—— Nuclear Energy ——
Indispensable Energy for Japan as an Island Economy

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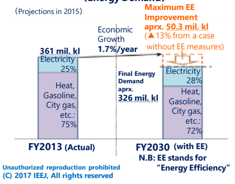
1. Japanese Energy Mix Revision and Its Background
(1) 2030 Energy Supply and Demand Structure: Difference Between 2010 and 2015 Versions

<1> Energy Demand and Primary Energy Supply Structure

● (Energy Supply) Nuclear and renewable energy had a combined share of aprx. 40% (37%) in the 2010 version of the target energy for 2030, against 24.3% in the 2015 version. The nuclear share in the 2015 version was halved from the 2010 version. Priority shifted from heavy dependence on nuclear energy to diversification.

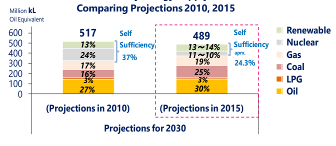
	① Economic Growth	② Energy Conservation	③ Energy Self-Sufficiency Ratio	④Energy-related CO_2 Emissions
2010 Ver.	(2007→2020) aprx. 2%/year (2020→2030) aprx. 1.2%/year	N.A.	aprx. 40% (37%)	730 mil. t-CO_2)
2015 Ver.	(2013→2030) 1.7%/year	Improving EE by 35% in 20 years (same as the level after "oil crisis")	24.3%	927 mil. t-CO_2) (Down 25% from FY2013)

(Energy Demand)



N.B: EE stands for "Energy Efficiency"

(Primary Energy Supply)
Comparing Projections 2010, 2015



(Source) (Projections in 2010) Joint Meeting, (The 2nd) Coordination Subcommittee, (The 4th) Basic Energy Planning Subcommittee, Advisory Committee for Agency for Natural Resources and Energy "Energy Supply and Demand Outlook in 2030" (June, 2010)
(Projections in 2015) METI "Long-term Energy Supply/Demand Outlook" (July 16, 2015)

1. Japanese Energy Mix Revision and Its Background
(1) 2030 Energy Supply and Demand Structure: Difference Between 2010 and 2015 Versions

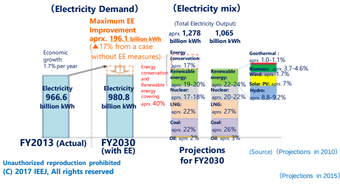
<2> Electricity Mix

● (Electricity Mix) Nuclear and renewable energy had a combined share of 68% in the 2010 version against 44% in the 2015 version. Nuclear energy's share was cut by 30% (from 49% to 20-22%). Priority shifted from heavy dependence on nuclear energy to diversification.

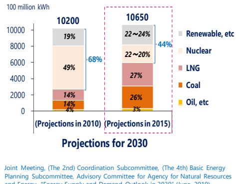
	①Energy Conservation	② Nuclear Energy's Share	③Renewable Energy's Share	④ Electricity Cost
2010 Ver.	N.A.	aprx. 50% (49%)	aprx. 20% (19%)	N.A.
2015 Ver.	Total power generation 17%	20-22%	22-24%	Down 2-5% from FY2013

(2015 version)
● Thorough energy conservation and maximum renewable energy expansion is set to cover aprx. 40% of total electricity generation, with nuclear energy's share of the electricity mix reduced substantially (from 29% before the March 2011 disaster to 20-22%).
● Base load share: 56% (against 63% before the March 2011 disaster)

(Electricity Demand) (Electricity mix)



(Electricity mix)
Comparing Projections 2010, 2015



(Source) (Projections in 2010) Joint Meeting, (The 2nd) Coordination Subcommittee, (The 4th) Basic Energy Planning Subcommittee, Advisory Committee for Agency for Natural Resources and Energy "Energy Supply and Demand Outlook in 2030" (June, 2010)
(Projections in 2015) METI "Long-term Energy Supply/Demand Outlook" (July 16, 2015)

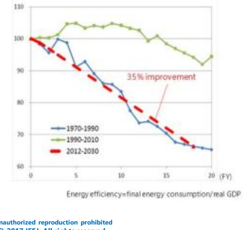
<Reference>

Promotion of Energy Conservation : Improvement of Ambitious Energy Efficiency

❖ The Ministry of Economy, Trade and Industry (METI) promulgated **"the Long-term Energy Supply and Demand Outlook"** in July 2015.

■ Thorough energy conservation measures would reduce final energy consumption by 13% to 326 million kl.
■ Energy conservation measures would be accumulated to improve energy efficiency as much as just after the oil crises.

【Energy efficiency improvement】



Energy efficiency=final energy consumption/real GDP

Further energy conservation (3 points)

① "Facility Renovation"
② "IT Utilization"
- FEMS (Factory Energy Management System)
- BEMS (Building 〃)
- HEMS (Home 〃)
- ITS (Intelligent Transport Systems)

③ "Energy Conservation in Buildings"

(Source) Document 3 "Long-term Energy Supply/Demand Outlook, Related Documents" p.66

<Reference>

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Specific Energy Conservation Assumptions

■ Energy savings in each sector would be accumulated to save energy consumption by 50.3 million kl

<Major energy conservation measures in each sector>

Industry sector <Down about 10.42 million kl>
- **4 major industries (steel, chemicals, cement, paper-pulp)**
  ⇒ Promoting low-carbon society action plans
- **Promoting plant energy management**
  ⇒ Improving energy efficiency through visualization of manufacturing lines
- **Developing and introducing innovative technologies**
  ⇒ Introducing COURSE50 (CO_2 Ultimate Reduction in Steelmaking Process by Innovative Technology for Cool Earth 50) to cut CO_2 emissions by some 30% through hydrogen reduction of iron ore, blast furnace gas CO_2 separation, etc.)
- **Cross-industry introduction of highly efficient equipment**
  ⇒ Low-carbon industrial furnaces, high-performance boilers, etc.

Commerce sector <Down about 12.26 million kl>
- **Energy-saving buildings**
  ⇒ Energy conservation standard adaptation requirement for new buildings
- **Introducing LED lights and organic light emitting displays**
  ⇒ Diffusing LED and other highly efficient lights
- **BEMS building energy management system for energy management**
  ⇒ Introducing BEMS for a half of buildings
- **Promoting national movements**

Transport sector <Down about 16.07 million kl>
- **Diffusing next-generation vehicles, improving fuel efficiency**
  ⇒ One of every two vehicles would be a next-generation vehicle
  ⇒ Fuel cell vehicles: More than 100,000 units in maximum annual sales
- **Traffic flow measures**

Residential sector <Down 11.6 million kl>
- **Energy-saving housing**
  ⇒ Energy conservation standard adaptation requirement for new housing
- **Introducing LED lights and organic light emitting displays**
  ⇒ Diffusing LED and other highly efficient lights
- **BEMS building energy management system for energy management**
  ⇒ Introducing BEMS for all houses
- **Promoting national movements**

(Note) The key issues include **"Facility Renovation"**, **"IT Utilization"**, and **"Energy Conservation in Buildings"** as well as the introduction of **"Benchmarking Systems"**.

(Source) Document 3 "Long-term Energy Supply/Demand Outlook, Related Documents" p.21 at 11th meeting (July 16, 2015) of the Long-term Energy Supply and Demand Outlook Subcommittee, Strategic Policy Committee, Advisory Committee for Natural Resources and Energy

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1. Japanese Energy Mix Revision and Its Background

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(2) Why is priority given to diversification ?
: Revision of basic plan

1. Structural Challenges in Japan's Energy Strategy (3E)

(1) … Fundamental vulnerabilities in the energy supply system (Energy Security)
(2) … Changes in the medium- to long-term energy demand structure
(3) … Unstable resource prices (Economic Efficiency)
(4) … Increasing GHG emissions (Environment)

2. …Nuclear plant accident…Emerging challenge =Realities of Quadlemma (3E+S+M)

(1) … Concerns over the safety of nuclear power → (Safety)
(2) … Outflow of national wealth, increasing supply uncertainty → (Economic Efficiency)
(3) … Impact on the macro economy, industry, and households (national livelihood) → (Macro Economy)
(4) … Surging GHG emissions → (Environment)
(5) … Power interchange and supply in emergency situations - defects found → (Energy Security ①)
(6) … Loss of confidence in the government and power companies
(7) … Increased introduction of co-generation
(8) … Changes in geopolitical structure → (Energy Security ②)
(9) … Development of the shale revolution
(10) … Global increase in the use of nuclear power

(Source) METI "Basic Energy Plan" April 2014, pp.8-14

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1. Japanese Energy Mix Revision and Its Background

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(2) Why is priority given to diversification ?
: Energy mix determination and responses Revision of basic plan

1. Position of Long-term Energy Supply and Demand Outlook

⇒ The Long-term Energy Supply and Demand Outlook is a desirable future energy supply and demand picture that may be realized when measures are implemented for policy targets that should be attained from the basic energy policy viewpoints of energy security, economic efficiency, environmental adaptation and safety (3E's + S), based on the Basic Energy Plan. The latest outlook is designed for 2030.

2. Basic policy for energy mix determination: Addressing the quadlemma

⇒ In the absence of perfect energy that can respond to the quadlemma, priority is given to diversification.

1) **Energy security**: **The energy self-sufficiency rate** will exceed the level before the March 2011 disaster (to about 25%).
2) **Economic efficiency: Power costs** will be reduced from present levels.
3) **Environmental friendliness:** With **a greenhouse gas emission reduction target** rivalling European and U.S. targets, Japan will lead the world in cutting GHG emissions.
4) **Safety:** At the same time, **dependence on nuclear power plants** will be reduced as much as possible.

3. Regular revision

⇒ The outlook will be revised as necessary when the Basic Energy Plan is updated every three years.

(METI "Long-term Energy Supply and Demand Outlook (July 2015)" released on July 16, 2015)

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2. Nuclear Energy Seen from Viewpoint of 3E's
(1) Energy Security

International energy situation destabilization: 3 risks

☑ Risk ① **Shale revolution and fate of crude oil prices after their plunge**

☑ Risk ② **Growing geopolitical destabilization**

☑ Risk ③ **Fate of Middle East after birth of U.S. Trump administration**

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2. Nuclear Energy Seen from Viewpoint of 3E's

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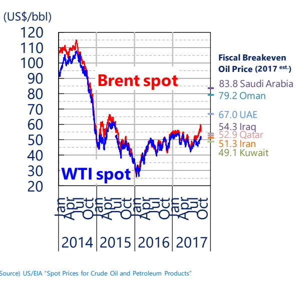
(1) Energy Security
Risk① Shale revolution and fate of crude oil prices after their plunge

❖ What mid- and long-term effects will arise if crude oil prices continue falling?
❖ What are the break-even prices for shale oil and gas production?



(Source) US/EIA "Spot Prices for Crude Oil and Petroleum Products"

IMF est. (Apr. 2017)	Fiscal Breakeven Oil Price ($/bbl)		
	2016	2017est.	2018est.
Saudi Arabia	93.7	↘ 83.8	↘ 74.4
Oman	80.1	→ 79.2	→ 78.8
Iran, I.R. of	73.1	↘ 51.3	↗ 58.8
United Arab Emirates	58.6	↗ 67.0	↘ 58.6
Qatar	54.6	→ 52.9	→ 54.9
Kuwait	46.5	→ 49.1	→ 50.4
Iraq	46.1	↗ 54.3	→ 56.5

(Source) IMF, Apr. 2017.

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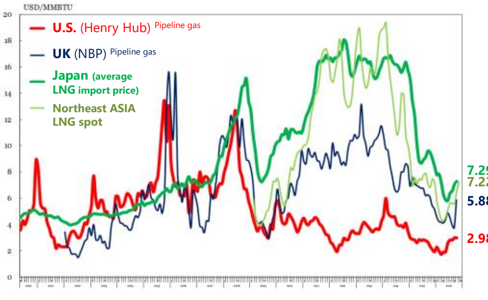
World Gas Price by Region

➢ Gas Prices for Japan and Asia are relatively high.



(Source) US.EIA, etc.

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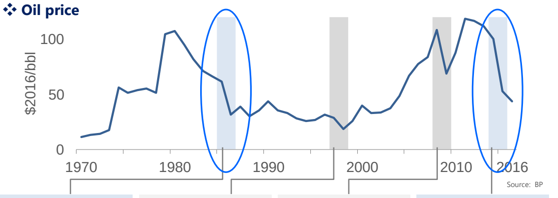
"History doesn't repeat itself, but it does rhyme" ~ Mark Twain

✣ Oil price



- Decreases in demand and increases in supply by non-OPEC countries following high price after the oil crises
- Severer competition in OPEC
- Easy supply-demand balance affected by the Netback pricing

- Decreases in emerging economies' demand on the Asian financial crisis
- Expansion of OPEC production quota and excess production by the members over their quota

- Sharp drop of demand on the Lehman shock
- Expansion of production capacity by Saudi Arabia and others

- Increases in supply by non-OPEC and OPEC countries
- Slow growth of global demand

(Source) IEEJ, Asia/World Energy Outlook 2015, Oct. 2015, etc.

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3 Energy Outlooks by 3 Energy Organizations

Crude oil and natural gas prices projected for 2030 (Main scenarios)

2030 Price Outlook	Crude Oil	Natural Gas (Japan)	Natural Gas (U.S.)	(Source)
Institute of Energy Economics, Japan (IEEJ)	95 $2016/bbl	10.9 $2016/Mbtu	4.5 $2016/Mbtu	"IEEJ Outlook 2018" (Oct, 2017)
International Energy Agency (IEA)	94 $2016/bbl	10.5 $2016/Mbtu	4.4 $2016/Mbtu	"World Energy Outlook 2017" New Policies Scenario, (Nov. 2017)
Energy Information Administration, U.S. Department of Energy (DOE/EIA)	90.4 $2016/bbl	N.A.	5.0 $2016/Mbtu	"Annual Energy Outlook 2017" (Jan. 2017)

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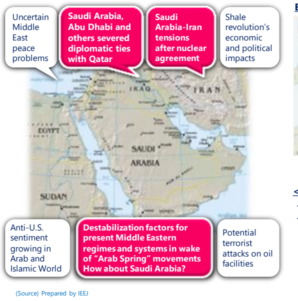
2. Nuclear Energy Seen from Viewpoint of 3E's

(1) Energy Security

Risk② Growing geopolitical destabilization

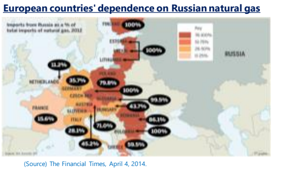
Destabilization of the Middle East



(Source) Prepared by IEEJ

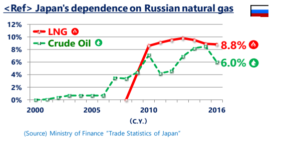
The Ukraine (Violation of international law in broad daylight)

European countries' dependence on Russian natural gas



(Source) The Financial Times, April 4, 2014.

<Ref> Japan's dependence on Russian natural gas

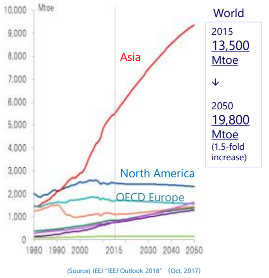


(Source) Ministry of Finance "Trade Statistics of Japan"

<Reference> 17

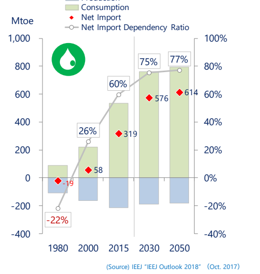
In the Asia ? : Competition for Resources and "Territorial Disputes"

Primary Energy Demand by Region (Reference)



(Source) IEEJ "IEEJ Outlook 2018" (Oct. 2017)

China Oil Supply and Demand Outlook



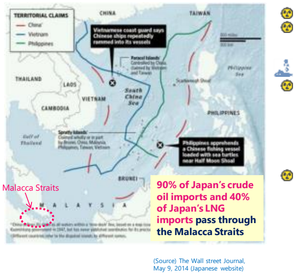
(Source) IEEJ "IEEJ Outlook 2018" (Oct. 2017)

<Reference> 18

In the Asia ? : Competition for Resources and "Territorial Disputes" : North Korean Provocations ?

South China Sea (Aggression in the gray zone)

Territorial disputes in South China Sea



(Source) The Wall street Journal, May 9, 2014 (Japanese website)

North Korean Provocations ?

10/9/2006 1st underground **nuclear test**

5/25/2009 2nd **nuclear test**

12/17/2011 Kim Jong Un named new leader (3rd supreme leader)

2/12/2013 3rd **nuclear test**

1/6/2016 1st successful hydrogen bomb test (viewed as **4th nuclear test** by the South Korean defense ministry)

2/7/2016 Kwangmyŏngsŏng-3 launched for a satellite (passing over Okinawa Prefecture)

4/23/2016 Firing a submarined launched ballistic missile (SLBM)

9/9/2016 **5th nuclear test**

7/4,28/2017 Firing Hwasong-14 **intercontinental ballistic missiles (ICBMs)**

8/29/2017 Firing Hwasong-12 **intermediate range ballistic missile (IRBM)** (The missile passes over Hokkaido without prior notification. The Japanese government issues a J-alert warning.)

9/3/2017 **6th nuclear test** (Announced as a successful hydrogen bomb test for ICBMs)

9/152017 Firing Hwasong-12 **IRBM** as seen on August 29 some 2 weeks ago (The missile passes over Hokkaido without prior notification again. The Japanese government issues a J-alert warning.)

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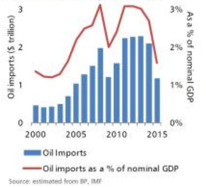
In Prosperity Prepare for Adversity

Energy Security | The uninterrupted availability of energy sources at an affordable price — IEA

Economic issue » Relaxed by lower oil price

✣ World oil import value



Source: estimated from BP, IMF

Note that there are some Mid-term concern:
- Investment shortage from price volatility and lower energy price,
- Investment shortage with concerns for turning into "stranded" assets, ...

Physical supply disruption » Risk will remain

✣ Country risks

Source: Coface "Country Risk Assessment Map" 2Q2016

Despite the current over-supply, geopolitical risk factors have not been resolved. While there are few issues such as Iranian nuclear issue, there are others which became more complex and aggravated.
- Saudi Arabia – Iran Relationships,
- ISIS issues, Syrian situation,
- Ukrainian issues, Western Countries – Russia relationships,
- Domestic situations of MENA countries, ...

(Source) IEEJ, Asia/World Energy Outlook 2016, Oct. 2016, etc.

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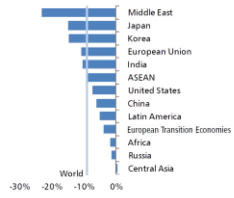
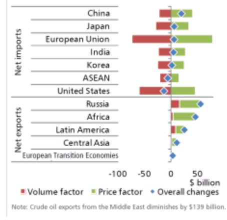
Supply Disruption (10 Mb/d) : Serious Damage to the World Economy

✣ Real GDP



✣ Crude oil net export value



Note: Crude oil exports from the Middle East diminishes by $139 billion.

In the situation where crude oil production in the Middle East drops unexpectedly and by large amount while other countries/regions are unable to increase the production to replace the lost volume, the world economy will shrink by 9%. It hits countries such as Japan and Korea which are dependent on imported oil the most.

Despite the increase in export value, the economy of the non-Middle East exporting regions will not manage to avoid being hit by the depression pressure.

(Source) IEEJ, Asia/World Energy Outlook 2016, Oct. 2016, etc.

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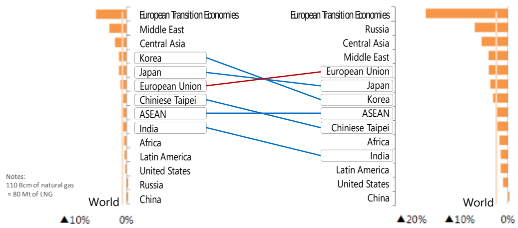
Gas Supply Disruption Hits Europe

✣ Changes in real GDP



With gas supply disruption, the European transition economies will be hardest hit because of the lower energy efficiency and higher dependence on natural gas. In case of Russian gas supply disruption, EU will also be hit hard. Japan and Korea suffer from the gas supply shortage as in the case of oil supply disruption.

Natural gas supply disruption causes smaller effect than crude oil disruption because of the smaller energy value (i.e. 110 Bcm/year natural gas is only 1/5 of 10 Mb/d crude oil).

(Source) IEEJ, Asia/World Energy Outlook 2016, Oct. 2016, etc.

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2. Nuclear Energy Seen from Viewpoint of 3E's

(1) Energy Security

Risk③ Fate of Middle East after birth of U.S. Trump administration

✣ **Policies of US President Trump** →**Growing Uncertainty**

- Good news for the US fossil-fuel industry, but output expansion might be limited at current prices
- Revoking the Paris Agreement and Iran nuclear deal could have serious impacts on international efforts to stop global warming and the Middle East situation
- New uncertainties in US politics likely to raise crude oil price volatility through financial markets

Energy	➢ Energy Independence (particularly from OPEC) ➢ Lift the prohibition on development of oil and natural gas on federal land ➢ Create jobs, increase wages, and lower energy prices by easing and eliminating energy development regulations ➢ Build oil pipelines and coal export facilities ➢ President Trump announces efforts to revive nuclear energy
Environment	➢ Possible exit from the Paris Agreement and Climate Change Treaty? ➢ Eliminate environmental regulations adopted by the Obama administration
Foreign policy	➢ Rectify interventionism (regime change, etc.) in other countries ➢ Support Middle East countries and forces fighting ISIS and other extremists ➢ Designate China as a currency manipulator and exit the TPPA ➢ Designate Iran as a nation supporting terrorists and possibly revoke the nuclear agreement →**Destabilization of the Middle East**

(Source) US President Trump's website

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2. Nuclear Energy Seen from Viewpoint of 3E's

(2) Economic Efficiency: Power Generation Costs by Source In Japan, nuclear plants post the lowest cost

Overview of 2030 model plant estimation results and sensitivity analyses

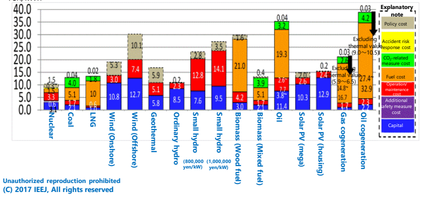
Power sources	Nuclear	Coal	LNG	Wind (Onshore)	Wind (Offshore)	Geothermal	Ordinary hydro	Small hydro 800,000 yen/kW	Small hydro 1 million yen/kW	Biomass (Wood fuel)	Biomass (Mixed fuel)	Oil	Solar PV (Mega)	Solar PV (Housing)	Gas cogeneration	Oil cogeneration
Operating rate Service life	70% 40years	70% 40years	70% 40years	20~23% 20years	30% 20years	83% 40years	45% 40years	60% 40years	60% 40 years	87% 40 years	70% 40 years	30・10% 40years	14% 30years	12% 30years	70% 30years	40% 30years
Generation cost yen/kWh	10.3~ (8.8~)	12.9 (12.9)	13.4 (13.4)	13.6 ~21.5 (9.8 ~15.6)	30.3 ~34.7 (20.2 ~23.2)	16.8 (10.9)	11.0 (10.8)	23.3 (20.4)	27.1 (23.6)	29.7 (28.1)	13.2 (12.9)	28.9 ~41.7 (28.9~ 41.6)	12.7 ~15.6 (11.0~ 13.4)	12.5 ~16.4 (12.3~ 16.2)	14.4 ~15.6 (14.4~ 15.6)	27.1 ~31.1 (27.1~ 31.1)
2011 Cost Review Committee report	8.9~	10.3	10.9	9.9~ 17.3	9.6~ 23.1	9.2~ 11.6	10.6	19.1 ~22.0	19.1 ~22.0	17.4 ~32.2	9.5 ~9.8	25.1~ 38.9	12.1~ 26.4	9.9~ 20.0	11.5	19.6

※1 Fossil fuel prices could drop depending on future policy efforts. Sensitivity analysis results follow:

※2 The operating rate in 2011 stood at 80% for Coal and LNG and 50%/10% for Oil.

※3 Figures in parentheses represent costs excluding the policy cost.

Sensitivity analysis for fossil fuel power generation	Coal	LNG	Oil
Impact of a 10% fuel price change (yen/kWh)	About ±0.4	About ±0.9	About ±1.5



<Adjustment costs accompanying penetration of naturally volatile power sources (solar PV and wind)>

Penetration rate for naturally volatile power sources	Penetration rate for renewables	Survey cost
About 66 billion kWh (6%)	About 19-21%	About 300 billion yen/year
About 93 billion kWh (9%)	About 22-24%	About 470 billion yen/year
About 124 billion kWh (12%)	About 25-27%	About 700 billion yen/year

※Penetration rates are based on total power generation at 1,065 billion kWh.

(Source) Document 3 "Long-term Energy Supply/Demand Outlook, Related Documents" p.83 at 11th meeting (July 16, 2015) of the Long-term Energy Supply and Demand Outlook Subcommittee, Strategic Policy Committee, Advisory Committee for Natural Resources and Energy

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(Nuclear energy) What is happening in U.S. ?

- **In the absence of nuclear plant construction over 30 years, technology, knowhow and experiences have been lost. Nuclear regulations have been tightened since the Fukushima accident, with nuclear plant construction costs rising.**
- **Gas prices have fallen.**
- **As a result, nuclear energy's competitiveness has declined relatively.**
- **However, President Trump declared the revival and expansion of the nuclear field. May nuclear energy's share of the power mix be maintained at around 20% ?**

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(Nuclear energy) What is happening in Europe ?

- **Europe lacks experiences with new-type reactors. A cost overrun has been seen. Nuclear regulations have been toughened since the Fukushima accident.**
- **Eventually, nuclear power generation costs have increased. However, no country other than Germany has adopted any clear nuclear phaseout policy.**
- **May the EU maintain nuclear energy's share of the power mix at around 20%?**

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2. Nuclear Energy Seen from Viewpoint of 3E's

(3) Environmental Friendliness: Climate Change Responses Gaining Momentum on Paris Accord

- **Japan** managed to make its target

(Japan's fossil fuel dependency has risen to 94% (2012))

・・・But, the energy mix was decided with the target

- **U.S.** revived up, **China** cannot escape

<U.S.> reduced emissions from thermal power by 30% thanks to shale revolution)

(China: coal is a source of PM2.5 pollution)

・・・U.S.-China Summit Talks in APEC (Nov. 2014)

- Consequently, **the targets for 2030**:

GHG reduction target in the **Paris Agreement**

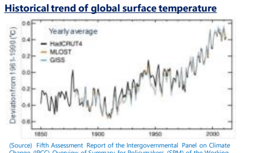
<Japan> 26% reduction by 2030 (compared with 2013)

< U.S. > 26-28% reduction by 2025 (compared with 2005)

< E U > 40-45% reduction (per GDP, compared with 2005)

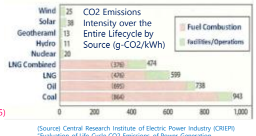
<China> CO_2 emissions will peak around 2030. 60～65% reduction (CO_2 per GDP, compared with 2005)

Historical trend of global surface temperature



(Source) Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) Overview of Summary for Policymakers (SPM) of the Working Group I (preliminary issue), released by the METI, September 27, 2013

Global warming perspective (comparison of CO2 emissions)



(Source) Central Research Institute of Electric Power Industry (CRIEPI) "Evaluation of Life Cycle CO2 Emissions of Power Generation Technologies: Update for State-of-the-art Plants" July, 2010.

<Reference> 27

Elements and Issues of Paris Agreement

	Paris Agreement (2015)	Kyoto Agreement (1997)
①Mitigation (GHG reduction)		
a. Participating countries	INDC*submitting countries : **192** (as of Apr., 2017)	Countries with reduction duties: **37** (US has not ratified)
b. Setting targets	**Bottom up**	**Top down**
c. Compliance	**No binding mechanism but 5 year review**	**Legally binding**
d. Japan7s joint credit mechanism	In addition to JI and CDM, International joint credit mechanism under negotiation	JI (Joint Implementation), CDM (Clean Development Mechanism) and International Emission trading
②Adaptation and funds	Discussion on global adaptation targets under way	At the COP15 meeting in Copenhagen in 2009, developed countries agreed to provide $30 billion in new or additional funds between 2010 and 2012 and mobilize $100 billion a year until 2020.
③Differentiated Treatment between developed and developing countries	All the countries including US, India and China (implemented to reflect equity and the principle of common but differentiated responsibilities and respective capabilities, in the light of different national circumstances)	Developed countries, excluding US, are responsible for reduction of GHG

*INDC (Intended Nationally Determined Contributions)

<Reference> 28

Japan, U.S., EU, and Taiwan Greenhouse Gas Emissions (GHG) Reduction Targets

	Estimated 2030* Emissions Reductions Relative to Different Base Year				GHG emissions per GDP (kg/U.S.dollar GDP)	
	Relative to 1990	Relative to 2005	Relative to 2013	Relative to BAU	Actual (2015)	Forecast (2030)
Japan (Target Year 2030)	▲17.9%	▲25.4%	**▲26.0%**	—	0.22	**0.15**
U.S. *(Target Year 2025)	▲12～15%*	**▲26～28%***	▲18～20%*	—	0.35	**0.23～0.24***
EU (Target Year 2030)	**▲40%**	▲35%	▲24%	—	0.24	**0.15**
Taiwan (Target Year 2030)	+57%	▲26%	▲25%	**▲50%**	0.57** (**2013)	**0.30**

N.B: BAU stands for "Business As Usual"

◆The **U.S.** submitted a reduction target compared with 2005 and the **EU** a target compared with 1990.
U.S. (2005→2025) EU (1990→2030)

(Source) Emission reduction targets: "The NDC interim registry". For Taiwan, Republic of China (Taiwan), "Intended Nationally Determined Contribution" (Sep. 2015) .
GHG emissions: GHG Inventories. For Taiwan, Taiwan Environmental Protection Administration, "2015 Taiwan Greenhouse Gas Inventory" (Feb. 2016).
GDPs: IEEJ, "IEEJ Outlook 2018" (Oct. 2016).

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2. Nuclear Energy Seen from Viewpoint of 3E's

(4) What Happened in Absence of Nuclear Power Generation : In fact not all right

- **From the viewpoint of the 3E's, the situation has seriously deteriorated (2010>2013).**

		Before 2011 disaster (FY2010)	After 2011 disaster (FY2013)	
Energy Security	Energy self-sufficiency rate (Total primary energy supply)	20%	6%	→Deteriorating energy self-sufficiency rate
Economic Efficiency	Power costs (Fuel cost + FIT purchase cost)	5.0 T yen Fuel cost : 5.0 tril. Yen (Crude oil price: $84/bbl) FIT purchase: 0 tril. yen	9.8 T yen Fuel cost: 9.2 T yen (Crude oil price: $110/bbl) (Volume factor+1.6 T yen Price factor+2.7 T yen) FIT purchase: 0.6 T yen	→Substantial rise in power charges
Environment	CO_2 emissions (Energy-related)	1.14 B yen	1.24 B yen	→Massive CO_2 emissions

(Sources) Prepared from Document 2 for the first meeting of the Roundtable for Studying Energy Situations (August 30, 2017) and p. 1 of "Reference (progress in attaining 2030 targets)" by the Agency for Natural Resources and Energy

- **Safe seen from viewpoint of "S" ・・・Grounded Aircraft**
- **No perfect energy seen from viewpoint of "3E's + S"**

⇒ Quadlemma

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3. Is Safety Secured ?
Nuclear Safety: from "Safety Myth" to "Reduction of Allowance Levels"

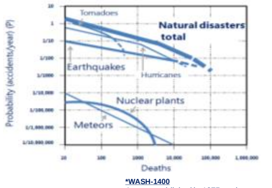
- **Ready technologically**
  (Already has world leading technology)
  ⇒ Endured the earthquake.
  ⇒ Accident caused by "station blackout" due to tsunami.

  US added "station blackout" to its safety standards following September 11, 2001 attacks.

- **Now ready in terms of institutional aspects (independence)**
  (The problem is the speed of the reviews.)

- **Safety culture is being enhanced**
  Two issues:
  (1) Voluntary safety efforts by operators
  In the US, NRC (regulators) vs. INPO (operators)※
  (2) Public mindset has shifted from the safety myth to absolute risk
  ⇒ The ideal is to "lower risks to tolerable levels"

Risk comparison between 100 nuclear power reactors and natural disasters in WASH-1400*



(Source) Nuclear Regulatory Commission (NRC) "Reactor safety study. An assessment of accident risks in U. S. commercial nuclear power plants. " 1975

***WASH-1400**
A report published in 1975 on the study of the applicability of probabilistic risk analysis to nuclear power plants. The study was conducted by the U.S. Nuclear Regulatory Commission (NRC) in the early 1970s and established the framework for probabilistically assessing the risks of accidents in nuclear power plants in a quantitative manner.

※**NRC :** Nuclear Regulatory Commission
INPO : Institute of Nuclear Power Operations

<Reference>

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Establishing a Safety Culture : Risk Tolerance

From the standpoint of medical science …

Dental X-ray	0.005 mSv
135g of brazil nuts	
Transatlantic flight	0.07 mSv
Average annual dose (UK)	2.7 mSv
CT scan (whole body)	9 mSv
Av dose 6M Chernobyl residents	10 mSv
Annual exposure to average smoker	13 mSv
Radiotherapy for breast cancer	50 Sv

(Source) Professor Gerry Thomas, Molecular Pathology, Imperial College London "Communicating Health Risks from Nuclear Accidents" (The 80th IEEJ Energy Seminar, March, 2015, presentation material)

<Reference>

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Fukushima Daiichi Accident and Safety Concerns

	Before Mar. 11, 2011		After	
	Favorable	Unfavorable	Favorable	Unfavorable
(1) Japan	62%	28%	39%	47%
(2) U.S.	53%	37%	47%	44%
(3) France	66%	33%	58%	41%
(4) Germany	34%	64%	26%	72%
(5) Russia	63%	32%	52%	27%
(6) S.Korea	65%	10%	64%	24%
(7) China	83%	16%	70%	30%
(8) India	58%	17%	49%	35%

(Source) Gallup International (April 19,2011)

- 2011 Fukushima Daiichi accident onwards:
  From high nuclear dependency to balancing energy sources ?
- Public opinion is divided on whether to abandon nuclear power

<Reference>

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Mail Poll (Yomiuri Shimbun: January-February 2017)

Q: Before the Great East Japan, Japan depended on nuclear energy for nearly 30% of its power supply. What should Japan do in regard to the nuclear share?

A:	1) Increase the share from the level before the disaster	2%
	2) Restore the share before the disaster	19%
	3) Reduce the share from the level before the disaster	50%
	4) Eliminate all nuclear power plants	26%
	5) Other, no answer	3%

<Reference>

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Judicial Stance on Nuclear Power Regulators' Decision in Major Countries

			Matters concerning safety	Process of establishing new regulatory requirements and compliance review
US, UK, France, Germany			Respect **the regulator's** decision	Review any defects in the regulatory procedures
Japan	(target NPPs) Oi (no.3,4) and Takahama (no.3,4)	Fukui District Court (1) (2015/4)	Decided by **the Court** (New regulatory requirements are too loose and lack rationality)	—
		Fukui D.C. (2) ('15/12)	Respect **the regulator's** decision (NRA's decision is completely rational)	Decided there were no defects in the regulatory procedures.
	Takahama (no.3,4)	Otsu D.C. ('16/3)	Decided by **the Court** (Feel reluctant to consider the regulatory requirements as the foundation of public safety)	By pointing out defects in the regulatory procedures, they seem to step into the matter of safety.
		Osaka High Court ('17/3)	Respect **the regulator's** decision (NRA's decision is completely rational)	Decided there were no defects in the regulatory procedures.
	Sendai (no.1,2)	Kagoshima D.C. ('15/4) Fukuoka H.C.'s Miyazaki branch ('16/4)		
	Ikata (no.3)	Hiroshima D.C. ('17/3) Matsuyama D.C. ('17/7)		
	Genkai (no.3,4)	Saga D.C. ('17/6)		

(As of Oct 24, 2017)

<Reference>

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Local Risks: Relations with Nuclear Power Plant Host Communities in Major Countries

	Relations with Nuclear Power Plant Host Communities
U.S.	・Learning lessons from a case in which a nuclear plant operation approval failed to be issued due to a host community's policy change after the construction of a nuclear plant, the United States introduced the integrated approval of nuclear power plant construction and operation. ・State governments control coolant water supply, preventing operation approval renewal in some cases.
U.K.	・Local community groups are organized, comprising business operators, central and local governments, local assemblies, military forces, trade unions, etc. ・Regulatory authorities provide community groups with quarterly nuclear power plant operation reports and conduct open briefings and question-and-answer sessions. However, regulatory activities and decisions on whether to restart reactors after regular checkups remain unaffected.
France	・Local information committees are organized, comprising politicians, environmental protection groups, economic organizations, trade unions, medical experts, etc. ・Local governments and information committees are given opportunities to hold hearings and provide opinions, but have no power to decide whether to approve facility installation or plant operation.
Germany	・The federal government controls nuclear fuel and radioactive waste and commissions state governments to regulate nuclear plant safety.
Japan	・Nuclear power plant hosting communities (prefectures and municipalities) conclude nonbinding safety agreements with plant operators. ・In a nuclear power plant restart process after the Fukushima accident, plant-hosting communities' approval has become effectively indispensable.

(Source) IEEJ

<Reference> 37

Slow but Steadily Restart Nuclear Power Plants in Japan

1. Number of reactors that can be used now	42	(= 54 －6 －6) (Decommissioning of the Fukushima Daiichi) No.1～6 (Decommissioning old units) Mihama No.1, 2 Tsuruga No.1 Shimane No.1 Ikata No.1 Genkai No.1
2. Number of reactors under screening by the NRA	21	(= 26 － 5)
3. In operation (Commercial Operations)	4	Sendai No.1 : Sep. 2015 (After a regular checkups (Oct. 2015-Jan. 2017), commercial operation resumed on Jan. 6, 2017.) Sendai No.2 : Nov. 2015 (After a regular checkups (Dec. 2016-Mar. 2017), commercial operation resumed on Mar. 24, 2017.) Takahama No.3 : Feb. 2016 (❖2 restart; July 4, 2017) Takahama No.4 : June 16, 2017 (❖2) (Regular checkups 1) Ikata No.3 : Sep. 2016 ❖1 STOP: Regular checkups (Oct. 3, 2017- est. Jan. 2018)

<Reference> 38

Status of Nuclear Reactors Approved After Implementation of New Regulatory Standards (on July 8, 2013) (4 in operation, 1 under checkups, 7 under screening)

Status	Company	Reactor	Test operation	Commercial operation	Suspension duration	Notes
In operation	Kyushu E.P.	Sendai Unit 1	①August 2015 ②December 2016	①9/10/2015-10/6/2016 ②1/6/2017-	Regular checkups 10/6/2016-1/6/2017	Resuming operation after regular checkups within 13 months after commercial operation
In operation	Kyushu E.P.	Sendai Unit 2	①October 2015 ②February 2017	①11/17/2015-12/16/2016 ②3/24/2017-	Regular checkups 12/16/2016-3/24/2017	Resuming operation after regular checkups within 13 months after commercial operation
In operation	Kansai E.P.	Takahama Unit 3	①January 2016 ②June 2017	①2/26/2016-3/10/2016 ②7/4/2017-	District court order 3/10/2016-3/28/2017	Takahama Units 3 and 4 were shut down due to a district court temporary injunction order for suspension. After a high court cancelled the temporary injunction order on March 28, 2017, they will restart after ❹ passing checkups.
In operation	Kansai E.P.	Takahama Unit 4	①February 2016 ②May 2017	(March 2016 ❹Suspension for checkups) ①6/16/2017-		
Under regular checkups	Shikoku E.P.	Ikata Unit 3	①August 2016	①9/7/2016-10/3/2017	Regular checkups 10/3/2017-(around 1/20/2018)	Under regular statutory checkups within 13 months after commercial operation
Under screening	Kansai E.P.	Oi Unit 3	❶❷❸Approval ❹Pre-use checkups (application on August 28, 2017)		Pursuing restart in or **after January 2018**	
Under screening	Kansai E.P.	Oi Unit 4	❶❷❸ Approval ❹Pre-use checkups (application on August 28, 2017)		Pursuing restart in or **after March 2018**	
Under screening	Kyushu E.P.	Genkai Unit 3	❶❷❸Approval ❹Pre-use checkups (application on August 28, 2017)		Pursuing restart in or **after January 2018**	
Under screening	Kyushu E.P.	Genkai Unit 4	❶❷❸Approval ❹Pre-use checkups (application on September 15, 2017)		Pursuing restart in or **after March 2018**	
Under screening	Kansai E.P.	Takahama Unit 1	❶❷Approval ❸Before application		Pursuing restart in or **after August 2019**	
Under screening	Kansai E.P.	Takahama Unit 2	❶❷Approval ❸Before application		Pursuing restart in or **after March 2020**	
Under screening	Kansai E.P.	Mihama Unit 3	❶❷Approval ❸Under screening (application on March 1, 2015)		Pursuing restart in or **after March 2020**	

(As of October 20, 2017)

<Reference> 39

Impact of Restart of Nuclear Reactors on the Japanese Economy : Realization of " M " ?

Effect of differing paces for restarting nuclear power plants [FY2018]

			Zero Case	Low Case	Reference Scenario	High Case
Nuclear power presupposition	Cumulative number of restarted nuclear reactors	[End of FY2017]	[0]	[5]	[9]	[9]
		End of FY2018	0	5	10	17
	Average period for operation(months)		0	10	9	8
	Power generation by nuclear (TWh)		0	31.6	65.6	99.4
	Power supply composition ratio		0%	3%	7%	10%
Economy	Electricity unit cost[1] (JPY/kWh)		6.1	5.9	5.8	5.6
	Fuel cost		3.8	3.7	3.5	3.4
	FIT purchasing cost		2.3	2.3	2.3	2.3
	Total fossil fuel imports (JPY trillion)		15.2	15.0	14.7	14.5
	Oil		9.0	8.9	8.8	8.7
	LNG		4.0	3.8	3.7	3.5
	Trade balance (JPY trillion)		1.5	1.7	2.0	2.2
	Real GDP (JPY2011 trillion)		536.1	536.3	536.6	536.9
	Gross national income per capita (JPY thousand)		4,361	4,363	4,365	4,367
Energy	Primary energy supply					
	Oil (GL)		197.3	195.1	192.8	190.8
	Natural gas (Mt of LNG equivalent)		90.0	86.8	83.4	79.9
	LNG imports (Mt)		86.8	83.7	80.3	76.7
	Self-sufficiency rate		9.9%	11.3%	12.8%	14.3%
Environment	Energy-related CO_2 emissions (Mt-CO_2)		1,126	1,111	1,096	1,081
	Changes from FY2013		[▲8.8%]	[▲10.0%]	[▲11.3%]	[▲12.5%]

1. Sum of fuel cost, FIT purchasing cost and grid stabilising cost divided by total power generation.

"Reference Scenario" : Nine nuclear power plants restart by the end of FY2017. Ten plants in total restart by the end of FY2018.

"Low Case" : Five nuclear power plants restart by the end of FY2018.

"High Case" : Nine nuclear power plants restart by the end of FY2017. Seventeen plants in total restart by the end of FY2018.

"Zero Operation Case" : We assume that no nuclear power plant will be in operation in FY2018. This case is prepared for comparison with the other cases.

(Source) IEEJ, Economic and Energy Outlook of Japan through FY2017, July 2016

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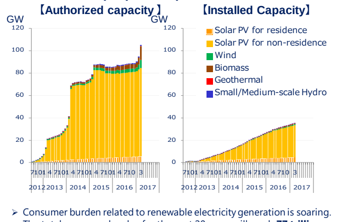
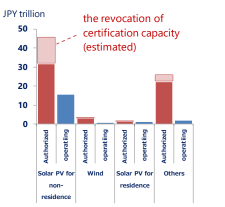
4. Why Is Running on 100% Renewables Difficult ?
(1) Renewable Energy Costs Are Still High

Feed-in Tariff (FIT) development



Japan's total FIT surcharge



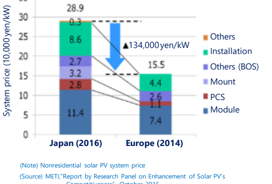
- Consumer burden related to renewable electricity generation is soaring. The total consumer burden for the next 20 years will reach **77 trillion yen** by operating just the **105 GW** capacity installed and licensed as of the end of **March 2017**. This inevitable burden is equivalent to a **4.5 yen/kWh** rise in tariffs, **or 27% for industrial and 19% for residential sectors**.
- **However, excluding the revocation of certification capacity** (an estimated **27.7 GW** (METI estimate, end of March 2017)), the cumulative total amount is **59 trillion yen.** This inevitable burden is equivalent to a **3.4 yen/kWh** rise in tariffs, **or 21% for industrial and 15% for residential sectors**.
- The rapid increase in solar power with high purchase price is greatly increasing the burden. The burden will grow further as power sources with longer lead times, such as wind power, start operation in addition to solar power.

Source: Agency for Natural Resources and Energy, "Status of Introduction of Renewable Electricity Generation Facilities (end of Mar. 2017)", Aug. 2017*
*(Latest as of Oct. 30, 2017)

<Reference> 42

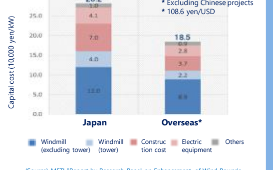
Issue Involving Renewables: Can costs be cut ?

Solar PV cost comparison (Japan and Europe)



(Note) Nonresidential solar PV system price
(Source) METI,"Report by Research Panel on Enhancement of Solar PV's Competitiveness", October 2016

Wind power generation cost comparison (Japan and World)



(Source) METI "Report by Research Panel on Enhancement of Wind Power's competitiveness" October 2016

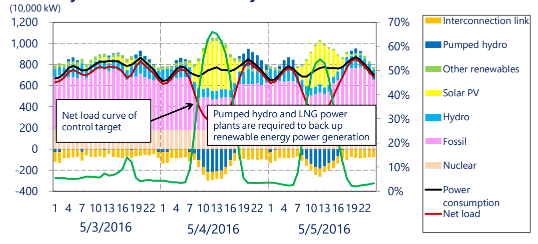
- High costs are attributable to the industry's multi-layer subcontracting structure, the absence of any competitive market, etc.
- It is pointed out that high FIT tariff prices impeded the development of a competitive market.
- The introduction of an auction system (planned for October 2017 for nonresidential solar PV systems), the establishment of a FIT tariff price reduction schedule and other initiatives under the revised FIT Act are implemented to enhance renewable energy power generation's competitiveness and cut relevant costs.

4. Why Is Running on 100% Renewables Difficult ?

(2) Backup power sources are required for renewable energy (solar PV and wind) power generation

- Although former general power utilities, power producers and suppliers, and the Japan Electric Power Exchange are separately attempting to optimize their respective operations, it is desirable to pave the way for them to unify their optimization methods as much as possible to minimize revisions by the power transmission and distribution sector.

May 3-6 2016 conditions in Kyushu Electric Power's service area



(Source) Kyushu Electric

Promoting Renewable Energies with Revised FIT System

- **Balance among renewable power sources**
  (← About 90% of FIT approved volume is business solar power)
  - Apply stricter approval criteria (completion of connection contracts, maximum three years from approval to operation, etc.)
  - Present FIT for a few years forward in the case of power sources with substantial lead time
- **Improve cost efficiency**
  (← Buying costs likely to reach about 2.3trn yen)
  - Bidding system; set a buying price that reflects a price goal
  - Consider international competition and energy savings efforts in designating fee alleviation or exemption for high-volume electricity users
- **Realization of efficient power transactions and distribution**
  (← Renewable energy grid-connection suspension issues occurred at Kyushu Electric and others in 2014)
  - Change obligatory buyers to transmission firms
    →Improve broad-area power sharing

(Revised FIT Act) "Act on Revisions to Portions of the Special Measures Act on Procurement of Renewable Energy Electricity by Electric Power Firms"
(Passed on May 25, 2016, promulgated on June 3, and takes effect on April 1, 2017)

Contents

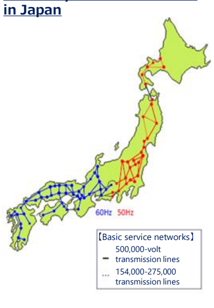
5. Why Can Germany Phase out Nuclear Plants ?

Differences between Japan and Germany

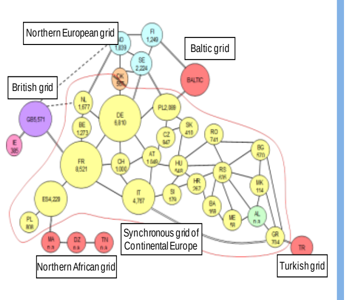
- **Geographical differences**
  - : Germany is located at the center of the EU power network where power demand is nearly 10 times as much as in Germany alone.
  - : Germany can import or export power if necessary.
  - : Germany can accommodate more unstable renewable energy power sources.
- **Differences in natural conditions**
  - : Germany, though with less solar energy resources, has stable wind energy sources. A combination of solar and wind power generation can moderate the fluctuation of volatile renewable energy power generation.
- **Topographical difference**
  - : Germany has more flat lands and wider shoals.
- **National character differences**
  - : Germans think that if any target fails to be achieved, policies should be revised. However, such approach cannot be adopted in Japan that cannot import power.

Geographical Difference Between Japan and Germany

Electricity Service Networks in Japan



International Grid Connections in Europe



Contents

Conclusion

1. After the Fukushima nuclear power plant accident following the Great East Japan Earthquake and Tsunami, Japan revised **its Basic Energy Plan and energy mix.** Its policy priority shifted **from the "3E's" to the "3E's plus S."** The key point of the energy mix shifted **from heavy dependence on nuclear energy to diversity.**
2. From **the viewpoint of the 3E's**, **nuclear is still an excellent energy source**. After all nuclear plants were shut down, particularly, **the 3E's deteriorated substantially**.
3. **"S"** has been **fundamentally revised and improved** from the viewpoint of the regulatory scheme. The future **challenges** include the **spread of the tolerable risk theory among citizens**, in addition to **safety culture** for enterprise efforts.
4. **Renewable energy still features high costs** in Japan. Backup power source costs will expand to stabilize power supply.
5. **Germany** that is said to be able to phase out nuclear power plants has **geographical and natural condition advantages**.
6. For its sustainable development, **Japan** has no choice but to use **multiple energy sources, including imperfect nuclear energy, in a balanced manner** under the principle of **the "3E's + S."**

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