

Energy in Japan after Fukushima

-Nuclear vs Coal vs Natural Gas not Renewable-

Dec 9th 2015

CEE annual meeting

Hisanori Nei

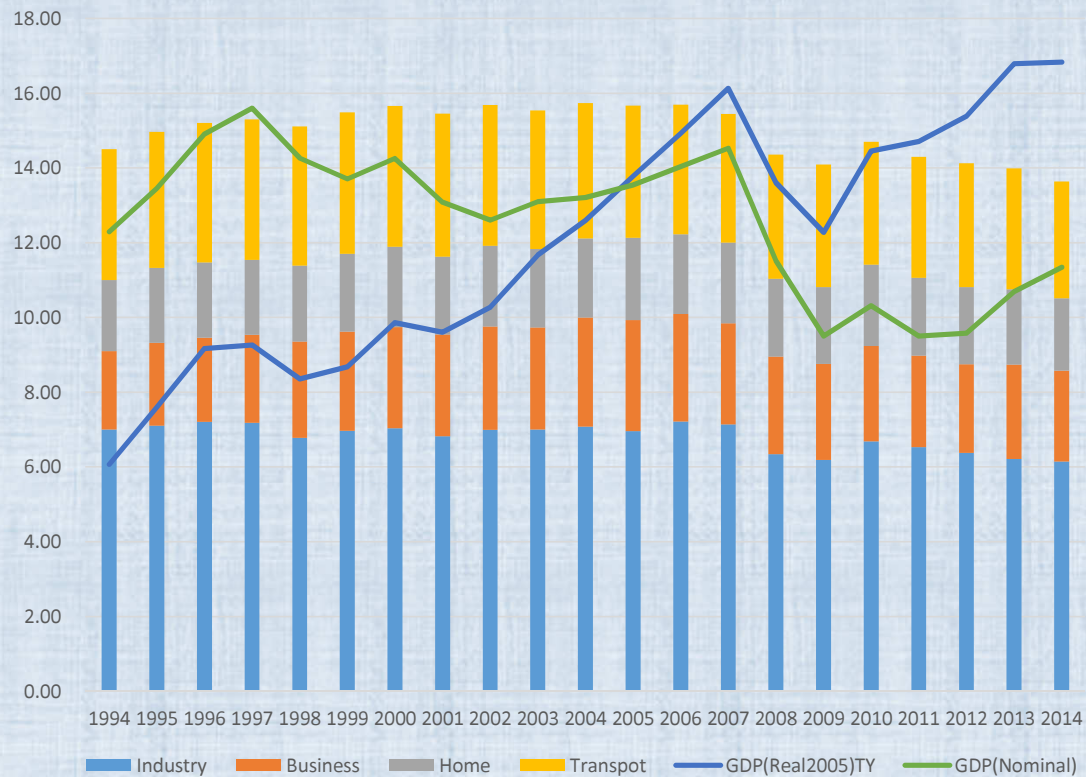
Professor

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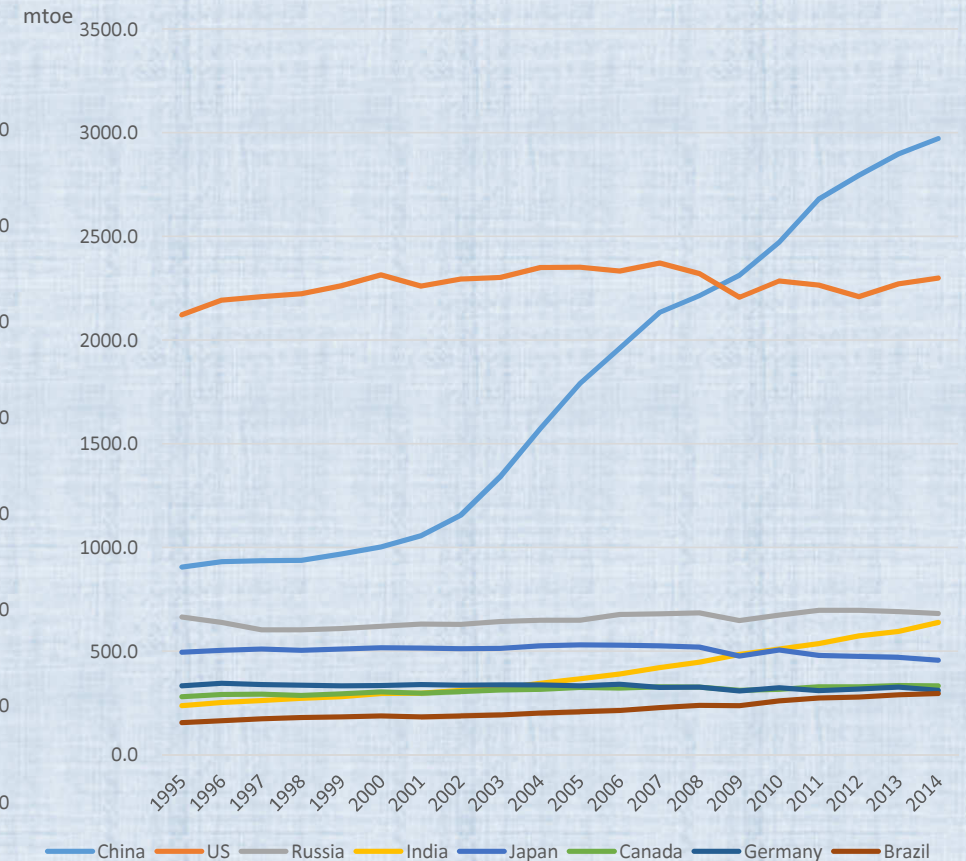
Japan

Japan is the 3rd largest Economy and consuming 5th largest volume of energy
After Fukushima(2011) , energy consumption has decline 4 consecutive years.
Last 3 years , Japanese economy has recovered by the Abenomics
In 2014, House sector shows most rate of reduction in energy demand

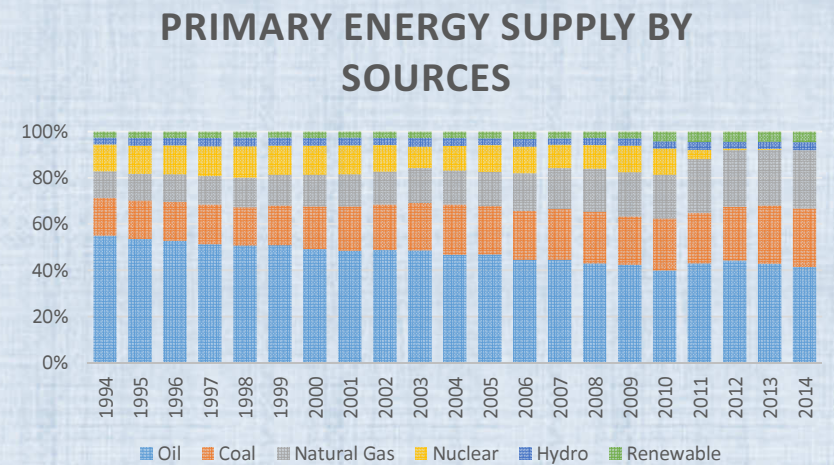
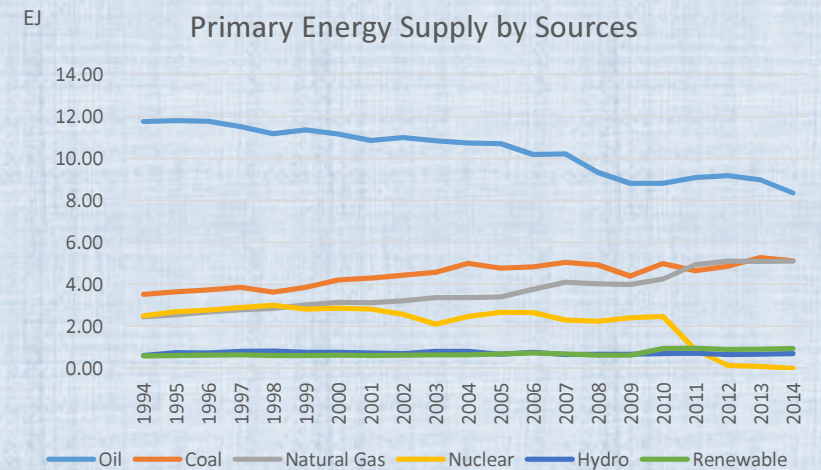
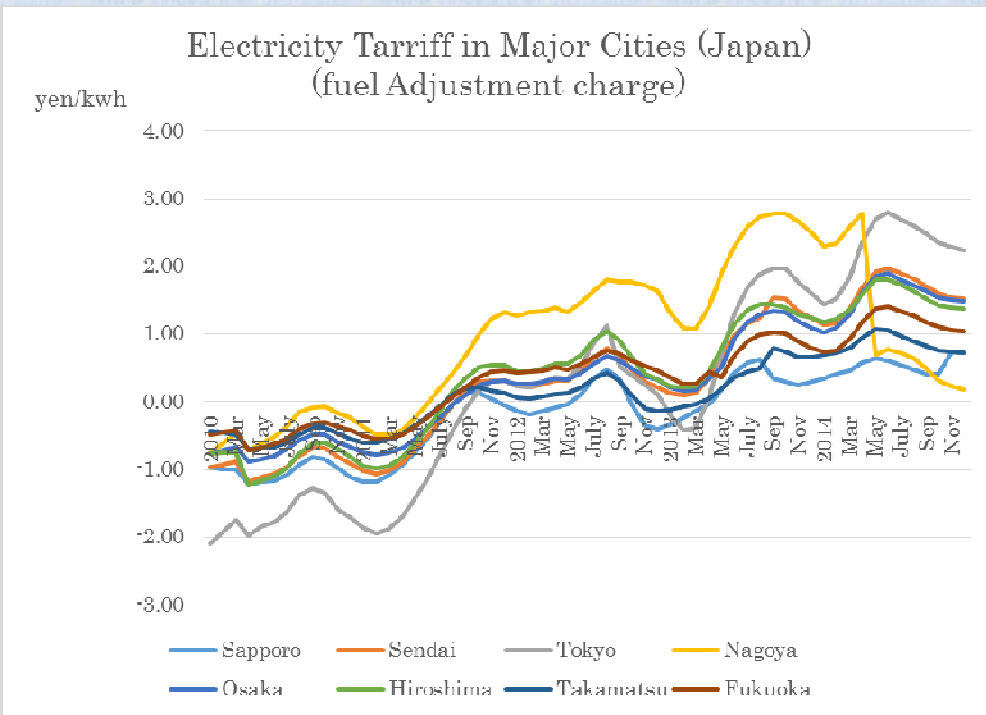
Final Energy Consumption & GDP



Primary Energy Supply by country

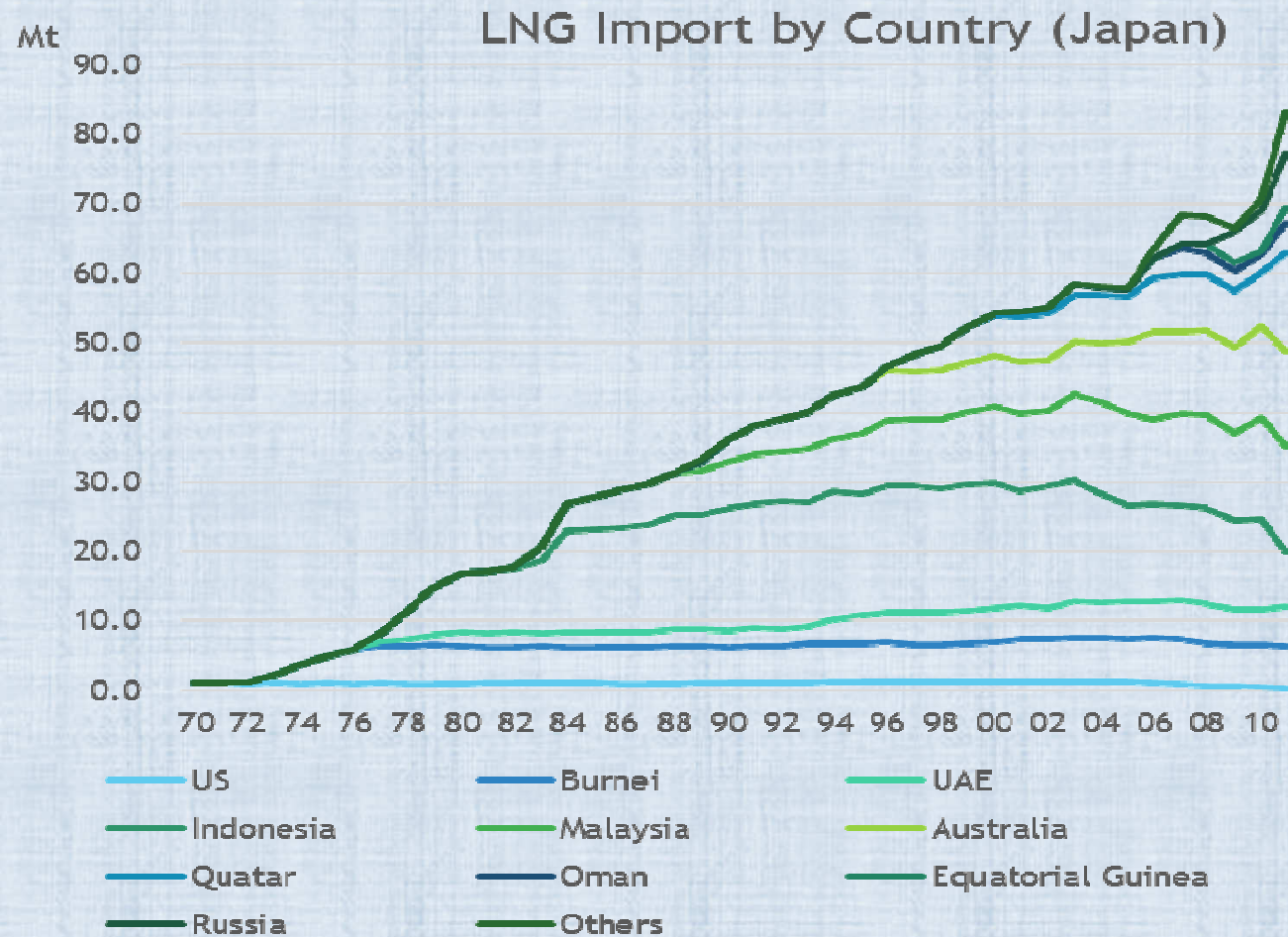


In 2014, we had no nuclear power supply. It's the first time since 1965. It result in constant increase of electricity tariff.



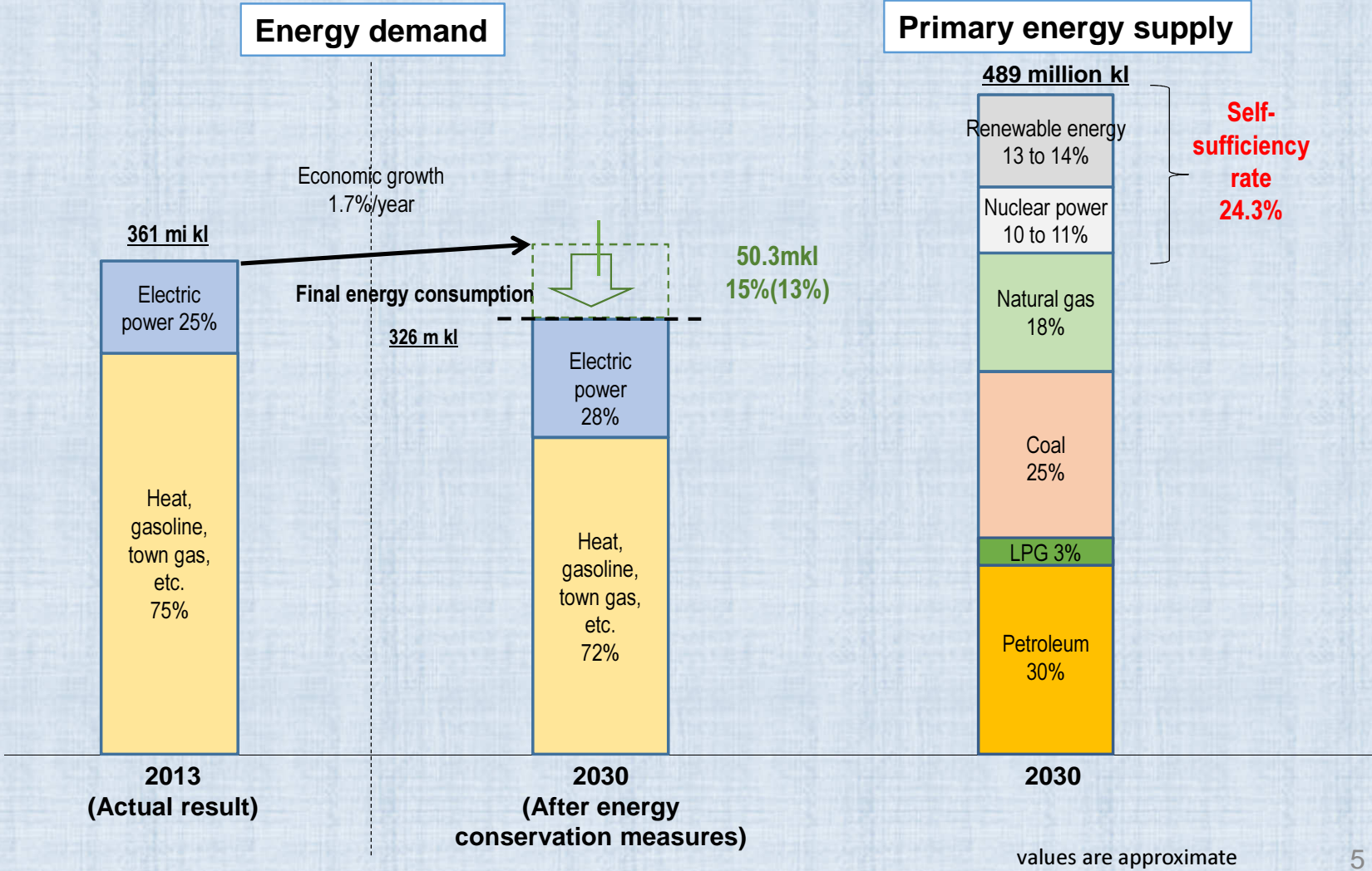
Natural Gas (LNG) has been major alternative power sources.

Thanks producers especially Qatar for the generous increase of LNG export to Japan.

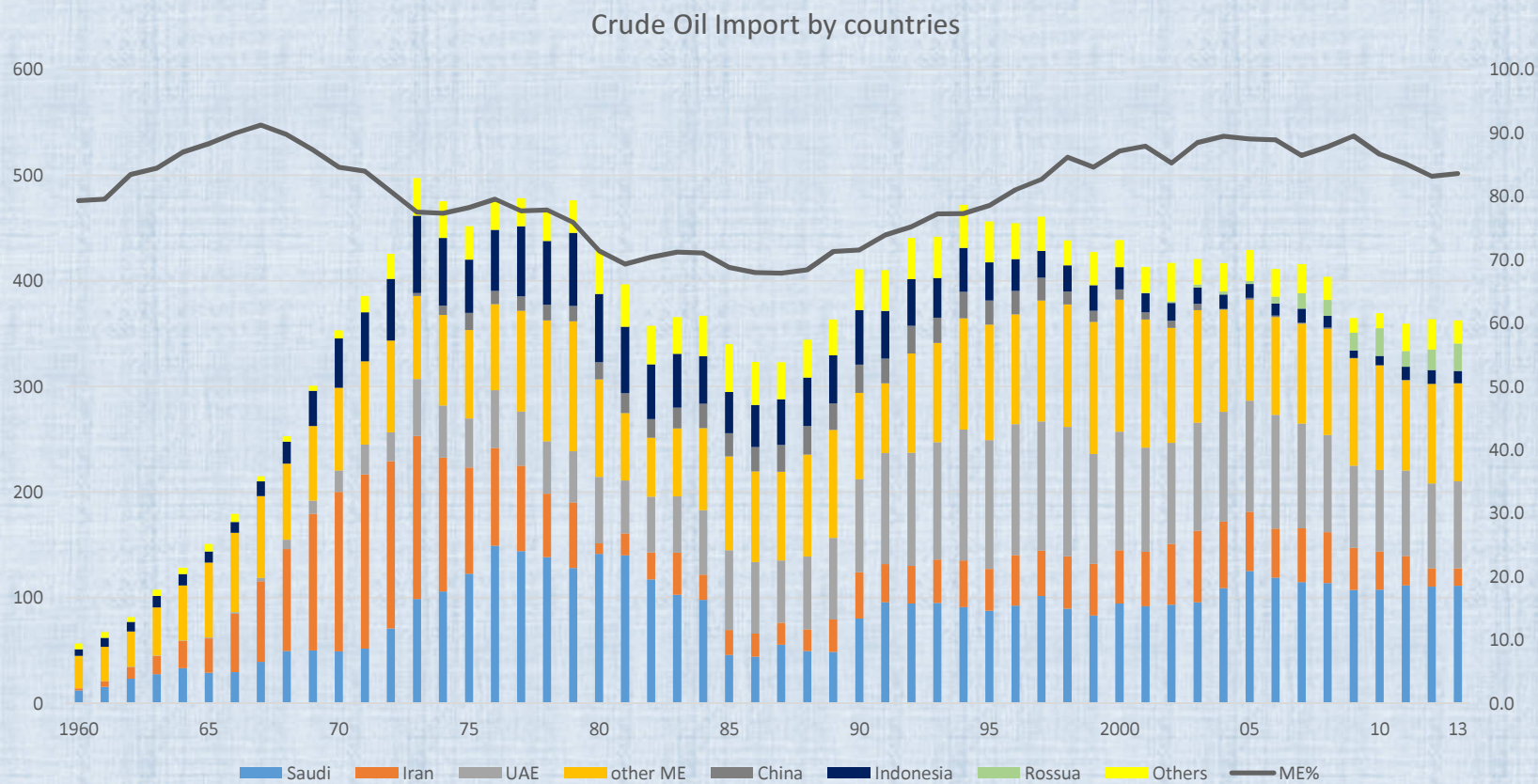


Mt	Long Term	Import 2011	Import 2010
UAE	4.3	5.6	5.1
Burnei	6.0	6.2	5.9
Malaysia	15.4	15.1	14.6
Indonesia	5.8	7.9	12.9
Qatar	6.0	14.3	7.7
Oman	3.0	4.2	2.7
Australia	13.3	13.6	13.2
Russia	4.9	7.8	6.0
U.S.A		0.2	0.6
Others		9.0	1.5
Total	58.8	83.2	70.6

GOJ concluded its energy mix at 2030 (July 2015)

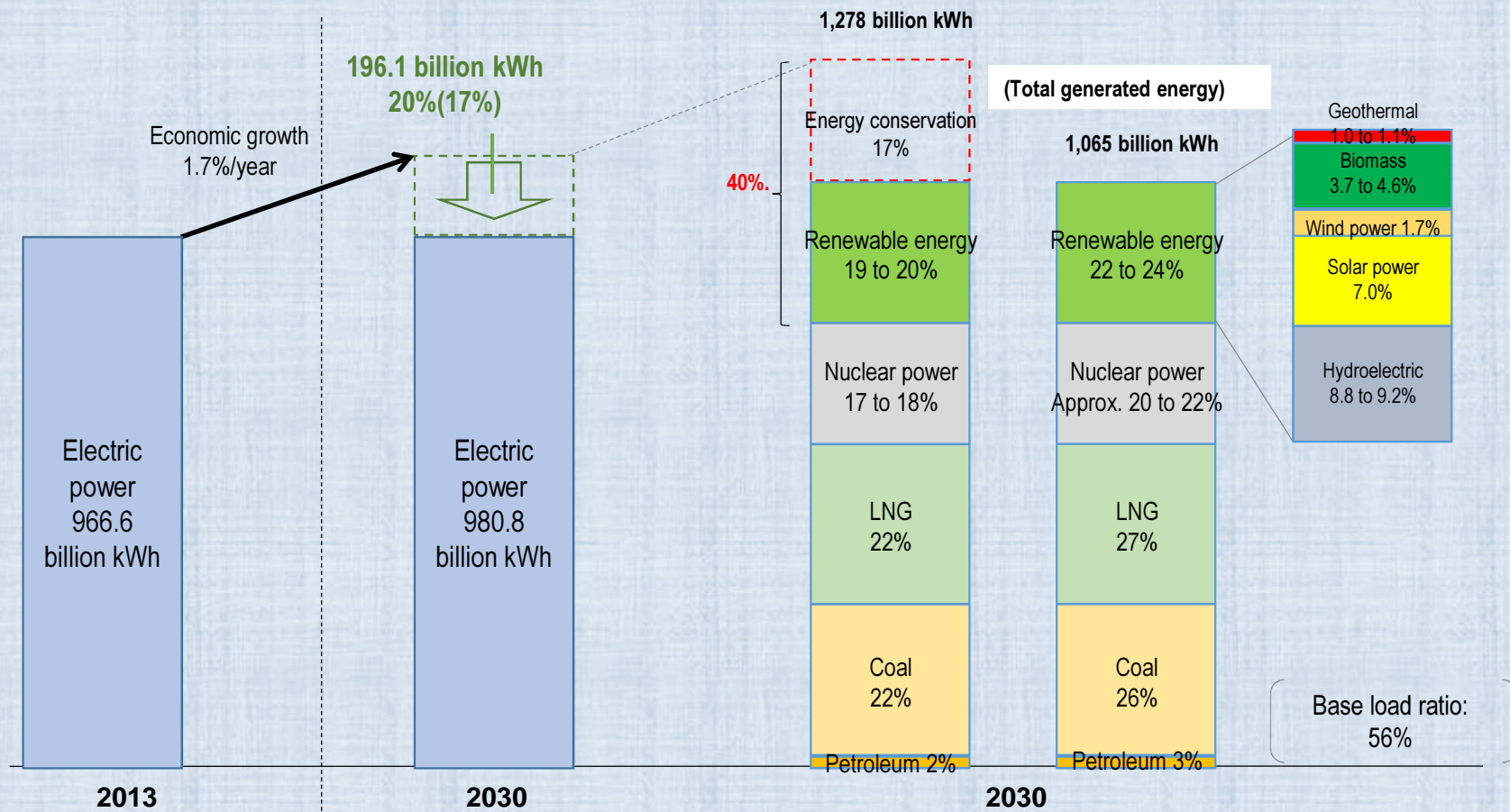


Japan is heavily depending on imported crude from ME



Power demand

Power source composition



values are approximate

Basic Act on Energy Policy (June 2002)

<Objectives>

- ▶ Securing of Stable Supply (Article2)
- ▶ Utilization of Market Mechanisms(Article4)
- ▶ Environmental Compliance(Article3)

<Responsibility of Stakeholders>

National Government(Article 5), Local Government(Article6), Business(Article 7), Citizens (Article8).Mutual Cooperation(Article9)

<Mandate/Obligation of National Government >

- /Legislative arrangement, Fiscal or Financial arrangement if needed(Article10)
- /Report to the Diet(Article 11: White Paper)
- /Strategic Energy Plan (Article 12: Strategic Energy Plan)
- /Promotion of International Cooperation (Article13)
- /Dissemination of Knowledge Regarding Energy (Article 14)

Major Change around the time of the Accident(Strategic Energy Plan)

❑TEPCO's Fukushima Accident and subsequent to NPS a stop

- Concerns over serious damage caused by the TEPCO'S Fukushima Nuclear Accident and the Safety of Nuclear Power Generation
- Outflow of National Wealth and increased supply instability due to higher dependency on fossil fuels
- Rapid increase in Greenhouse gas emissions in Japan
- Exposed defects related to supply systems, including power interchange and emergency supply between eastern and western Japan
- Reduced confidence in the government and business operators involved in energy supply
- Change in the demand trend-increased introduction of cogeneration and changes in power saving actions
- Higher electricity bills due to a change in the power source mix. And the impact of the international regional differences in energy price on the macro economy, industry and household economy (by combination with the shale revolution)

❑Shale Revolution

- Signs of a change in the global energy supply-demand structure caused by the shale revolution in North America

❑Turmoil in MENA region after "Arab-Springs"

- Change in the geopolitical structure of resource-supplying regions, including instability in the Middle Eastern and North African regions.

The Strategic Energy Plan

The Strategic Energy Plan (First) Oct. 7th 2003

(Background)

/TEPCO's Falsification Scandal---Subsequences to 17 NPS shut down

/Kyoto Protocol ratified (June 2002)

The Strategic Energy Plan (Second) Mar. 9th 2007

(Background)

/Oil Price Increase---Demand Shock

/Kyoto Protocol Effective (Feb. 2005), First Commitment Period start 2008

/New National Energy Strategy (May 2006) ---Nuclear Renaissance

The Strategic Energy Plan (Third) June. 18th 2010

(Background)

/Administration Change from LDP to DP

/Oil Price Spike and fluctuate

/25% CO2 emission reduction proposal by PM of Japan (Sep 2009. UN)

There are several challenges to overcome for achieving the policy target

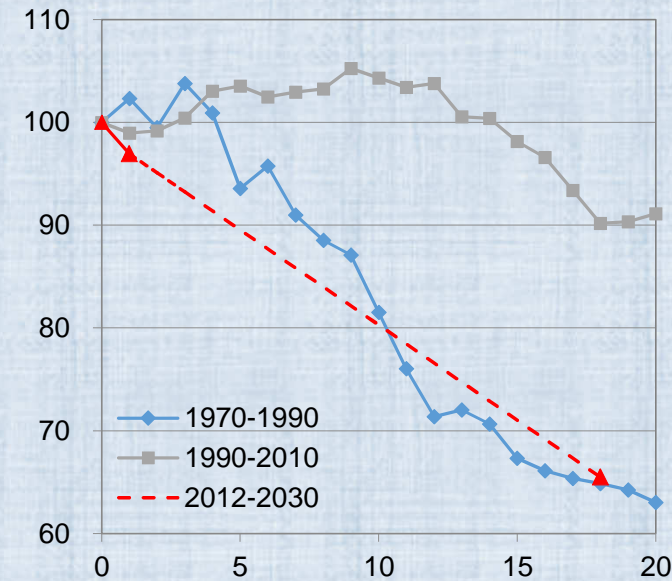
/The target of Energy Conservation is extremely high.

/The share of Renewable and Nuclear ▪ ▪ ▪ Political Message

/Power Market Reform ▪ ▪ ▪ Uncertain

/Coal vs Natural Gas ▪ ▪ ▪ Fuel Price

/Nuclear



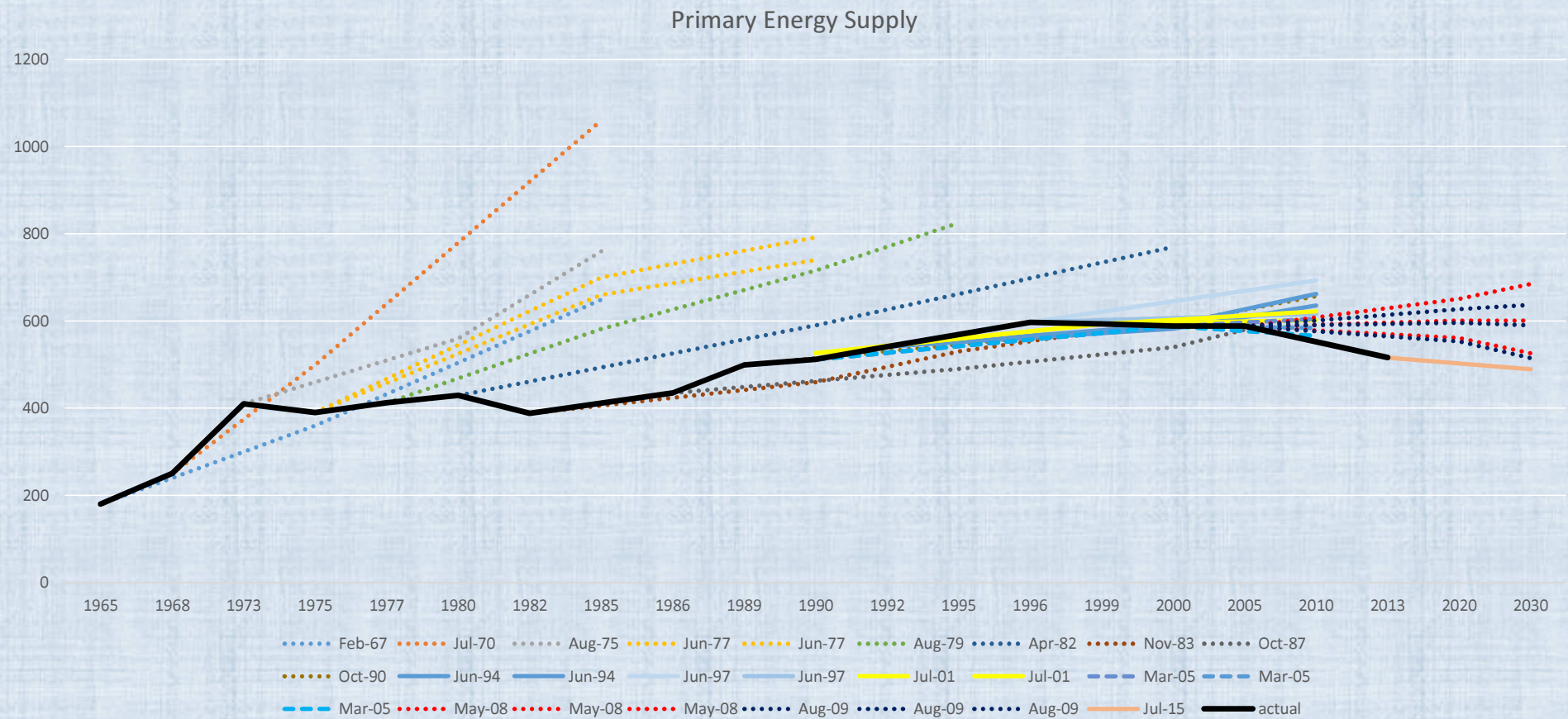
GOJ need to review its Strategic Energy Plan in every 3 years by Law.

/Last Strategic Energy Plan was published on April 2014.

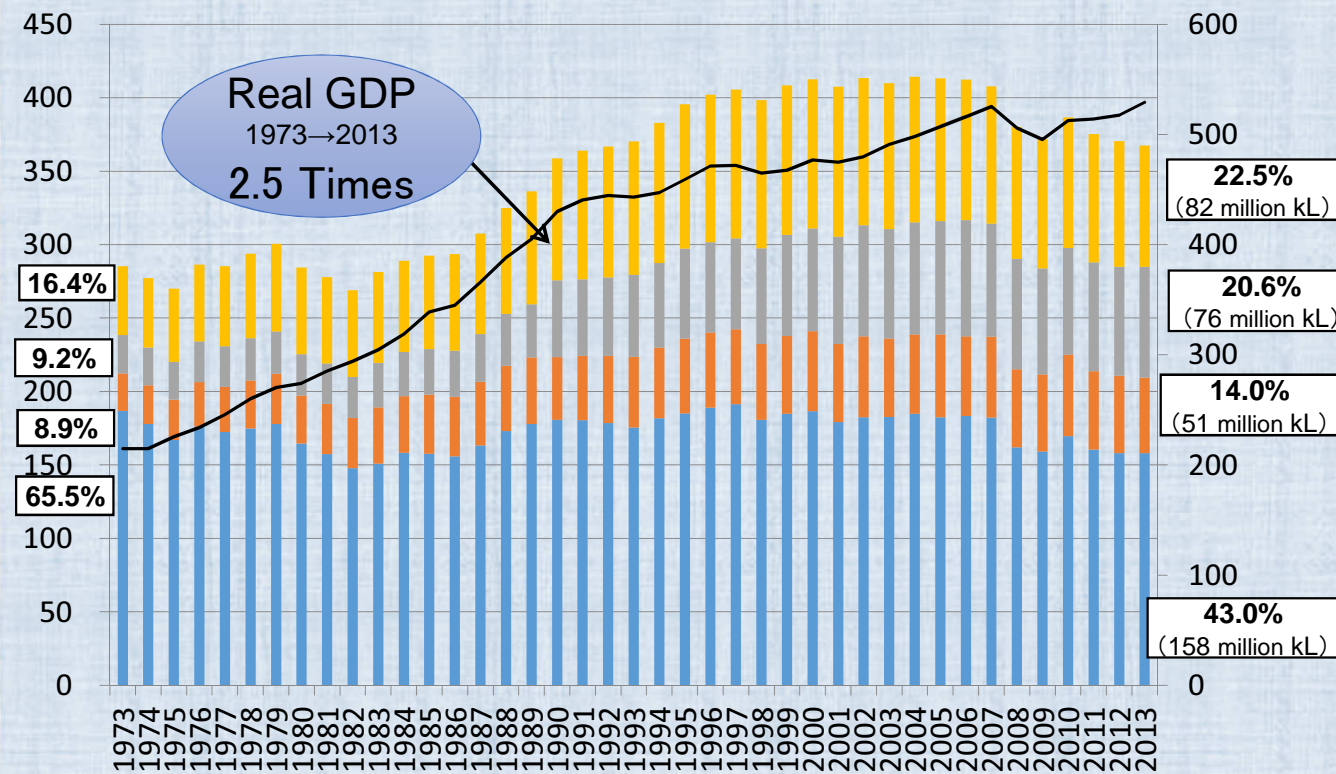
/In fact, the amendment of the plan has been done every 3 – 4 years.

/Next 3 years, there should be some progresses to create more concrete plan .

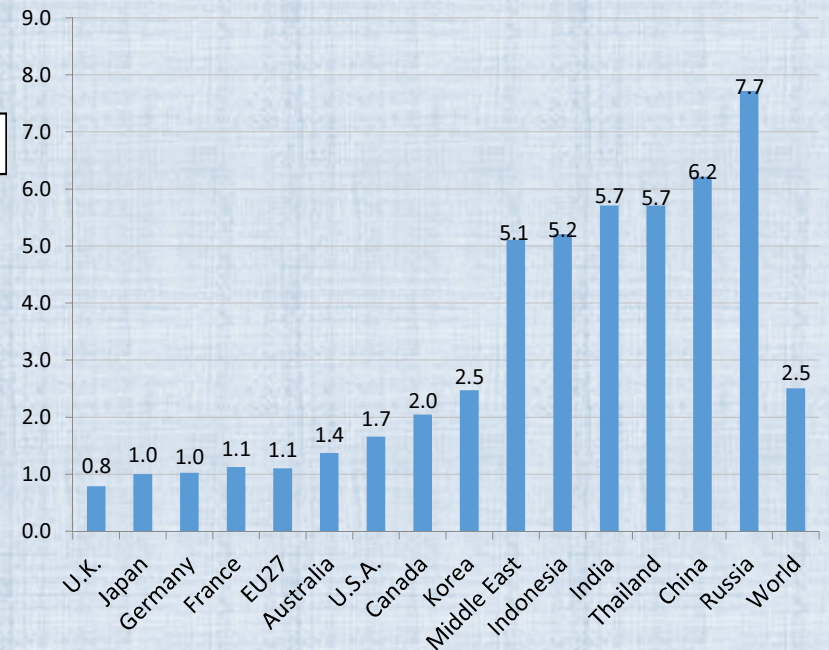
Historically, between 1960 and 1980, actual energy consumption had been lower than planned energy outlook. From late 80s , it had been difficult to lower energy demand than planned outlook by 2008.



Do we have more rooms to improve energy efficiency?



Primary energy supply per GDP unit of each country (2011)



History of Electricity System Reform in Japan

No competition in the electricity market before 1995.

10 vertically integrated GEUs(General Electricity Utilities) dominated and controlled the market

1995

- Open the IPP (Independent Power Producer) market

2000

- Introduce partial retail competition (>2000kw)
- Accounting separation of Transmission/Distribution sector

2005

- Expand retail competition(>50kw)
- Establish the whole sale power exchange(JEPX)

(2008)

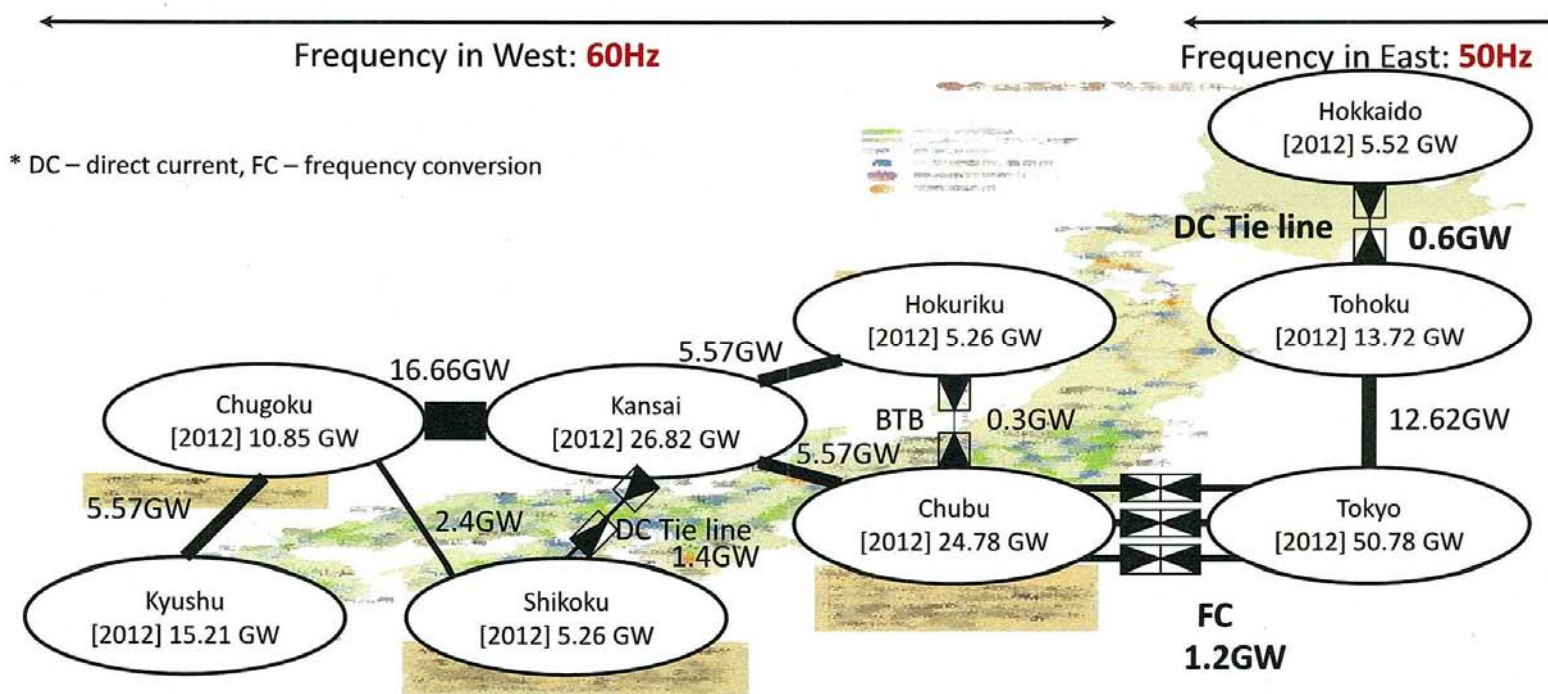
- Modify the rule of wheeling rates

Current electricity system

- Partial liberalization : retail competition for over 50kw customers
- Retail players : 10 big GEUs(vertically integrated, regional monopoly), PPS, etc
- Situation is...
 - Share of non-GEU power producer and supplier : 3.6%
 - 0.6% of the total retail market sales is transacted at JEPX

Negative aspects of regional monopoly were revealed by 3.11

- 1.Lack of system to transmit electricity beyond regions.
- 2.Little competition and strong price control
3. Limit in digesting the change in energy mix (cf. renewables)



Decision on Electricity System Reform in 2013

- The Cabinet decided to execute the Policy on Electricity System Reform on April 2, 2013

Objectives:

/Securing the stable supply

/Suppressing electricity rates to the maximum extent possible

/Expanding choices for consumers and business opportunities

Process:

A bold reform will be steadily carried out step by step focusing on the 3 agendas:

/Cross-regional Coordination of Transmission Operators was established on April 2015

/Full Retail Competition starts at April 2016 (regulated tariff expired by 2020)

/Unbundle the transmission/distribution sector by 2020

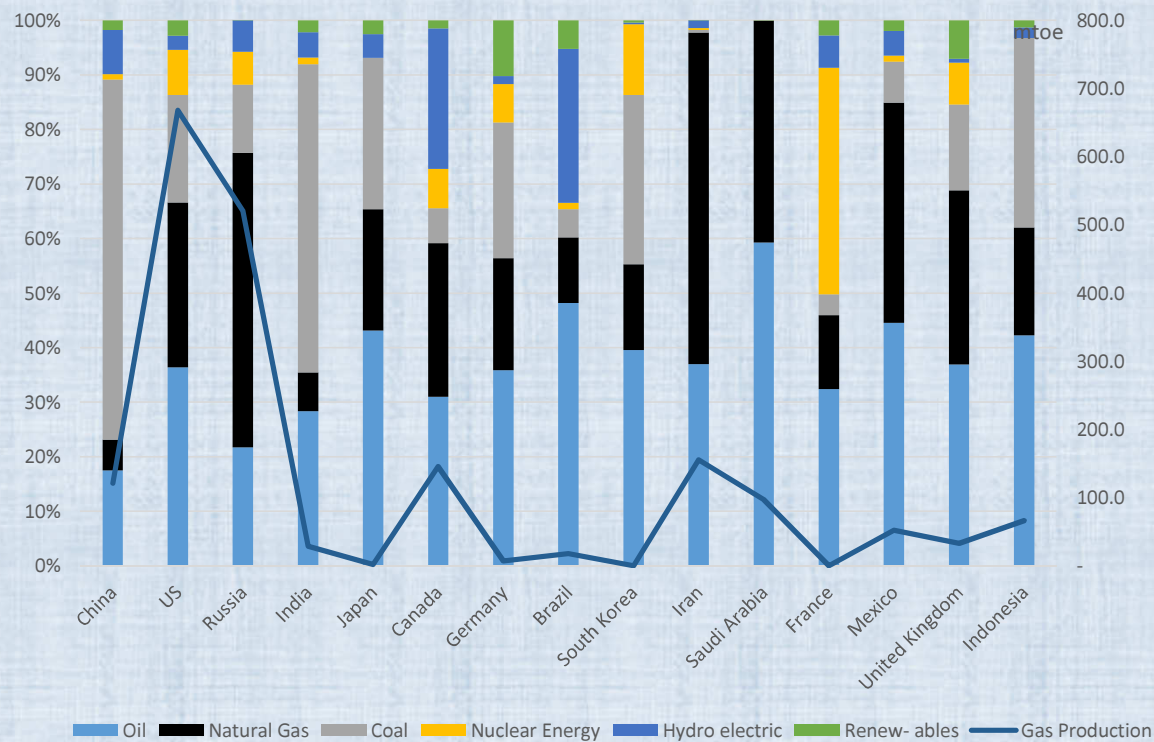
Supply Share of Natural Gas is varied by countries.

Japan maintain the largest volume of Import.

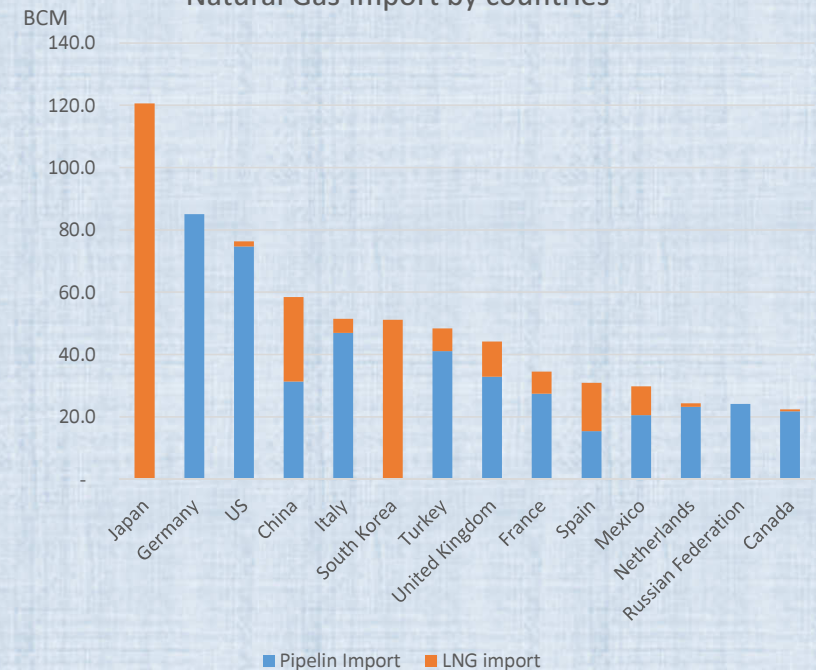
After the Fukushima Nuclear Accident, Japan increase its NG import from 75Mt to 90Mt/year

If NPS resume as expected, import volume will decrease to previous level.

Supply Share by Sources - Gas Production



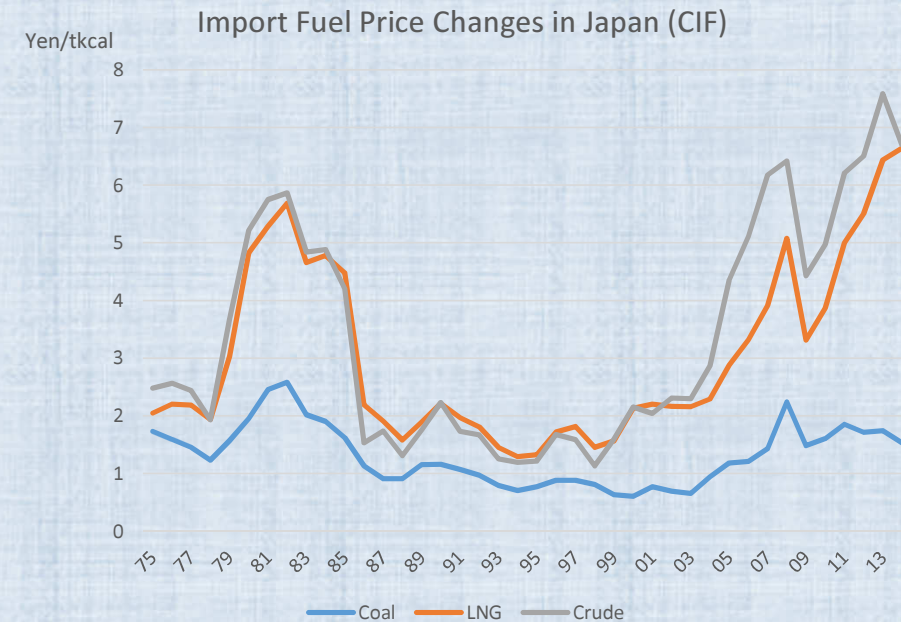
Natural Gas Import by countries



/Fuel Price difference make difficult to increase Natural Gas Power Units

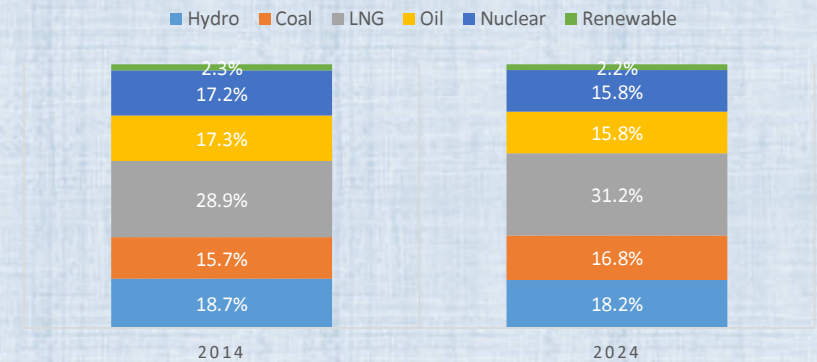
/Utilities consider to build new NG Power Unit as well as Coal ones.

/Under the future liberalized power market, many smaller (less than 112.5Mw) coal power plants are planned to build



Mkw	2014	New	Add	Abolish	2024
Hydro	48.14	0.4	0.03	0.04	48.53
Normal	20.82	0.2	0.03	0.04	21.01
Pumped-St	27.32	0.2	0	0	27.52
Thermal	159.41	14.71	0.97	5.07	170.02
Coal	40.41	4.77	0.61	1.01	44.78
LNG	74.55	9.48	0.36	1.2	83.19
Oil	44.45	0.46	0	2.86	42.05
Nuclear	44.26	0	0	2.22	42.04
Renewable	5.86	0.09	0	0	5.95
Wind	0.09	0.02	0	0	0.11
Photovolta	4.47	0.03	0	0	4.5
Others	1.3	0.04	0	0	1.34
Total	257.67	15.2	1	7.33	266.54

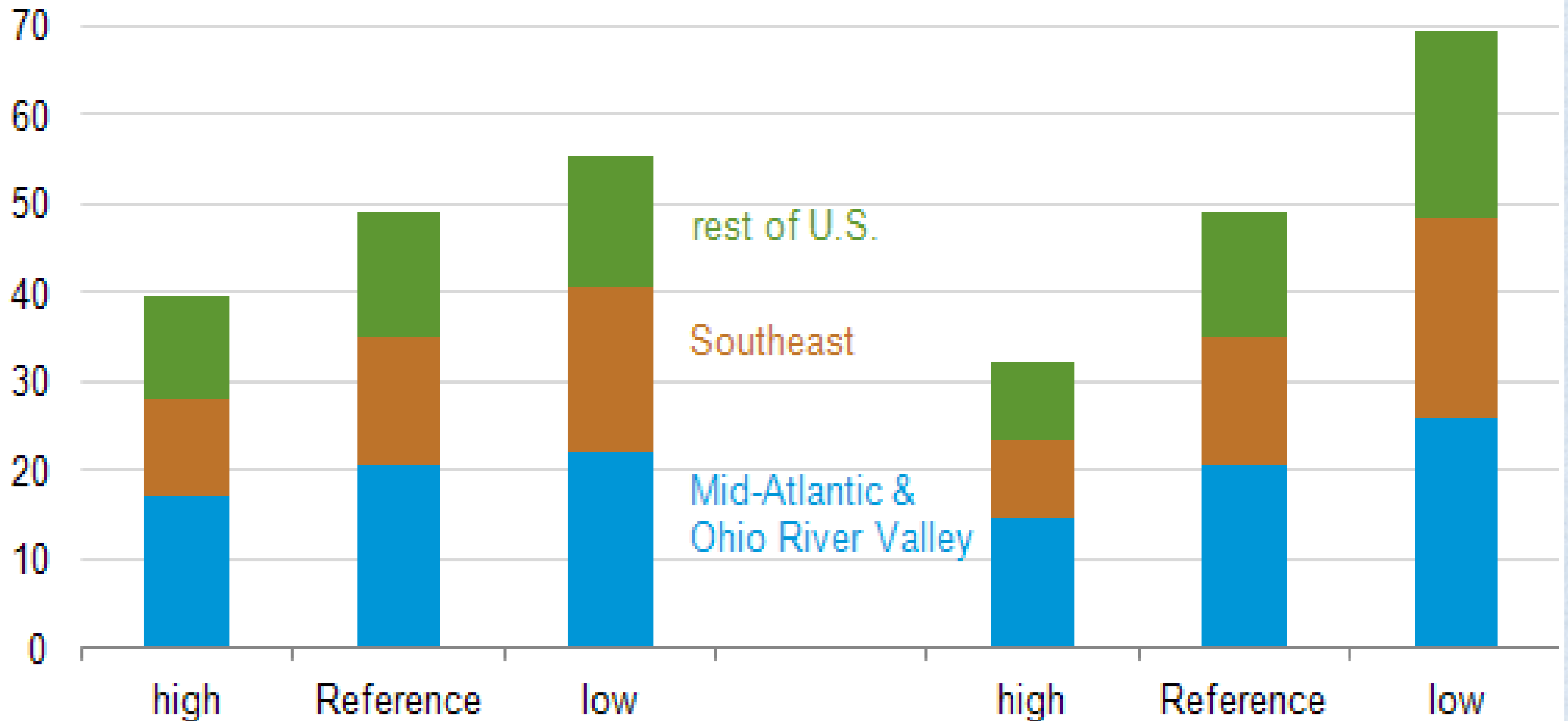
COMPOSITION OF POWER PLANT BY UTILITIES



EIA Coal Retirement Forecast

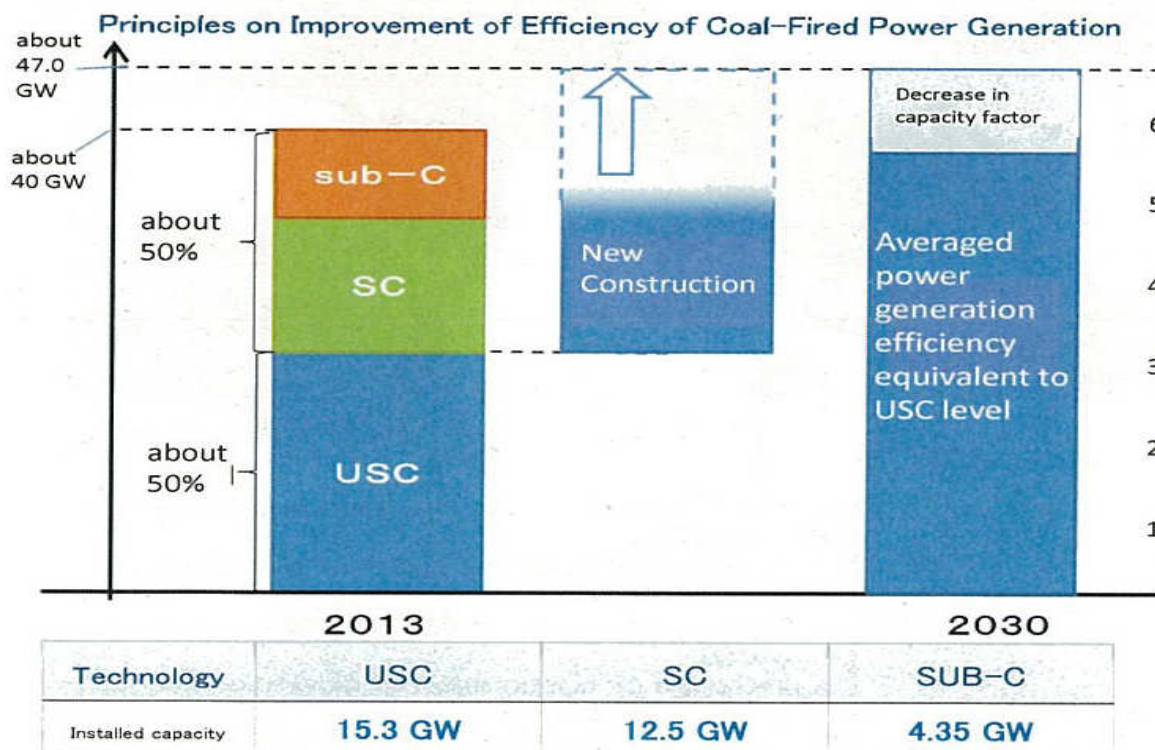
Projected retirements of coal-fired generators through 2020

gigawatts

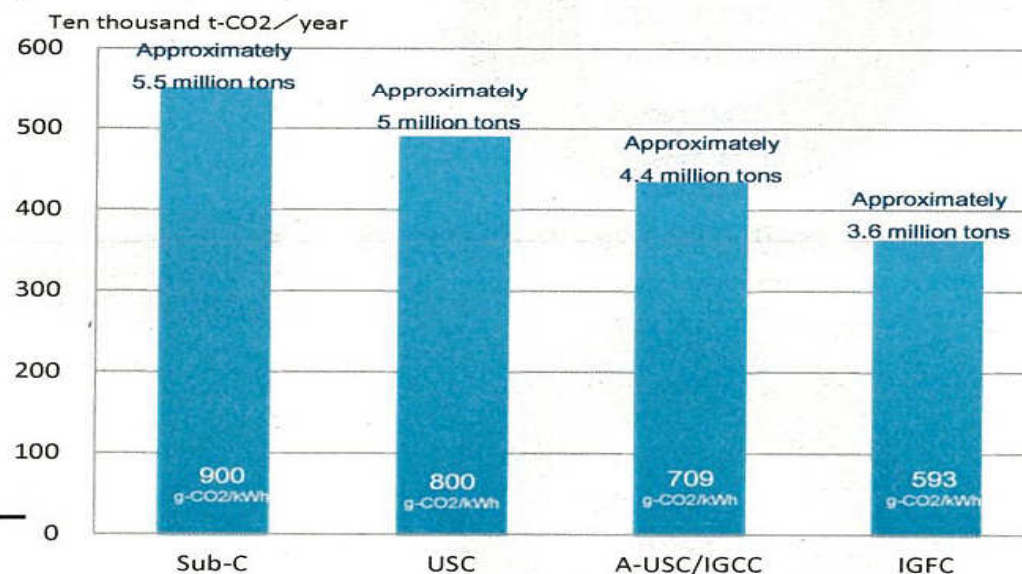


Reducing CO2 Emissions to use High Efficiency of Coal-Fired plants

- Japan will continue to replace the old plants with higher efficient one. Average efficiency of domestic coal-fired power plants should be equivalent to “USC level” by 2030, leading to CO2 emission reduction.
- Japan will introduce the next-generation coal-fired power technologies, such as A-USC and IGCC within 10 years.



Comparison of CO2 emissions among coal-fired power technologies (case of 1,000MW plant)



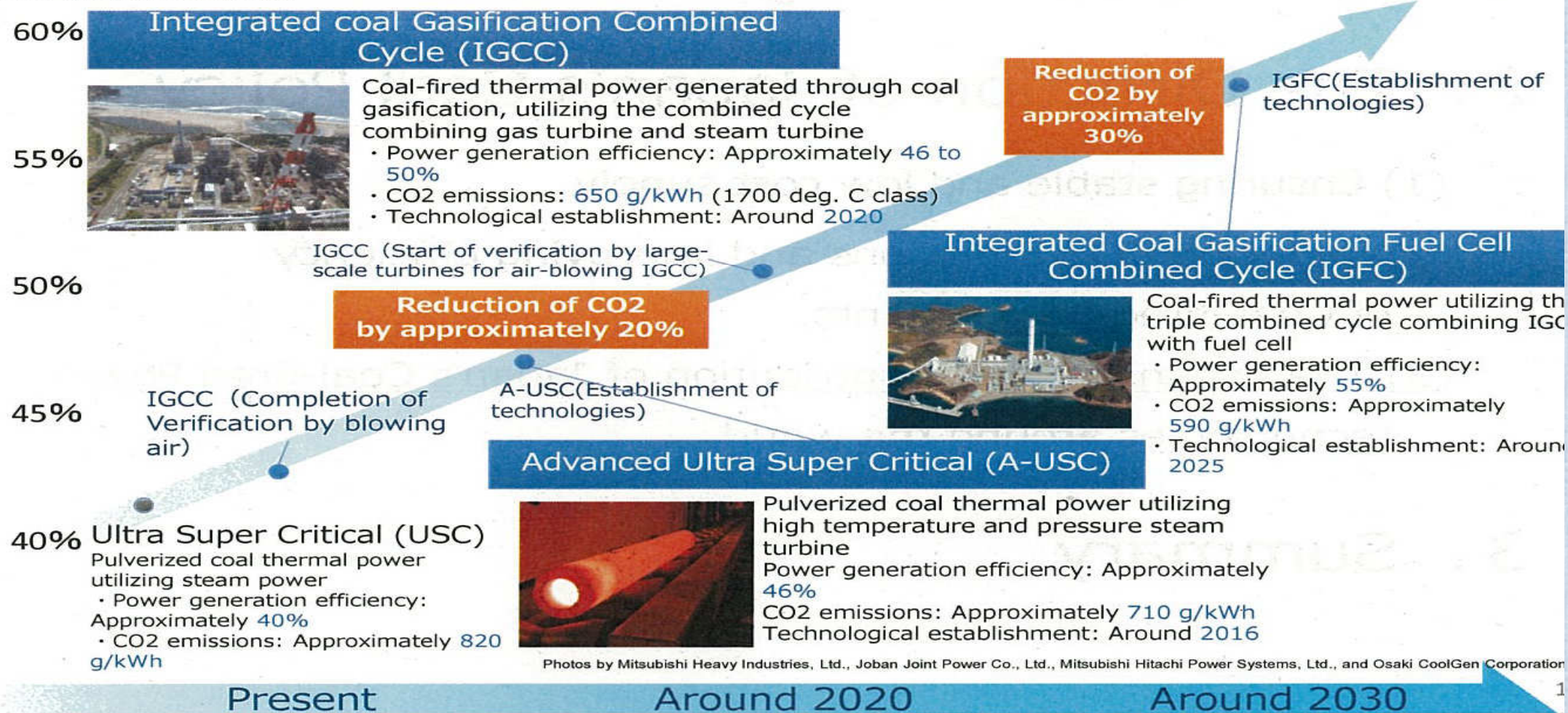
* Preliminarily calculated based on the annual operation rate of 70%

Note: The total of general and wholesale electricity utilities, excluding wholesale supply. The installed capacities are as of March 2015.

Establishment of Next-Generation Coal-Fired Power Technologies

- Aiming at establishing IGFC technology, ultimate high-efficiency coal-fired power technology, by 2025

Power generation efficiency



Photos by Mitsubishi Heavy Industries, Ltd., Joban Joint Power Co., Ltd., Mitsubishi Hitachi Power Systems, Ltd., and Osaki CoolGen Corporation

Change of Nuclear Regulatory System

Reform of Nuclear Regulatory Organization

/Independence

Separate the functions for nuclear regulation and nuclear promotion

Establish the Nuclear Regulation Authority(NRA) as an independent commission body

Amendments to the Nuclear Regulation Act

/New regulation on severe accidents

/Regulation based on the state-of-the art information (backfitting)

/40-years operational limit for NPPs (exceptional less-than-20 years extension)

New Regulatory Requirement

/Strengthening of Design Basis

/Severe Accident Measures

/Enhanced Measures for Earthquake/Tsunami

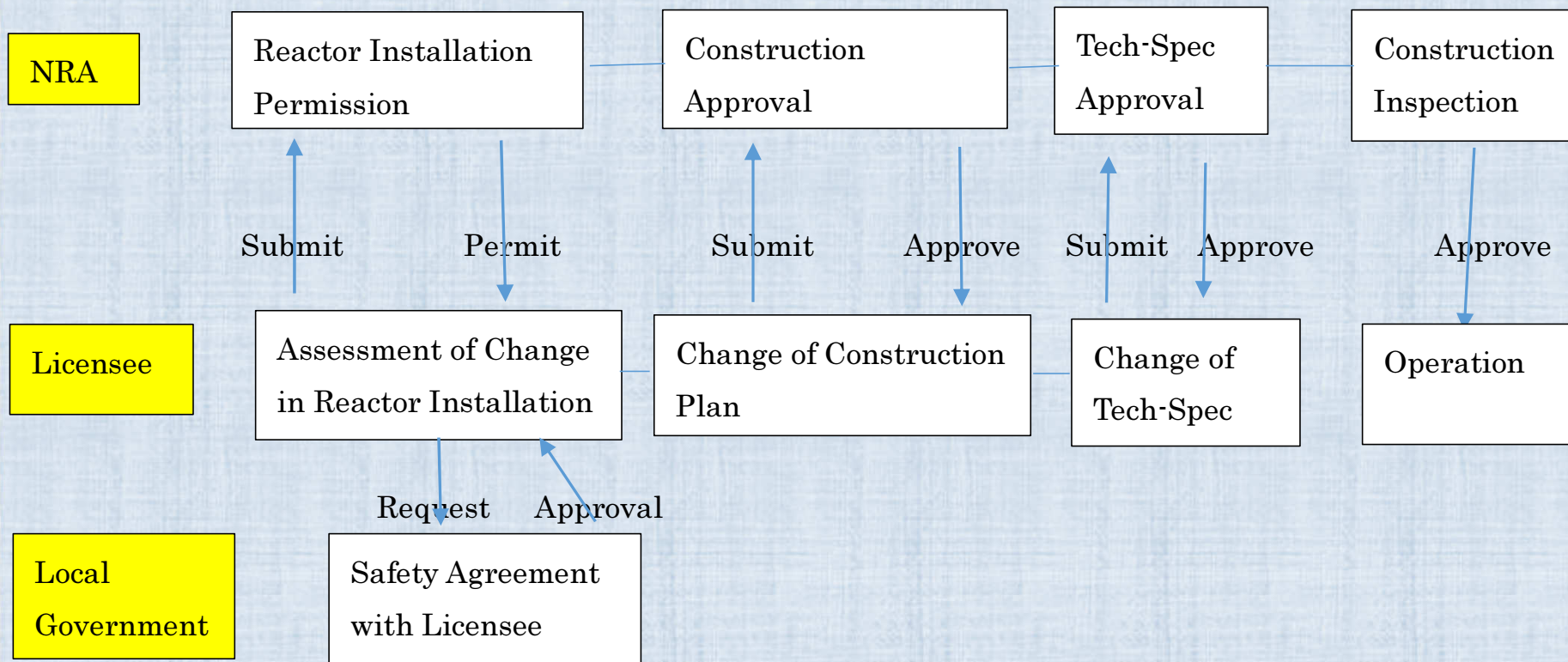
Principle of Regulation

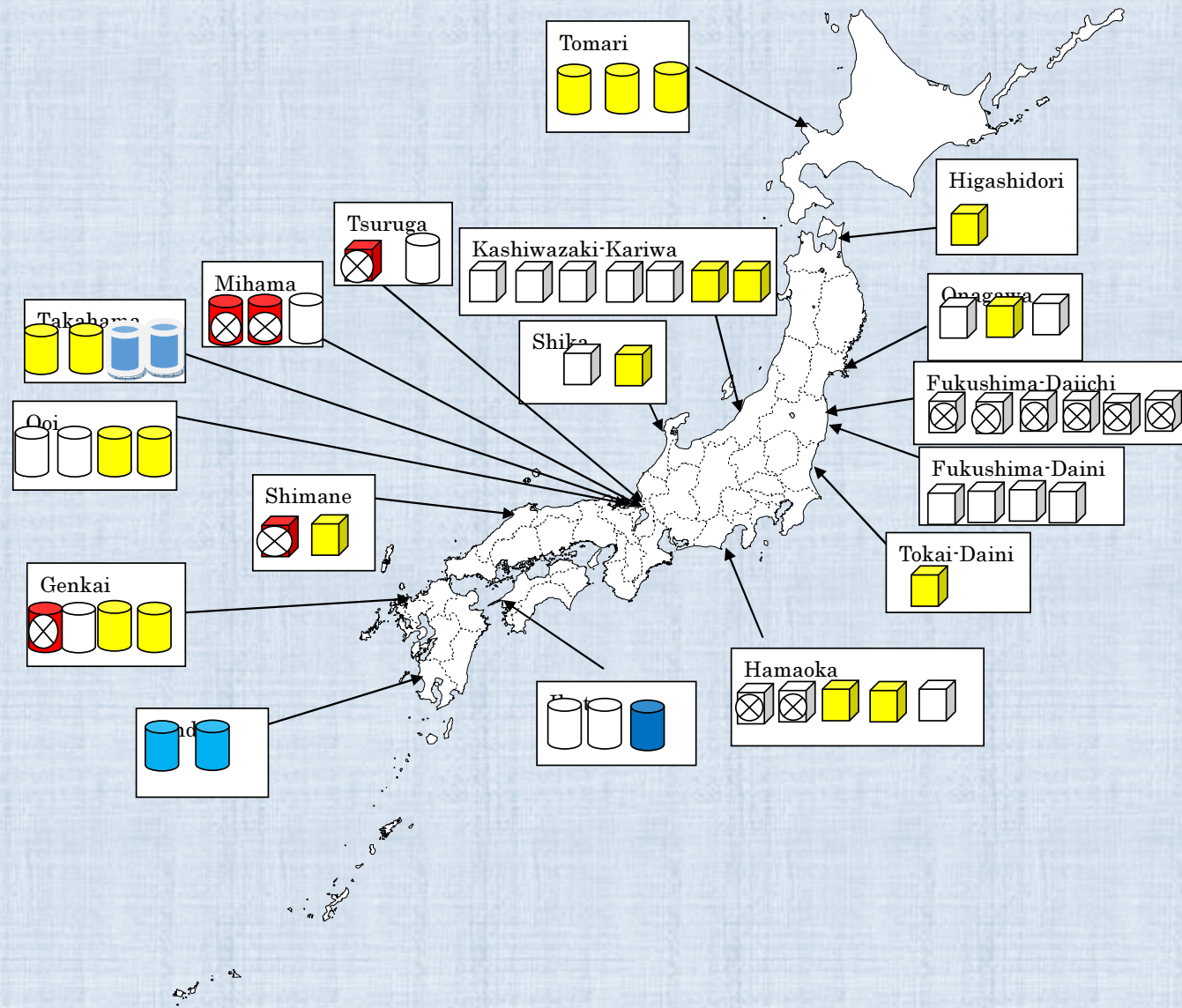
/Place emphasis of Defense-in-Depth

/Eliminate common cause failure

/Protective measures against extreme natural hazards

Process of Resuming Nuclear Power Plant in Japan





Next Challenge of Nuclear in Japan

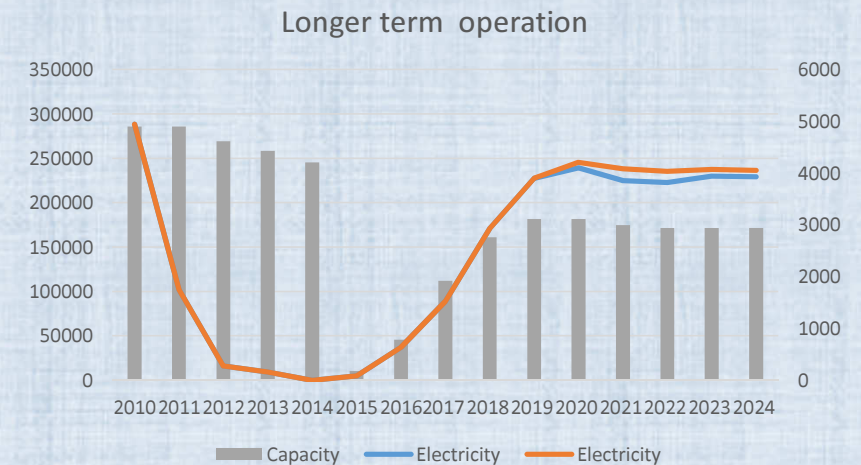
After Fukushima, new regulatory system and severer safety standards are implemented. It has required to the utilities or licensees to do many works. It needs time for several years. The main process of resuming NPS has not been changed significantly. After years, power supply by NPS in Japan will recover. We need to consider next issue challenged by the industry.

NRA's permission for over 40 Years Operation NPS in within a few years

EDMG facility by 2018

Longer Post-Outage Period after 2017

New NPS development



Next Challenge of Nuclear in Japan

After Fukushima, new regulatory system and severer safety standards are implemented. It has required to the utilities or licensees to do many works. It needs time for several years.

The main process of resuming NPS has not been changed significantly.

/Fukushima Daiichi(2011)

Sendai NPS Unit 1 resuming 25 months after new regulation guideline set ,
36 months after NRA establishment, 36 month

/Kashiwazaki Kariwa(2007)

25 month to 45 month more after the earthquake (Unit 6-7, Unit1, Unit5)

*Unit 2-4 never operated since then

/Shika Criticality event hiding (2007) 25months after stopping for inspection /Hamaoka & Shika
Turbine Missile(2006) 8 month to 20 month after the accident

/Onagawa Earthquake(2005) 7 month to 21 month after the scram

/Mihama Unit 3 accident (2004) 32 month after the accident

/Fukushima Daiichi Falsification (2002) 40 month after stopping for inspection

/Monju (FBR) (1995) 178 month after the accident

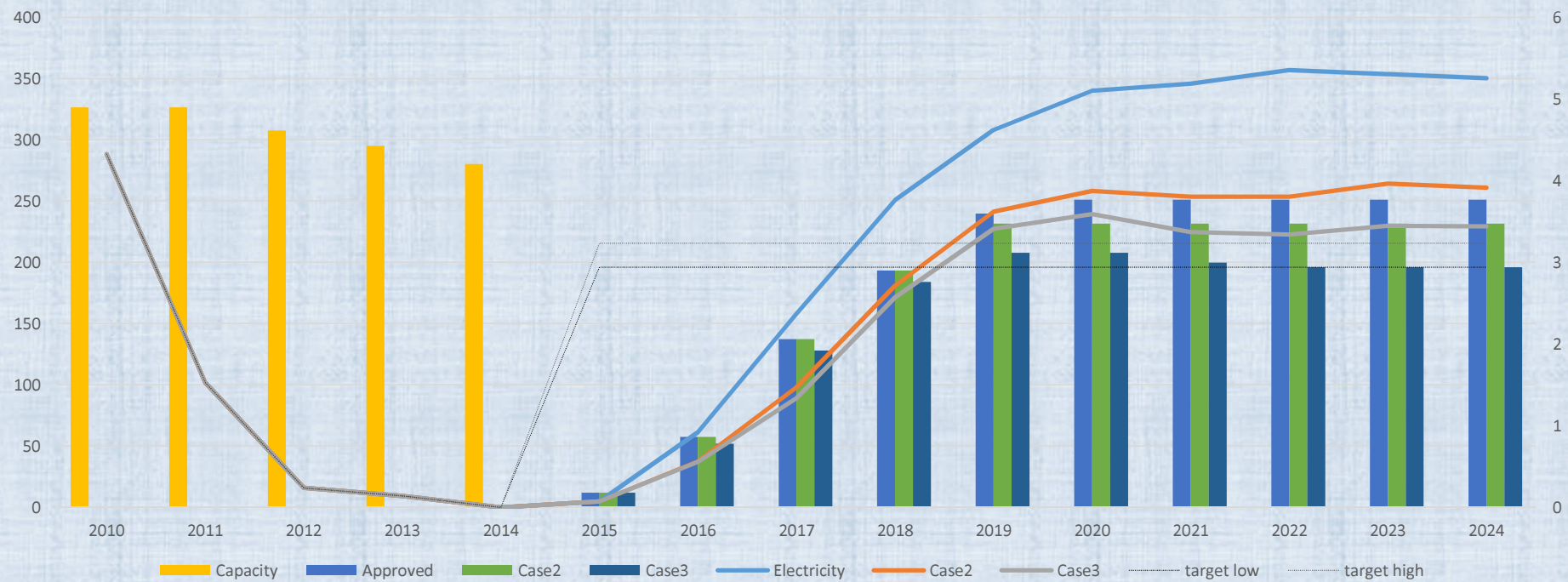
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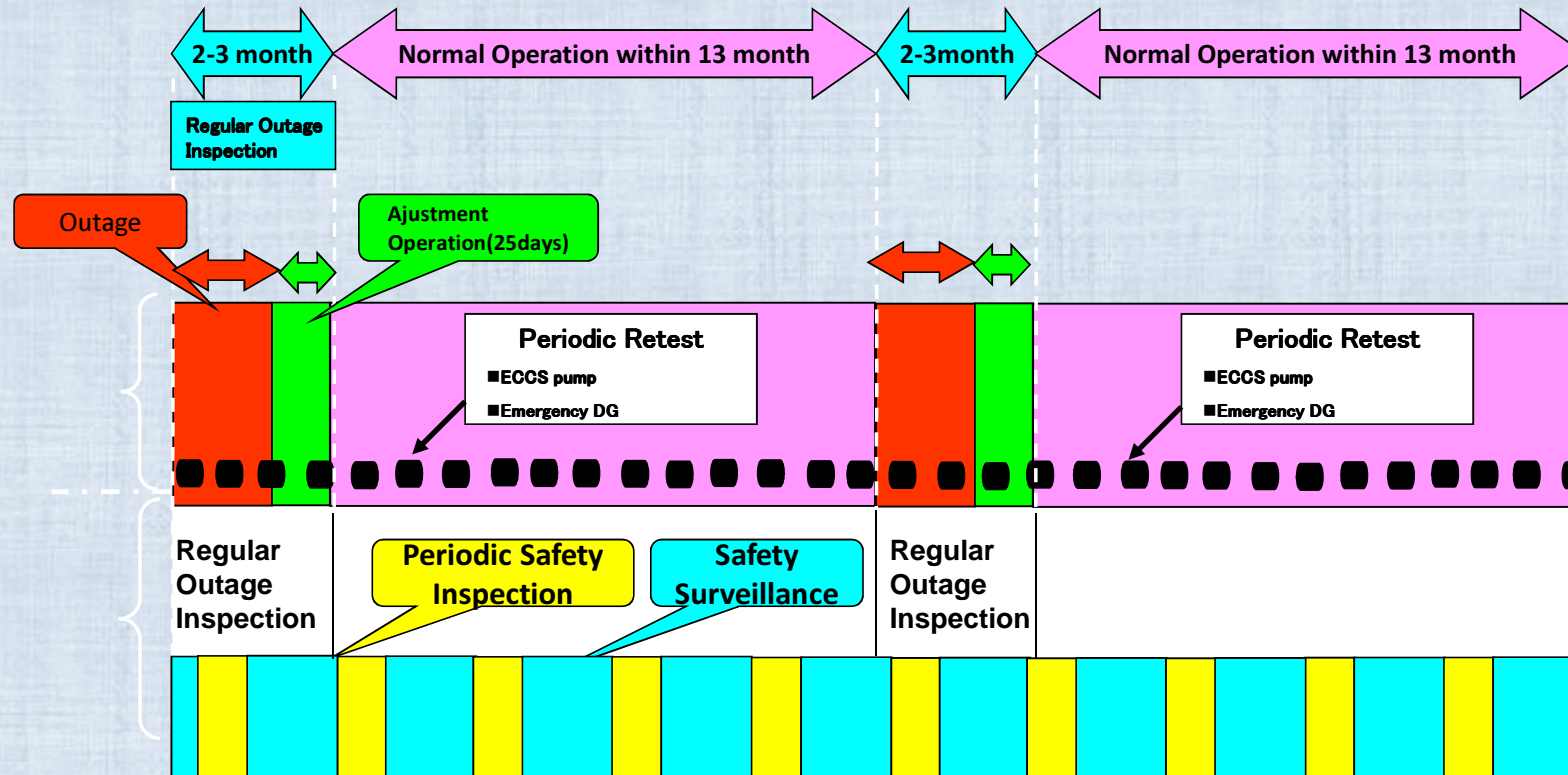
Estimation for NPS supply recovery

- /NPS supply will recover by 2020 exceeding the target of the outlook in 2018
- /If NRA reject the proposed TA related with fault line assessment, it still exceed the target.
- /If NRA agreed the fault line assessment, It will exceed the lever of before the accident

Nuclear Capacity & Electricity Generation



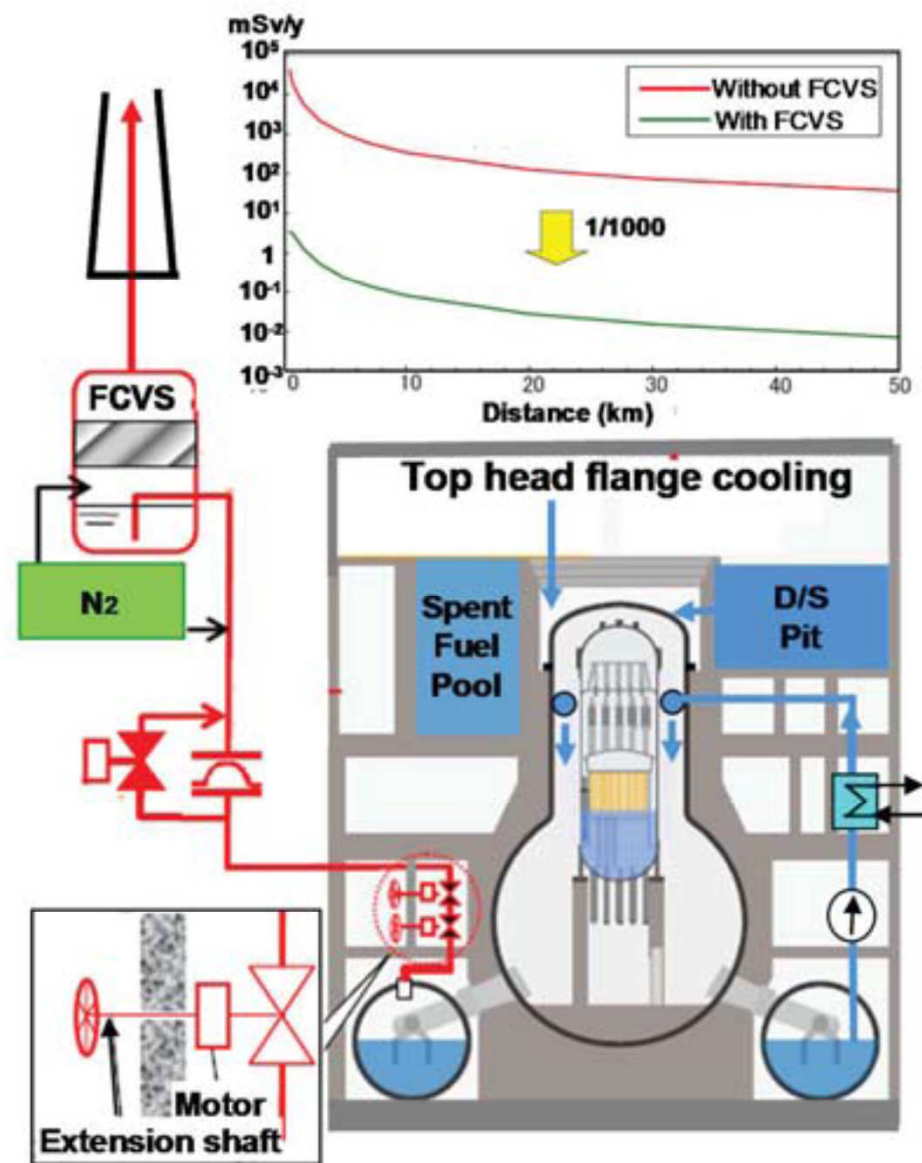
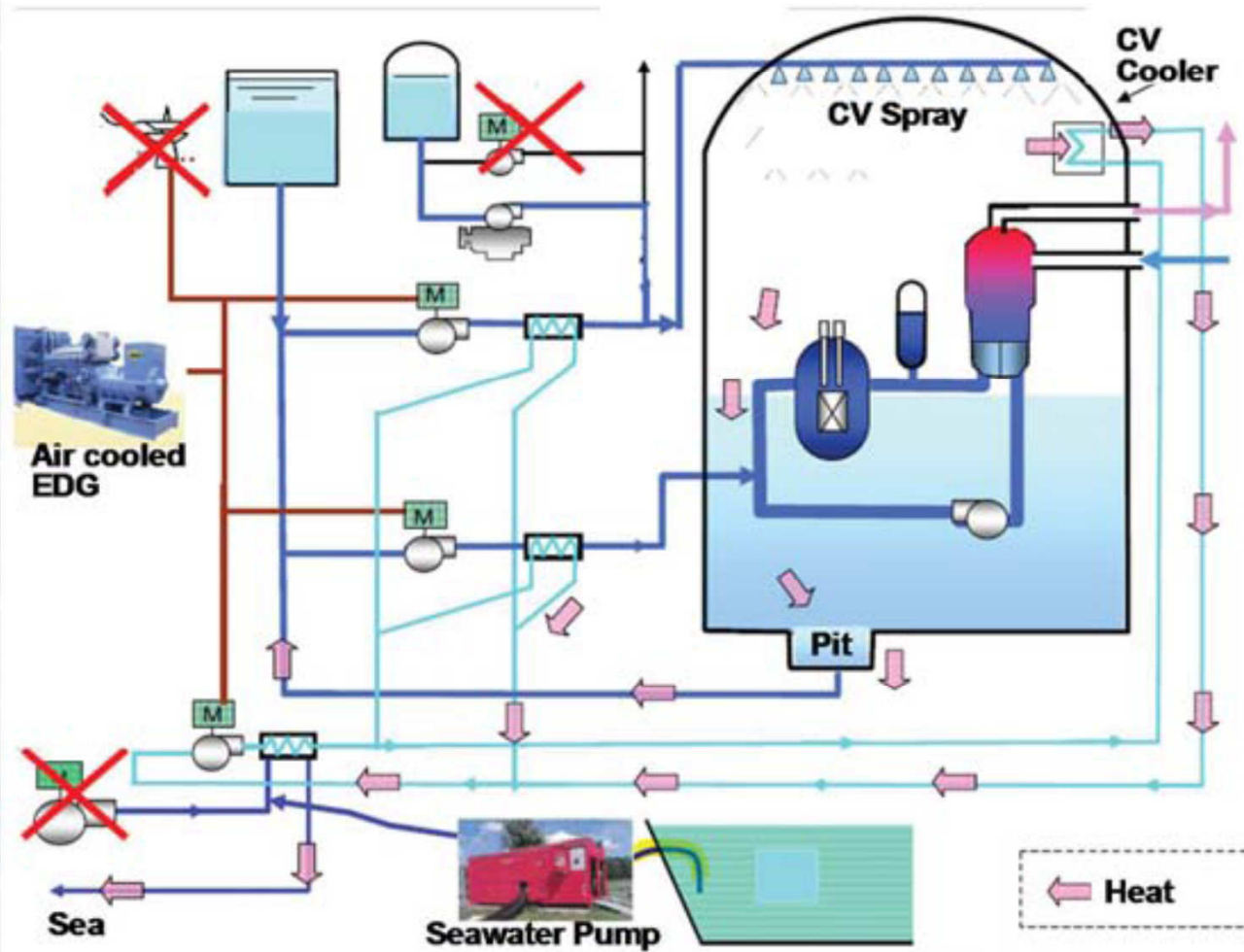
NPS Operation and Inspection in Japan



There are 100s of mobile equipment provided in NPSs

Resilience for AC power supply





Resilience for CV cooling



Resilience for H₂ Accumulation

Hydrogen Passive Autocatalytic
Recombiner



Heated Igniter



Resilience for Water Injection & Tsunami

Motor driven pump



Water Proof Door



Mobile Water Injection Pump



New NPS construction at Sanmen China(Nov. 2015)

Unit 1



Unit 2

