Japan).
* The power cost in FY2030 includes 0.1 trillion yen as a cost for stable power grids.

Source: Prepared by ANRE based on the data in the Comprehensive Energy Statistics, etc.

Position of nuclear energy in the primary energy structure and its policy direction

（quoted from Strategic Energy Plan 2014）

＜Position＞

…Nuclear power is an important base-load power source as a low carbon and quasi-domestic energy source, contributing to stability of energy supply-demand structure, on the major premise of ensuring of its safety, …

＜Policy Direction＞

…Dependency on nuclear power generation will be lowered to the extent possible by energy saving and introducing renewable energy as well as improving the efficiency of thermal power generation, etc.…

Nuclear Power Plants in Japan

In Operation — **7** reactors

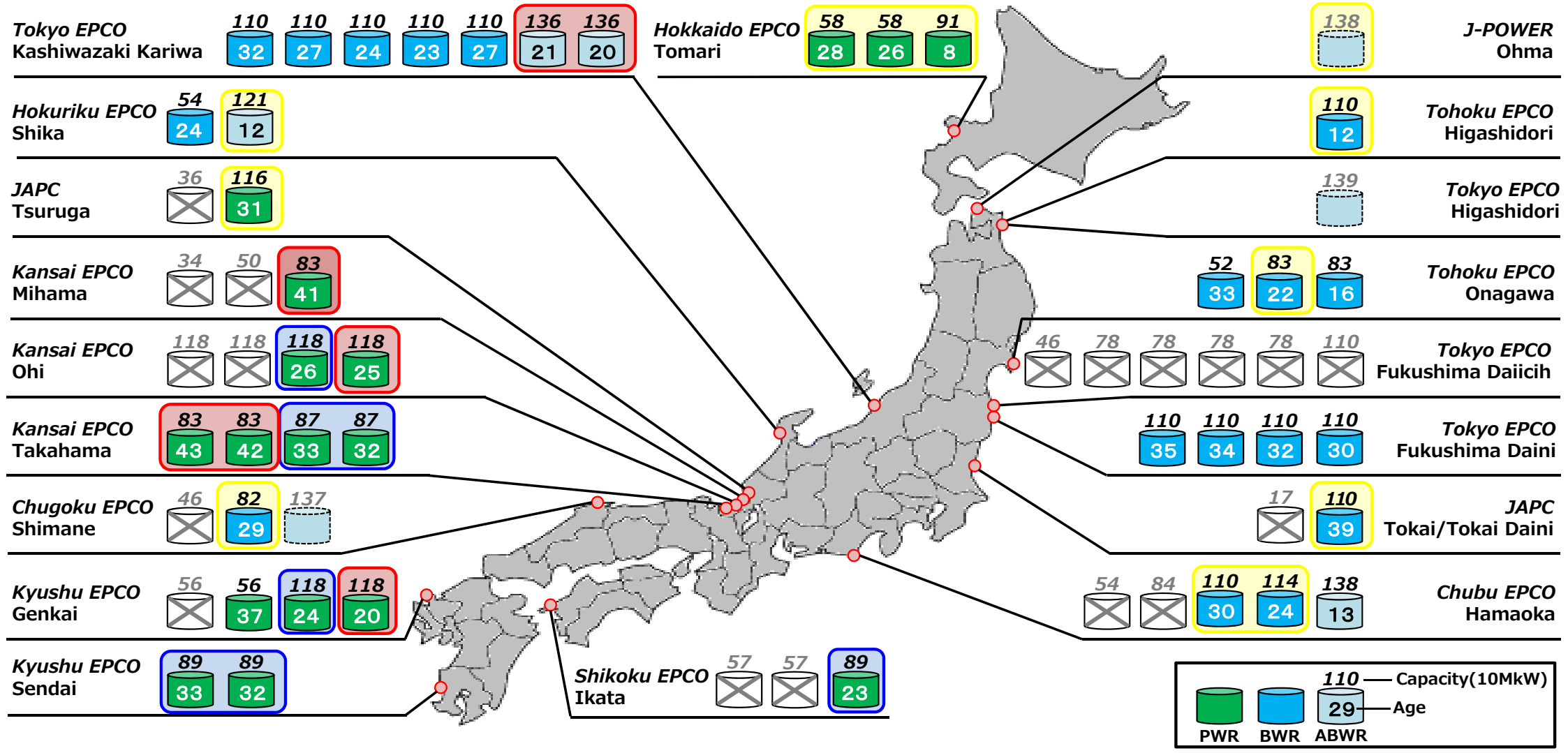
Passed NRA Review for the Permission for Changes in Reactor Installation — **7** reactors

Under NRA Review — **12** reactors

already decided to **Decommission** — **18** reactors

*Ikata Unit 3 and Sendai Unit 1 are under the periodic inspection. Genkai Unit 3 is under the pre-service inspection

As of 3rd, Apr, 2018



Nuclear Energy

- Restarting nuclear power plants with safe as the top priority, contributing to reducing CO2 emissions and mitigating burden of increased renewable energy cost -

Target share of nuclear power in all power sources in FY2030: 20-22%

- **7 units: Restarted on the premise of secured safety**
- **7 units: Permissions for Changes in Reactor Installation** granted
- **12 units: Under examination according to the new regulatory requirements**

Impacts caused by restarting units

Operation of one unit:

Reduction of fuel cost → 35.0-63.0 billion yen/year*

Reduction of CO2 emissions

→ 2.60 million - 4.90 million tons/year*

(Total CO2 emissions per year in Japan: Approx. 1.1 billion tons)

* These figures are estimated values (FY2016) in the case where a 1 million kW-level nuclear power plant (with the operation rate of 80%) is operated by LNG or oil-fired thermal power in the place of nuclear power.

Greatest challenge in the nuclear power field: Recovering social trust

<Restoration from damage caused by the accident and reconstruction of Fukushima>

- Sincerely reflecting upon the accident in Fukushima Prefecture
- The government of Japan intends to proactively lead efforts for decommissioning, addressing contaminated water and reconstruction of Fukushima.

<Improving safety>

- Formulated the world's strictest-level new regulatory requirements; strict examinations by the Nuclear Regulation Authority
- Establishing a system for improving continuous and autonomous safety

<Enhancing disaster prevention>

- Providing a backup system in formulating evaluation plans in collaboration among the government and related organizations
- Enhancing disaster prevention in collaboration among related organizations, e.g., operational units, and nuclear operators

<Final disposal and interim storage>

- Publicizing the Nationwide Map of Scientific Features for Geological Disposal under the leadership of the government, and fostering public understanding of these issues
- Enhancing efforts for expanding interim-storage capacity of spent fuels in public-private collaboration

Securing technologies and human resources

- Securing personnel with advanced skills, advancing technological development, and promoting investment as necessary measures for restarting and decommissioning of nuclear power plants with safety as the top priority

The Strategies of Major Countries for 2050

	Reduction Target	Flexibility	Main Strategy, Posture		
			Zero Emission	Energy Conservation /Electrification	Overseas
United States	**▲80% or more** (as percentage of 2005)	**Ambitious vision towards reduction target** (not intended as current policy proposals) providing **an ambitious vision** to reduce net GHG emissions by 80 percent or more below 2005 levels by 2050.	**Increase** Variable renewable energy + Nuclear power	**Large-scale electrification** (20%→45~60%)	**Contribution through expanding market for US products**
Canada	**▲80%** (as percentage of 2005)	**Informing the conversation** (not a blue print for action) not a blue print for action. Rather, the report is meant to **inform the conversation** about how Canada can achieve a low-carbon economy.	**Securing the electricity** Hydro power・Variable renewables + Nuclear power Approx. 80% of electricity source already zero emission	**Large-scale electrification** (20%→40~70%)	**Looking to contribute internationally** (0~15%)
France	**▲75%** (as percentage of 1990)	**Possible path for achieving objectives** (not an action plan) the scenario is not an action plan: it rather **presents a possible path** for achieving our objectives.	**Securing the electricity** Renewable energy + Nuclear power ※Zero emission rate already at more than 90%	**Large-scale energy conservation** (half as percentage of 1990)	**Contribution through international development support by French businesses**
United Kingdom*	**▲80% or more** (as percentage of 1990)	**Helps players identify steps to take in the next few years by exploring potential pathways** (long-term predictions are difficult) exploring the plausible potential pathways to 2050 **helps us to identify low-regrets steps we can take in the next few** years common to many versions of the future	**Increase** Variable renewables + Nuclear power	**Promote energy conservation/electrification**	**Lead the world through environmental investment**
Germany	**▲80~95%** (as percentage of 1990)	**Point to the direction towards reducing emissions** (not a search for masterplan) ※Conduct regular reviews not a rigid instrument; it points to **the direction** needed to achieve a greenhouse gas-neutral economy.	**Increase** Variable renewable energy	**Large-scale energy conservation** (half as percentage of 1990)	**Maintaining and bolstering investment sentiment in LDCs**

* Not yet submitted to UNFCCC as long-term strategy. Created from *The Clean Growth Strategy* (November 2017).

Four Countries decided to phase out Nuclear Power after Fukushima Accident. Many other Countries are choosing Nuclear Power for Carbon Reduction and other Reasons.

Use nuclear power in the future

- United States [99]
- France [58]
- China [37]
- Russia [35]
- India [22]
- Canada [19]
- Ukraine [15]
- United Kingdom [15]
- Sweden [8]
- Czech [6]
- Pakistan [5]
- Finland [4]
- Hungary [4]
- Argentina [3]
- South Africa [2]
- Brazil [2]
- Bulgaria [2]
- Mexico [2]
- Netherlands [1]

[] indicates number of units in operation

- Turkey
- Belarus
- Chile
- Egypt
- Indonesia
- Israel
- Jordan
- Kazakhstan
- Malaysia
- Poland
- Saudi Arabia
- Thailand
- Bangladesh
- UAE

- There are also many countries that have not clarified their stance

Now using Nuclear Power

- South Korea* [24] (by cabinet decision 2017, closing expected after 2080)
- Germany [8] (by legislation in 2011, to be closed in 2022)
- Belgium [7] (by legislation in 2003, to be closed in 2025)
- Taiwan [6] (by legislation in 2017, to be closed in 2025)
- Switzerland** [5] (by legislation 2017, closing TBD)

(year nuclear power generation closing determined/year scheduled for closedown)

*In South Korea, 5 reactors are under construction.
(2 of them are decided to continue after deliberative polling)

**In Switzerland, there is not placed a limit on years in operation.

[]: units in operation

Not using Nuclear Power

- Italy (by cabinet decision 1988, closed down in 1990)
- Austria (by legislation 1979)
- Australia(by legislation 1998)

Source: Created by Agency for Natural Resources and Energy from World Nuclear Association website (viewed August 1, 2017)
Note: Only major countries are listed.

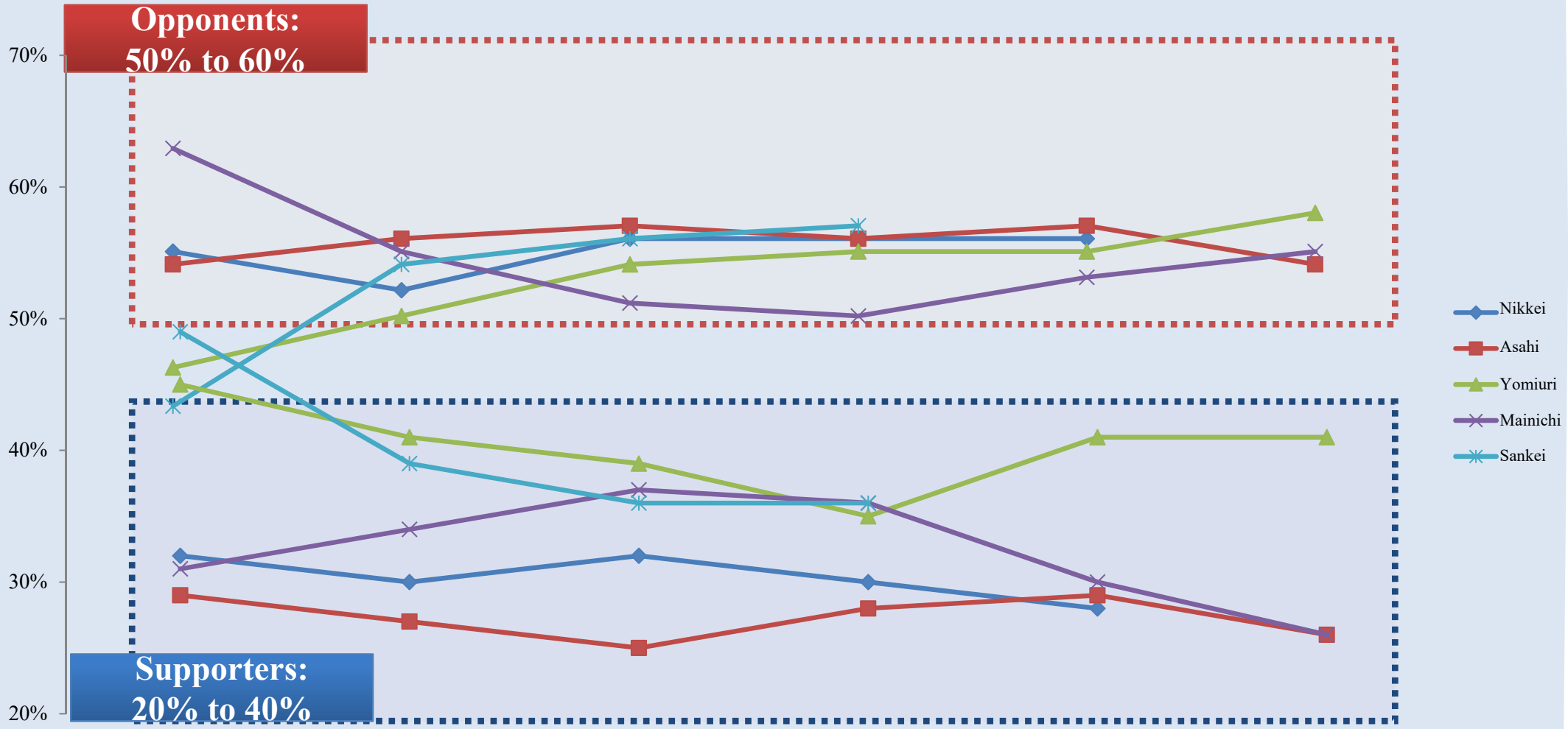
Abandon nuclear power in the future

Regarding resumption of operations of nuclear power plants, opponents outnumber supporters two to one. In Japan, the restoration of public trust is the biggest challenge.

After the nuclear accident in Fukushima (2012) | 2013 | 2014 | 2015 | 2016 | 2017

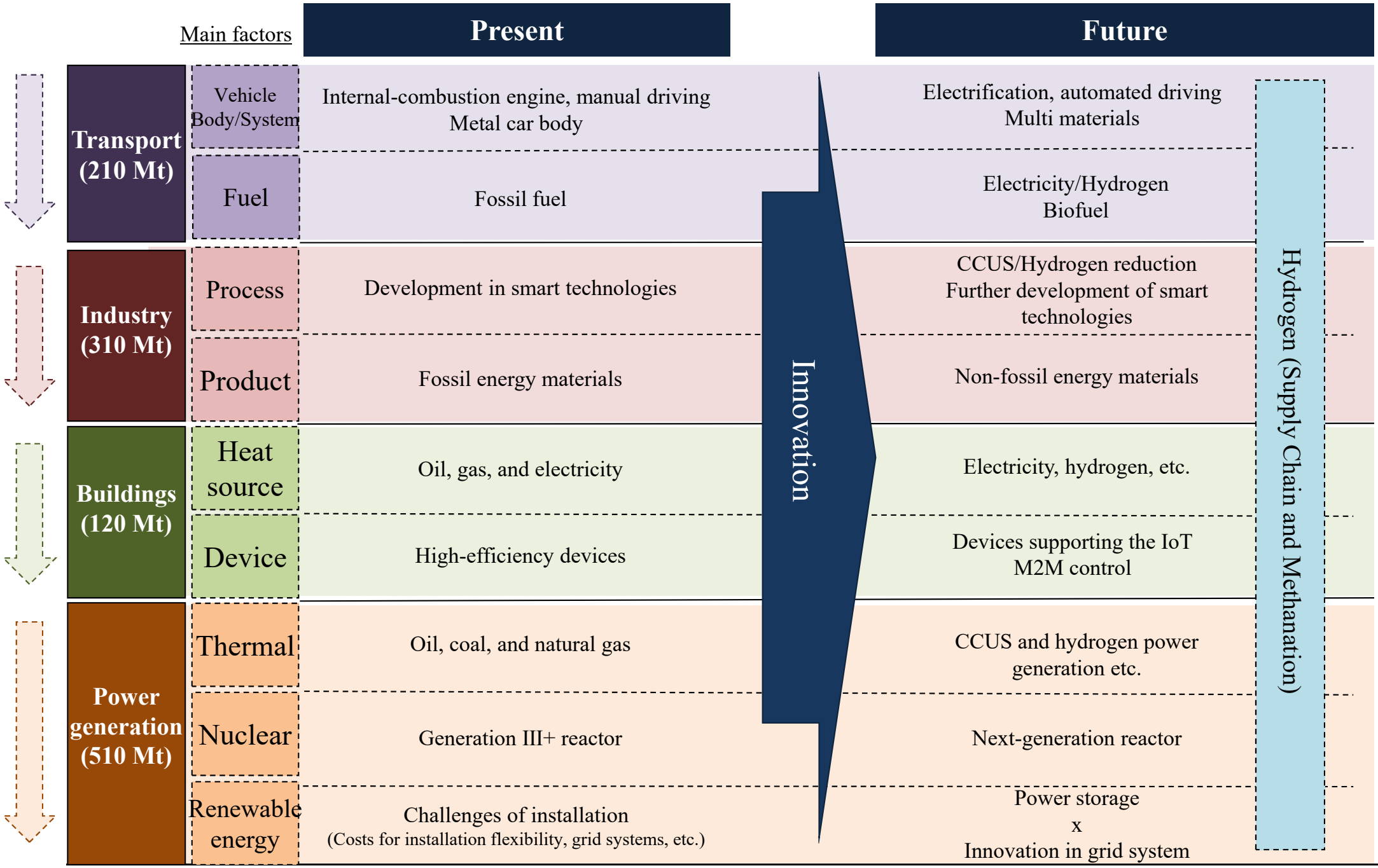
* No survey by Sankei Shimbun since 2015

* No survey by Nikkei Shimbun since 2016



○How do public opinions concerning nuclear power differ by country?

CO2 Emissions by sector and corresponding mitigation technologies



* The figures inside ( ) are the amounts of CO2 emissions in FY 2015.

Source: Agency for Natural Resources and Energy