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Asia / World Energy Outlook 2012

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Projection Outline

● Objective:

To present a realistic projection of world energy demand and supply. The outlook results from a fully logical and consistent way of quantifying a careful investigation of the current and anticipated socio-economic situations and applying energy fundamentals. The outlook also incorporates a particular analysis of the situation in Asia. The analysis of Asia was carefully implemented through the exchange of information with numerous research institutes and organizations in the region.

● Projection Period: From 2011 to 2035 and 2050

● Methodology: Energy Demand and Supply Model, Macro-Economic Model, Bottom-up Type Technology Estimation Model

● Scenarios:

■ Reference

Reference scenario assumes highly probable deployment of energy policies and technologies based on current economic & political situations. The reference scenario provides for a normative future evolution of energy demand and supply

■ Advanced Technologies Scenario (Adv. Tech.)

This scenario develops future picture which assumes;

- An accelerated rate of R&D to encourage global deployment of advanced technologies.
- The promotion of a global technological cooperation with technology transfers from developed to developing countries
- The uptake by all the countries of the world of measures promoting advanced technologies.

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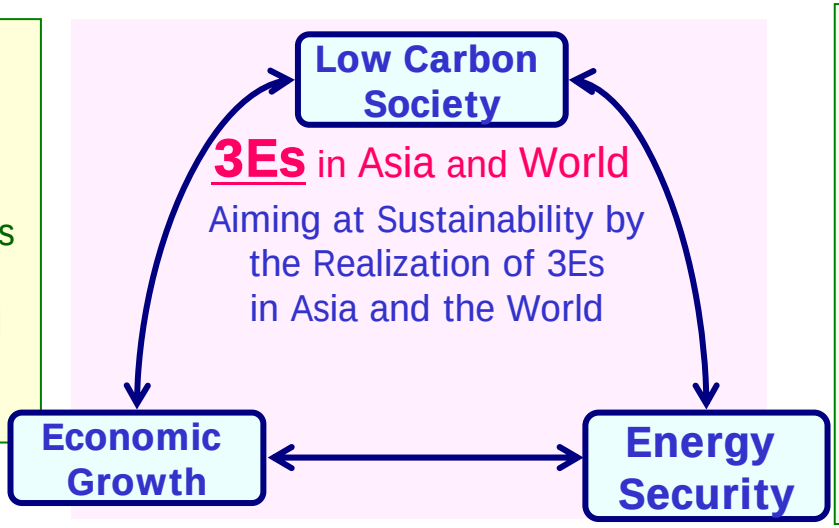
Towards the Realization of 3Es in Asia and in the World (Environment, Economy, Energy security)

Agenda on Energy-Environmental Policy

Firm resolutions on ensuring energy security, R&D and address climate change issues

- ■Expansion of non-fossil fuel
- ■Best mix (diversification and efficient energy use)
- ■Oil & gas supply security



Technological Strategy of Japan

Japan should focus on its competitive technological edge.

- ■Accelerated R&D for Advanced Technologies towards 2030&2050
- ■Transfer of low carbon technologies to other countries.
- ■Transfer of knowledge on establishing energy policies to other countries.
- ■Achieving economic growth by establishing new energy & environmental industry

Development and deployment of innovative technology and transformation of social system

2020 — 2030 — 2035 — 2050

- ▪Nuclear
- ▪PV, Wind, Bio-fuel etc.
- ▪Environmentally acceptable use of fossil fuel
  - Clean Coal Technology (IGCC, CCS)
  - MACC
- ▪Clean Energy Vehicles (Plug-in Hybrid Vehicles、EV etc.)
- ▪Battery technology、Power electronics etc.
- ▪Fuel cell
- ▪Heat-pump
- ▪Smart grid, smart meter etc.

Energy demand expansion in China, India etc.

Risk of extraordinary price escalation of fossil fuel (Peak-out of Easy Oil)

Massive introduction of innovative technologies

Acceleration of development of low carbon technology
⇒Sustainable economic growth

- ▪Fast Breeder Reactor (FBR)
- ▪SPS
- ▪Innovative industrial process
- ▪Geo-engineering
- ▪Distributed energy system
- ▪Low carbon towns/cities
- ▪Hydrogen society
- ▪3R (reuse, reduce, recycle) technology

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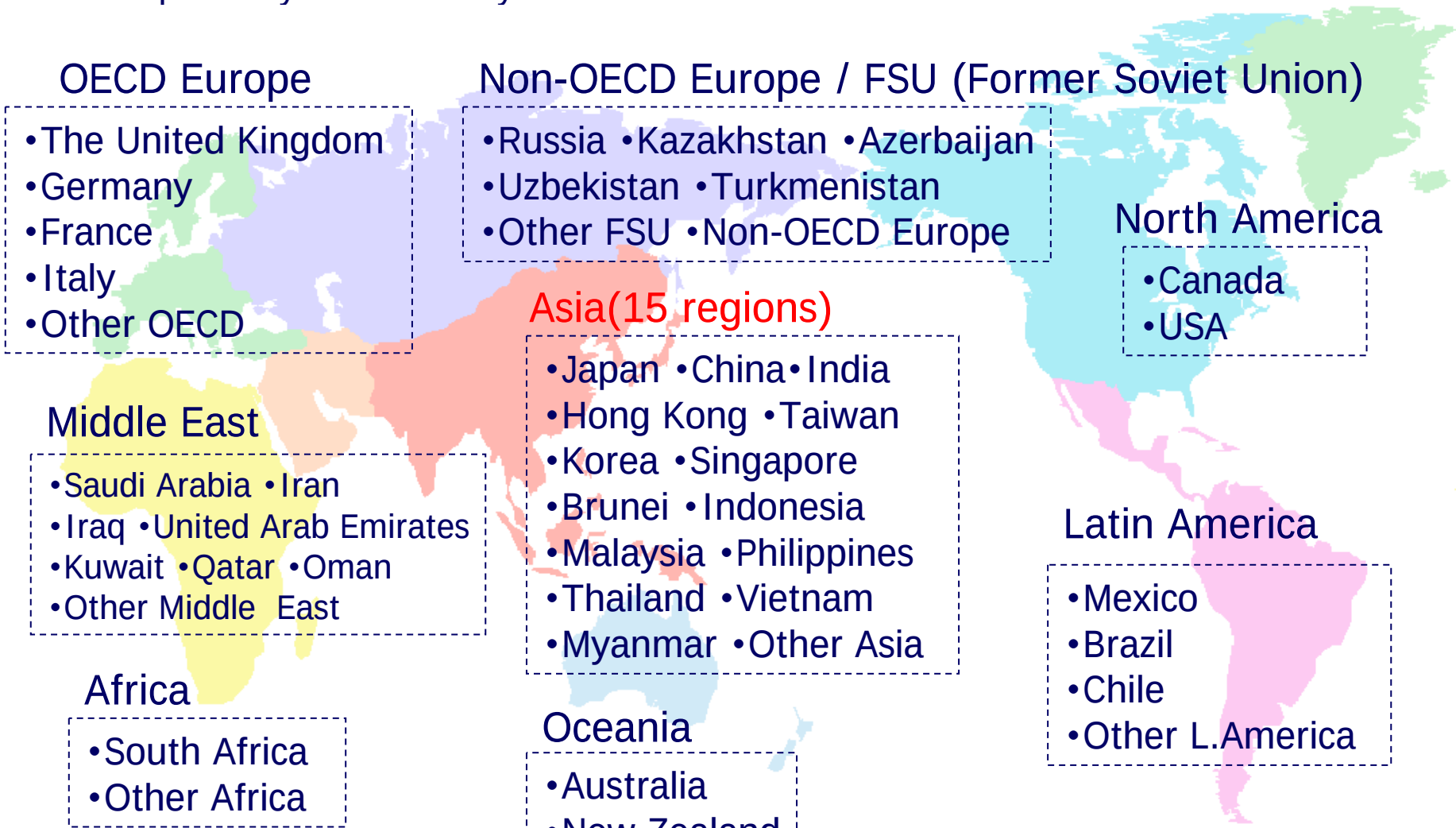
Geographical Coverage

- The world is geographically divided into 45 regions, of which Asia represents 15 regions.
- Geopolitically detailed analysis into Asian countries.



OECD Europe
- The United Kingdom
- Germany
- France
- Italy
- Other OECD

Non-OECD Europe / FSU (Former Soviet Union)
- Russia
- Kazakhstan
- Azerbaijan
- Uzbekistan
- Turkmenistan
- Other FSU
- Non-OECD Europe

North America
- Canada
- USA

Asia(15 regions)
- Japan
- China
- India
- Hong Kong
- Taiwan
- Korea
- Singapore
- Brunei
- Indonesia
- Malaysia
- Philippines
- Thailand
- Vietnam
- Myanmar
- Other Asia

Middle East
- Saudi Arabia
- Iran
- Iraq
- United Arab Emirates
- Kuwait
- Qatar
- Oman
- Other Middle East

Latin America
- Mexico
- Brazil
- Chile
- Other L.America

Africa
- South Africa
- Other Africa

Oceania
- Australia
- New Zealand

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Modeling Framework

Macro-Economic Model†

- GDP components
- Price/Labor etc.
- Industrial activities
- Transport activities

GDP, Crude oil price, Exchange rate, Population, Power generation outlook, World trade etc.

† Development of country-specific macro economic model in China, Korea and ASEAN countries (Indonesia, Malaysia, Philippines, Thailand)

Energy Demand-Supply Model

- Energy Demand
- Conversion Sector
- Energy Supply

World Trading Model of Crude Oil and Petroleum Products (LP Optimization)

End-use Energy Technology Model (Automobile, Electric Appliances etc.)

CO_2 emissions

These models allow for a better understanding of the interactions among numerous parameters, in a logical and consistent way.

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Outline - Asia/World Energy Outlook 2012 -

- Major Assumptions
  - GDP, Population, and Energy Prices
- Projection Results for World and Asia
  - Primary Energy Demand, and CO_2 Emissions
  - Motorization, Power Generation Mix, and Renewables
- Energy Outlook in China and India
- Best Energy Mix in Asia and Middle East
- Energy Outlook through 2050
- Implications

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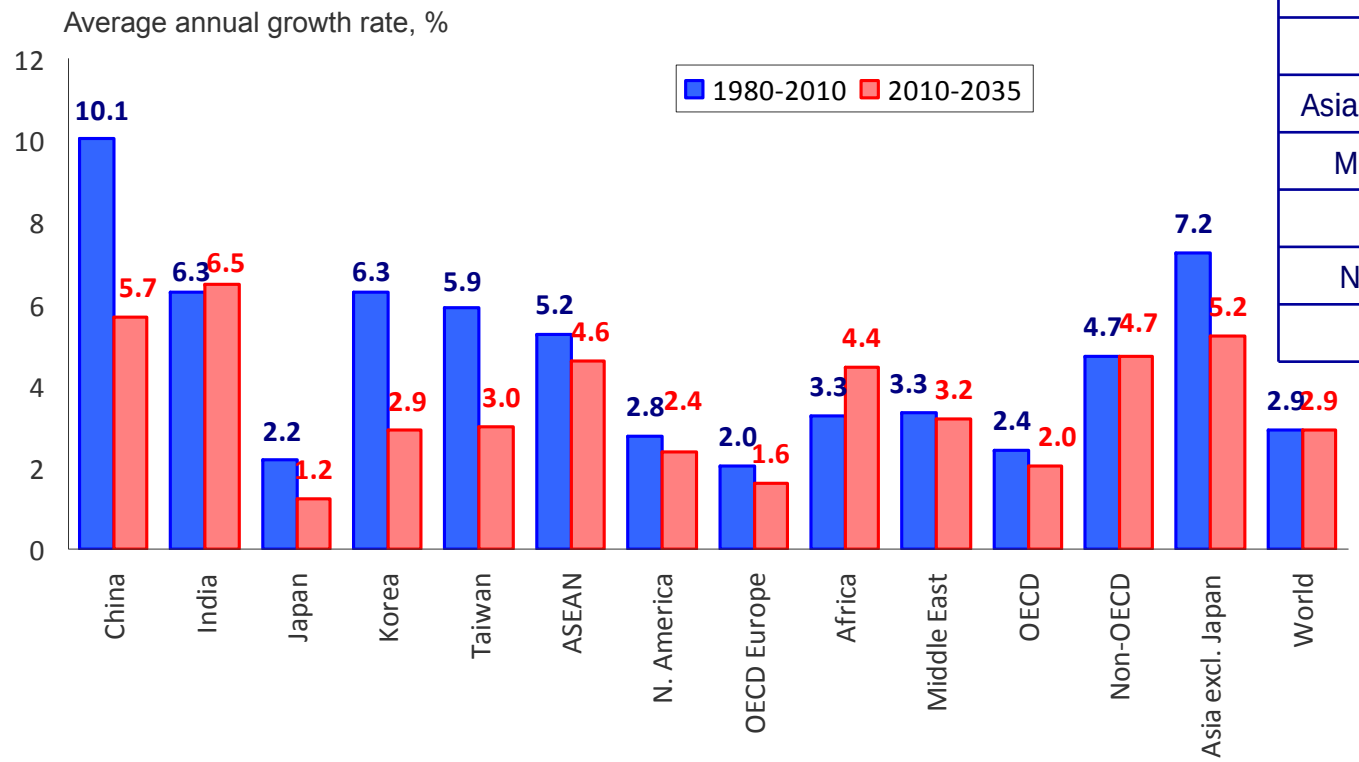
Major Assumptions: Gross Domestic Product



	2010-2035
China	**5.7%**
India	**6.5%**
Asia (ex. Japan)	**5.2%**
Middle East	**3.2%**
OECD	**2.0%**
Non-OECD	**4.7%**
World	**2.9%**

- World economy will continue to grow at more than 2.9% per annum, through to 2035. The economic stimulus measures by numerous countries will bring an early recovery from the globally felt financial crisis that slowed recent economic growth.
- China's labor force which supported the economic growth is close to peaking. GDP in China is expected to slow down toward 2035.
- GDP in India and ASEAN countries will register high growth, reflecting increases in improved labor quality, and liberalization and direct investment from foreign countries.

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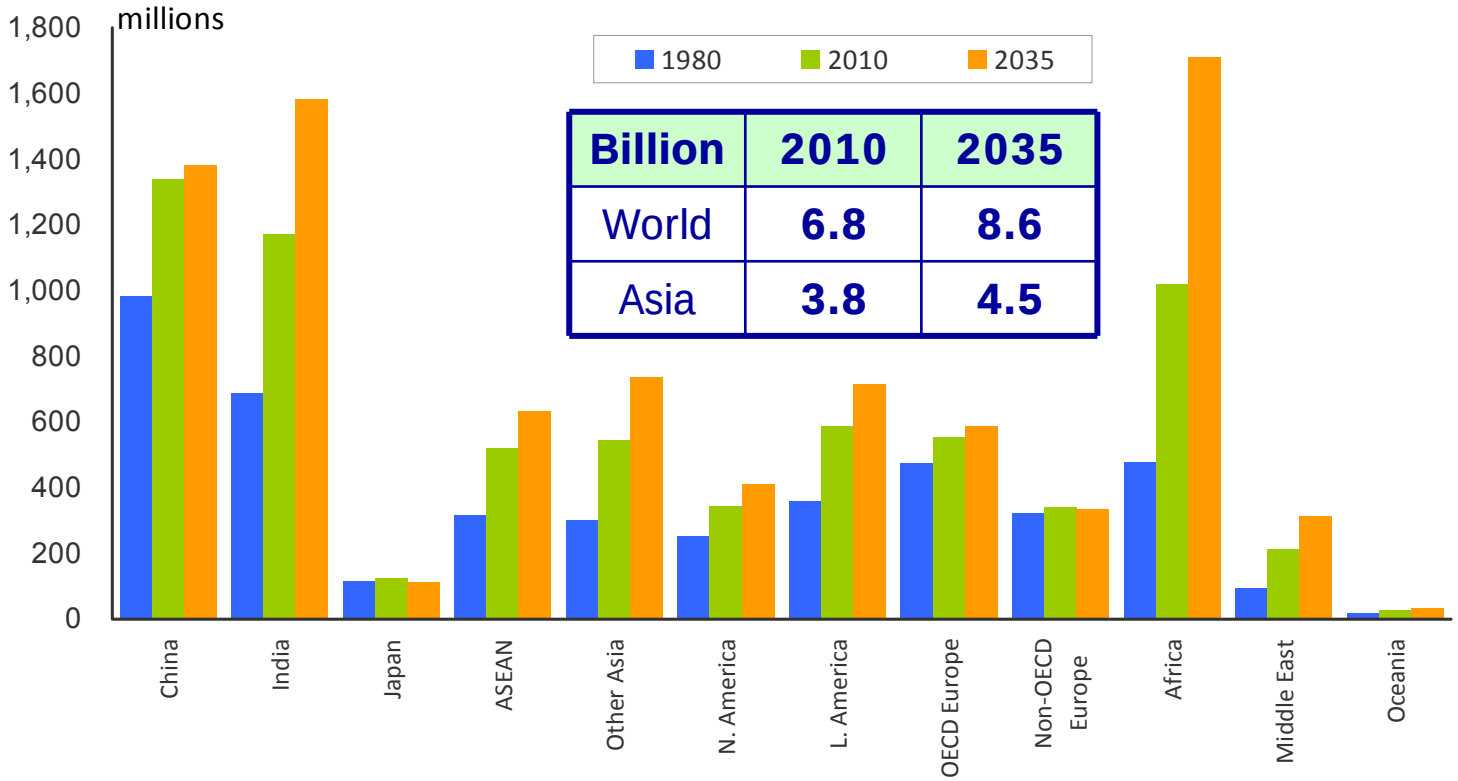
Major Assumptions: Population



Billion	2010	2035
World	6.8	8.6
Asia	3.8	4.5

China

2010
1.34 bil
↓
2035
1.38 bil
(**0.04** bil growth)

India

2010
1.17 bil
↓
2035
1.58 bil
(**0.42** bil growth)

- Developing countries account for roughly 90% of the increase in world population over the period 2009-2035.
- China's population will peak in 2030 as a result of past and current declining birth rate.
- India's population will surpass China during the 20's representing the biggest in the world by 2035. India's population will become first in the world.

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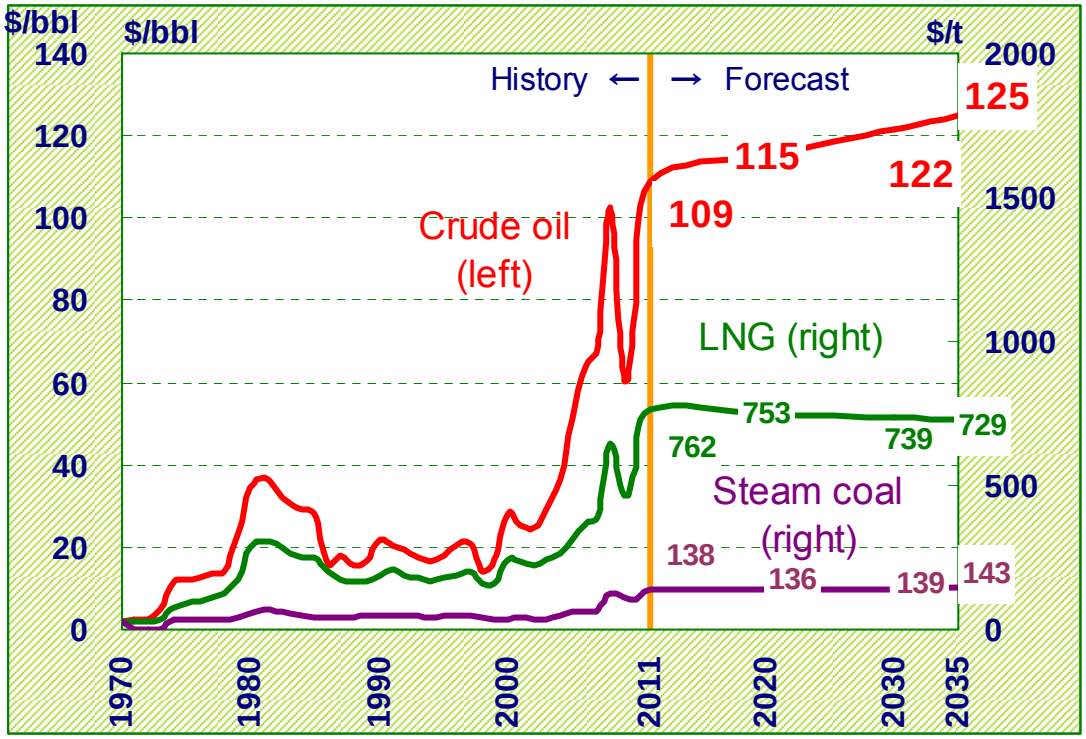
Major Assumptions: Energy Prices (2011price USD)



In the graph, energy prices are expressed as Japan's import energy prices (on a CIF basis).

- Crude oil prices will continue to rise in the future resulting from the tight supply-demand balance. Oil demand is projected to increase driven mainly by Asia, while upstream investment may not progress at a pace meeting the demand growth.
- Japan's LNG import price is projected to gradually decline.
- Coal price will show relatively moderate growth compared with the crude oil.

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Energy Prices and Relative Prices

【Real Price & Nominal Price】

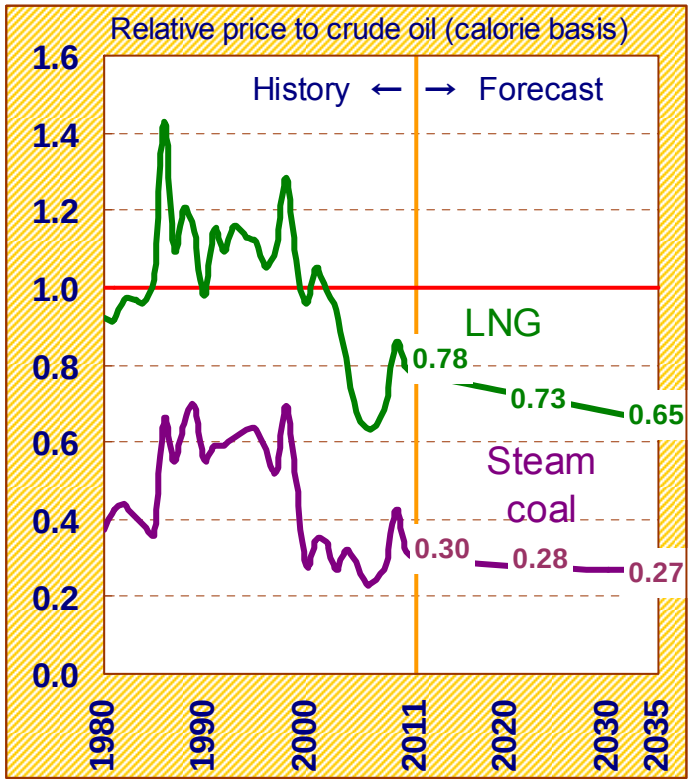
		2000	2011	2020	2030	2035
Crude oil USD/bbl	**Real**	**35**	**109**	**115**	**122**	**125**
	Nominal	28	109	137	177	201
LNG USD/t	**Real**	**303**	**762**	**753**	**739**	**729**
	Nominal	244	762	899	1,076	1,173
Steam coal USD/t	**Real**	**44**	**138**	**136**	**139**	**143**
	Nominal	35	138	163	203	230

【LNG Price Relative to Crude Oil】

USD/MBtu	2011	2020	2030	2035
Japan	**14.7**	**14.5**	**14.3**	**14.1**
Europe	**10.5**	**11.2**	**12.1**	**12.6**
U.S.	**4.1**	**5.2**	**6.4**	**7.1**

* Real prices are set in 2011.
** Inflation rates are assumed at 2% annually.

【Relative Prices (Crude Oil = 1)】



■ The gap among regional LNG prices will be smaller with time because of increasing inter-regional trade etc.

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Assumptions on Advanced Technologies Scenario

Countries in the world are assumed to strengthen the numerous measures that contribute to energy security and address global warming issues. Technological development and its international transfer will be promoted and, as a result, advanced technologies will become widely and commercially available internationally.

Regulation, National target, SSL etc.	Promotion of R&D, International Cooperation
Carbon Tax, Emissions Trading, RPS, Subsidy Provisions, FIT, Efficiency Standards, Automobile Fuel Efficiency Standard, Low Carbon Fuel Standard, Energy Efficiency Labeling, and National Target.	Encouragement of Investment for R&D, International Cooperation on Energy Efficient Technology, Support on Establishment of Efficiency Standard

【Demand Side Technologies】

■ Industry

Best available technology on industrial processes will be deployed internationally (steel making, cement, paper, oil refinery, etc.).

■ Transport

Clean energy vehicles will be globally utilized (highly fuel efficient, hybrid, plug-in hybrid, electric and fuel cell vehicles).

■ Building

All available efficient technologies will be widely in use. (electric appliances , water-heating system, air conditioning system, lighting, and insulation technologies)

【Supply Side Technologies】

■ Renewables

Accelerated penetration of Wind, PV, concentrated Solar Power, biomass power generation, and bio-fuels

■ Nuclear

Further expansion of nuclear power plants, and enhancement of operating ratio

■ Highly Efficient Power Plants

For coal-fired power plant (USC, IGCC, IGFC), For natural gas plants (More Advanced Combined Cycle)

■ CCS

Introduction in fossil fuel-fired power plants as well as in some industrial sectors

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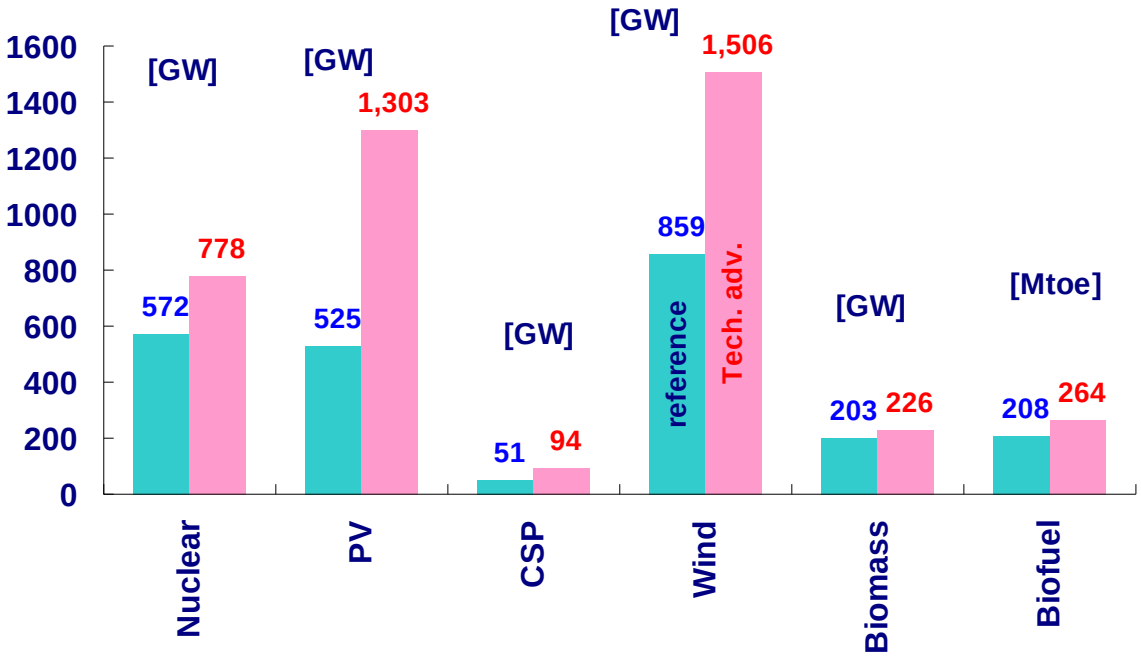
Assumptions on Adv. Tech. Scenario (World, 2035)



Non-fossil fuel (Mtoe)

2010
1,432 Mtoe
↓
2035

Reference	Adv.Tech
2,604 Mtoe	**3,446 Mtoe**
(1.8-fold inc)	(2.4-fold inc)

Share of non-fossil fuel

2010
12%
↓
2035

Reference	Adv.Tech.
15%	**23%**

■ Further expansion of nuclear and renewables is likely to be realized at the same pace as global electricity demand growth.
■ Biofuel will expand substantially when cellulosic biofuel becomes commercially viable. Cellulosic biofuel does not compete with food production and land use.
■ By 2035, the industry, building and transport sectors will achieve further savings of 422 Mtoe (13%), 533 Mtoe (15%) and 407 Mtoe (14%) respectively , compared to the reference scenario.
■ Average efficiency of fossil fuel-fired power generation will reach 42% by 2035, compared to the reference scenario at 41%.

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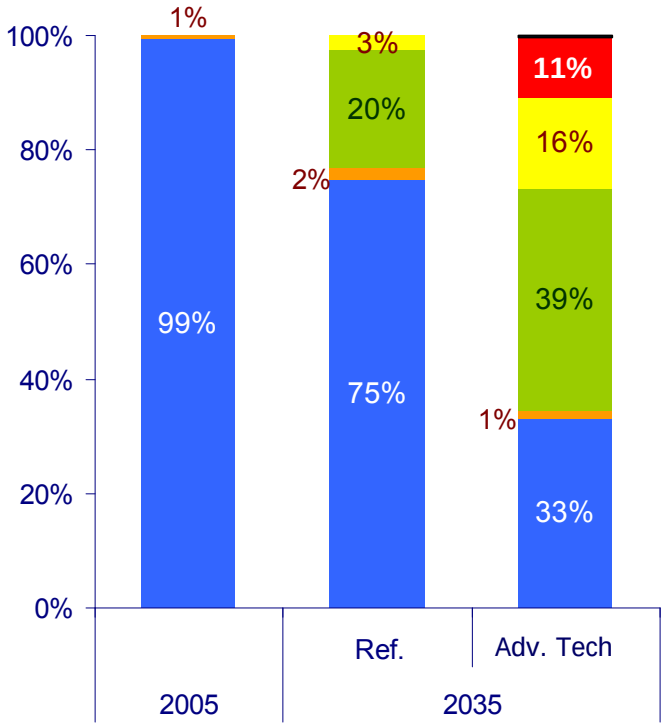
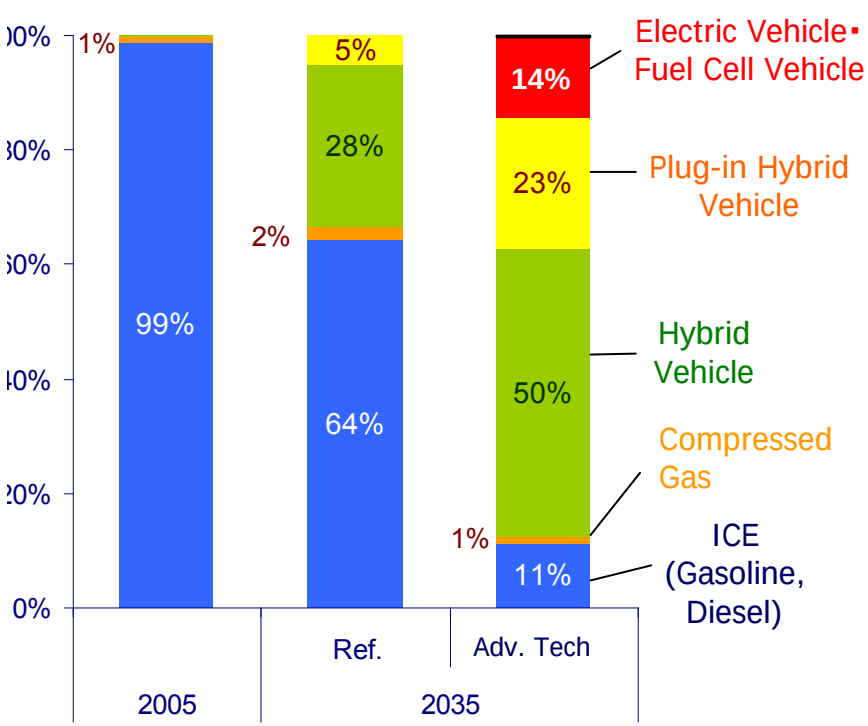
Vehicle Stock and Sales by Type (World)

【The Share of Vehicle Stocks by Type (World)】



【The Share of Vehicles' Annual Sales by Type (World)】



Share of clean energy vehicles in total stocks (2035)

Reference **25 %**
Adv. Tech **67 %**

Share of clean energy vehicles in annual sales (2035)

Reference **36 %**
Adv. Tech **89 %**

In the Advanced Techologies Scenario, clean energy vehicles will gradually account for almost 90% of the annual sales by 2035, and comprise two-thirds of the total stock.

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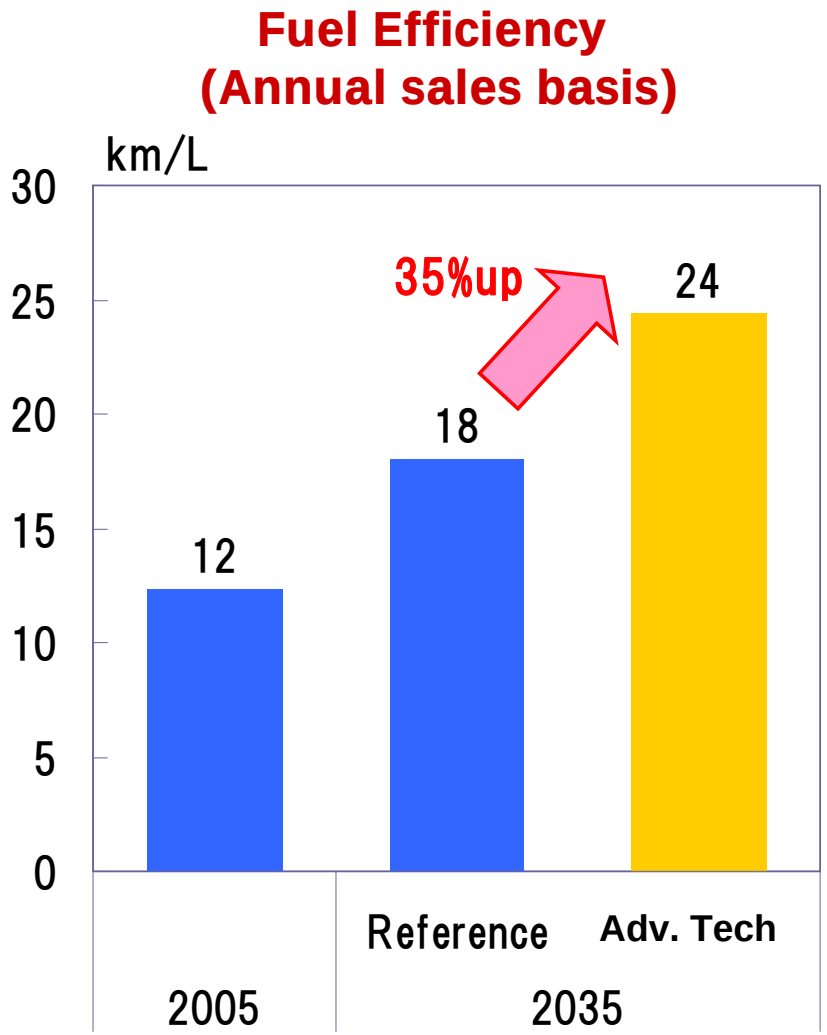
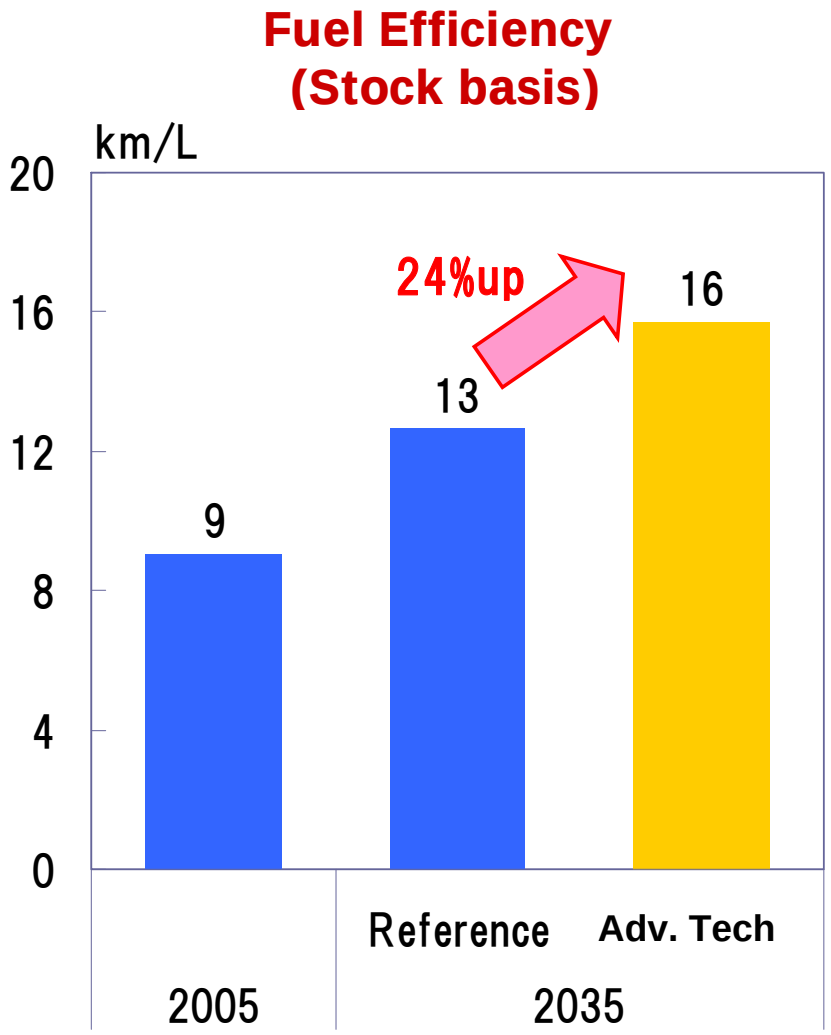
Fuel Efficiency of Passenger Vehicles (World)





In 2035, the passenger vehicles' fuel efficiency in the Adv. Tech. Scenario will achieve a 35% improvement in comparison with the Reference Scenario, raising the average stock by 24%.

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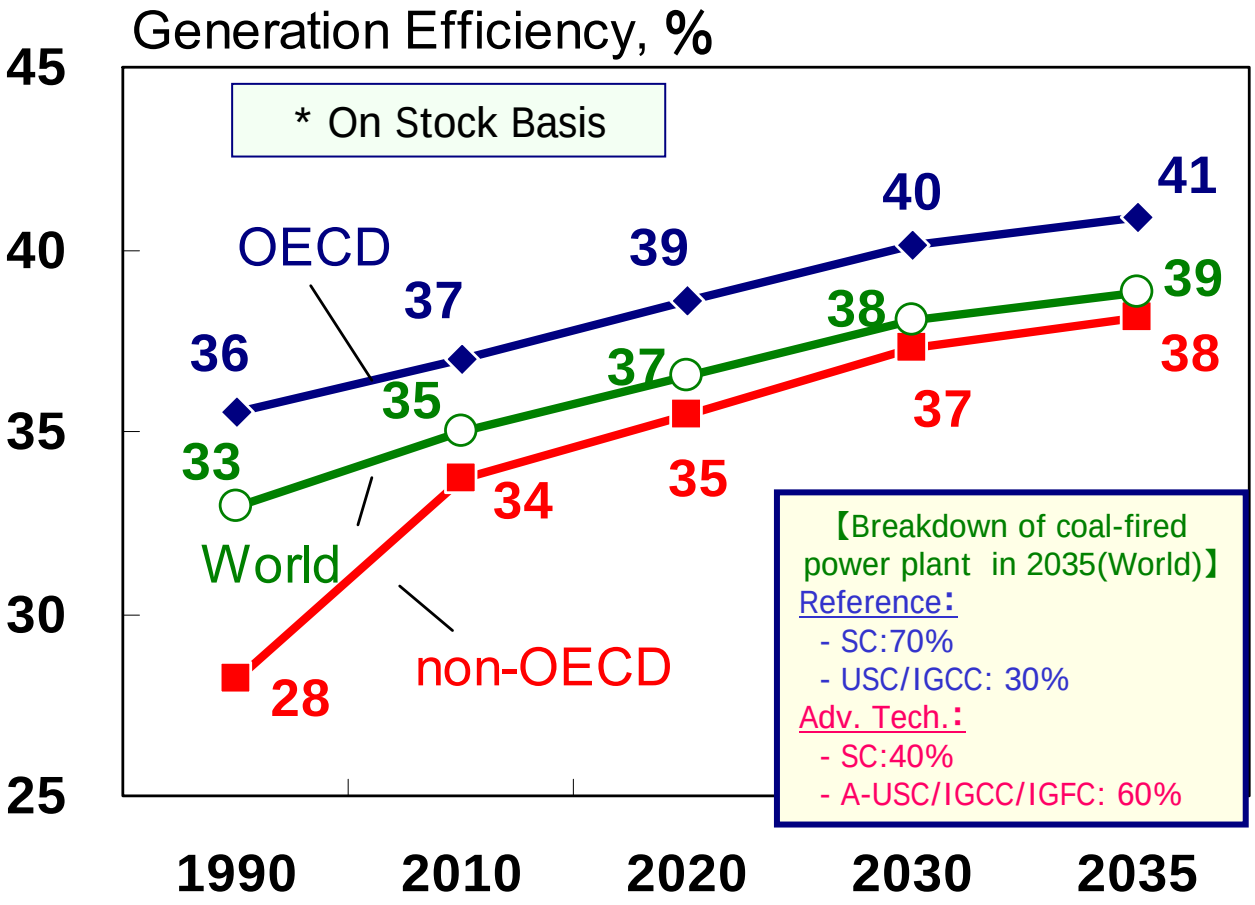
Power Generation Efficiency of Coal-fired Power Plant

Power Generation Efficiency of Coal-fired Power Plant *(Reference)

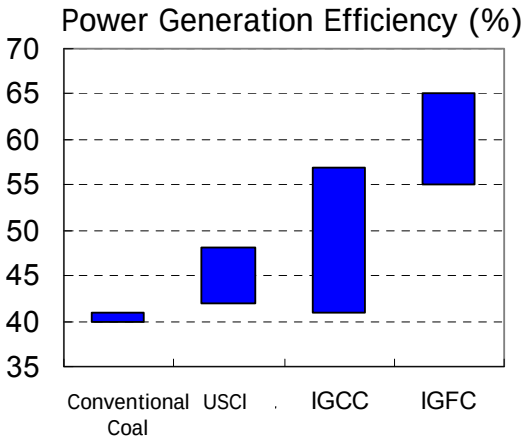


Stock-based Efficiency of Coal-fired Power Plant (World)

2010
35 %
↓
2035

Reference	Adv. Tech
39 %	**41 %**
(**6**points up)	(**8**points up)

Advanced Coal-fired Plant



In the Adv.Tech. Scenario, coal-fired generation efficiency will increase by a further 2 % compared to the Reference Scenario. As a result of this enhancement in efficiency, an additional 1.0 Gt-CO_2 will be reduced.

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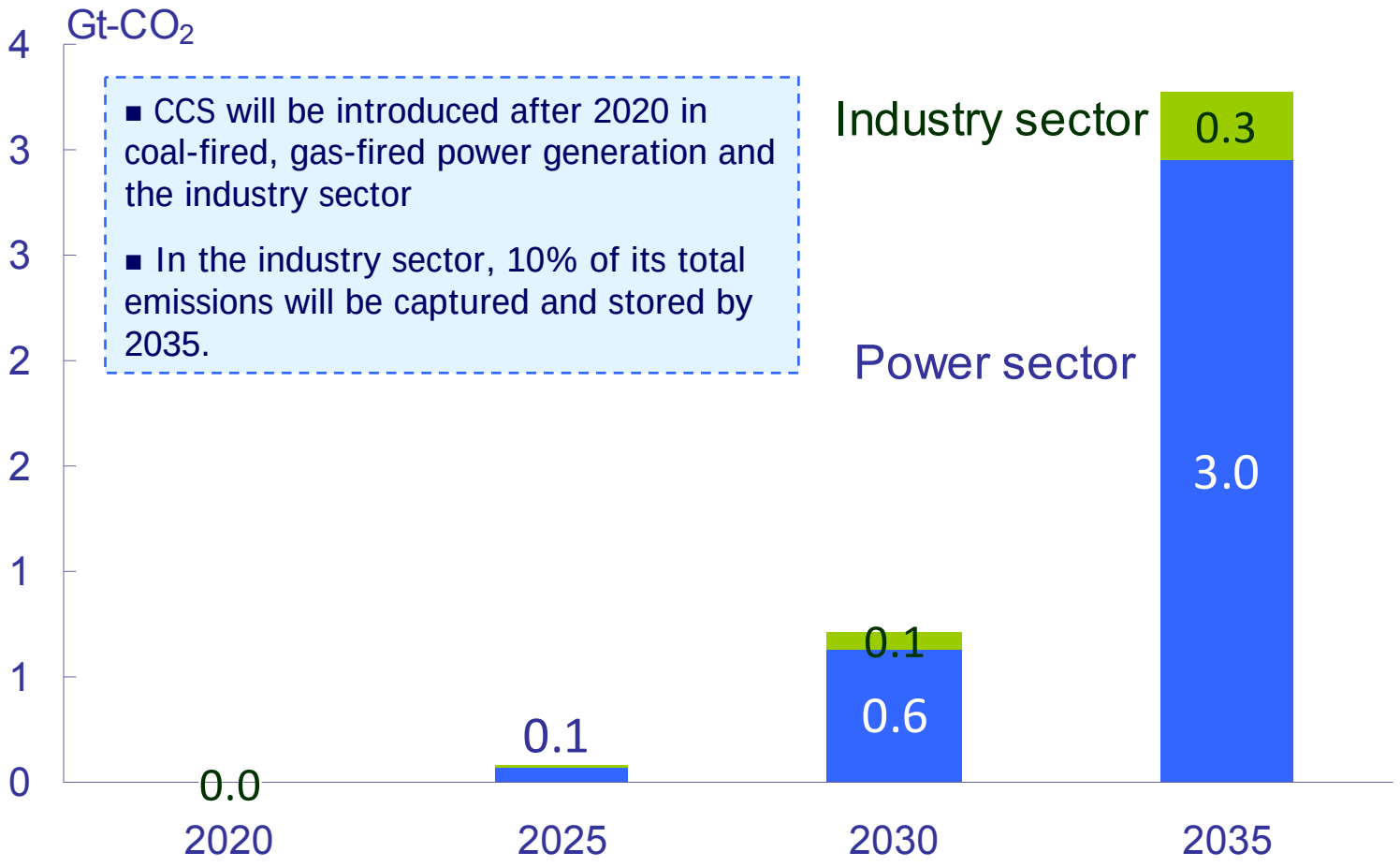
CO_2 Capture & Storage (CCS)



■ Cumulative captured and stored CO_2 from 2020 to 2035 will reach 12 Gt. That projected CO_2 emissions reduction from the CCS in the Tech. Adv. Scenario can be easily accommodated in geological structures (estimated at 10 trillion tons) and in depleted gas, oil and coal fields (estimated at1 trillion tons).

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Energy Outlook in Asia and the World 2010-2035

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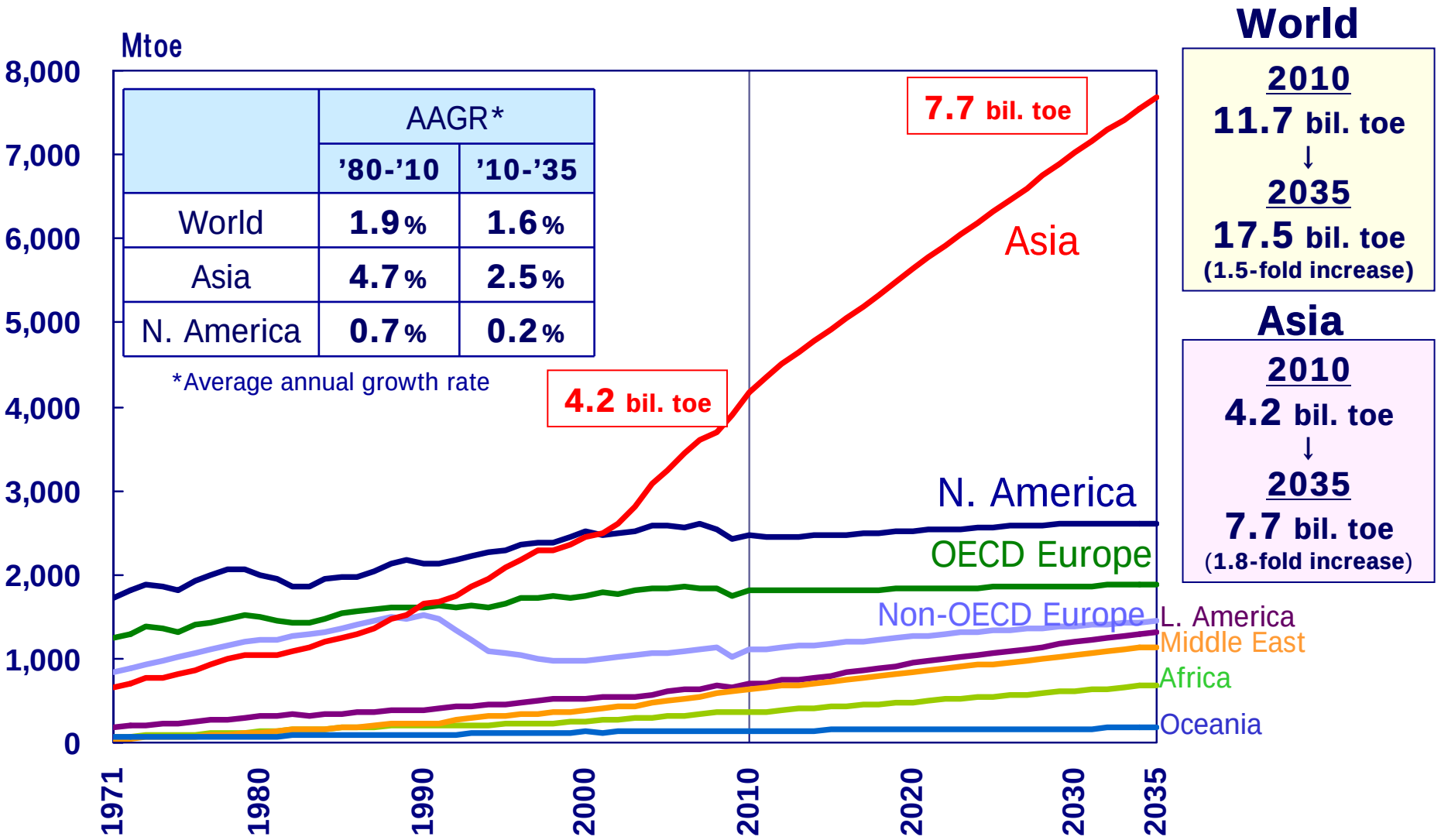
Primary Energy Demand by Region (World)

Reference



■ Reflecting high economic growth for Asian countries, primary energy demand in Asia will increase 1.8 times by 2035 from current levels; 4.2 billion toe(2010) → 7.7 billion toe(2035).

■ Non-OECD countries will represent 93% of incremental growth of global energy demand.

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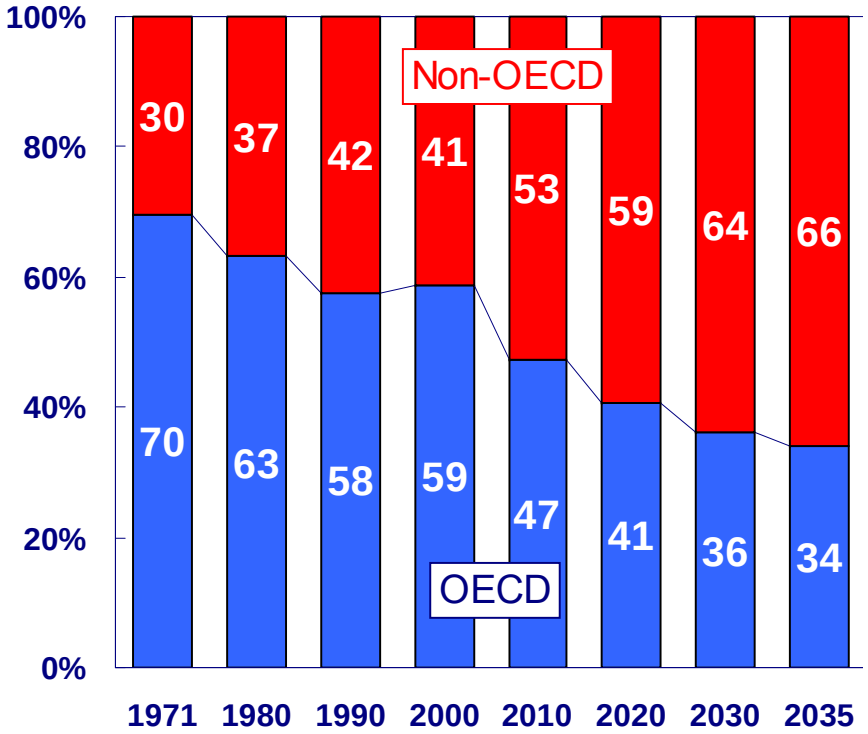
Primary Energy Demand (Regional Share)

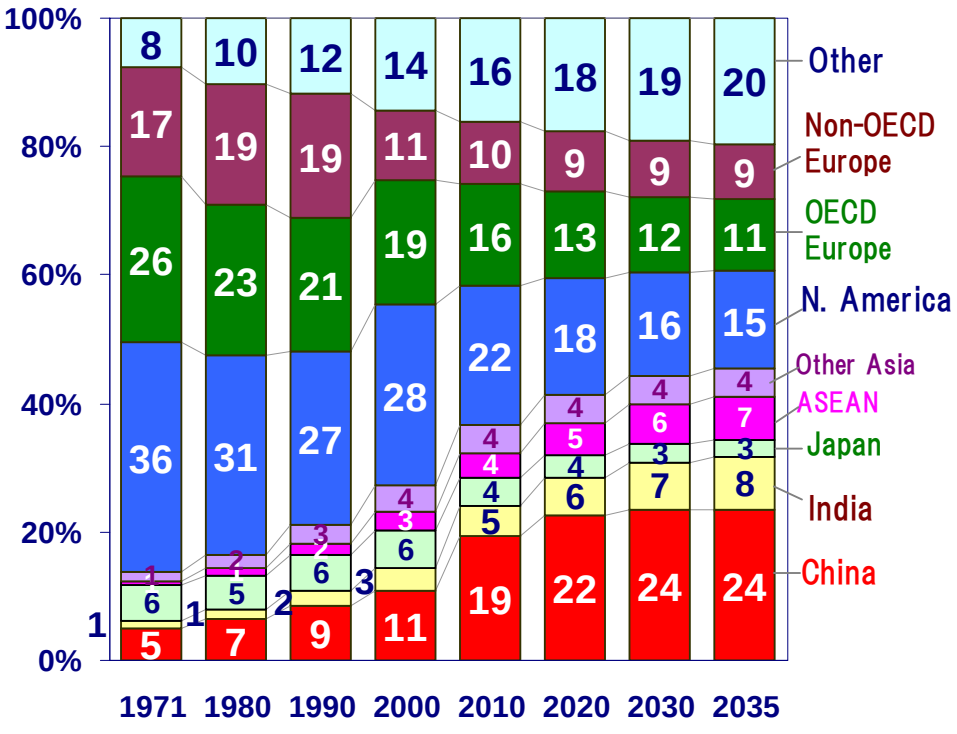
Reference

Share in increase (2010-2035)

China	India	Japan	ASEAN	Other Asia	N. America	OECD Europe
32%	15%	-1%	12%	5%	3%	1%

Asia occupies more than 60% of total growth.





■ Reflecting steady economic growth, energy demand in Non-OECD will exceed that of OECD.
■ Energy demand in Asia will exhibit a rapid growth, with the share of Asia in the world energy demand expanding from 37% in 2010 to 45% by 2035.
■ The share of China in the world energy demand will increase to 24% by 2035, and India to 8% (a total of 32%). The share of Japan will decline from 4% in 2010 to 3% of world energy demand in 2035.

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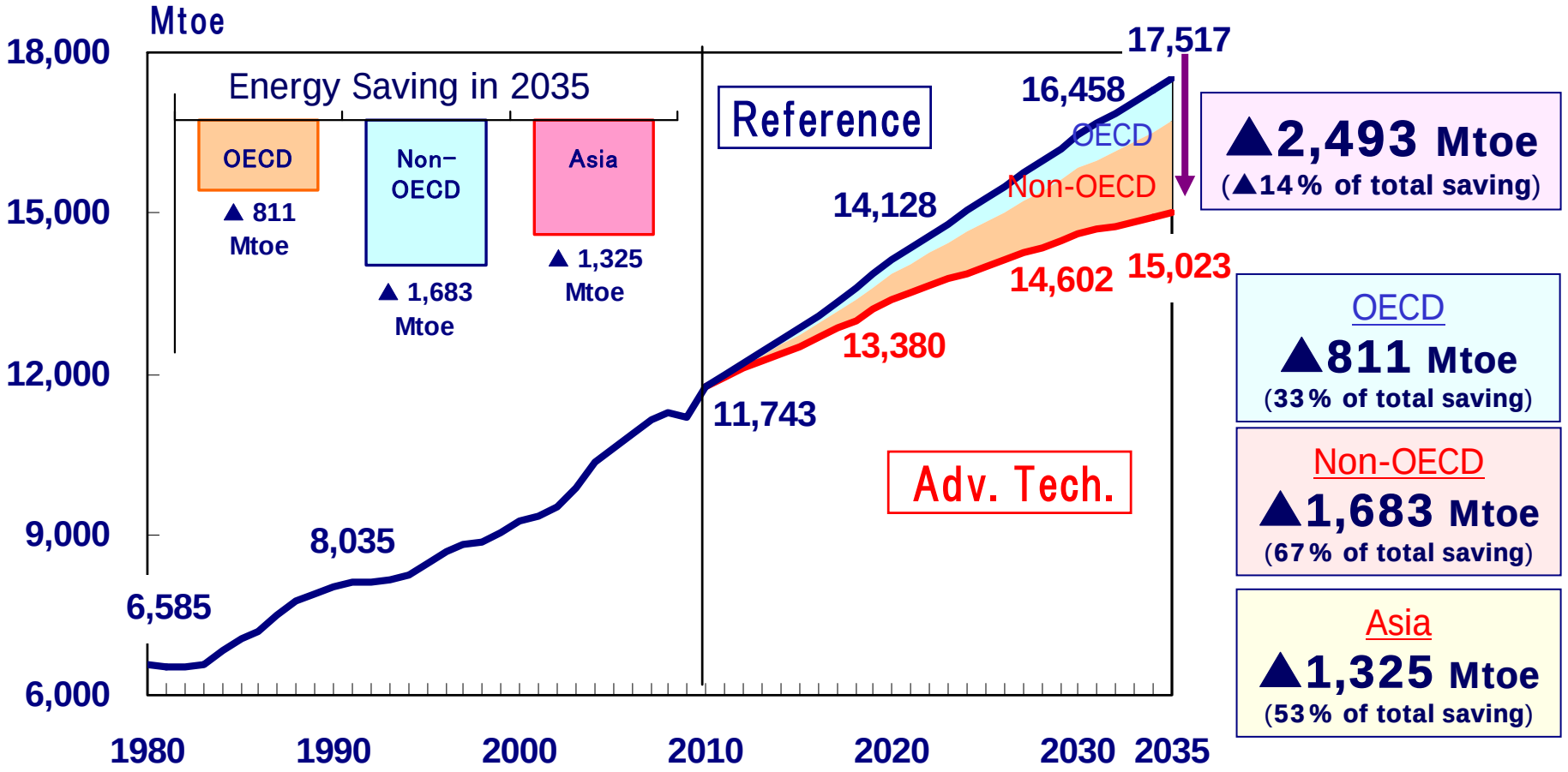
Primary Energy Demand (World)

Reference
Adv. Tech.



■ In 2035, total primary energy demand in the Adv. Tech Scenario will be 2,493 Mtoe (about 14%) lower than the Reference Scenario. This saving is more than 5.0 times Japan's total demand in 2010.
■ In the Adv. Tech. Scenario, Non-OECD countries will contribute more than two thirds of the potential savings. The potential in Asia is particularly significant.

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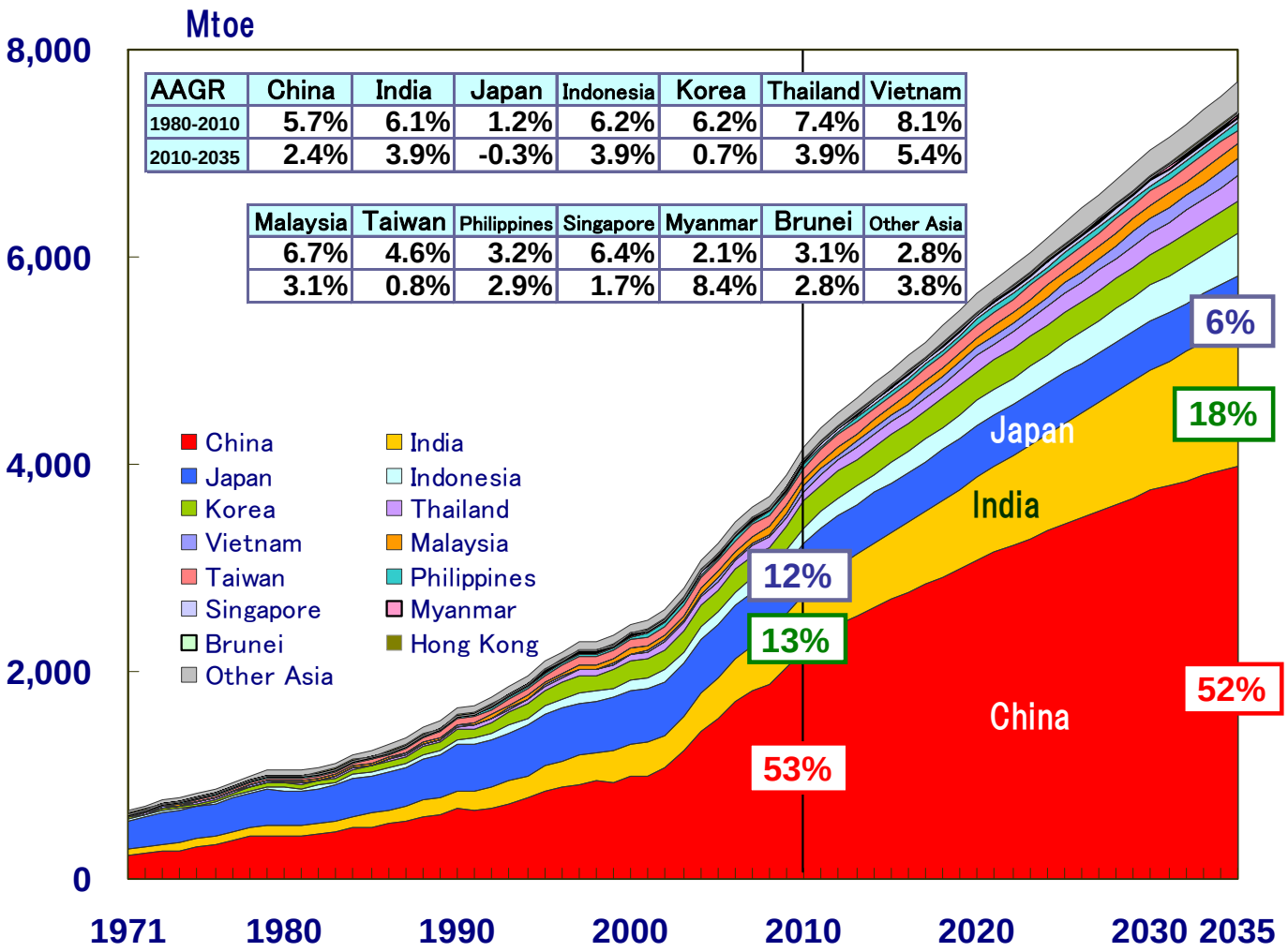
Primary Energy Demand (Asia)

Reference



AAGR	China	India	Japan	Indonesia	Korea	Thailand	Vietnam
1980-2010	5.7%	6.1%	1.2%	6.2%	6.2%	7.4%	8.1%
2010-2035	2.4%	3.9%	-0.3%	3.9%	0.7%	3.9%	5.4%

Malaysia	Taiwan	Philippines	Singapore	Myanmar	Brunei	Other Asia
6.7%	4.6%	3.2%	6.4%	2.1%	3.1%	2.8%
3.1%	0.8%	2.9%	1.7%	8.4%	2.8%	3.8%

Asia

2010

4.2 bil. toe

↓

2035

7.7 bil. toe

(**1.8-fold increase**)

China / India

2010

2.2 bil. toe / 0.52 bil. toe

↓

2035

4.0 bil. toe / 1.4 bil. toe

(**1.8-fold inc. / 2.6-fold inc.**)

■ The increase in energy demand of China and India reflects the high economic growths of those countries. Together they will represent almost 70% of the Asian primary energy demand by 2035.

■ Japan's energy requirements will decline overtime and its share in Asia will substantially decline from 12% in 2010 to 6% in 2035.

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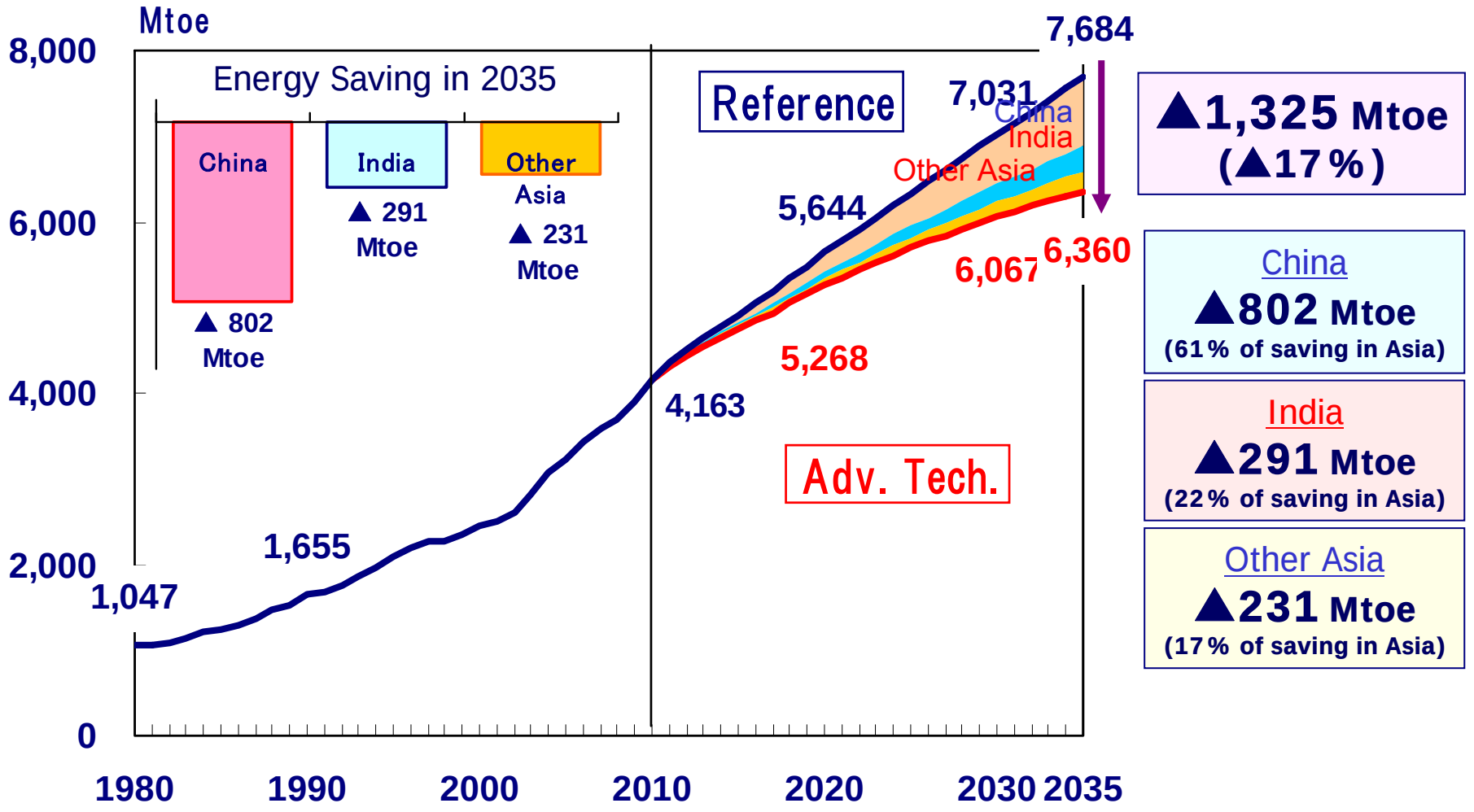
Primary Energy Demand (Asia)

Reference
Adv. Tech.



■ The potential savings in Asia under the Adv. Tech. Scenario will be 1,325 Mtoe (equivalent to about 2.7 times Japan's current consumption). China and India which represents 70% of the Asian's demand, will have 83% of the saving potential.

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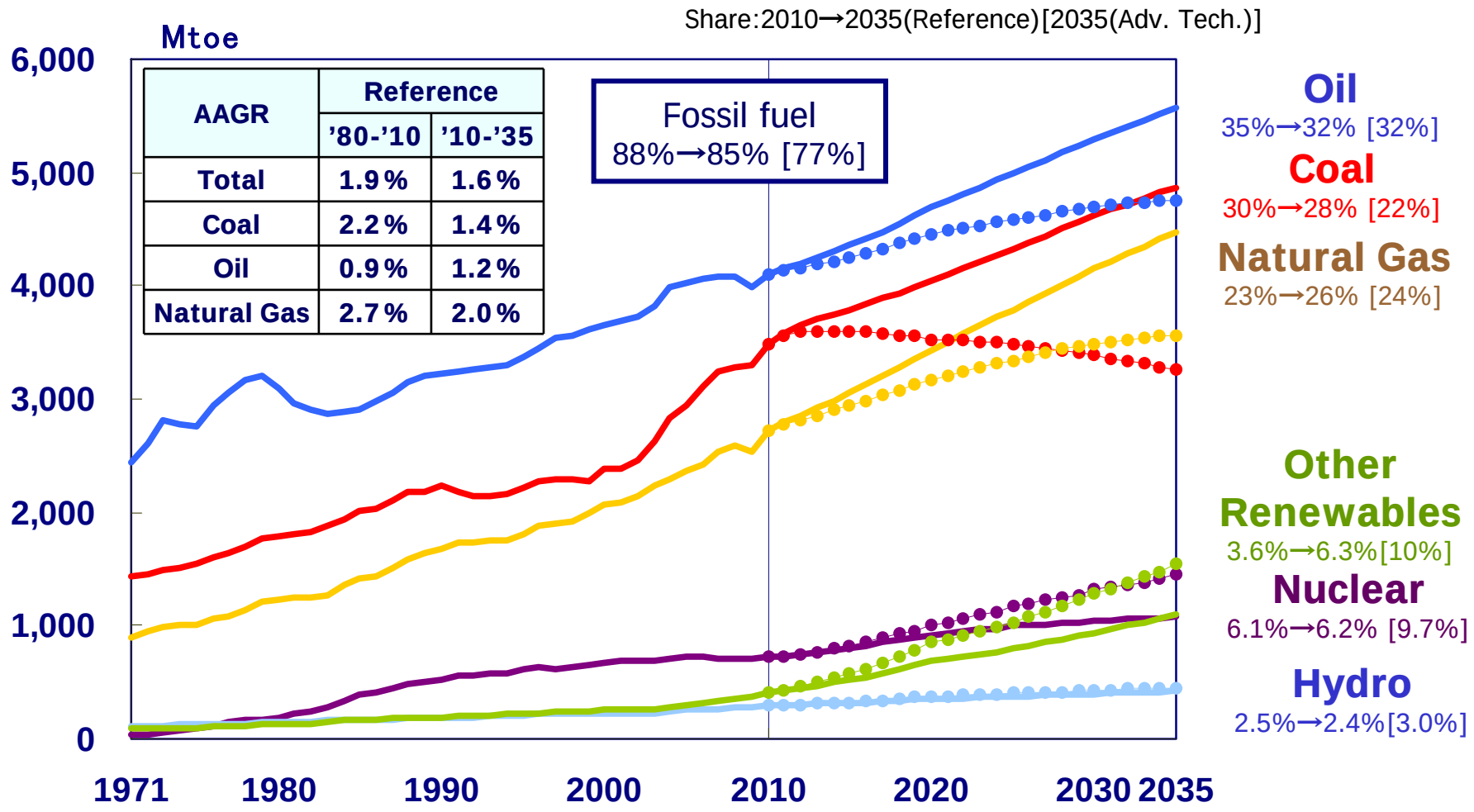
Primary Energy Demand by Type (World)

Solid line: Reference
Dotted line: Adv. Tech.



■In the Reference scenario, fossil fuels will continue to increase in use and account for more than 85% of the primary energy mix and each one will maintain their ranking in terms of share.

■In the Adv. Tech. Scenario, however, coal use will start its decline within a few years to reach levels lower than current consumption by 2035. Oil and natural gas (with its extensive use in various sectors) will continue to grow at a lower pace throughout the period to 2035.

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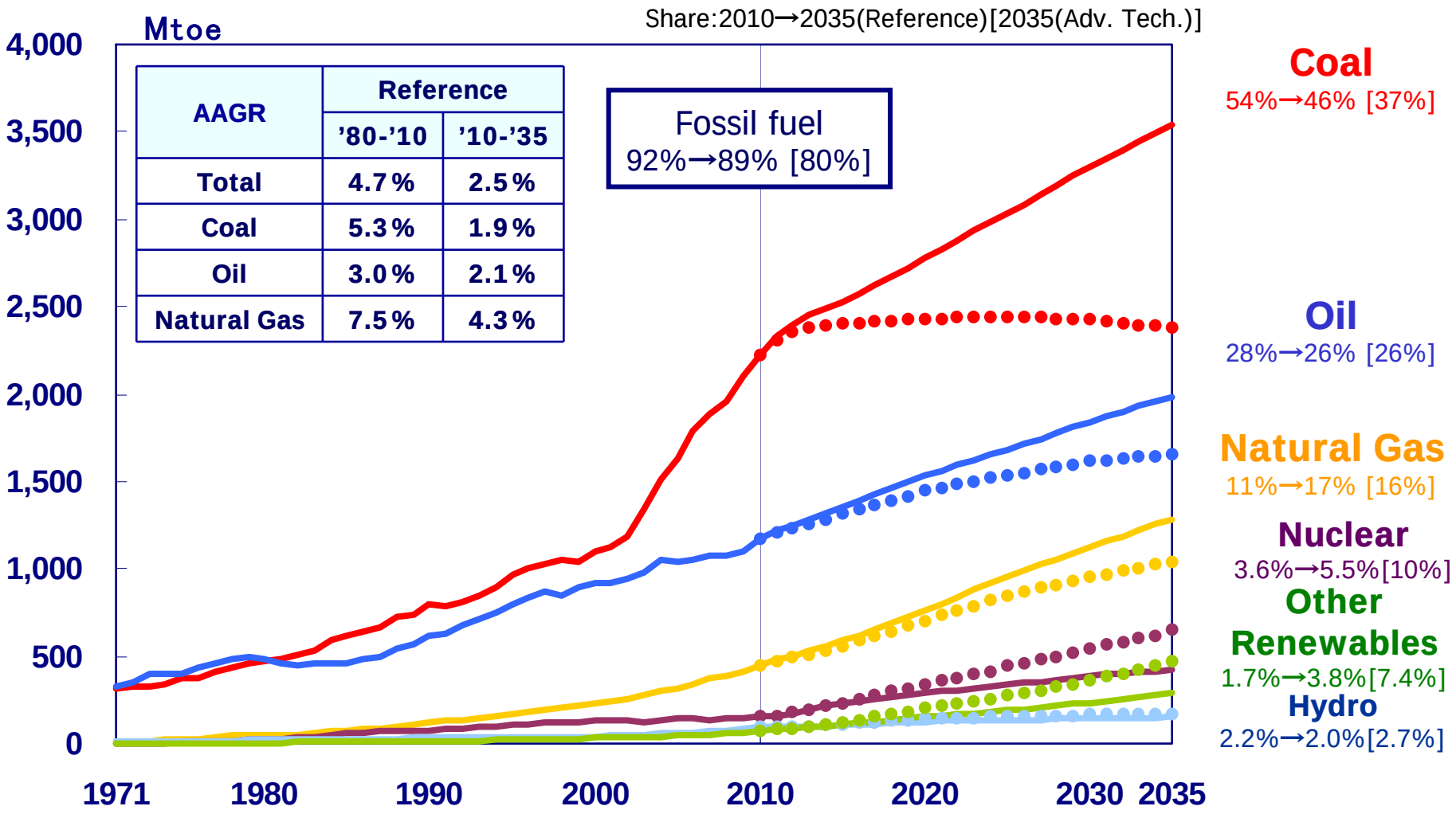
Primary Energy Demand by Type (Asia)

Solid line: Reference
Dotted line: Adv. Tech.



- Although coal and oil will continue to maintain the dominant share of energy demand through 2035, their combined shares will diminish from 82% today to 72%.
- The share of natural gas will increase substantially reaching 17% by 2035, driven mainly by power generation.

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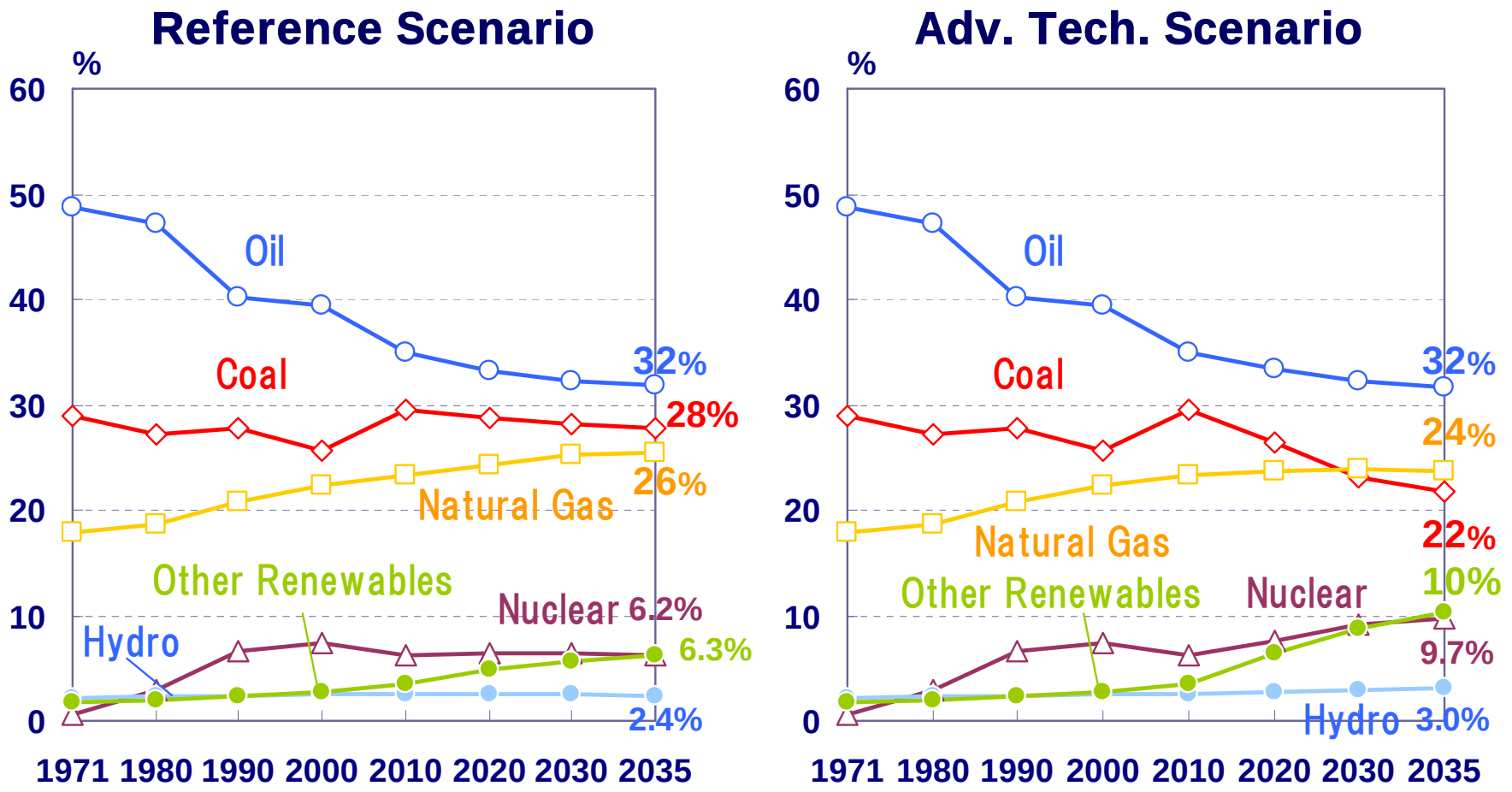
Primary Energy Mix (World)



■ In the Reference Scenarios, the oil's share decreases substantially to 32%, while the share of natural gas and renewables will expand substantially.

■ In the Adv. Tech. Scenario, coal will significantly decrease mainly in Non-OECD. The share of nuclear and renewables will gradually expand. Fossil fuel will remain the most important fuel in primary energy mix in 2035, maintaining the 77% share.

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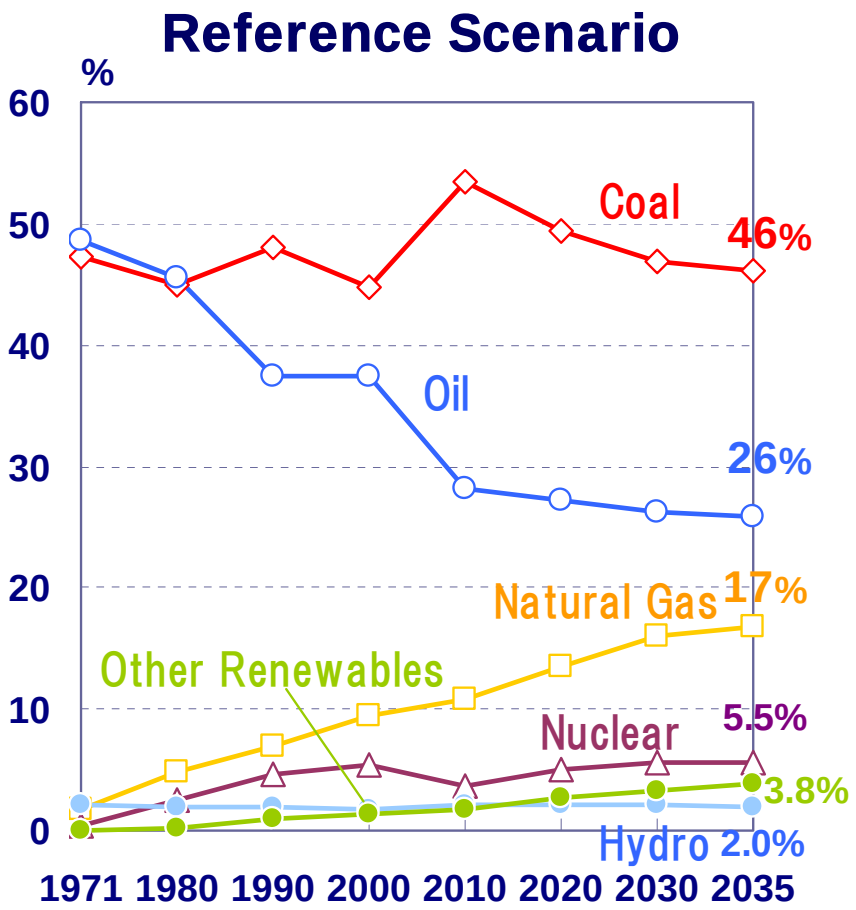
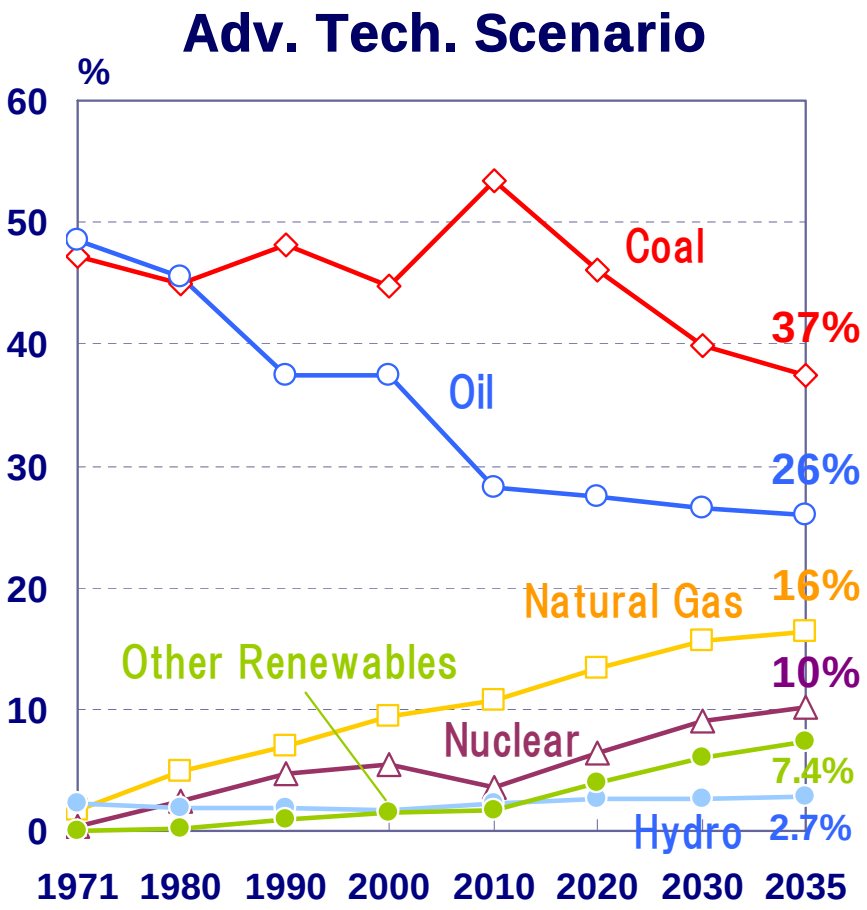
Primary Energy Mix (Asia)





■ Coal will keep the biggest share of primary energy demand driven by the electric power demand through 2035. (The coal's share in Asia: 54% (2010) →46% (2035) in Reference, 37% (2035) in Adv. Tech.)

■ Natural gas in both scenarios will continue to grow. In the Adv. Tech. Scenario, the share of nuclear will gradually increase with active building-up of nuclear power plants in China, India and South Korea.

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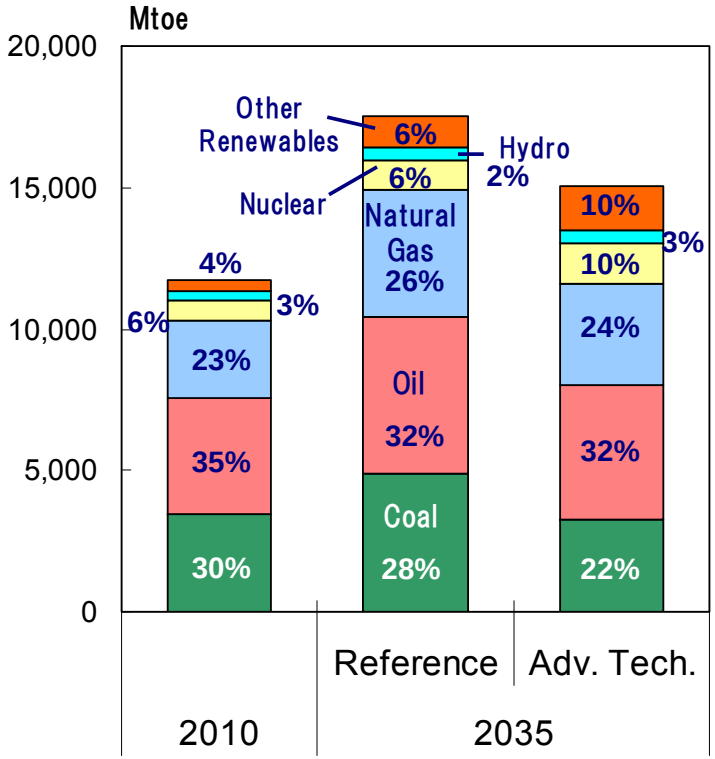
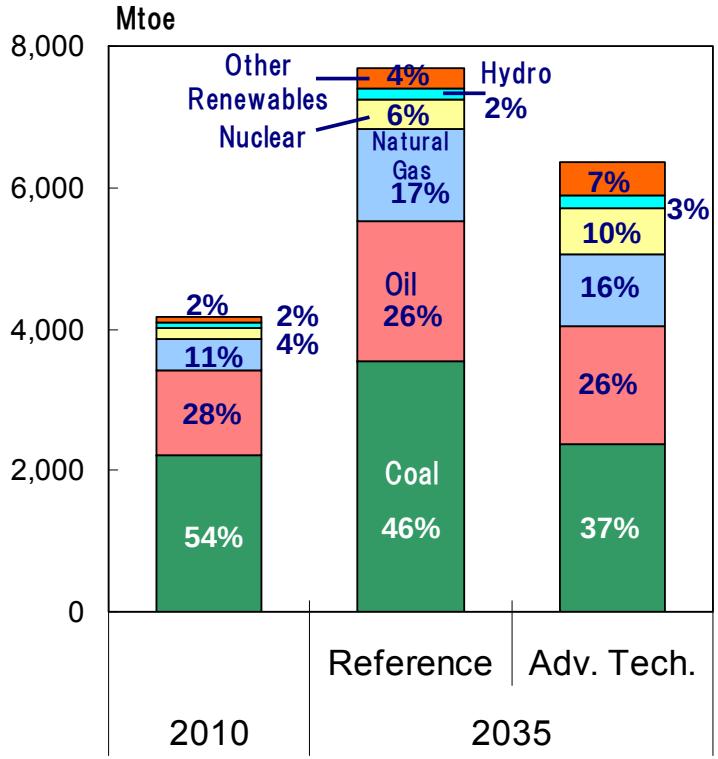
Primary Energy Mix (World, Asia)

Reference
Adv. Tech.

【World】



【Asia】



Share of Non Fossil Fuel (World)

2010
12 %
↓
2035
Reference Adv. Tech.
15 % **23 %**
(3%up) **(11%up)**

Share of Non Fossil Fuel (Asia)

2010
8 %
↓
2035
Reference Adv. Tech.
11 % **20 %**
(4%up)
(13%up)

■ In the Adv. Tech. Scenario, the share of non fossil fuel in the energy demand will increase to 22/23%, in 2035.
■ Of course fossil fuel will continue to be the most important fuel in the world and Asia by 2035.

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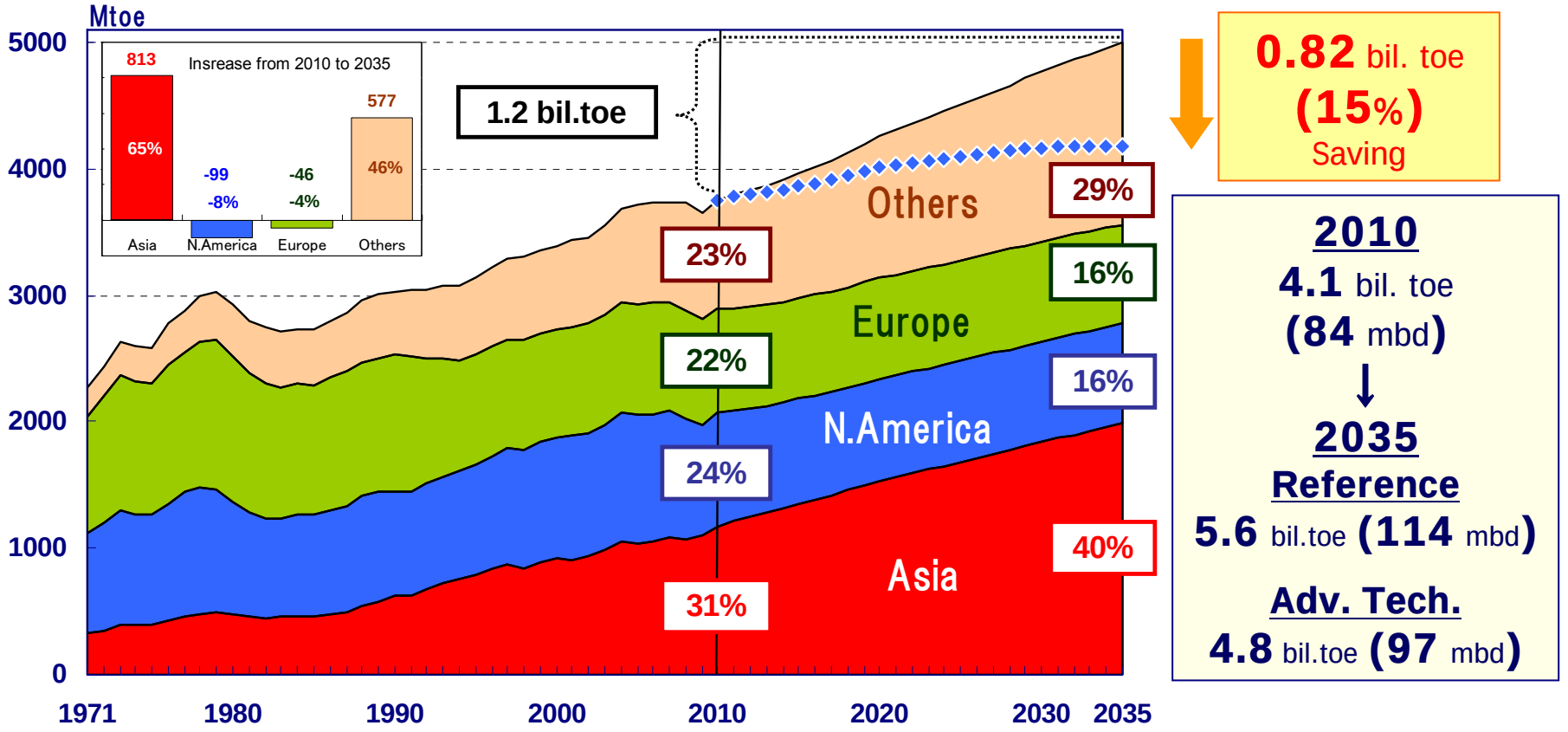
Oil Demand by Region (World)

Solid line: Reference
Dotted line: Adv. Tech.



■ The share of Asia in the world oil demand will increase from 31% (2010) to 40% (2035). About 60% of the global oil growth will take place in Asia.

■ Oil demand in OECD started to decrease in 2005. As this trend will continue through 2035, the share of OECD will decrease from about 52% in 2010 to 35% in 2035.

■ In the Adv. Tech. the world oil demand will be 0.82 billion ton (15%) lower in 2035 compared with the Reference Scenario.

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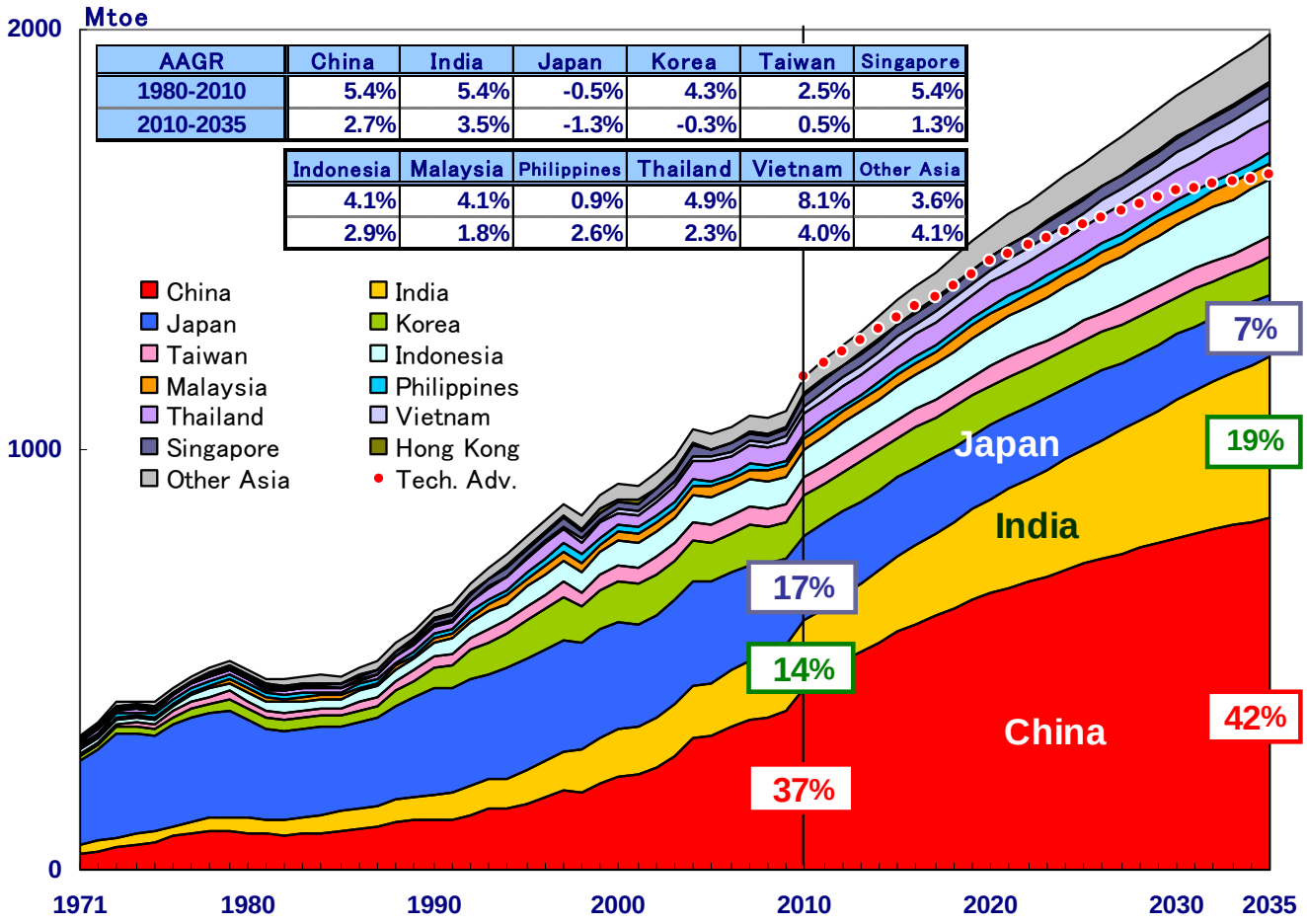
Oil Demand by Region (Asia)

Reference
Adv. Tech.



AAGR	China	India	Japan	Korea	Taiwan	Singapore
1980-2010	5.4%	5.4%	-0.5%	4.3%	2.5%	5.4%
2010-2035	2.7%	3.5%	-1.3%	-0.3%	0.5%	1.3%

Indonesia	Malaysia	Philippines	Thailand	Vietnam	Other Asia
4.1%	4.1%	0.9%	4.9%	8.1%	3.6%
2.9%	1.8%	2.6%	2.3%	4.0%	4.1%

0.34 bil.toe
(17%)
Reduction

2010
1.17 bil.toe
(24.1 mbd**)**
↓
2035
Reference
1.99 bil.toe **(40.7** mbd**)**
Adv. Tech.
1.65 bil.toe **(33.8** mbd**)**

■ Though the vehicles' fuel efficiency may be improved, and clean energy vehicles may expand, oil demand in Asia will expand from 24.1 million B/D in 2010 to 40.7 million B/D in 2035, due mainly to its escalating vehicle ownership. The share of China and India together in Asian oil demand will grow from 51% in 2010 to 62% in 2035.

■ Even in the Adv. Tech. Scenario, projected oil demand saving will be equal to 17% of the Reference Scenario in 2035.

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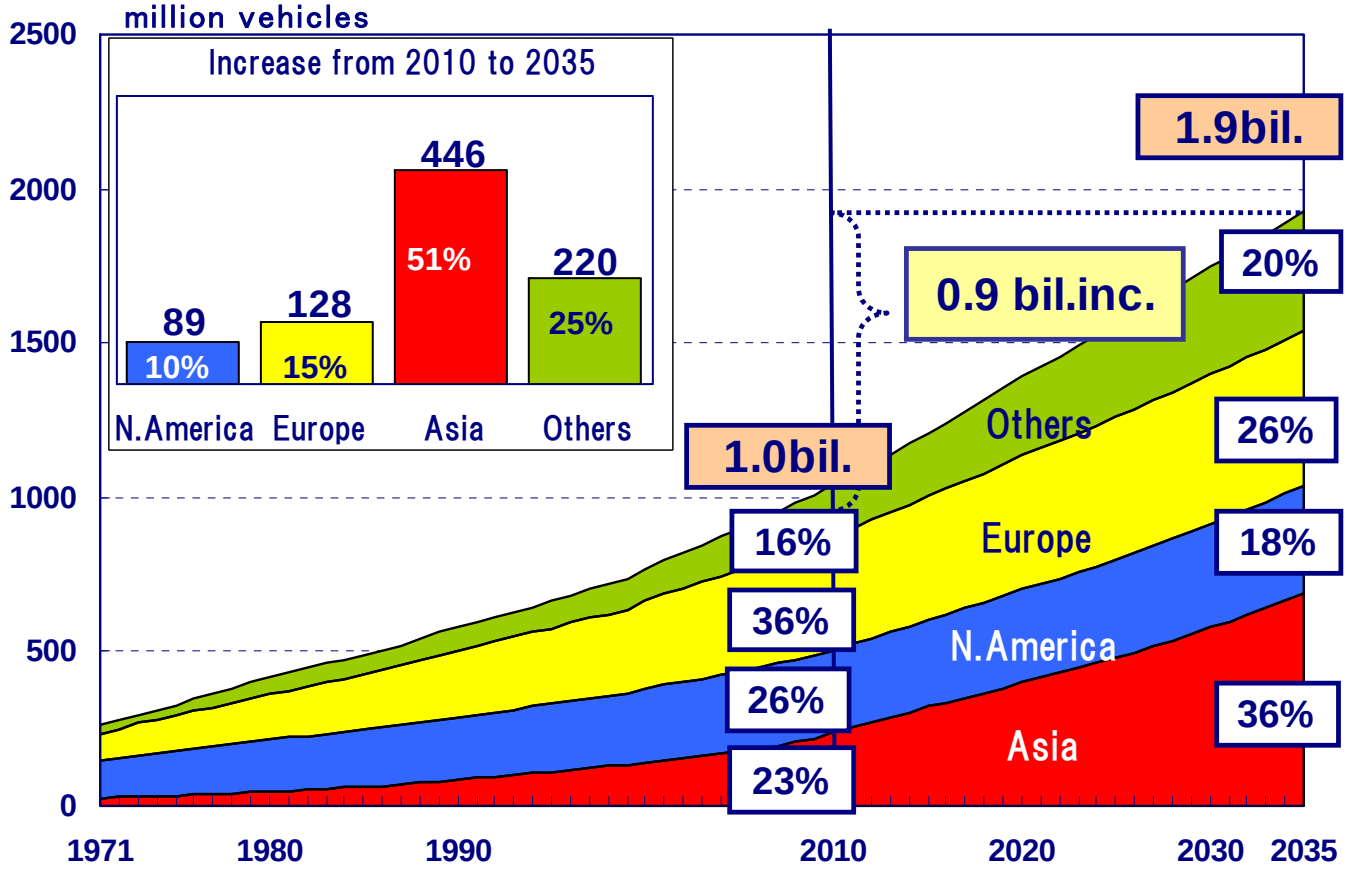
The Number of Vehicles (World)

Reference
Adv. Tech.



World

2010
1.0 bil.
↓
2035
1.9 bil.
(**1.9**-fold inc.)

Asia

2010
0.24 bil.
↓
2035
0.69 bil.
(**2.8**-fold inc.)

- Approximately 36% of the world vehicle stocks will be concentrated in Asia.
- The share of vehicle stocks in OECD will decline from 67% in 2010 to 46% in 2035.The stock in Non-OECD will surpass that of OECD by 2035.

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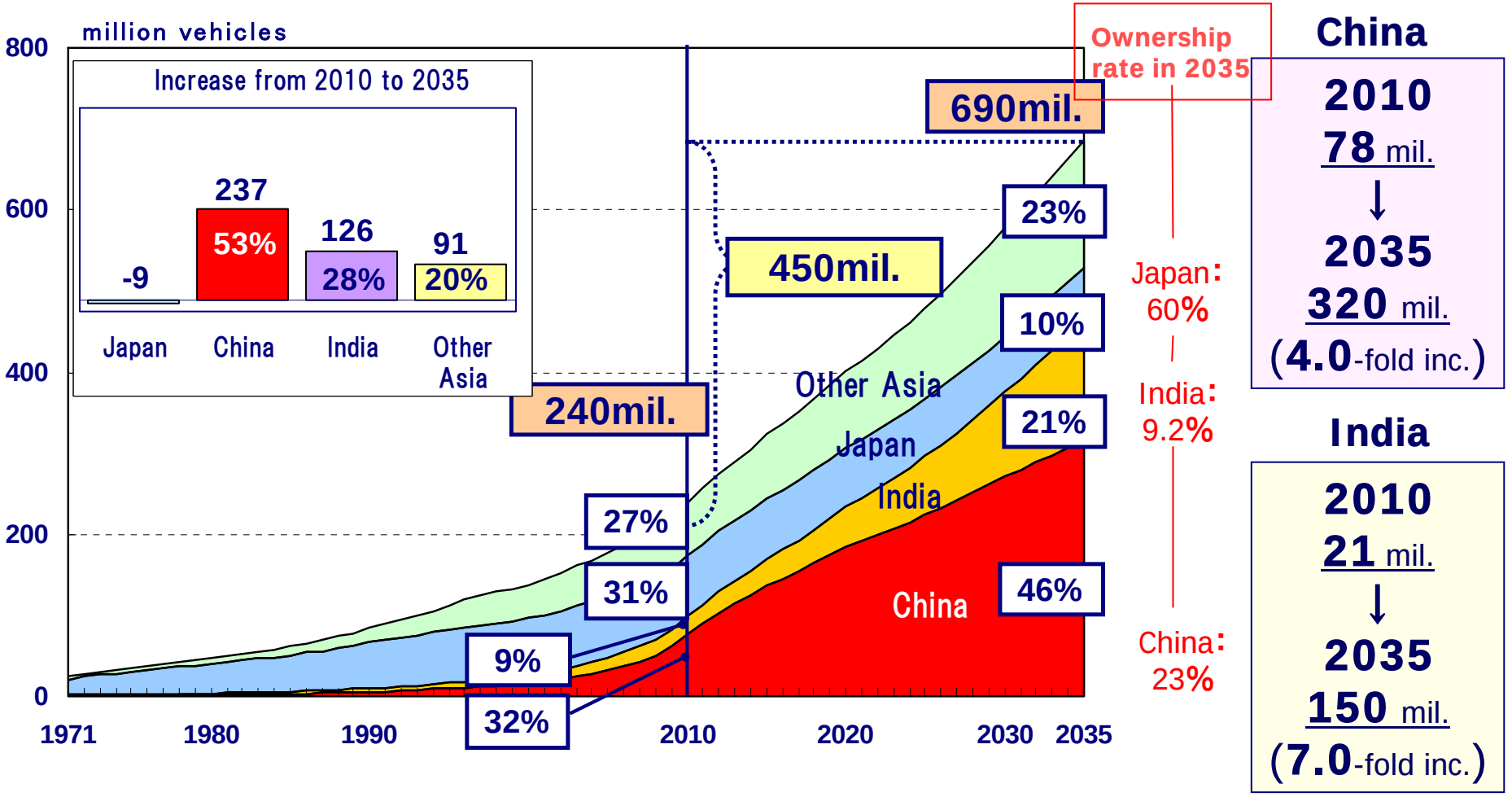
The Number of Vehicles (Asia)

Reference
Adv. Tech.



China vehicle stocks will expand substantially due to an increase in the income level. Number of vehicle stocks in China will increase from 78 million units in 2010 to 320 million units in 2035. India's vehicle stocks will surpass that of Japan around 2025. Number of vehicle stocks in India increase from 21 million units in 2010 to 150 million units in 2035.

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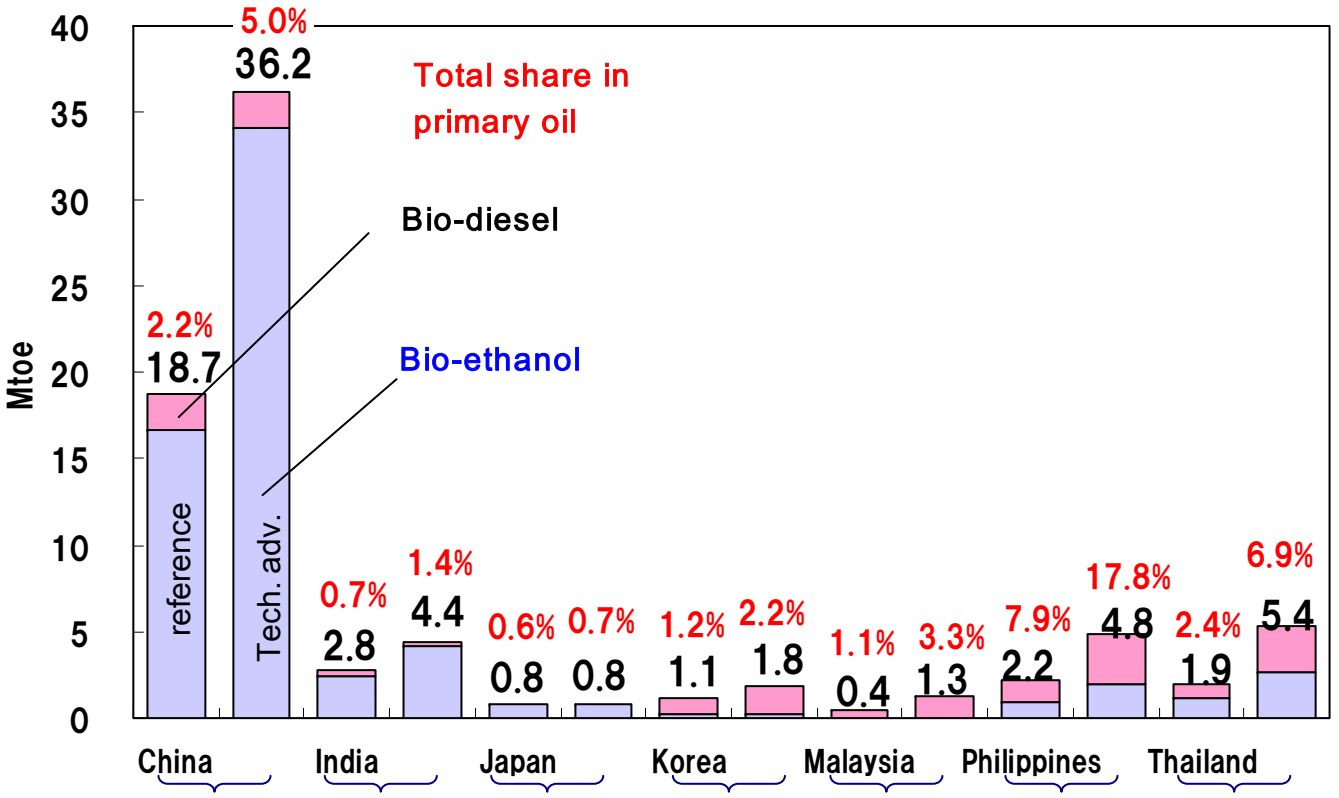
Biofuel Outlook in Asia and the World (2035)



World

2010
61 mil. toe
↓
2035
210 mil. toe
(**3.4**-fold inc.)

Asia

2010
2.9 mil. toe
↓
2035
30 mil. toe
(**10**-fold inc.)

■In the Reference Scenario, the world biofuel demand is expected to reach 210 Mtoe by 2035 mainly driven by the growth in North America, Europe and Latin America. Asia will consume 30 Mtoe of bio-fuel by 2035. The share of bio-fuel in global liquid fuel will amount to 3.6% in 2035.

■In Asia, ethanol demand will mainly increase in China, India and Japan, while biodiesel will increase in Korea, Indonesia, and Malaysia.

■In the Adv. Tech. Scenario, the world bio-fuel demand will reach 260 Mtoe 2035, and that of Asia will reach 56 Mtoe.

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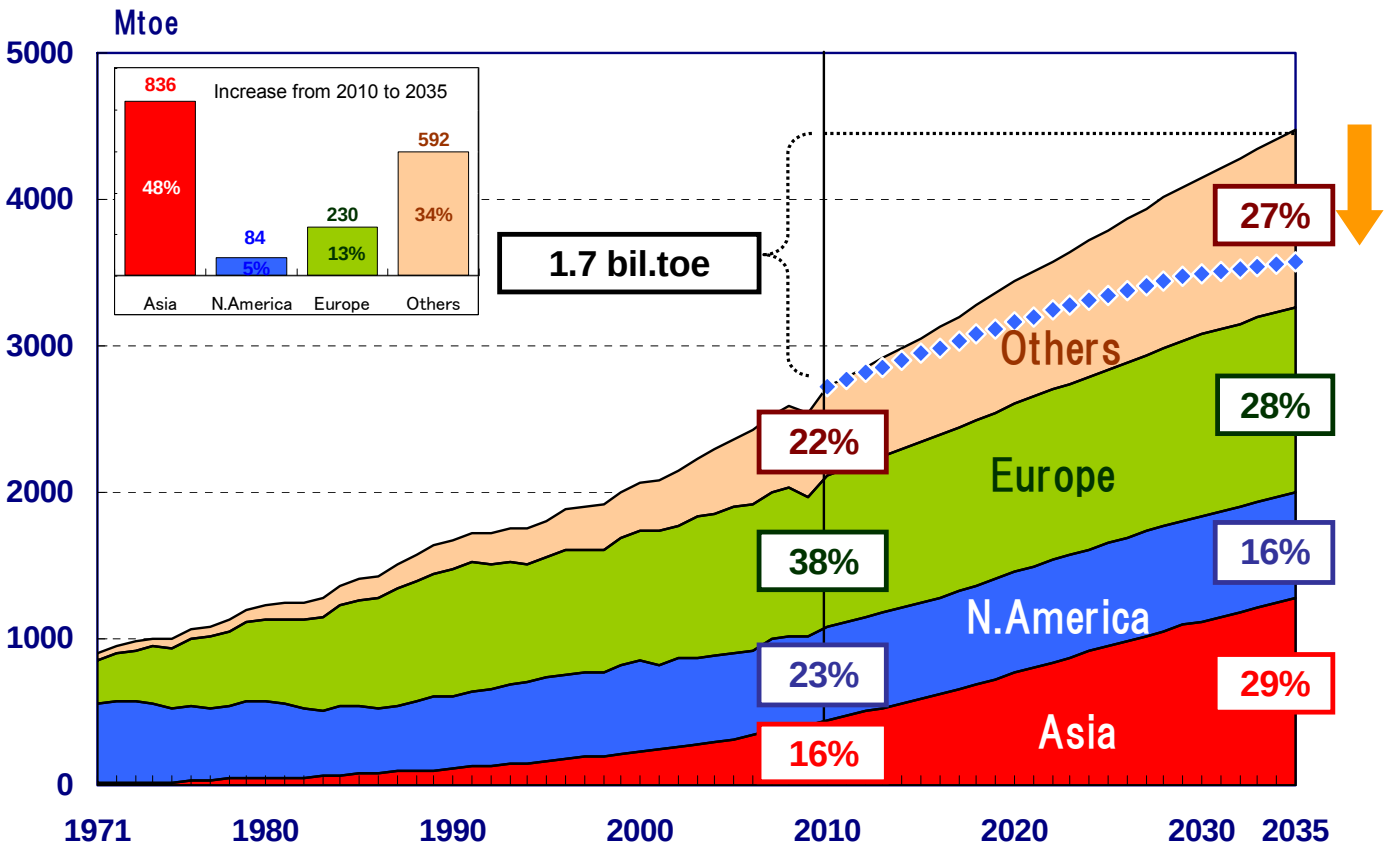
Natural Gas Demand by Region (World)

Reference
Adv. Tech.



0.90 bil.
(20%)
Reduction

2010
2.7 billion toe
(3.0 trillion m^3**)**
(2.2 bil.tonnes LNG**)**
↓
2035
Reference
4.5 billion toe
(5 trillion m^3**)**
(3.6 bil.tonnes LNG**)**
Adv. Tech.
3.6 billion toe
(4.0 trillion m^3**)**
(2.9 bil.tonnes LNG**)**

- The world natural gas demand is expected to increase from 3.0 trillion cubic meters (tcm) in 2010 to 5.0 tcm in 2035, a 1.6-fold increase.
- Non-OECD will account for 85% of the growth in the world natural gas demand from 2010 to 2035,
- In the Adv. Tech. Scenario, natural gas demand will be 0.90 tcm lower than the Reference Scenario. Despite the projected saving, natural gas demand will continue to grow in the Adv. Tech. Scenario suggesting further needs of energy resources development.

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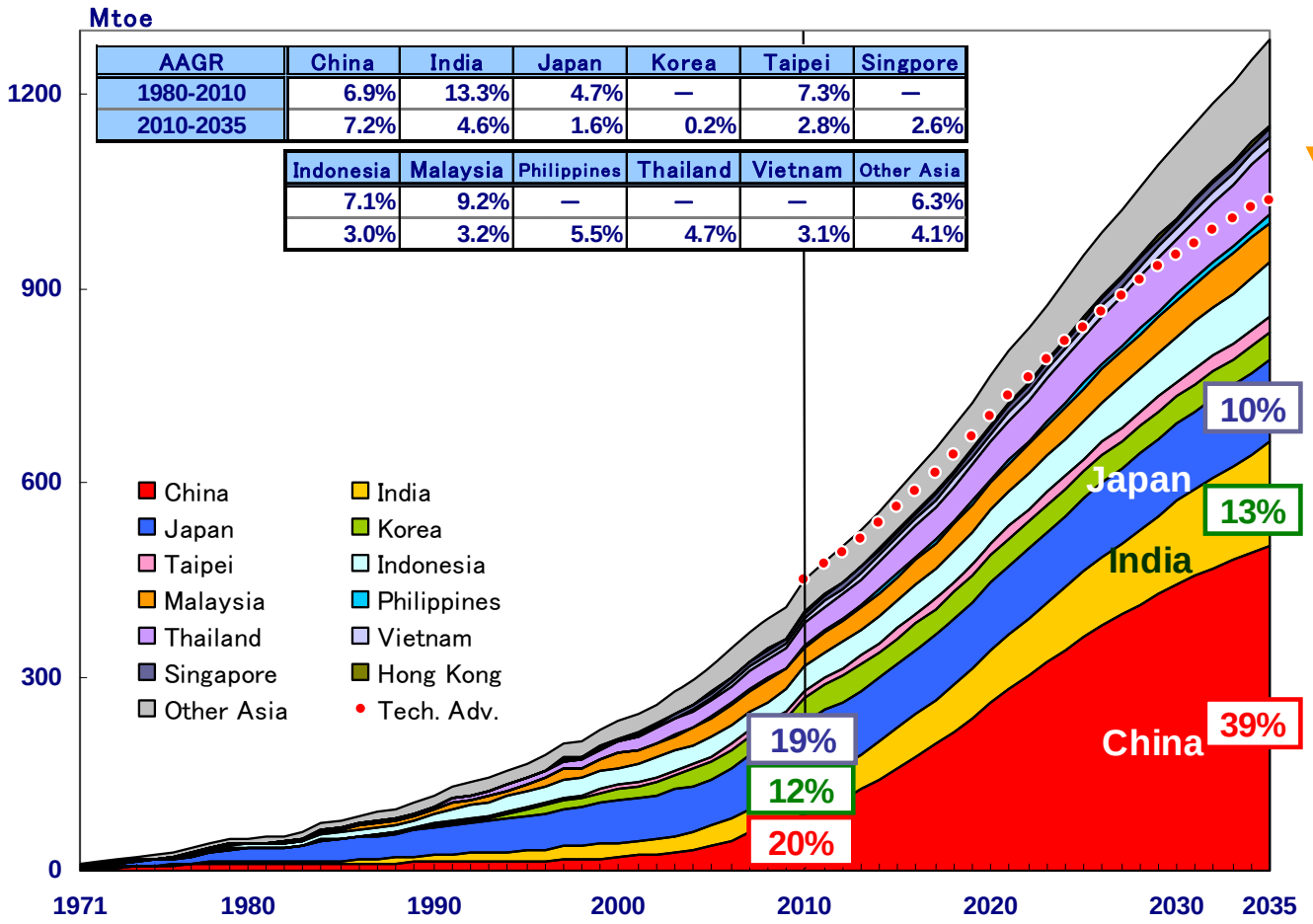
Natural Gas Demand by Country (Asia)

Reference
Adv. Tech.



AAGR	China	India	Japan	Korea	Taipei	Singpore
1980-2010	6.9%	13.3%	4.7%	—	7.3%	—
2010-2035	7.2%	4.6%	1.6%	0.2%	2.8%	2.6%

Indonesia	Malaysia	Philippines	Thailand	Vietnam	Other Asia
7.1%	9.2%	—	—	—	6.3%
3.0%	3.2%	5.5%	4.7%	3.1%	4.1%

0.25 bil.
(19%)
Reduction

2010
0.45 billion toe
(500 billion m^3**)**
(0.36 bil.tonnes LNG**)**
↓
2035
Reference
1.29 billion toe
(1.4 trillion m^3**)**
(1.04 bil.tonnes LNG**)**
Adv. Tech.
1.04 billion toe
(1.2 trillion m^3**)**
(0.84 bil.tonnes LNG**)**

■ Natural gas demand in China will considerably increase (7%/y) due mainly to the increasing demand for power generation and gas use in urban areas. India's natural gas demand will also expand but at a lower pace (5%/y), representing a three-fold increase from 2010 to 2035.

■ In the Adv. Tech. Scenario, the world natural gas demand will be 280 bcm (or 19%) lower than the Reference Scenario by 2035. Despite the gains, natural gas demand will increase at a relatively fast pace of 3.4% per year through 2035.

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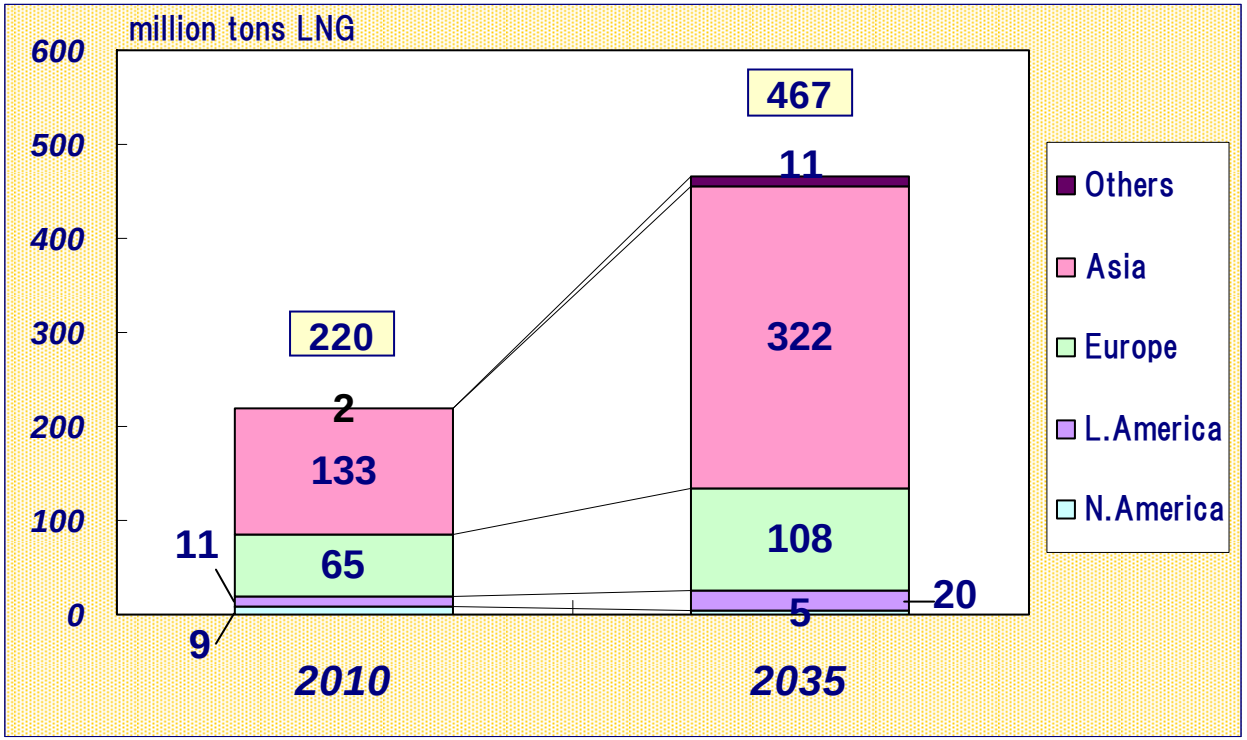
LNG Demand Outlook (World)

Reference



■ World LNG demand will expand 110% from 220 million tons in 2010 to 467 million tons in 2035.
■ Asia's LNG demand will increase by 189 million tons, accounting for 77% of the world's LNG demand growth through 2035. Growth of LNG in Europe (43 million tons) will account for 18% of the world LNG demand growth, whereas LNG import to north America will not increase in the future.

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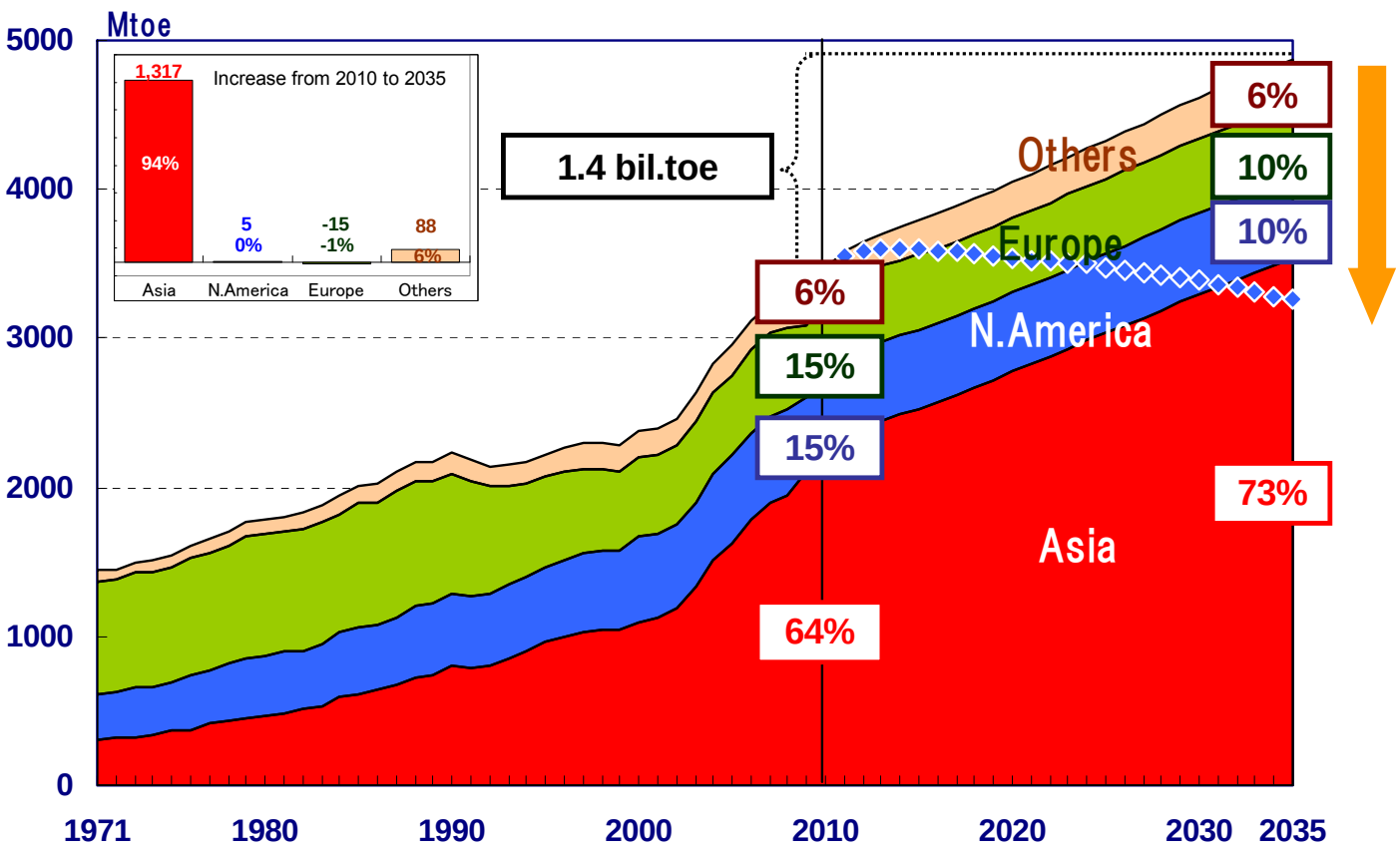
Coal Demand by Region (World)

Reference
Adv. Tech.



1.6 bil.toe
(33%)
Reduction

2010
3.5 billion toe
(5.0 billion tce*)

↓

2035

Reference
4.9 billion toe
(7.0 billion tce*)

Adv.Tech.Scenario
3.3 billion toe
(4.7 billion tce*)

***Tons of coal equivalent**

- Asia will account for about 90% of the world coal demand growth through 2035, and the share of Asia in total coal demand will expand to 73% in 2035 from 64% in 2010.
- In the Adv. Tech. Scenario, the world coal demand in 2035 will be 1.6 billion toe (or 33%) lower compared with the Reference Scenario.

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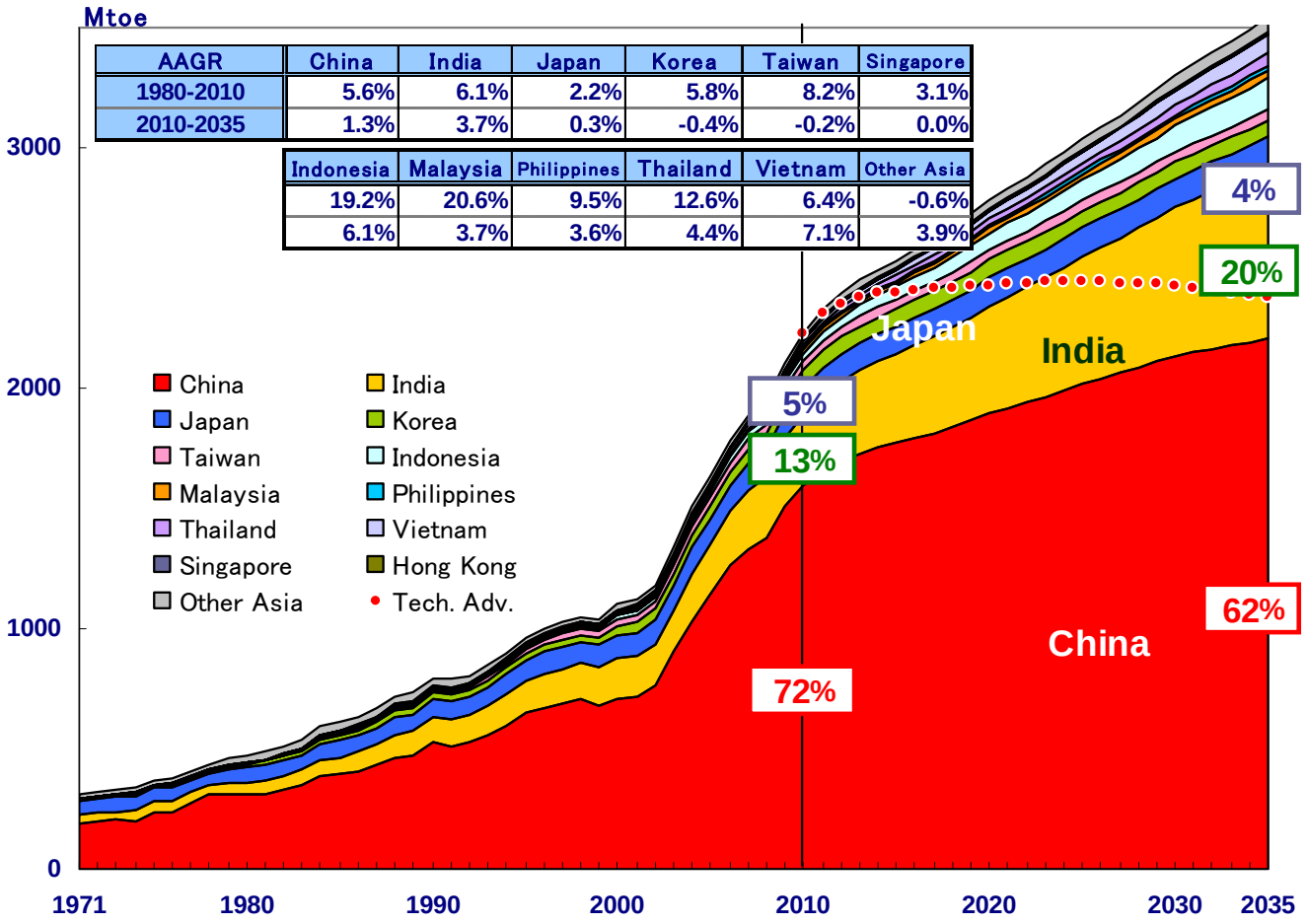
Coal Demand by Country (Asia)

Reference
Adv. Tech.



AAGR	China	India	Japan	Korea	Taiwan	Singapore
1980-2010	5.6%	6.1%	2.2%	5.8%	8.2%	3.1%
2010-2035	1.3%	3.7%	0.3%	-0.4%	-0.2%	0.0%

Indonesia	Malaysia	Philippines	Thailand	Vietnam	Other Asia
19.2%	20.6%	9.5%	12.6%	6.4%	-0.6%
6.1%	3.7%	3.6%	4.4%	7.1%	3.9%

1.2 bil.toe
(33%)
Reduction

2010
2.2 billion toe
(3.2 billion tce)
↓
2035
Reference
3.5 billion toe
(5.1 billion tce*)

Adv.Tech.Scenario
2.4 billion toe
(3.4 billion tce*)

***Tons of coal equivalent**

■ The power sector, mainly in China and India, will drive coal demand. Both those countries have abundant domestic coal reserves.

■In the Adv. Tech. Scenario, Asian coal demand in 2035 will be 1.2 billion toe (or 33%) lower due to shift to natural gas and enhancement of power generation efficiency compared with the Reference Scenario.

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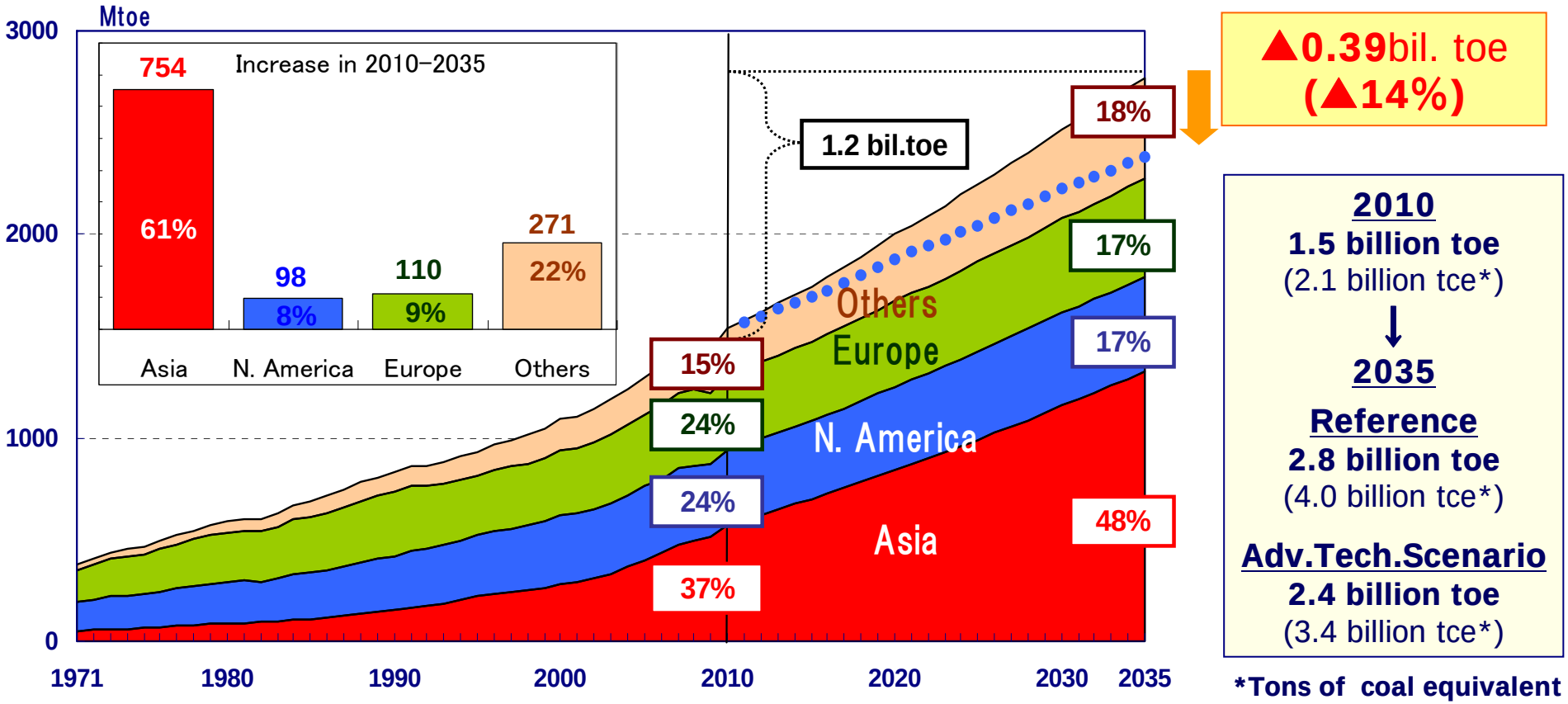
Electricity Demand by Region (World)

Reference
Adv. Tech.



- Asia will account for 60% of the world electricity demand growth through 2035, and the share of Asia in total electricity demand will expand to almost 50%.
- OECD is responsible for 20% of the world electricity demand growth through 2035, and Non-OECD is responsible for the rest. The share of OECD in electricity demand will decrease from 52% in 2010 to 37% in 2035, and Non-OECD will increase from 48% in 2010 to 63% in 2035.
- In the Adv. Tech. Scenario, the world electricity demand in 2035 will be 0.39 billion toe (or 14%) lower compared with the Reference Scenario.

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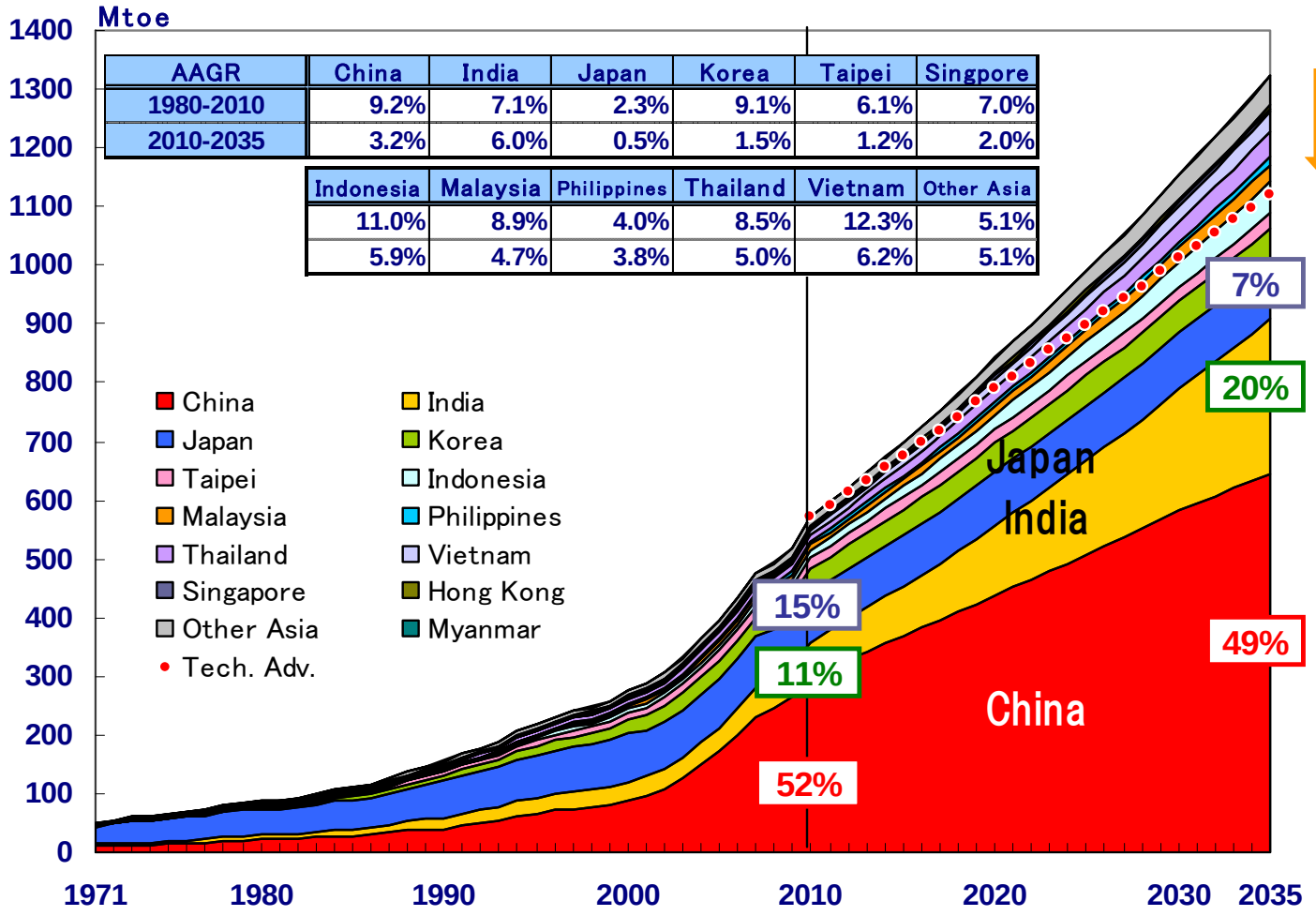
Electricity Demand by Country (Asia)

Reference
Adv. Tech.



AAGR	China	India	Japan	Korea	Taipei	Singpore
1980-2010	9.2%	7.1%	2.3%	9.1%	6.1%	7.0%
2010-2035	3.2%	6.0%	0.5%	1.5%	1.2%	2.0%

Indonesia	Malaysia	Philippines	Thailand	Vietnam	Other Asia
11.0%	8.9%	4.0%	8.5%	12.3%	5.1%
5.9%	4.7%	3.8%	5.0%	6.2%	5.1%

▲0.2 billion toe (▲15%)

2010
0.57 billion toe
(0.82 billion tce)
↓
2035
Reference
1.3 billion toe
(1.89 billion tce)

Adv. Tech.Scenario
1.12 billion toe
(1.6 billion tce)

- Electricity demand in Asia will increase rapidly driven by the improvement of living standards. Electricity demand in China will expand 217% by 2035, and India will expand by 432% during the same period.
- Through 2035, electricity demand will increase at a faster rate than final energy demand (Reference Scenario at 3.4% per year, and Adv. Tech. Scenario at 2.7% per year).

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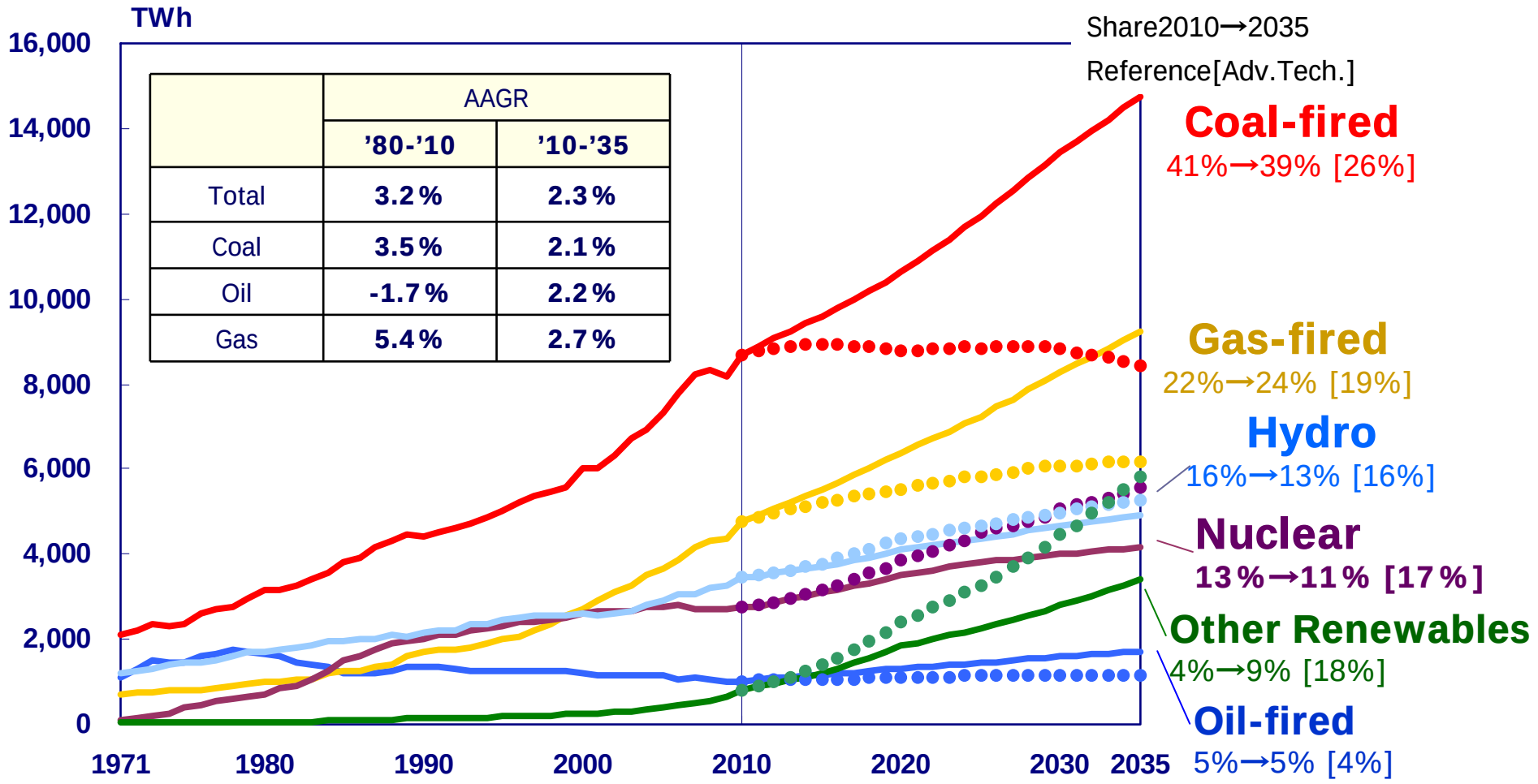
Power Generation Mix by Fuel (World)

Solid line: Reference
Dotted line: Adv. Tech.



	AAGR	
	'80-'10	'10-'35
Total	3.2%	2.3%
Coal	3.5%	2.1%
Oil	-1.7%	2.2%
Gas	5.4%	2.7%

■ While natural gas-fired generation is projected to increase significantly, coal-fired generation will continue to dominate power generation mix by 2035.

■ In Adv. Tech. Scenario, the share of coal-fired generation in 2035 will decline rapidly to 26%, while nuclear and renewables are expanding.

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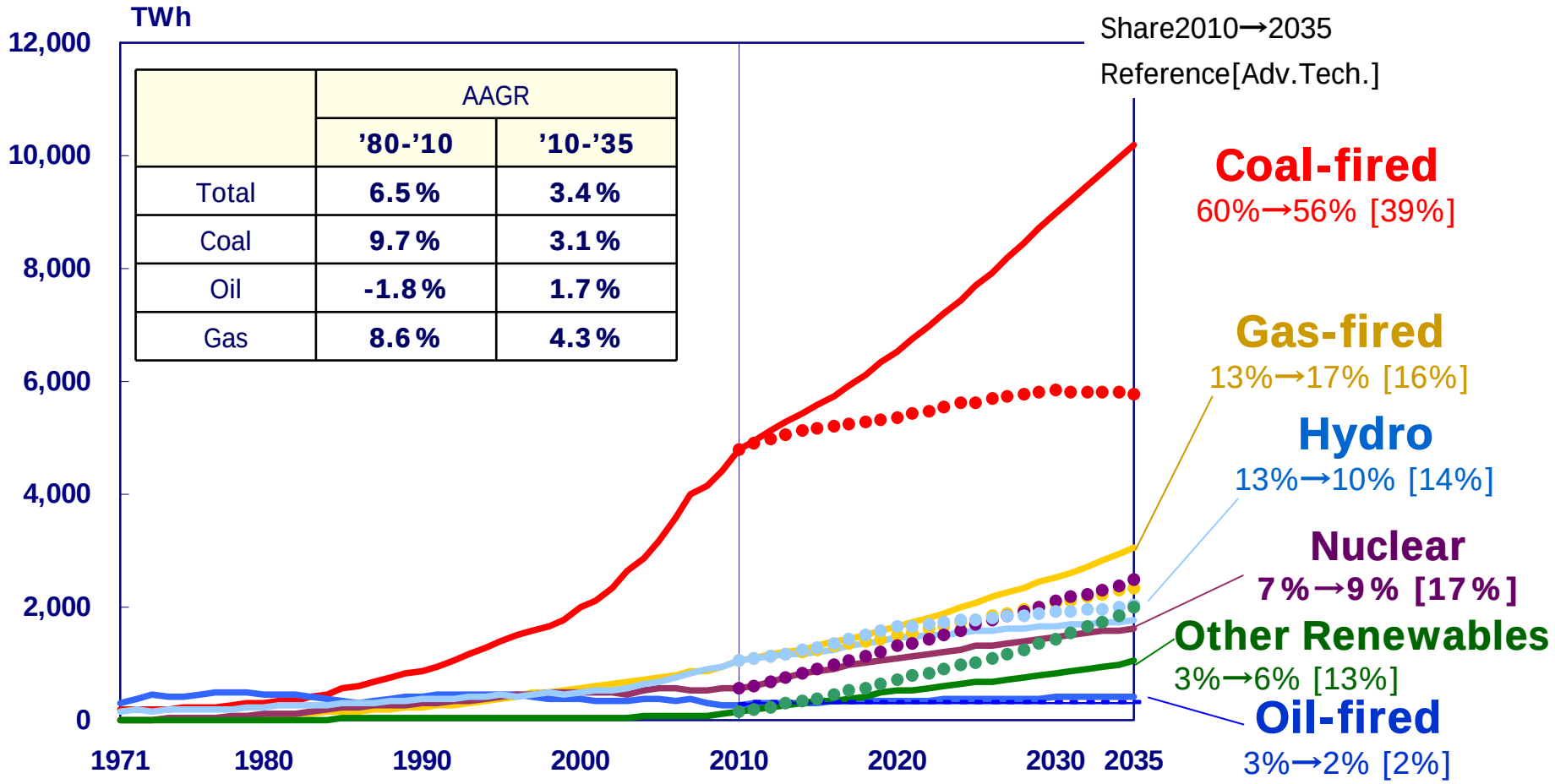
Power Generation Mix by Source (Asia)

Solid line: Reference
Dotted line: Adv. Tech.



	AAGR	
	'80-'10	'10-'35
Total	6.5%	3.4%
Coal	9.7%	3.1%
Oil	-1.8%	1.7%
Gas	8.6%	4.3%

- The Asia's share of coal in the generation mix will remain higher than 50%, reflecting resources availability.
- The share of natural gas will increase from 13% in 2010 to 17% in 2035. The share of nuclear power generation will remain 9% in 2035.
- In the Adv. Tech. Scenario, the share of coal will decline from 60% in 2009 to 39% in 2035. Clean coal technology (CCT) is expected to play an important role in addressing global warming issues.

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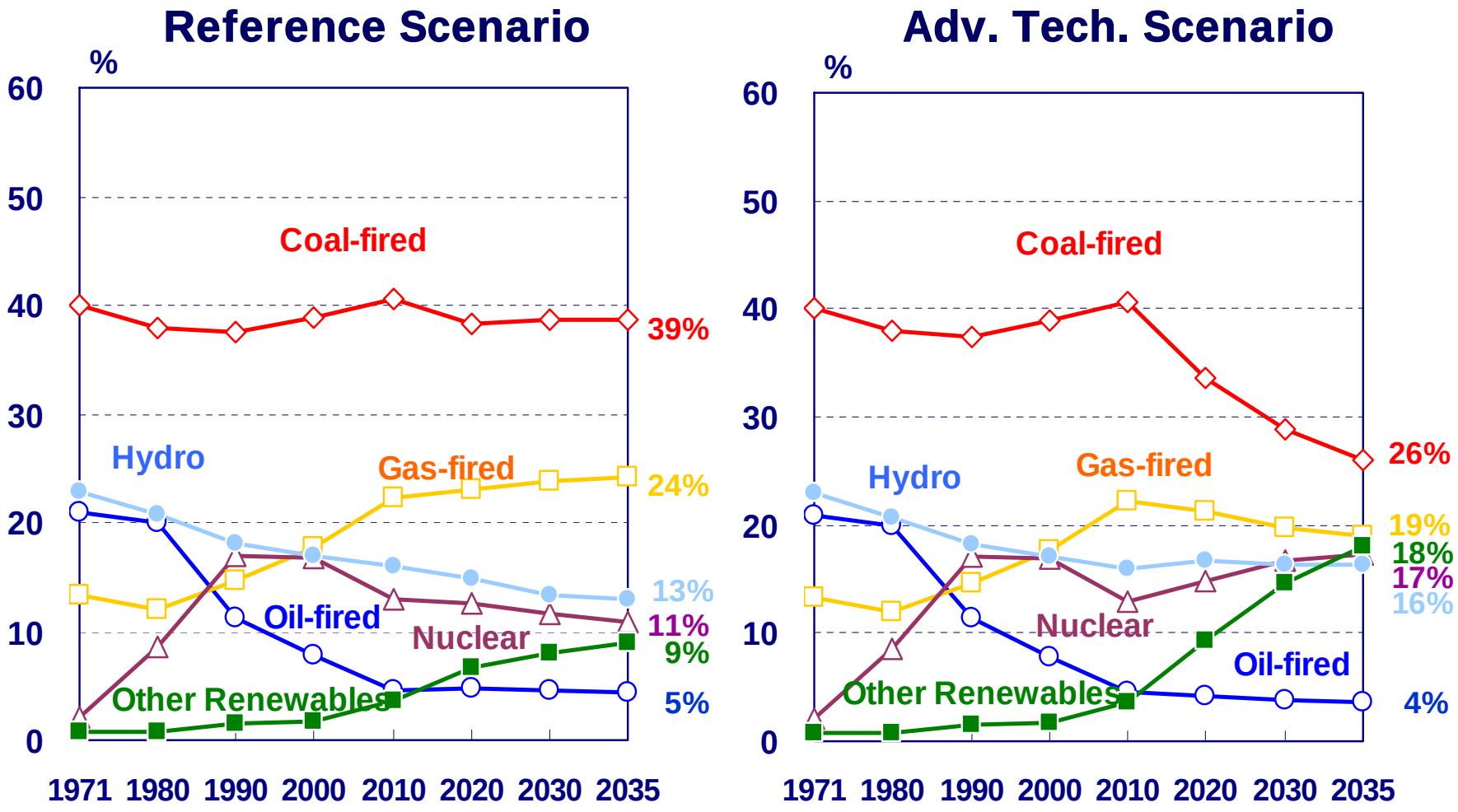
Power Generation Mix by Source (World)



- Coal-fired generation will maintain the biggest share in the power generation mix by 2035.
- In the Adv. Tech. Scenario, the share of coal-fired generation will decrease substantially, while that of renewable energy and nuclear will increase.

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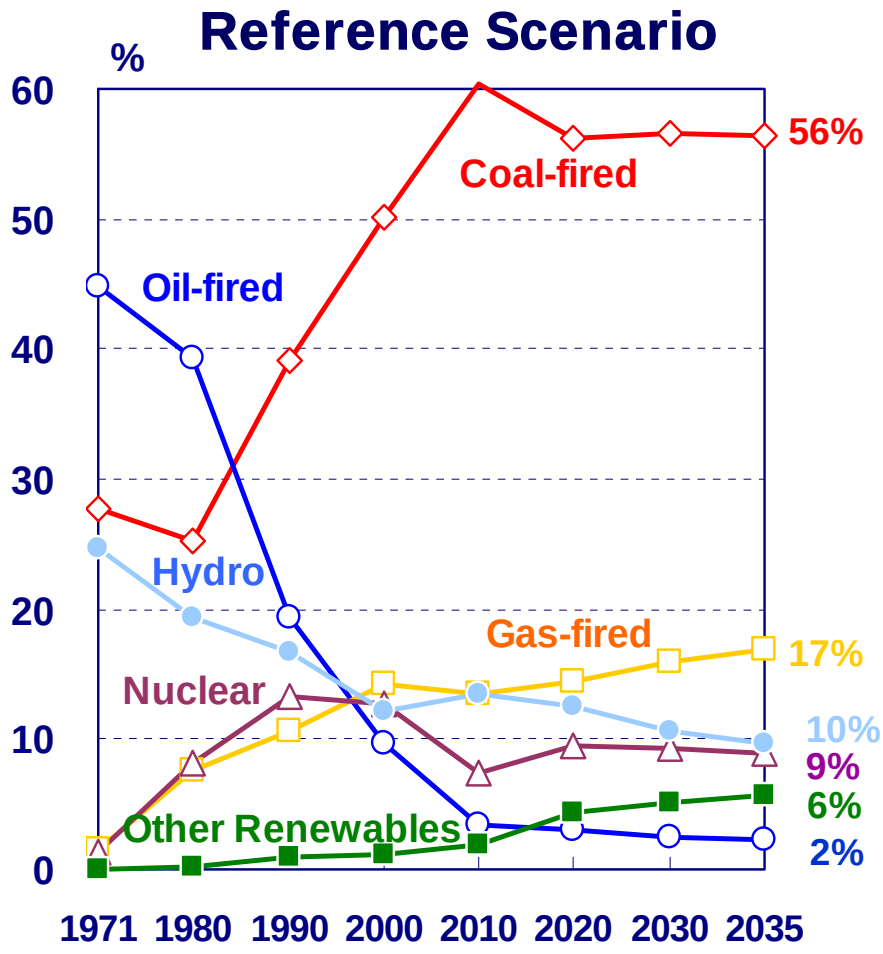
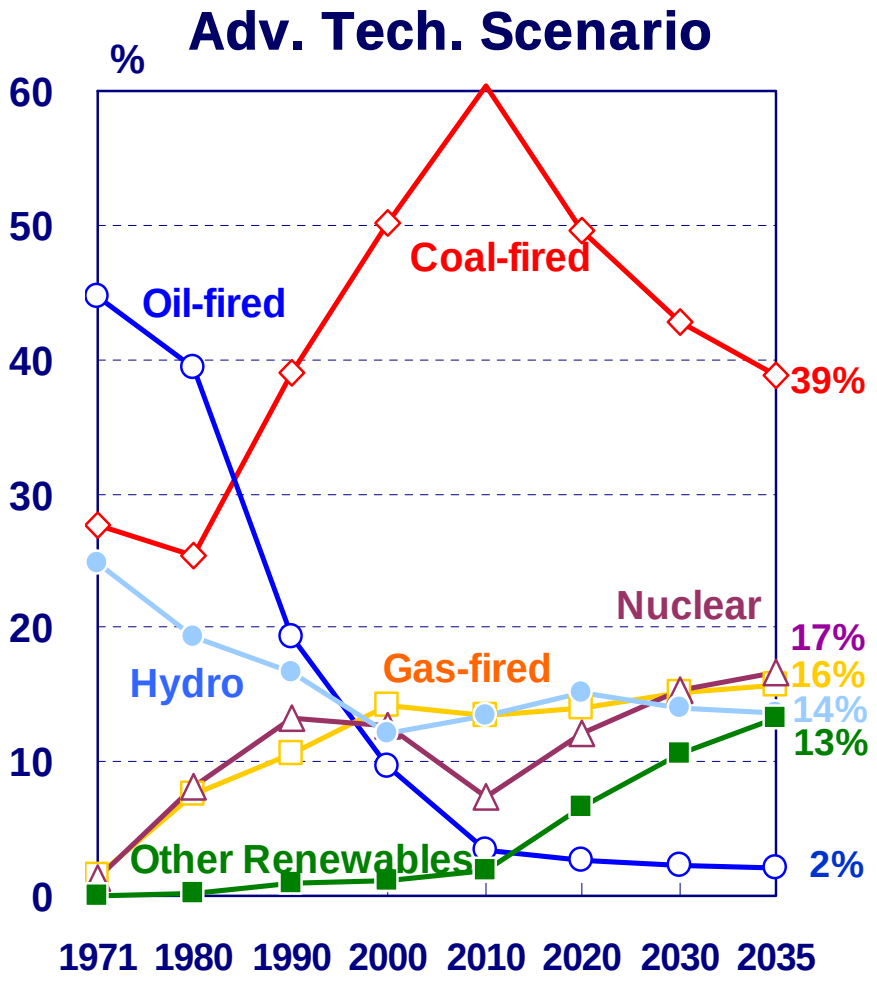
Power Generation Mix by Source (Asia)





- In Asia, the share of coal-fired generation will increase to meet growing electricity demand.
- In the Adv. Tech. Scenario, the share of coal-fired generation will decrease substantially, which will be substituted by the increases in renewable energy, hydro and nuclear share.

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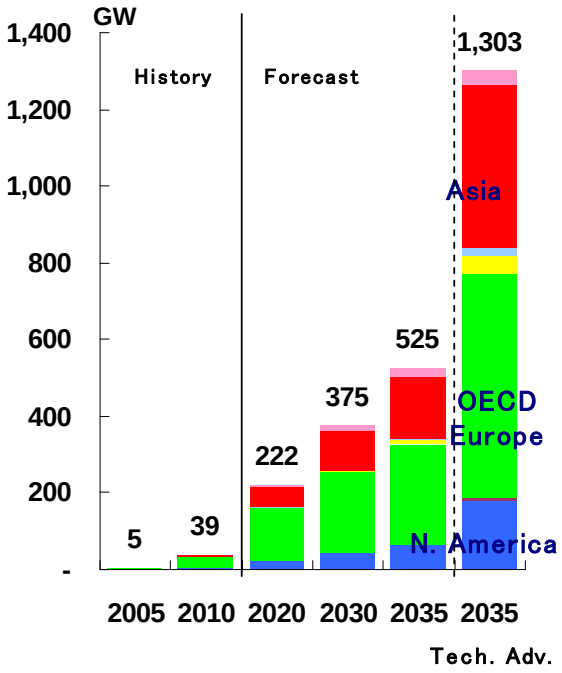
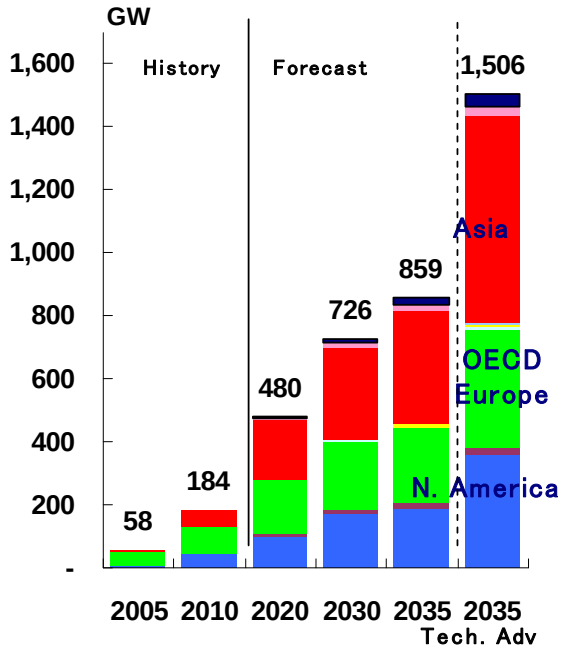
Photovoltaic, Wind Power (World)

Photovoltaic (PV)



Wind Power



Photovoltaic (PV)

World	Asia
2010 39 GW ↓ 2035 Ref. 525GW Adv. Tech. 1,303GW	2010 5.5 GW ↓ 2035 Ref. 161GW Adv. Tech. 420GW

Wind Power

World	Asia
2010 184 GW ↓ 2035 Ref. 859GW Adv. Tech. 1,506GW	2010 47 GW ↓ 2035 Ref. 360GW Adv. Tech. 660GW

■ Renewables are expected to expand due to technological advancement and supportive political measures such as feed-in tariff and subsidization.

■ World PV generating capacity will grow to 525GW by 2035 and world wind power capacity will reach 859 GW by 2035, both under the Reference Scenario.

■ The share of power generation from wind and PV together in total global power generation will grow from 1.8% in 2010 to 5.6% in 2035 in the Reference Scenario. In the Advanced Technologies Scenario, PV grows 2.5 times of Reference Scenario, and Wind 1.8 times.

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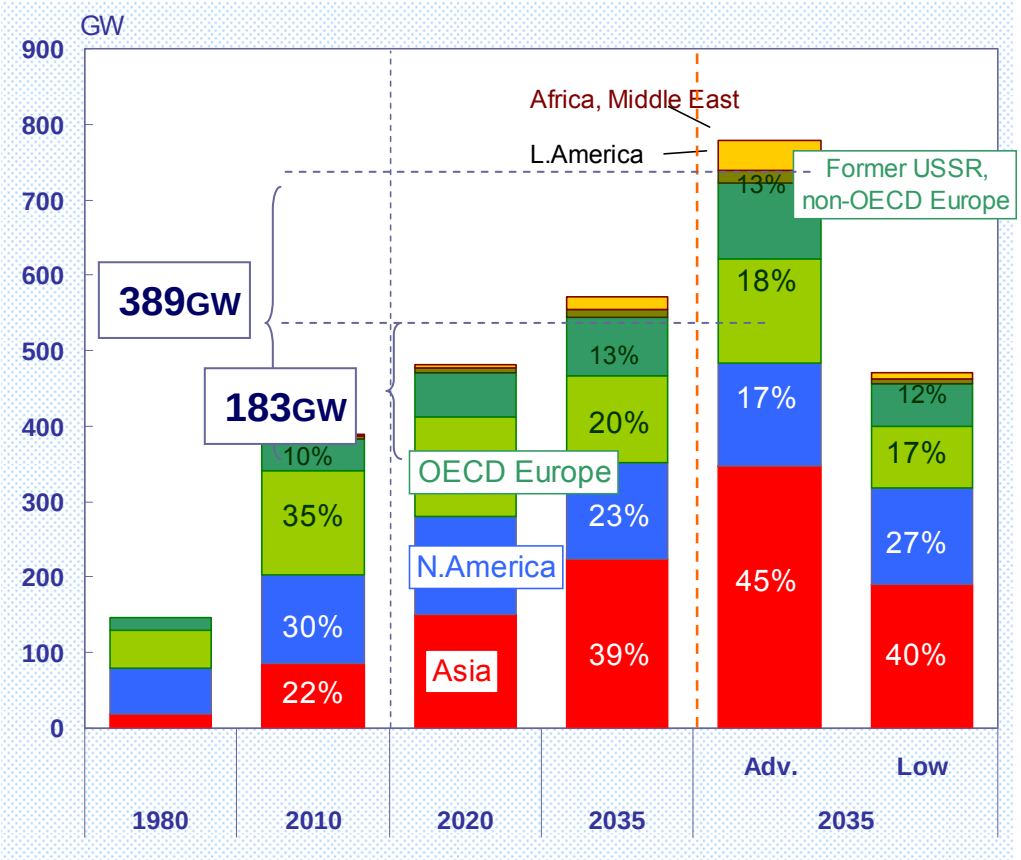
Nuclear Power Generation Capacity (World)



World

2010
389GW
↓
2035

Reference
572GW
(**183**GW increase)

Adv. Tech.
778GW
(**389**GW increase)

Low nuclear
471GW
(**82**GW increase)

- Nuclear capacity is projected to grow from 389 GW in 2010 to 572 GW in 2035 (an increase of 183 GW). More than 2/3 of the increase is expected in Asia.
- Current nuclear capacity is expected to double in the Adv. Tech. Scenario, reaching 778 GW by 2035.
- In the low nuclear scenario, the capacity will increase in Asia and decrease in Europe, reaching 471 GW by 2035.

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Nuclear Power Capacity in Asia

(GW)

	2010	2020			2035		
		Ref.	Adv.	Low	Ref.	Adv.	Low
China	9	59	72	59	111	162	111
Taiwan	5	8	8	5	7	8	4
S.Korea	18	30	30	24	43	43	34
ASEAN	0	0	1	0	11	27	2
India	4	18	26	18	38	72	38
Asia	85	150	181	127	223	347	190

■ In the Adv. Tech. Scenario, nuclear power capacity in China will expand to 72 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.

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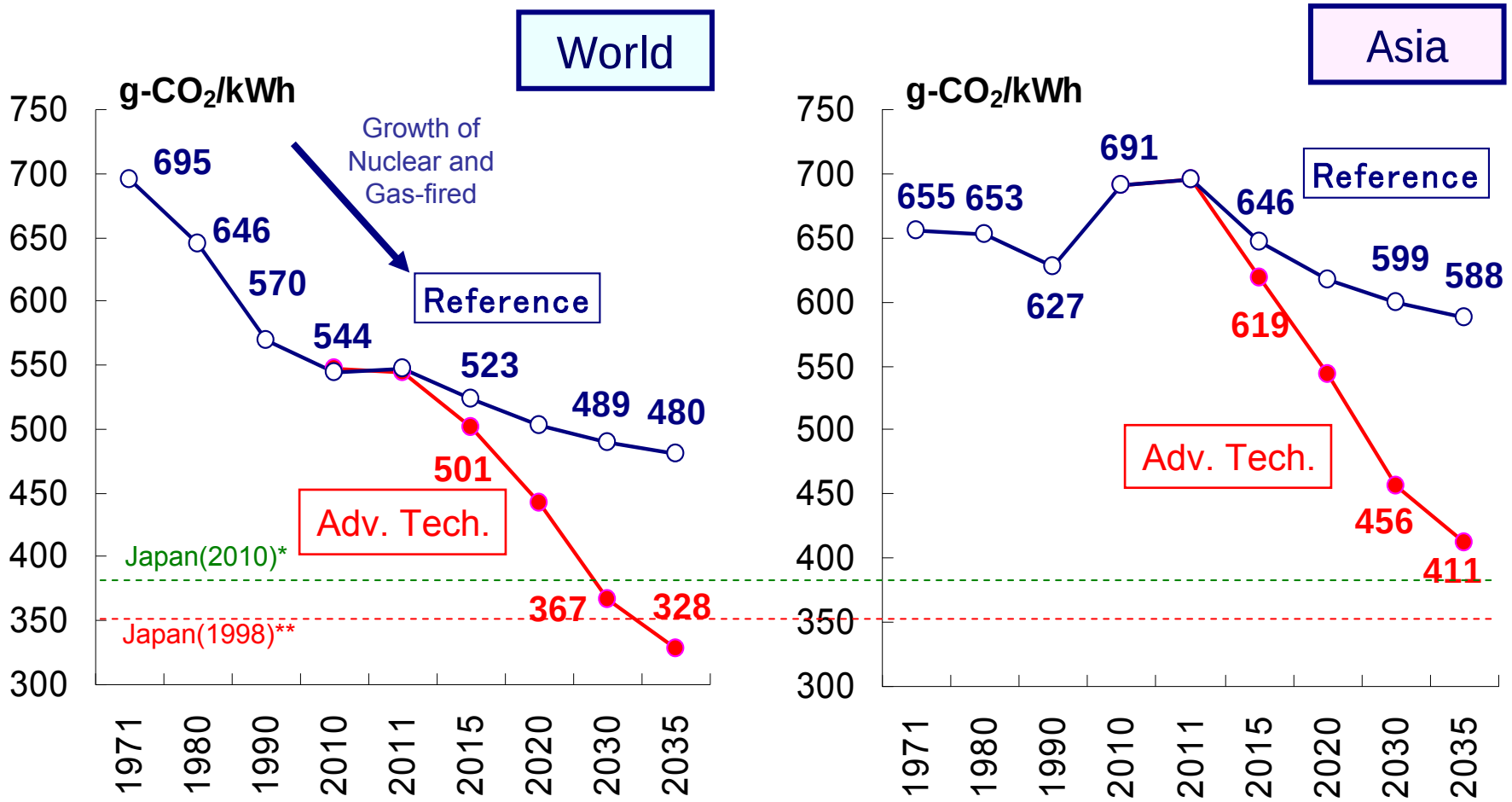
Carbon Intensity of Electricity (CO_2 Emissions per kWh)



*390g-CO_2/kWh **350g-CO_2/kWh

- The average CO_2 emissions per kWh will be reduced substantially reflecting the expansion in nuclear and renewable energy as well as efficiency improvements in fossil-fired power generation.
- In the Adv. Tech. Scenario, the average CO_2 emissions per kWh in 2035 will be 40% less than the 2010 level. In Asia the reduction will reach 41%.

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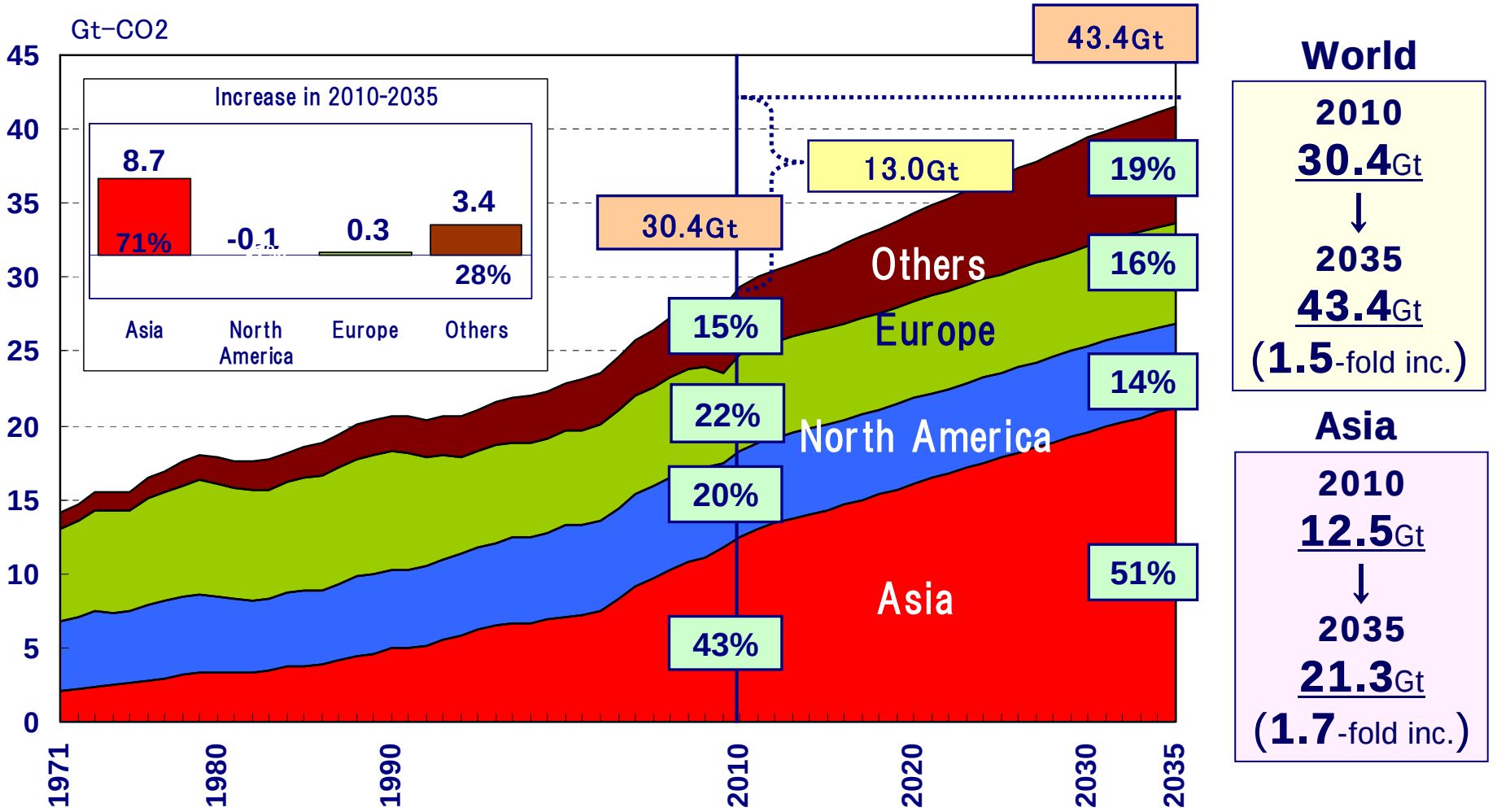
CO_2 Emission by Region (World)

Reference



■ Non-OECD accounts for over 90% of the growth in global CO_2 emissions, through 2035. Asia alone will account for about 70% of global growth.

■The share of OECD will decrease from 42% in 2010 to 29% in 2035.

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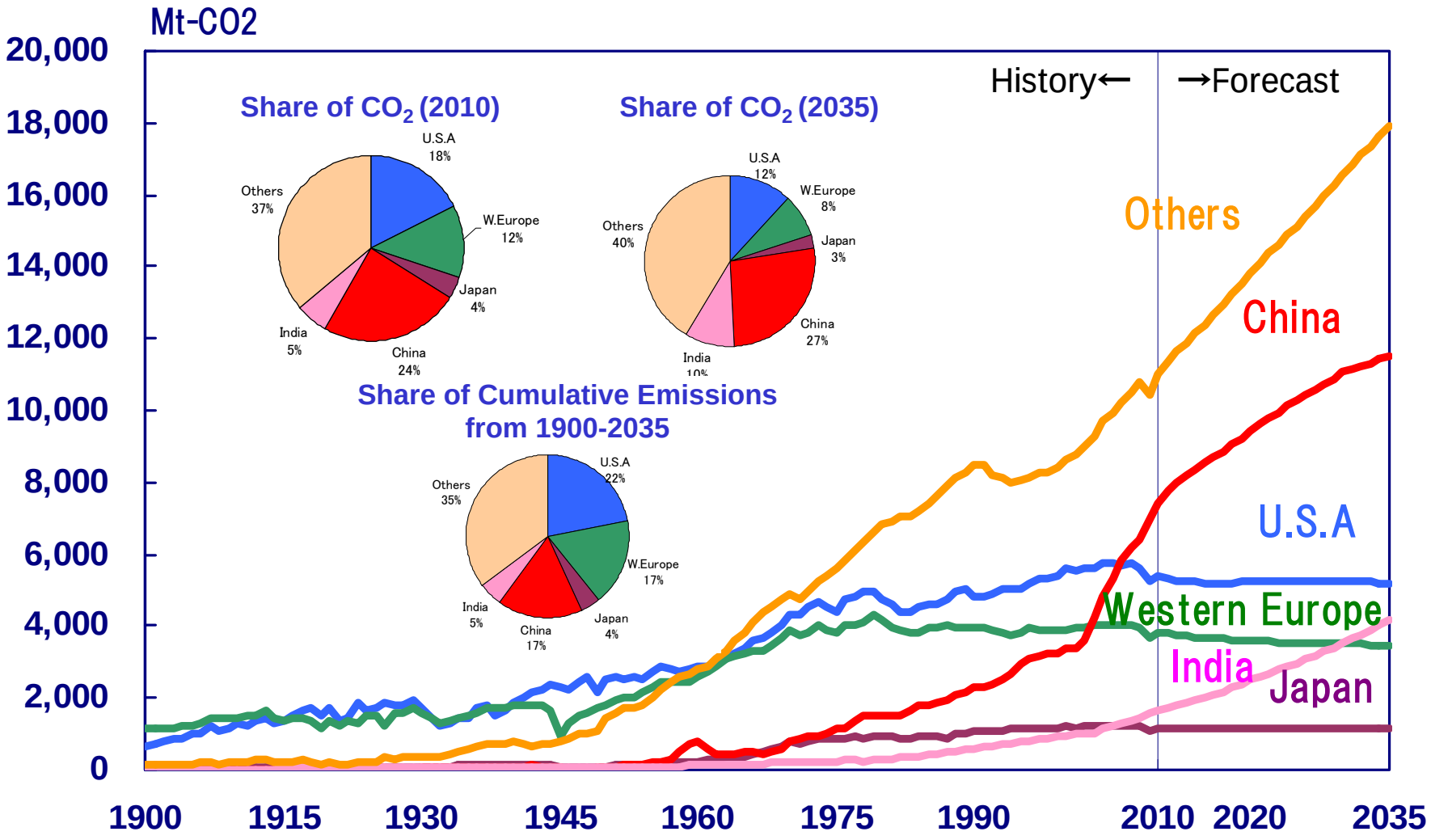
CO_2 Emissions (World)

Reference



- China overtook USA as world's biggest CO_2 emitter in 2007. By 2035, India will emit almost as much as the USA.
- India's cumulative CO_2 emissions from 1990 will surpass that of Japan by 2025.

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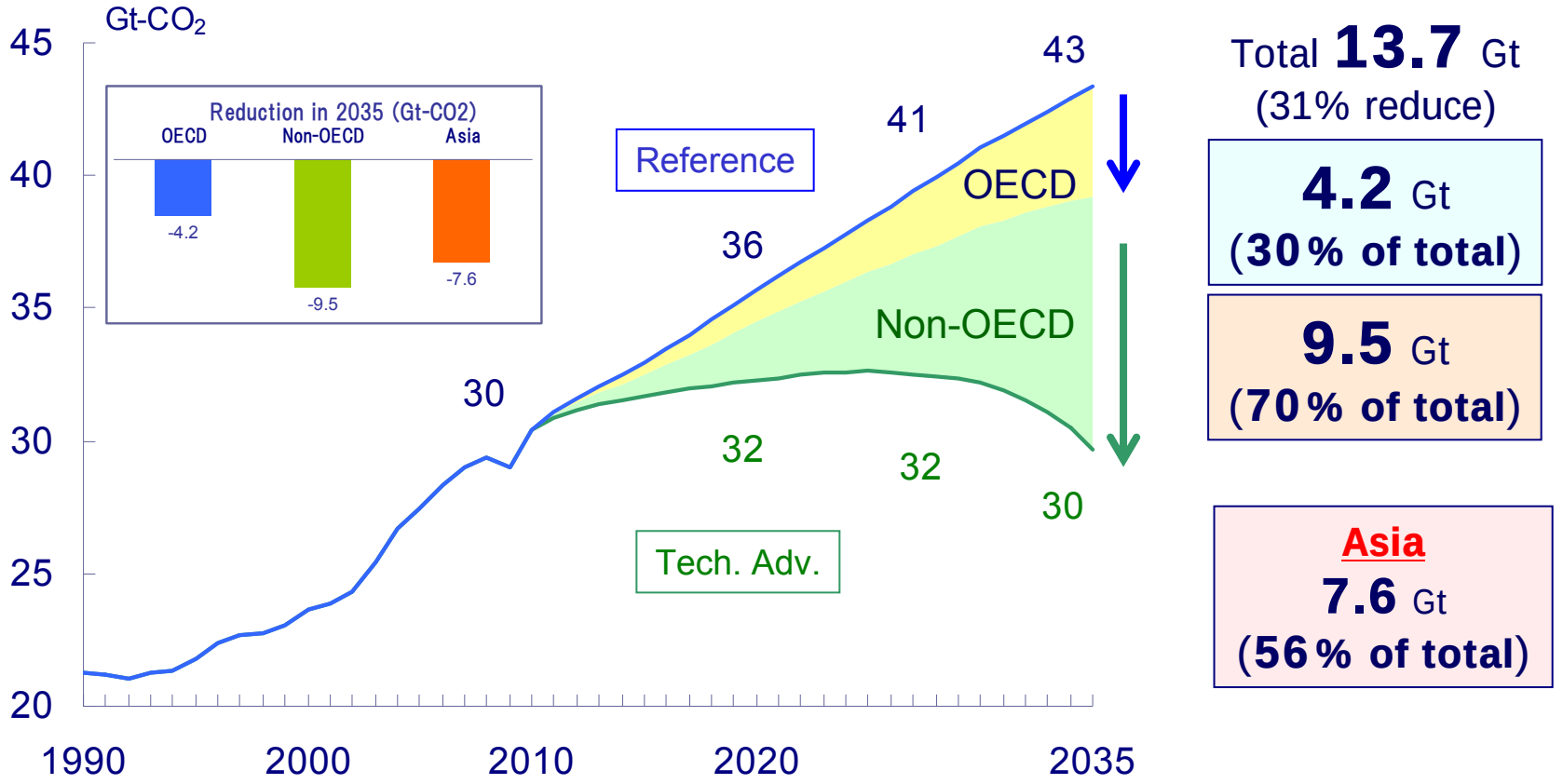
CO_2 Emissions Reduction by Region (World)

Reference
Adv. Tech.



■ In 2035, Non-OECD's CO_2 emissions reduction (between the Reference and the Adv. Tech. Scenario) is estimated to reach 9.5 Gt, more than twice that of OECD at 4.2 Gt. Among Non-OECD's projected CO_2 emissions reduction, Asia will account for over 80%.

■ Technology transfer and swift deployment of advanced technology in Asia is indispensable in order to address global warming issues.

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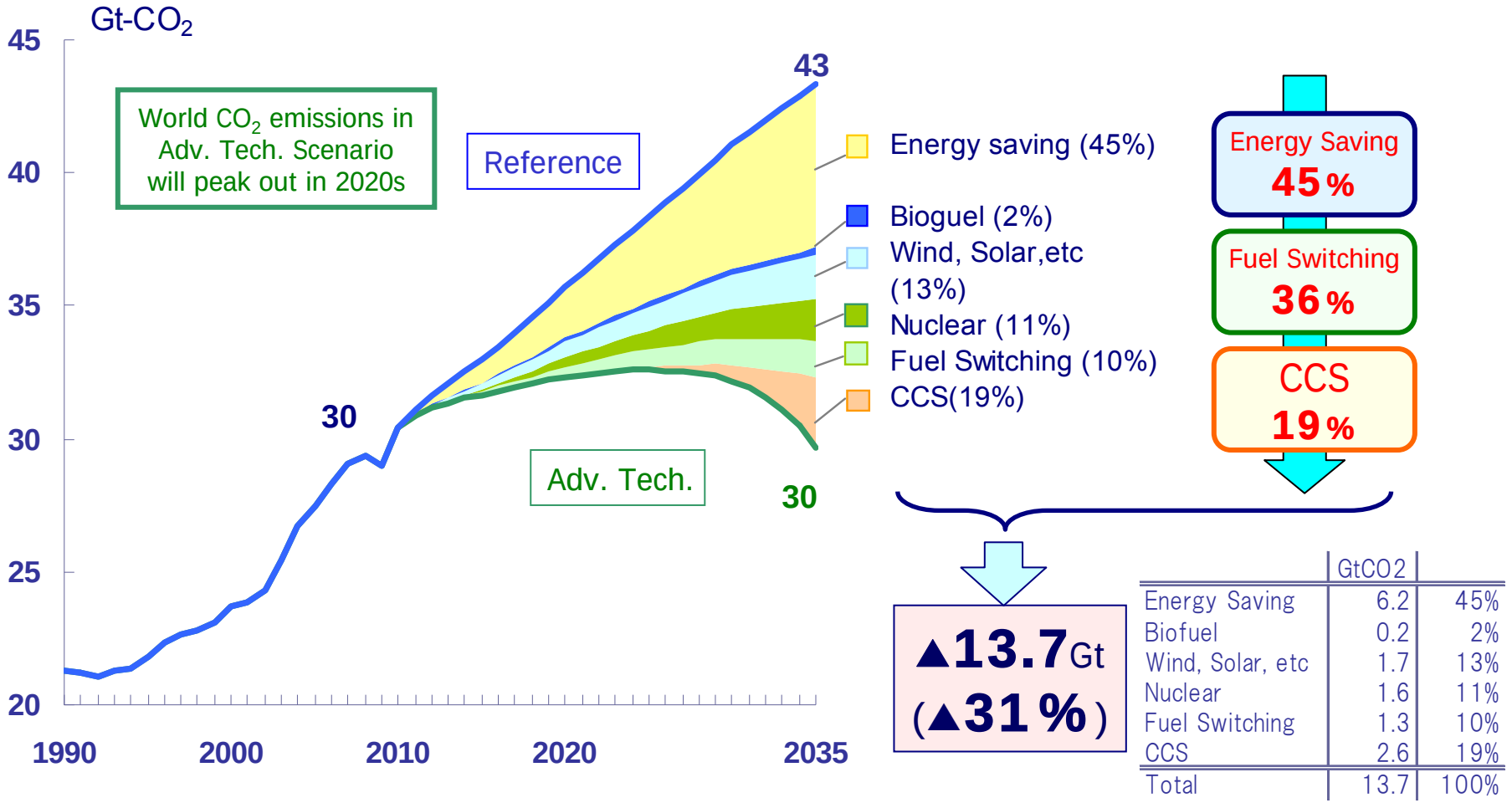
CO_2 Emissions Reduction by Technology (World)

Reference
Adv. Tech.



	GtCO2	
Energy Saving	6.2	45%
Biofuel	0.2	2%
Wind, Solar, etc	1.7	13%
Nuclear	1.6	11%
Fuel Switching	1.3	10%
CCS	2.6	19%
Total	13.7	100%

■ In the Adv. Tech. Scenario, between 2005 and 2020 the world CO_2 emissions will increase by 4.8 Gt-CO_2 (or 18% up from the 2005 level), while the CO_2 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 CO_2 emissions reduction.

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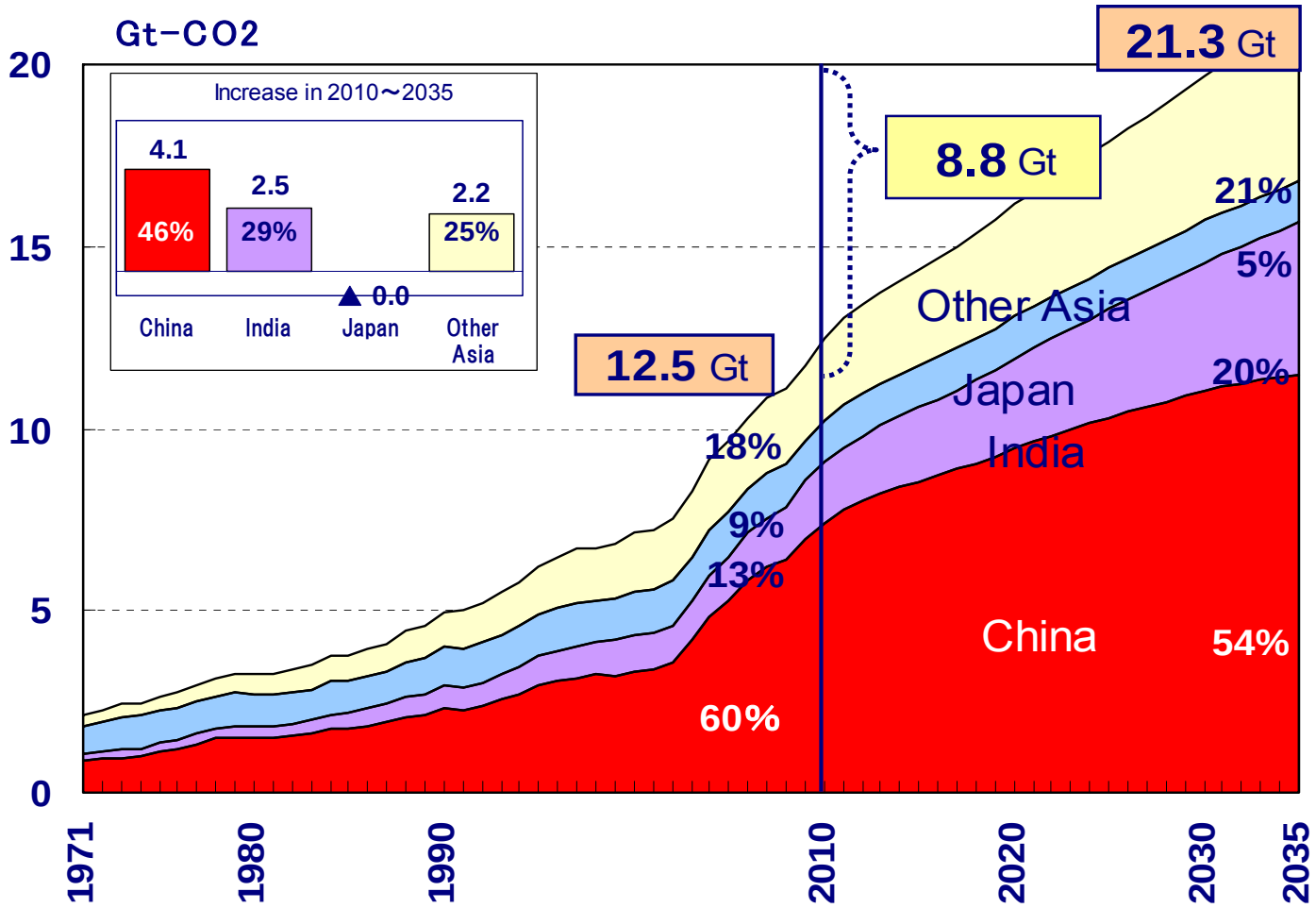
CO_2 Emission by Region (Asia)

Reference



China

2010
7.4 Gt
↓
2035
11.5 Gt
(**1.5**-fold inc.)

India

2010
1.7 Gt
↓
2035
4.2 Gt
(**2.5**-fold inc.)

■CO_2 emissions in Asia will steadily increase driven by coal consumption. The China and India combined share of the Asian total remains constant throughout the exercise at almost 75%. Japan's major loss of share is taken up by "Other Asian"

■ Increase in Asia will account for about 70% of the world CO_2 emissions growth through 2035.

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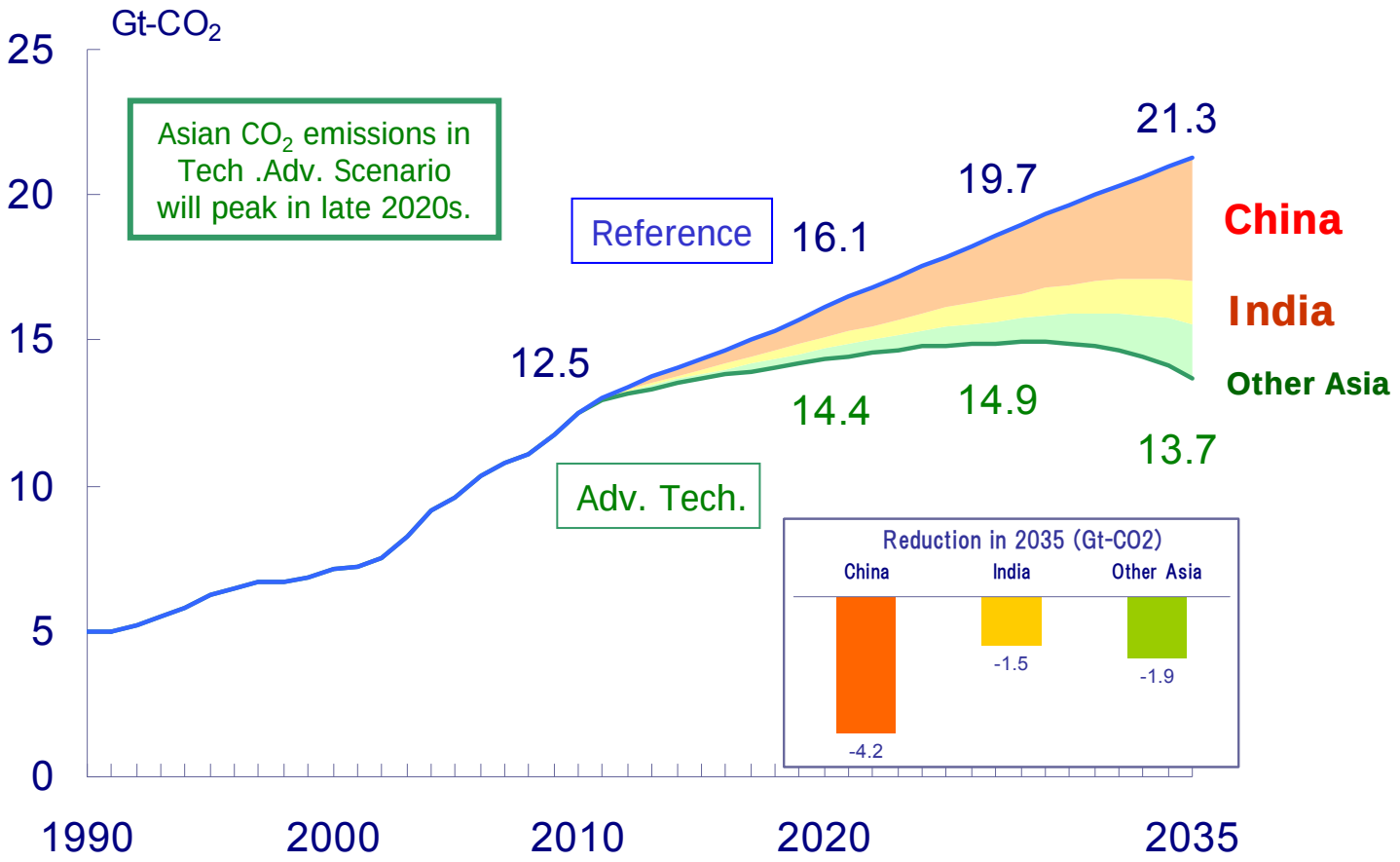
CO_2 Reduction by Region (Asia)

Reference
Adv. Tech.



Total **7.6**Gt
(36% reduction)

China
4.2 Gt
(56% of total)

India
1.5 Gt
(20% of total)

Other Asia
1.9 Gt
(25% of total)

■ In the Adv. Tech. Scenario, CO_2 emissions in Asia will continue to increase by 19% from 2010 to 2025. The emissions will reach their peak in late 2020s.
■ China and India have great potential to reduce CO_2 emissions. China's CO_2 emissions reduction will account for 56% of Asia's reduction in 2035. India and other Asian countries will account for the remaining 45%.

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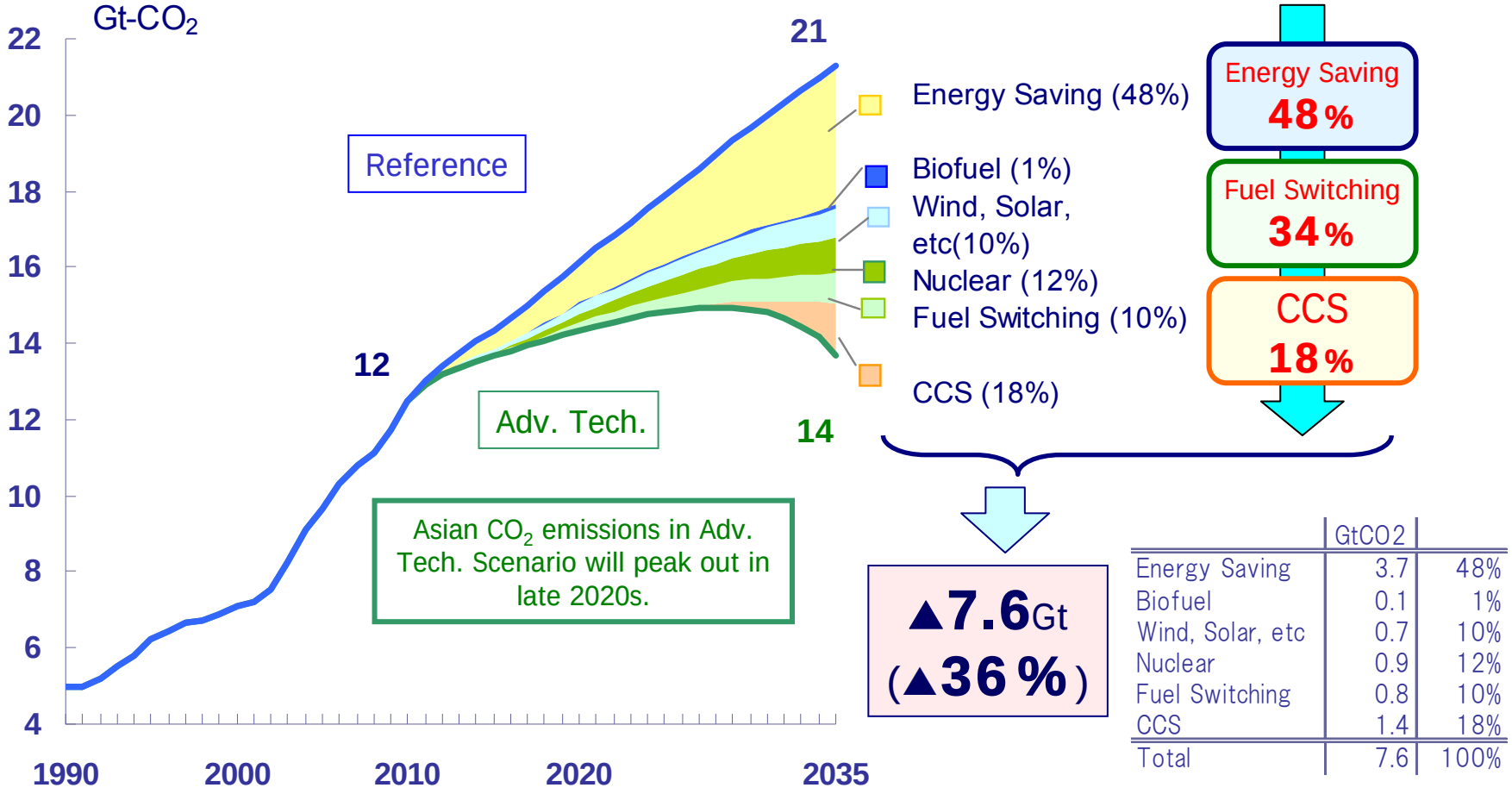
CO_2 Emissions Reduction by Technology (Asia)

Reference
Adv. Tech.



	GtCO2	
Energy Saving	3.7	48%
Biofuel	0.1	1%
Wind, Solar, etc	0.7	10%
Nuclear	0.9	12%
Fuel Switching	0.8	10%
CCS	1.4	18%
Total	7.6	100%

■ Aggressive development and deployment of advanced technologies in Asia enables to considerably reduce CO_2 emissions and realize its peak by late 2020s.

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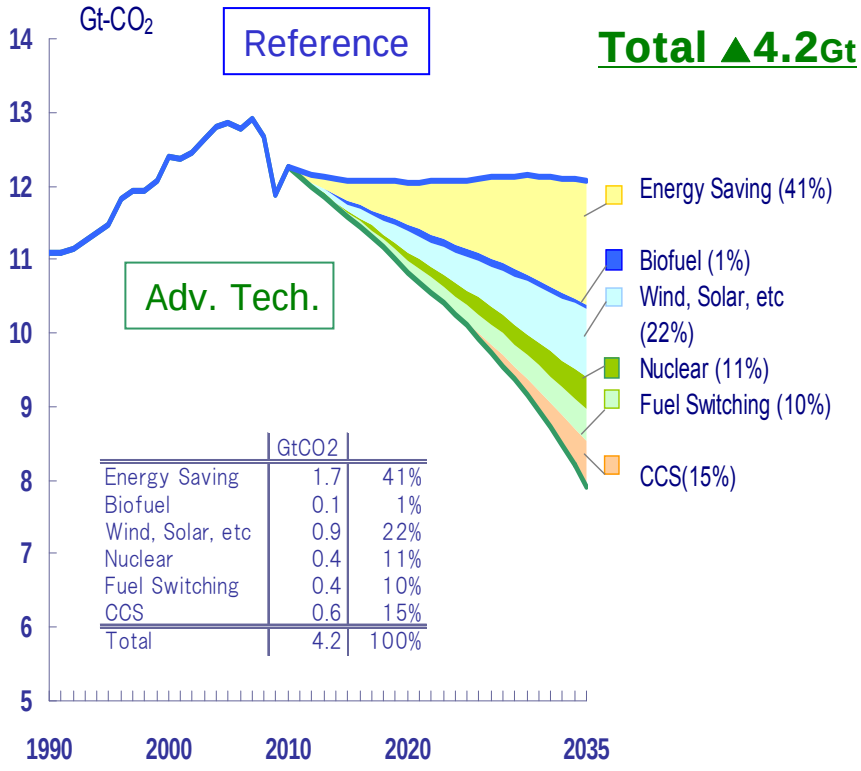
CO_2 Emissions Reduction by Technology (OECD, and Non-OECD)

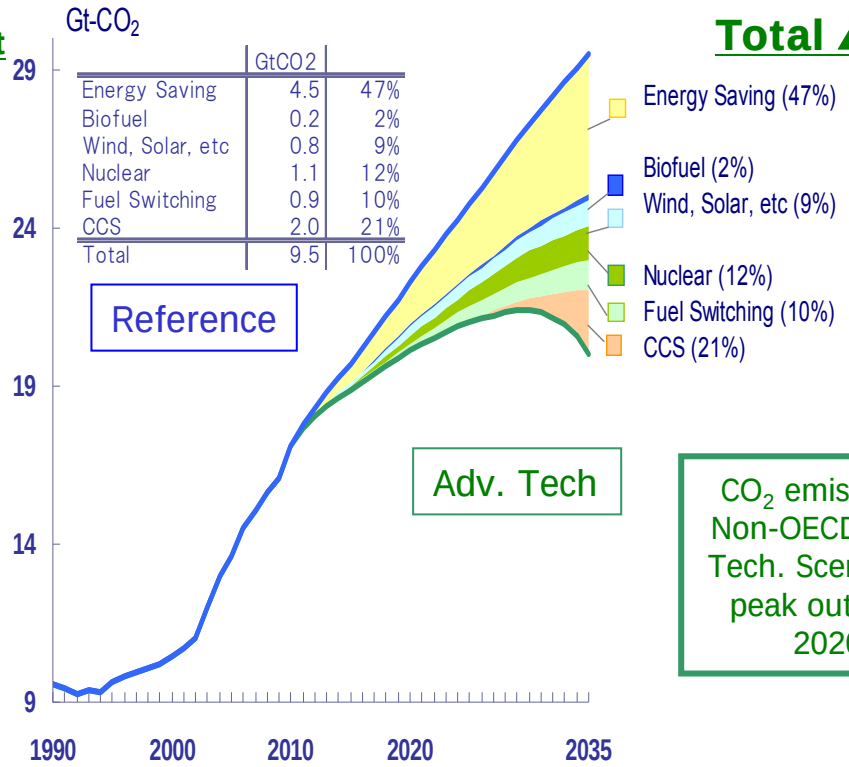
Reference
Adv. Tech.

OECD



	GtCO2	
Energy Saving	1.7	41%
Biofuel	0.1	1%
Wind, Solar, etc	0.9	22%
Nuclear	0.4	11%
Fuel Switching	0.4	10%
CCS	0.6	15%
Total	4.2	100%

Non-OECD



	GtCO2	
Energy Saving	4.5	47%
Biofuel	0.2	2%
Wind, Solar, etc	0.8	9%
Nuclear	1.1	12%
Fuel Switching	0.9	10%
CCS	2.0	21%
Total	9.5	100%

CO_2 emissions of Non-OECD in Adv. Tech. Scenario will peak out in late 2020s.

■ Various technologies are needed to reduce CO_2 emissions. In OECD, energy saving will be responsible for the largest share at 41% (or 1.7 Gt). It is followed by nuclear at 11% (or 0.4 Gt), renewable energy at 24% (or 1.0 Gt), fuel switching at 10% (or 0.4 Gt), and CCS at 15% (0.6 Gt).

■ In Non-OECD, energy saving will be responsible for more than half of the 9.5 Gt reduction. Supportive measures concerning technology transfer and the establishment of efficiency standards are important to realize those CO_2 emissions reduction while further enhancing energy security.

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Energy Demand and Supply in China

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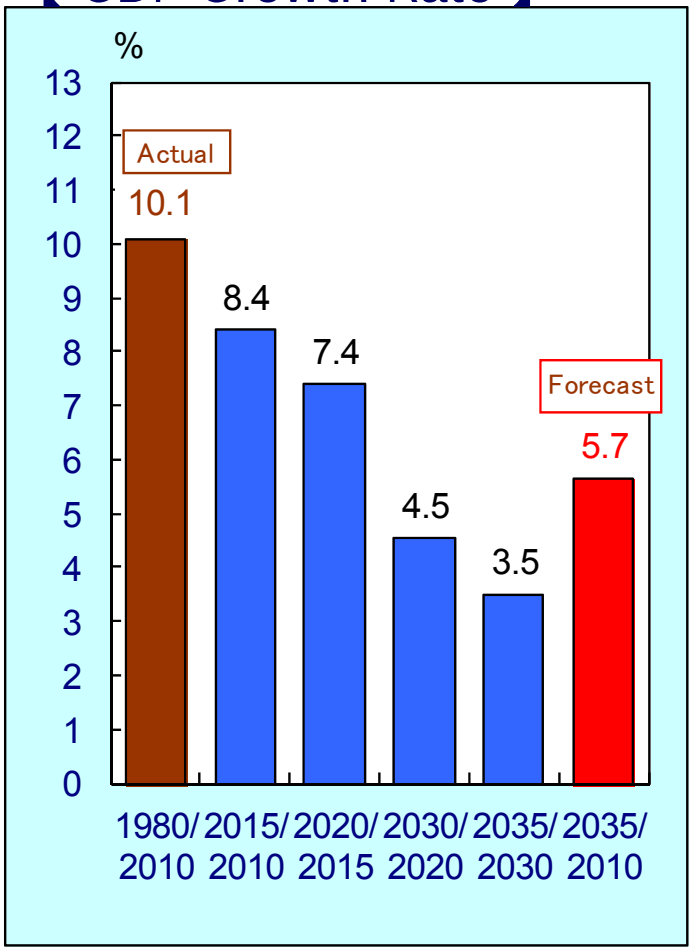
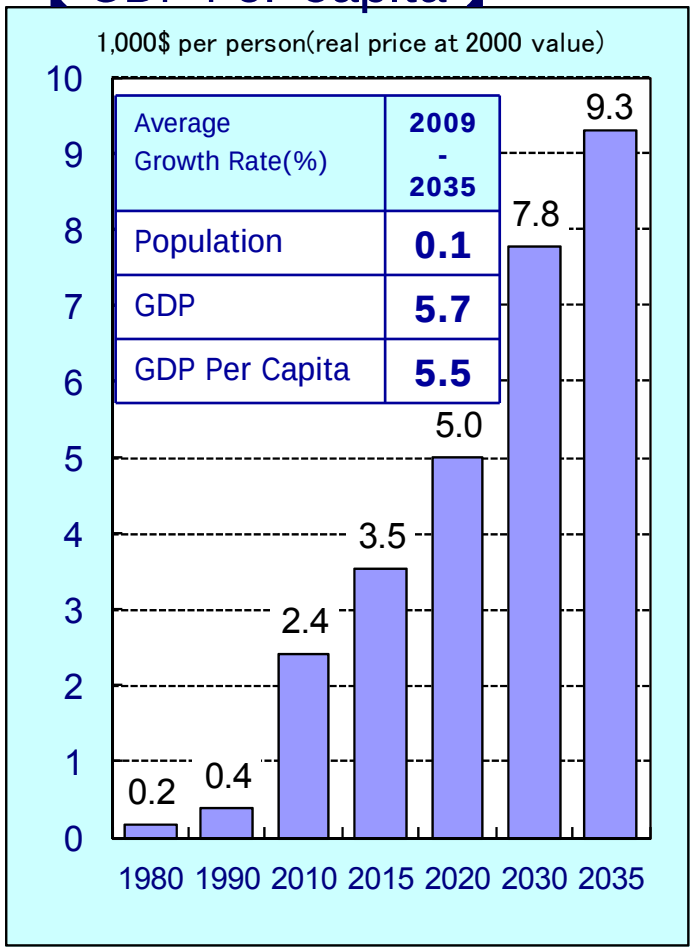
GDP Growth of China

【 GDP Growth Rate 】



【 GDP Per Capita 】



GDP

2010
3.2 T.USD
↓
2035
12.9 T.USD
(**4.0**times)

■ In the future, China's economy will gradually grow at a moderate pace due to the shift from export and investment-driven growth to domestic consumption-led growth. Other factors, including decrease in labor, environmental considerations and resource constraints, are additional reasons for the moderate growth.

■ GDP per capita (at 2000 price) is expected to reach 9 thousand USD in 2035, a four-fold increase from the 2010 level.

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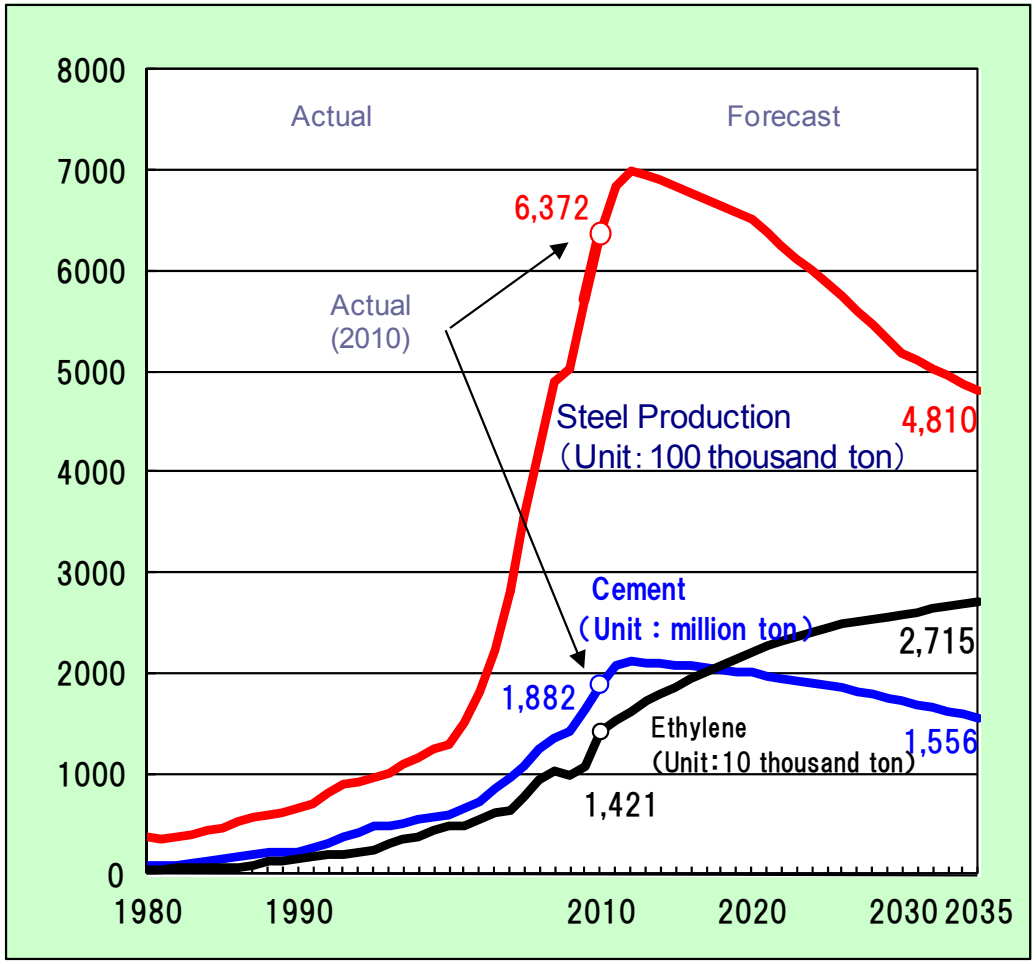
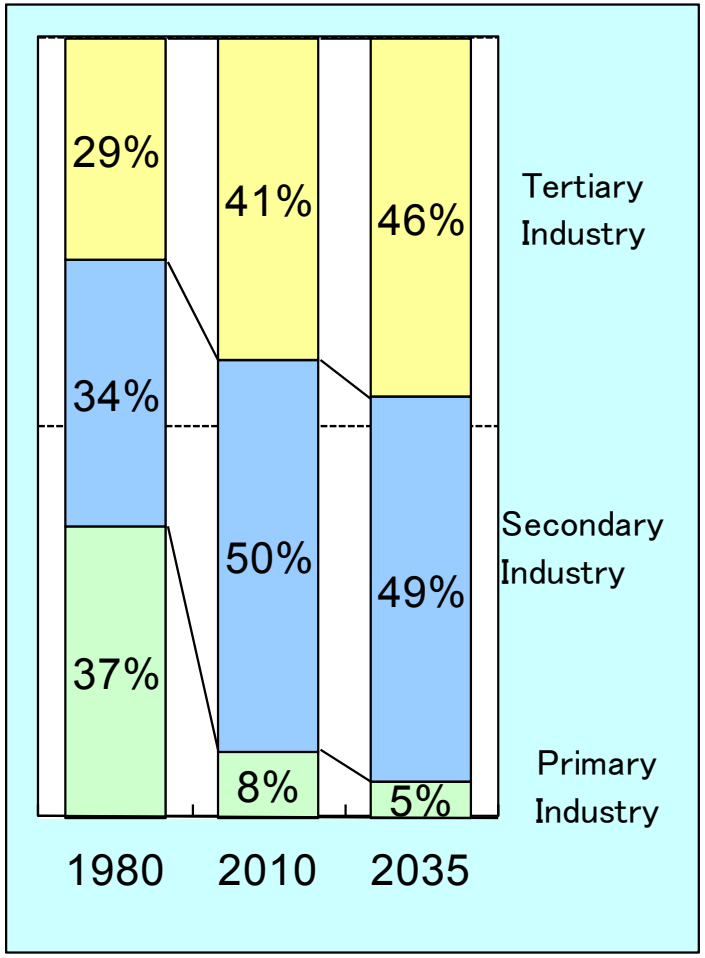
Raw Material Production and Industrial Structure in China

【 Raw Material Production 】



【 Industrial Structure 】



■ Raw materials production will reach peak in the future. Steel production will decrease from about 700 million ton currently to below 500 million ton by 2035.

■ As the share of tertiary industries is increasing rapidly, the share of heavy primary industries is likely to decrease over time. The share of secondary industry will remain at similar levels throughout.

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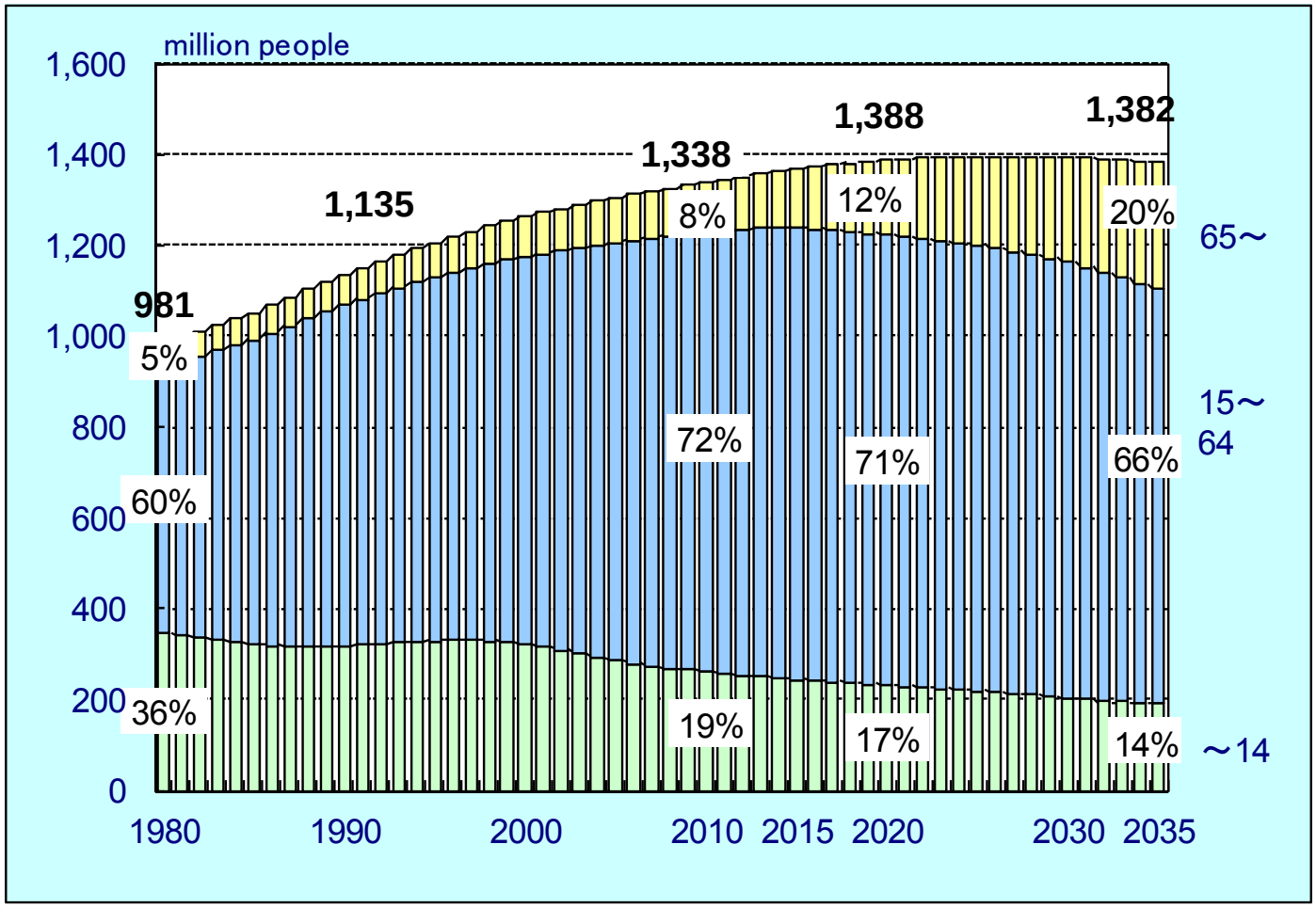
Population in China



Average Growth Rate (%)	2009-2035
Total	**0.1**
Over 65	**3.8**

Total Population (Million)

2010
1,340
↓
2035
1,380
(**1.03** times)

Urbanization Rate

2010
44.9%
↓
2035
64.9%
(**20** points up)

■ Population will increase at 0.1% annually and will peak at around 1,400 million by 2025. By then it will be surpassed by India.
■ The share of population over 65 will reach 20% in 2035 from 8% in 2010. Labor force population will peak by 2015 and begin to decrease.

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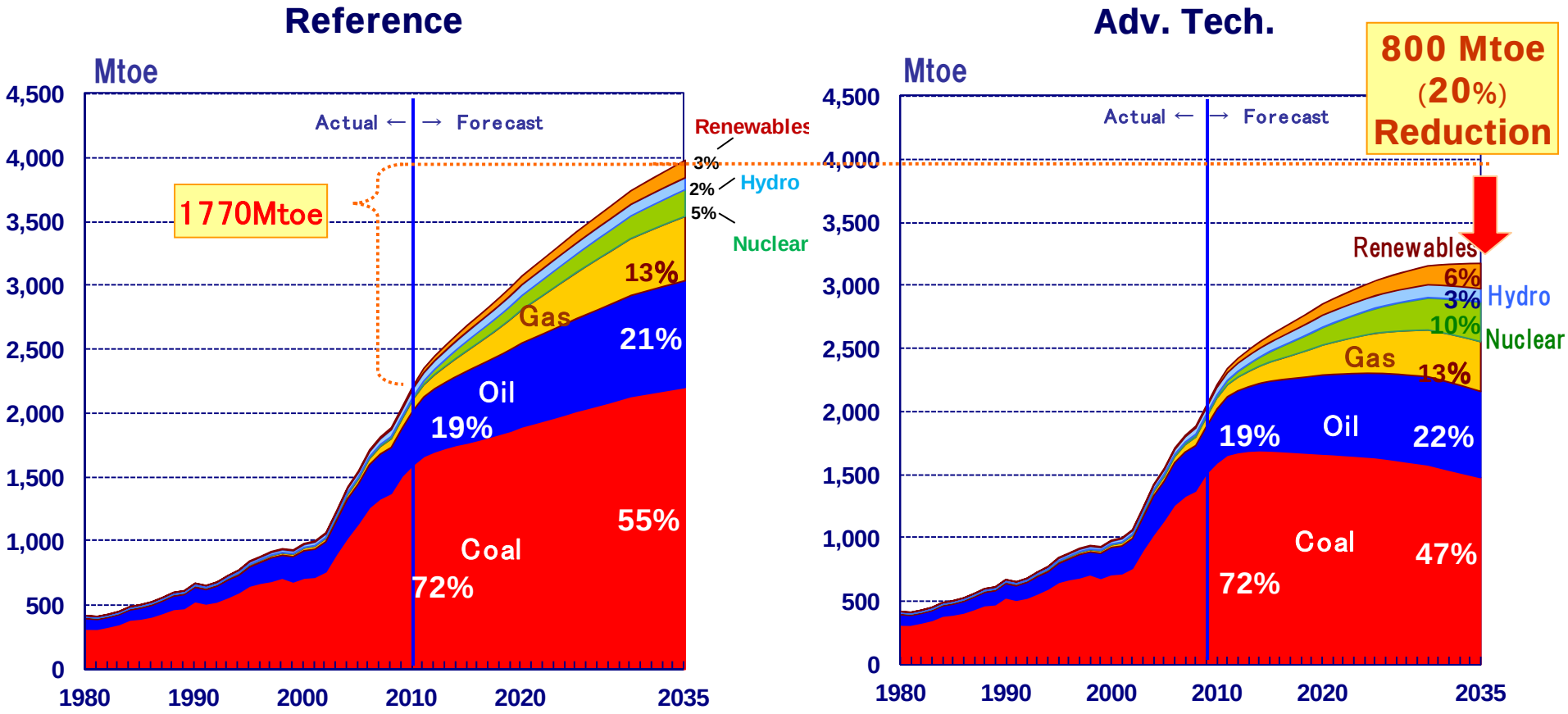
Primary Energy Demand in China

Reference
Adv. Tech.



■ TPED will increase at an annual rate of 2.4% in the Reference Scenario at the back of robust economic growth. Coal will grow substantially driven by the power sector, and oil will expand reflecting rapid motorization. Natural gas will increase sharply for the household and commercial usage, especially in urban areas.

■ In the Adv. Tech. Scenario, coal demand will decrease, especially in power generation, accounting for 800 Mtoe (20% down) reduction compared with Reference Scenario in 2035.

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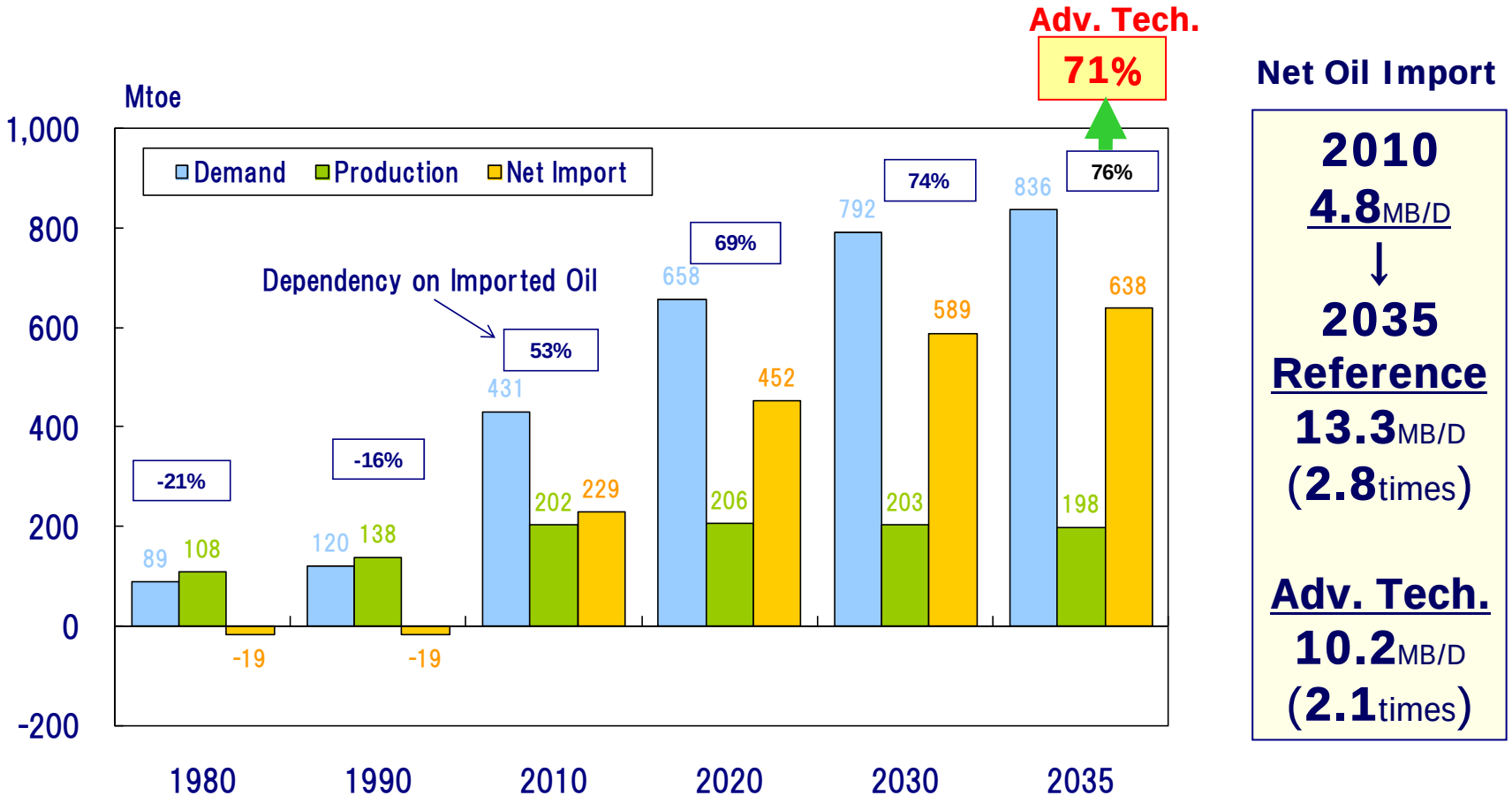
Oil Demand and Supply in China



Net Oil Import

2010
4.8MB/D
↓
2035
Reference
13.3MB/D
(**2.8**times)

Adv. Tech.
10.2MB/D
(**2.1**times)

- Net oil import is projected to expand from 230 million ton (4.5mb/d) in 2010 to 640 million ton (12 mb/d) in 2035. As a result, net oil import ratio will reach 76% in 2035 from 53% in 2010.
- In the Adv. Tech. Scenario, oil demand will grow at a relatively slow rate, but net oil import ratio will still increase to 71% in 2035.
- In order to sustain domestic oil production, continued investments are required to explore and develop oil fields in the western part of China and offshore.

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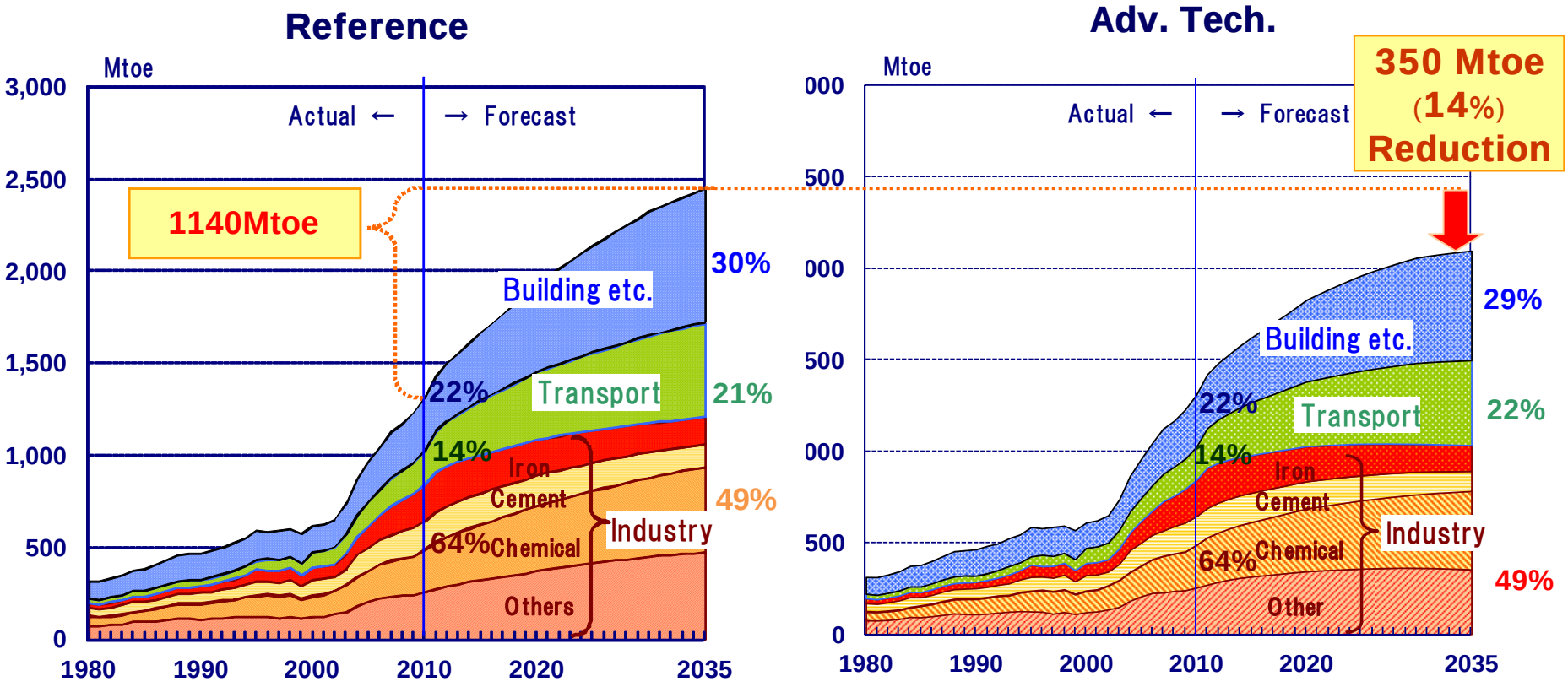
Final Energy Demand in China



Note: The industry sector includes non-energy usage.

■ Energy demand of heavy industry which has been strong up to now will grow relatively slowly in the future.

■ By contrast, energy demand of the household, buildings, and transport sectors will increase substantially. Although the share of the household and commercial sectors will reach 30% in 2035 (from 22% in 2010) , the per capita energy demand of those sectors will still be lower than the OECD average.

■ In the Tech. adv. Scenario, energy demand of the household, building, and transport sectors is expected to have big potential for reduction.

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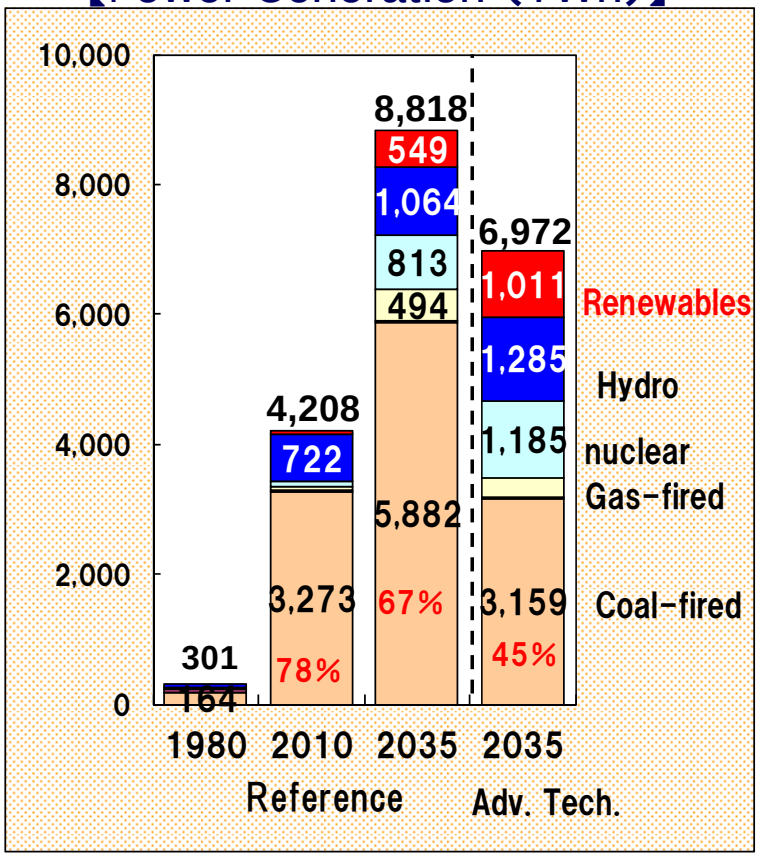
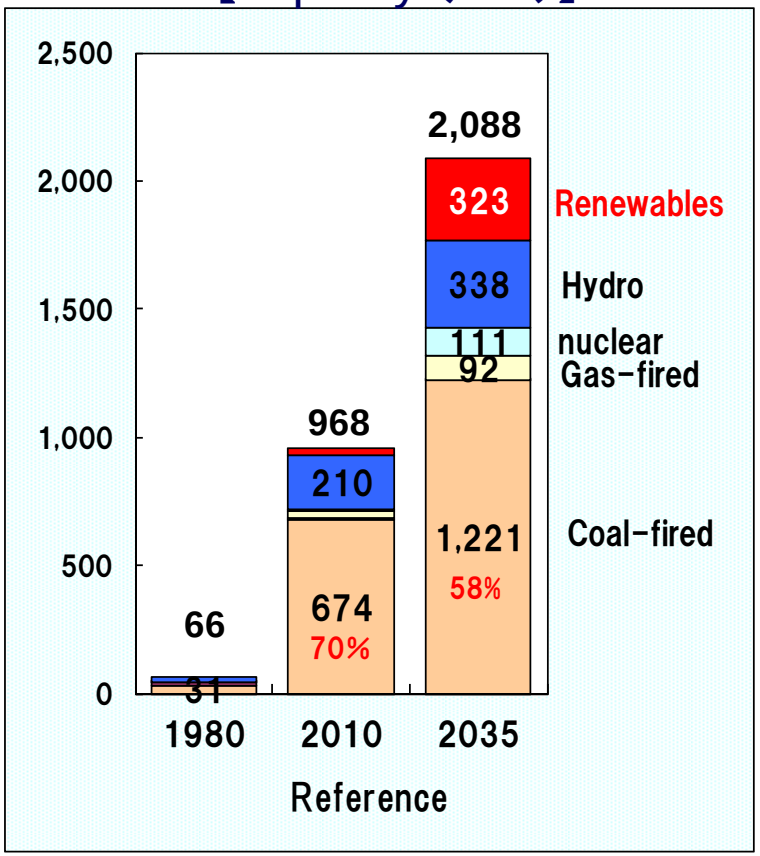
Power Generation Sector

【Power Generation (TWh)】



【Capacity (GW)】



■ Total power generation capacity will increase on average by 45 GW per year, from 970 GW in 2010 to 2,090 GW in 2035,. The share of coal-fired power plant will gradually decline to 58% in 2035, still representing almost half of the world coal-fired power generation capacity.

■ Total power generation will more than double, increasing from 4,208 TWh in 2009 to 8818TWh in 2035. Power generation from gas-fired, nuclear and renewables will substantially increase, while hydro power will represent moderate growth. . The share of coal-fired will decline from 78% in 2010 to 67% in 2035.

■In the Adv. Tech. Scenario, generation from nuclear, hydro and renewable energy will sharply expand to substitute a further decline in coal-fired generation.

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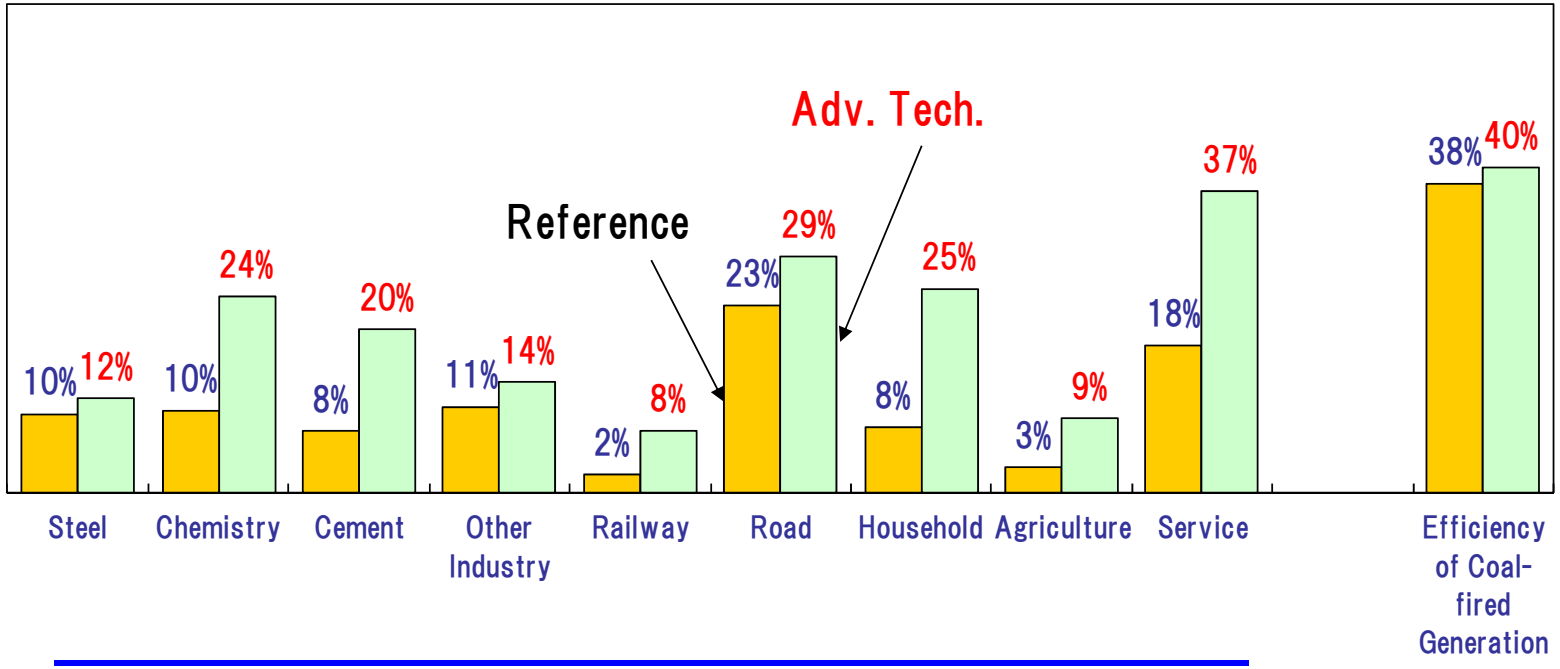
Energy Savings by Sector



Energy saving ratio in 2035 from 2010

■ In the household and building sectors, heating price reform and energy labeling system will play key roles for energy efficiency improvement.
■ The chemical sector may need to introduce large-scale production facilities toward improving production process efficiency in addition to the fuel switching from coal to alternative energy sources.
■ The cement industry would have to increase dry-kiln system (from 78%→nearly 100%) and expand waste heat recovery system.
■ In the power sector, expanding average power generation capacity (100MW→ 350MW) and introduce advanced technology like IGCC will provide considerable savings of coal demand.

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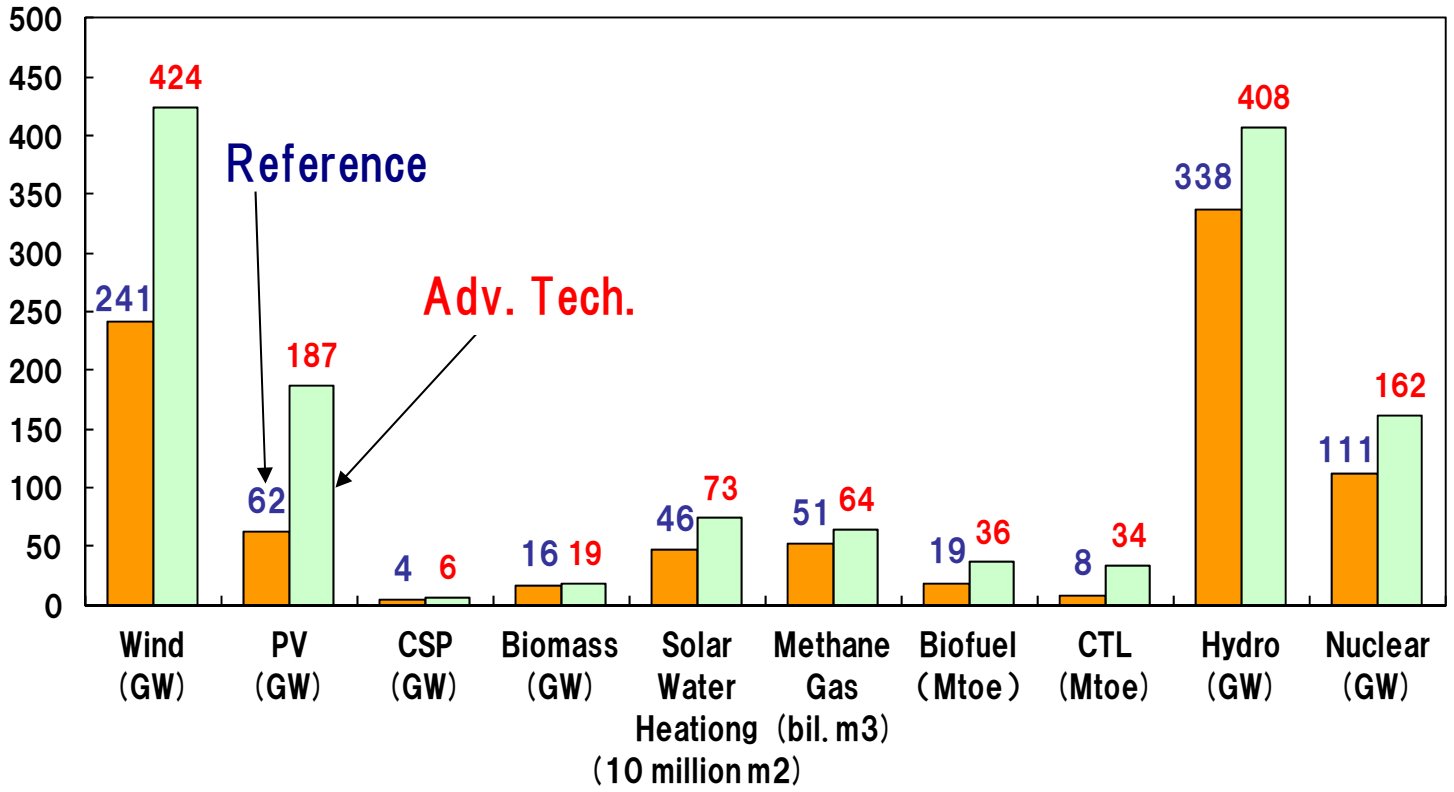
Expansion of Non-fossil Fuel in China (2035)



Non-fossil Fuel (2035)

Reference
440 Mtoe
Ratio of TPE
(11%)

Adv. Tech.
620Mtoe
Ratio of TPE
(20%)

- Hydro expansion will be limited due to resource constraints and environmental considerations.
- Great expansion of nuclear and wind power is expected to meet considerable electricity demand growth and need for environment protection.
- Non-fossil fuel will reach 440 Mtoe in 2035, representing 11% of TPED in the Reference Scenario. In the Adv. Tech. Scenario, the share increases to 20% by 2035.

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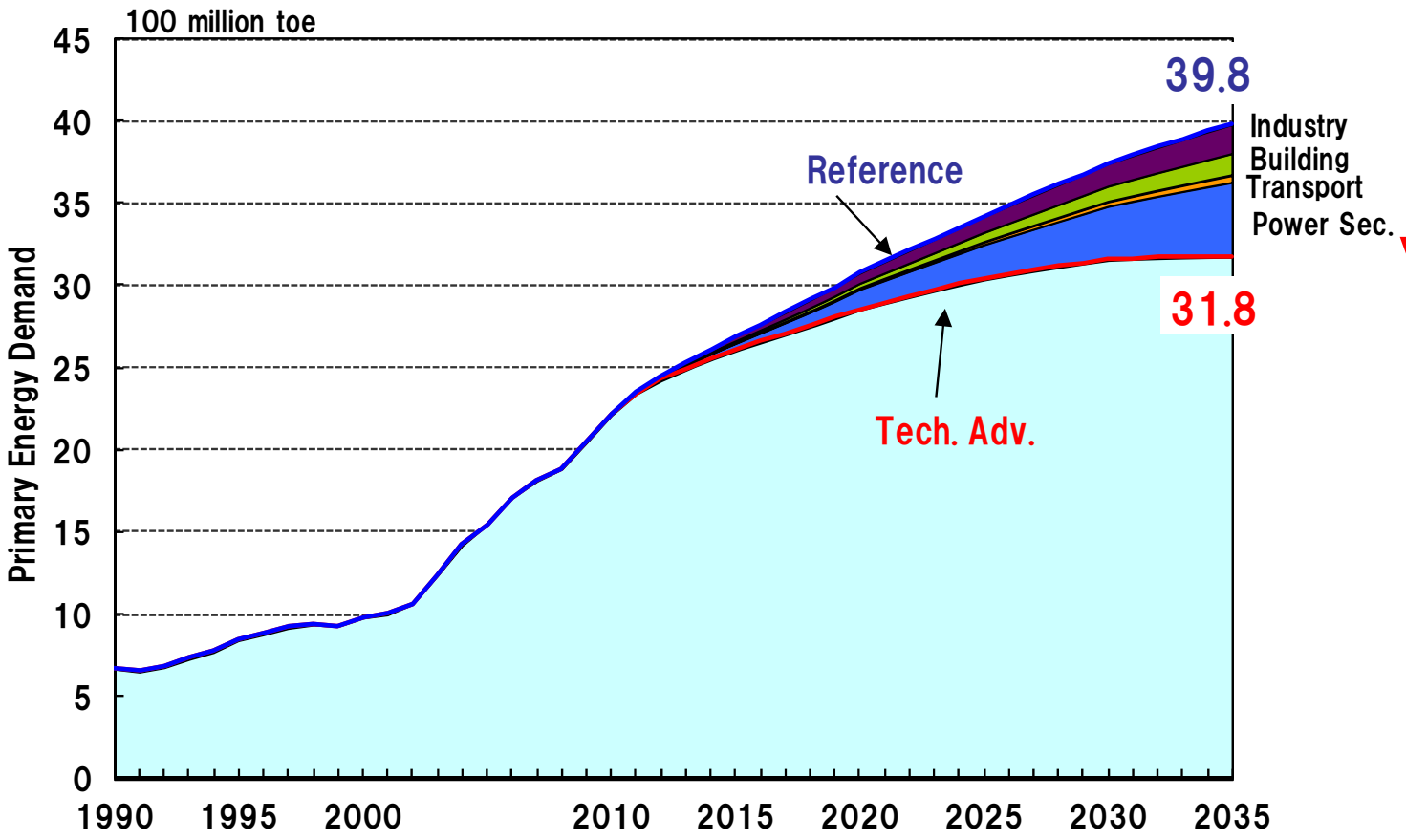
Primary Energy Demand in China

Reference
Adv. Tech.



TPE

2035
800 Mtoe
decrease
(20 %down)

■ In the Adv. Tech. Scenario, TPED will be 800 Mtoe lower (or 20%) compared with the Reference Scenario. The power sector provides the largest potential for energy savings.

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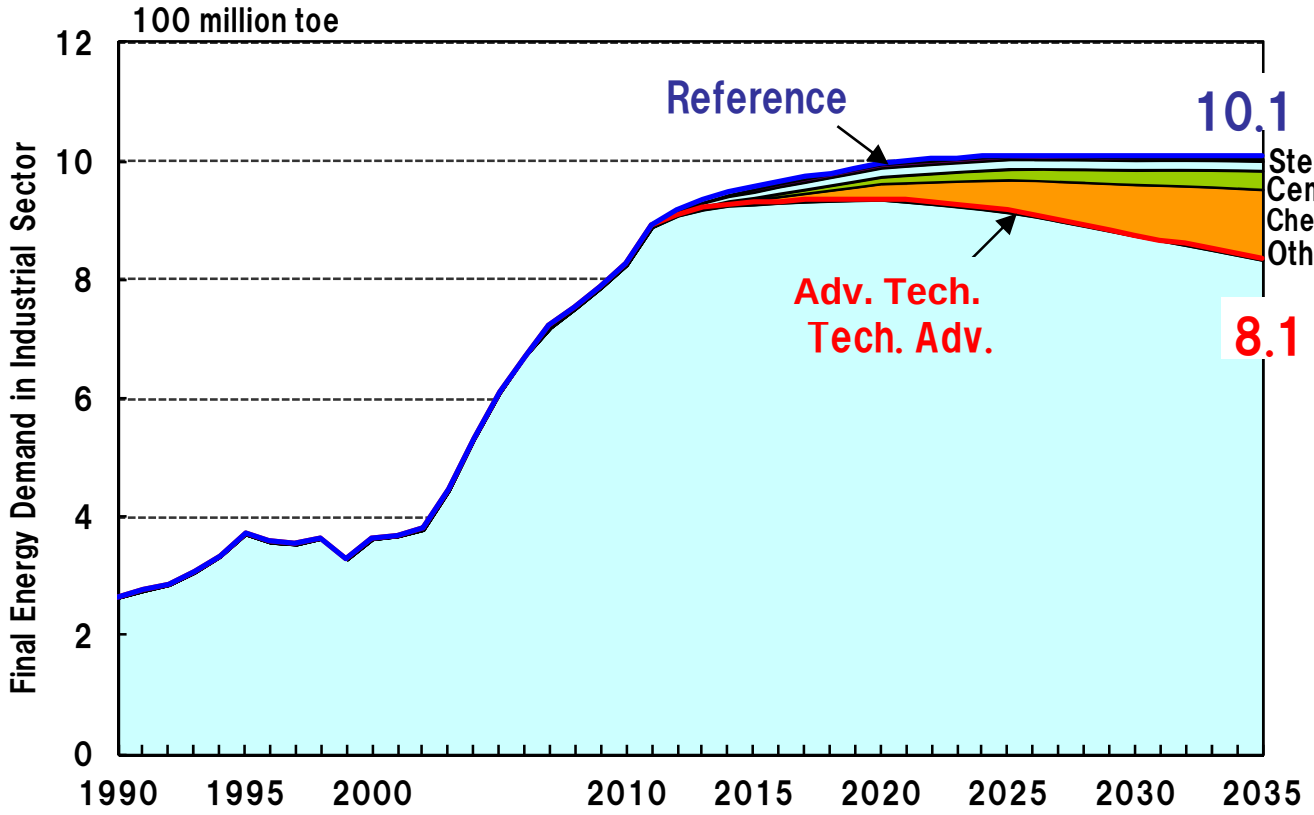
Final Energy Demand in the Industry Sector

Reference
Adv. Tech.



FED

2035
170 Mtoe
decrease
(17 % down**)**

Note: Include energy demand in coke-production process

■ In the Reference Scenario, energy demand of the industry sector will grow moderately at 0.8% per year after 2009, reflecting energy savings and decreasing trend of raw material production.
■In the Adv. Tech. Scenario, final energy demand will decrease by 170 Mtoe (17%).

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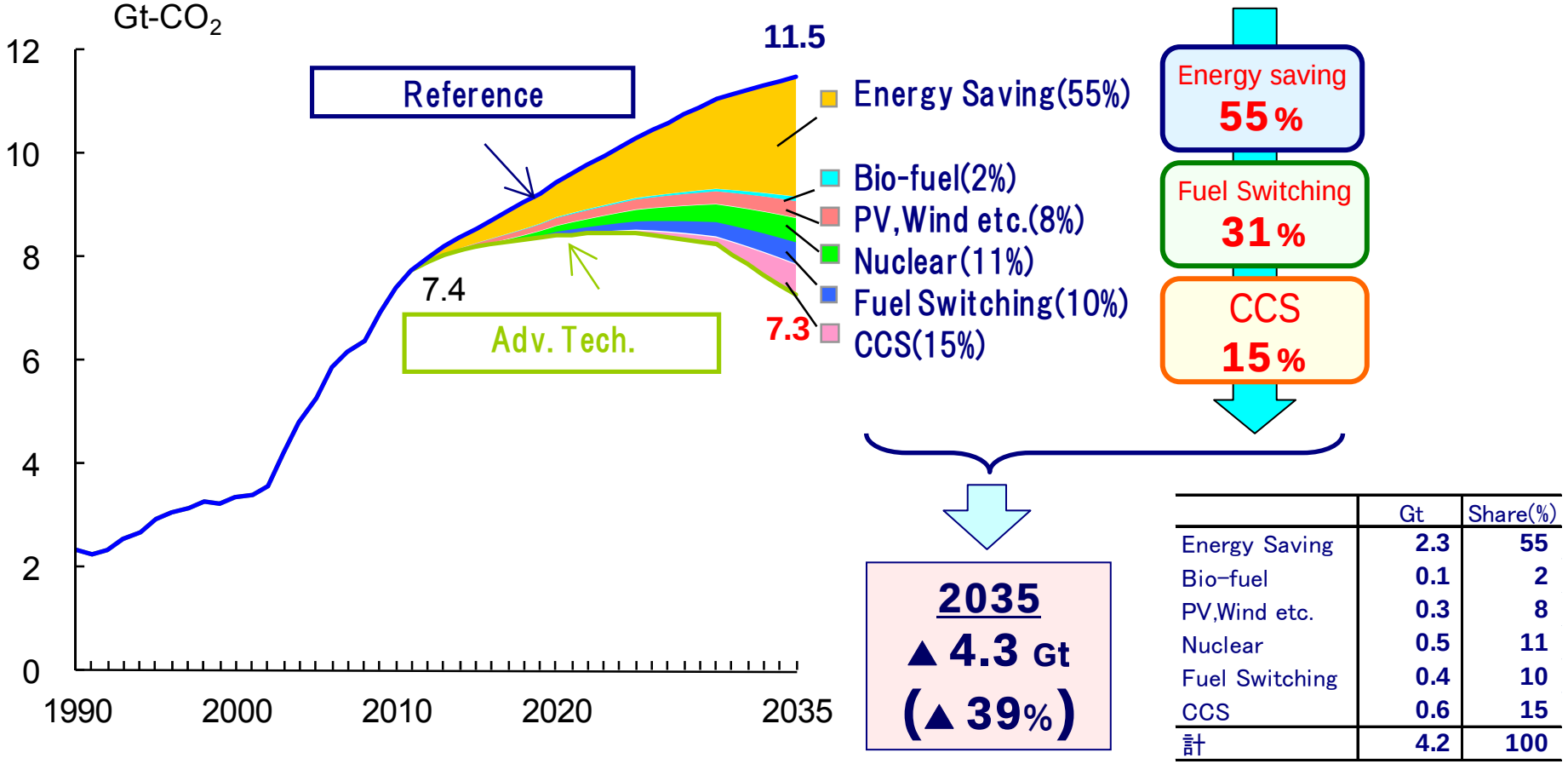
CO_2 Emissions in China

Reference
Adv. Tech.



	Gt	Share(%)
Energy Saving	2.3	55
Bio-fuel	0.1	2
PV,Wind etc.	0.3	8
Nuclear	0.5	11
Fuel Switching	0.4	10
CCS	0.6	15
計	4.2	100

- In the Reference Scenario, CO_2 emissions will increase by 4.1Gt (up 55%) between 2010 to 2035.
- In the Adv. Tech. Scenario, CO_2 emissions will be 4.2 Gt (down 37%) lower than the Reference Scenario in 2035.
- CO_2 emissions will peak around 2025 due to energy saving and fuel switching to non-fossil fuels.

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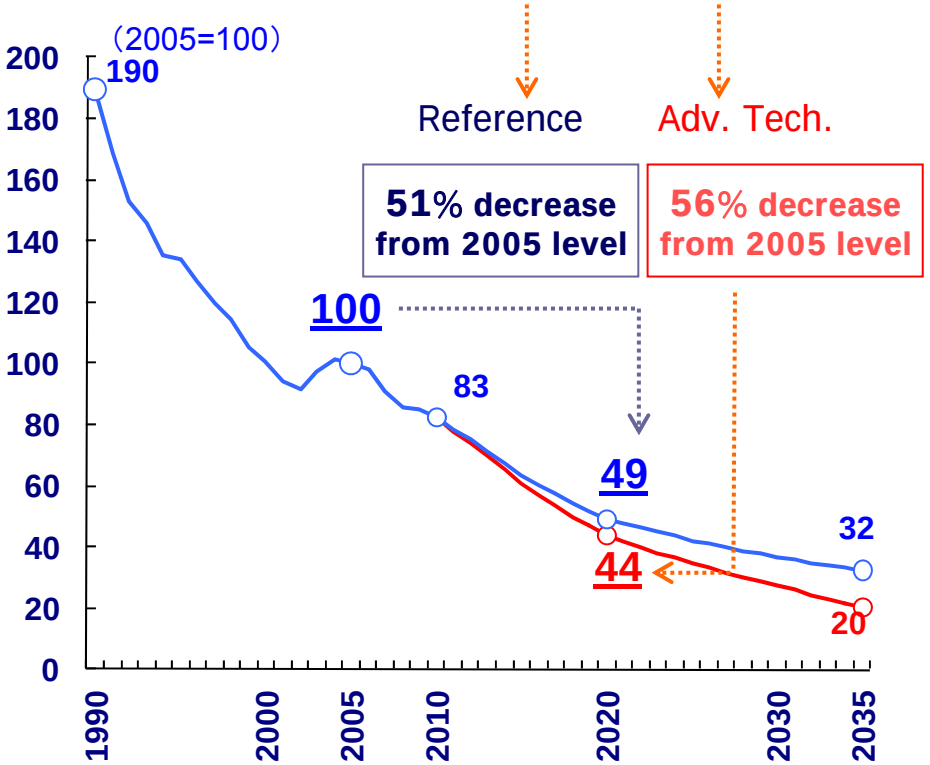
CO_2 Emissions per GDP

Reference
Adv. Tech.

National Target : 40 to 45% reduction by 2020



Decomposition Analysis of CO_2 Emissions

	1990–2005	2005–2020 Reference	2005–2020 Tech. adv.
CO2 Emission ΔC	5.6	3.9	3.1
Carbon Intersity Δ(C/E)	▲ 0.1	▲ 0.7	▲ 1.0
Energy Saving Δ(E/Y)	▲ 4.0	▲ 4.0	▲ 4.4
Economic Growth ΔY	10.2	9.0	

$$C = (C/E) * (E/Y) * Y$$

$$\Delta C = \Delta(C/E) + \Delta(E/Y) + \Delta Y$$

Decarbonization / Energy-Saving / Economic-Growth

- In November 25, 2009, the State Council of the Chinese government decided to improve CO_2 intensity (calculated as CO_2 emissions per GDP) by 40%-45% from the 2005 level by 2020.
- The projected CO_2 emissions intensity (per GDP) will substantially improve beyond the official targets. The reduction is 48% in the Reference Scenario and 57% in the Adv. Tech. Scenario.

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Energy Demand and Supply in India

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Energy and Economic Situation in India

Robust economic growth and consequent energy demand growth

Annual Average Growth Rate (AAGR) from 1990 to 2010

GDP: 6.6%, TPES: 5.4%, Coal: 5.3%, Oil: 5.0%, Gas: 8.4%

Rapid increase in CO_2 emissions and serious local environmental problems

AAGR from 1990 to 2010: 5.3%

Electric power shortage

Energy efficiency improvement

TPES per GDP (2010) (toe per million $ at 2000 value)

India: 696, World: 296, Non-OECD: 608, Japan: 99, China: 745

Rising trend of reliance on imported oil

Dependency on oil import (2010)：74%

Heavy reliance on coal

Share of coal on TPES: 55% (2010)

Energy Policy of India

Basic Agenda of Energy Policy on 12th 5 year Plan (2012/04～2017/03)

(1) Encouragement of energy-saving, (2) Rationalization of energy price, (3) Further exploration of domestic oil and gas, (4) Stepped-up addition of power generation capacity, (5) Exploitation of substantially large number of coal deposits, (6) Expansion of renewable energy

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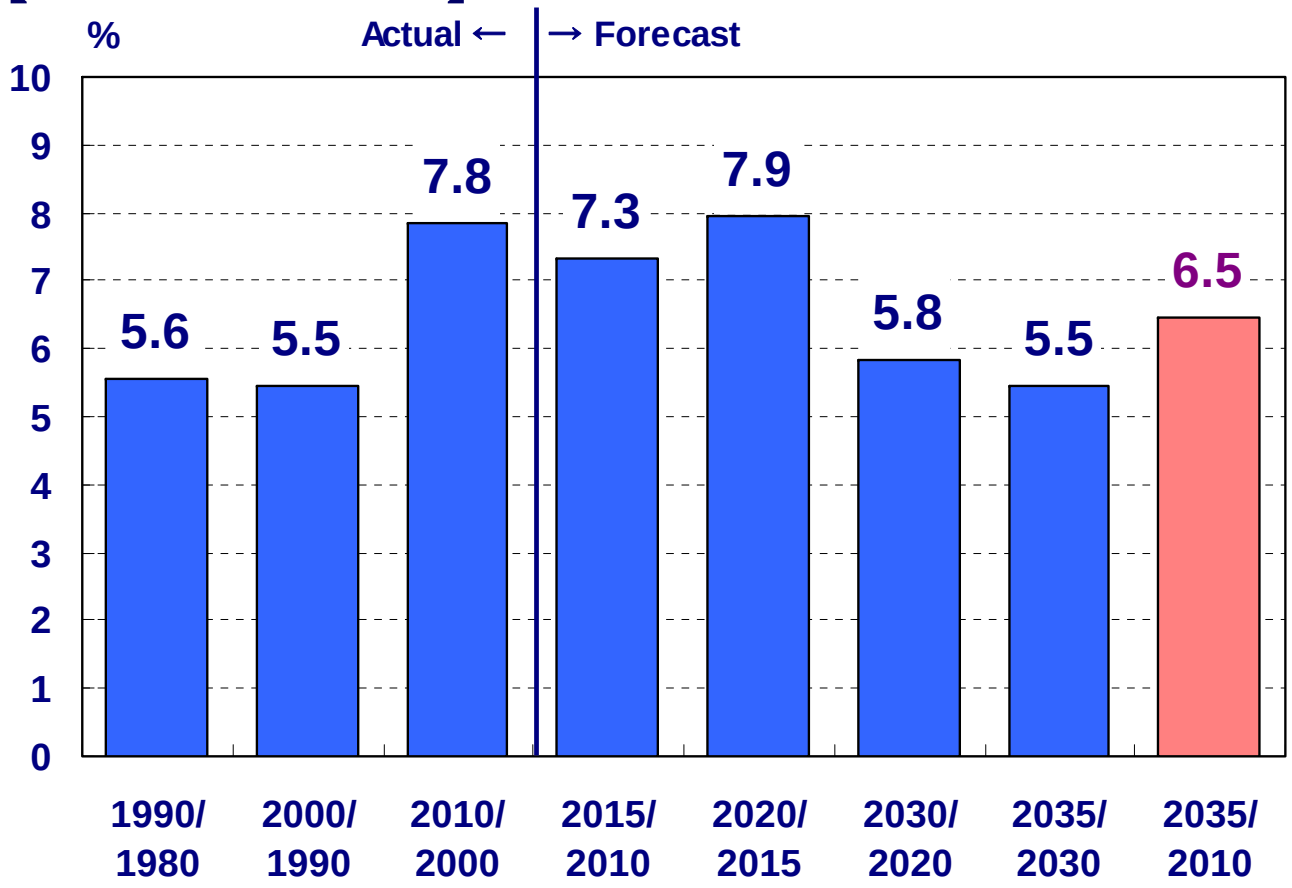
GDP Growth

【GDP Growth Rate】



GDP

2009
1.00TUSD
↓
2035
4.78TUSD
(**4.8 folds**)

GDP per capita

2010
850USD
↓
2035
3,023USD
(**3.6** folds)

■ GDP will continue to grow robustly due to increase in workforce population, improved quality of labor force, opening up of the market, and growing FDI.
■ Downside factor on GDP growth is the shortage of infrastructure in electric power supply, transportation, port and railway.
■ In 2035, GDP per capita will increase to reach 3,000 USD, one-third of that of China.

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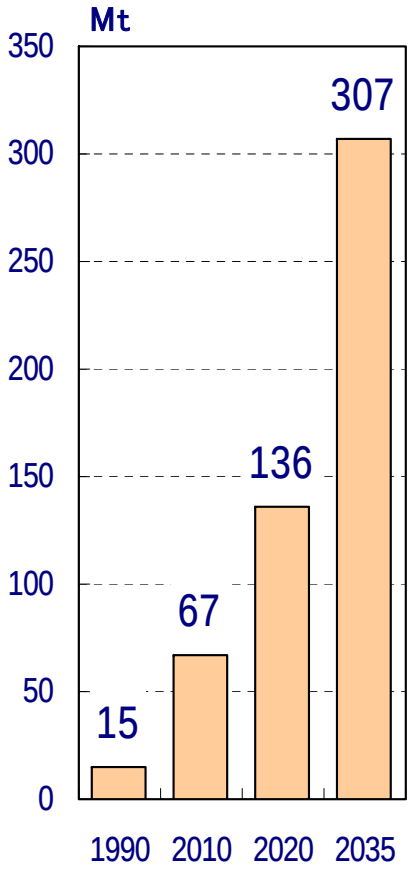
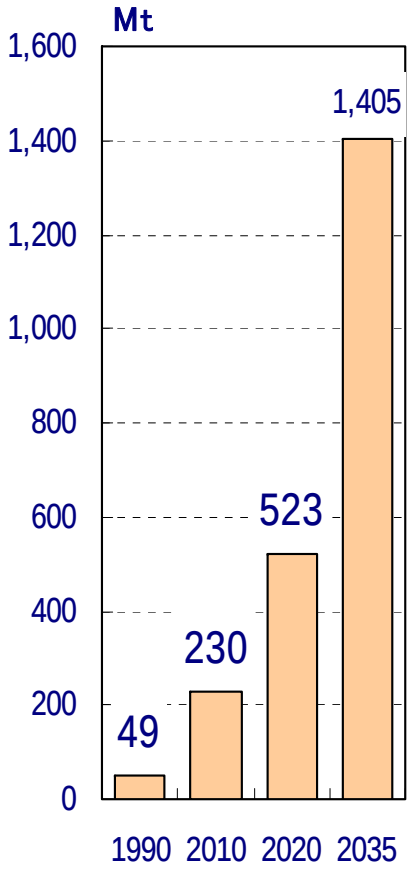
Production of Raw Material in India

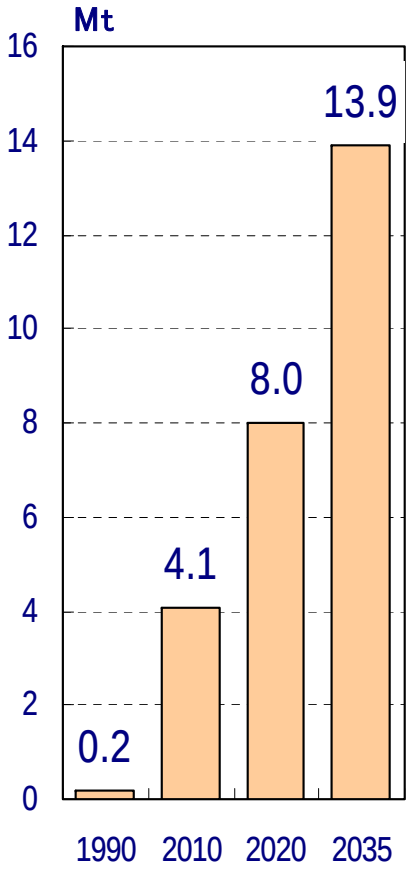
【Crude Steel】



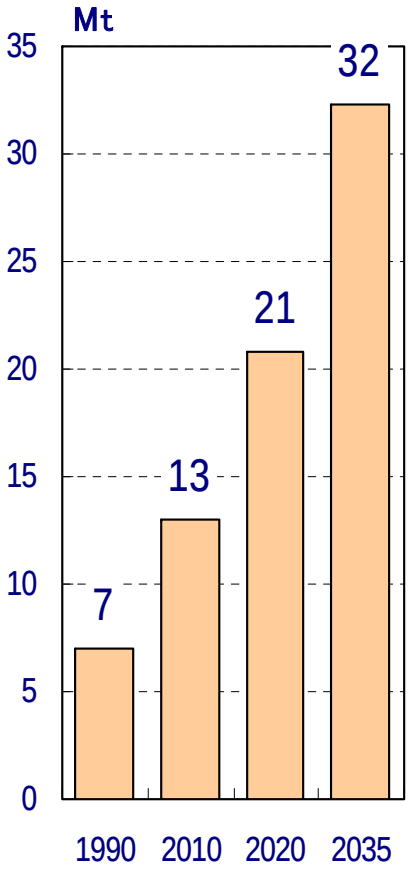
【Cement】



【Ethylene】



【Nitrogen Fertilizer】



■ Infrastructure development, and expansion of manufacturing industry will result in sharp increases in crude steel, cement and ethylene productions.

■ Nitrogen fertilizer production will grow moderately in accordance with the projected moderate growth of agriculture production.

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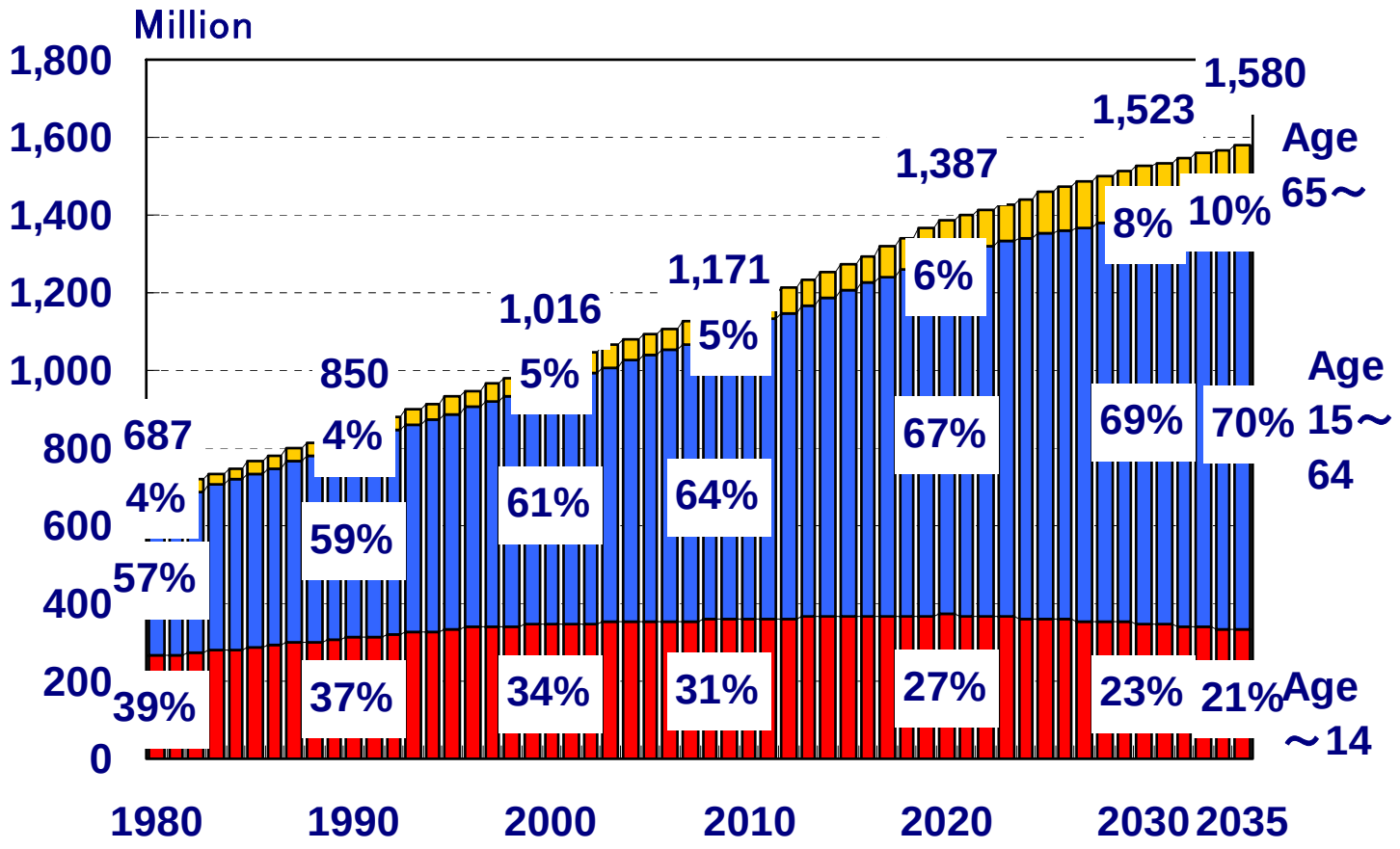
Population in India



Total Population

2010
1,171 mil.
↓
2035
1,580 mil.
(**1.4** folds)

Urbanization Rate

2010
30%
↓
2035
43%
(**13** points up)

- Growing at an annual rate of 1.2%, total population will reach 1.5 billion in 2035 to become the world's most populous country.
- The share of labor force will continue to increase, reaching 70% of the total in 2035.
- The share of urban population will increase to 43% in 2035 from 30% in 2009.

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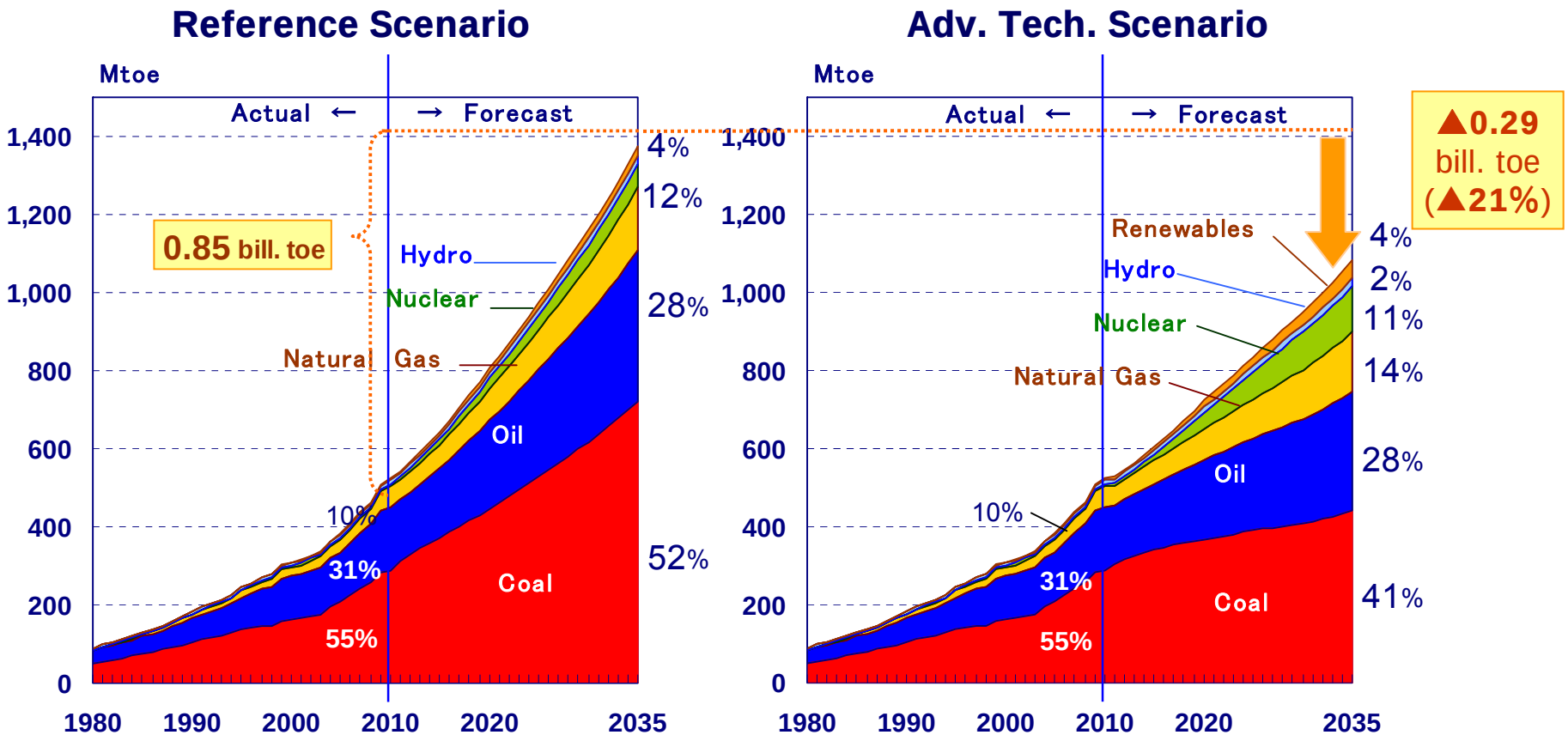
Primary Energy Demand in India

Reference
Adv. Tech.



■ In the Reference Scenario, TPED will increase at annual rate of 3.8%. Fossil fuels will account for 90% of the incremental energy growth by 2035.

■ Driven by the power and industry sectors, coal demand will maintain the largest share at about 51% throughout the projection period.

■ The power and industry sectors will lead natural gas demand growth. Development of domestic resources is expected, while much of the natural gas demand should be met by import.

■ By 2035, compared with the Reference Scenario, TPED will be 290 Mtoe lower (21%) in the Adv. Tech. Scenario.

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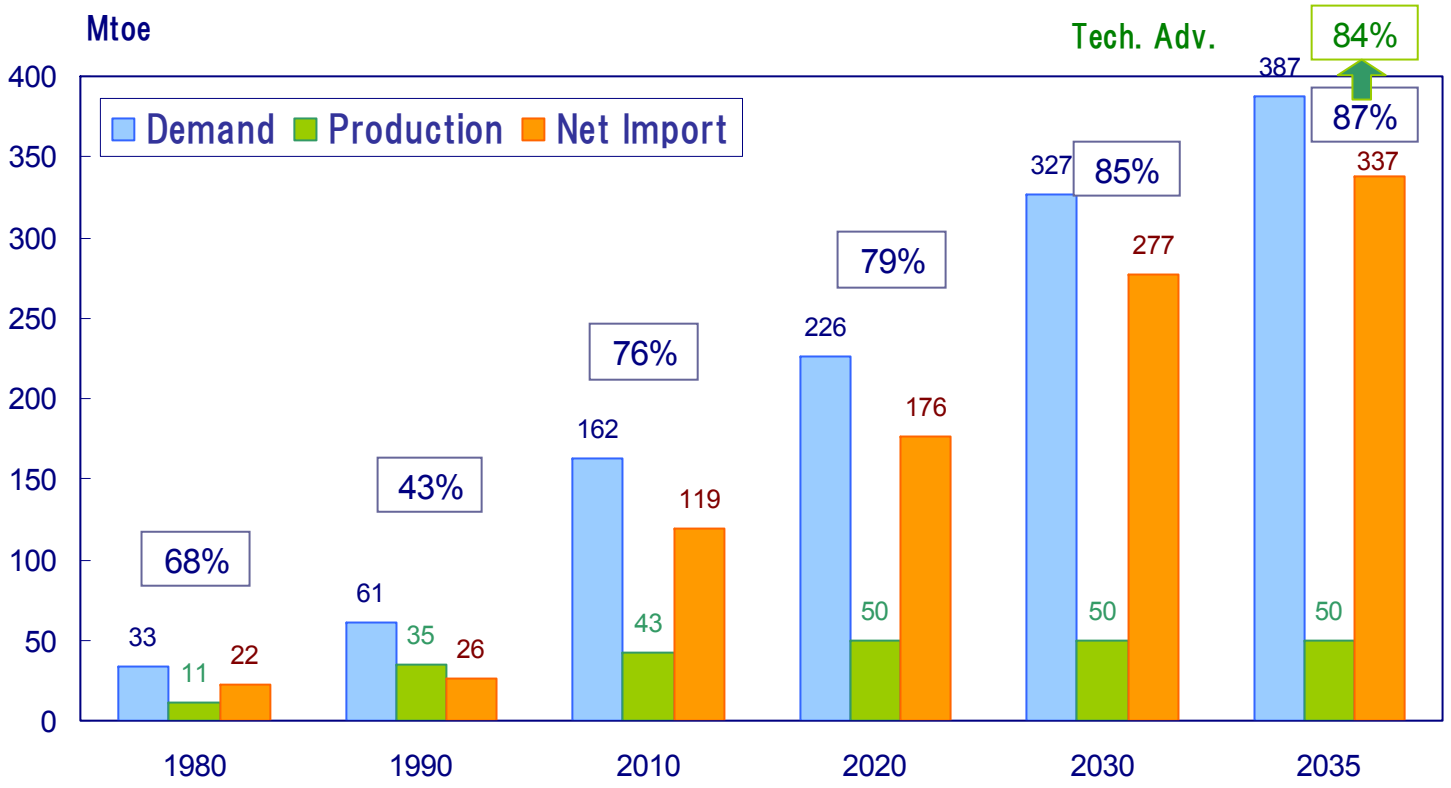
Oil Demand and Supply in India



Net Oil Import

2010
2.5MB/D
↓
2035
Reference
6.9MB/D
(**2.8**folds)

Adv. Tech. Adv.
5.2MB/D
(**2.1**folds)

- Net oil import is projected to expand from 119 million ton (2.5mb/d) in 2010 to 337 million ton (6.9 Mb/d) in 2035. Net oil import ratio will reach 87% in 2035.
- In the Advanced Technologies scenario, net oil import ratio will reach 84% by 2035.

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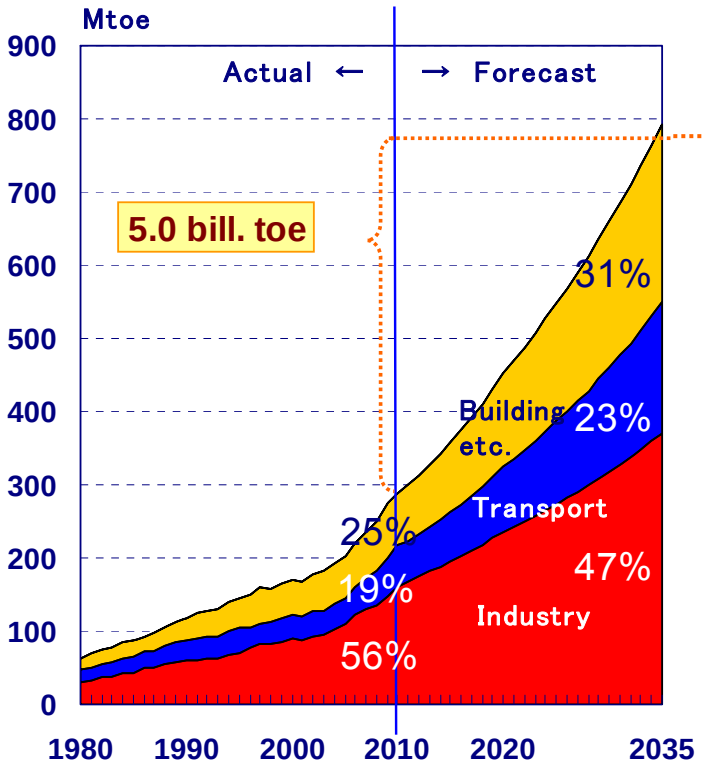
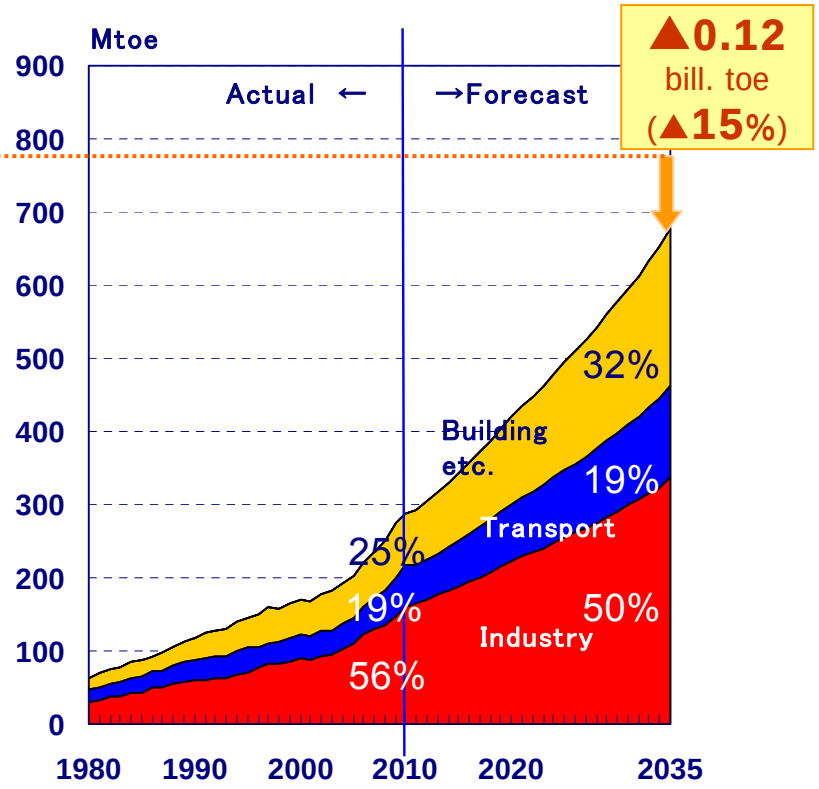
Final Energy Demand in India

Reference
Adv. Tech.

Reference Scenario



Adv. Tech. Scenario



(The industry sector includes non-energy use)

- Industry will increase rapidly due to industrialization and production increases from the heavy industry.
- Electricity demand grows at an annual rate of 5.8%. Per capita electricity demand will increase to 1,947kWh in 2035 (almost twice as much as that of Japan in 2010).
- In the Adv. Tech. Scenario, energy demand will be 120 Mtoe lower (15%) in 2035 compared with the Reference Scenario.

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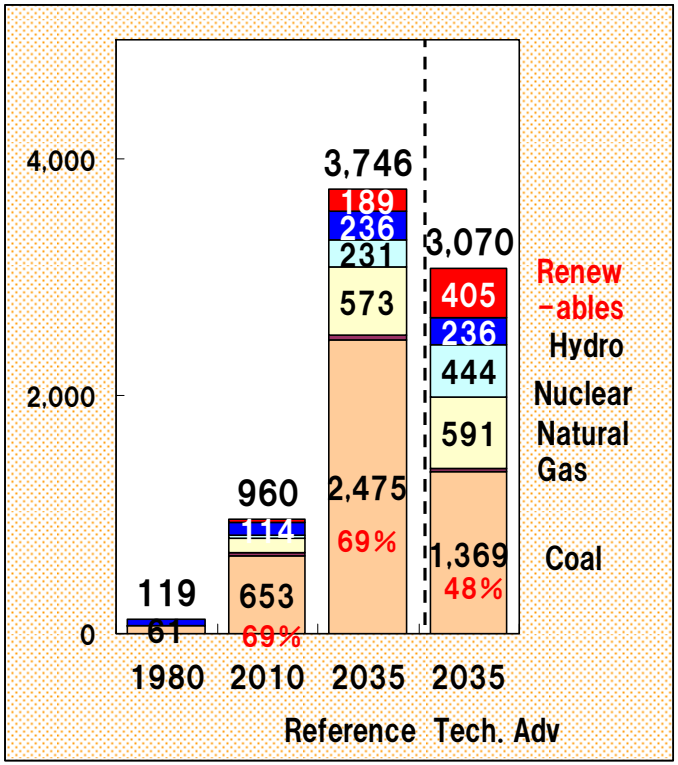
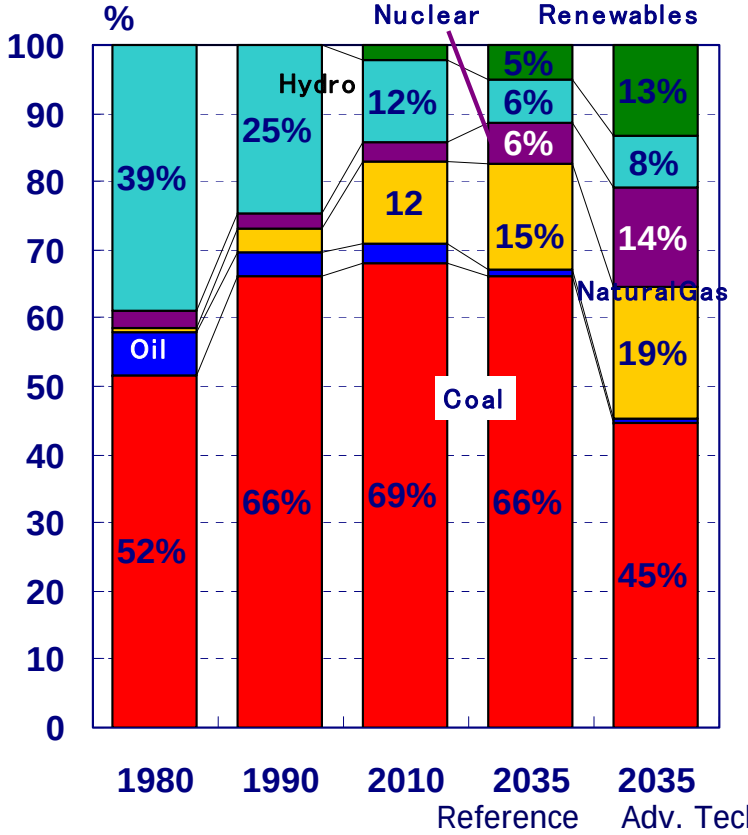
Power Generation Mix in India

【Power Generation】



【Power Generation Mix】



■ Coal-fired power will continue to account for the largest share. The generation efficiency will improve led by the government's Ultra Mega Power Project to introduce several 4GW-class super critical coal-fired power plants.

■ On the other hand, the share of natural gas and nuclear will gradually expand and power generation mix will become more diversified.

■ Capacity of nuclear will increase from 4.1 GW in 2010 to 32GW in 2030 (an 7.9-fold increase).

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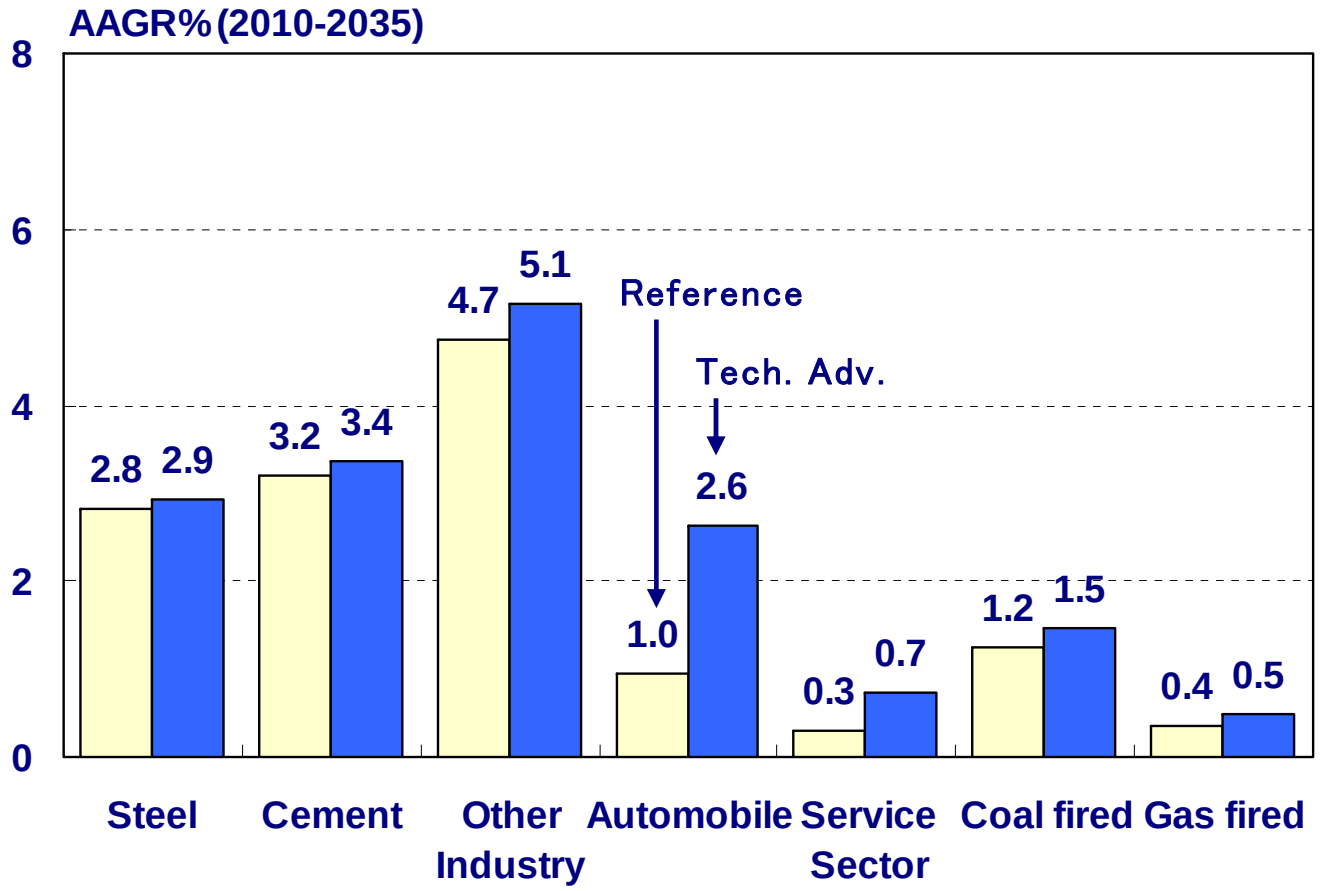
Energy Efficiency Improvement by Sector



■ Newly built factories in India will introduce production systems, with high energy efficiency levels, comparable to international standards. This will be realized with the uptake of various technologies, including pulverized coal injection and blast furnace gas, new type kilns, highly efficient furnaces, motors, and boilers.

■ Policies and measures need to be introduced to promote purchase of energy efficient products for the household customers.

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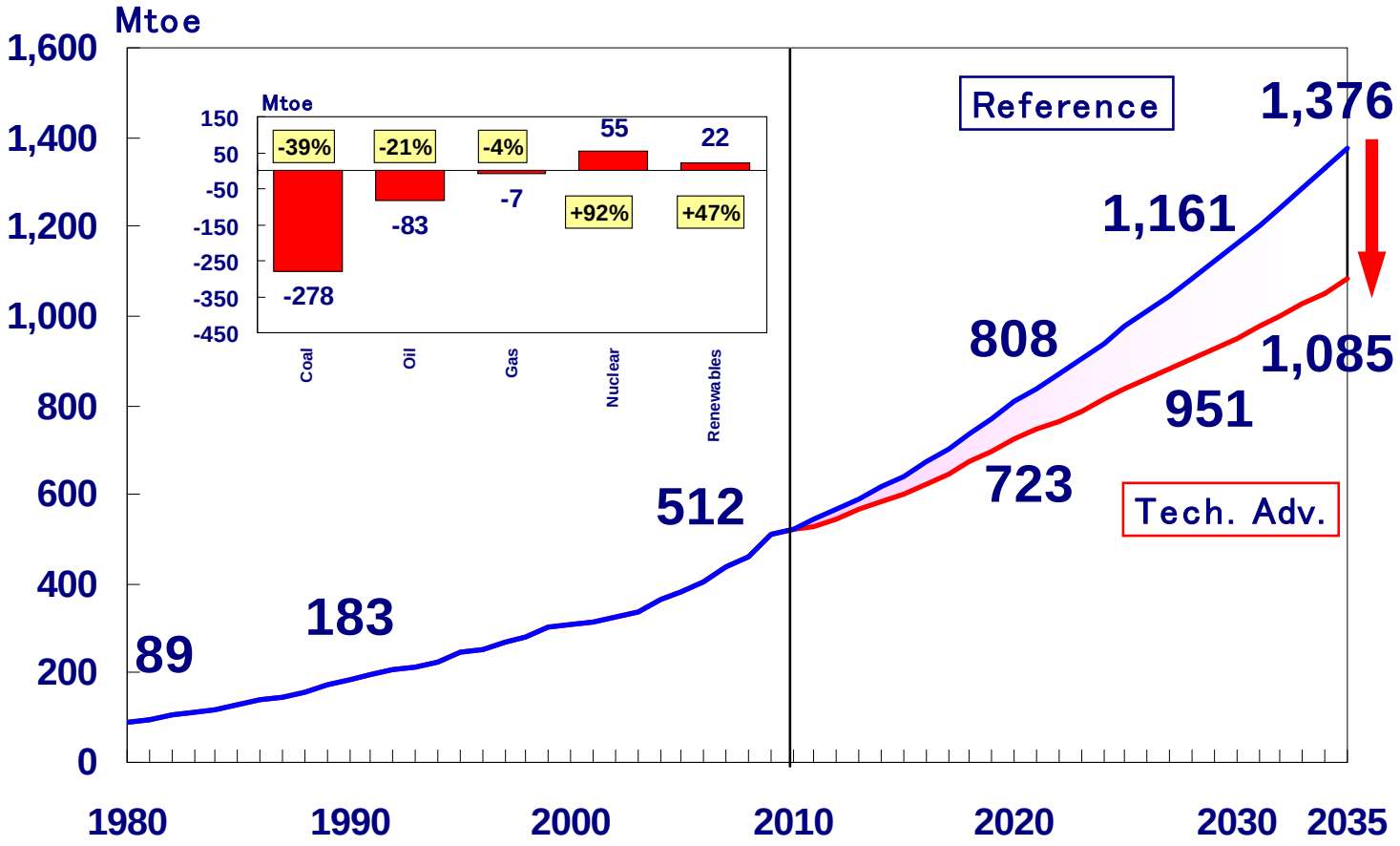
Primary Energy Demand in India

Reference
Adv. Tech.



TPED

2035
▲290 Mtoe
(▲21 %)

- In the Adv. Tech. Scenario, India's primary energy demand will be 290 Mtoe lower in 2035 compared with the Reference Scenario.
- Substantial reduction in coal demand at 280 Mtoe is expected due to the introduction of clean coal technology.

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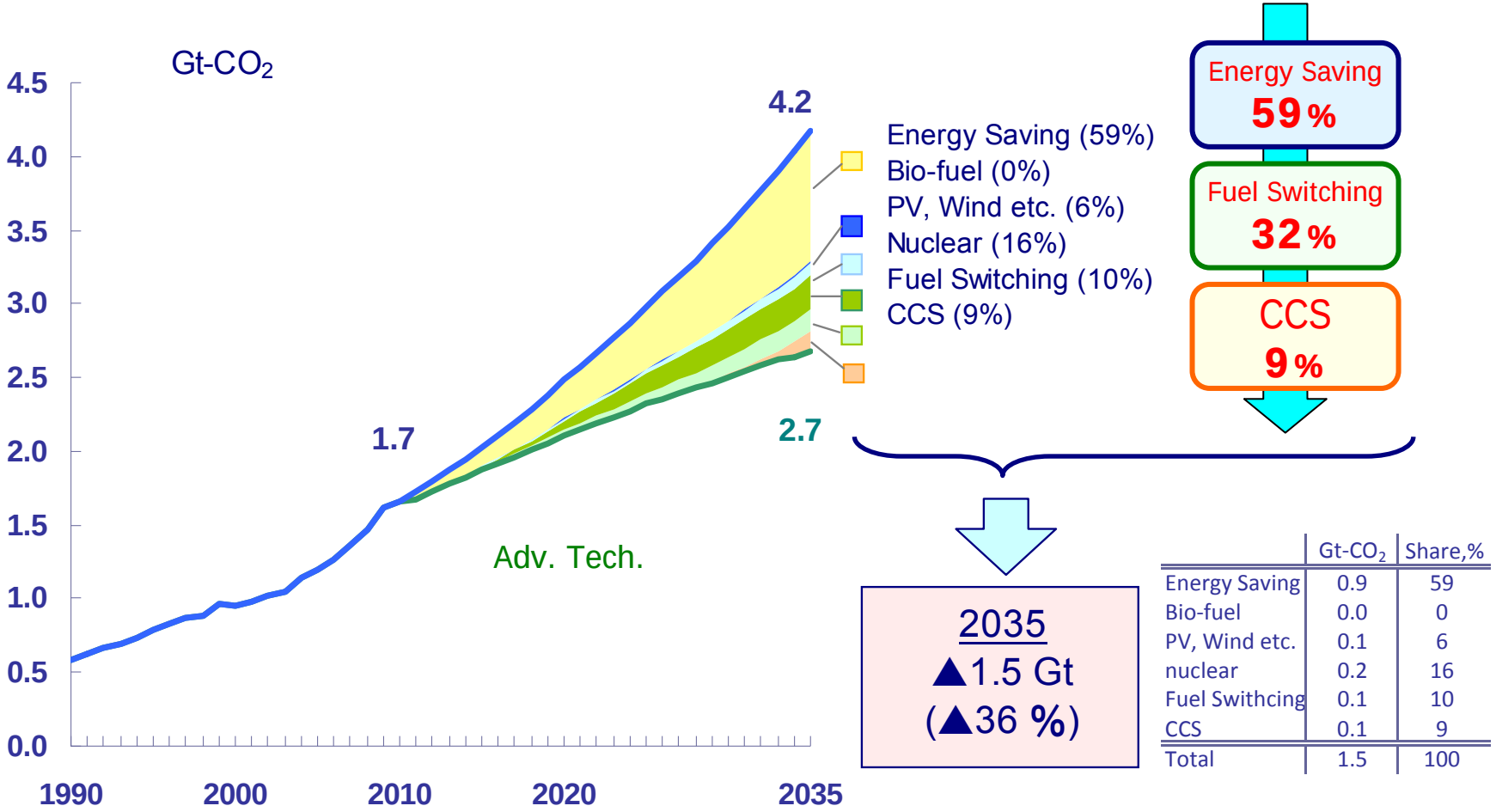
CO_2 Emissions Reduction in India

Reference
Adv. Tech.



	Gt-CO_2	Share,%
Energy Saving	0.9	59
Bio-fuel	0.0	0
PV, Wind etc.	0.1	6
nuclear	0.2	16
Fuel Swithcing	0.1	10
CCS	0.1	9
Total	1.5	100

- In the Reference Scenario, CO_2 emission will increase by 2.6 Gt (158%) in 2035 from 2010.
- In the Adv. Tech. Scenario, CO_2 emissions will be 1.5 Gt (36%) lower from the Reference Scenario.

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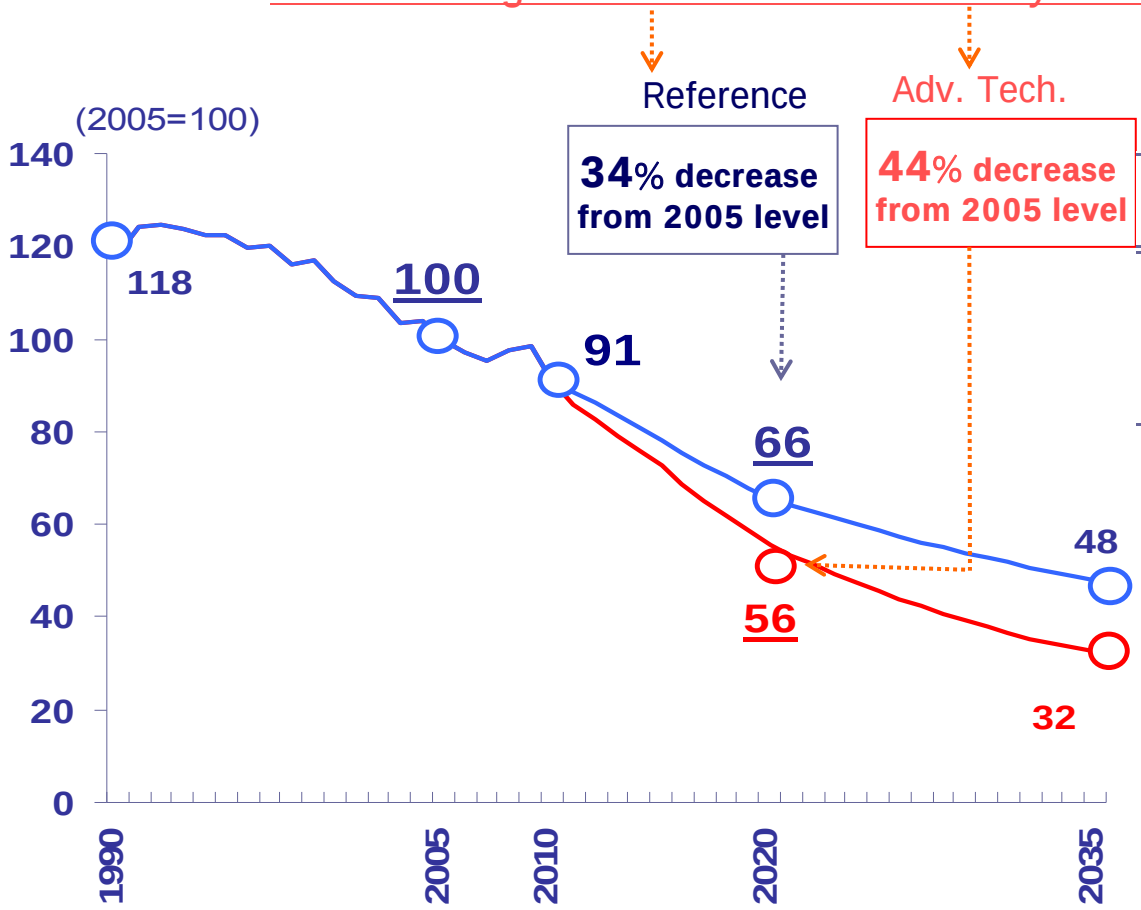
CO_2 Emissions per GDP

Reference
Adv. Tech.

National Target : 20 to 25% reduction by 2020



Decomposition Analysis of CO_2 Emissions

		1990-2005	2005-2020	
			Reference	Tech. Adv.
$CO_{2Emissions}$	ΔC	4.8	5.0	3.9
Carbon Intensity	Δ(C/E	▲ 0.2	▲ 0.1	▲ 0.5
Energy Saving	Δ(E/Y	▲ 0.9	▲ 2.7	▲ 3.4
Economic Growth	ΔY	6.0	8.0	

$$C = (C/E) * (E/Y) * Y$$

$$\Delta C = \Delta(C/E) + \Delta(E/Y) + \Delta Y$$

Decarbonization / Energy-Saving/ Economic-Growth

- India announced to improve its CO_2 intensity (calculated as CO_2 emissions per GDP) by 20 to 25% from 2005 level by 2020.
- The improvement in CO_2 emissions per GDP in 2020 will exceed those targets reaching 34% in the Reference Scenario and 44% in the Adv. Tech. Scenario.

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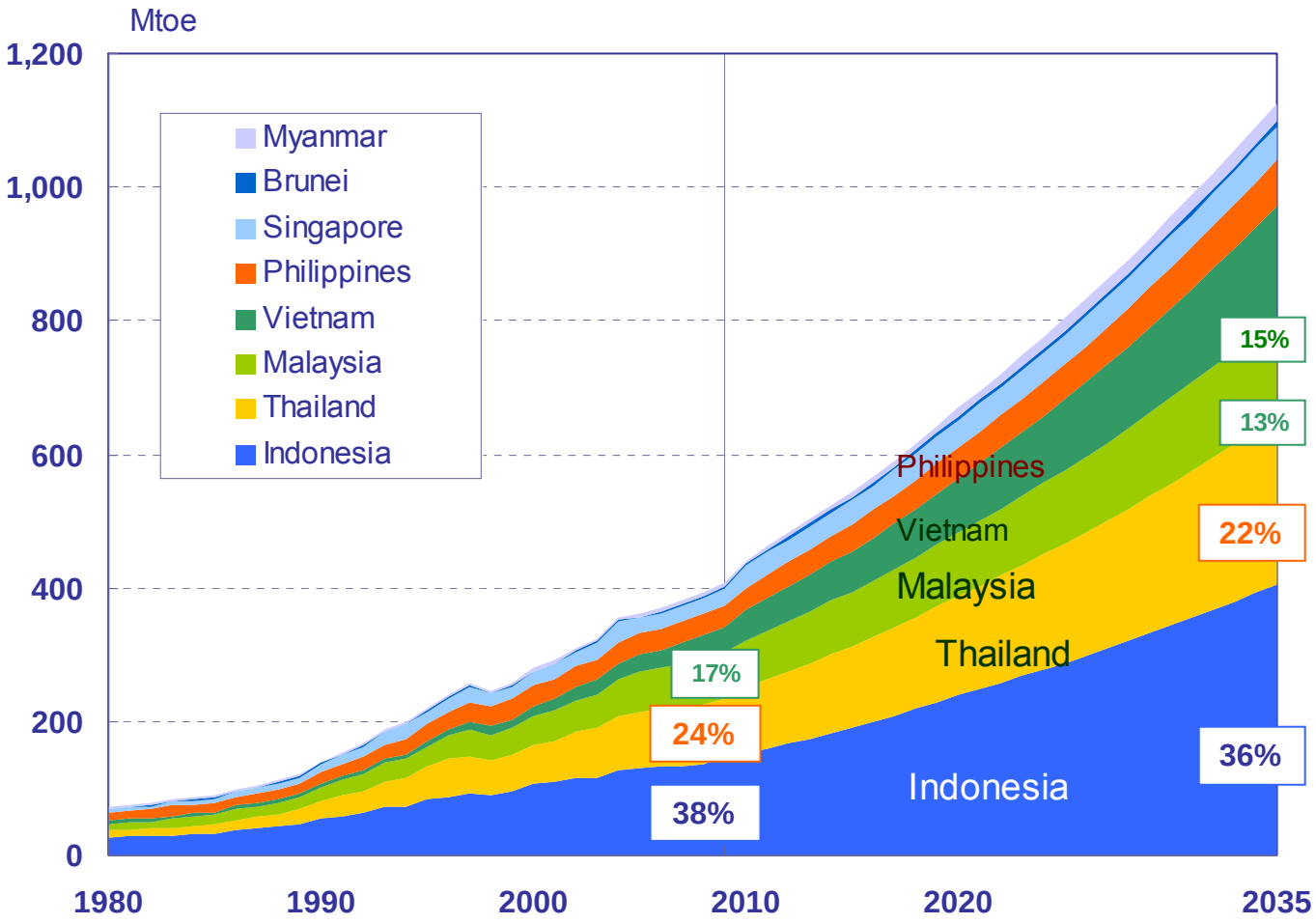
Energy Demand of ASEAN Countries

Reference Scenario



TPED (ASEAN 8)

2010
440 mtoe
↓
2035
Reference
1,120 mtoe
(2.6-fold increase)

Tech. Adv.
1,050 mtoe
(2.4-fold increase)

■ Total primary energy demand in ASEAN countries will grow at 3.9% annually, reaching 1.1 billion toe in 2035.

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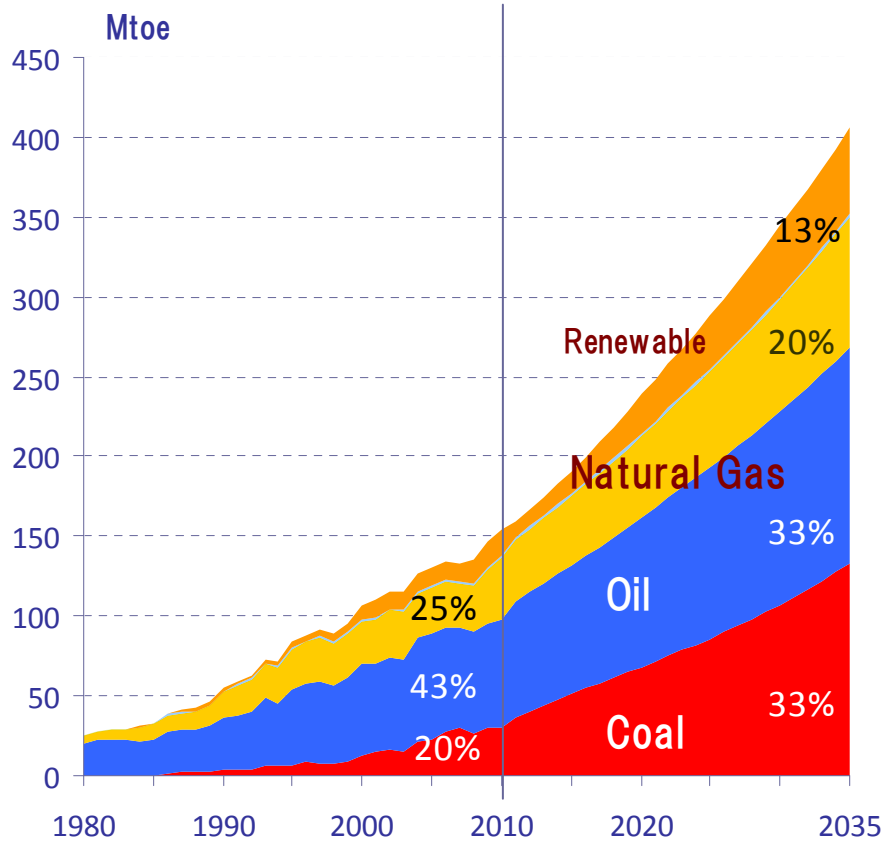
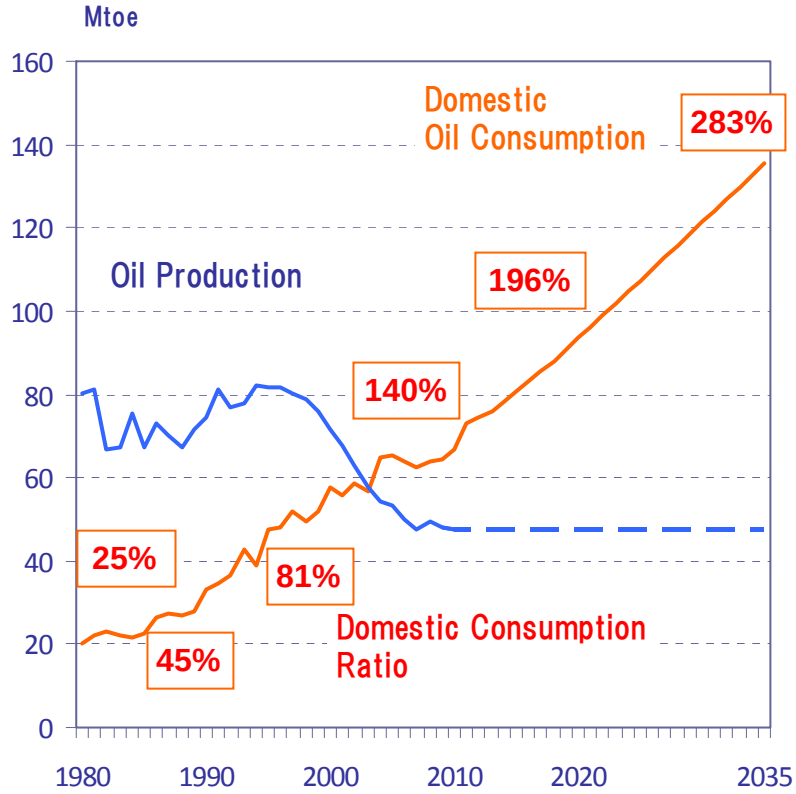
Energy Demand and Supply in Indonesia

Reference Scenario





■ Indonesia became a net oil importer after 2000, and the oil consumption will continue to grow in the future. Net oil import to Indonesia will reach 1.8 million B/D in 2035 in the Reference Scenario, and 1.3 million B/D in the Tech. Adv. Scenario.

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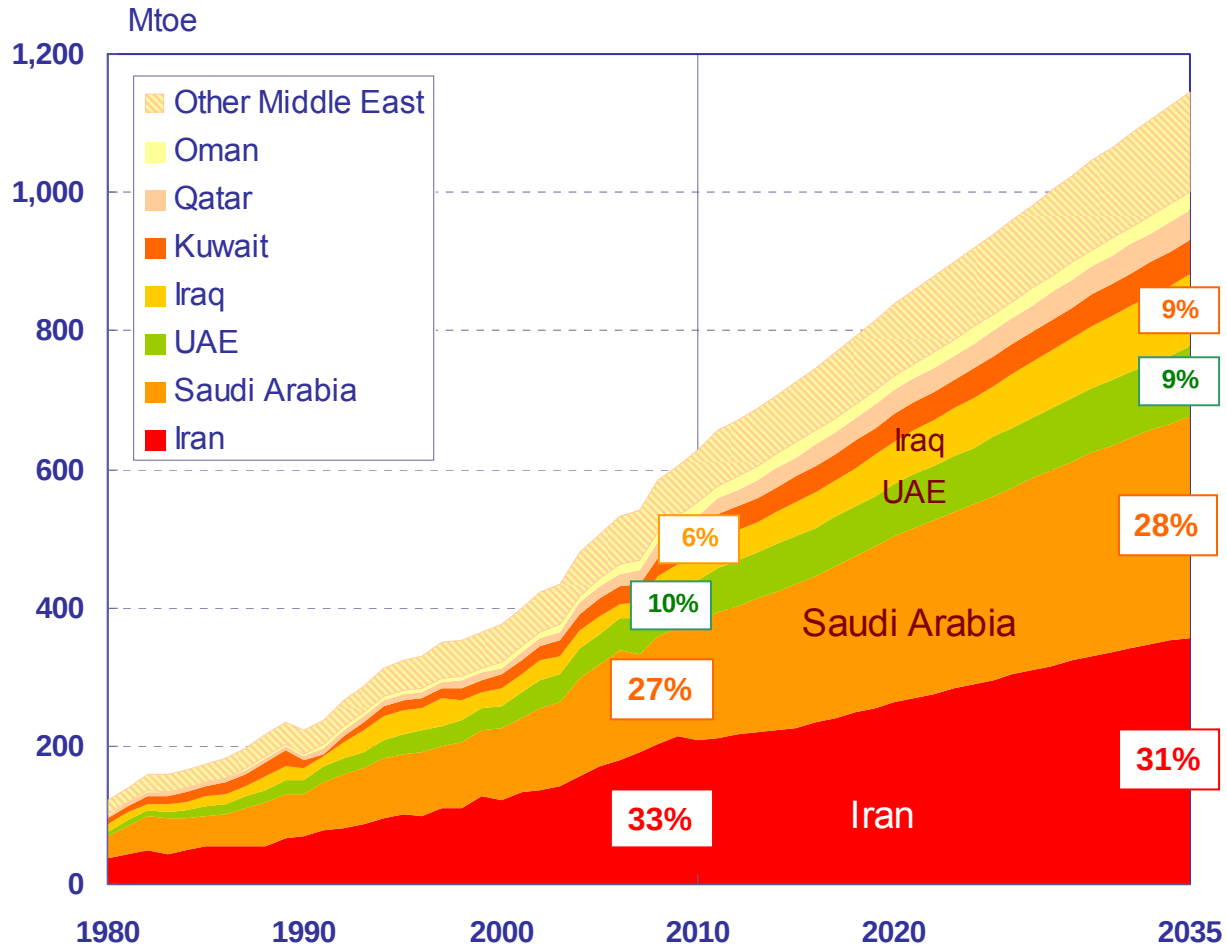
Energy Demand in Middle East

Reference Scenario



TPED (Middle East)

2010
630 mtoe
↓
2035
Reference
1,100 mtoe
(1.8-fold increase)

Tech. Adv.
1,000 mtoe
(1.6-fold increase)

■ Total primary energy demand in Middle East will nearly double by 2035, due to high economic growth.

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Energy Mix in Asia and the Middle East

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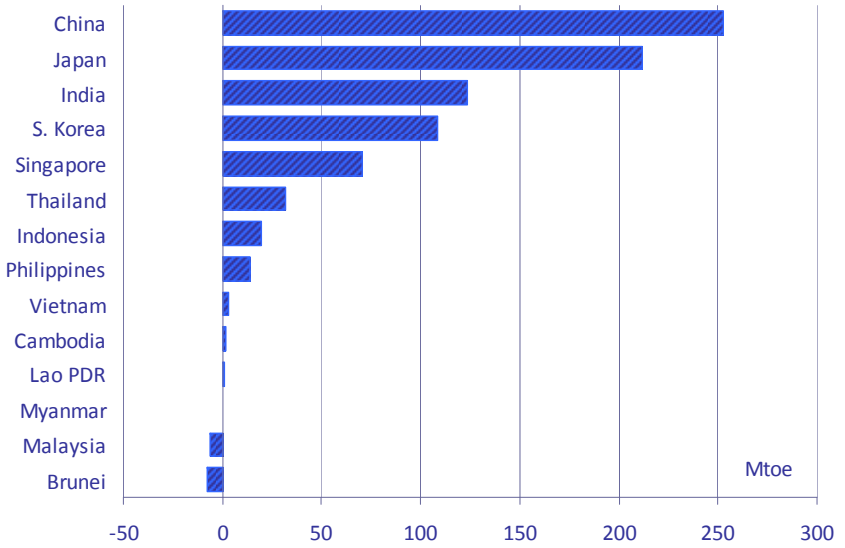
Overview of Energy Utilization in Asia and the Middle East
(1) Oil

In Asia, the increase in oil demand has surpassed that of oil production, and thus imports are expanding. It is essential to reinforce relationships with oil-producing regions/countries including the Middle East.

Oil imports in major Asian countries (2010)



Source: IEA, Lao PDR Ministry of Mines and Energy

◎ China

Currently, half of its oil imports come from the Middle East. It is actively trying to diversify crude oil procurement by constructing international oil pipelines, acquiring interests in overseas oil fields, etc.

◎ India

Domestic resource development projects have not made as much progress as expected, and crude oil imports are rapidly expanding. On the other hand, exports of petroleum products are also expanding due to the construction of state-of-the-art export refineries.

◎ ASEAN

Oil demand is rapidly expanding due to a remarkable increase in automobile ownership. Indonesia has already become a net oil importer. Even Malaysia, which currently exports oil, may become a net importer in the near future as its exports are decreasing.

◎ Middle East

It is crucial to maintain and expand the export capacity after meeting the increase in domestic demand. The political situation, such as relations between Iran and Israel, is also critical.

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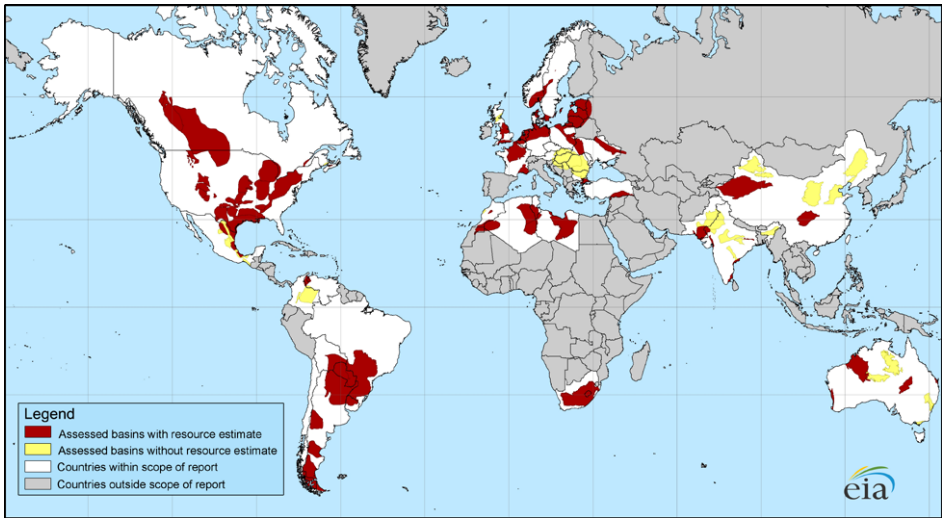
Overview of Energy Utilization in Asia and the Middle East
(2) Natural Gas

Export capacity in South-East Asia, which has conventionally been a natural gas supplier, has been falling considerably. How to secure supplies from outside the region and the development trend of non-conventional natural gas resources are now attracting attention.

Potential shale gas reserves in the world

Source: IEA



◎ China

China aims to expand the share of natural gas in its energy consumption, and the demand for natural gas is rising rapidly. China is increasing imports through pipelines and LNG, and also promoting the development of non-conventional energy resources.

◎ India

Production of the Krishna Godavari gas field, regarded as a key for resolving the supply shortage, has not grown as much as expected. Projects to construct LNG import bases are making rapid progress.

◎ ASEAN

Although Indonesia, Malaysia and Brunei supply LNG to North-East Asia, their surplus export capacity is decreasing due to rising domestic demand. On the other hand, the first LNG receiving terminal in South-East Asia started operation in Thailand in 2011. Receiving terminals are under construction also in Singapore, and construction projects are under way in the Philippines and Vietnam.

◎ Middle East

Resource development projects are actively under way in Qatar and the UAE, which are seeking to expand their supply capacity.

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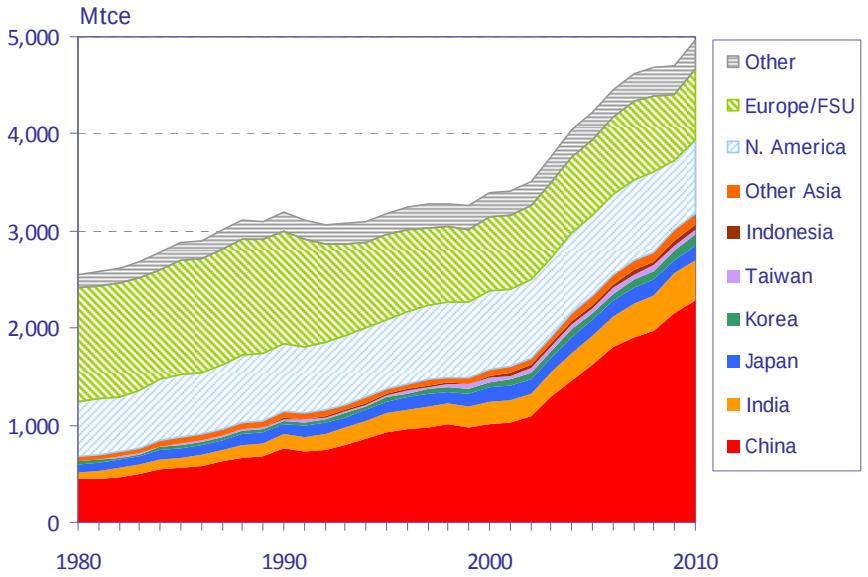
Overview of Energy Utilization in Asia and the Middle East
(3) Coal

A high degree of self-sufficiency has been maintained in Asia thanks to abundant resources in the region. However, imports may expand as demand increases in the future.

Coal consumption by region

Source: IEA



◎ China

China consumes approximately half of all coal produced in the world. Although it had increased domestic production in line with increasing consumption, it suddenly became a net importer in 2009. Coal imports will increase as domestic demand expands, although the amount will change according to the prices. Considering the scale of coal deposits and the increase in production capacity, imports are unlikely to increase dramatically.

◎ India

Although India has also abundant coal resources, the increase in demand surpassed domestic production because of low quality and productivity. As a result, India imported 15% of its demand in 2011. Imports are projected to continue increasing, so it may eventually become the world's largest coal importer, overtaking China and Japan.

◎ ASEAN

Indonesia has been rapidly increasing its coal exports since the early 2000s and became the world's largest coal exporter in 2011, overtaking Australia. However, with the expansion of domestic demand, exports are projected to reach a peak in the near future. On the other hand, although Vietnam has been an exporter of anthracite, imports of steam coal are likely to increase because of the increase in demand for coal for power generation. Thailand, the Philippines and Malaysia, which have been coal importers, will expand their imports in the future to meet the increase in demand for coal for power generation.

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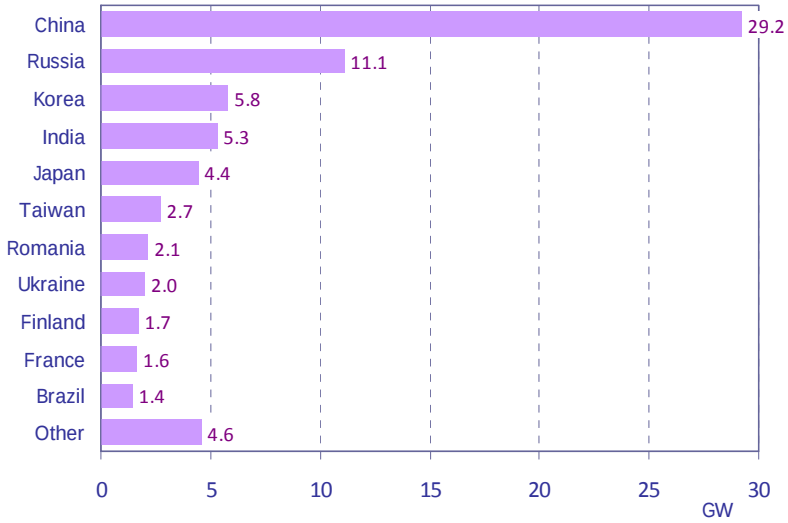
Overview of Energy Utilization in Asia and the Middle East
(4) Nuclear Power

As of January 2012, 47 nuclear power plants with a capacity of 49 GW are under construction in Asia, except Japan, and the Middle East (accounting for approximately 70% of nuclear plants under construction in the world).

Nuclear power generation capacity under construction

Source: Japan Atomic Industrial Forum, State Council of China



◎ China

As of October 2012, the world's largest fleet of 26 units with a capacity of 29 GW is under construction in China. Although China temporarily stopped licensing the construction of new NPPs after the Fukushima accident, it is expected to restart soon after approving the new nuclear safety program.

◎ India

With the thorium cycle development program utilizing domestic heavy water reactors (PHWRs) still ongoing, India has also been simultaneously introducing LWR technologies from Russia and France. At present, 7 units with a total capacity of 5.3 GW are under construction, which exceeds the existing installed capacity.

◎ ASEAN

In Vietnam, new construction projects are in progress in cooperation with Russia and Japan. Although other ASEAN countries had been planning to construct new NPPs, they have been reconsidering their plans after the Fukushima accident.

◎ Middle East

A new construction project has already started and is progressing in the UAE in cooperation with Korea. Saudi Arabia has also announced plans to construct a total of 16 units by 2030. However, new construction projects have been put on hold in Kuwait and Jordan.

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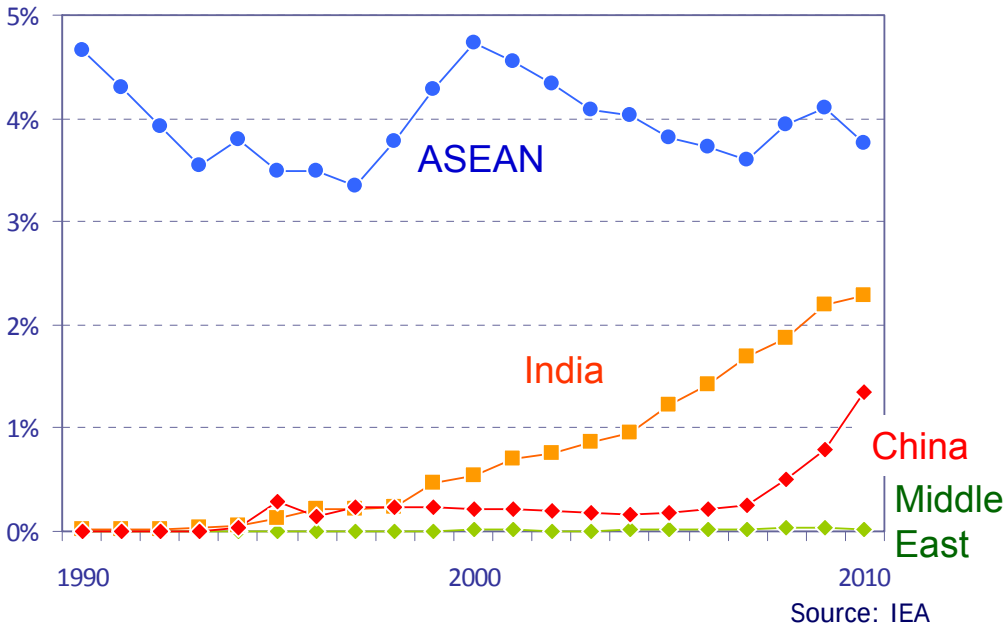
Overview of Energy Utilization in Asia and the Middle East
(5) Renewable Energy

Each country is actively promoting policies to encourage the introduction of renewable energy. However, the share of power from renewable energy remains low as electricity demand continues to increase rapidly.

Proportion of introduction of renewable energy (excluding hydropower)



Source: IEA

◎ China

China has expanded its installed capacity of wind power generation, although hydropower generation remains its base. During the period of the 12th 5-year plan (2011–2015), photovoltaic power is expected to be rapidly promoted along with hydro and wind power by the introduction of a feed-in-tariff (FIT) system.

◎ India

India has been developing its abundant hydropower resources. Although the amount of photovoltaic power is still small, it is planned to be expanded in the future.

◎ ASEAN

Each country has established aggressive targets for introducing renewable energy. Some countries have introduced a FIT system as a key measure. Indonesia and the Philippines have introduced large amounts of geothermal power and further development is expected.

◎ Middle East

Some countries, including Saudi Arabia and the UEA, have been actively conducting R&D on photovoltaic and solar thermal power generation. However, incentives for investment are low due to extremely cheap electricity prices. A system to encourage full-fledged diffusion is needed.

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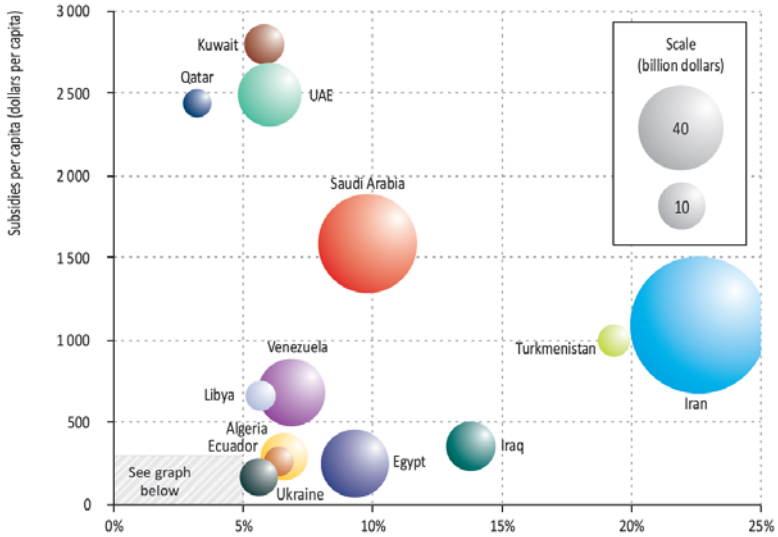
Overview of Energy Utilization in Asia and the Middle East
(6) Energy Conservation

Countries place energy conservation as an important policy. However, the degree of progress in energy conservation significantly differs partly because of the relationship with subsidy policies.

Subsidy policy of major countries

Vertical: Per capita subsidy
Horizontal: Subsidy as a percentage of GDP



Source: IEA WEO 2011

◎ China

China places energy conservation as an important policy, and has accomplished great success through a fast-acting strong policy.

Continuous progress in energy conservation is expected by implementing a more detailed and careful energy management system.

◎ India

India has established an Energy Conservation Act and has been promoting energy conservation through the Bureau of Energy Efficiency (BEE). However, electricity and energy prices, which are kept at very low levels, are slowing the progress of energy conservation technology. Electricity shortages due to the rapid growth in demand have become a serious problem.

◎ ASEAN

Each country recognizes the importance of energy conservation and has been actively promoting it, particularly in the industry sector. However, cheap energy prices hinder the promotion of energy conservation.

◎ Middle East

As domestic energy demand increases, awareness of the importance of energy conservation has rapidly increased in recent years. However, it is politically difficult to raise extremely low energy prices, therefore effective means of energy conservation must be established.

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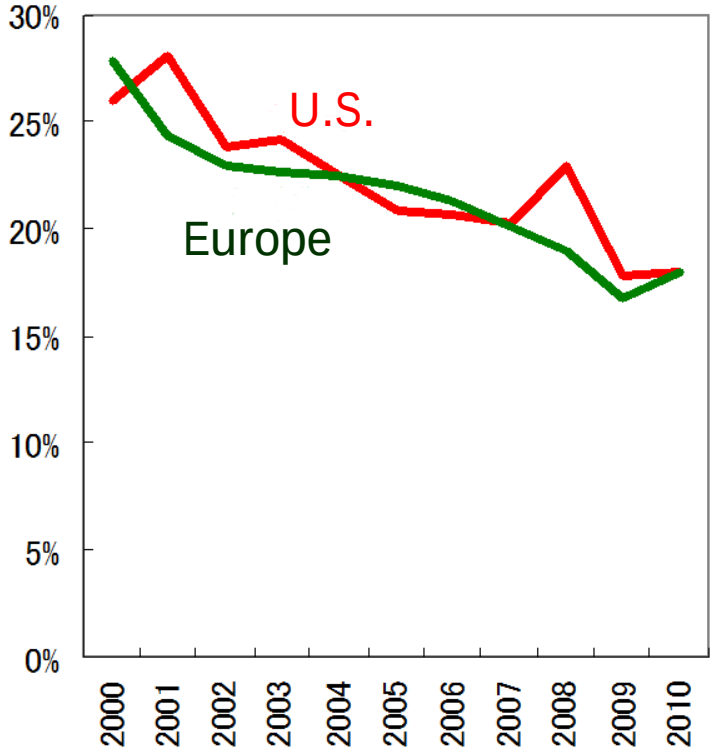
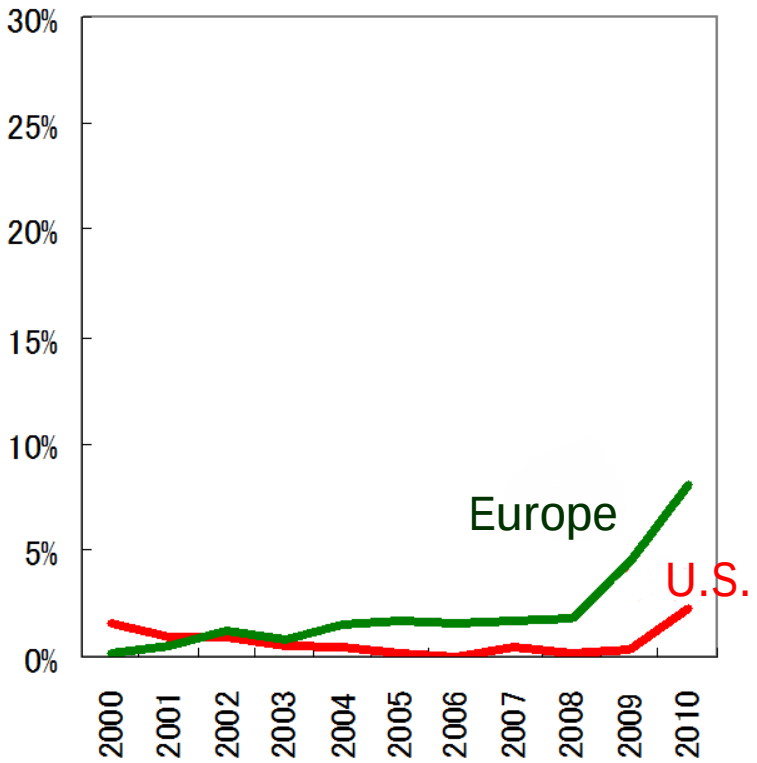
Dependency on Oil and Natural Gas Imports from the Middle East (In the Case of US and Europe)

Dependency on oil imports from the Middle East



Dependency on natural gas imports from the Middle East



- Oil: US dependency on the Middle East continues to decline due to increasing imports from Canada and Central and South America, while the dependency of Europe on the Middle East also continues to decline due to increasing imports from the former Soviet Union.
- Natural gas: Dependency on the Middle East has slightly increased due to reinforcement of LNG export capacity in the Middle East.

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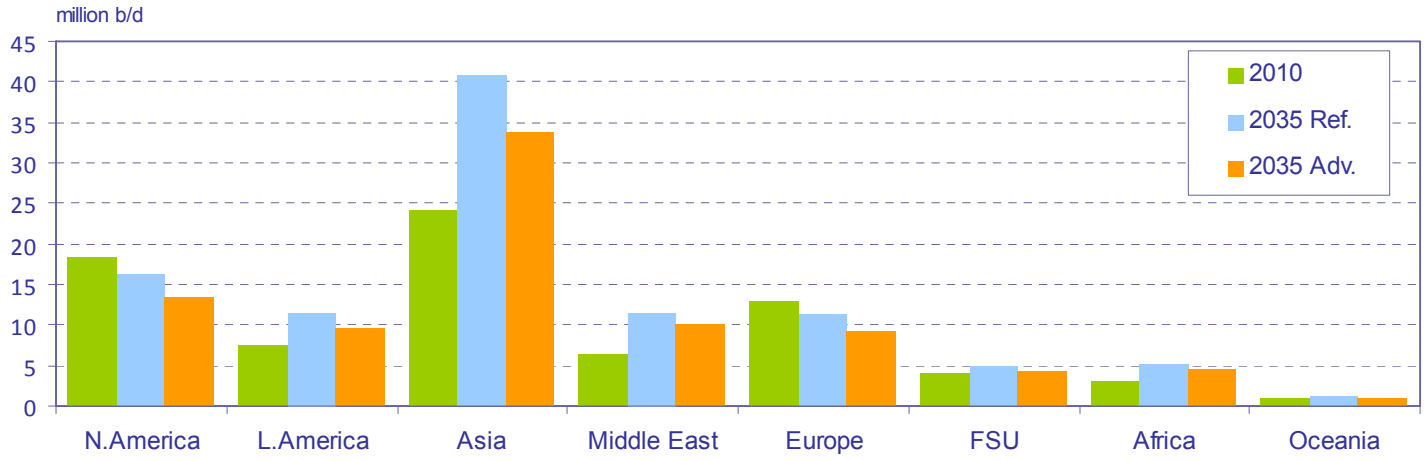
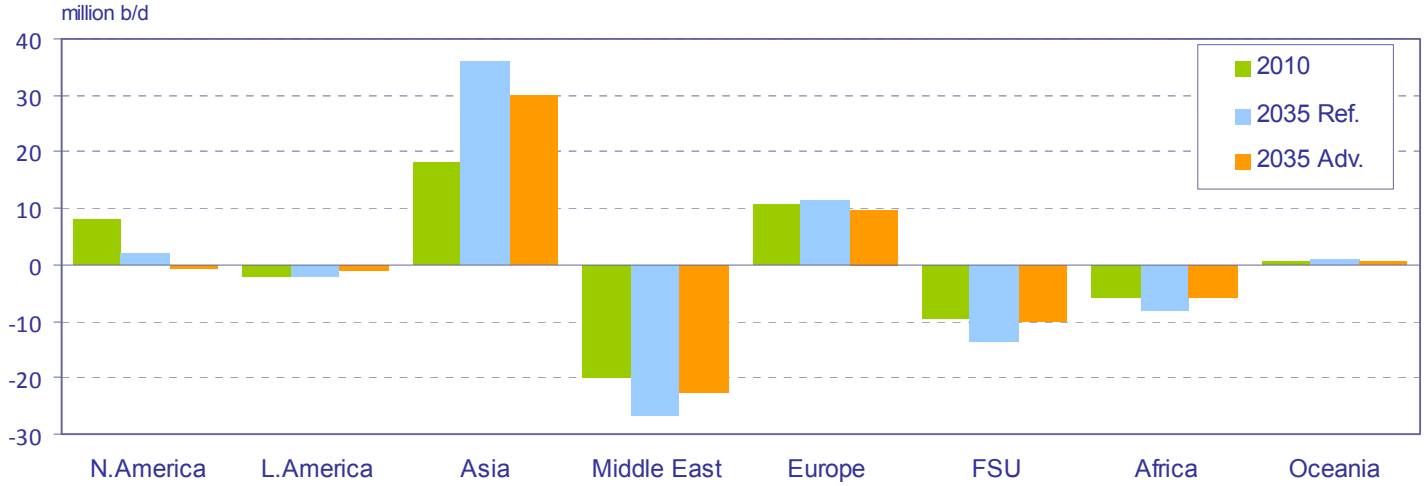
Oil Supply and Demand by Region

Demand



Net import



- Demand for oil will grow especially in Asia in the future, while North America is heading toward achieving self-sufficiency. Oil imports in Europe are likely to decline.
- The Middle East needs to increase production to meet the growing demand in Asia. The share of Asia as an export destination is increasing.

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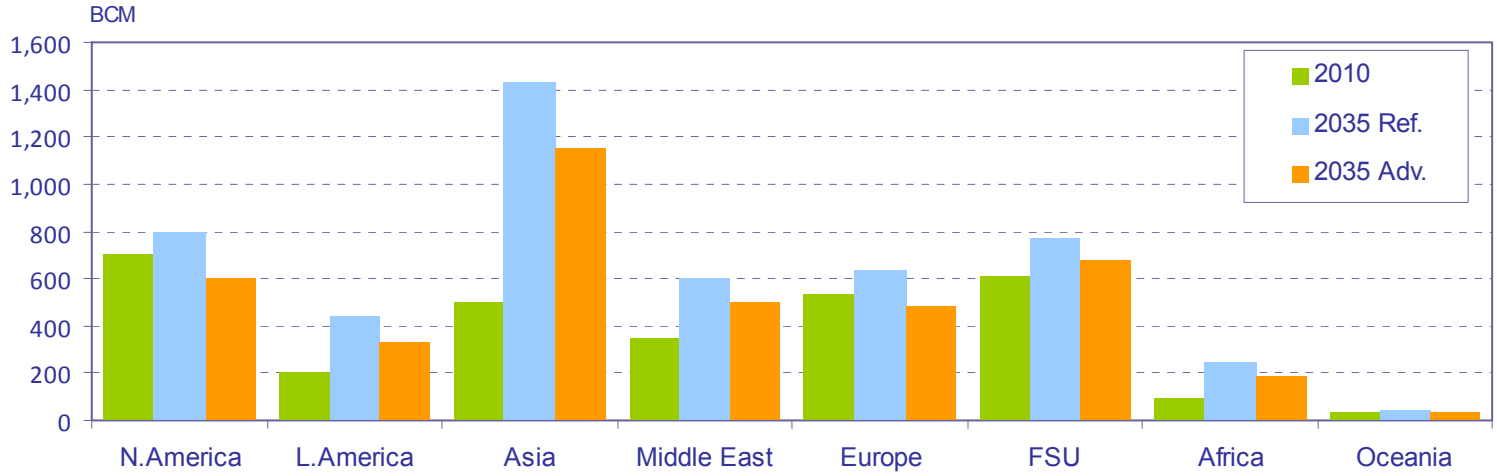
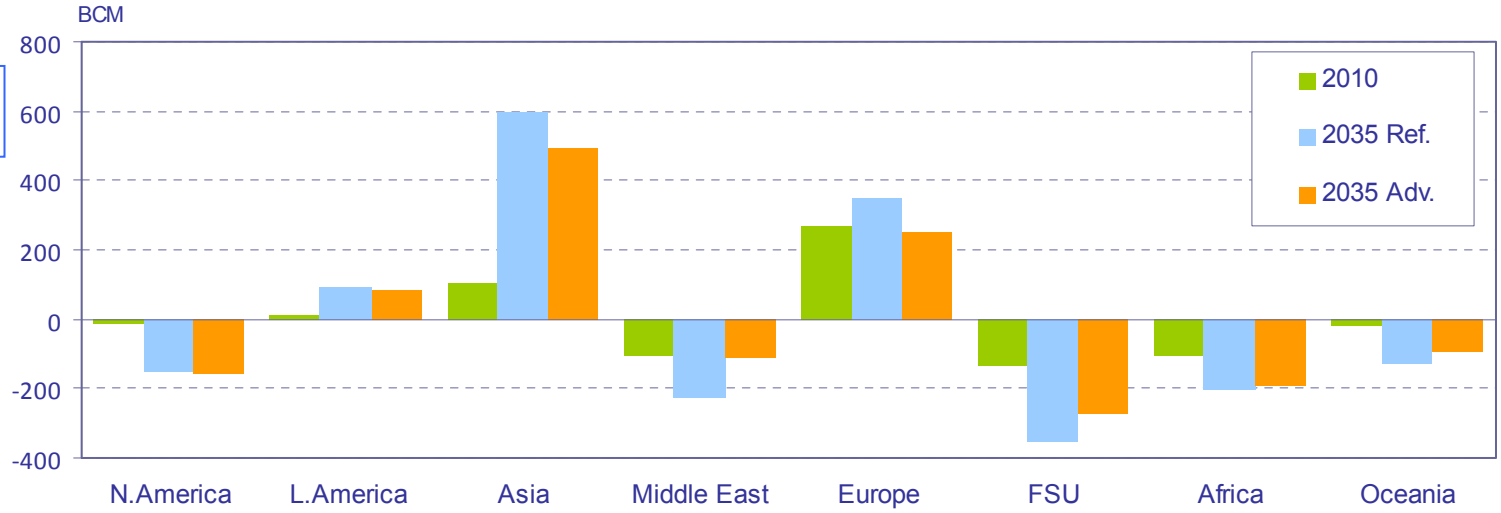
Natural Gas Supply and Demand by Region

Demand



Net import



▪Demand for natural gas is growing in Asia, Central and South America, the Middle East and Africa. Especially in the Advanced Technology Scenario, demand will decrease in North America and Europe.

▪Exports from North America will increase, while imports to Asia will rise strongly. Diversification of supply sources will become a critical issue.

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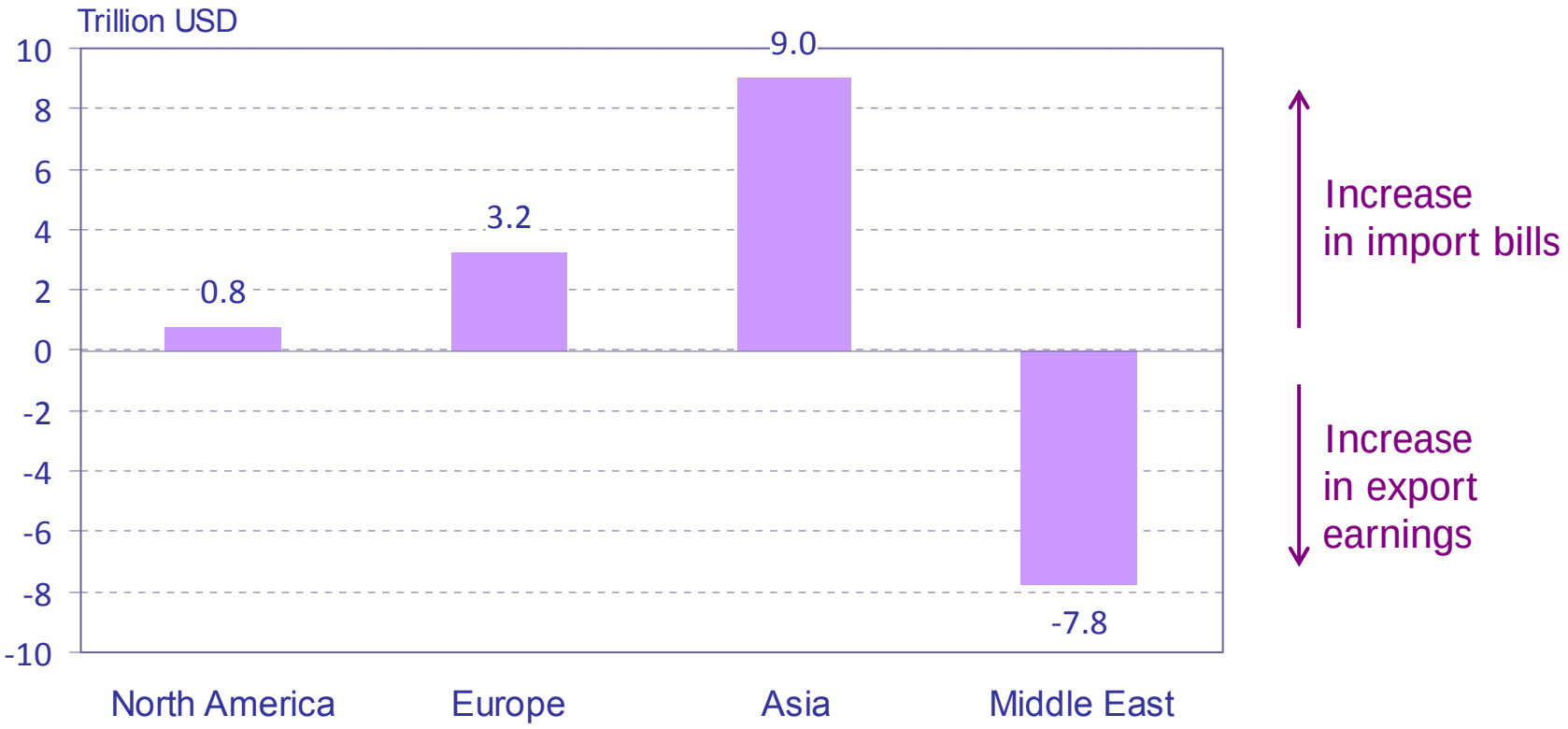
Impact of 30% Increase in Oil & Gas Prices on Cumulative Fuel Import Bills till 2035 by Region



If oil and gas prices rise by 30%, cumulative fossil fuel import costs in Asia till 2035 are estimated to increase by $9.0 trillion, while exports from the Middle East will increase by $7.8 trillion.
The influence of rising oil and gas prices will remain relatively low in North America and Europe where the growth in demand is smaller than in Asia, or demand may even decrease.

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Assessment of Energy Mix in Asia and the Middle East through 2035

■ Viewpoints for evaluating energy supply and demand: 3Es+S

E-1. Energy security

E-2. Environmental protection

E-3. Economic efficiency/rationality

S. Safety

■ It is important to note that in non-OECD countries in Asia and the Middle East, unlike Japan and Korea, nuclear energy and renewable energy do not complement each other, but both help to reduce fossil fuel consumption.

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Assumptions of Cases for Assessing the Energy Mix

Evaluate 3Es+S in Asia (non-OECD countries in Asia) based on the following 5 cases:

Reference Scenario

Case 0: Dependent on thermal power

(Renewable and nuclear: same as in 2010)

Advanced Technology Scenario (maximum introduction of energy-saving measures)

Case 1: Dependent on thermal power

(Renewable and nuclear: same as in 2010)

Case 2: Development of renewable energy

Case 3: Development of nuclear energy

Case 4: Development of nuclear energy + renewable energy

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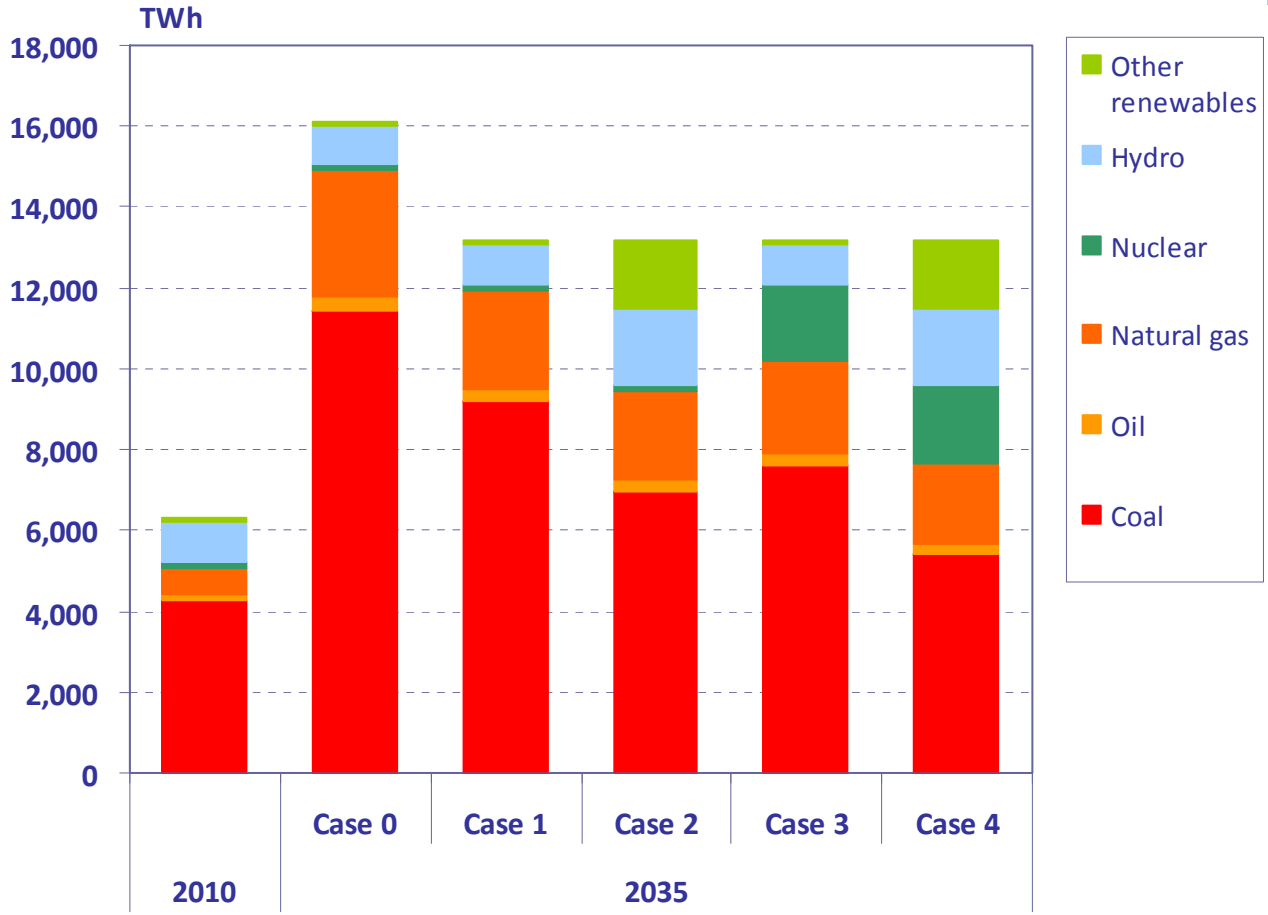
Power Generation Mix for the Five Cases

Non-OECD Asia



In cases 2, 3 and 4 the amount of introduction of nuclear and renewables equivalent to what is assumed in the Advanced Technology Scenario is assumed. The share of renewable energy (including hydropower) and nuclear energy in the power generation mix in 2035 remains at approximately 27% and 14%, respectively. Even if both types of energy are introduced at the maximum rate, the share of thermal power generation exceeds 60% in 2035.

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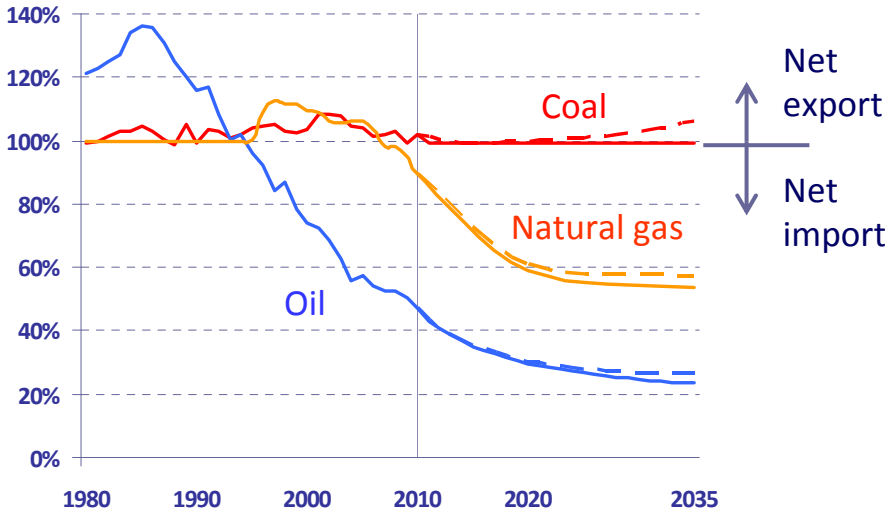
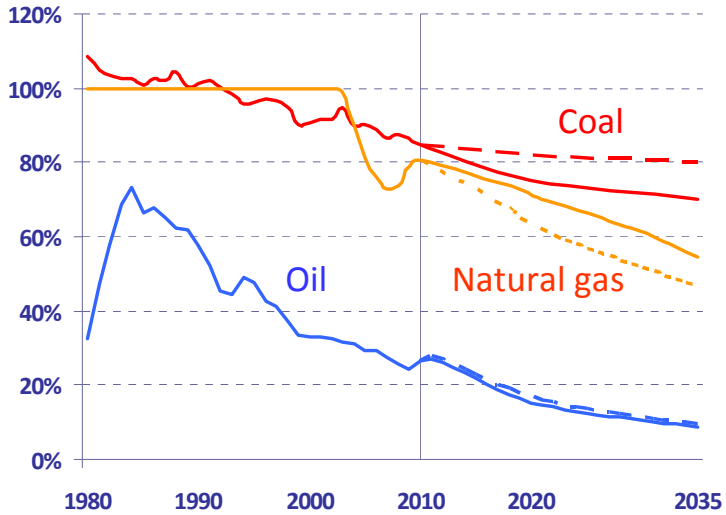
E1 Energy Security: Outlook for Self-Sufficiency of Fossil Fuel in Each Region

Solid line: Reference
Dashed line: Advanced Technology

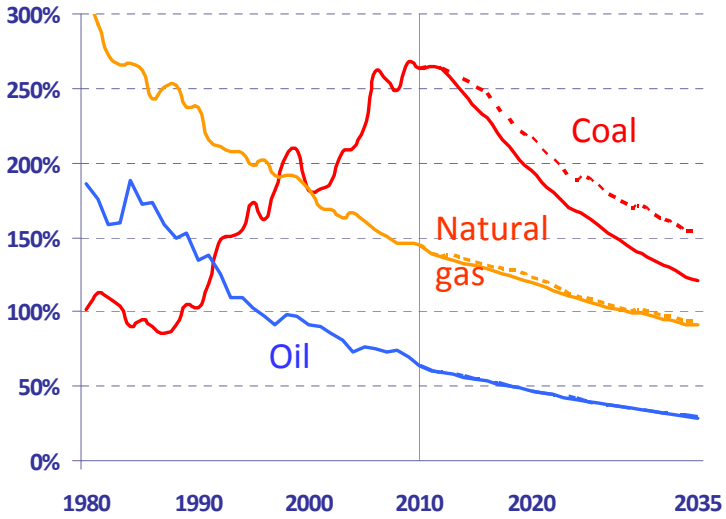
China



India



ASEAN



- The self-sufficiency rates of oil and natural gas have already fallen below 100% in China and India, and are declining further.
- In ASEAN countries, the self-sufficiency rate of oil dropped below 100% in the 1990s and continues to decline.
  Although the self-sufficiency rate of natural gas remains at 150%, ASEAN countries are expected to become net importers around 2030.
- The self-sufficiency rate of coal remains relatively high in every country/region.

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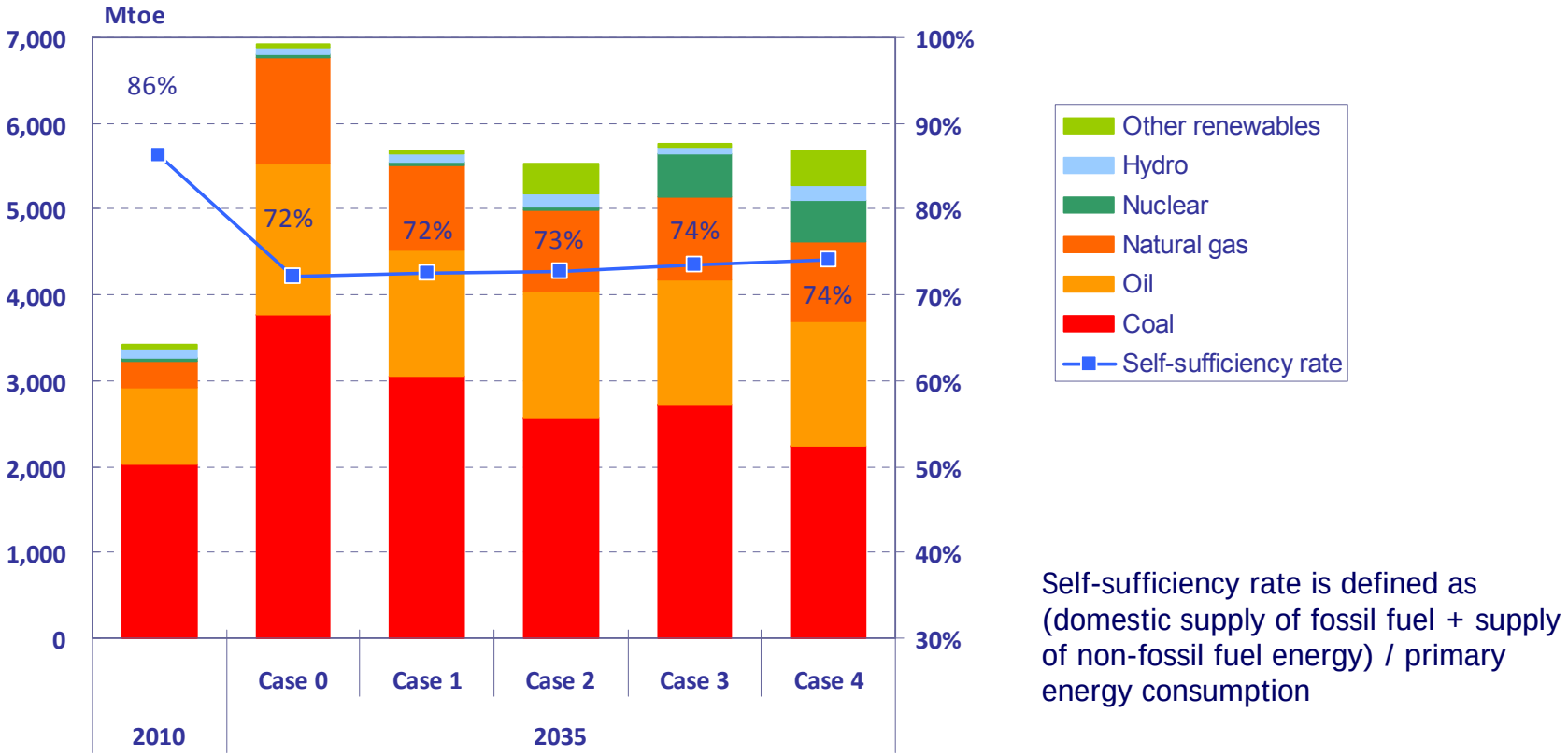
E1 Energy Security: Self-Sufficiency Rates

Non-OECD Asia



Self-sufficiency rate is defined as (domestic supply of fossil fuel + supply of non-fossil fuel energy) / primary energy consumption

- The self-sufficiency rate is projected to decline in non-OECD Asia up to 2035 due to the increase in imports of oil and natural gas.
- Imports of fossil fuel decrease and the self sufficiency rates rise by energy saving. On the other hand, the effect of introducing nuclear and renewable energies is rather small because coal is substituted.
- If the dependency on coal is halved, the energy self-sufficiency falls to as low as 57%. Coal remains an important fuel in Asia in terms of energy security.

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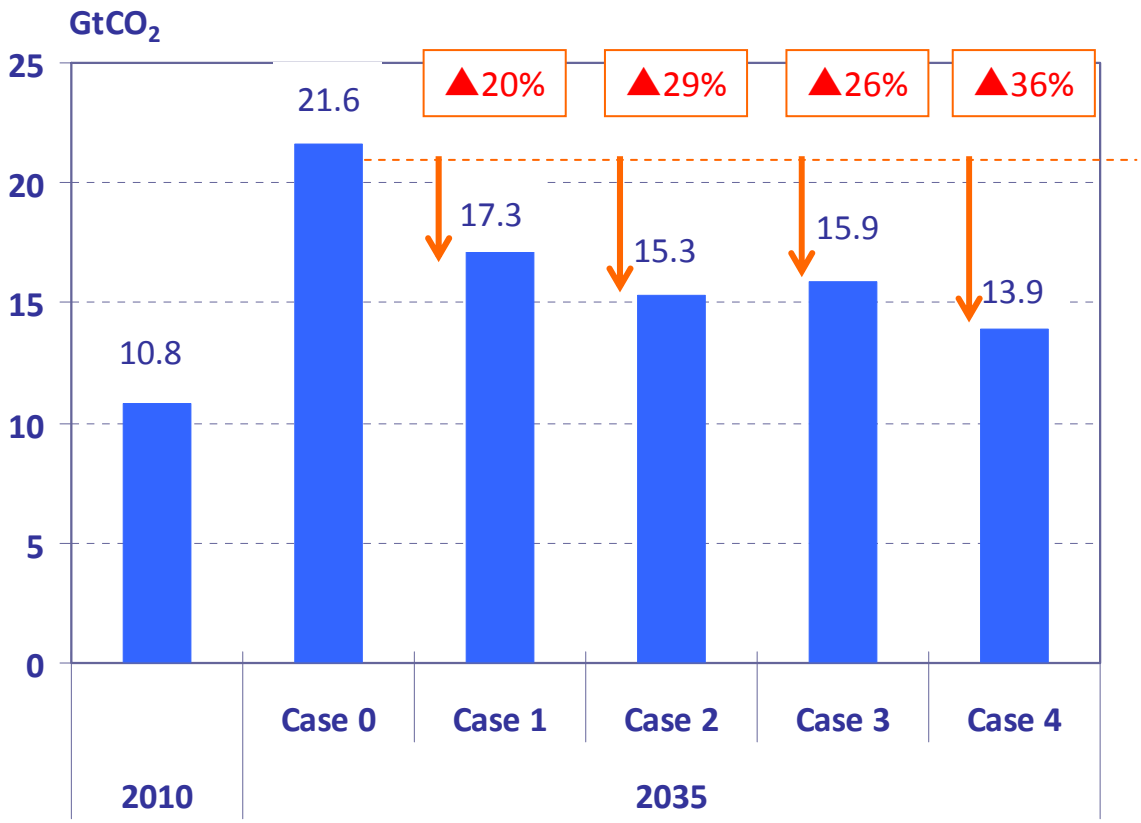
E2 Environmental Protection: Energy-Related CO_2 Emissions

Non-OECD Asia



4.3 billion toe are cut by energy conservation (20% reduction from the case without energy saving), 2 billion toe by renewable energy (9% reduction), and 1.4 billion toe by nuclear energy (7% reduction). Subsequently, a total of 7.7 billion toe are cut (36% reduction). This reduction is equivalent to 18% of CO_2 emissions in the world in 2035 (Reference Scenario).

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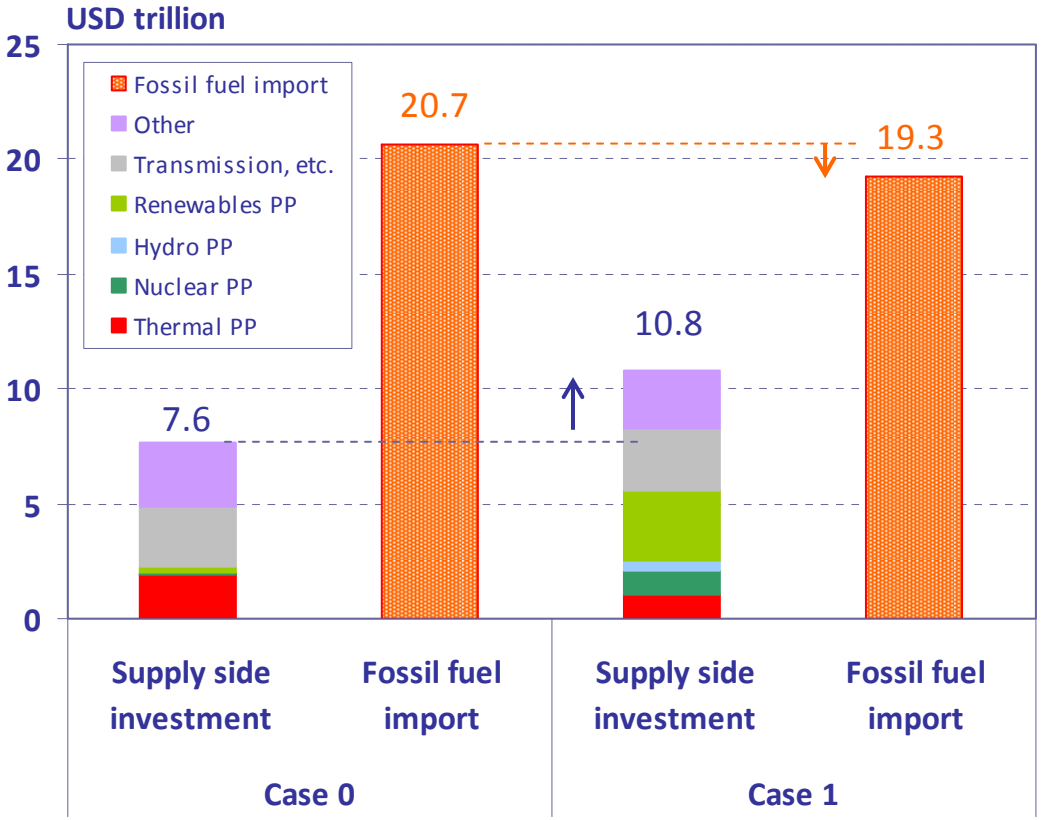
E3 Economic Efficiency: Cumulative Investment and Fossil Fuel Imports till 2035

Non-OECD Asia



In Case 1 (“thermal power dependent”), imports of oil and natural gas reach as much as $21 trillion compared to cumulative investments related to energy supply (to 2035) of $7.6 trillion. Even though imports can be cut by developing renewable and nuclear energies, they considerably exceed the investments.

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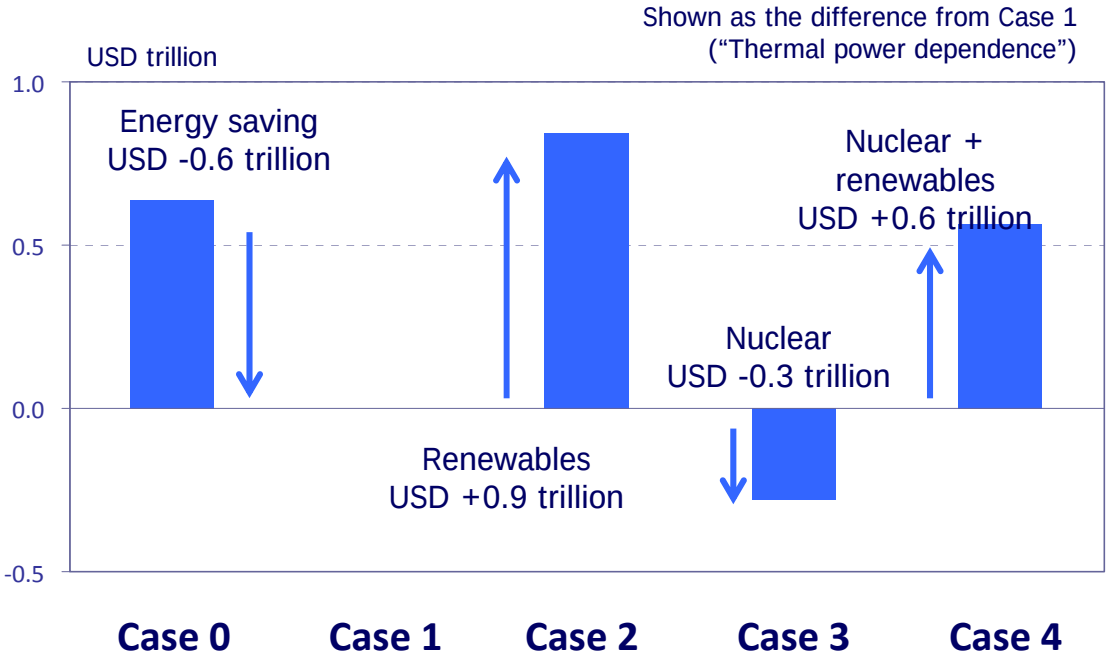
E3 Economic Efficiency: Cumulative Burden till 2035

Non-OECD Asia



USD trillion

	Case 0	Case 1	Case 2	Case 3	Case 4
Investment for energy saving	-6.1	—	—	—	—
Investment for energy supply	1.6	—	2.6	0.6	3.1
O&M	0.1	—	0.4	0.6	1.0
Fossil fuel purchase	5.0	—	-2.1	-1.5	-3.5
Total	0.6	—	0.9	-0.3	0.6

In comparison with Case 0 ("Without energy-saving"), in Case 1 ("Thermal power dependence with energy-saving efforts"), cumulative investments increase by $6.1 trillion due to investments in energy conservation. On the other hand, the net financial burden can be reduced cumulatively by $0.6 trillion due to the decrease in fossil fuel purchase costs and the decline in investments on the energy supply side.

Renewable energy provides positive costs, and nuclear energy provides negative costs as the decrease in fossil fuel imports surpasses the initial investment and operation/maintenance costs.

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Assumptions on Nuclear and Renewable Energy Costsz

◎ **Renewables**: Costs are set referring to OECD/NEA's "Projected Costs of Generating Electricity 2010 Edition", and considering cost reductions in the future
They do not include costs for grid stability and backup.

◎ **Nuclear**: Operation/maintenance costs, fuel costs, etc. are based on OECD/NEA's documents. Additionally, the report from Japan's Costs Verification Committee was referred to for the social costs, including costs for regional relations, accident risks, R&D, waste disposal, decommissioning, etc.

	Initial investment ($/kW)	**Capital costs per unit of power generation** (Discount rate: 5%, Cent/kWh)	**Operation / Maintenance costs** (Cent/kWh)	**Fuel costs + social costs, etc.** (Cent/kWh)
PV	3,000 → 2,000	22 → 15	2.0	
Onshore wind	2,000	7.9	2.0	
Offshore wind	3,000	8.7	3.0	
Geothermal	1,800	1.4	1.9	
Nuclear	4,000	3.2	1.5	0.9 + 1.0

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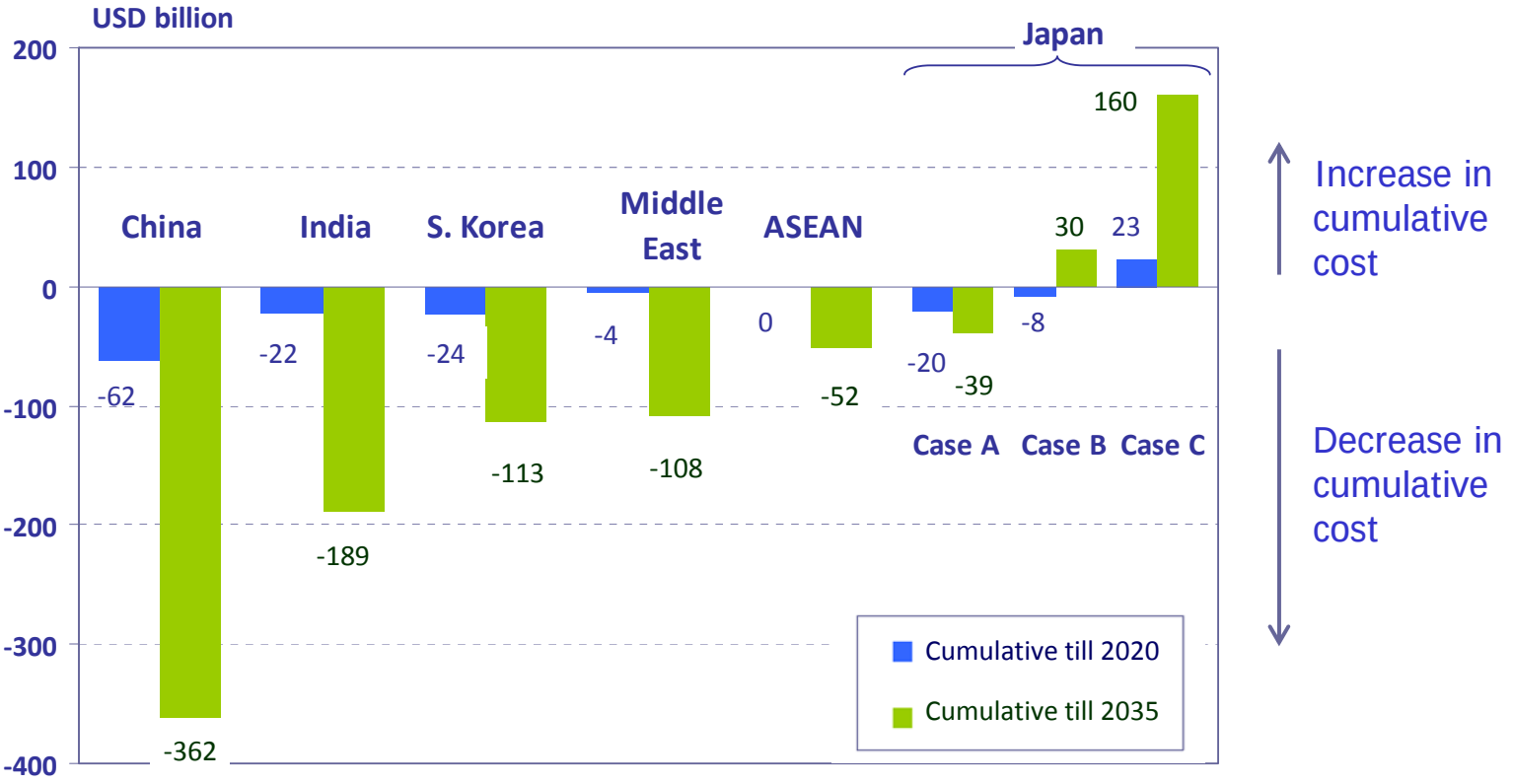
E3 Economic Efficiency: Cost Reduction by Nuclear Power Generation (Cumulative Reduction till 2035)

In this chart the cost reduction is calculated as the reduction of fossil fuel purchase costs by nuclear introduction (net increase from the actual figure in 2010), minus the increase in miscellaneous costs including operation/maintenance costs and social costs.



Fossil fuel purchase costs are expected to decrease in each country due to construction of nuclear power plants between 2010 and 2035 (equivalent to the Advanced Technology Scenario).
Cumulative costs are projected to be cut by $360 billion and $190 billion in China and India, respectively.
In the case of Japan, among respective cases of A: sustaining nuclear power (equivalent to 25% of the total electricity output in 2030), B: phasing out nuclear power (15%, same as above), and C: abolishing nuclear power (0%), cumulative cost is expected to increase by $160 billion in Case C.

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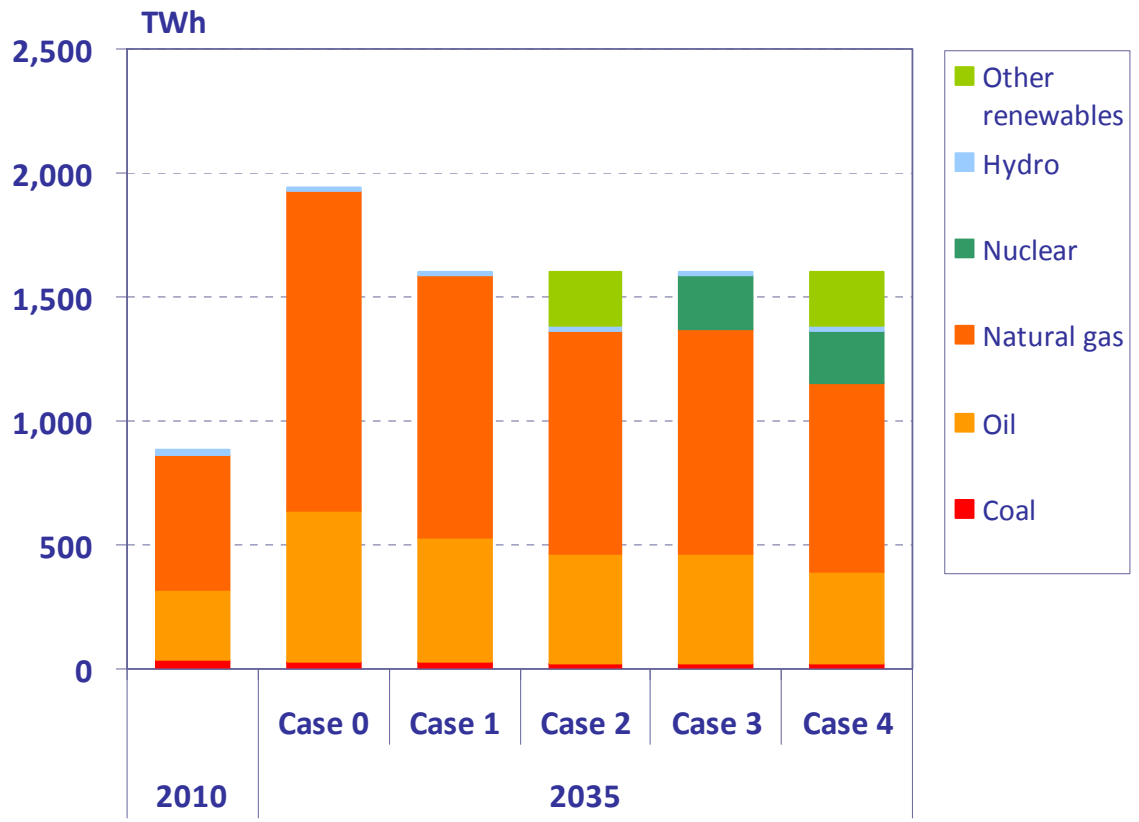
3Es in the Middle East: Power Generation Mix



- In the Middle East, the construction of new nuclear power plants has already started but the introduction of renewable energy has not been fully launched. Therefore, large-scale introduction of renewable energy is assumed to occur beyond 2035, and later than the commencement of nuclear power in the Advance Technology Scenario in the “Asia/World Energy Outlook 2012”.
- In the following slides, for the purpose of analyzing the effect of nuclear and renewables, the introduction of renewable energy equivalent to the assumption in 2050 in AWEO 2012 was assumed in 2035 in Cases 3 and 4. Nevertheless, the share in the total electricity output remains at approximately 15%.

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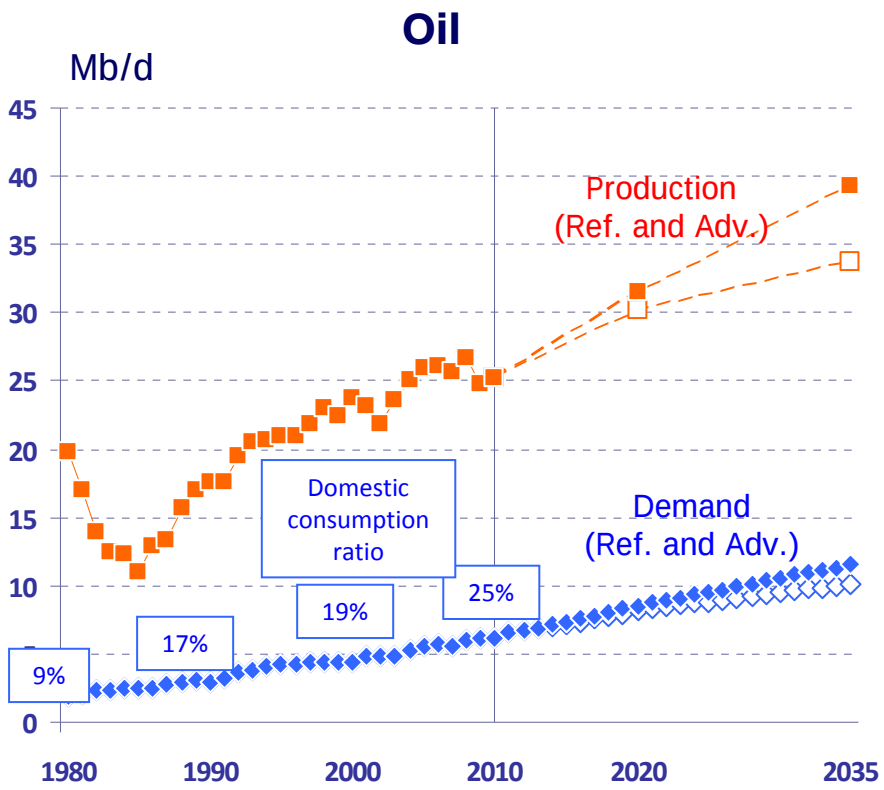
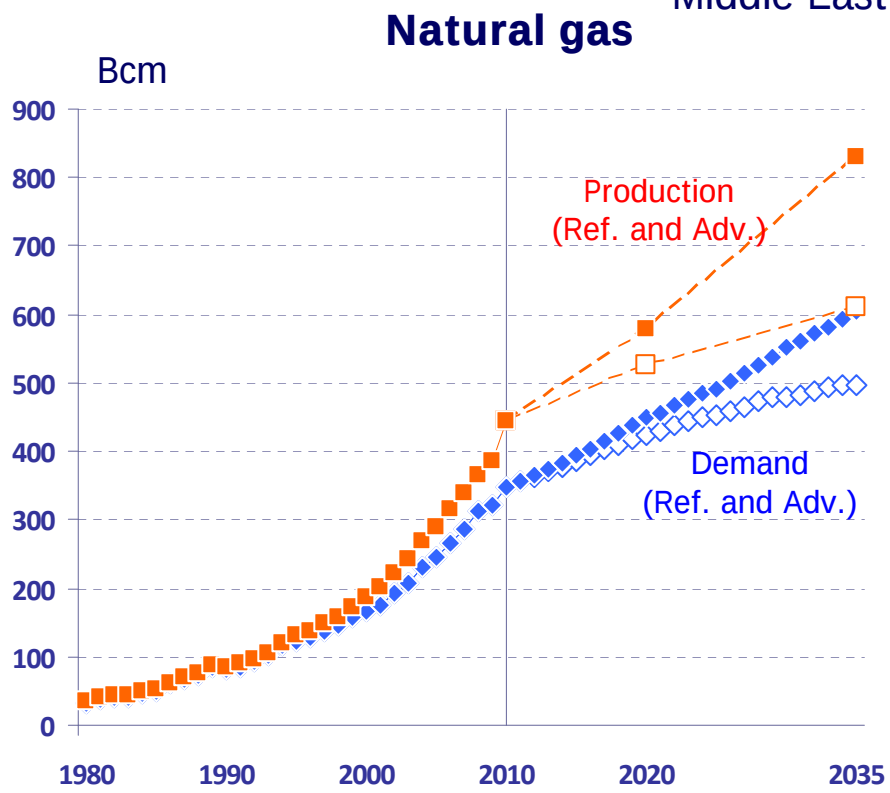
Energy Supply and Demand Outlook in the Middle East (Oil and Natural Gas)

Middle East





Demand for oil and natural gas is projected to rapidly increase in the Middle East. A considerable increase in production is required even in the Advanced Technology Scenario in order to meet the increase in demand in the region and the increase in exports to Asia, especially for oil.

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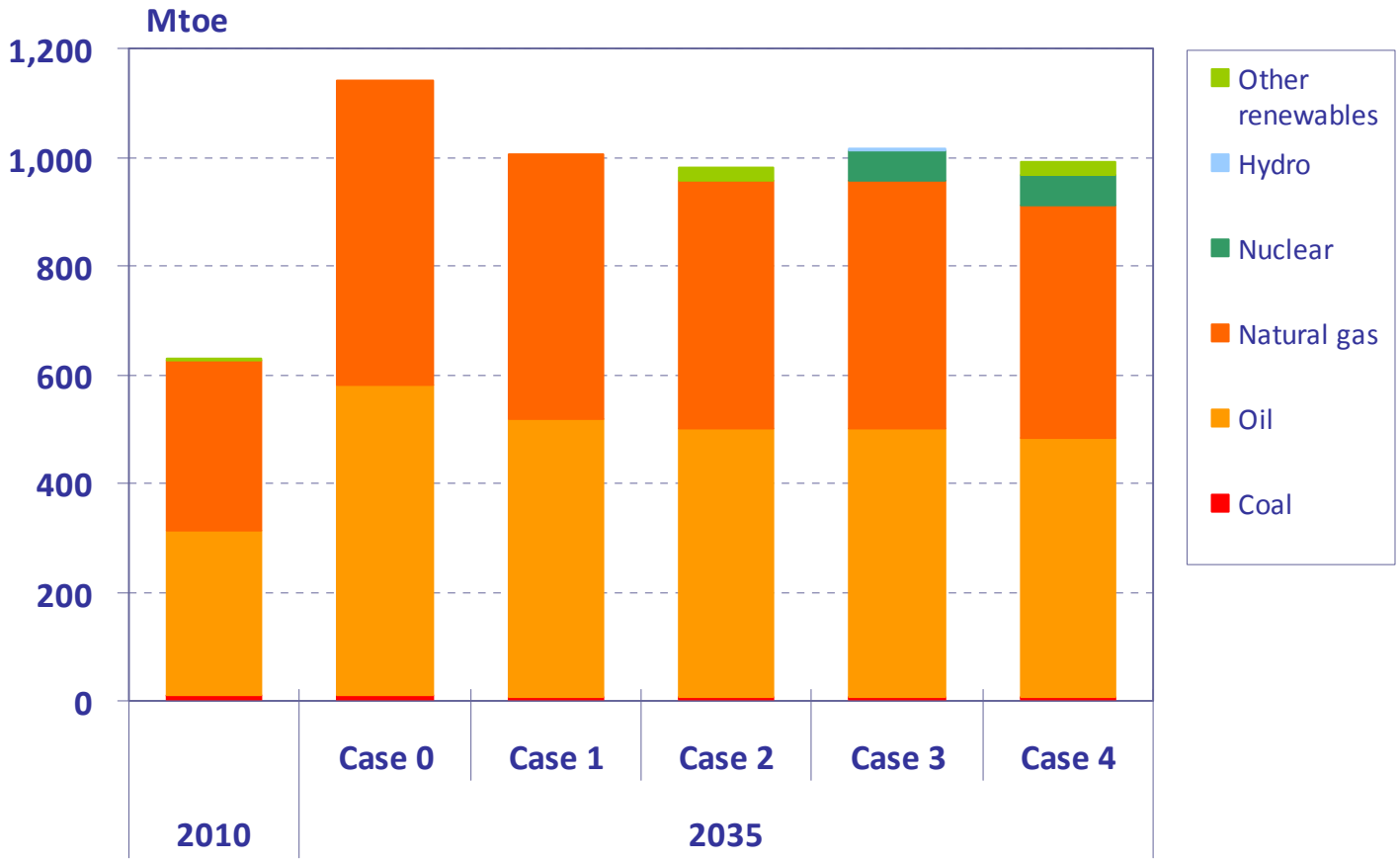
Outlook for Primary Energy Supply

Middle East



Even if the introduction of both renewable energy and nuclear energy progresses, the share of these two energies combined in the primary energy supply is only approximately 8%. Therefore, introducing these non-fossil fuel power sources contributes relatively little to the reduction of fossil fuel consumption.

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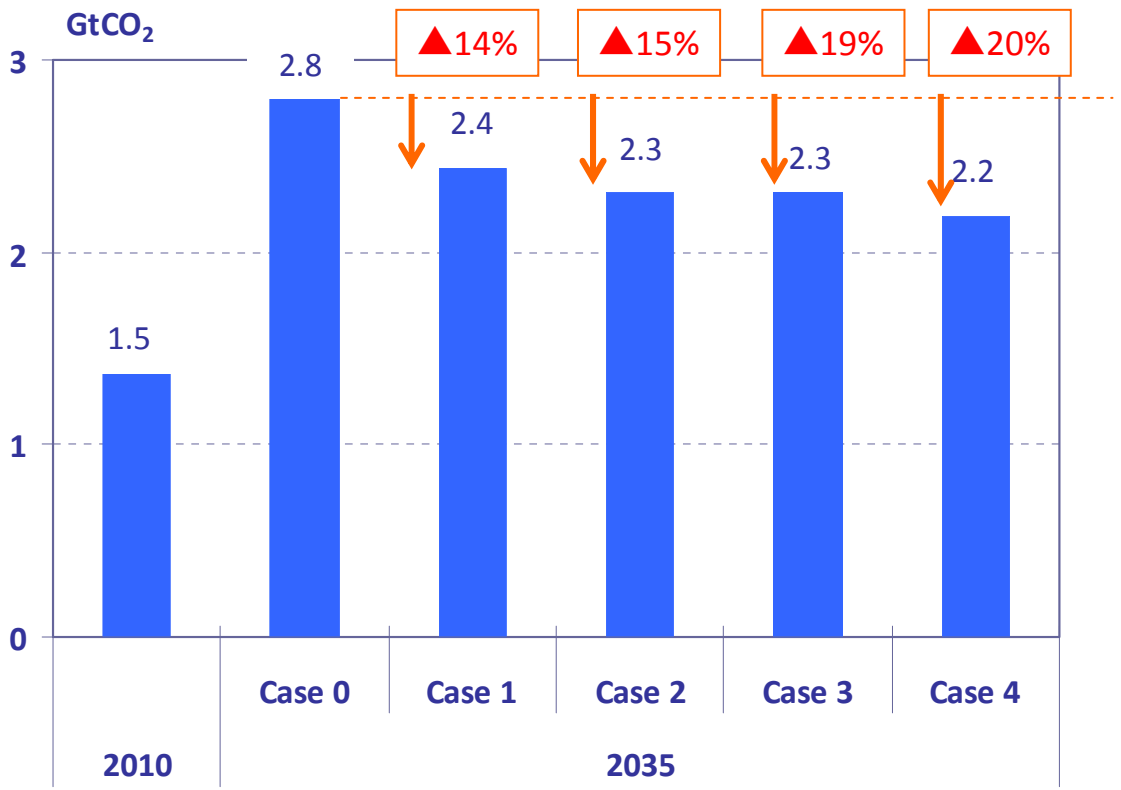
E2 Environmental Protection: Energy-Originated CO_2 Emissions

Middle East



Emissions of 360 Mtoe are cut by energy conservation (13% reduction from the case without energy saving), 130 Mtoe are cut by renewable energy (4% reduction), and 120 Mtoe are cut by nuclear energy (4% reduction), giving a total reduction of 610 Mtoe (22%). Thus, renewable energy and nuclear energy can both reduce CO_2 emissions.

However, compared with the case of non-OECD Asia, the rate of CO_2 emission reduction is smaller because of the low introduction rate and not using coal thermal power.

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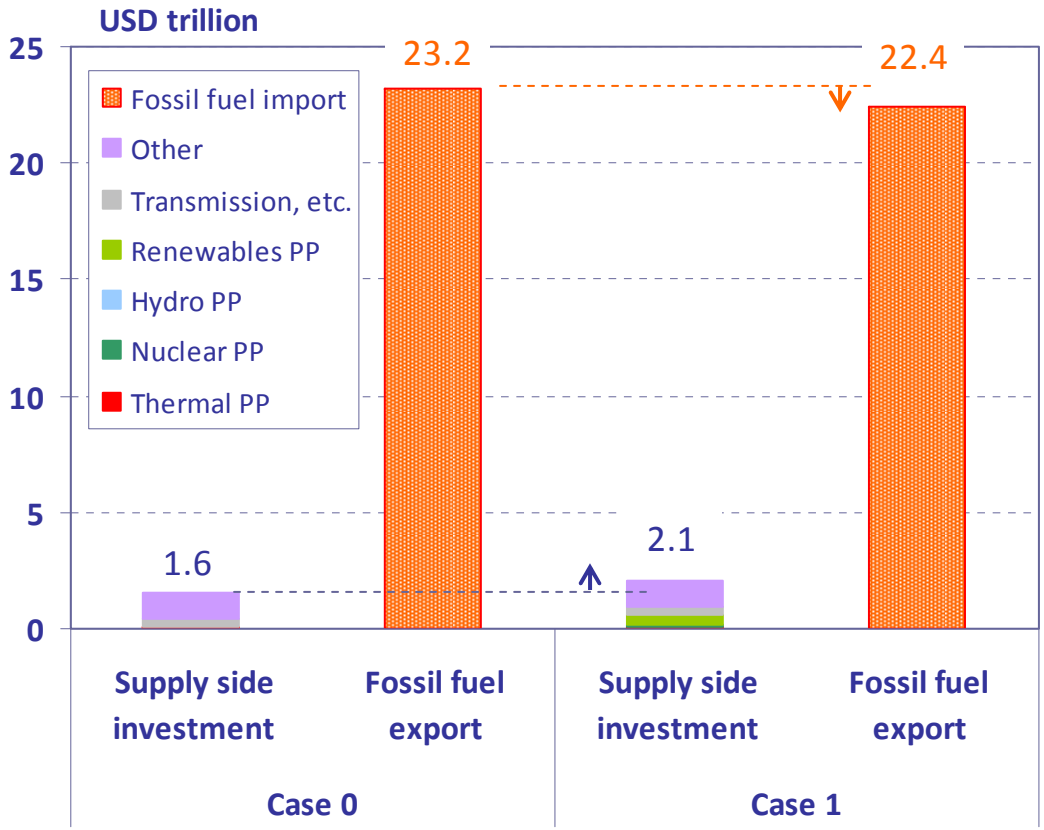
E3 Economic Efficiency: Cumulative Investment and Fossil Fuel Exports till 2035

Middle East



The cumulative investment on energy supply in the “thermal power dependence” case (to 2035) is $1.6 trillion, while exports of fossil fuel (oil and natural gas) are $23 trillion. Thus, exports of fossil fuel will continue to dominate the economies of the Middle East countries.

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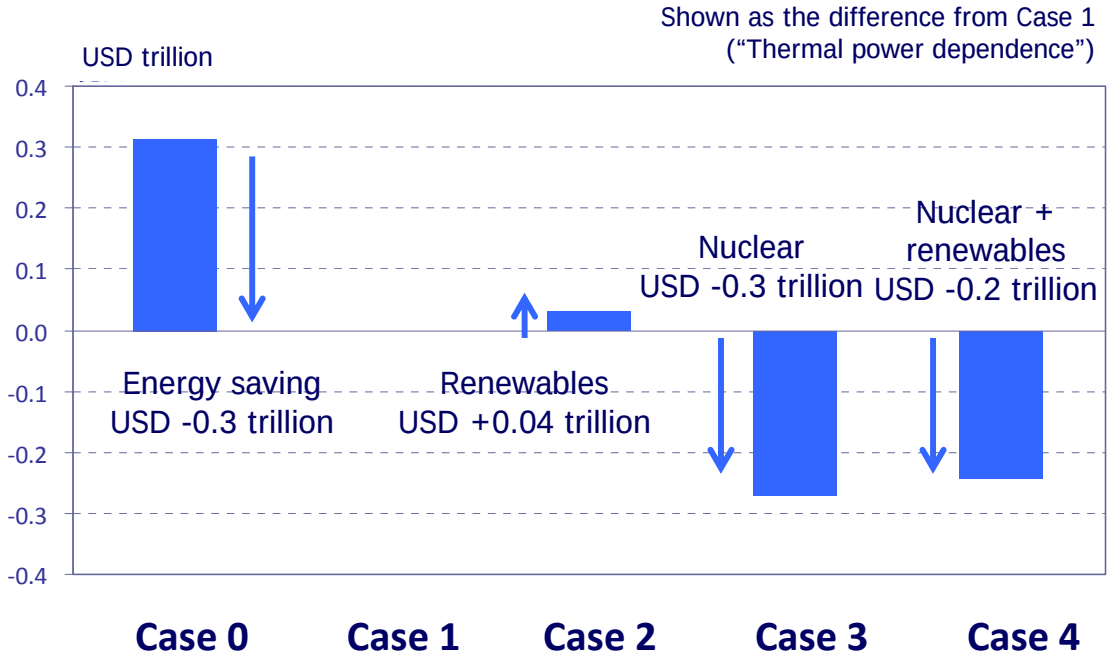
E3 Economic Efficiency: Cumulative Financial Burden till 2035

Middle East



USD trillion

Investment for energy saving	-0.5	—	—	—	—
Investment for energy supply	0.3	—	0.4	0.1	0.5
O&M	0.01	—	0.1	0.1	0.1
Fossil fuel purchase	0.5	—	-0.4	-0.4	-0.8
Total	0.3	—	0.04	-0.3	-0.2

In the Middle East, the share of coal-fired thermal power generation is smaller than in Asia, and expensive oil-fired and natural gas-fired thermal generation accounts for almost all the share. Therefore, if the reduction in fossil fuel consumption can be used for export, the net financial burden of introducing renewables becomes smaller.

The conclusion that energy conservation provides significant economic merits through reduction of fossil fuel consumption is the same as for non-OECD Asia.

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Conclusions for Energy Mix in Asia and the Middle East (1)

◎ Energy Security

- **Energy self-sufficiency in Asia is declining** due to sluggish growth of oil and natural gas production. **Coal plays the key role** for securing a stable supply and continues to be used.

- The stable increase of production by continuing to invest in development in the Middle East is essential for securing the supply of oil and natural gas. Also, **exports of energy resources in the Middle East are expected to concentrate on Asia**, **so the relationships between these two regions must be strengthened**. On the other hand, for Asia, it is crucial to try to diversify the supply sources.

- Although renewable energy and nuclear energy help to stabilize the energy self-sufficiency rate, the effect becomes more obvious beyond 2035. Therefore, **it is necessary to introduce these types of energy with a long-term perspective**.

◎ Environmental Protection

- Both nuclear and renewable energy help to reduce CO_2 emissions. However, **energy conservation makes a larger contribution to the reduction of CO_2 emissions**. Therefore, effective political measures are needed.

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Conclusions for Energy Mix in Asia and the Middle East (2)

◎ Economic Efficiency and Rationality

・Progress in **energy conservation** allows **Asia to reduce its fossil fuel imports and the Middle East to gain an extra margin for its energy exports**. Both regions can thus secure economic benefits and handle the issues related to the other 2Es.

・ Although nuclear energy provides economic merits, **renewable energy** is expensive at present. Therefore, for renewable energy to spread, it is essential to **reinforce its competitiveness by reducing the cost**.

・ However, fossil fuel prices still govern the economic efficiency of energy supply. As **nuclear and renewable energy** can help **suppress the risk of a surge in fossil fuel prices**, they should continue to be developed and introduced.

◎ Safety

Nuclear power generation continues to expand in many countries in Asia and the Middle East, so **international cooperation should be stepped up to ensure the safe operation** of nuclear facilities.

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Beyond 2035;
Asia/World Energy Outlook through 2050

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GDP, Population and Energy Price

	2010	2035	2050
GDP (2000 real price)	**42** tril. $ (AAGR in 1990-2010：2.7%)	**86** tril. $ (AAGR in 2010-2035：3.1%)	**118** tril. $ (AAGR in 2035-2050：2.1%) (AAGR in 2010-2050：2.6%)
Population	**6.8** bil.	**8.6** bil. (1.8 bil. increase from 2010)	**9.3** bil. (2.5 bil. increase from 2010)
GDP per Capita	**6** thousand $	**10** thousand $	**13** thousand $
Oil Price (On a Japanese CIF basis、2011 real price)	(2011) **109 $/bbl**	**125 $/bbl** (Nominal price：210 $/bbl)	**130 $/bbl** (Nominal price：281 $/bbl)

- Global GDP will grow annually at 2.6% from 2010 to 2050.
- World total population will expand from 6.8 bil. in 2010 to 9.3 bil. in 2050.
- Crude oil price (on a Japanese CIF basis、2011 real price) is assumed to increase from 109$/bbl in 2011 to 130 $/bbl in 2050.

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Assumed Energy and Environmental Technologies

	2010	2035		2050	
	Actual	Reference	Adv. Tech.	Reference	Adv. Tech.
Nuclear	389 GW	572 GW	778 GW	736 GW	1,085 GW
Conversion Efficiency	Coal:35% Gas:40%	Coal: 39% Gas: 45%	Coal: 41% Gas: 47%	Coal: 40% Gas: 47%	Coal: 43% Gas: 49%
Photovoltaic	39 GW	525 GW	1,303 GW	824 GW	2,261 GW
CSP	0.6 GW	51 GW	94 GW	94 GW	372 GW
Wind	184 GW	859 GW	1,506 GW	1,254 GW	2,456 GW
Biomass Power Gen.	71 GW	203 GW	226 GW	259 GW	279 GW
Biofuel	61 Mtoe	208 Mtoe	264 Mtoe	274 Mtoe	340 Mtoe
CCS	-	0	2.6 bil. Ton	0	10.0 bil. Ton
Adv. Vehicle in Annual Sales PHEV EV/FCV	-	5% 1%	20% 21%	10% 4%	16% 36%
Average Fuel Efficiency of new vehicle sales	(2010) 14 km/L	18 km/L	26 km/L	20 km/L	30 km/L

CSP: Concentrated Solar Power, **CCS**: Carbon Capture and Storage, **PHEV**: Plug-in Hybrid Electric Vehicle, **EV**: Electric Vehicle, and **FCV**: Fuel Cell Vehicle

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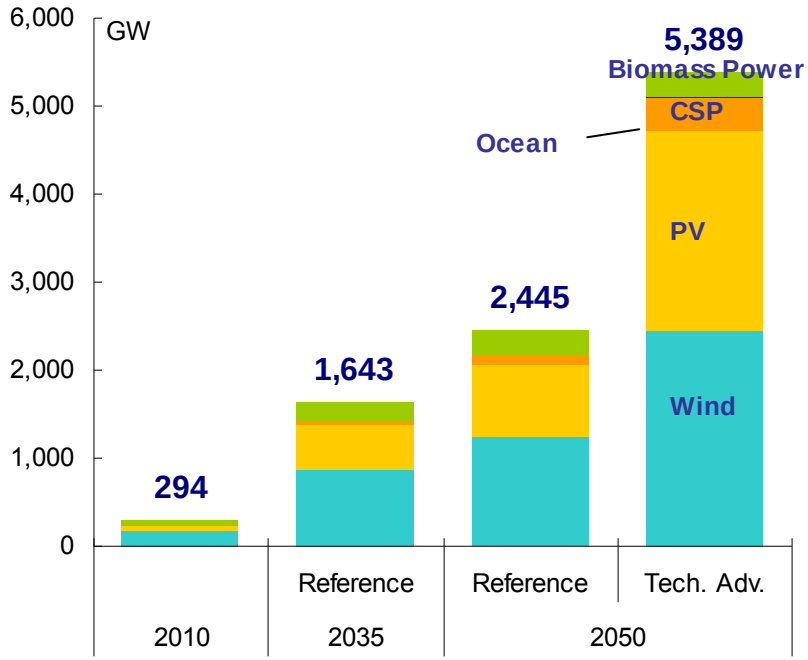
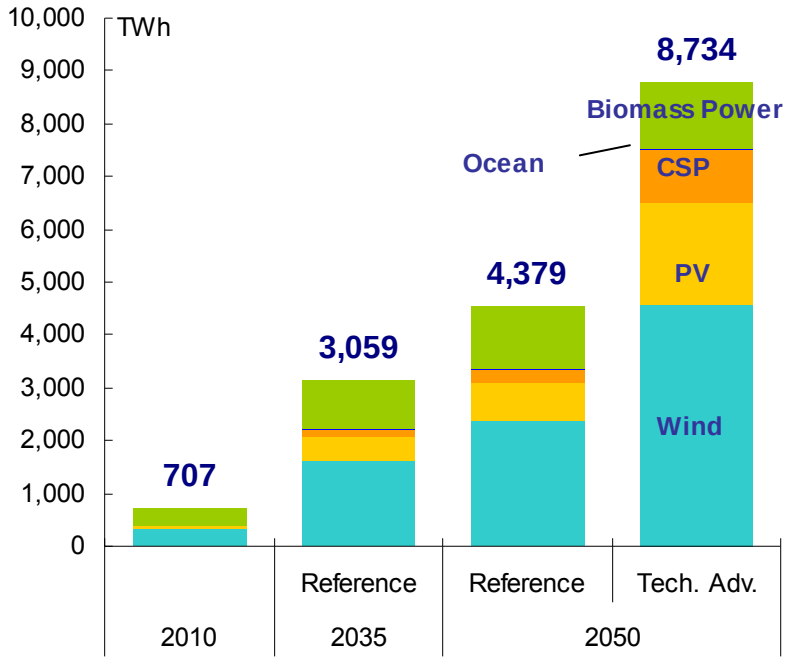
Renewable Power Generation (World)

Electric Power Capacity



Electric Power Generation



■ In the Adv. Tech. Scenario, by 2050, renewable power generation capacity, excluding hydro, will expand 12 times as much as that of 2010.

■ Wind power capacity in 2050 will exhibit a 13-fold increase compared with that in 2010; PV capacity, 58-fold increase; CSP capacity, 620-fold increase; ocean energy capacity, 88-fold increase; biomass capacity, 4-fold increase.

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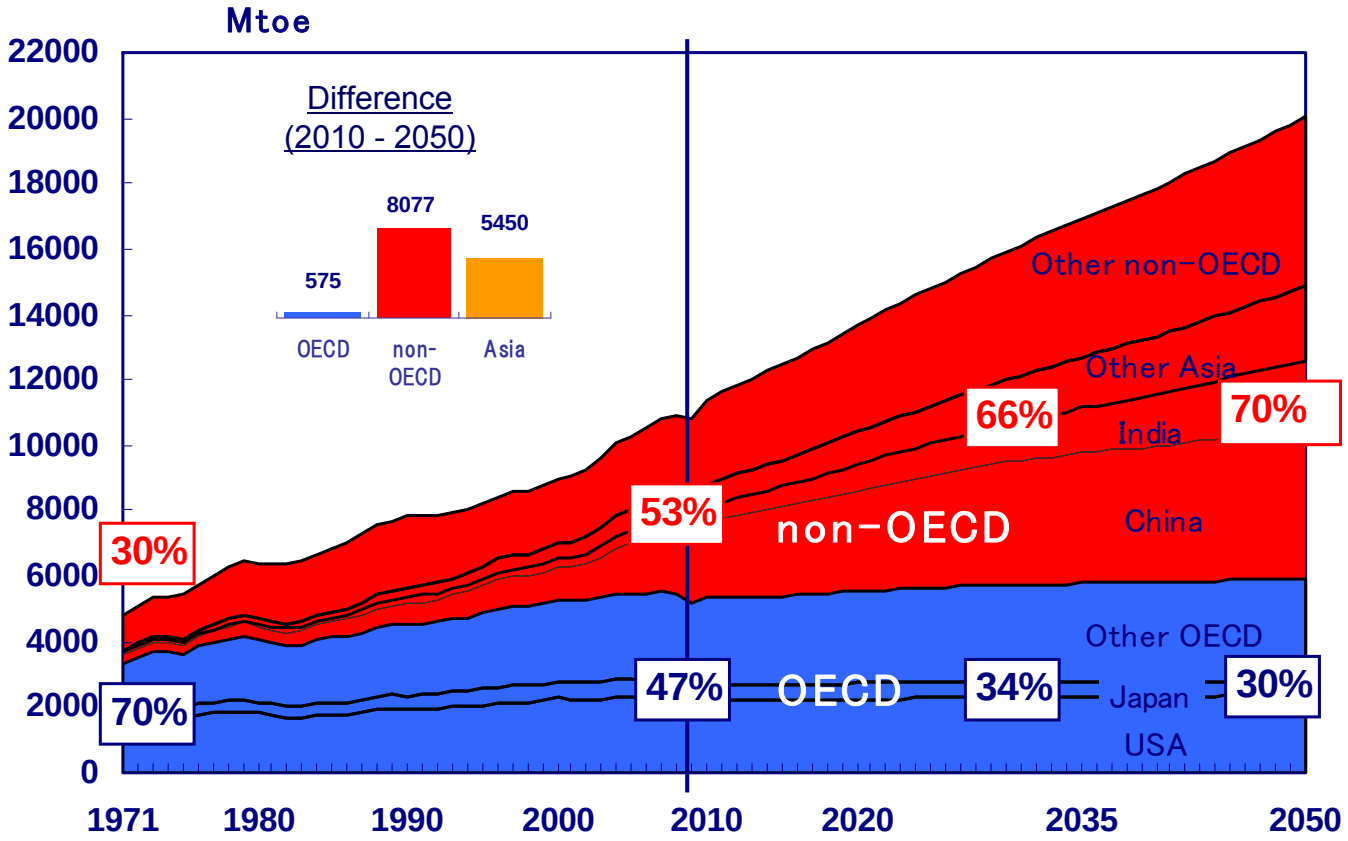
Primary Energy Demand (World)

Reference



■ World primary energy demand will increase from 11.4 Btoe in 2010 to 20.0 Btoe in 2050, showing a 1.8-fold increase from 2010.

■ The primary energy demand by Non-OECD countries will account for approximately 70 % of the world primary energy demand.

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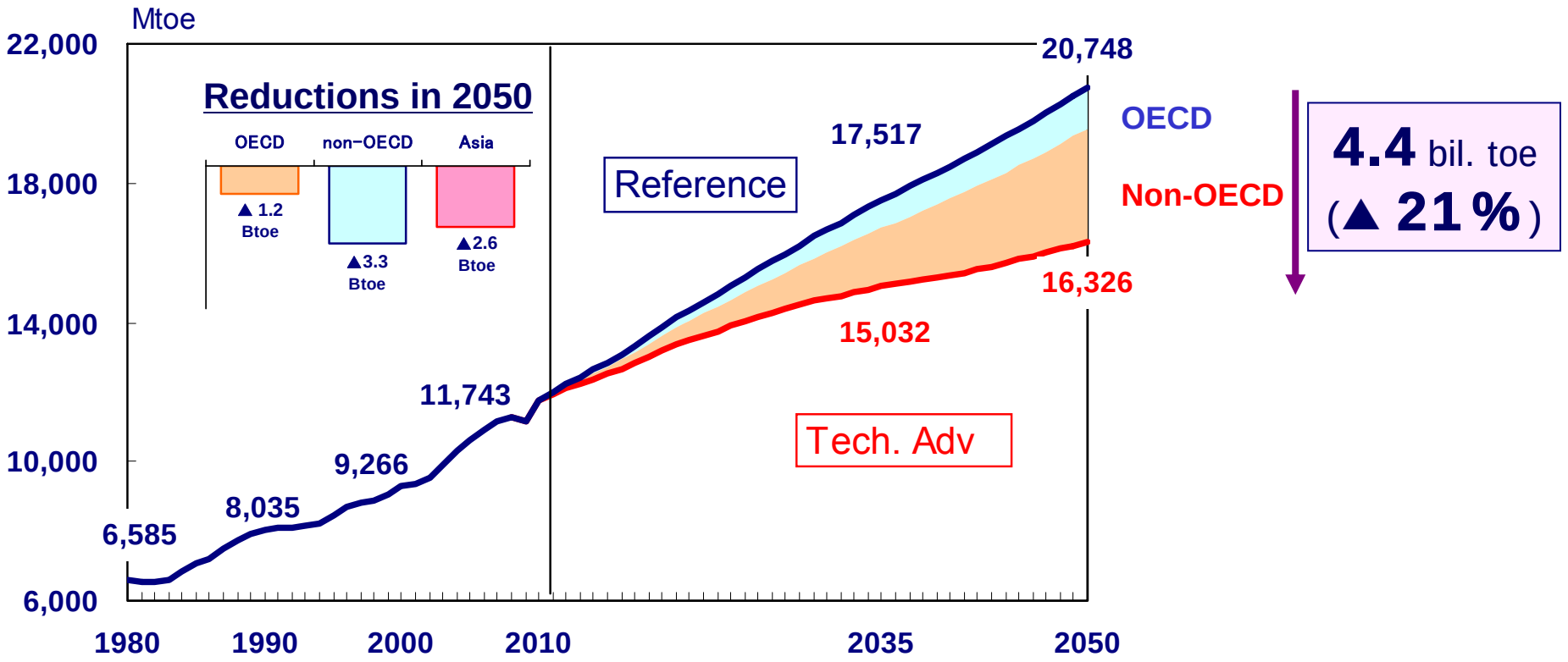
Primary Energy Demand (World)

Reference
Adv. Tech.



■ The world primary energy demand will peak out around 2050 in the Adv.Tech. Scenario.
■ In 2050, world primary energy demand in the Adv.Tech. Scenario will be decreased by 4.4 Btoe in comparison with the Reference Scenario. The demand by OECD and non-OECD will be decreased by 1.2 Btoe and 3.3 Btoe, respectively. The demand by non-OECD and Asian countries will be largely decreased because of diffusing innovative technologies.

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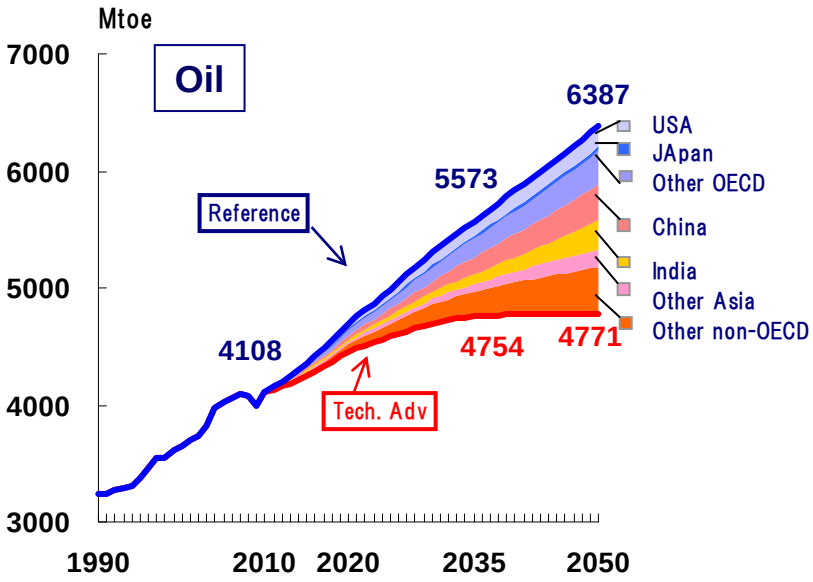
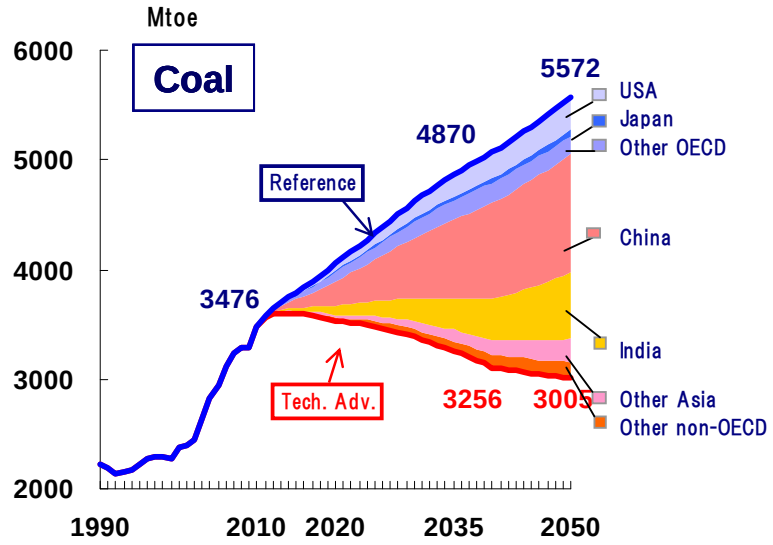
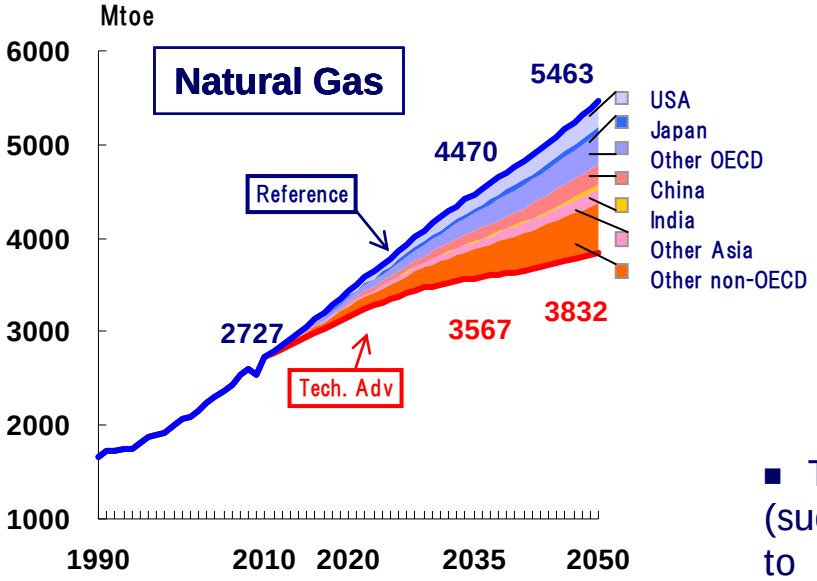
Fossil Fuel Demand







Reduction in 2050 (Regional Breakdown)

(Oil)

	Mtoe	Share
USA	181	11%
Japan	33	2%
Other OECD	279	17%
China	317	20%
India	251	16%
Other Asia	151	9%
Other non-OECD	403	25%
OECD	493	31%
non-OECD	1,122	69%
Developing Asia	719	45%
World	1,616	100%

(Coal)

	Mtoe	Share
USA	299	12%
Japan	57	2%
Other OECD	163	6%
China	1,077	42%
India	610	24%
Other Asia	215	8%
Other non-OECD	147	6%
OECD	518	20%
non-OECD	2,049	80%
Developing Asia	1,902	74%
World	2,567	100%

(Natural Gas)

	Mtoe	Share
USA	276	17%
Japan	68	4%
Other OECD	329	20%
China	222	14%
India	44	3%
Other Asia	155	9%
Other non-OECD	538	33%
OECD	673	41%
non-OECD	958	59%
Developing Asia	421	26%
World	1,631	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

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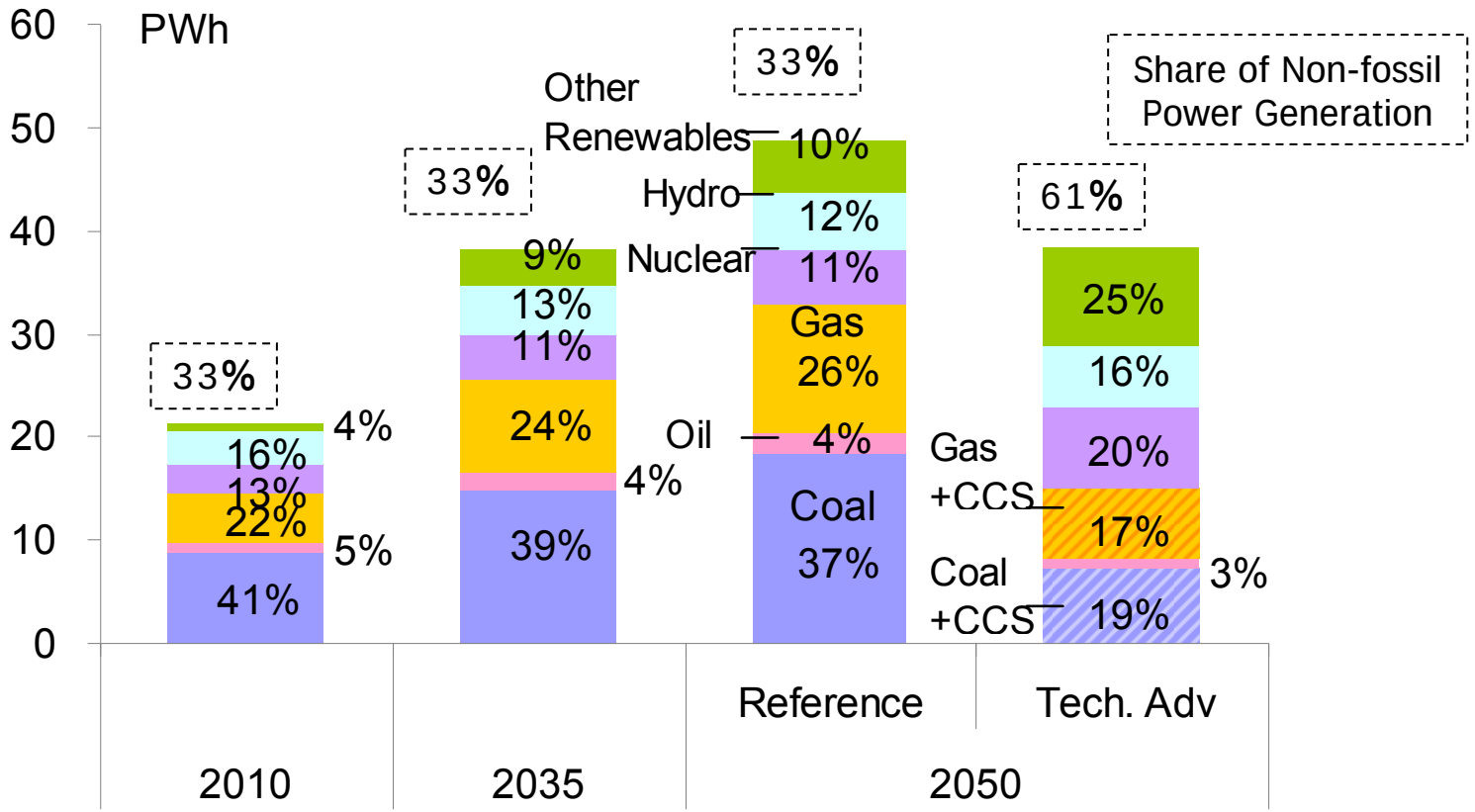
Power Generation Mix (World)



■ In the Reference Scenario, the world power generation will grow from 21 PWh in 2010 to 49 PWh in 2050. In the Adv. Tech. scenario, the power generation in 2050 will reach 38 PWh – lower than the Reference Scenario due to energy conservation.

■ The share of non-fossil power generation (including renewable and nuclear) will account for 33% in Reference and 61% in Adv.Tech. Scenario by 2050.

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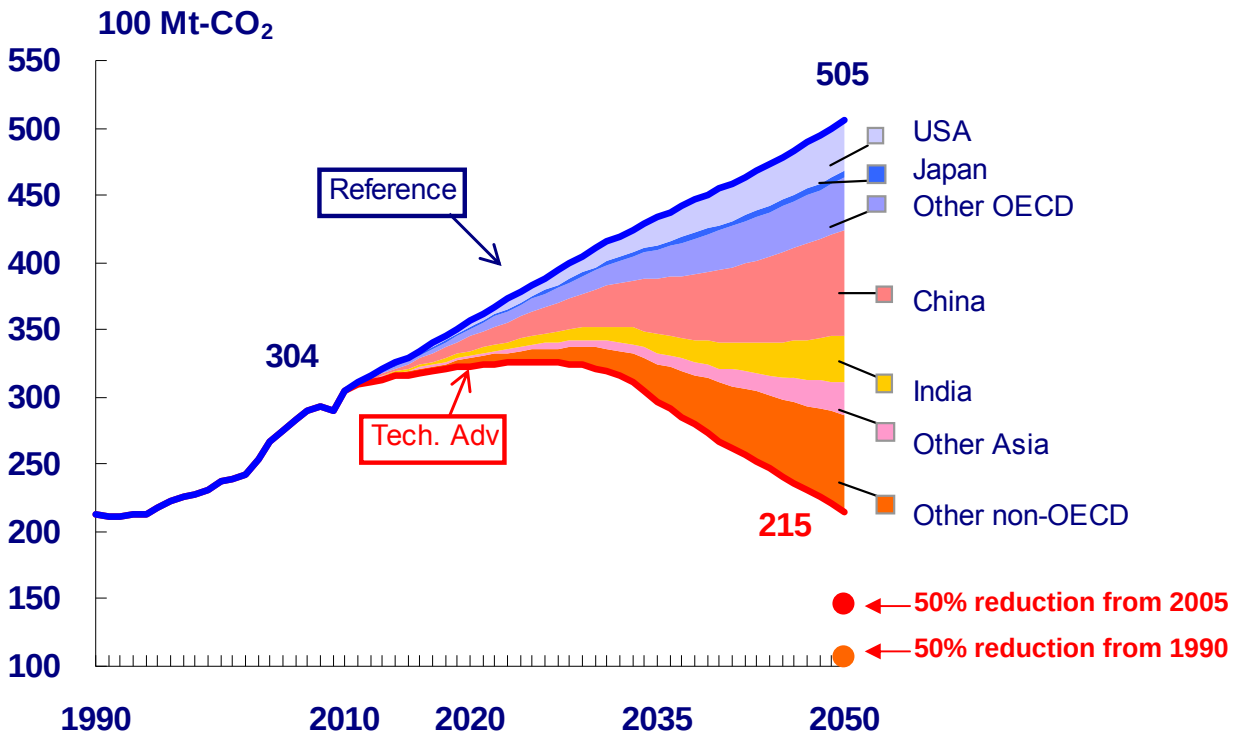
CO_2 Emissions Reduction Potential by Region (World)



CO_2 emissions reduction in 2050

	100 Mt	Share
USA	37	13%
Japan	5	2%
Other OECD	39	13%
China	78	27%
India	35	12%
Other Asia	23	8%
Other non-OECD	73	25%
OECD	81	28%
non-OECD	209	72%
Developing Asia	137	47%
World	290	100%

■ Non-OECD will account for 72% of the world CO_2 emissions reduction potential in 2050. This suggests that reinforcement of energy and environmental measures in developing countries would be important toward the global efforts to CO_2 emissions reduction.

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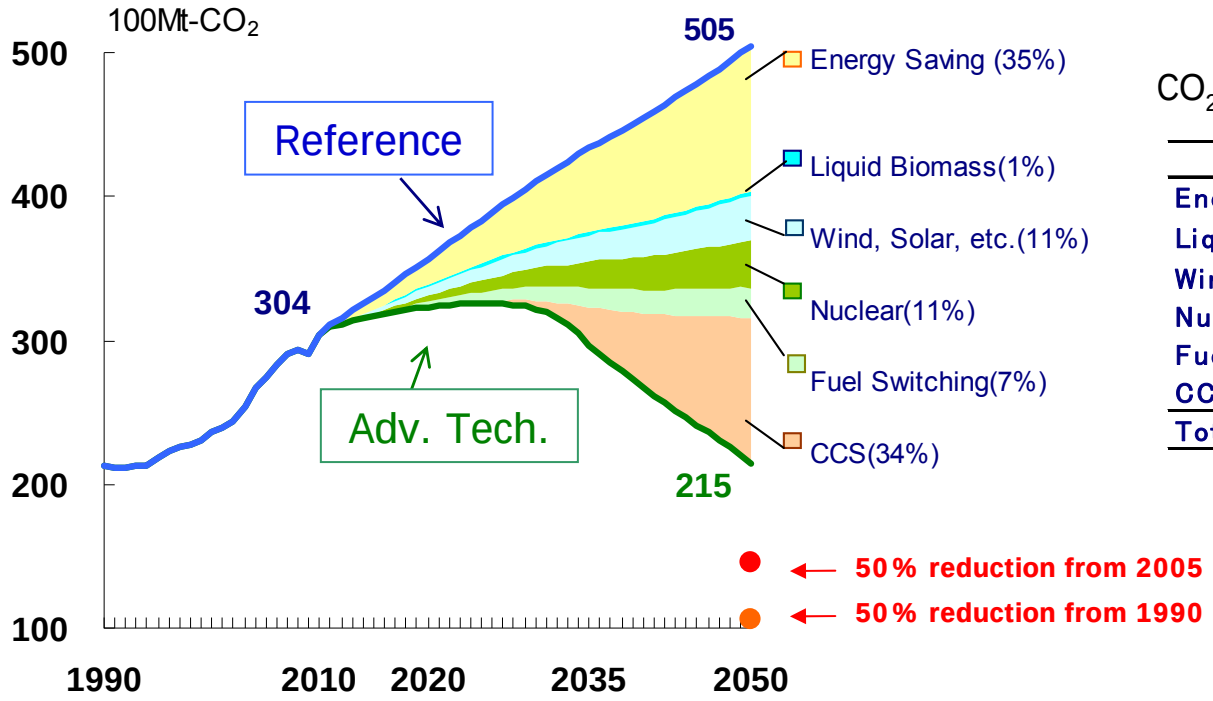
CO_2 Emissions Reduction Potential by Technology (World)



CO_2 emissions reduction in 2050

	100Mt	Share
Energy Saving	102	35%
Liquid biomass	3	1%
Wind, Solar, etc.	31	11%
Nuclear	32	11%
Fuel Switching	21	7%
CCS	100	34%
Total	290	100%

■ Energy saving technology principally contributes to the world CO_2 reduction in 2050. Fuel switching and CCS will substantially mitigate global emissions as well.
■ In order to halving world CO_2 emissions, further political and technological measures are required, such as progressive R&D, and development of low-carbon-emitting cities.

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Visions through 2050

- Every possible measure must be taken to slash CO_2 emissions by 2050. Technologies such as renewable energy, nuclear energy and CCS **should be promoted for the long term**.

- It is **difficult to achieve the target of "halving global CO_2 emissions by 2050" only by using technologies** whose commercialization looks viable at present. If nuclear development stagnates, the target will be even harder to attain. Therefore, **utmost effort should be made to develop and spread innovative energy technologies** that exceed the assumptions of this analysis.

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Implications for Japan

- It is vital for a resource-poor country like Japan to assure energy security.

- Concerning fossil fuel procurement, mid- to long-term international cooperation with Asian countries is important. It is also important to diversify supply sources while maintaining and enhancing relations with energy-producing countries in the Middle East, etc.

- Concerning environmental issues, international cooperation for more effective and efficient reductions should be sought, in addition to domestic efforts.

- For safety, with nuclear power being reinforced mainly in Asia, Japan must make international contributions to nuclear safety assurance, based on the lessons learned from the Fukushima accident.

- Further development and utilization of energy conservation and environmental protection technologies in which Japan has competitive advantages should be the major pillar in Japan's growth and international energy strategies.

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＜Reference Material＞

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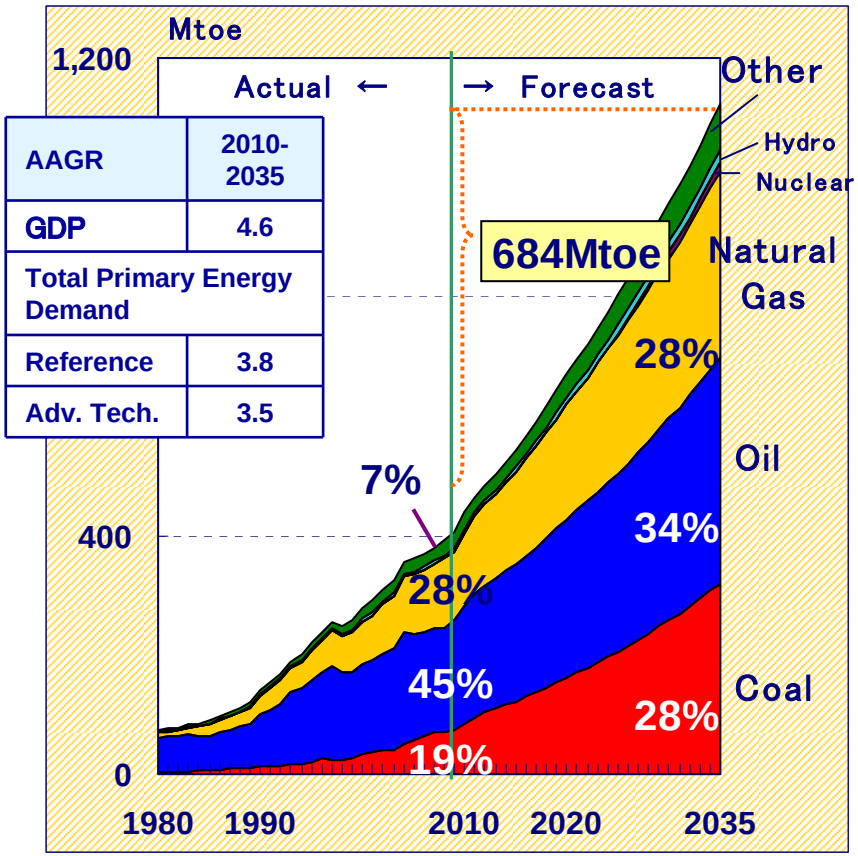
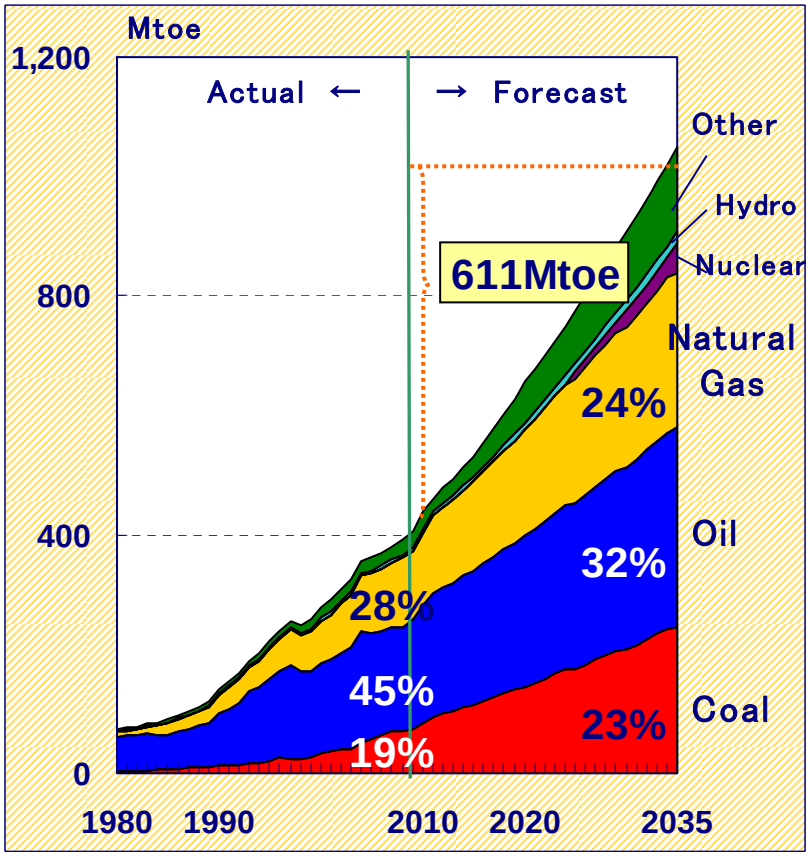
Primary Energy Demand (ASEAN)

【Reference Scenario】



AAGR	2010-2035
GDP	4.6
Total Primary Energy Demand	
Reference	3.8
Adv. Tech.	3.5

【Adv. Tech. Scenario】



ASEAN countries have achieved economic growth reflecting on abundant labor force and exporting manufacturing product to international market. These factors have led to increase its energy demand. Electricity demand, in particular, represents fast growth and a couple of nuclear power plants is projected to be installed for securing electricity supply.

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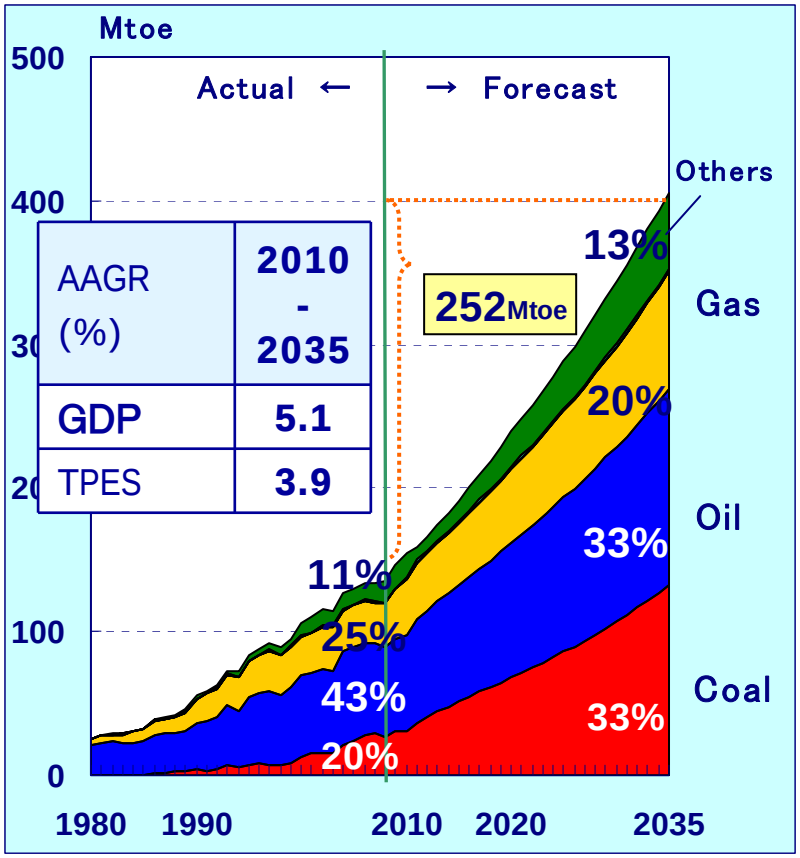
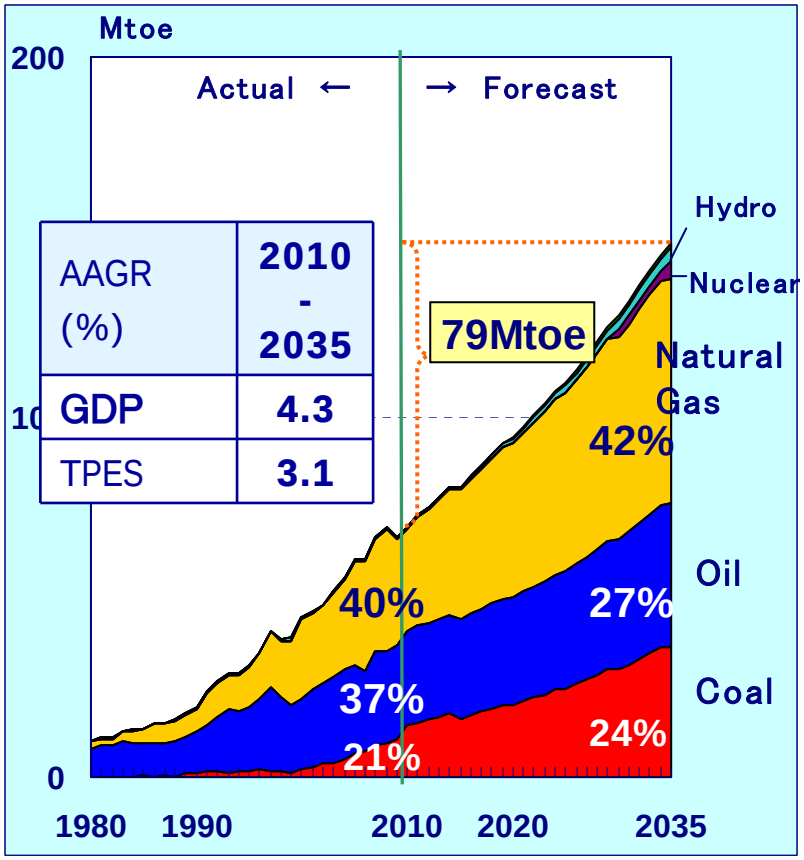
Primary Energy Demand (Indonesia, and Malaysia)

【Indonesia】 (Reference)



【Malaysia】 (Reference)



Indonesia: Major target of energy policy is composed of securing energy supply, exporting domestic energy resources at high value, managing domestic energy reserves, and providing affordable energy to low-income people.

Malaysia: Political priority is emphasized on ensuring affordable energy supply and sustainable economic growth. Basic target is fuel diversification, energy efficiency and environmental protection.

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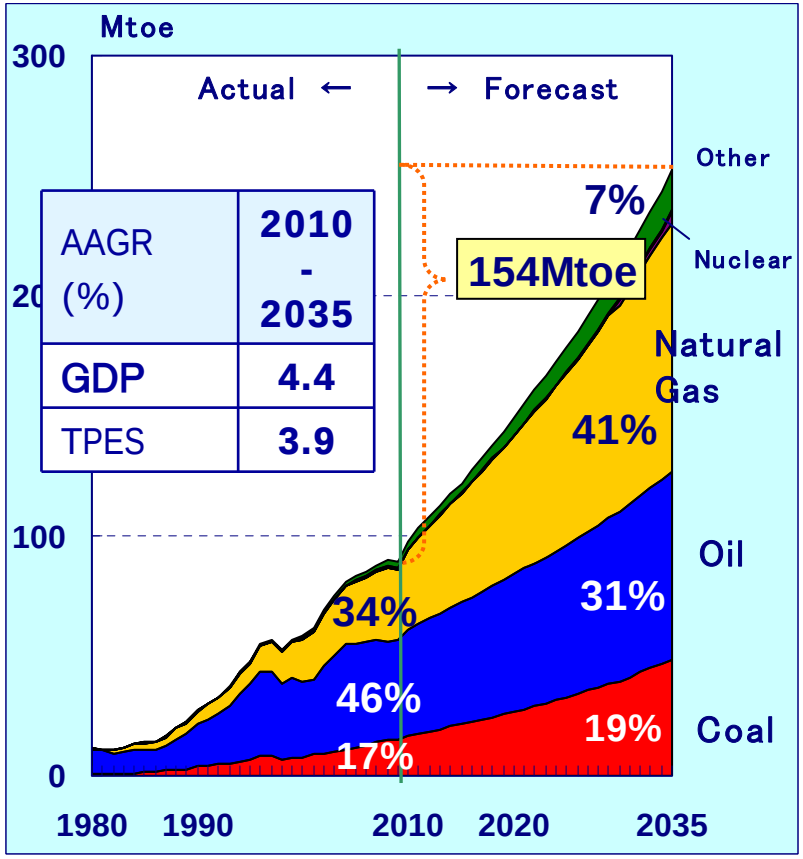
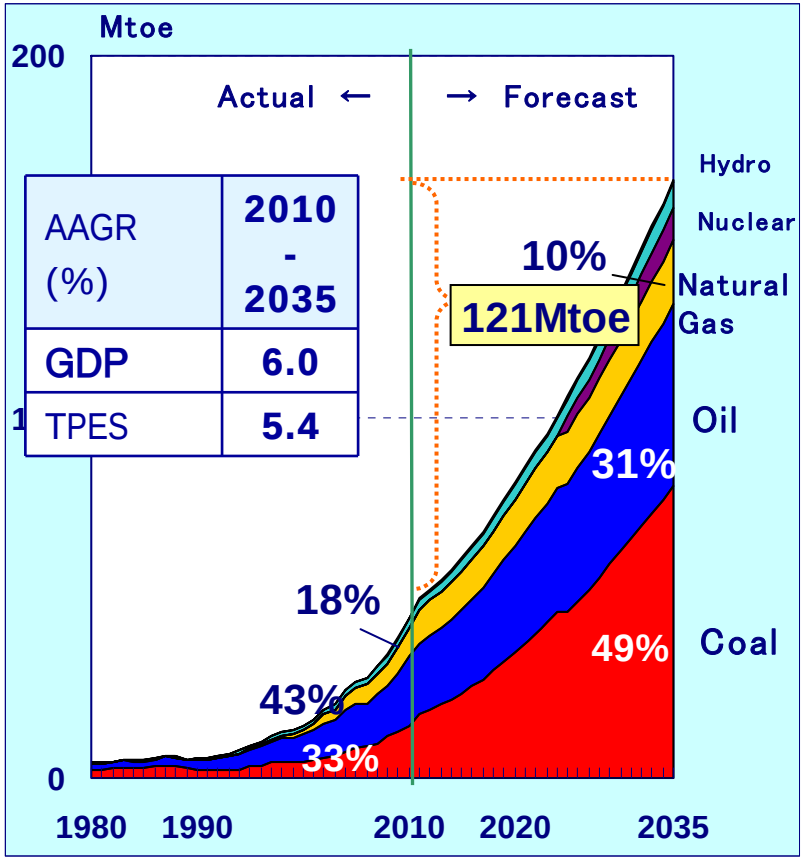
Primary Energy Demand (Thailand, and Vietnam)

【Thailand】 (Reference)



【Vietnam】 (Reference)



Thailand: Energy policy emphasis is placed on energy supply security, appropriate energy price, alternative fuel, energy efficiency, and environmental protection. The government focuses on the CDM project.

Vietnam: The government aims to promote foreign investment in the upstream sector in order to ramp up domestic oil production, and increase oil export for expanding foreign currency revenues.

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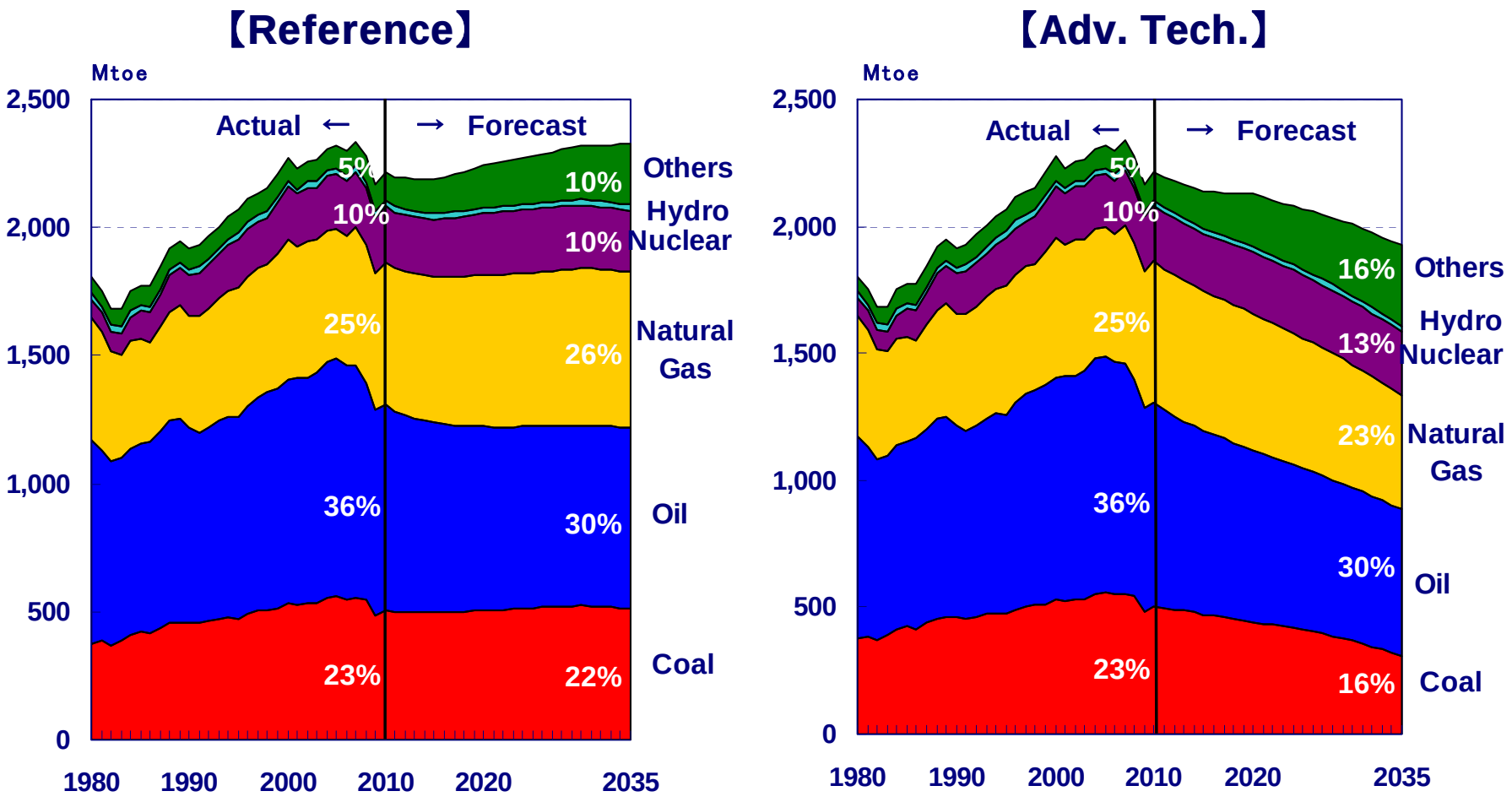
Primary Energy Demand in the U.S.



■ Oil demand will decrease due to the vehicles fuel efficiency improvement and deployment of bio-fuel. Oil demand will decline from 16.5 mb/d in 2010 to 14.5 mb/d in Reference and 11.9 mb/d in Adv. Tech. by 2035.

■ Renewables, particularly wind and bio-fuel, will considerably increase.

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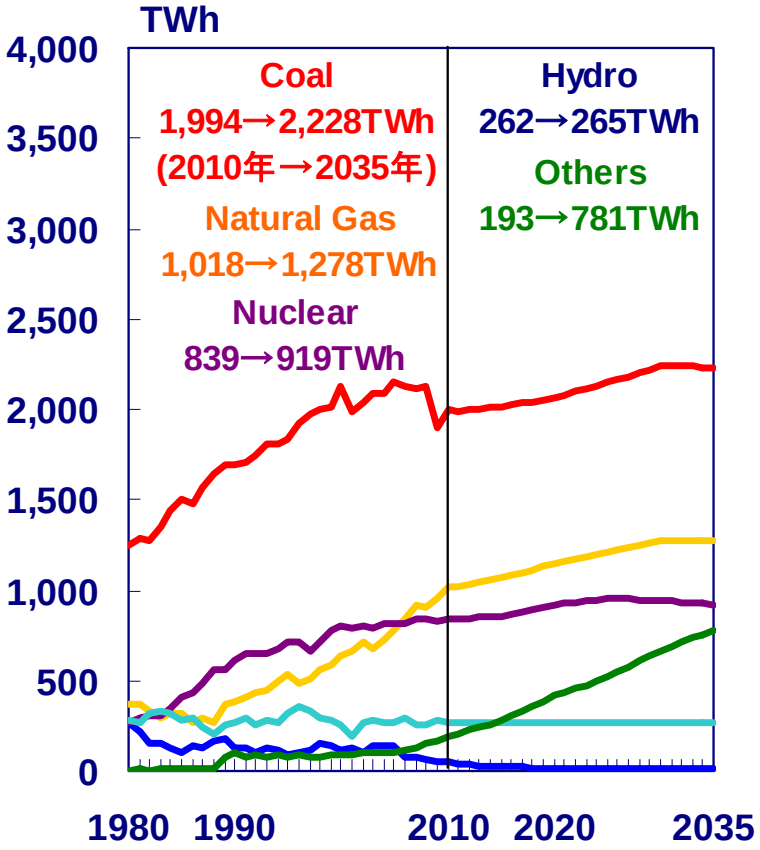
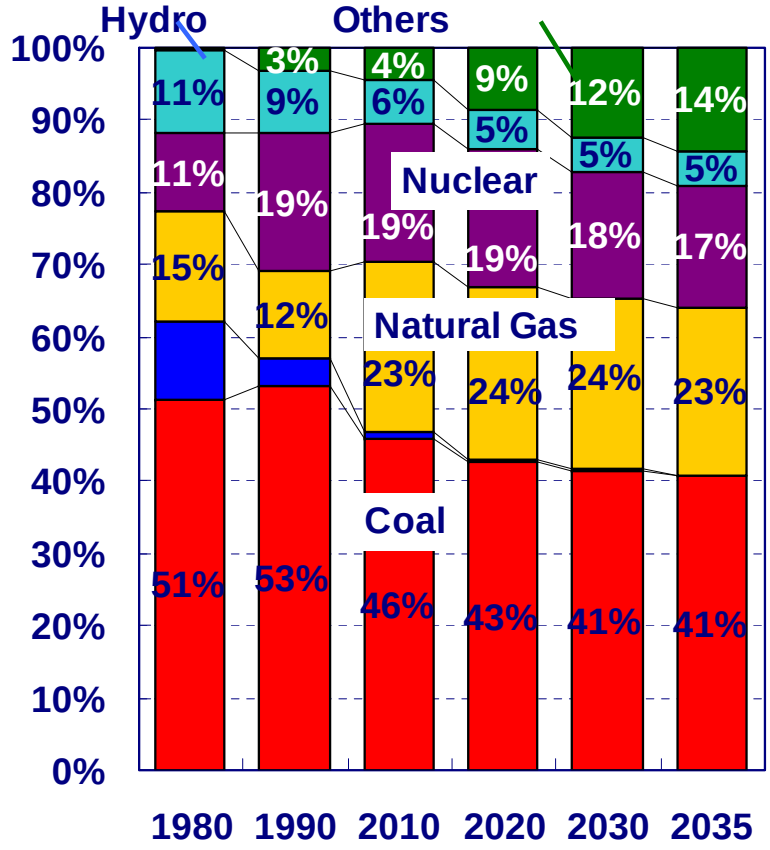
Power Generation Mix in the U.S.

【Power Generation】 (Reference)



【Power Generation Mix】 (Reference)



■Coal-fired generation will remain in a base source of electricity. And natural gas-fired generation will increase continuously due to shale gas developments.

■The share of renewable, particularly solar and wind, will increase from 4% in 2010 to 14% in 2035.

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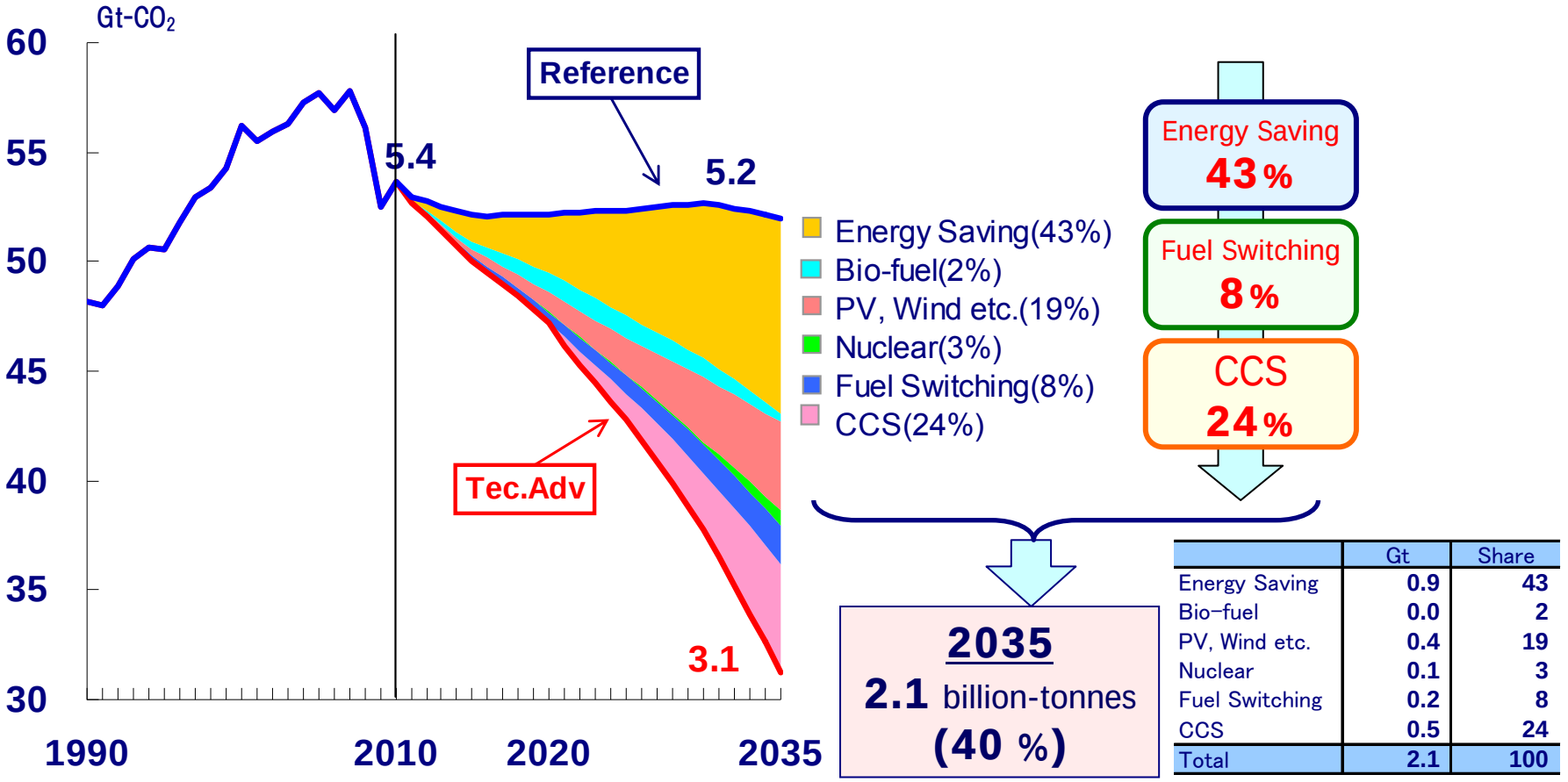
CO_2 Emissions Reduction in the U.S.



	Gt	Share
Energy Saving	0.9	43
Bio-fuel	0.0	2
PV, Wind etc.	0.4	19
Nuclear	0.1	3
Fuel Switching	0.2	8
CCS	0.5	24
Total	2.1	100

■ CO_2 emissions in the Adv. Tech. Scenario will be 2.1 billion toe lower compared with the Reference Scenario.

■ The CO_2 emissions in U.S. building sector is likely to grow continuously, suggesting that measures need to be implemented to improve energy efficiency and utilize low-carbon emission power generation technologies.

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