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Impact of March 11 and Fukushima Incident on Energy Development in Japan and the World

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Outline

1. Energy issues after Great East Japan Earthquake and Fukushima Nuclear Incident
 - Temporary shortage of fossil fuel and resolution
 - Shortage of electricity supply and the effort of electricity saving (summer 2011)
 - Power generation mix and fossil fuel consumption

2. Impact of Fukushima Incident on Energy Development in Japan
 - review and restructure Basic Energy Plan

3. Impact of Fukushima Incident on Global Energy Development
 - Low Nuclear Scenario

1. Energy issues after Great East Japan Earthquake and Fukushima Nuclear Incident

Fuel Shortage after March 11 and Resolution

【Oil】

- Localized shortage of petroleum products supply
 - Shut down of crude oil processing facilities (1400kB/D, 31% of Japan Total)
 - Damage to transport routes, storage facilities, gas stations
- Supply strengthen and shortage dissolution
 - Temporary reduction of compulsory oil stock piling quota (70days→67days→45days)
 - Recovery of crude oil processing facilities, improvement in operating ratio
 - Restrain export, Increase import, grant aid from China(20kt oil)...
 - Recovery of Transport routes and Supply systems

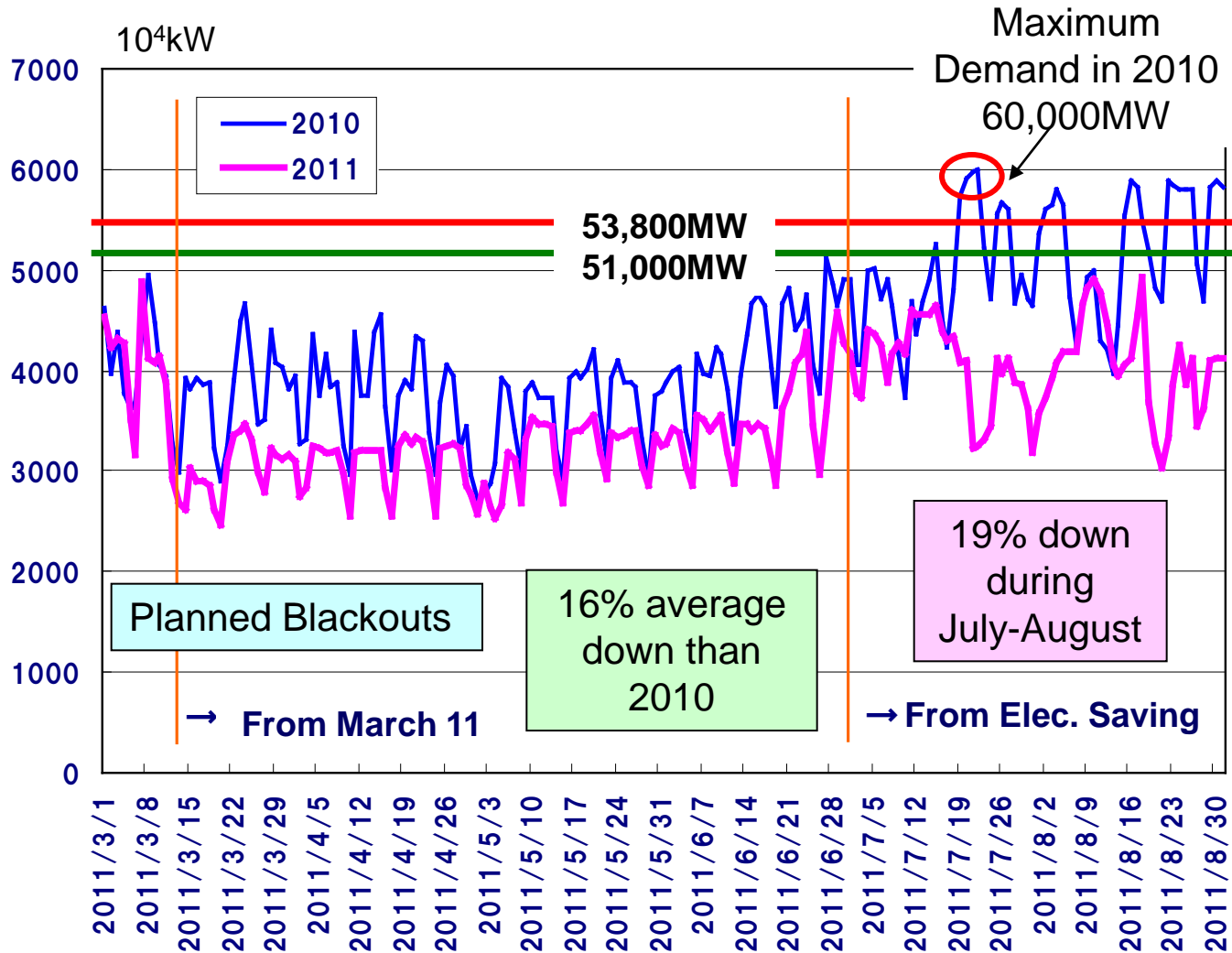
【Gas】

- Town gas supply stopped in devastated areas
 - Town gas supply for 460,000 users stopped
 - Shut down of LNG receiving terminal
- Recovery of Town gas supply
 - Additional LNG procurement, additional supply from producers: Qatar, Russia...
 - Recovery of gas supply systems (99% at the end of April)

Meanwhile, demand of LNG and oil for power generation rose, due to shut down of nuclear and coal-fired thermal power plants

Shortage of power supply after March 11

◆ Power demand at 14:00 (TEPCO's service area)



Target 15% cut

Maximum Demand in 2010: 60,000MW

Prospect of Supply Capability: 53,800MW

Necessary reduction ratio of Demand:

10.3%

Source) Made by IEEJ with Tokyo Electric Power Company (TEPCO) briefing paper data

Summer Electricity Saving Effort by Sector

Achievements by different sectors:

- Households: almost achieved the target, partly because of less hot summer
- Small customers: higher than target, potential for power saving like to reduce lamp
- Large customers: higher than target, effect of restriction of electricity use by law (300 law violator within 19,000 Large customers)

◆ Power demand compared to 2010 (TEPCO's service area)

kW	TEPCO※1	National Policy Unit※2
Households	▲6%	▲11%
Small customers	▲19%	▲19%
Large customers	▲29%	▲27%
Total	▲18%	▲19%

Source) TEPCO. National Policy Unit. Partly estimated by IEEJ

※1: Comparison between 2010/7/23 and 2011/8/18

※2: Comparison between elected days, in which the temperature is comparable.9:00-20:00

◆ Electricity volume compared to 2010(TEPCO)

kWh	July-August
Households (lighting)	▲12.4%
Small customers	▲17.1%
Large customers	▲11.4%
Total	▲14.0%

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Power Supply Recovery & Thermal Power Increase

【Government's actions】

■ Various deregulations

- Exemption of Environmental Impact Assessment Act for thermal power plant expansion
- Approve the delay of periodic inspection of thermal power plants

■ Promotion of private and distributed electric power generation

- Encourage private generators to sell electricity, support for installation and fuel cost

【Electricity companies' actions】

■ Restore damaged thermal power plants

■ Restart long-idled thermal power plants

■ Install new emergency power generator (gas turbine etc.)

■ Increase power transfer among interconnected regions

Increase in gas and oil fired power

■ Nuclear plant: incident-affected, stop, delay of re-operation

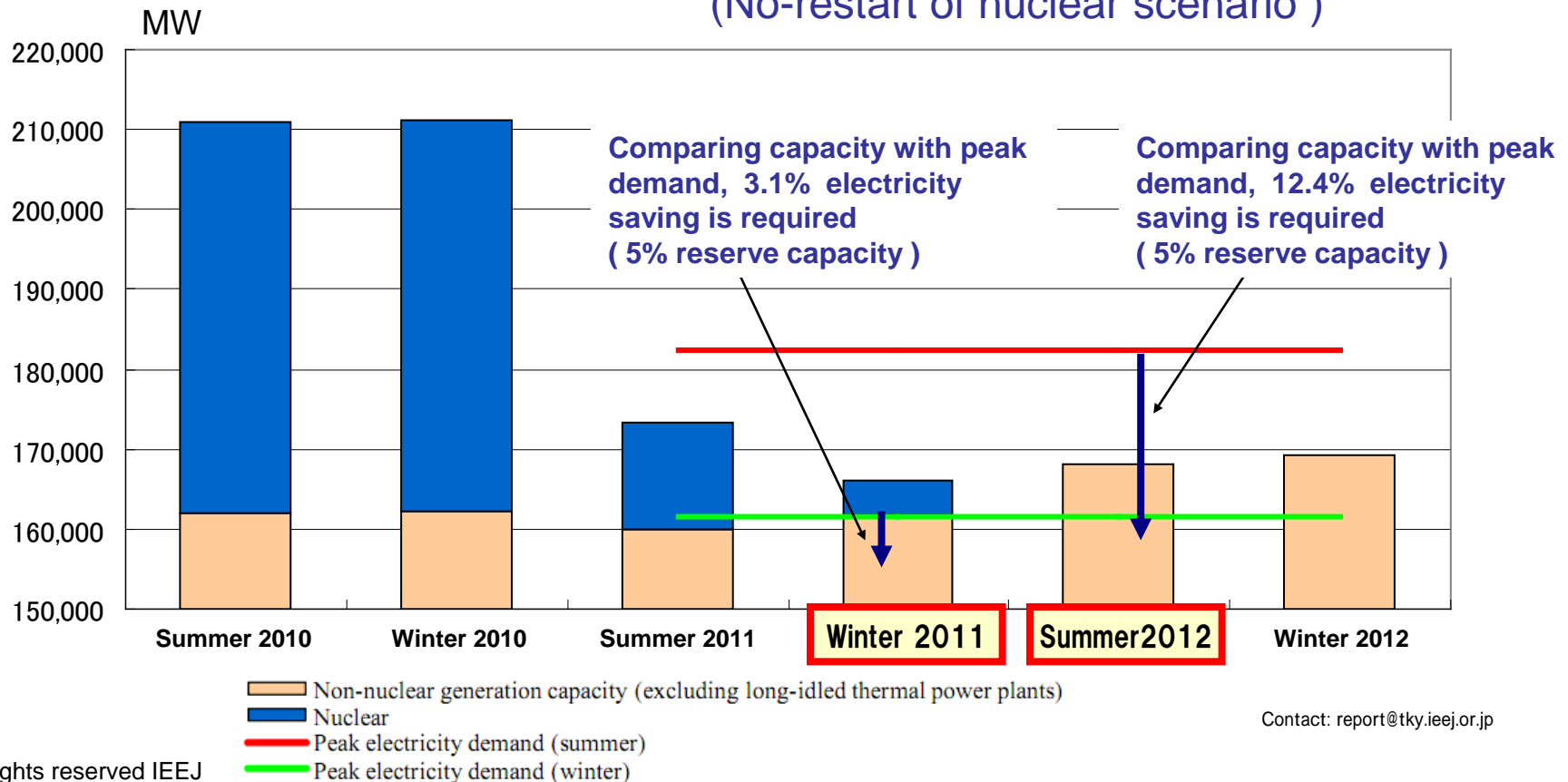
■ Coal fired plants stop due to disaster, Coal demand decrease in 2011

■ Increase in gas, oil fired power of electricity companies and private generators

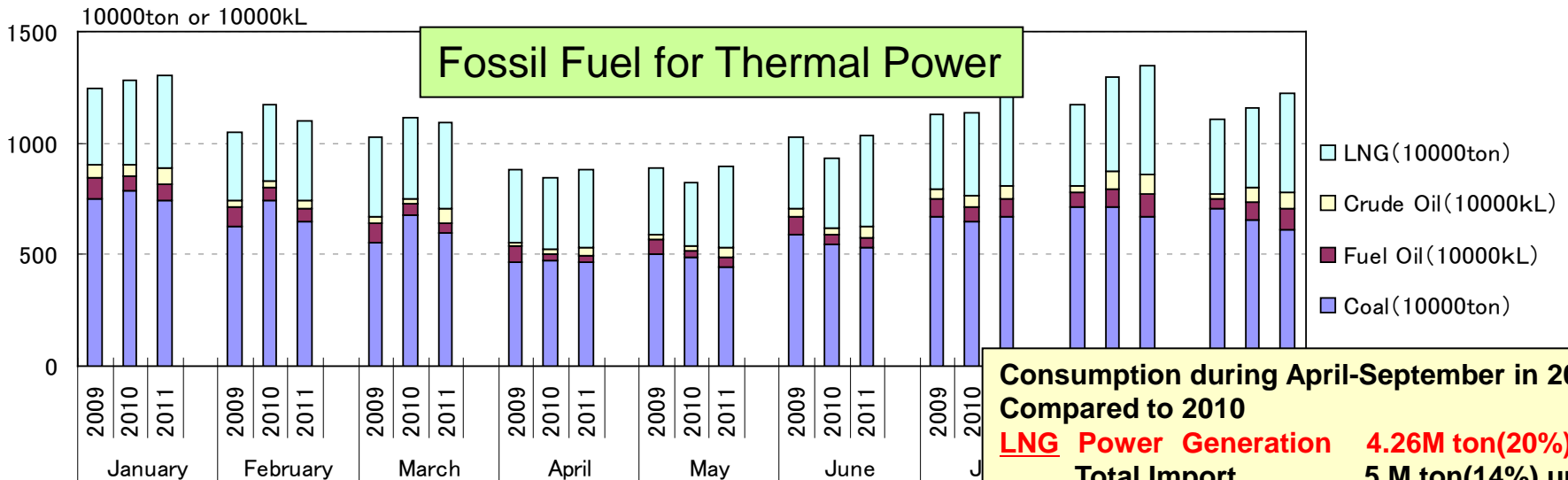
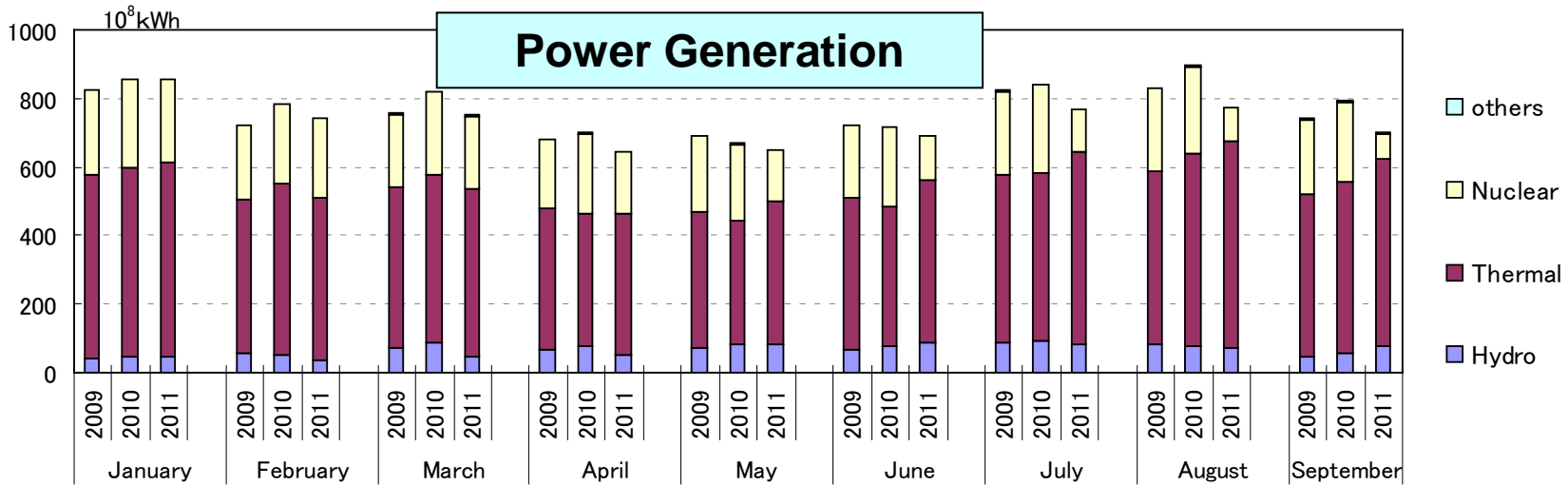
Power shortage is not over

- In case of no-restart of nuclear power plant, Japan may fall into electricity supply shortage in 2011 Winter and 2012 Summer.
- If reserve capacity(5%) is taken into consideration, 3.1% electricity saving is required in 2011 Winter, and 12.4% in 2012 Summer.

◆ Comparison of Japan's total power generation capacity and peak demand (No-restart of nuclear scenario)



Impact on Fossil Fuel for Power Generation



Consumption during April-September in 2011 Compared to 2010

LNG Power Generation	4.26M ton(20%) up
Total Import	5 M ton(14%) up
Oil Power Generation	1.57M kL(27%) up
Net Import	0.46M kL(0.5%) up

Source) Monthly Report on Electric Power Statistics

Note: Total of Electric Utilities

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Impact on price of electricity

【 No-restart of Nuclear Scenario】

Fossil fuel consumption for Power Generation in F.Y.2012 compared to F.Y.2010

Coal: 8.65 Million ton up

Oil: 28.13 Million kL up

LNG: 19.46 Million ton up

More 3.6 Trillion Yen for Import

Note: According to IEEJ Short-term Outlook: in F.Y. 2012 GDP will be 2.8% up, Power demand will be 4.0% up than 2011 (1.8% up than 2010)

- if all of the import cost increment is simply added to electricity price

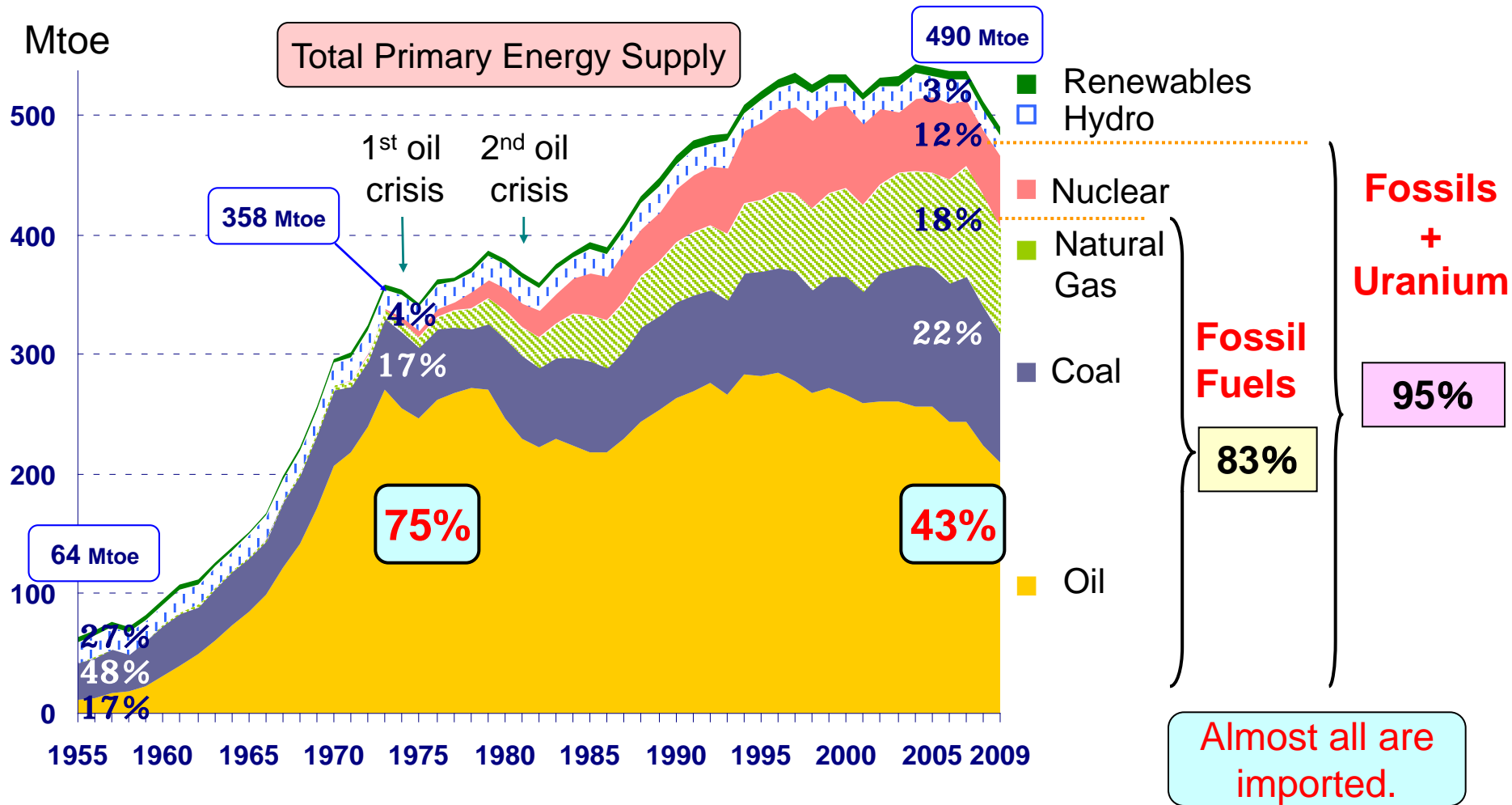
3.9 Yen/kWh price up

it is equal to 38% of Price for Industrial Power(Special High Voltage)

19% of Price for Household Lighting

2. Impact of Fukushima Incident on Energy Development in Japan

Japan's Energy Mix

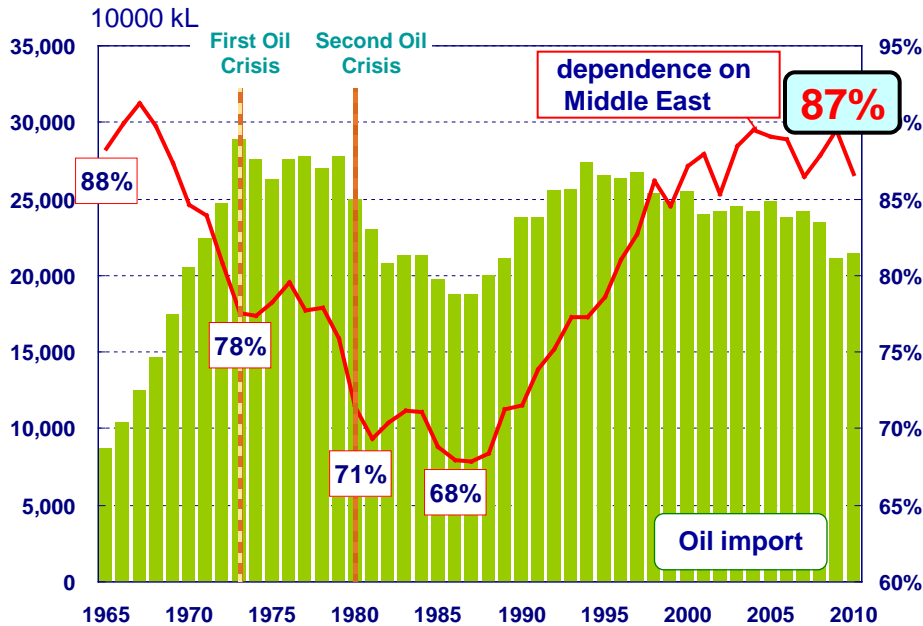


Japan has promoted energy diversity since the oil crises.
But the dependency on both fossil fuel and import energy is still high.

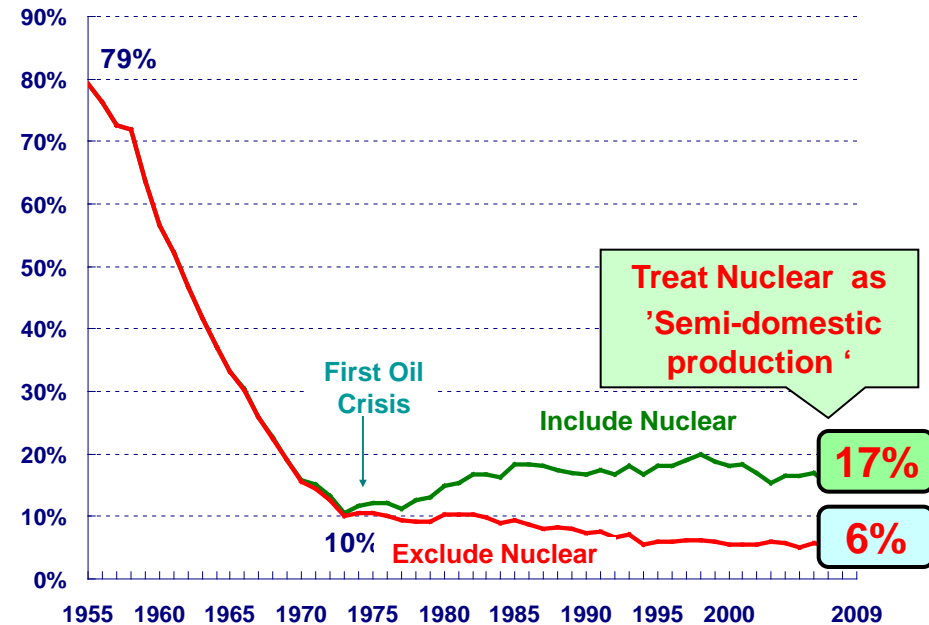
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Insufficient energy security

High dependence on Middle East oil

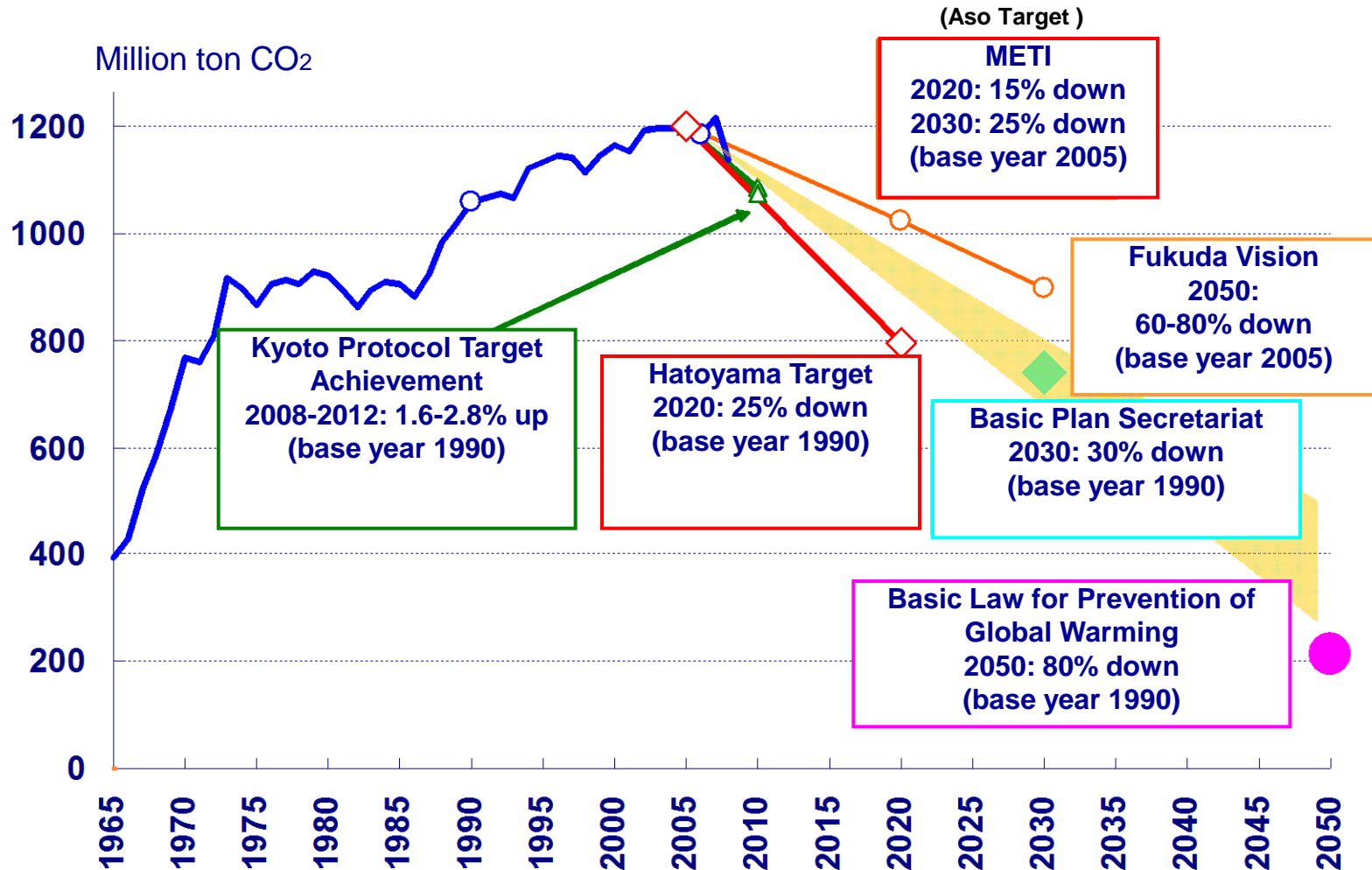


Low energy self-sufficiency



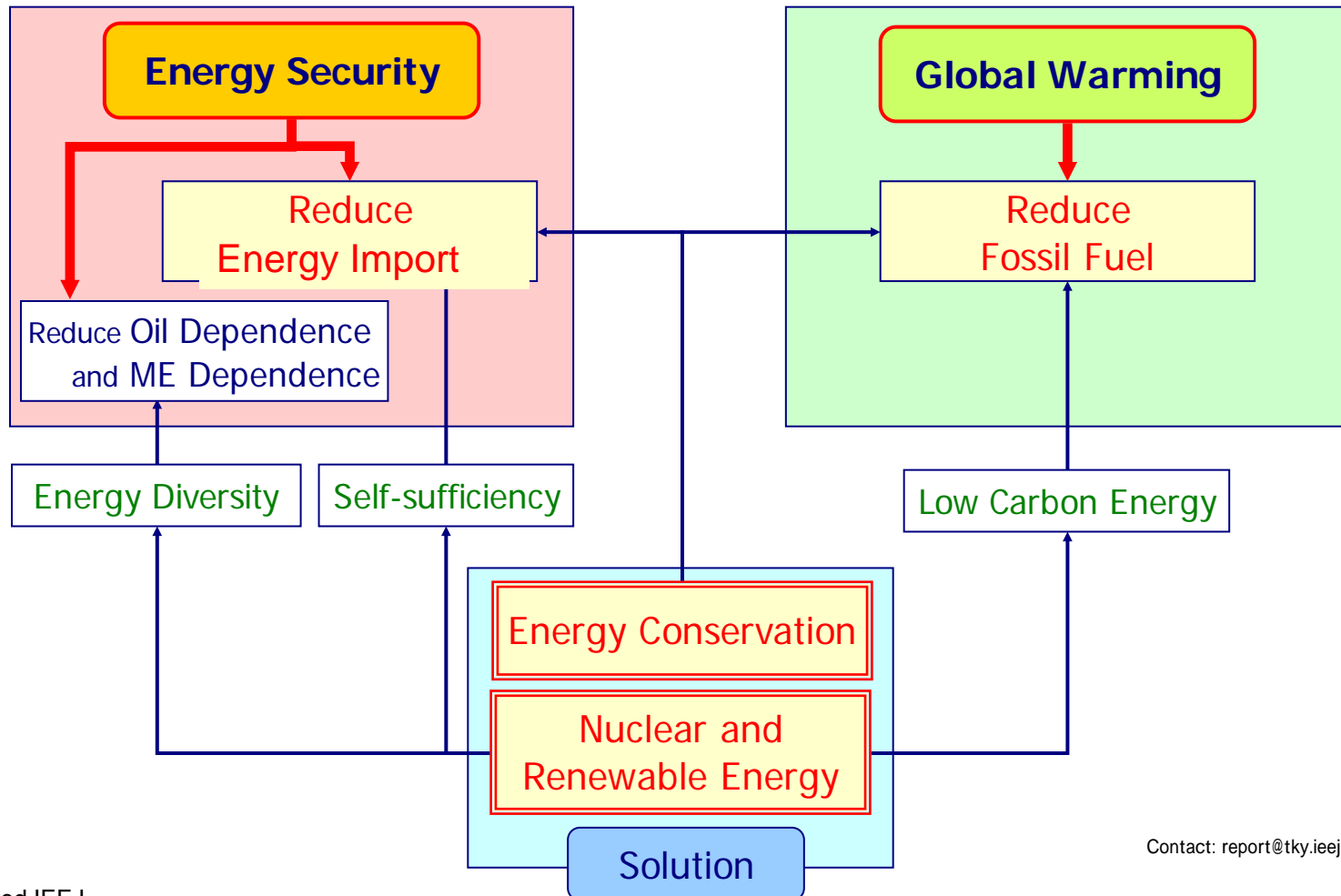
Recently Middle East dependence of crude oil is about 90%, higher than the oil crises period. If excluding nuclear, energy self-sufficiency will be only 6%, and it will rise to 17% when taking nuclear as 'semi-domestic production'.

CO₂ Emission Reduction Targets of Japan



Targets of Japan's Energy Strategy

The main target is to **secure the energy supply** and **mitigate GHGs**. The two targets can be met at the same time by **promoting energy conservation** and **using low carbon energies**.



Basic Act on Energy Policy and Basic Energy Plan

Basic Act on Energy Policy

(enacted in June 2002)

【Fundamental Principles】

- ① Securing of a stable supply
- ② Environmental suitability
- ③ Utilization of market mechanisms

The government must formulate a basic plan on energy supply and demand in order to promote measures on energy supply and demand on a **long-term, comprehensive and systematic** basis.

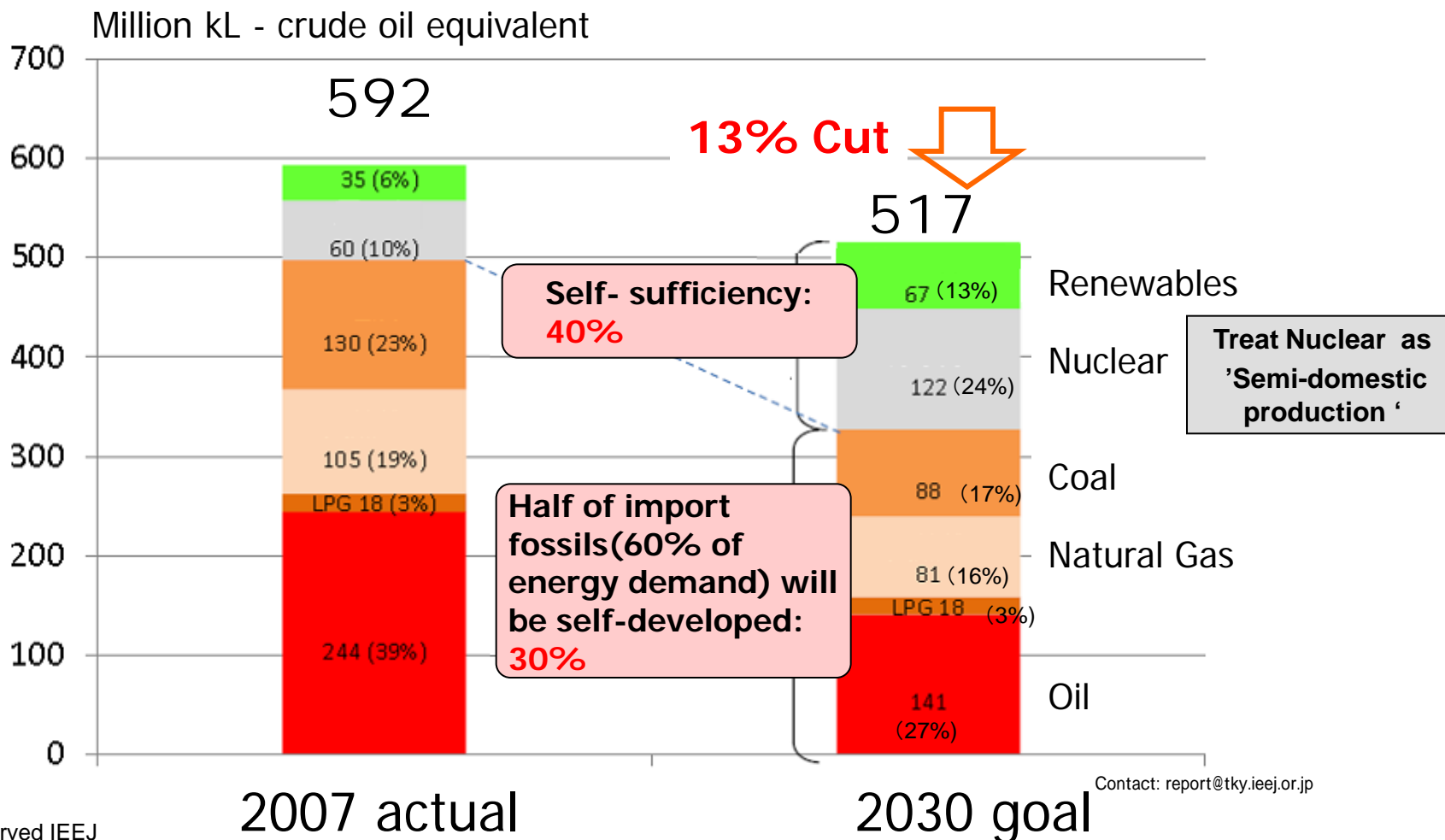
Basic Energy Plan

(Formulation October 2003,
Revision: March 2007
June 2010)

- Energy security
- Environmental protection
- Efficient supply
- Energy-based economic growth
- Reform of the energy industrial structure

【Basic Energy Plan】Energy Mix

- Raise Energy Independence Ratio** (Self-sufficiency + Self-development rate) from 38%(2007) to 70% (2030)
- Reduce CO₂ Emission** by 30% vs. 1990 level

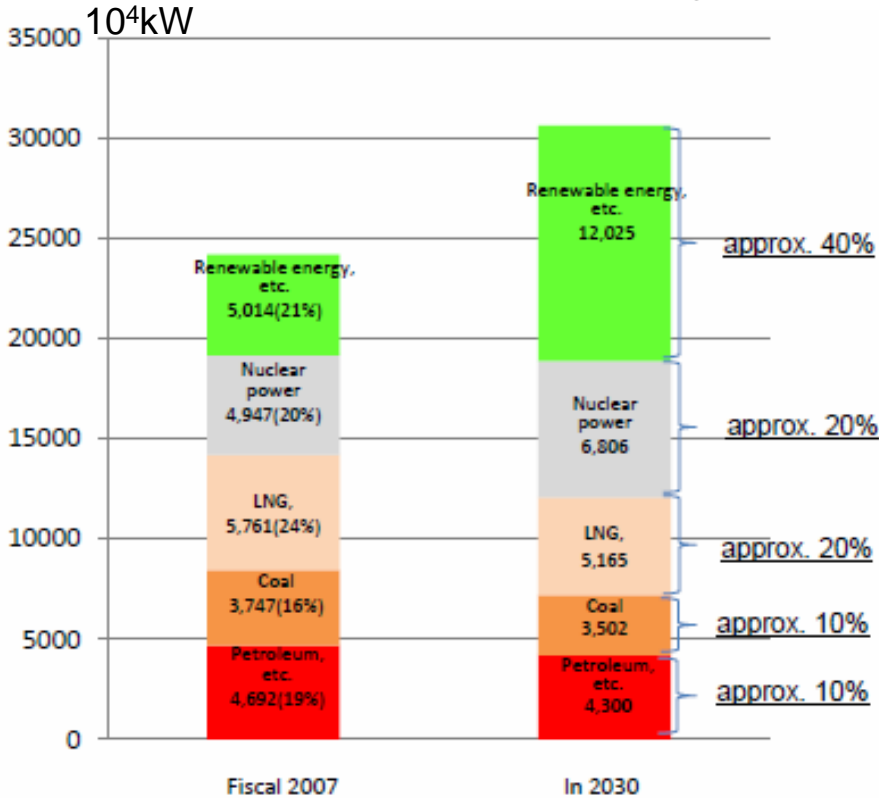


【Basic Energy Plan】 Generation Mix

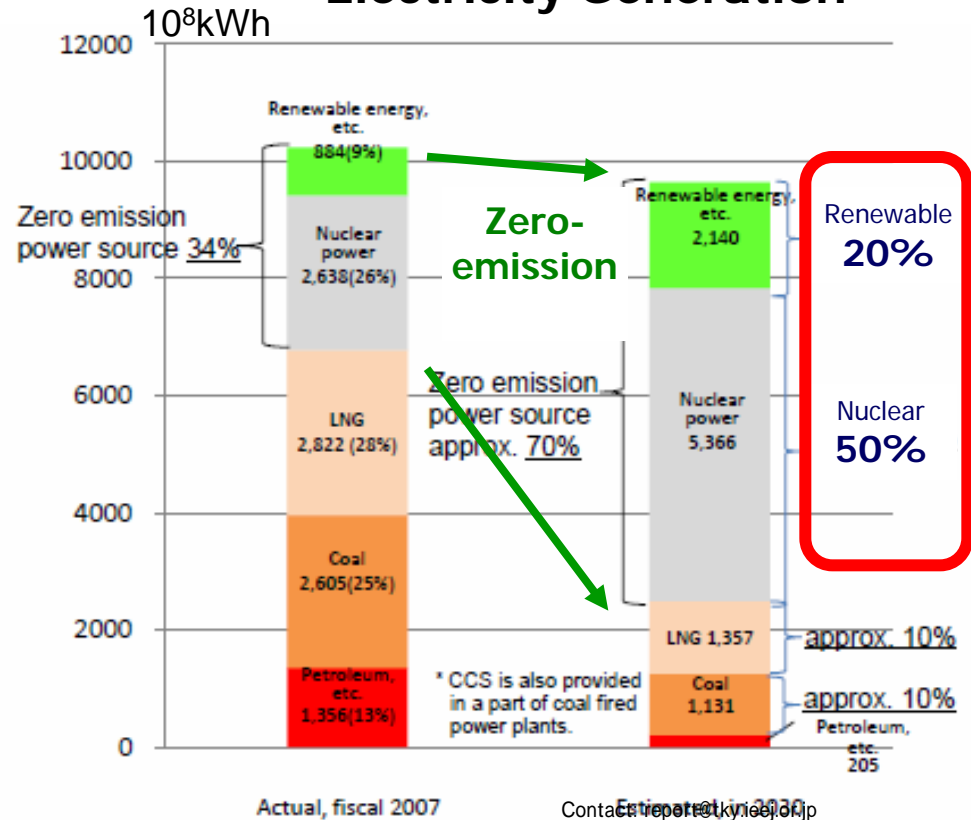


- **Build 14 new nuclear reactors** and raise utility factor from 60% to 90%
- **Introduce 2.4 times as much renewable** (15 times for non-hydro renewables)
- **Increase zero-emission electricity share** from 34% to 70%

Generation Capacity

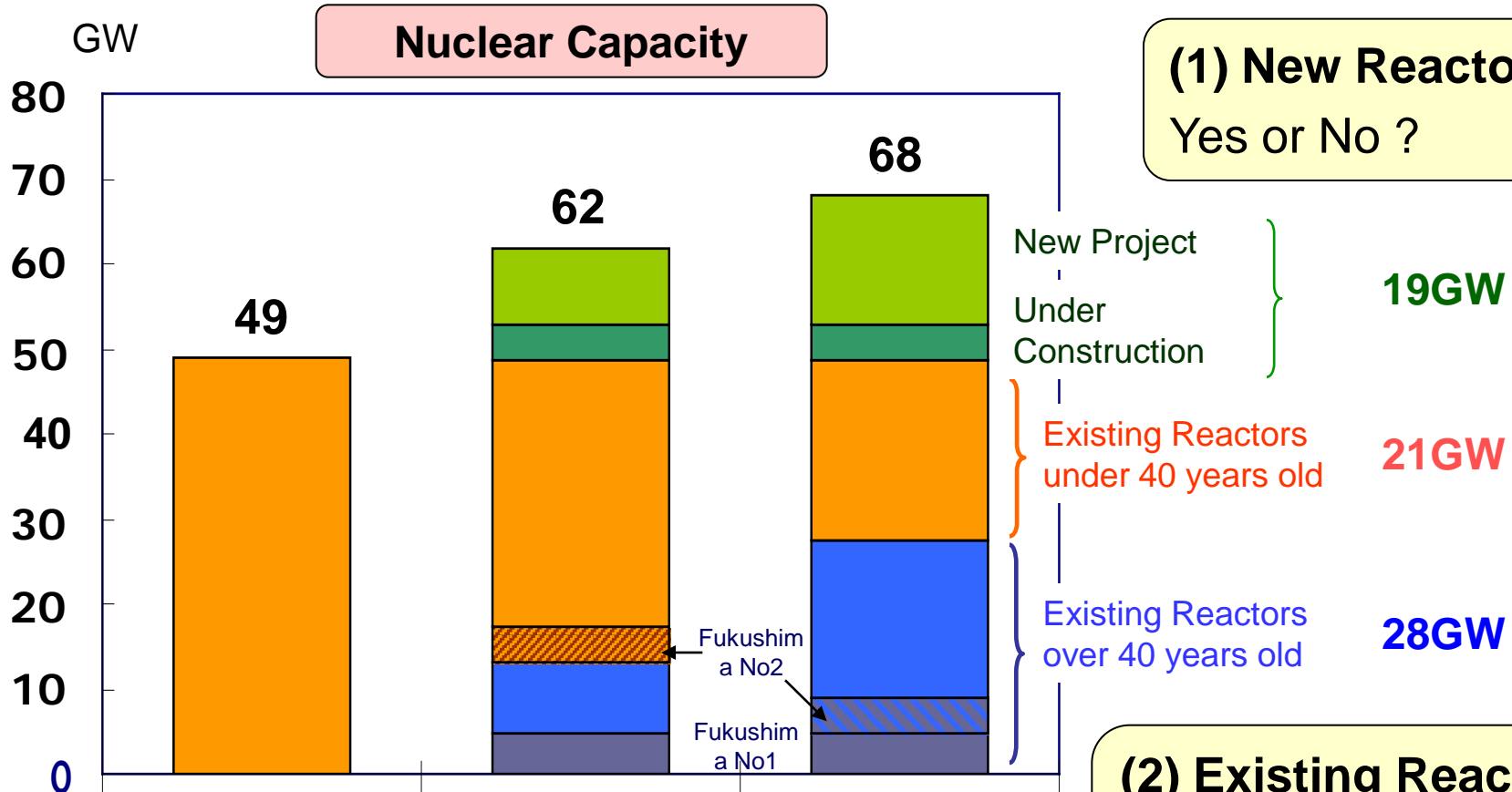


Electricity Generation



Contact: energy@ieej.jp

Where is Nuclear Policy heading?



(1) New Reactors
Yes or No ?

(2) Existing Reactors
Decommission or Prolong ?

30% of Electricity demand

50%

Required Capacity to Replace one Nuclear Reactor(1GW)

To substitute one Nuclear reactor(1GW), 7GW of Solar power or 4GW of Wind power is required due to low utility factor.

	Capacity (10 ⁴ kW)	Utility Factor (%)	Lot Area (km ²)
Nuclear	100	80	
PV	667	12	60
Wind (On-Shore)	400	20	200
Wind (Off-Shore)	267	30	
Small hydro	100	80	
Geothermal	114	70	

CO₂ emission

Oil fired	267	30	476Mton
LNG fired	133	60	297Mton
Coal fired	114	70	571Mton

Comparison of Space Requirement, etc.

		Energy Security	Economic Efficiency	Eco-Friendly	Supply Stability	Other problems
		Self-Sufficiency	Generation Cost (JY/kWh)	CO ₂ emission (gCO ₂ /kWh)	Utility Factor	
Thermal	Oil	0.4%	10.0-17.3	679	30-80%	-
	Coal	0%	5.0-6.5	815	70-80%	-
	LNG	4%	5.8-7.1	423	60-80%	-
Nuclear		0~100%	4.8-6.2	0	70%	Radioactivity risk
Renewables	Hydro	100%	8.2-13.3	0	45%	Environmental destruction
	Solar	100%	37-46	0	12%	Right to sunshine
	Wind	100%	11-26	0	20%	Low-frequency vibration
	Geothermal	100%	12-24	0	70%	National park law

Options for Nuclear Alternative

① Thorough Energy Saving (Electricity Saving)

- Big cost-benefit
- Grant of economical incentives

② Promotion of Distributed Power

a) Renewable Energy

- Maximum installation while considering cost and external diseconomy
- Time-conscious target setting and support measures

b) Cogeneration, Fuel cell

- Advanced use (effective use of electricity and heat) of fossil fuel (Gas, Kerosene)
- Peak suppression and backup power (complement the instability of renewable energy)

③ Thermal power is indispensable

- Growing importance when consider stability of supply(Base-load, Peak-load)
- Cost and environment conscious thermal power mix

Power Mix Scenarios

breakdown of Power Generation in 2030

	Nuclear	Renewable	Energy Saving + Cogeneration ¹⁾	Zero emission ²⁾
Basic Plan	50%	20%	0% ³⁾	70%
Scenario 1	30%	25%	15%	70%
Scenario 2	25%	30%	15%	70%
Scenario 3	15%	30%	15%	60%
Scenario 4	0%	40%	15%	55%

1) For the purpose of simpler comparison with Basic Plan, here the influence of energy saving and cogeneration, which should be deducted from denominator, is added to numerator.

2) Energy saving contributes 12.5% and cogeneration contributes 2.5%.

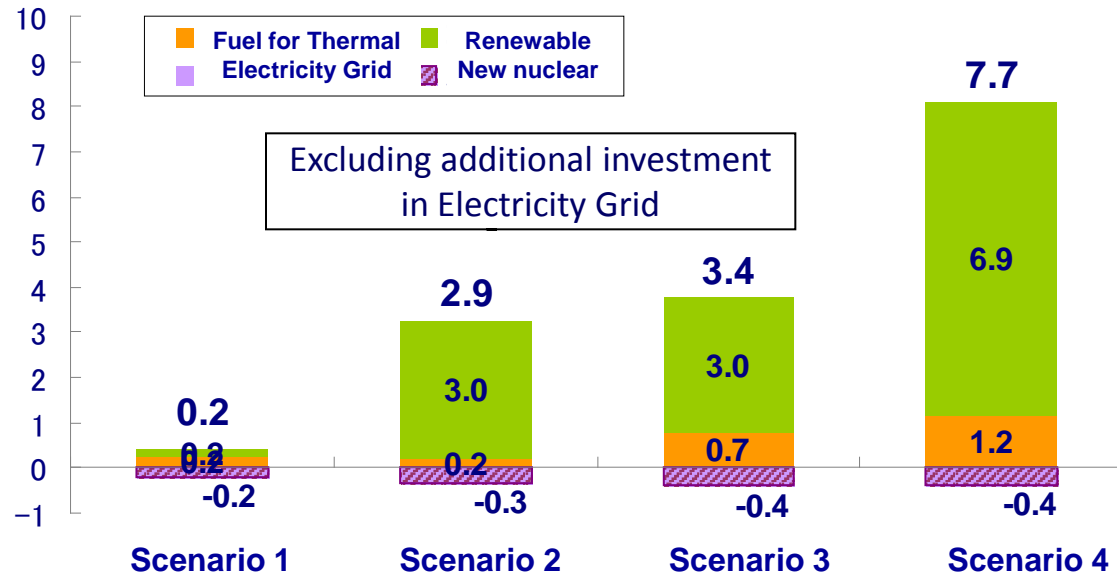
3) 30% of increment of electricity demand is cut by improvement of efficiency.

Cost and CO₂ Emission in each Scenario



Increment of Cost (in 2030, Compare with Basic Plan)

Trillion Yen



Economic efficiency

- Increment of power cost
- Increment of electric bill of standard household
- Appreciation rate of power price for Industries

Environment

- CO₂ emission up from 1990

Energy security

- Self-sufficiency ratio of Power

	Scenario 1	Scenario 2	Scenario 3	Scenario 4	
Increment of power cost	0.2	2.8	3.3	7.6	Yen/kWh
Increment of electric bill of standard household	(65 Yen) 1%	(852 Yen) 13%	(997 Yen) 15%	(2269Yen) 35%	Yen/Month,%
Appreciation rate of power price for Industries	2%	28%	33%	74%	
CO ₂ emission up from 1990	-28%	-28%	-23%	-20%	
Self-sufficiency ratio of Power	70%	70%	62%	55%	

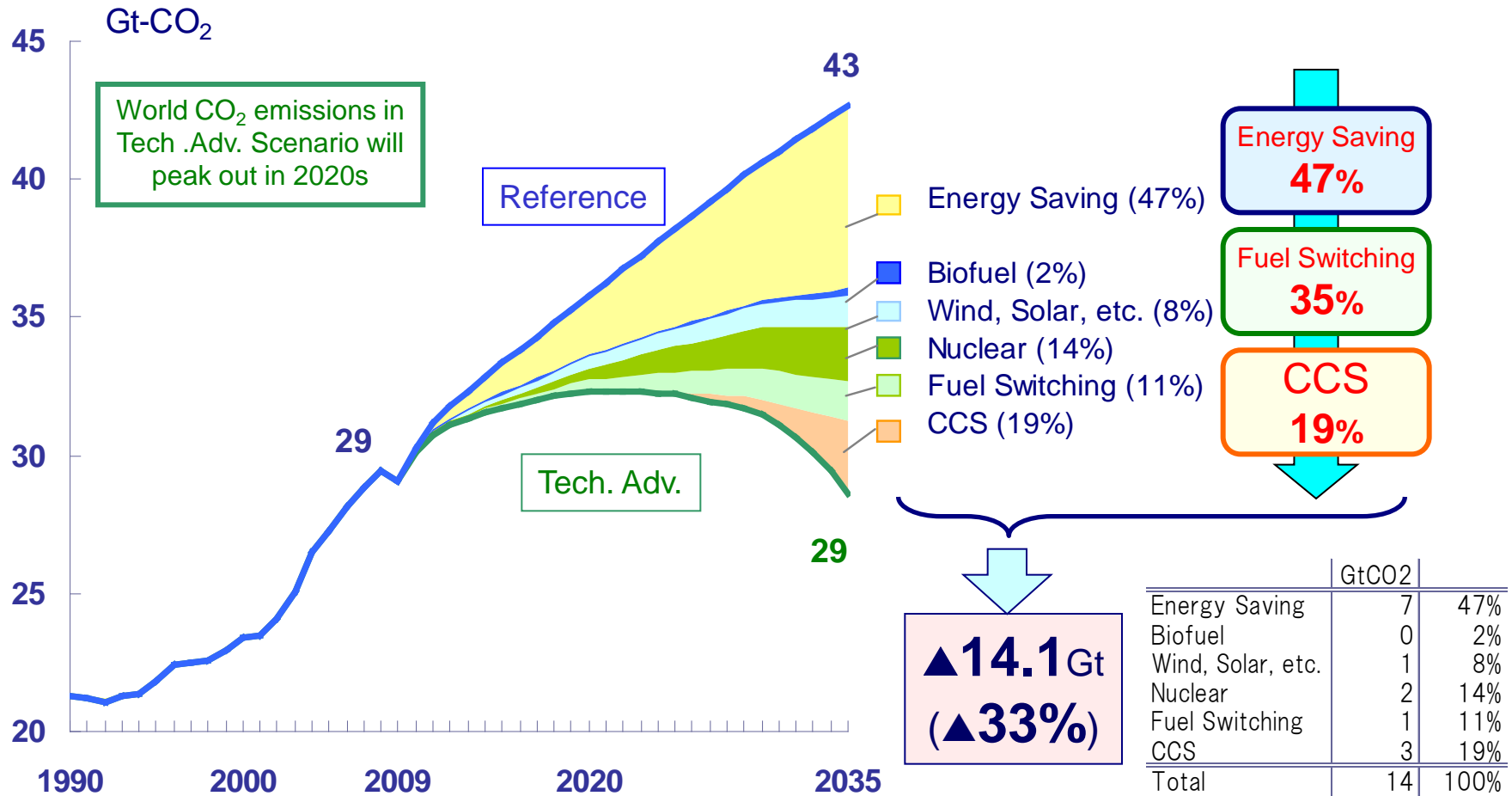
Evaluation of Power Mix Scenarios

- It is important to evaluate each scenario objectively and quantitatively from the aspects of cost, environment, and security

	Cost	CO ₂	Security (self-sufficiency ratio)	Feasibility
Scenario 1	○	○	○	△△
Scenario 2	△	○	○	△
Scenario 3	△ △	△	△	△ △ △
Scenario 4	△ △ △	△ △	△ △	△ △ △ △

3. Impact of Fukushima Incident on Global Energy Development

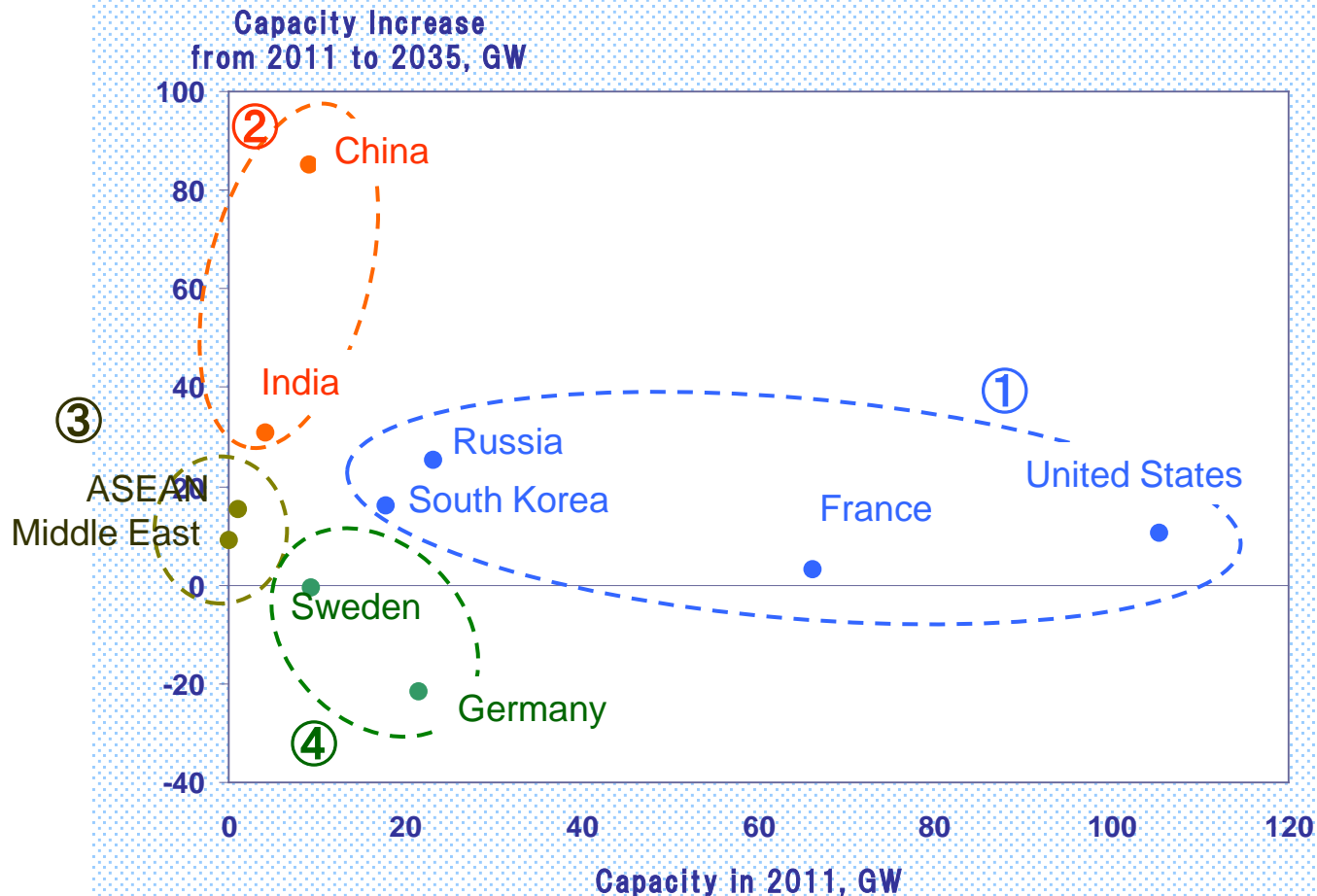
CO₂ Emissions Reduction by Nuclear



■ In the Tech. Adv. Scenario, between 2005 and 2020 the world CO₂ emissions will increase by 5.1 Gt-CO₂ (or 19% up from the 2005 level), while the CO₂ emissions will reach its peak during 2020s with the introduction of advanced energy and environmental technologies.

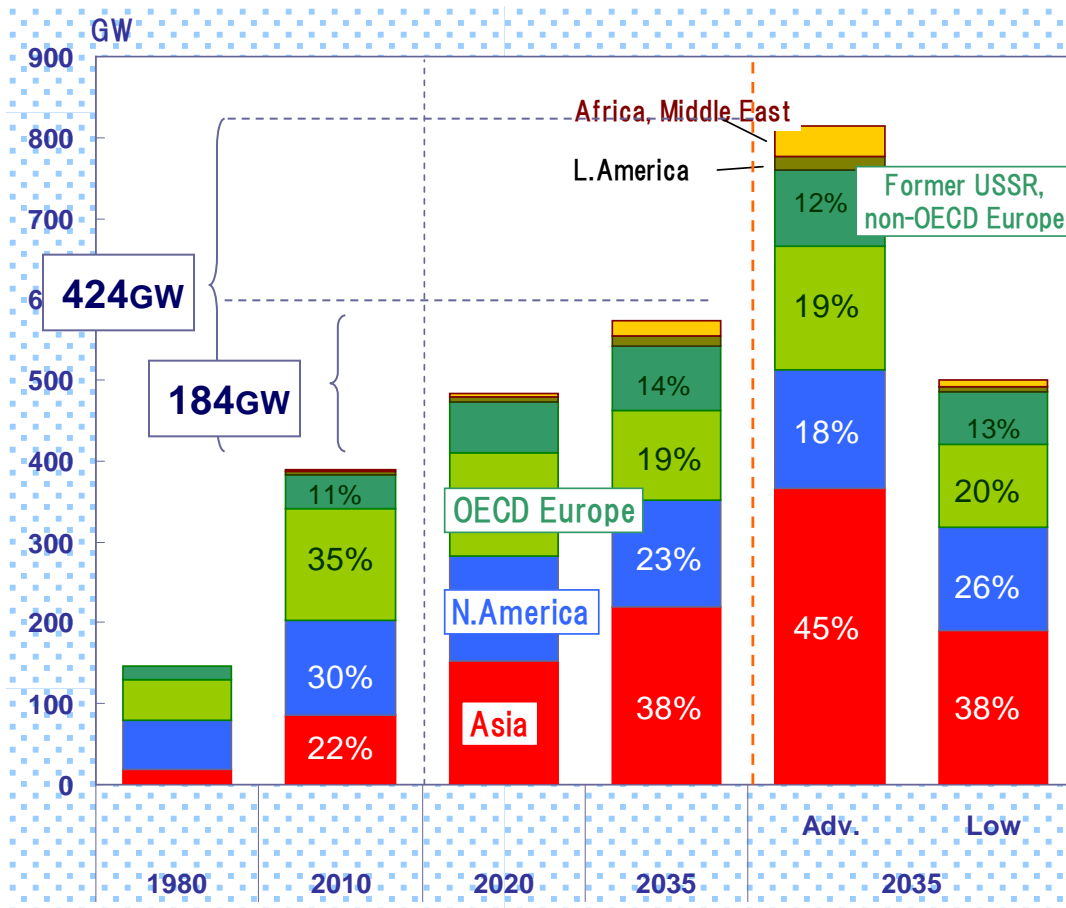
■ Various technological options, including energy saving, enhancement of power generation efficiency, renewables, nuclear, and CCS altogether contribute to massive CO₂ emissions reduction.

Nuclear Policies after Fukushima Incident



- ① Nuclear Promoting Countries (US, France, etc.) : Continue to make the best use of nuclear power.
- ② Emerging Countries (China and India) : No change of massive construction plans
- ③ Newcomer Countries (ASEAN and Middle East) : Reevaluate the construction plans in some countries
- ④ Phasing-out Countries (Germany, etc.) : Stop nuclear power after some decades of operation.

World Nuclear Power Capacity (1)



World

2010
392GW

↓

2035

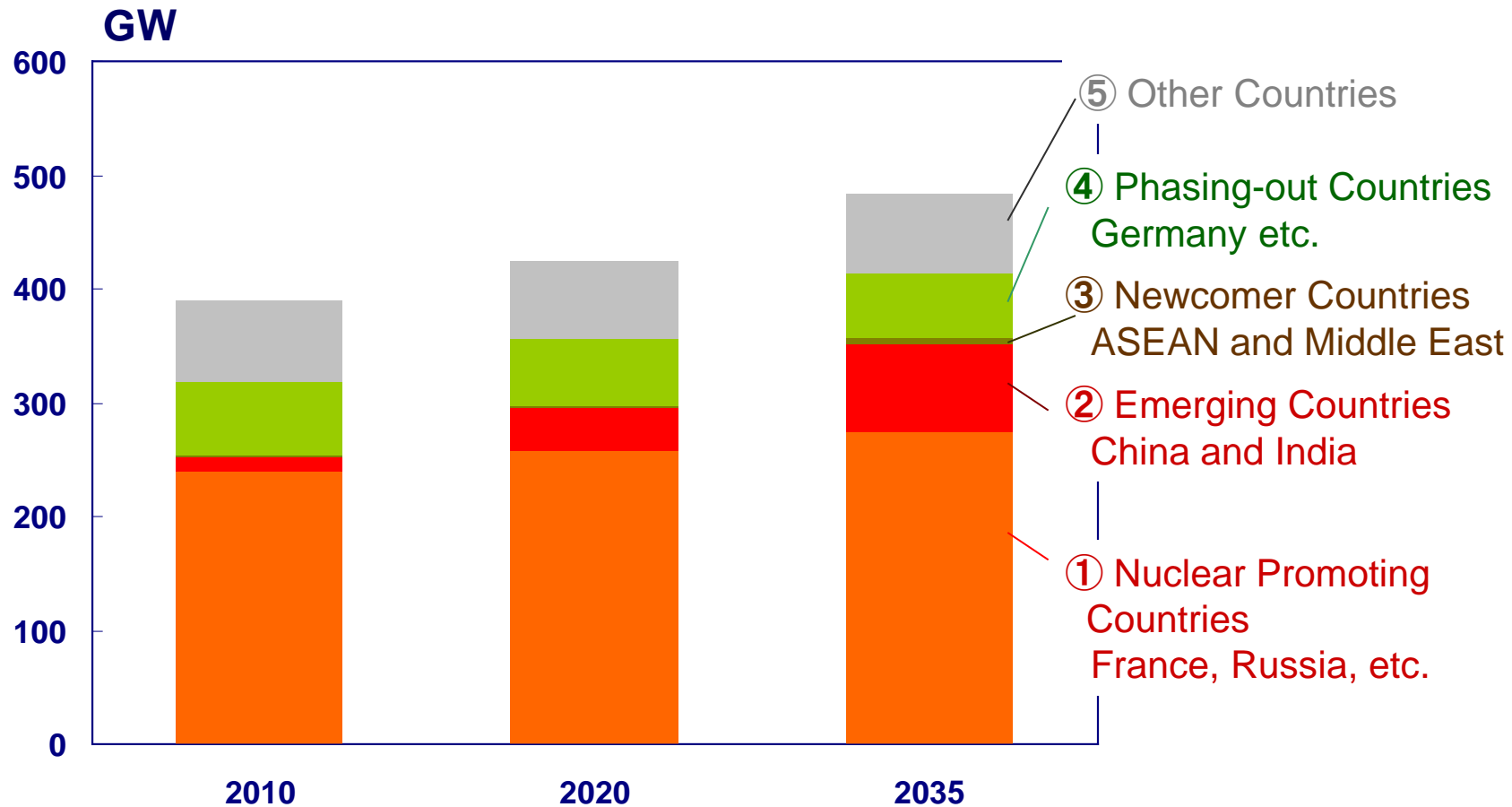
Reference
574GW
(182GW increase)

Advanced
814GW
(422GW increase)

Low nuclear
500GW
(110GW increase)

- Nuclear capacity is projected to grow from 392 GW in 2010 to 574 GW in 2035 (182 GW increments). The largest increase in the nuclear capacity is expected in Asia (135 GW increments).
- Further increase in nuclear capacity is expected in the Adv. Tech. Scenario, reaching 814 GW in 2035.
- In the low nuclear scenario, the capacity will increase in Asia and decrease in Europe, reaching 500GW in 2035 in total.

World Nuclear Power Capacity (2)



■ More than 60% of the world's total nuclear capacity is located to the nuclear promoting countries and emerging countries, where the capacity will grow towards 2035.

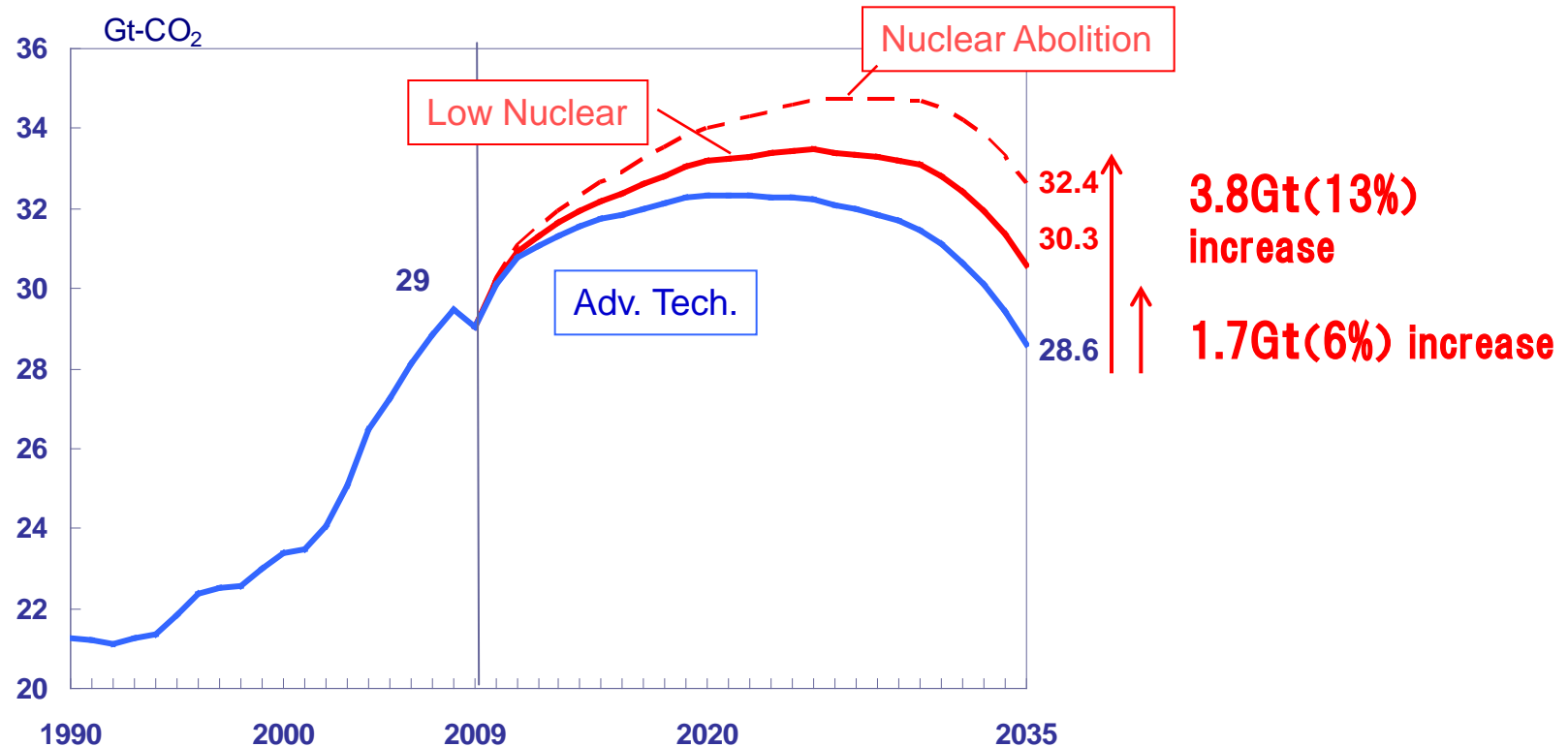
Nuclear Power Capacity in Asia

(GW)

	2010	2020			2035		
		Ref.	Adv.	Low	Ref.	Adv.	Low
China	9	60	70	60	104	158	104
Taiwan	5	8	8	5	6	8	4
S. Korea	18	24	32	24	34	48	34
ASEAN	0	0	0	0	9	26	3
India	4	18	26	18	35	72	35
Asia	85	153	179	139	220	366	190

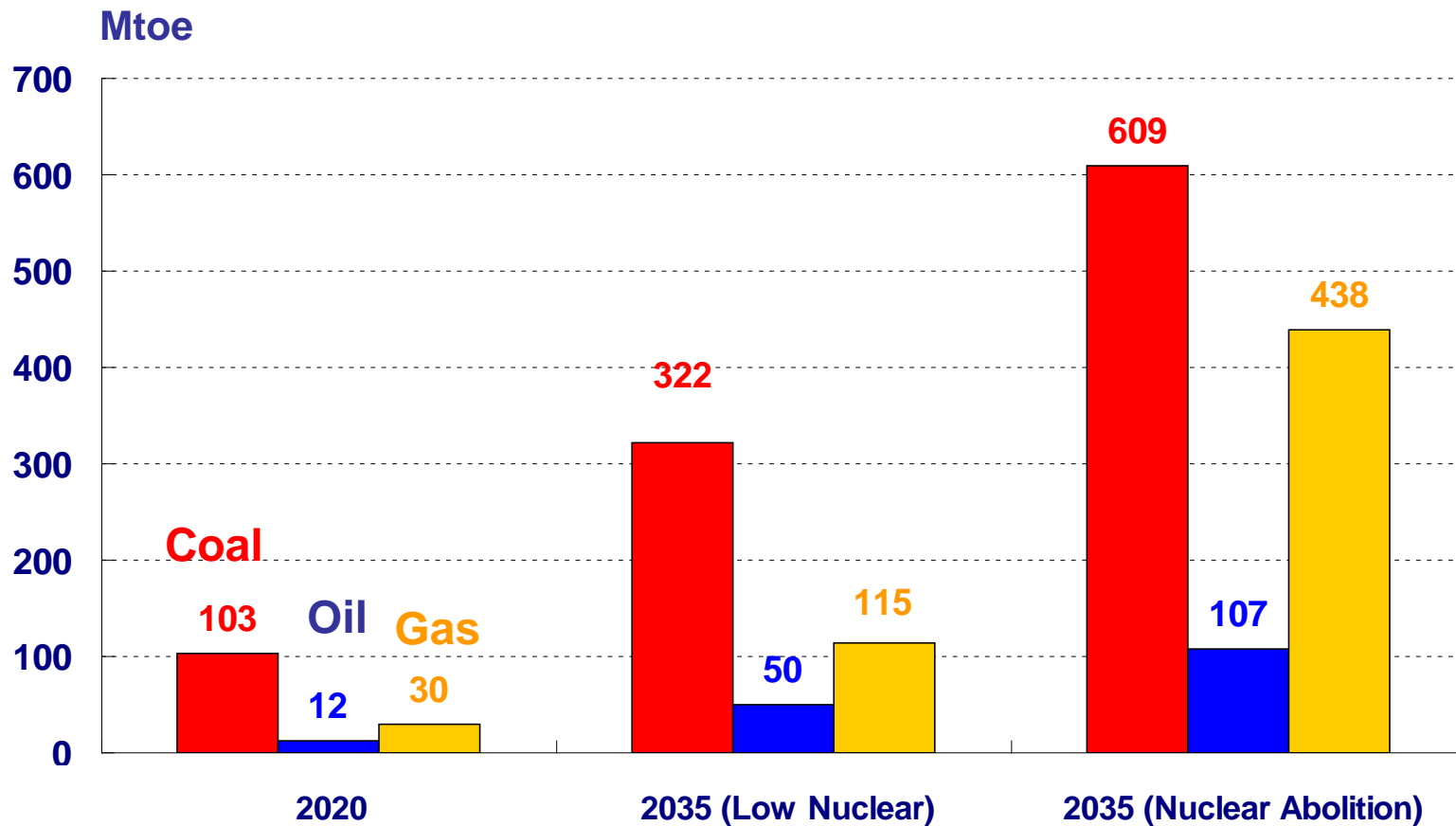
- In the Adv. Tech. Scenario, nuclear power capacity in China will expand to 70 GW in 2020 - the largest in Asia.
- Nuclear power capacity in India will increase using the overseas light-water nuclear reactor technologies in addition to domestically developed thorium fuel cycle.
- Even in the low nuclear scenario, Asia's nuclear capacity will grow due to massive construction in China and India.

Impact to CO₂ Emissions



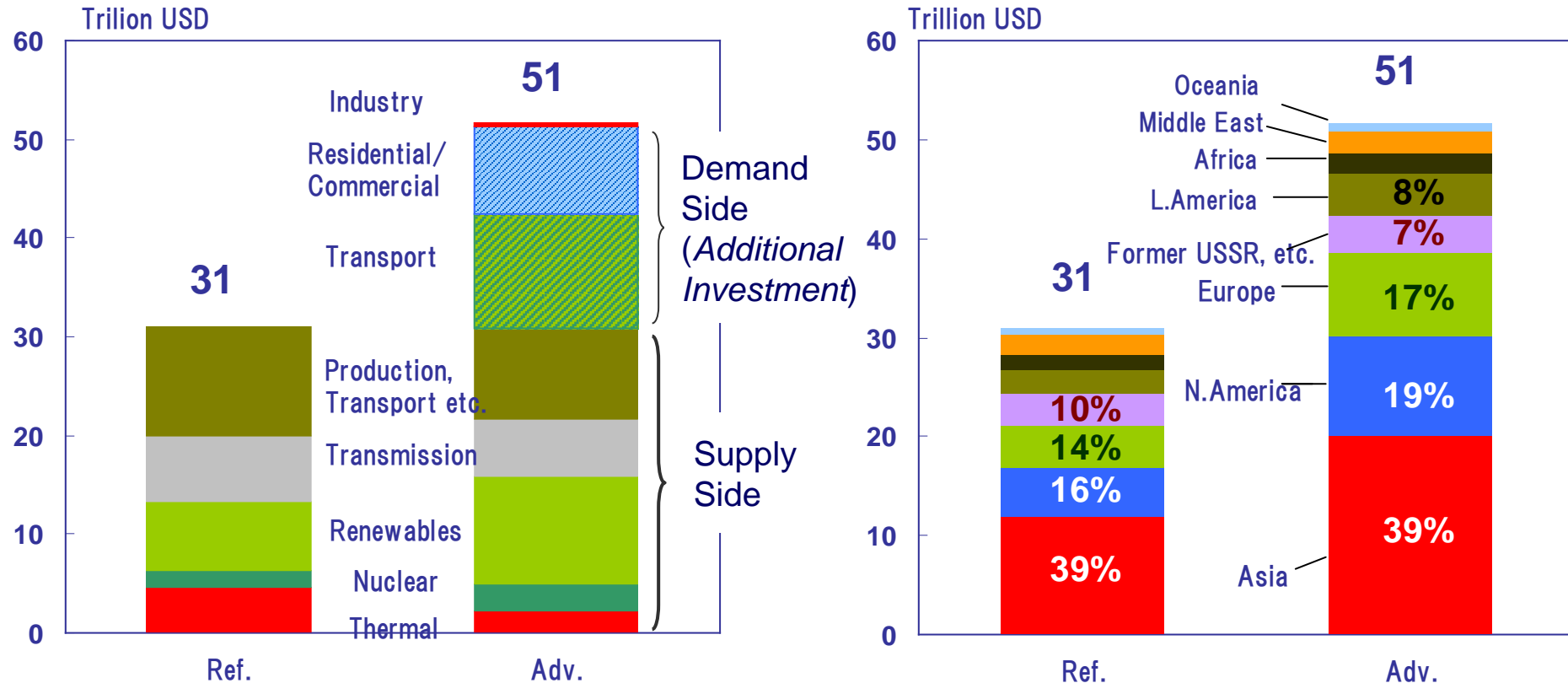
- In the low nuclear scenario, CO₂ emission in 2035 will increase by 1.7Gt or 6% if nuclear is replaced by fossil fuel-fired power generation.
- If nuclear power is completely shut-down by 2035, CO₂ emissions will increase by 3.8Gt or 13% in 2035.

Effects on Fossil Fuel Consumption



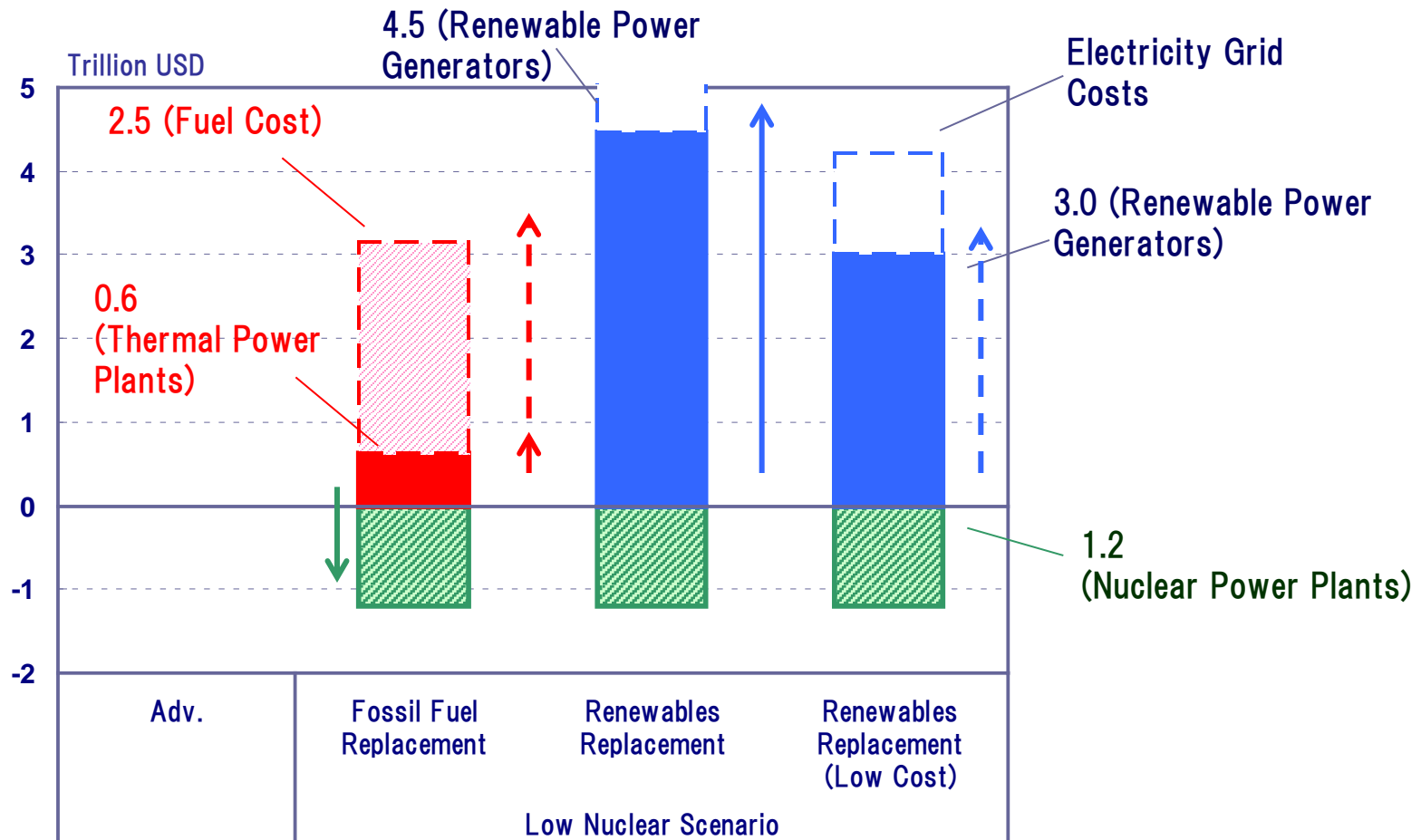
- In the low nuclear scenario, world coal and natural gas consumption will increase by 0.46 billion tons (322 Mtoe) and 130 bcm (120 Mtoe). The natural gas demand increase is equivalent to about half of the world's LNG trade in 2010.

World Investment Requirements (2009-2035)



- To meet the world's energy demand growth in the Reference Scenario, about US\$ 31 trillion (between 2009 and 2035) is needed for the supply side.
- In the Adv. Tech. Scenario, investment of US\$ 20 trillion will additionally be needed to energy demand sectors for industry, residential/commercial, and transport.
- By region, Asia will account for the largest share in the world's energy investment requirements.

Increase in Cumulative Investment up to 2035 (Low Nuclear Scenario)



- In the low nuclear scenario, cumulative investment to power plants will decrease by US\$ 0.6 trillion (0.6 thermal power minus 1.2 nuclear), whereas fossil fuel cost will increase by US\$ 2.5 trillion.
- If nuclear will be replaced by renewable power generation, cumulative investment will increase by US\$ 1.8 to 3.3 trillion. In this case, additional investment to the electricity grid will be needed.

Thank you for your attention!