Energy Mix and Role of Technologies:
Japan's Lessons Learnt and its Implications

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Outline - Energy Mix & Role of Technologies

1. **Short term challenges after Great East Japan Earthquake**
   - **Temporary shortage of fossil fuel and resolution**
   - **Shortage of electricity supply and the effort of electricity saving (summer 2011 and 2012)**
   - **Power generation mix and fossil fuel consumption**

2. **Mid-long term challenges in Japan**
   - **review and restructure Basic Energy Plan**

3. **Role of Technologies in the World**
   - **Acceleration in investment and technology innovation**

Japan has Weakness in Energy Security

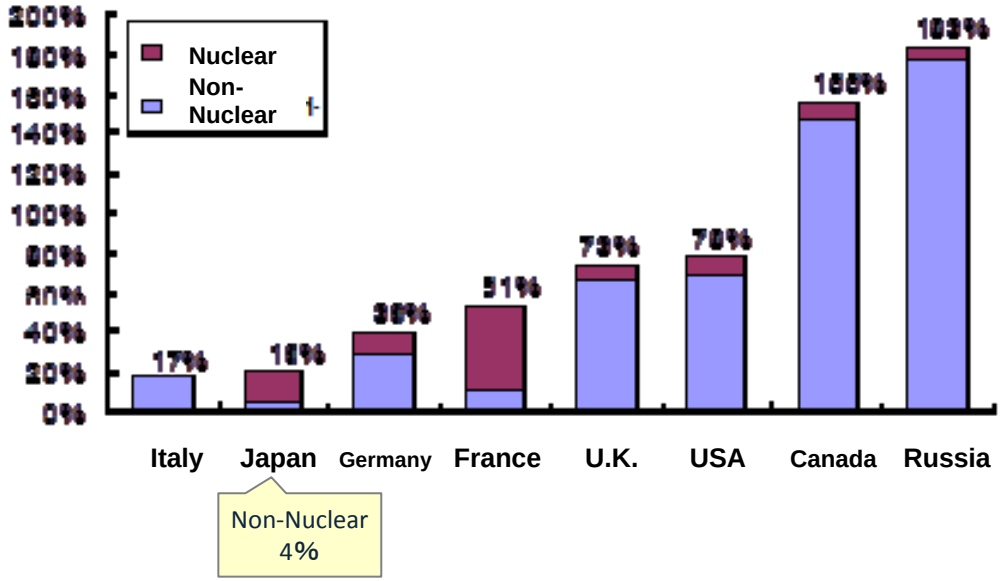
■**Energy Security** is

"To **secure sufficient** energy supply necessary for daily life and economic/ industrial activities at **reasonable prices**. "

■**Japan** is one of the countries which has **extremely weak energy security** in the world.

- **Energy self sufficiency** is **the lowest among G8 countries (4%)**

Major Countries' Energy Self-Sufficiency (2010)



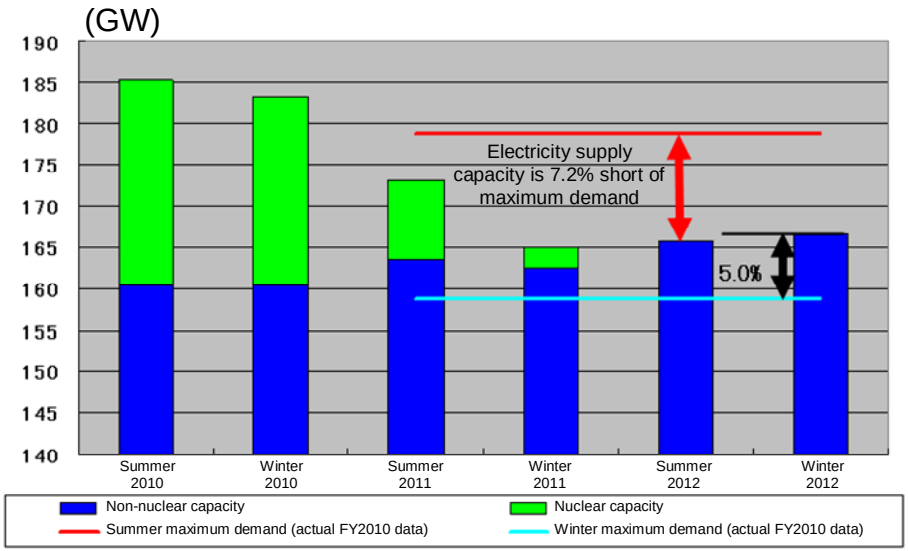
(Source) IEA

1. Short Term Challenges for Energy Policy in Japan

Power shortage is not over

◆Comparison of Japan's total power generation capacity and peak demand

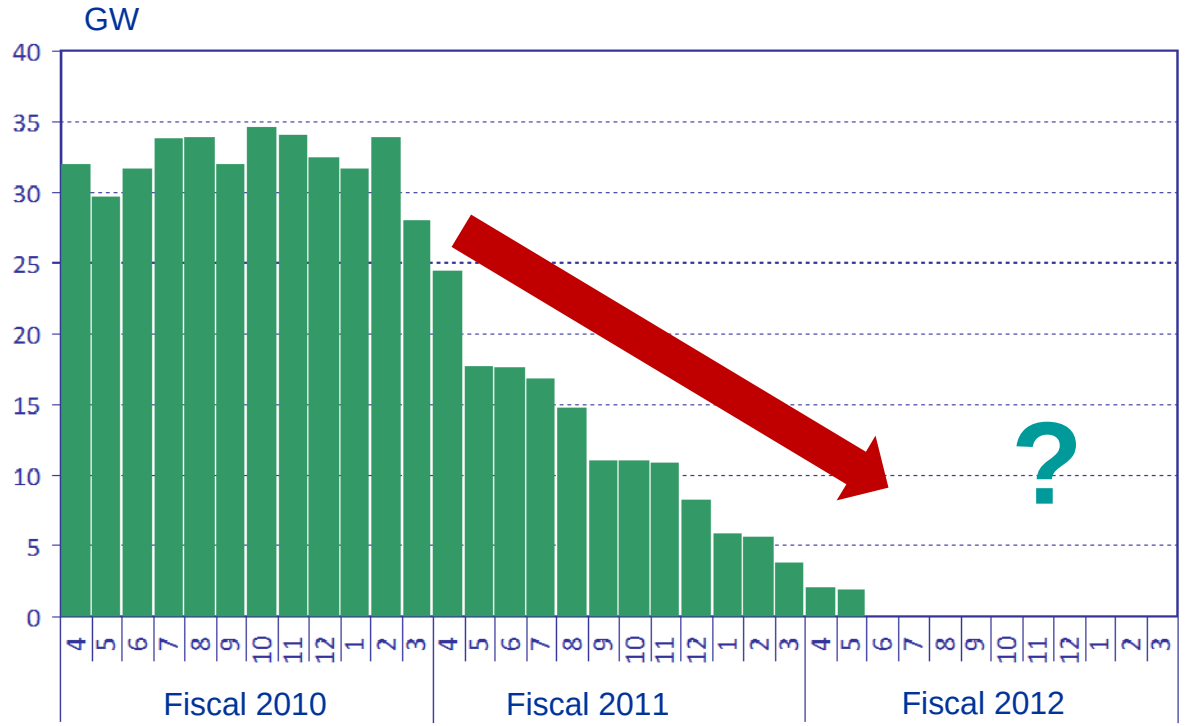
(No-restart of nuclear scenario)



Source: Actual data and estimates from IEEJ, excluding Okinawa Electric Power Co.

All Existing Nuclear Plants Stopped in May 2012

◆Outlook for the Operation of Nuclear Power Plants in Japan (worst-case scenario)



◎ In the worst-case scenario, supposing long delays in starting up nuclear power plants after scheduled outages, the gradual loss of generation capacity will make it difficult for the utilities to cope with peak electricity demand in the summer 2012, seriously affecting industrial activity, etc.

(2) Summer Power Outlook – improved over time

- Increased supply capacity in comparison to 2011 summer
- Peak demand outlook is based on slower economic activities and same electricity saving efforts as last summer.
- As a result, supply-demand gap becomes close to zero on all Japan basis.

  N.B. Reserve rate (generally 7-8%) is not considered

9 Utilities	July 29th, 2011 Announcement (2nd Energy Environment Council)	Nov. 1st, 2011 Announcement (4th Energy Environment Council)	April 23rd, 2012 Announcement (1st Supply-Demand Check Committee)	May 14th, 2012 Announcement (7th Energy Environment Council)
Supply Capacity Outlook	16,297 万kW	16,703	17,025	17,032
Peak Demand Outlook	17,954 万kW	17,964	17,091	17,006
Supply-Demand Gap	▲9.2%	▲7.0	▲0.4	+0.1

Source: Compiled from Energy & Environment Council (May 14th, 2012)

<Reference> Supply Outlook for Summer 2012 (9 Utilities total)

Unit: 10MW	2010 Actual	2011 Actual	2012 Outlook	± from 2011
Nuclear	3,483	1,177	0	-1,177
Thermal Plants	12,542	12,511	13,783	1,272
Permanent	12,398	12,019	12,891	872
Not in Operation	-	168	273	105
Emergency Unit	-	87	318	231
Purchase (auto-gen)	144	237	301	64
Hydro	1,367	1,380	1,270	-110
Pumped Storage	2,141	2,059	1,967	-92
Geothermal & Solar	30	30	65	35
Flex	0	65	0	-65
Supply to PPS, etc	-47	-82	-51	31
Total Supply Capacity	19,518	17,141	17,032	-109

Zero **Nuclear** replaced by **Thermal Plants**

Postponed Periodic Check, Recovery of Damaged Plants

Big Increase in Tohoku & Kanto areas

Capacity：53.7GW
（Not including emergency unit：23GW）

Assuming Ordinary Water Level

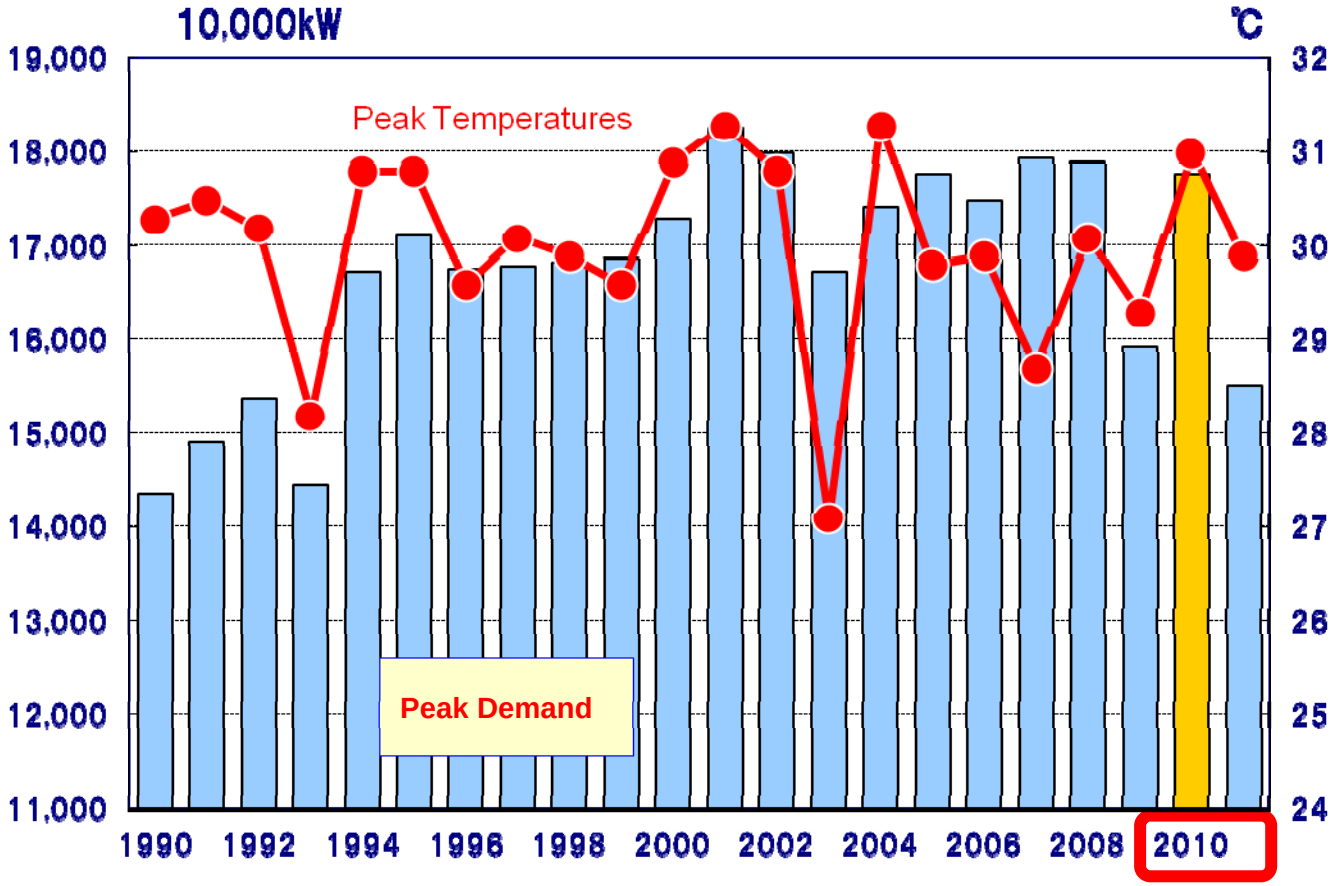
Limited capacity & time
- Installed Capacity：26.7GW
- Supply Capacity：19.7GW

Almost same supply capacity as 2011

Source: Compiled from Energy & Environment Council (May 14th, 2012)

(Ref.) Shift in Peak Electricity Demand and Peak Temperatures

- While 2010 is the base year for power saving, it was not necessarily a record year for either peak demand or peak temperatures.



Note: Peak demand = Maximum average power over of 3 days
Peak temperature = Weighted average by population of peak temperatures in 12 major cities

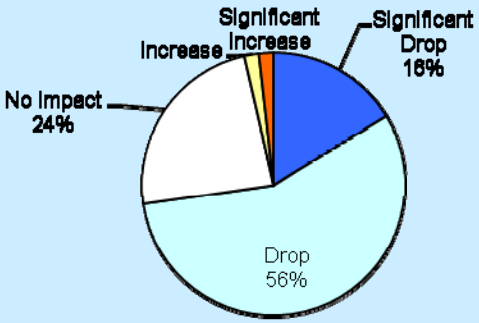
Source: Compiled from IEEJ "Energy Statistics Handbook" etc.

Impact on Manufacturing & Economy

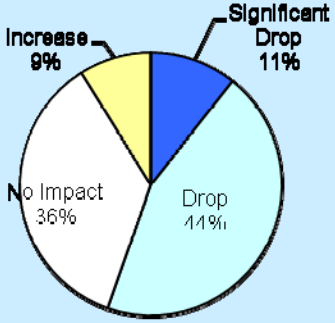
- 70% of manufacturers responded that this will have a negative impact on production.
- Trend seen toward increased shift to overseas production (reduce domestic investment, increase investment overseas)

(Impact of unstable electricity supply and rising electricity rates)

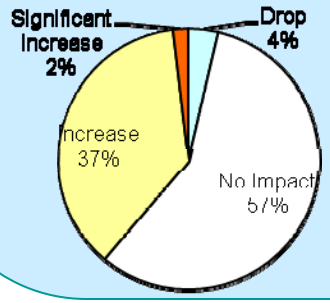
Impact on Production



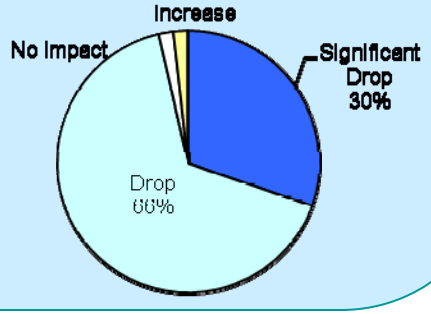
Impact on Domestic Capital Investment



Impact on Overseas Capital Investment



Impact on Profits



Source: Compiled from Keidanren report "Results of Emergency Survey Regarding Near-Term Electricity Supply and Electricity Rates" (April 23, 2012)

5.74 GW of electricity (further 3.2%) needs to be reduced in addition to the last summer's power saving efforts (i.e. 6.0% saving from 2010 level).

Short-term impact

GDP: - 0.5%

(2012 total: about 30 US$ billion)

Loss of 50,000 Jobs

Increase of fuel cost

2011: 2.3 trillion yen
(30 billion US$)

2012: 3.1~3.4 trillion yen
(40 ~ 43 billion US$)

Outlook for Summer Supply/Demand, and Measures
(announced May 18)

* Demand forecast including the economic impact, established power savings (average of 9 companies -6% vs. 2010) and adjustment contracts

Established power savings (total 6% for nine companies vs. 2010) alone cannot ensure reserve capacity of 3.%

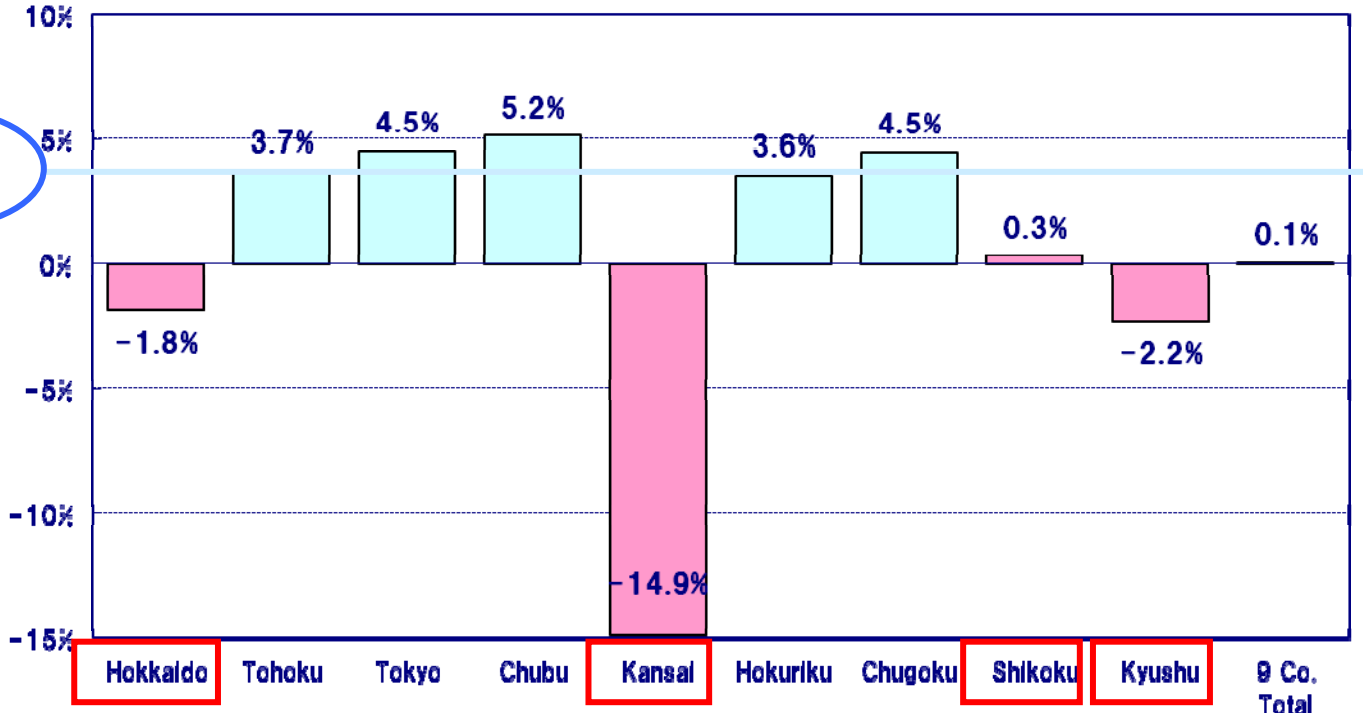
Reserve Capacity 3%

•5-15% savings vs. 2010 called for in service areas of 7 companies (excl. Tohoku/ Tokyo)

Additional savings equivalent to 3.2% average across all 9 companies

•Order for usage restrictions to be avoided, though preparations for planned blackouts will continue.

2012 Supply/Demand Gap = (**Supply capacity – Peak Demand*) / Peak Demand***



	Hokkaido	Tohoku	Tokyo	Chubu	Kansai	Hokuriku	Chugoku	Shikoku	Kyushu	9 Co. Total
Targeted savings (%, vs. 2010)	-7	(-8.7) *1	(-8.0) *1	-5	-15	-5	-5	-7	-10	(-8.6) *2
Usage restriction order					×					
Planned blackouts	Prepare				Prepare			Prepare	Prepare	

*1: Established power savings (Demand for savings without numerical targets)
*2: Average power savings rate for all 9 companies vs. 2010

Source: Compiled from "Energy/Environment Meeting" Materials (May 18, 2012)

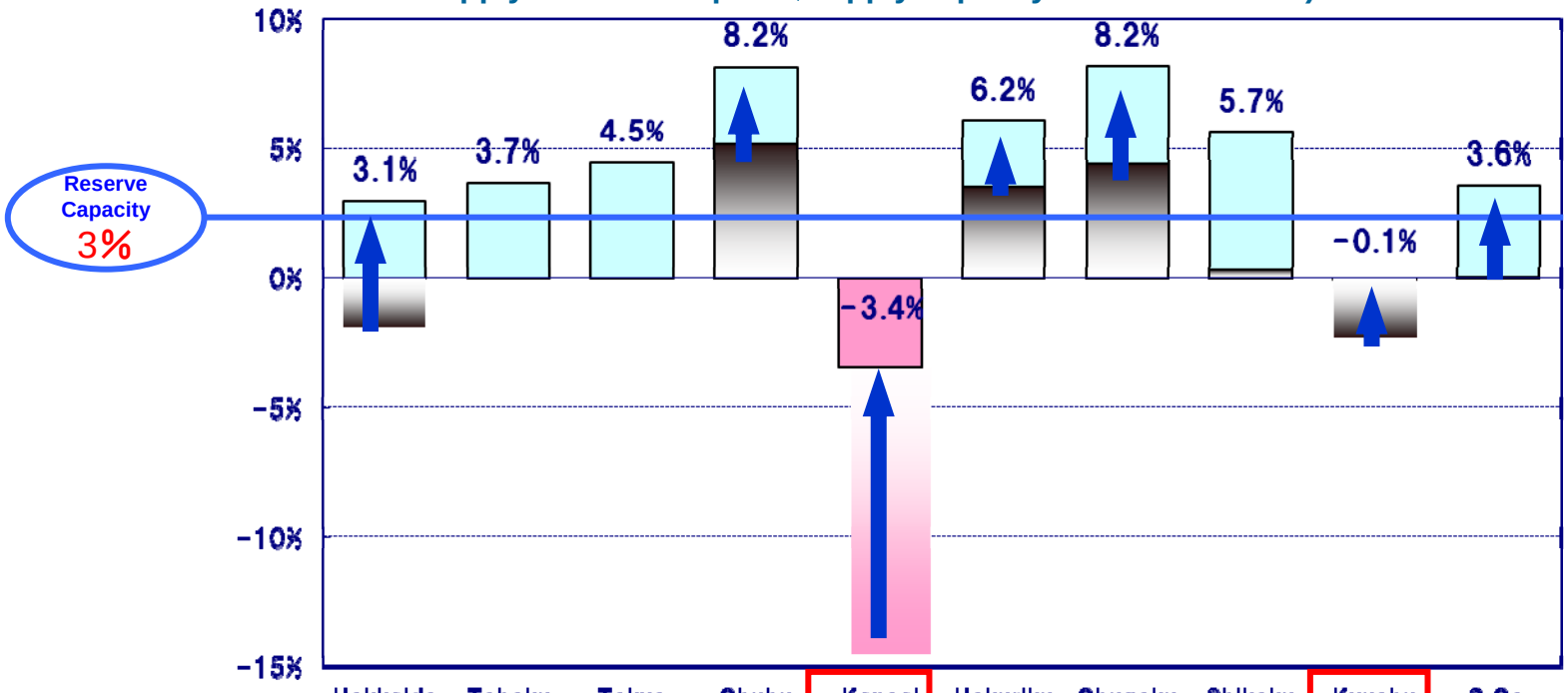
- Power saving periods: 7/2–9/7 (weekdays) 9 a.m.–8 p.m., except in Hokkaido, 7/23–9/7 (9 a.m.–8 p.m.), 9/10–9/14 (5 p.m.–8 p.m.)
- Request for general power saving across all regions without numerical targets: 7/2–9/28 (9 a.m.–8 p.m.). General power saving also called for in the early morning (7 a.m.–9 a.m.) and at night (8 p.m.–1 a.m.)

Supply/Demand Gap Following Additional Power Savings (-3.2% vs. 2010)

- **Supply/demand gap is in negative figure for Kansai, Kyushu. Assume need for accommodation from other companies.**
- **Supply/demand gap for East Japan as a whole is +4.3%, Central and West Japan +3.1%. A tight supply/demand balance.**

***Power supply/demand incorporating additional power savings (average of 9 companies -3.2% vs. 2010)**

2012 Supply/Demand Gap = (Supply capacity – Peak Demand*) / Peak Demand*



Accommodation Capacity (10,000kW)	0	10	85	134	-168	17	60	15	-48	107

Capacity for Accommodation: Supply capacity in excess of reserve capacity (assuming reserve rate of 3%)

West/Central Japan Accommodation Capacity: 110MW

Source: Compiled from "Energy/Environment Meeting" Materials (May 18, 2012)

Power Saving Measures

- Are power savings possible without the usage restriction order?
(Preparations to be made for planned blackouts)
- Little expectation that a majority of households will conserve.
Easier to roll out conclusive measures targeting a small number of major customers.

Actual 2011 Summer Savings: TEPCO Service Area

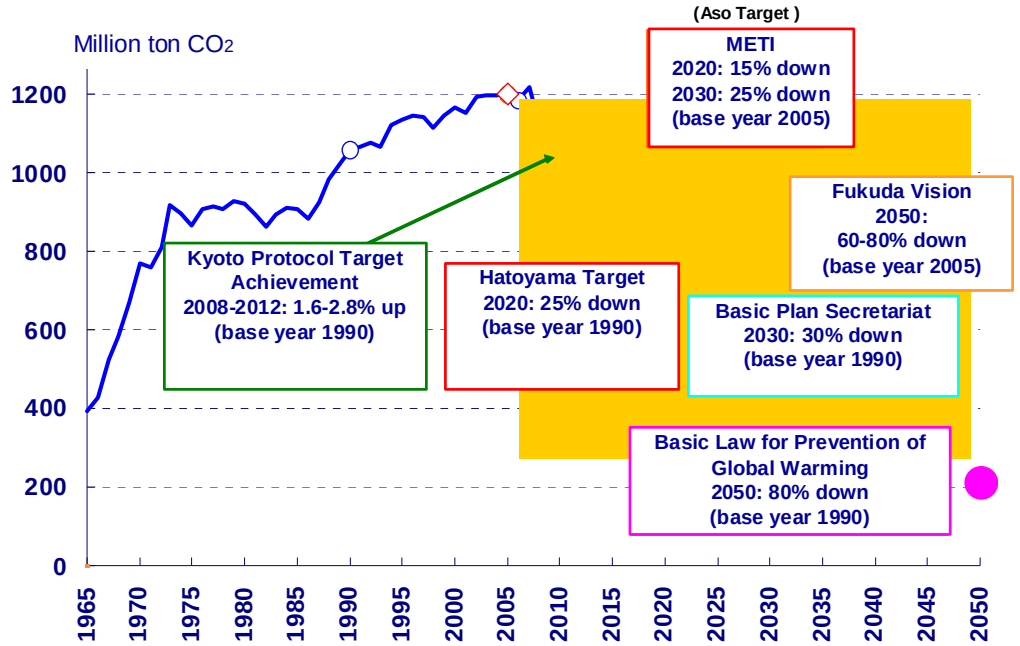
	Target	Actual	Assessment
Overall	Flat 15%	-18%	Achieved
Household	Request for power savings	-6%	Not achieved
Small Customers	Request for power savings	-19%	Achieved
Major Customers	Usage restriction order	-29%	Achieved

- Peak cut approach did not seem to sink in with the household sector.
- Reduced lighting, higher air conditioner temperature settings showed significant results, mainly in the office sector.
- Manufacturing contributed through shift to holiday and nighttime operations, and shift of production to other regions.
- May be difficult to implement this year.

- Conclusive efforts to firmly entrench power savings
- Lower contracted electric power
- Use of time-differentiated rates, etc.

2. Mid & Long-term challenges in energy policy in Japan

CO_2 Emission Reduction Targets of Japan

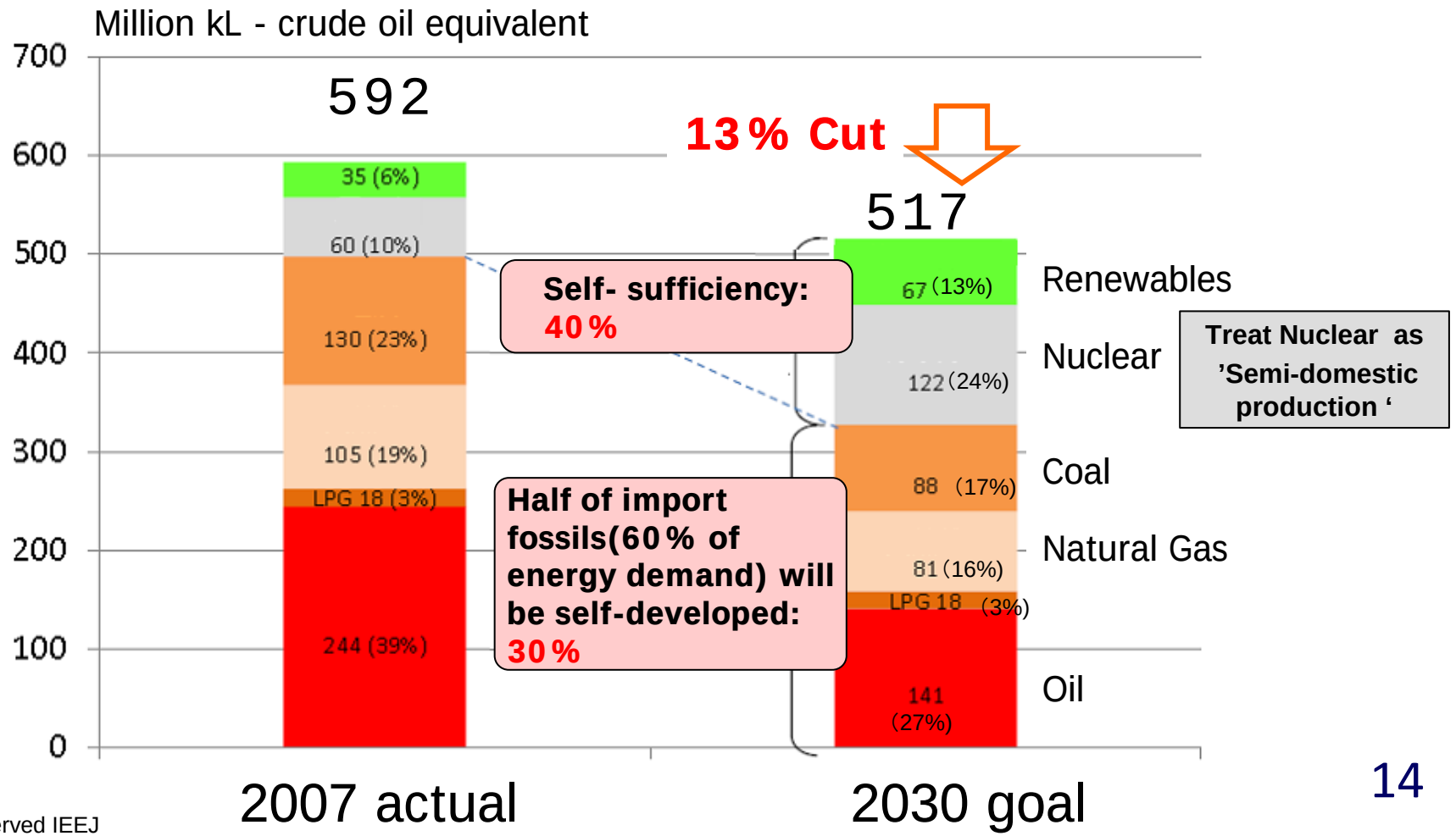


【2010 Basic Energy Plan】

Nuclear was important ingredient of Energy Mix

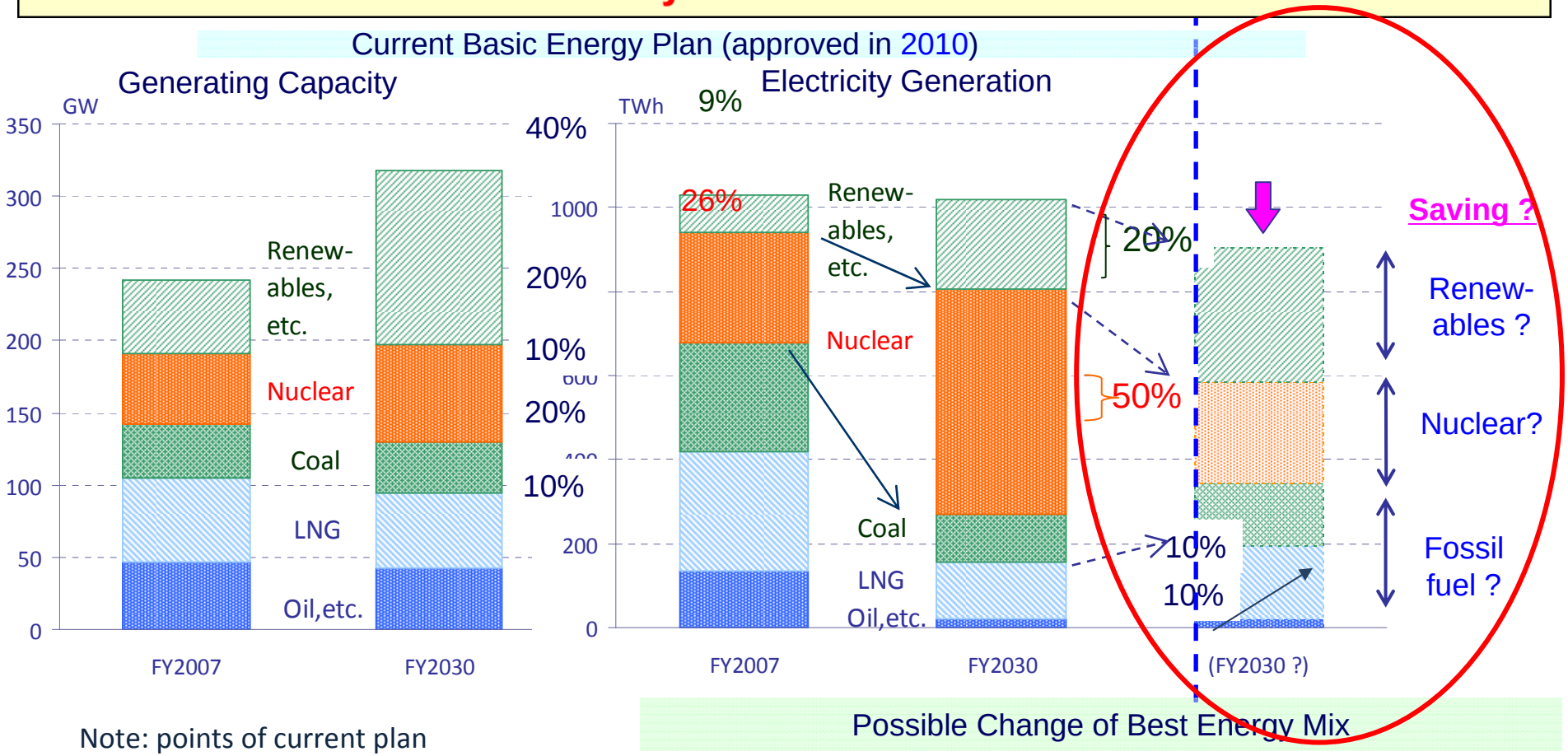
-Raise Energy Independence Ratio（Self-sufficiency + Self-development rate）from 38%(2007) to 70% (2030)

-Reduce CO_2 Emission by 30% vs. 1990 level



Need to revise Energy Mix Plan - post Fukushima -

-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%



Note: points of current plan

① raise self-sufficiency of energy supply : 38 -> 70

② reduce emissions by 30% in 2030 compared to 1990 level

<Under Discussion>

Four Options for Power Generation Mix

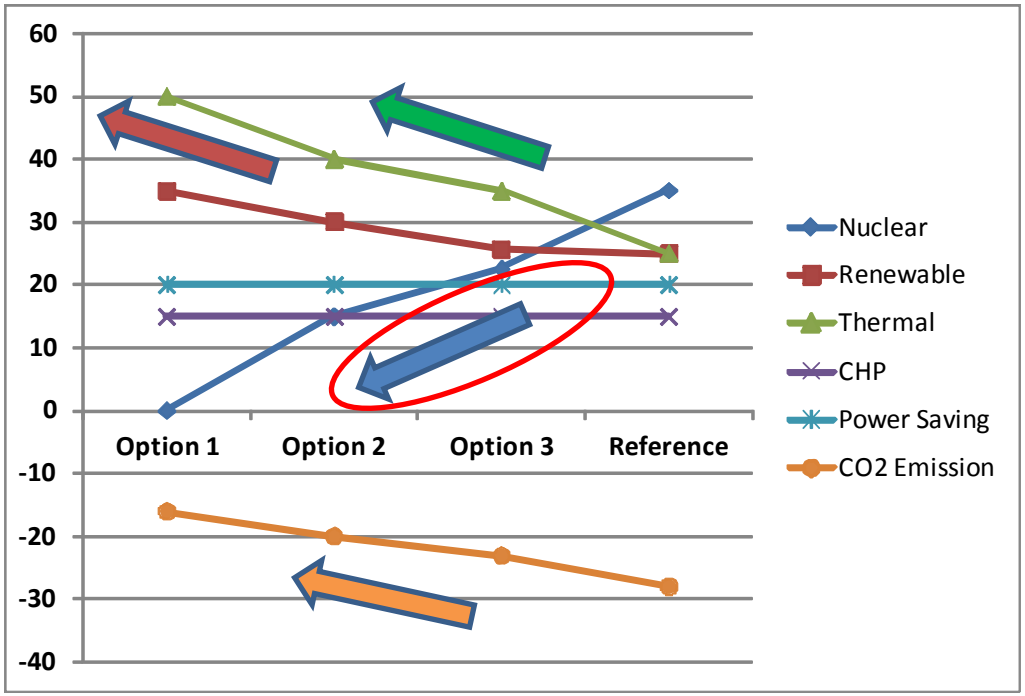
at the National Energy Committee（7th June 2012）

	Nuclear	Renewable	Thermal	CHP	Power Saving	CO2 Emission
Option 1	0%	35%	50%	15%	20%	-16%
Option 2	15%	30%	40%	15%	20%	-20%
Option 3	20-25%	25-30%	35%	15%	20%	-23%
Reference	35%	25%	25%	15%	20%	-28%

Less Nuclear

More Renewable & More Thermal

More CO2 Emission



What are behind these cases?

- Record Biggest Electricity Saving is Required (-0.5% (1973-90) →-1.5-2%)

  ➔ New tariff scheme, smart meters, ESCO, etc.
- Renewable Power Gen Faces Lower Operation Rate

  ➔ 60-70% capacity increase can only add 30-40% supply
- Lower Nuclear Share requires More Thermal Plants (27%→)

  ➔ Thermal plants : 35-50% share in power generation
- More Cogeneration (CHP) & Distributed Power Gen (Capacity: 4.4 folds)
- Drastic Nuclear Power Reduction from 2010 Plan required

  70GW (2010Plan) ➔ 0-35 GW (Cases 1-3)
- Huge Economic Loss of 1-5% GDP reduction (including double to triple electricity tariff)
- CO2 reduction will only be by 2-7% against 25% reduction target (by 2020 from 1990)

What are important in choosing Best Energy Mix?

1) Comprehensive Perspective

● S+3E : **Safety** + **Energy Security** + **Efficiency** + **Environment**

● No Perfect Energy exists for Japan without domestic energy resource

● **Well-balanced Mix** of 4 power gen technologies (Nuclear, Renewable, Fossil Fuels and Cogeneration) in addition to enhanced energy efficiency is essential.

● "**Nuclear**" : "Renewable" : "Thermal Power" : "Cogeneration"
= **25%** : 25% : 35% : 15%

2) Long-term Perspective

● 2030 is **only 18 years away**

● We **have not yet found** ideal/suitable energy which can **substitute Nuclear** and **meet 3E requirement by 2050**.

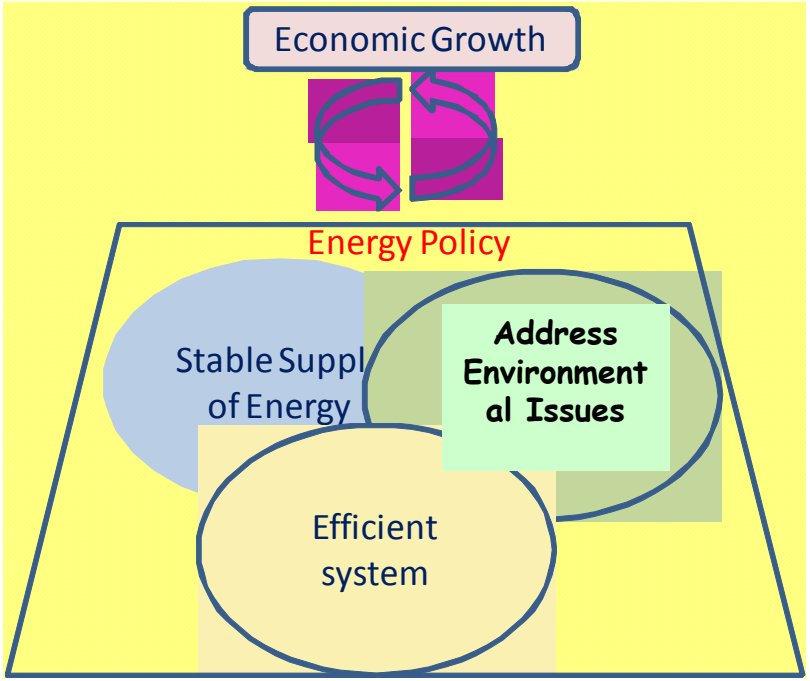
3) International Perspective

● Germany chose to phase out Nuclear but with **EU power network** (10 times more supply than German power demand)

● Nuclear is expected to grow in **China, India**, etc.
: 4－7 folds in coming 20 years（up to 160－260 units）

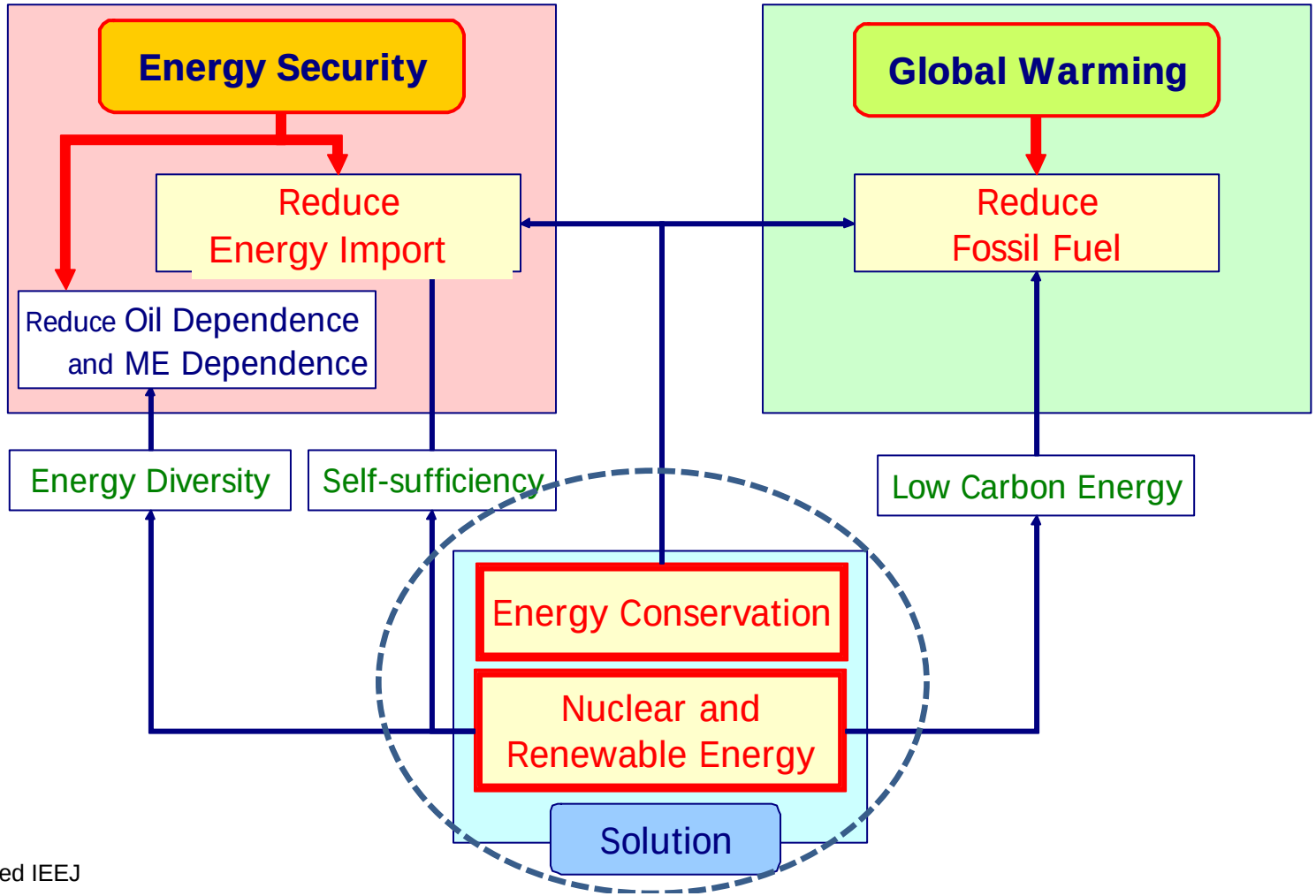
3E+S are Keys to Energy Policy of Japan

to address both Energy Security & Climate Change



Targets : Energy Security & Climate Change

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.



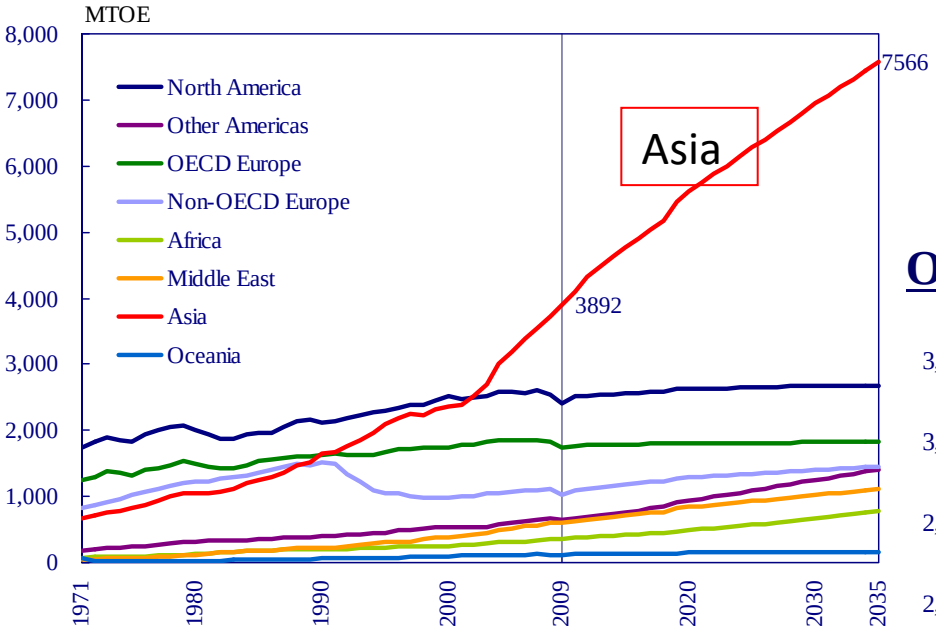
3. Role of Energy Technologies

- Acceleration in technology innovation is required to meet the target of “50% reduction by 2050”

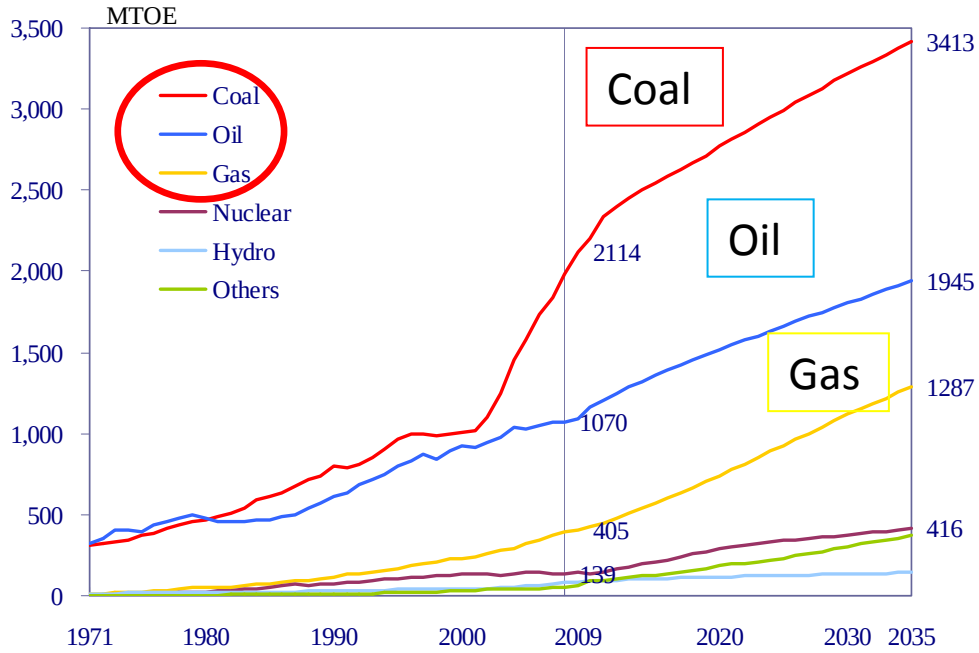
Primary Energy Demand in Asia (by fuel)

Reference

Outlook for Energy Demand by Region



Outlook for Energy Demand in Asia by Source



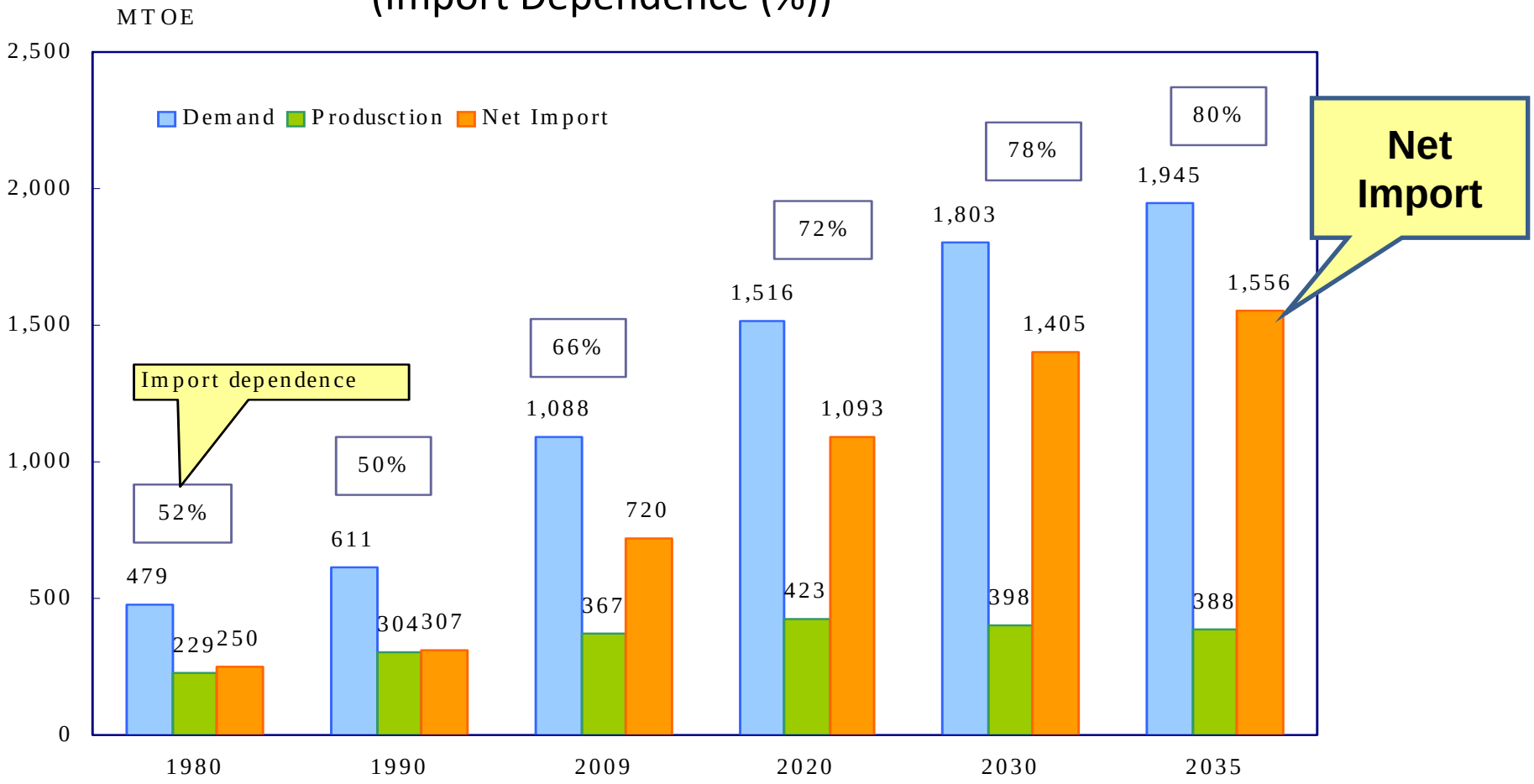
Source: IEEJ (Asia / World Energy Outlook 2011)

Supply-Demand Balance of Oil in Asia

Reference

Supply-Demand balance

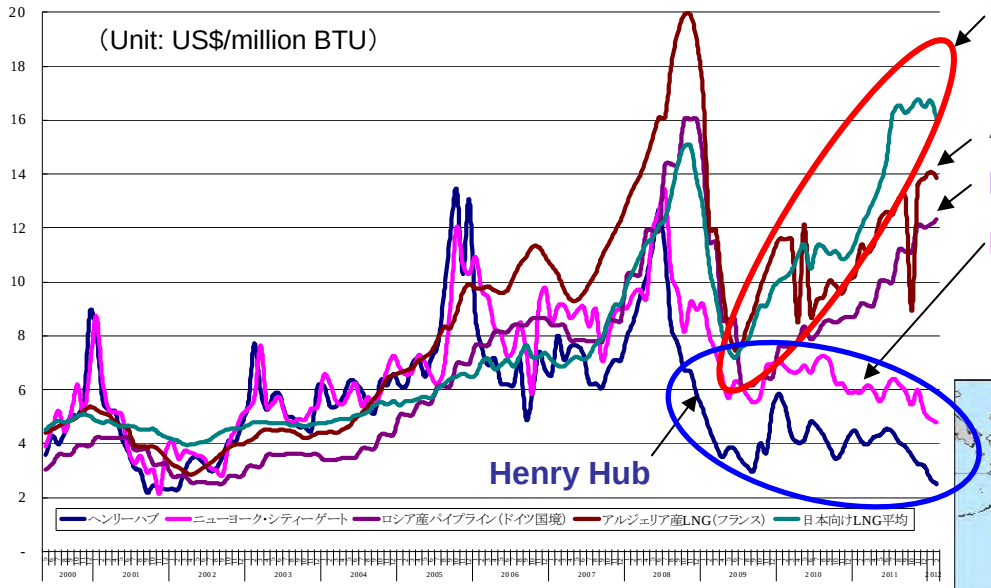
(Import Dependence (%))



Source: IEEJ (Asia / World Energy Outlook 2011)

Asia is facing Higher Gas Prices

Comparison of Regional Natural Gas Prices



LNG for Japan

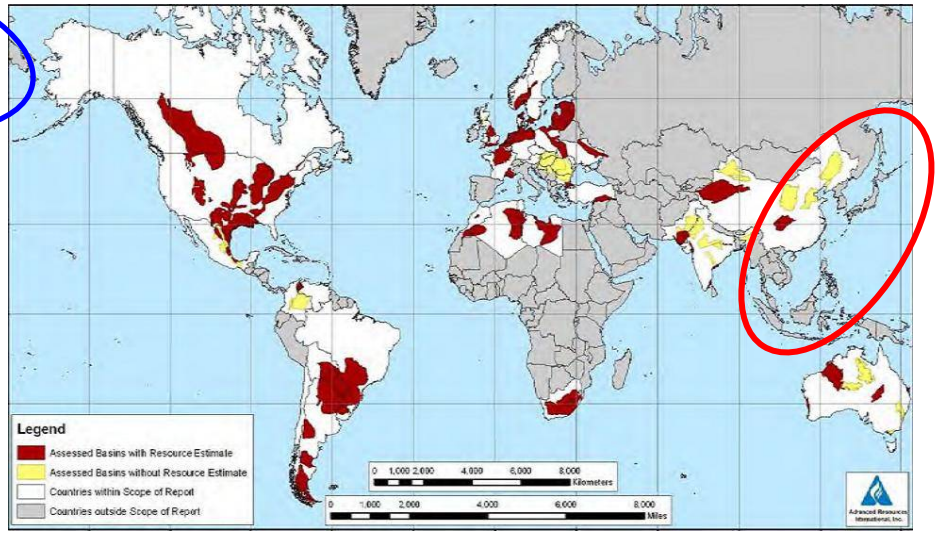
Algerian LNG (France)

Russian PL (German boarder)

NY City Gate

（Source）Compiled from Trade Statistics (Japan), 、US/DOE、Energy Intelligence data

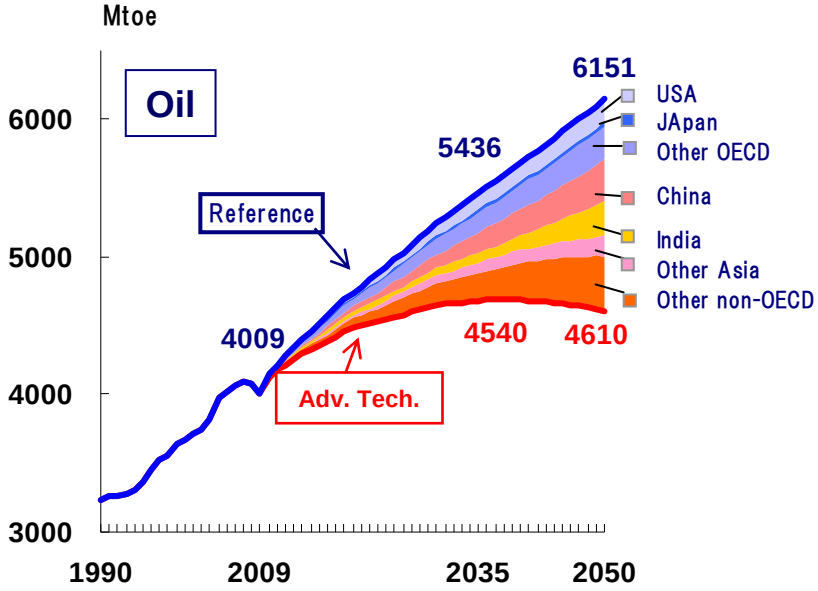
World Shale Gas Resources

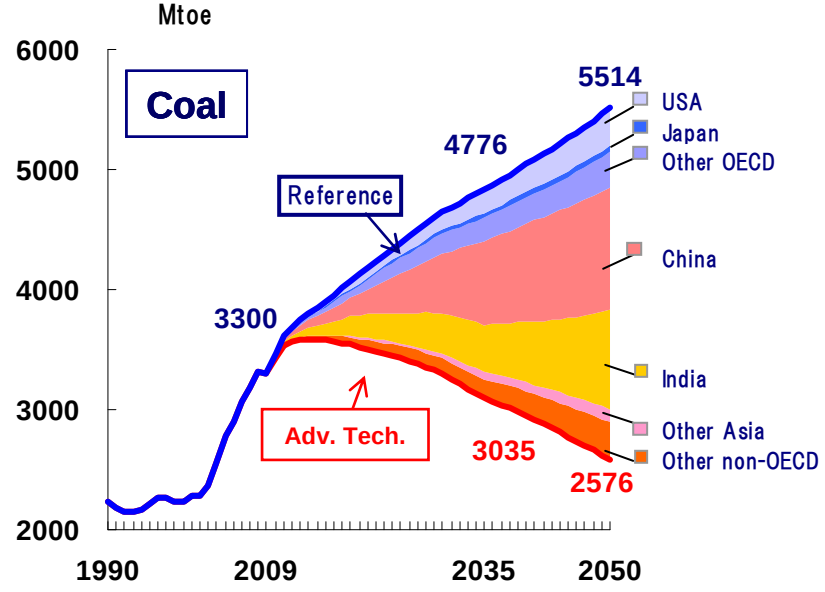


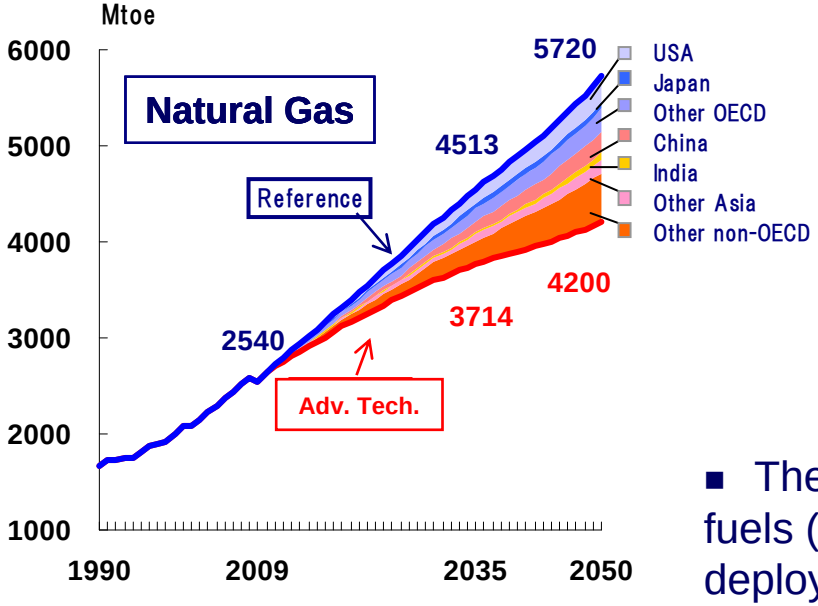
（Source） US/DOE study, World Shale Gas Resources: An Initial Assessment of 14 Regions Outside the United States, APRIL 2011, prepared by Advanced Resources International (ARI) for the United States' Energy Information Administration (EIA).

Fossil Fuel Demand (2050)

Reference
Adv. Tech.







Reduction in 2050 (Regional Breakdown)

(Oil)

	Mtoe	Share
USA	168	11%
Japan	33	2%
Other OECD	242	16%
China	296	19%
India	257	17%
Other Asia	151	10%
Other non-OECD	394	26%
OECD	442	29%
non-OECD	1,099	71%
Developing Asia	705	46%
World	1,541	100%

(Coal)

	Mtoe	Share
USA	316	11%
Japan	56	2%
Other OECD	287	10%
China	1,021	35%
India	829	28%
Other Asia	114	4%
Other non-OECD	316	11%
OECD	659	22%
non-OECD	2,280	78%
Developing Asia	1,964	67%
World	2,938	100%

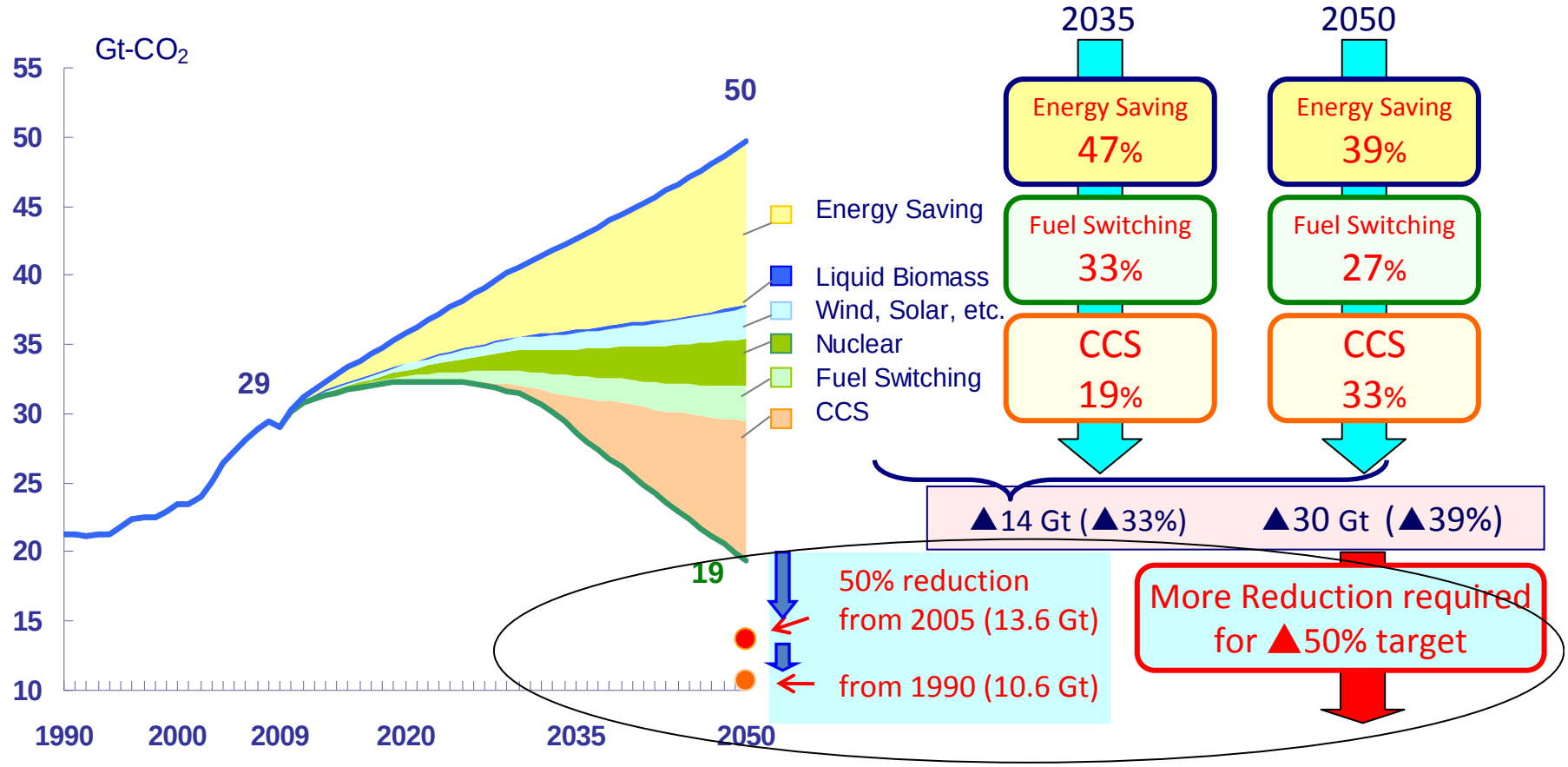
(Natural Gas)

	Mtoe	Share
USA	271	18%
Japan	63	4%
Other OECD	238	16%
China	211	14%
India	81	5%
Other Asia	142	9%
Other non-OECD	514	34%
OECD	572	38%
non-OECD	948	62%
Developing Asia	434	29%
World	1,520	100%

- The highly efficient technologies consuming fossil fuels (such as clean coal technologies) need to be deployed in order to largely decrease the fossil fuel consumption

CO2 Emissions Reduction by Technology (World)

Reference Tech. Adv.



■ For 50% reduction of global CO2 emission, additional long-term measures are necessary and **development of innovative technology** is essential.

Source: IEEJ (Asia/World Energy Outlook 2011)

Acceleration Required - R&D (Technologies and Investment)

- Robust Economic Growth in Asia → Steady Increase in Energy Use (Fossil Fuels).
- **Supply Constraint** (geopolitical issues, shock, accident, etc.)
  - → Energy Insecurity in Asia (growth center) → Worldwide (negative) Economic Impacts
- 3E (Energy Security, Environment, Economy) plus S (Safety) become essential for mid to long-term strategy. (3E+Safety)
- Importance of a comprehensive perspective in both demand and supply
  - ✓ More Efficient Energy Use
  - ✓ Cleaner Use of Fossil Fuels + ✓ Safer Nuclear Energy Technology
  - ✓ Lower Cost Renewable Energy

- Maximum utilization and expansion of technologies including nuclear energy based on current expectations for development and possibility for practical use **will not be enough to reach** the target of 50% reduction of global CO2 emission by 2050.
  - → If nuclear power usage **slows down**, it will become **even more difficult**.

- **Accelerated** investment and development & dissemination of **innovative technologies** will be essential to achieve 50% emission reduction target.

Thank you for your attention!

IEEJ Asia/ World Energy Outlook 2012

To be announced in October!

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