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Asia / World Energy Outlook 2009

The Role of Technology Towards the Resolution of Energy & Environmental Issues in Asia

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Outline - Asia/World Energy Outlook 2009 -

- **Projection Outline**
  - Objective, Methodology, Major assumptions
- **Projection Results Overview: World and Asia**
  - Primary Energy Demand・CO_2 Emissions
  - Motorization, Power Generation Mix, Renewables
- **Technologically Advanced Scenario (Tech. Adv.)**
- **Energy Outlook in Major Countries**
  - China, India, ASEAN, United States of America
- **Implication**

Projection Outline

● **Objective:** Attempt to quantitatively simulate realistic energy pictures in a fully logical and consistent way, with elaborate investigation into current status of socio-economic and energy fundamentals, in both world and Asian regions. Analysis of Asian region is, in particular, carefully implemented through the exchange of information with numerous agencies specialized in study of Asia.

● **Projection Period:** **2008 ～ 2035**

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

● **Scenarios:**

■ **Reference**

Reference scenario anticipates highly probable deployment of energy policy and energy technology based on current economic & political situations, which yields normative future evolution of energy demand and supply

■ **Technologically Advanced Scenario (Tech. Adv.)**

This scenario develops future picture which assumes;

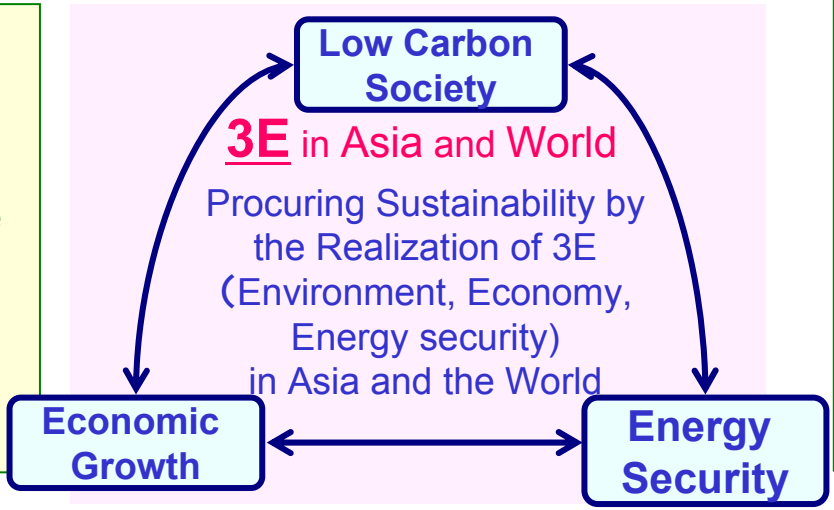
- Accelerated R&D encourages global deployment of advanced technology.
- Global technological cooperation and technological transfer from developed to developing countries are promoted.
- All the countries of the world take technological advanced measures in order to secure energy demand and supply.

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

Agenda on Energy-Environmental Policy

Firm resolutions on ensuring energy security, R&D and adressing climate change are significant

- ■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 Technology towards 2030 & 2050
- ■Transfer of low carbon technology and knowledge on building energy policy to other countries.
- ■Achieving economic growth by establishing new energy & environmental industry

Development and deployment of innovative technology and social system from long-term viewpoint

2020

- ・Nuclear
- ・PV, Wind, Bio-fuel etc.
- ・Environmentally compatible use of fossil fuel
  - Clean Coal Technology(IGCCI, 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.

2030 2035

- Energy demand expansion in China, India etc.
- Risk of extraordinary price escalation of fossil fuel (Peak-out of Easy Oil)
- Massive introduction of innovative technology

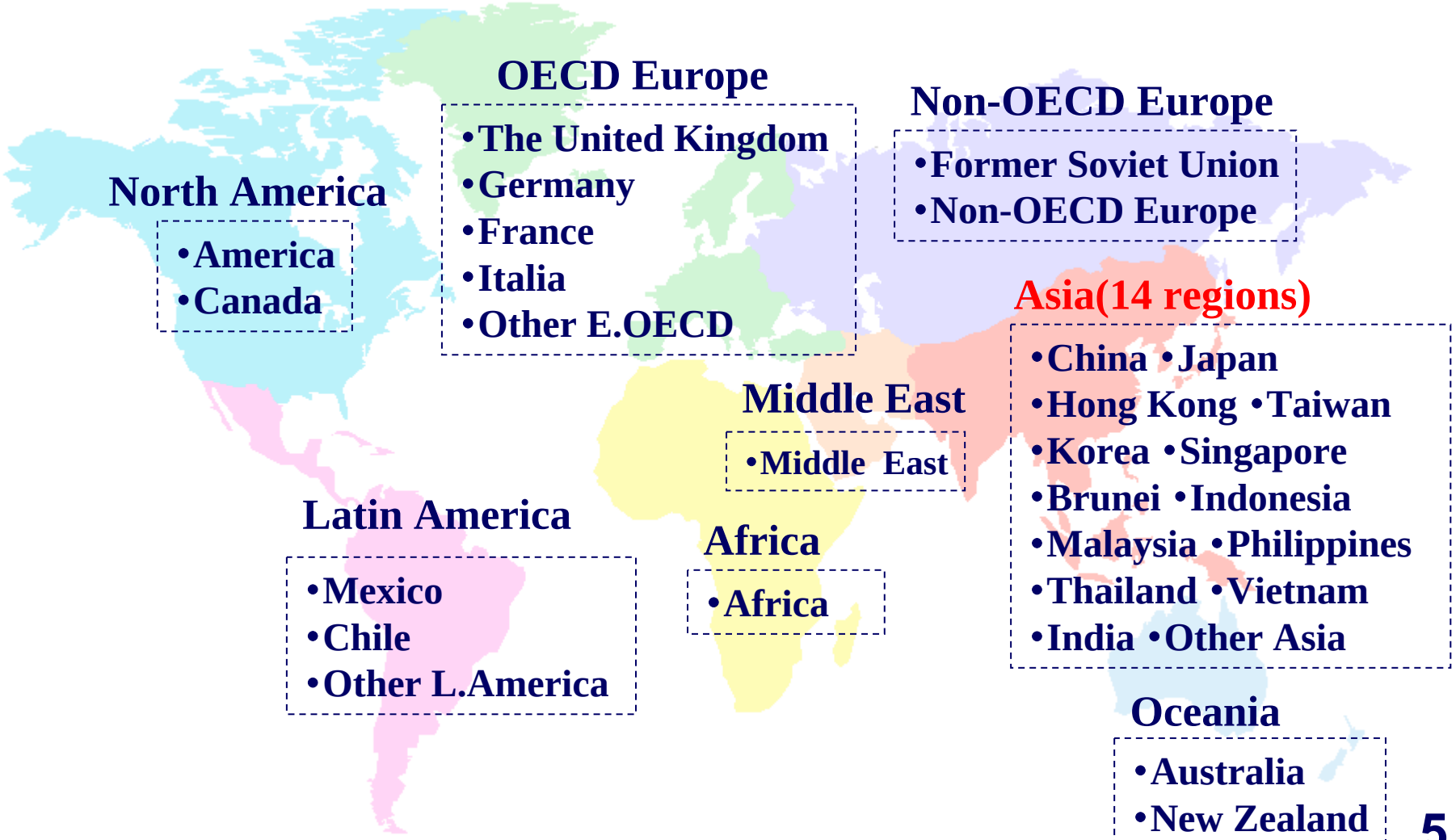
Acceleration of development of low carbon technology
⇒Sustainable economic growth

2050

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

Geographical Coverage

- The whole world is geographically divided into 30 regions, Asia into 14 regions.
- Geopolitically detailed analysis into Asian countries.



Basic 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
- CO_2 emissions

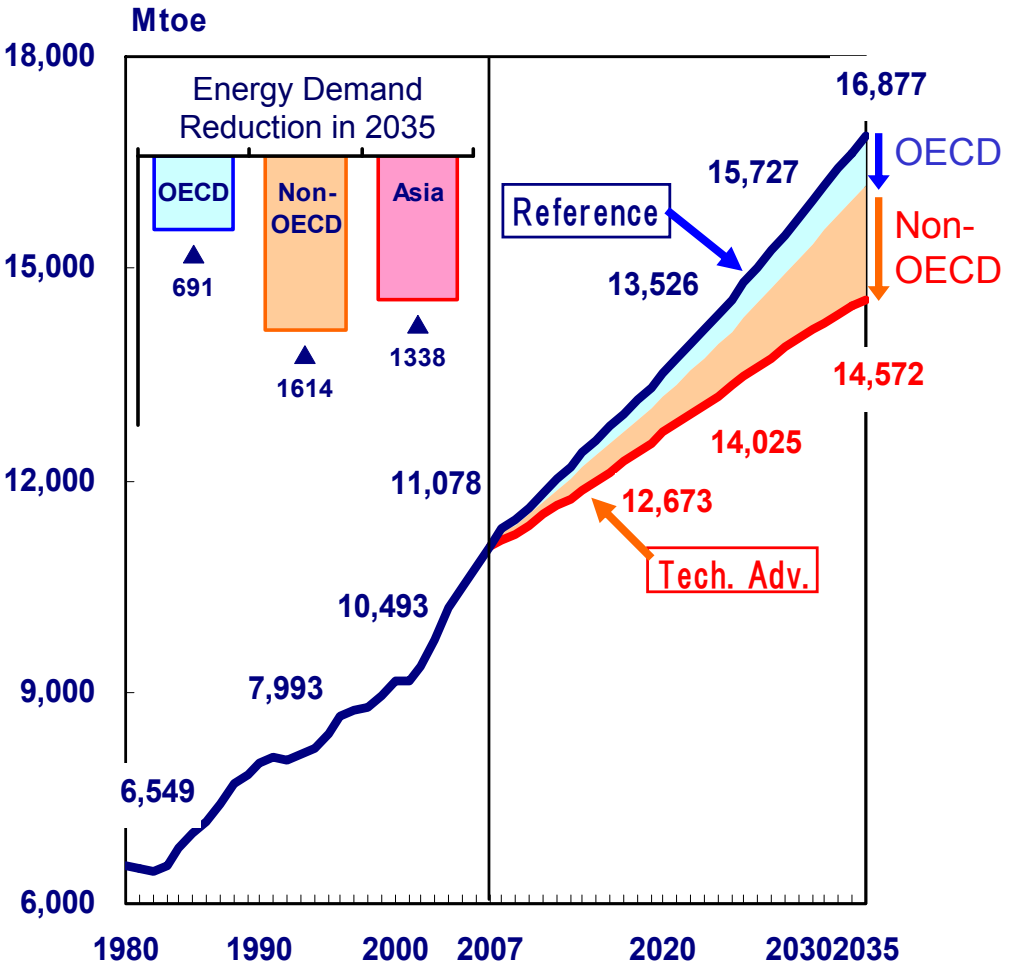
World Trading Model of Crude Oil and Petroleum Products (LP Optimization)

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

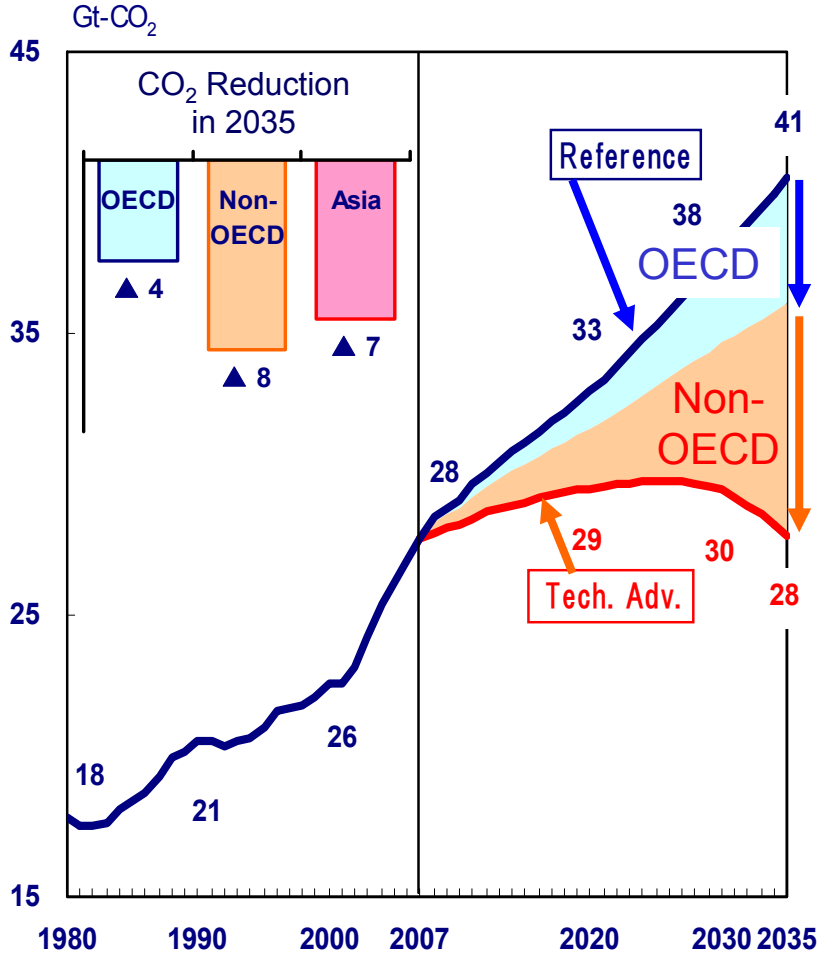
These models allow us to fully understanding the interaction among numerous parameters in a logical and consistent way.

Highlight: Primary Energy Demand & CO_2 Emissions

Primary Energy Demand



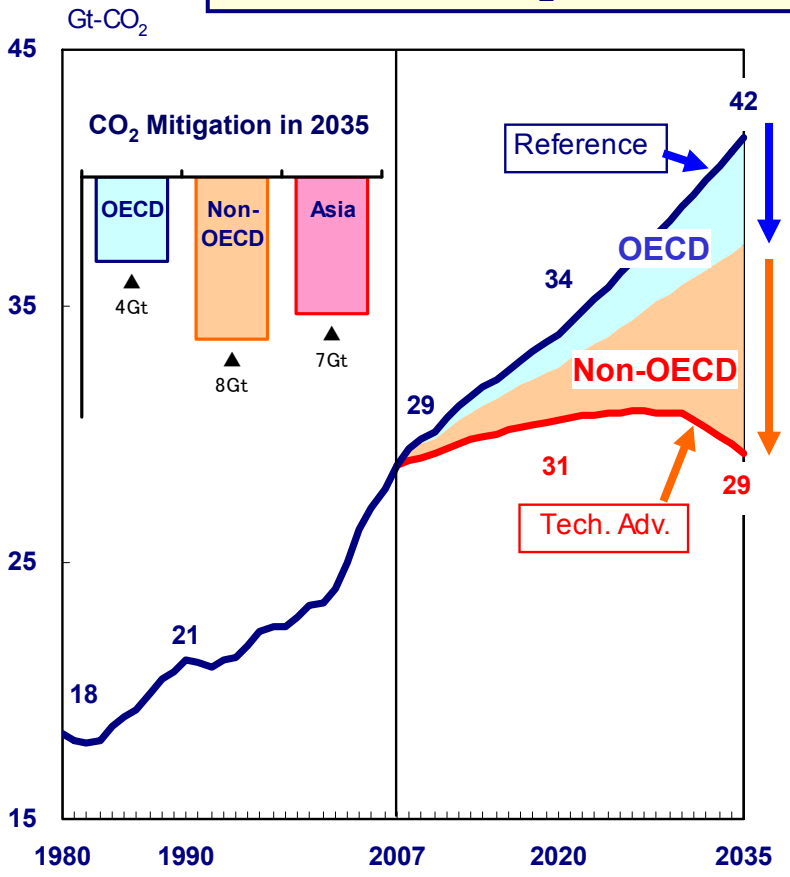
CO_2 Emissions

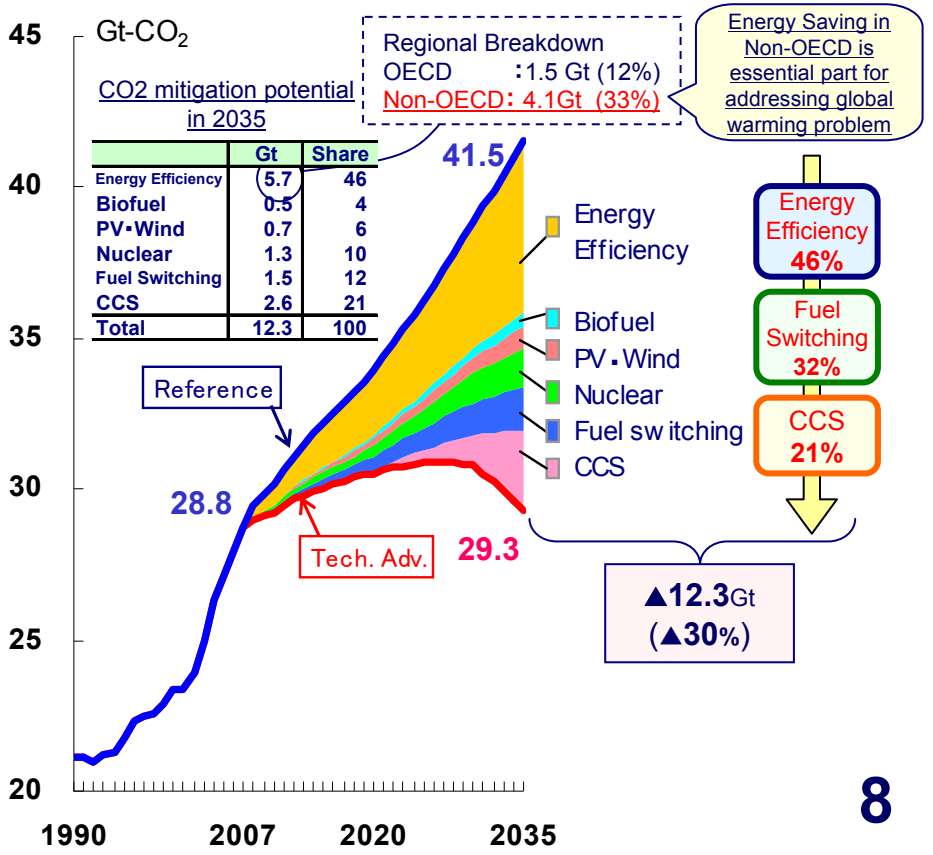


Highlight: CO_2 Emissions (World)

■ In 2035, world total primary energy demand in Tech. Adv. Scenario decreases by 2,300 Mtoe in comparison with Reference Scenario. 2300 Mtoe is approximately 4 times as much as TPES of Japan. Energy saving of Non-OECD in 2035 is almost double as large as that of OECD. Saving potential in Asia, 1,300 Mtoe, shows particularly massive amount.
■ In 2035, global CO2 emissions in Tech. Adv. Scenario decreases by 12.3 Gt-CO2 (30% reduction). 12.3 Gt is about 10 times as much as CO2 emissions of Japan. CO2 mitigation of Non-OECD in 2035 amounts to double as large as that of OECD. Abatement potential in Asia, 6.8 Gt-CO2, represents particularly immense amount.
⇒ Technology transfer and swift deployment of advanced technology in Asia, which shows most prominent energy demand growth and CO2 emissions increase, is indispensable in order to address global warming problem.

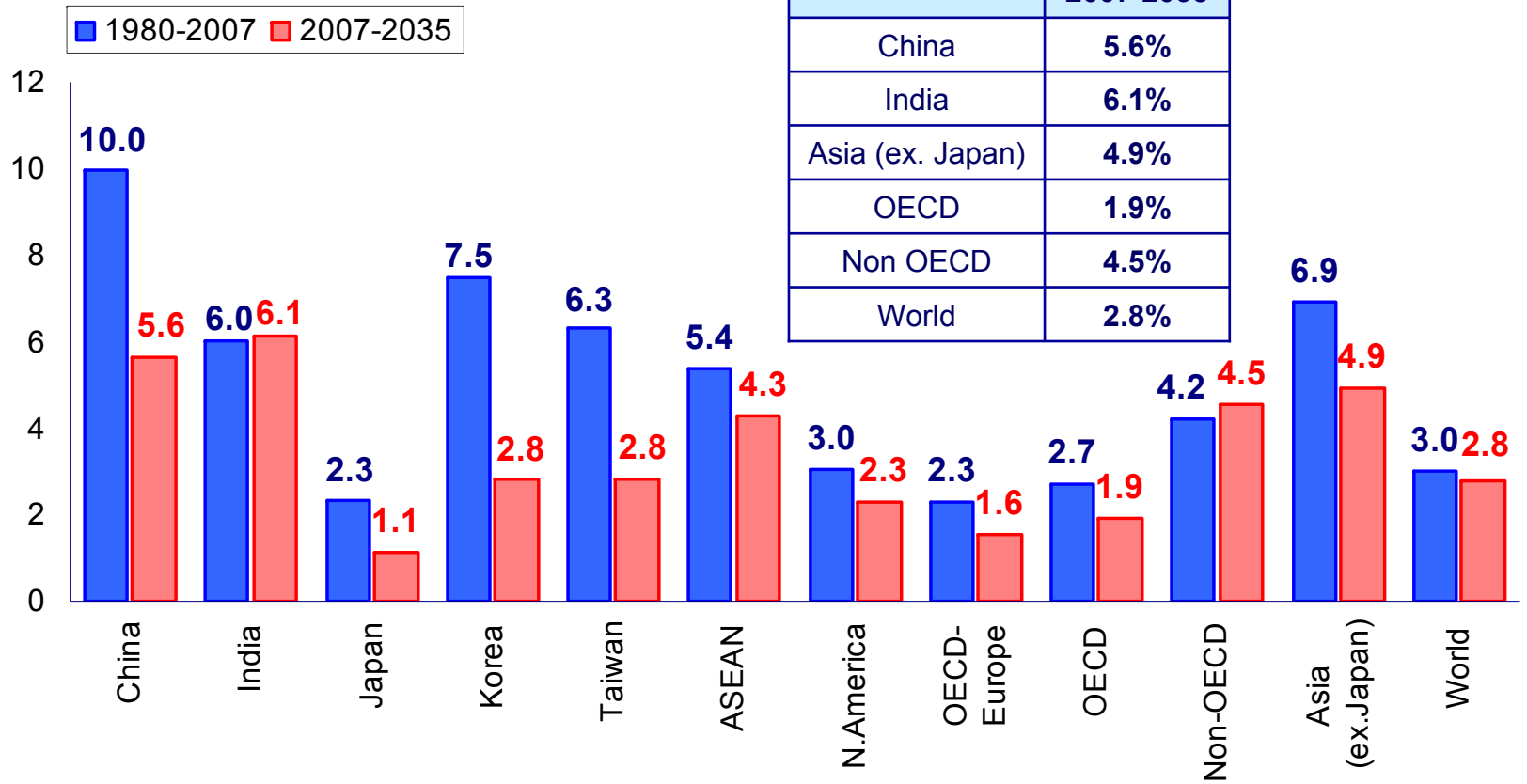
Global CO_2 Emissions (Reference & Tech. Adv. Scenario)





Major Assumption： GDP

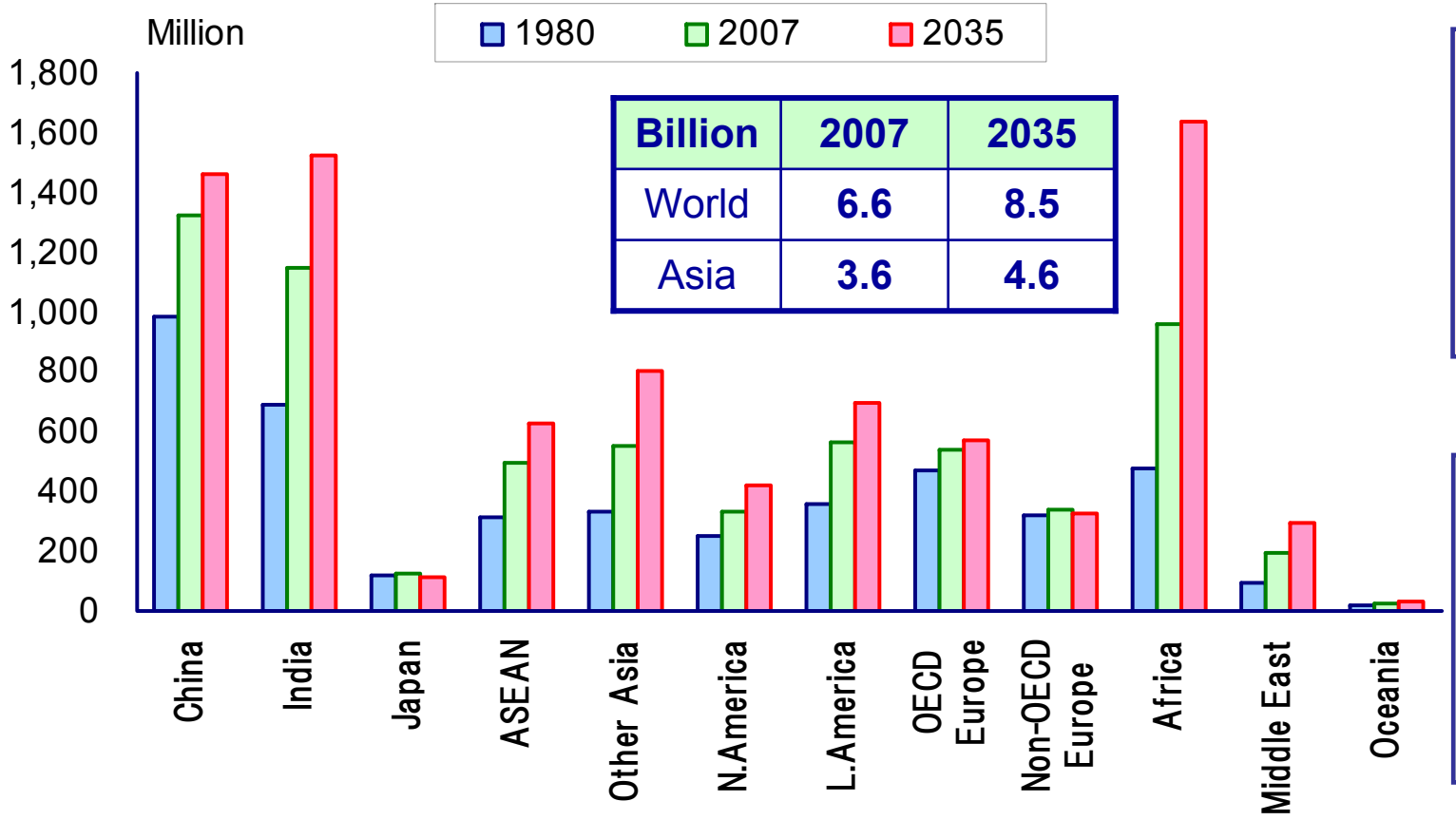
Average Annual Growth Rate(%)



	2007-2035
China	5.6%
India	6.1%
Asia (ex. Japan)	4.9%
OECD	1.9%
Non OECD	4.5%
World	2.8%

- World economy will continue to grow at 2.8% per annum to 2035. Though recent world economy shows sluggish growth reflecting on subprime debacle and subsequent financial crunch in USA, global economy is projected to recover supported by economy-boosting measures by numerous countries.
- GDP in China continues to achieve relatively high growth and shifts toward moderate growth, as Chinese economic driver gradually changes from investment and export to domestic private consumption.
- GDP in India assumes high growth reflecting on improving economic efficiency by liberalization and direct investment from foreign countries.
- ASEAN countries will achieve continuous moderate growth on the basis of domestic private investment and foreign export.

Major Assumption： Population



Billion	2007	2035
World	6.6	8.5
Asia	3.6	4.6

China

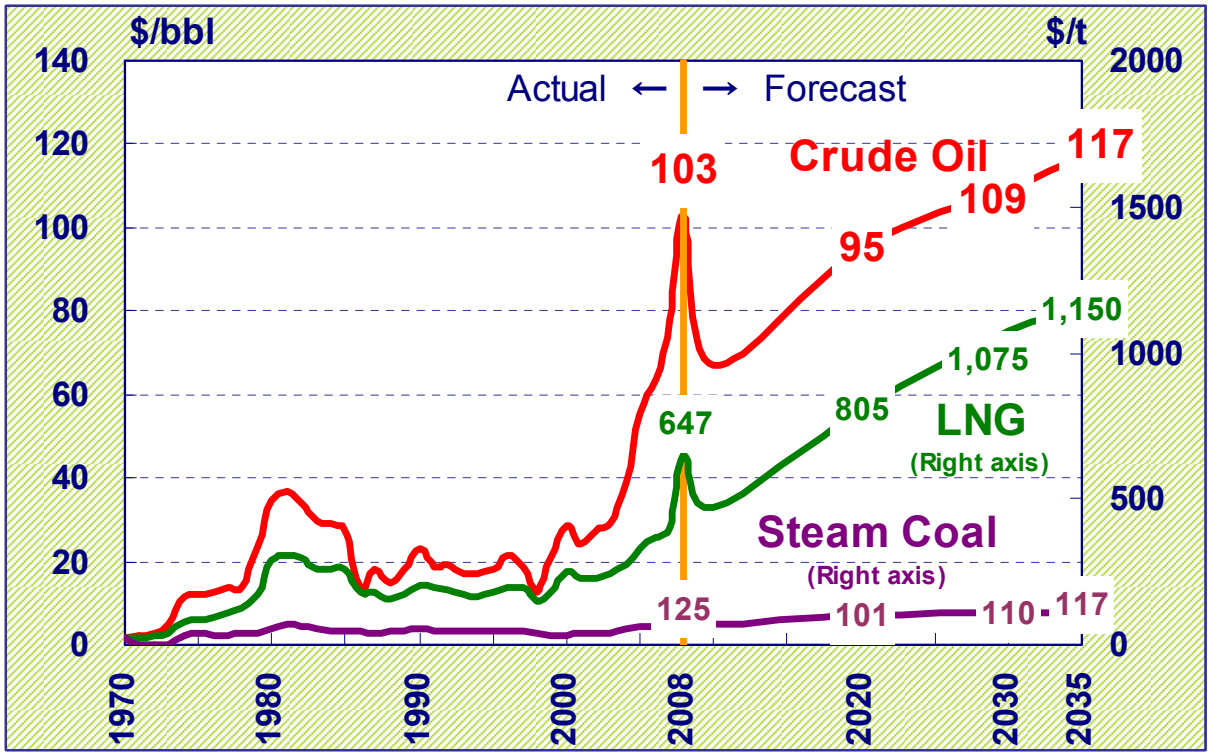
2007
1.32 bil.
↓
2035
1.46 bil.
(**0.14** bil. growth)

India

2007
1.15 bil.
↓
2035年
1.53 bil.
(**0.38** bil. growth)

- Of the incremental increase in population over the period 2007-2035, roughly 90% derives from Non-OECD.
- Population in China and India together will amount to about 3 billion and its share will grow to 35% by 2035.
- Chinese population will peak out in 2030 and experience aging combined with the diminishing number of children.

Major Assumption：Energy Price



(*) 2008 real price (**) All the prices are calendar year data; In the graph, energy prices are explained by Japan's import energy price (on a CIF basis).

■High crude oil price (import CIF price in Japan) in 2008 will head for slowdown by 2010. After 2010, international oil market is forecast to become tightened as a result of oil demand increasing mainly driven by Asia, combined with stagnation of investment in upstream sector, boosting oil price higher for 2035. (The above trajectory of crude oil price is determined as a middle line of assumed price range from 90$/bbl to 110$/bbl in 2020 and from 110$/bbl to 130$/bbl in 2035)

■LNG price is projected to increase in accordance with crude oil price.

■Coal price will show relatively moderate growth compared with crude oil and LNG.

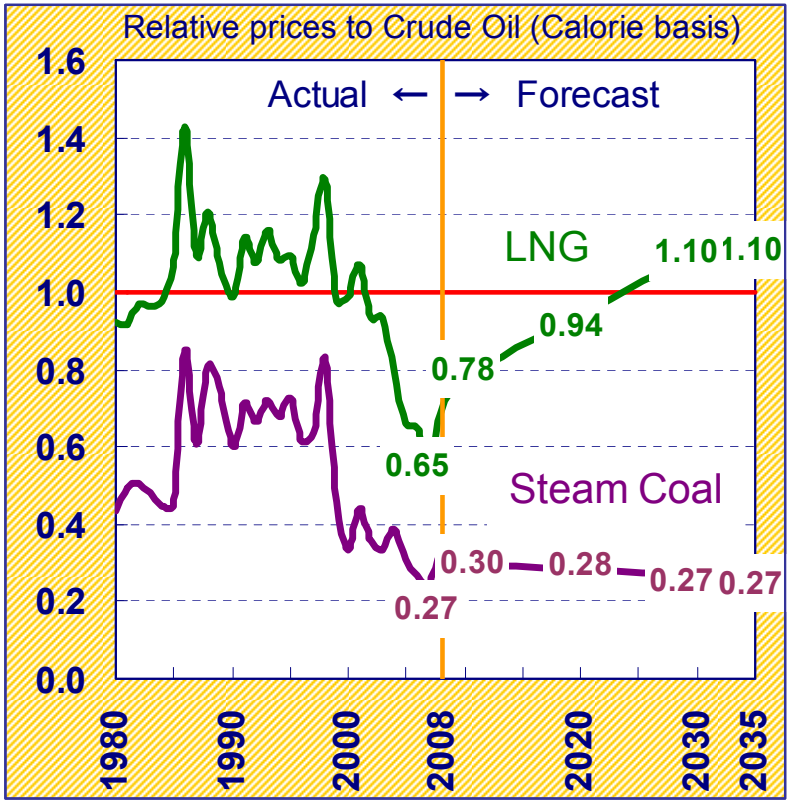
Energy Price and Relative Price

【Real price & Nominal Price】

		2000	2008	2010	2020	2030	2035
Crude Oil	**Real**	**32**	**103**	**67**	**95**	**109**	**117**
$/bbl	Nominal	28	103	70	121	169	200
LNG	**Real**	**282**	**647**	**467**	**805**	**1,075**	**1,150**
$/t	Nominal	251	647	486	1,021	1,661	1,963
Steam Coal	**Real**	**39**	**125**	**74**	**101**	**110**	**117**
$/t	Nominal	35	125	77	128	169	200

* Real prices are set in 2008.
** Inflation rates are assumed at 2% annually.

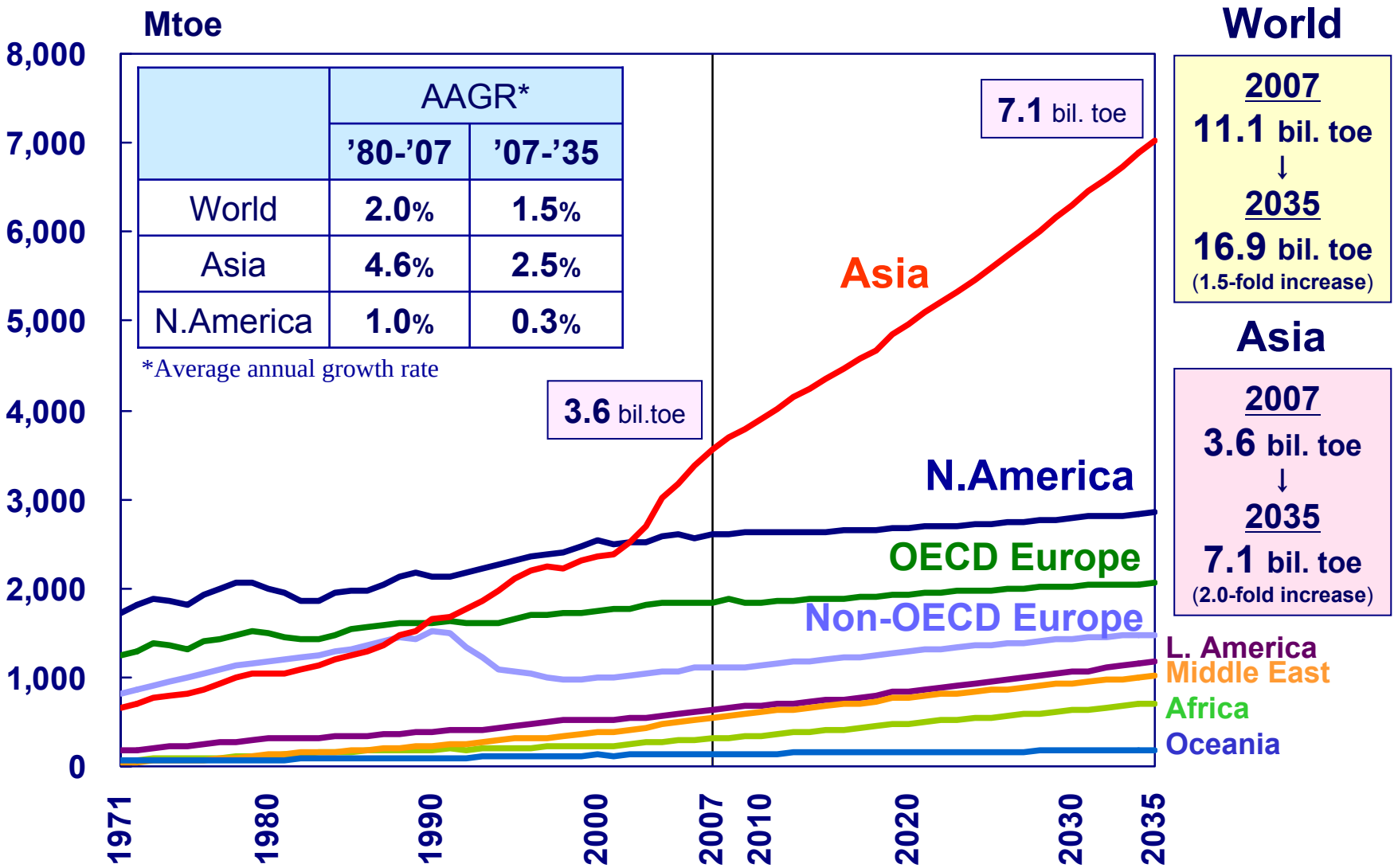
【Relative Prices to Crude Oil】



■ Currently, LNG price is cheaper compared with crude oil price. For the long-term trend, the price gap between crude oil and LNG will become smaller. By 2030, LNG price will outstrip that of crude oil reflecting on the possible change of LNG price formula and environmental premium of natural gas.
■ Coal relative price will remain roughly constant for 2030.

Energy Outlook in World and Asia

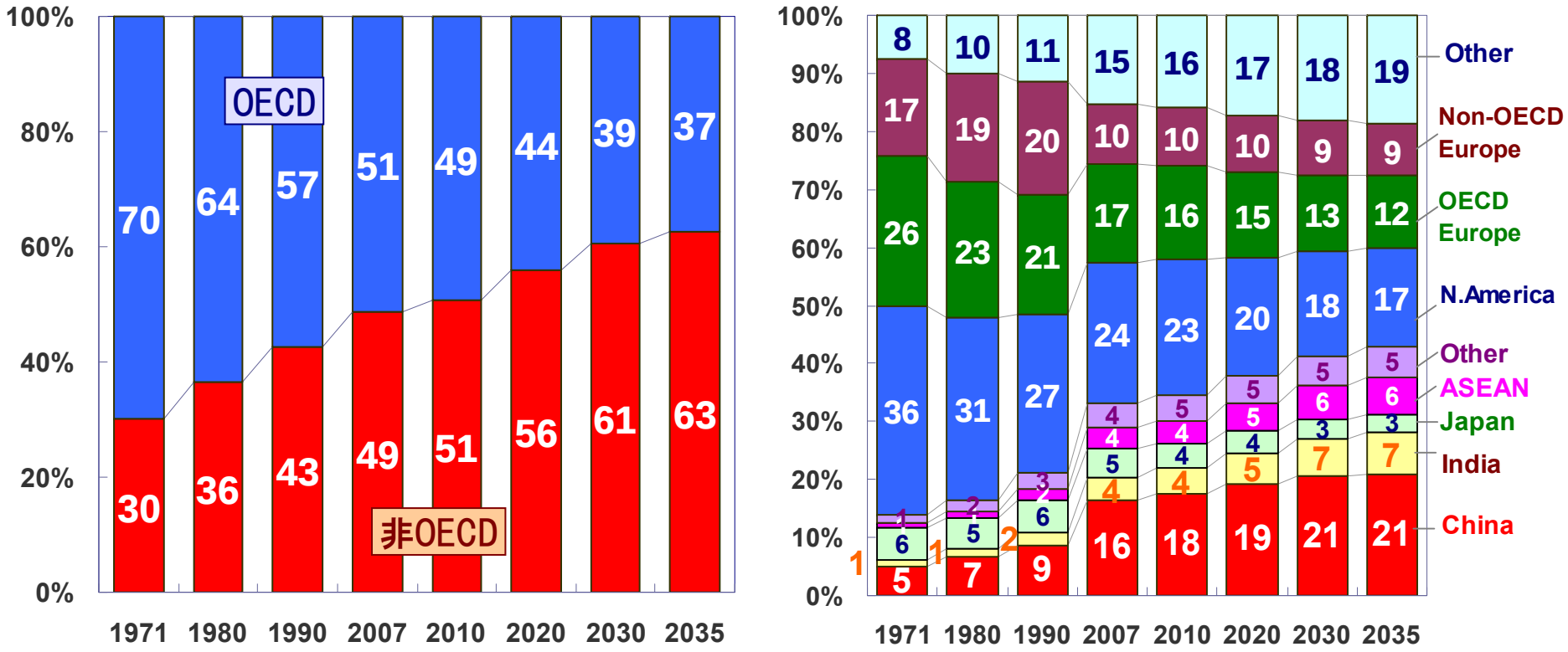
Primary Energy Demand by Region (World)



■ By 2035, primary energy demand of Asia achieves twice as much as current level, reflecting high economic growth; 3.6 billion toe(2007) → 7.1 billion toe(2035).

■ Non-OECD will represent 90% of incremental growth of global energy demand toward 2035.

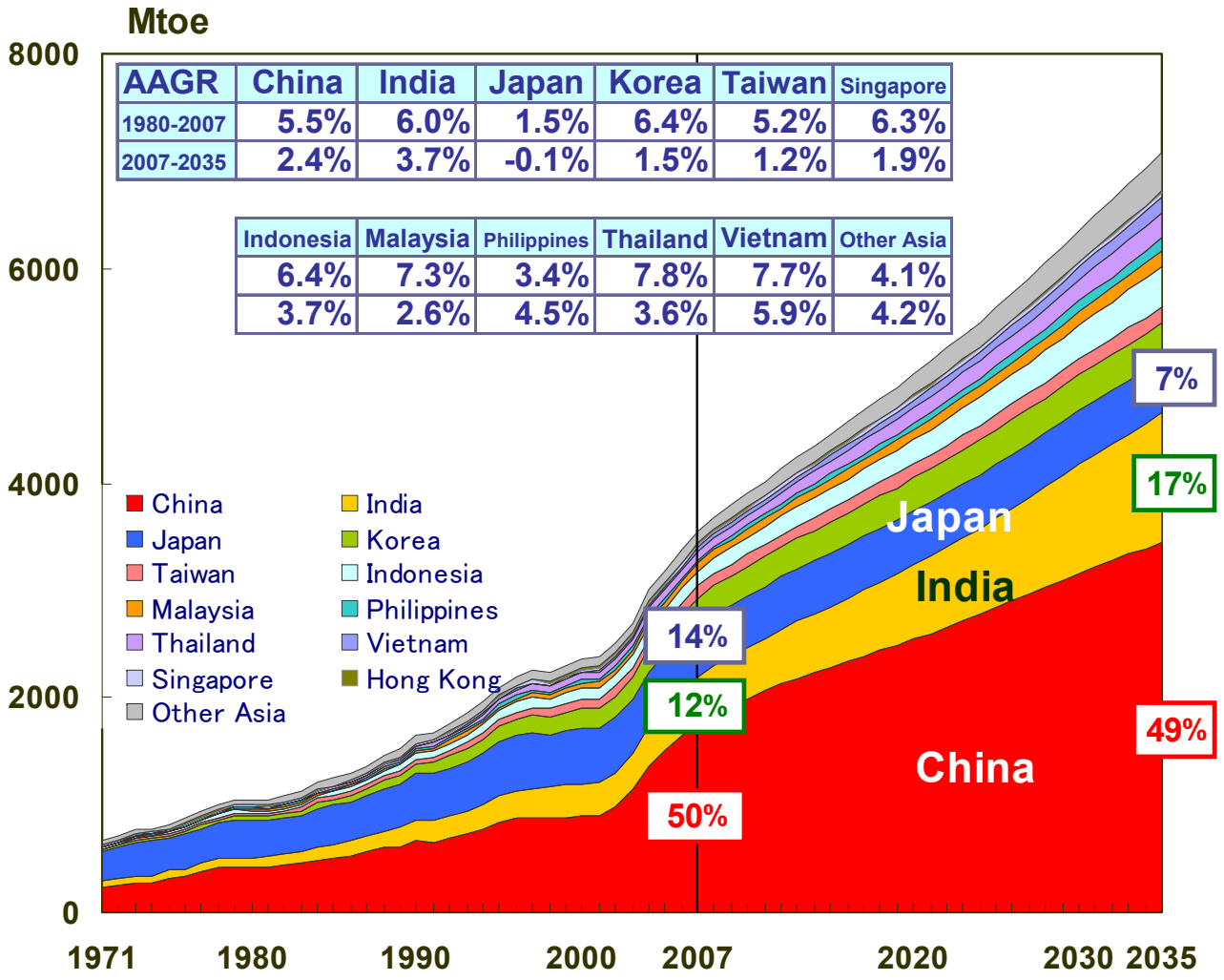
Primary Energy Demand (Regional Share)



■ Energy demand in Non-OECD and Asian region will exhibit a rapid expansion, with the share of Asian regions in world energy demand extending to around 40% by 2035.

■ The share of China in world energy demand will increase to 21% by 2035, and India to 7%. These two countries in aggregate account for around 30% of world energy demand. The share of Japan will shrink from 5% in 2007 to 3% in 2035.

Primary Energy Demand (Asia)



AAGR	China	India	Japan	Korea	Taiwan	Singapore
1980-2007	5.5%	6.0%	1.5%	6.4%	5.2%	6.3%
2007-2035	2.4%	3.7%	-0.1%	1.5%	1.2%	1.9%

Indonesia	Malaysia	Philippines	Thailand	Vietnam	Other Asia
6.4%	7.3%	3.4%	7.8%	7.7%	4.1%
3.7%	2.6%	4.5%	3.6%	5.9%	4.2%

Asia

2007
3.6 bil. toe
↓
2035
7.1 bil. toe
(2.0-fold increase)

China / India

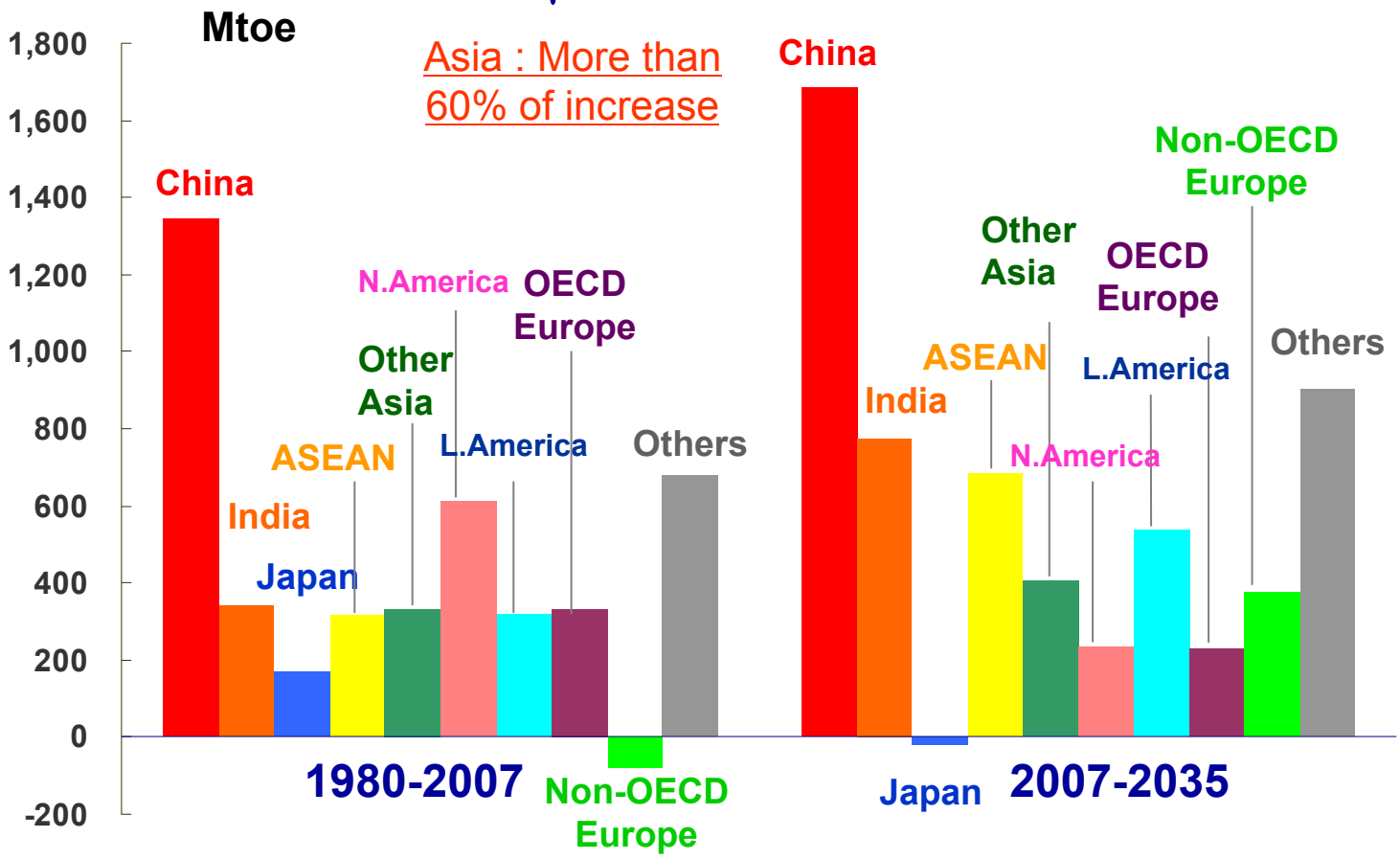
2007
1.8 bil. toe / 0.4 bil. toe
↓
2035
3.5 bil. toe / 1.2 bil. toe
(1.9-fold inc. / 2.8-fold inc.)

- Based on booming economic growth, the share of China and India together in Asian primary energy demand significantly increases to 66% by 2035.
- Japan's energy share in Asia, with its slower-paced economic growth and depopulation, will decline from 14% in 2007 to 7% in 2035.

Incremental Increase in Primary Energy Demand by Region, 2007-2035

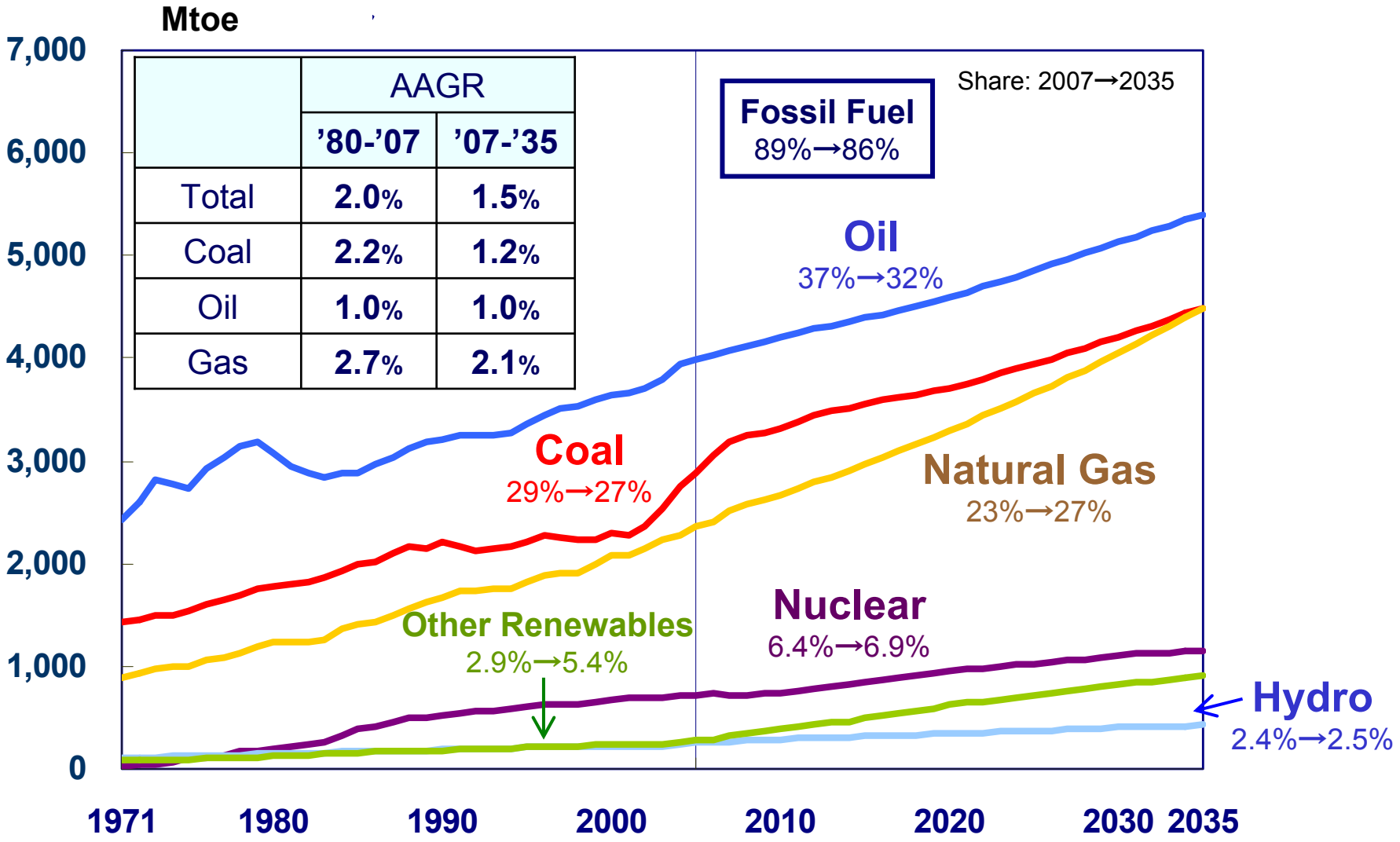
Share in increase, 2007-2035

China	India	Japan	ASEAN	Other Asia	N.America
29%	13%	0%	12%	7%	4%



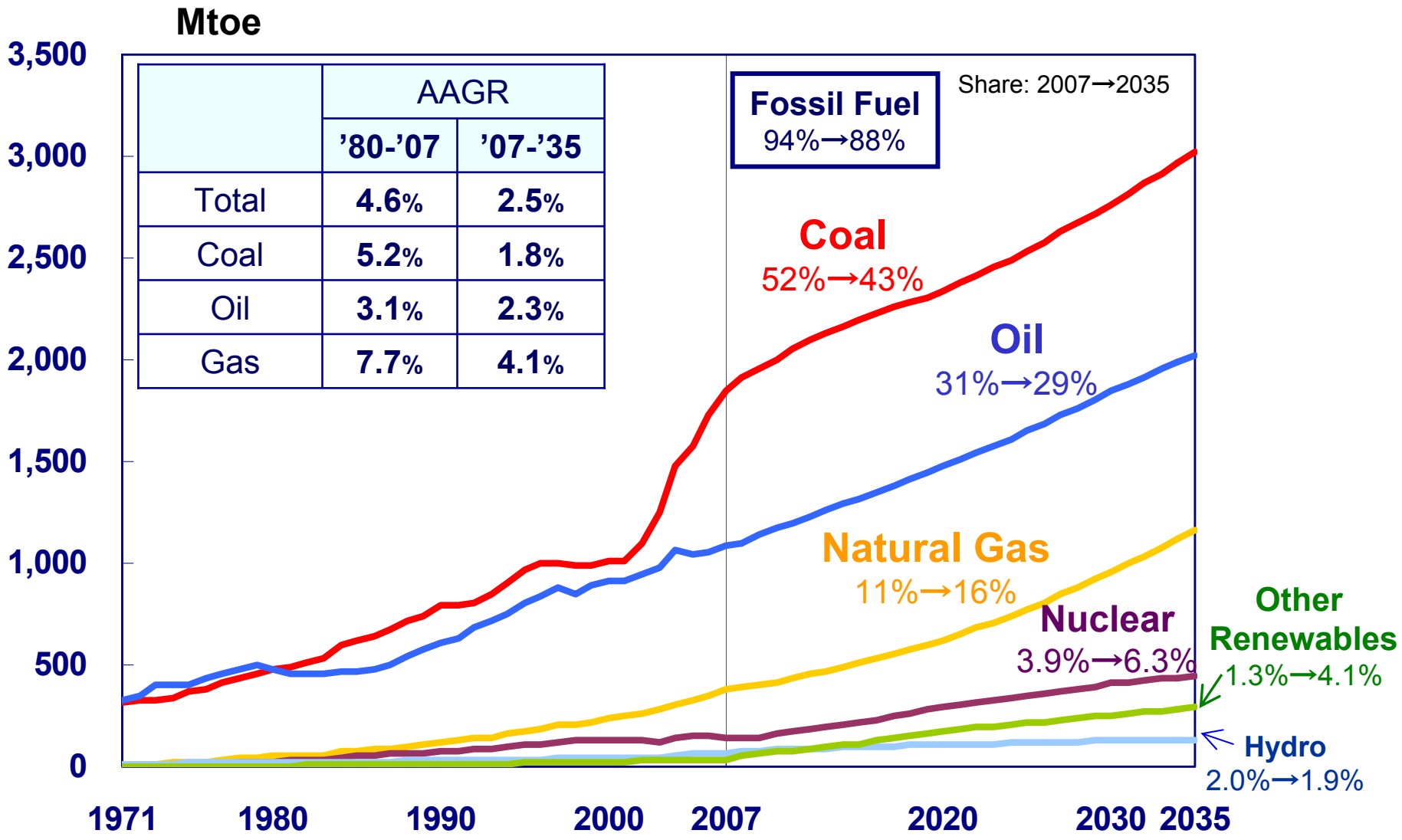
61% of global energy demand increase to 2035 is due to Asia. In particular, approximately 40% of both China and India dominates the world increase. OECD is responsible for 12%, and Non-OECD, 88%.

Primary Energy Demand by Fuel (World)



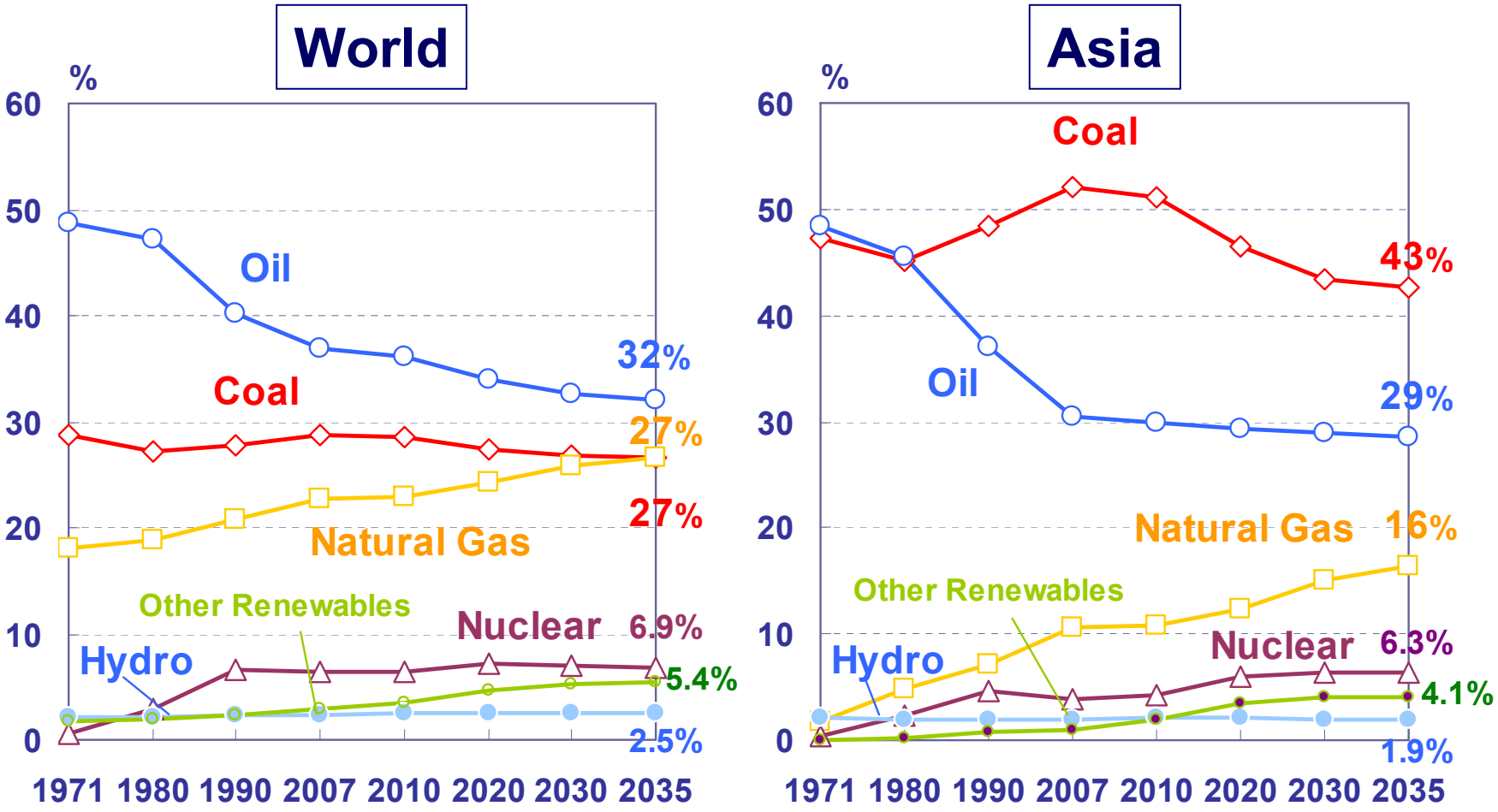
- Oil will remain the largest fuel in primary energy mix by 2035. Around 2035, natural gas demand will grow with its future extensive use in various sectors, eventually catching up with coal around 2035.
- Fossil fuel continues to be the most important fuel by 2035, though its share will slightly decrease from 89% in 2007 to 86% in 2035.

Primary Energy Demand by Fuel (Asia)



- Coal and Oil will continue to maintain its centrality over Asian energy demand until 2035.
- The share of natural gas will grow substantially to 16% by 2035, driven mainly by power generation. Fossil fuel dominates 88% of total energy supply and plays a key role by 2035.

Primary Energy Mix by Fuel (World and Asia)

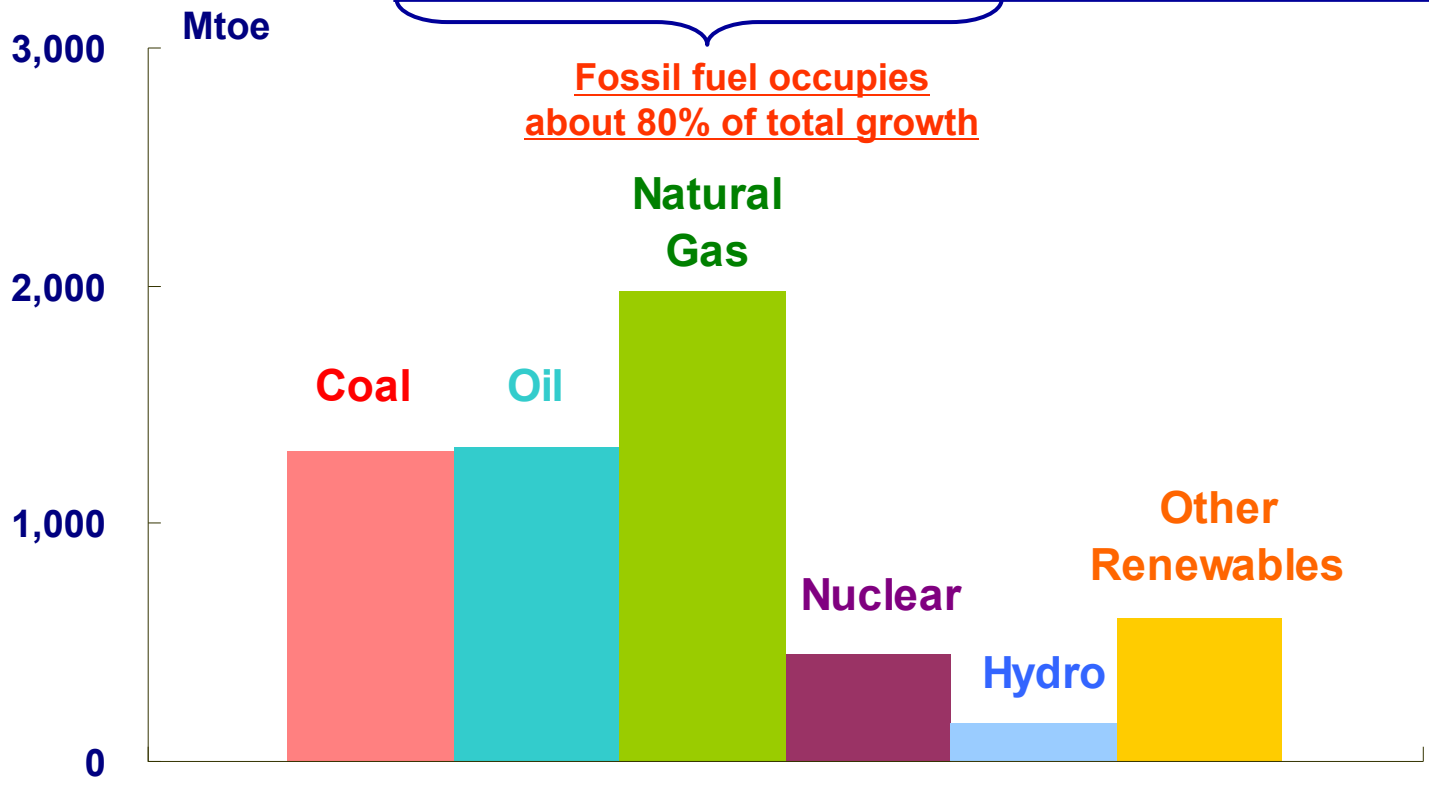


- In Asia, coal remains the largest of primary energy source reflecting on boosting electric power demand by 2035. (Coal share in Asia: 2007: 52%→2035: 43%)
- Nuclear share in Asia gradually expands with active building-up of nuclear power plants in China, India, Japan and South Korea.

Increase in Primary Energy Demand by Fuel ; World

Increase in 2007-2035

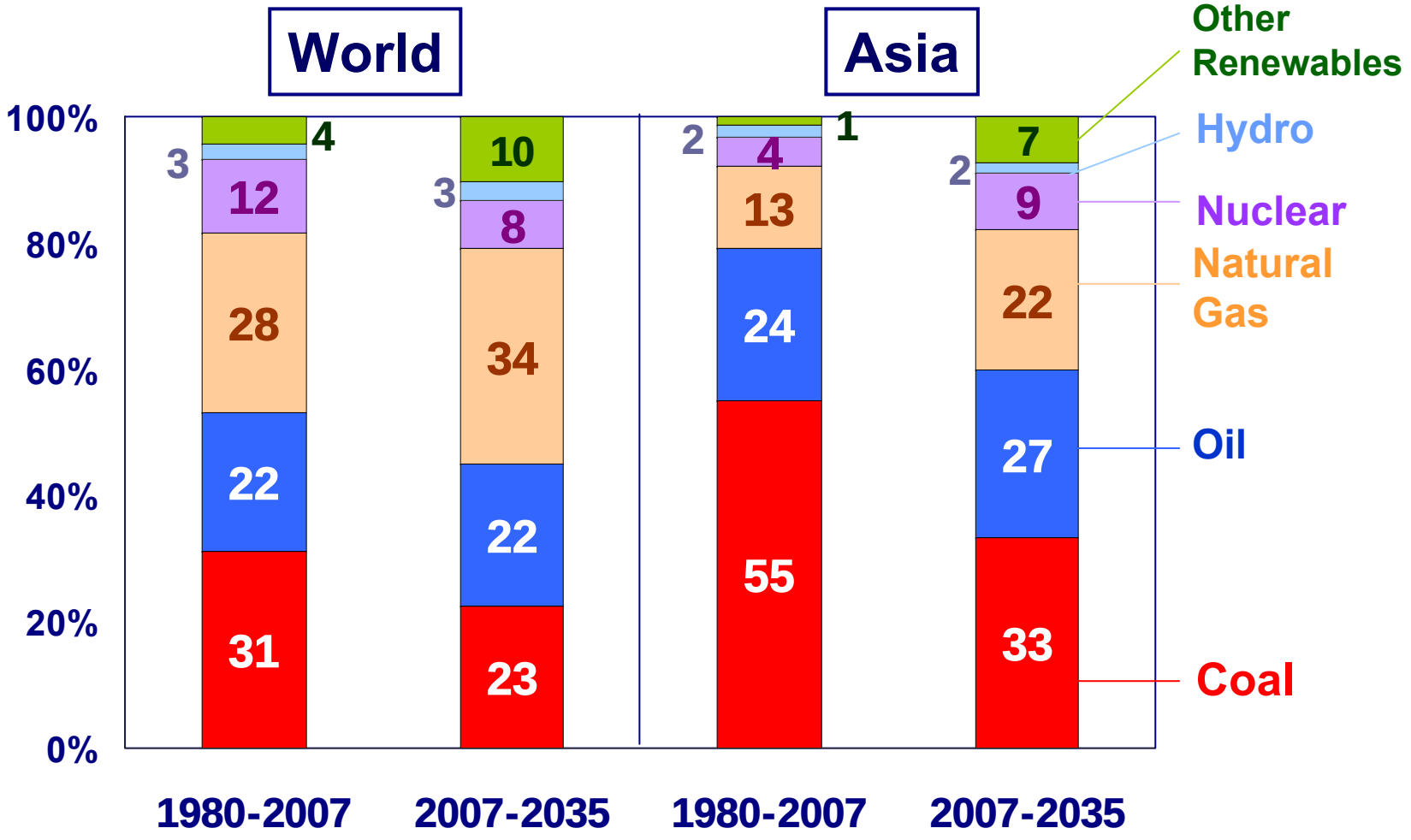
Coal	Oil	Gas	Nuclear	Hydro	Other Renewables
23 %	**22 %**	**34 %**	**8 %**	**3 %**	**10 %**



Increase from 2007 to 2035

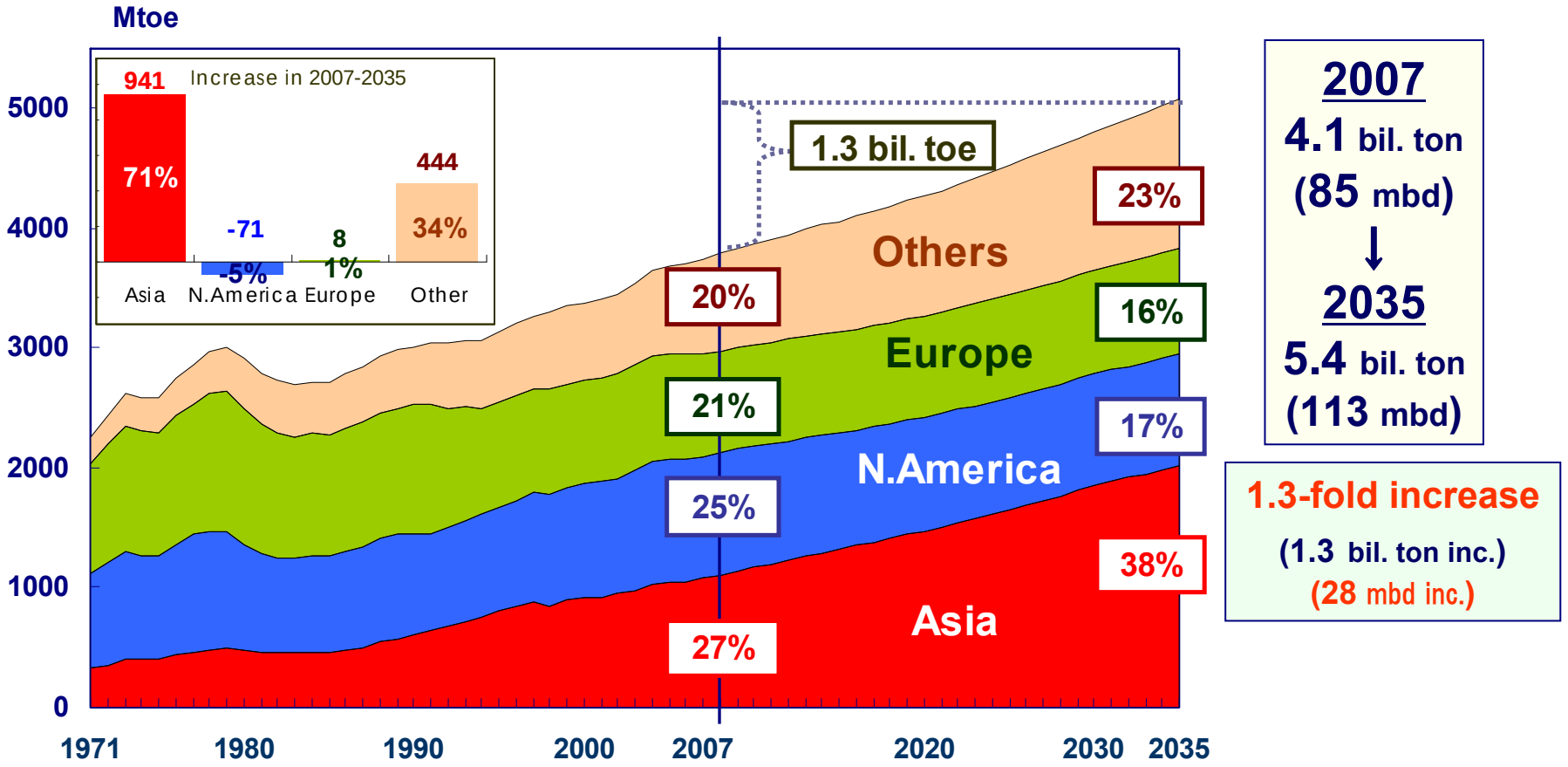
- 79% of global energy growth by 2035 will be concentrated on fossil fuels
- Fossil fuel demand growth to 2035 in Non-OECD will be responsible for about 90% of global fossil demand increasing.

Share of Increase in Primary Energy Demand by Fuel, World and Asia , 2007-2035



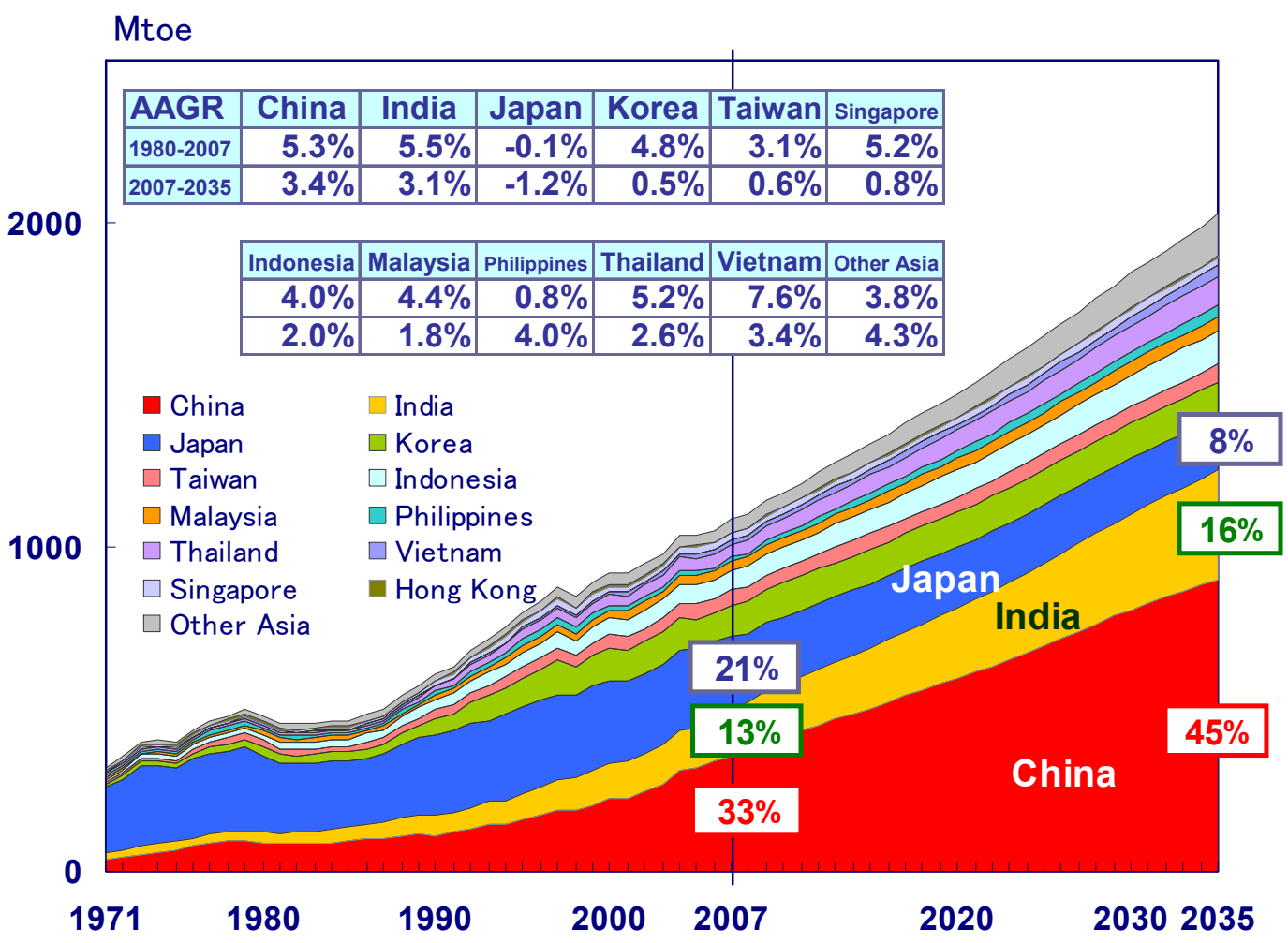
- Almost 80% of energy demand increase will be attributable to fossil fuels both in world and Asia.
- In Asia, coal will account for more than 30% of its energy demand increase to 2035 and play a central role in terms of energy supply.

Oil Demand by Region (World)



- More than 70% of global oil increase will be derived from Asia; The share of Asia in terms of global oil demand will increase from 27% to 38%; Asia will continue to be the centre of oil demand by 2035.
- Oil demand in OECD started to decrease since 2005 and continue to decrease at -0.3% per annum to 2035; Non-OECD will show significant oil demand growth annually at 2.4%.

Oil Demand by Region (Asia)



AAGR	China	India	Japan	Korea	Taiwan	Singapore
1980-2007	5.3%	5.5%	-0.1%	4.8%	3.1%	5.2%
2007-2035	3.4%	3.1%	-1.2%	0.5%	0.6%	0.8%

Indonesia	Malaysia	Philippines	Thailand	Vietnam	Other Asia
4.0%	4.4%	0.8%	5.2%	7.6%	3.8%
2.0%	1.8%	4.0%	2.6%	3.4%	4.3%

2007

1.1 billion ton

(23 mbd)

↓

2035

2.0 billion ton

(42 mbd)

1.9-fold increase

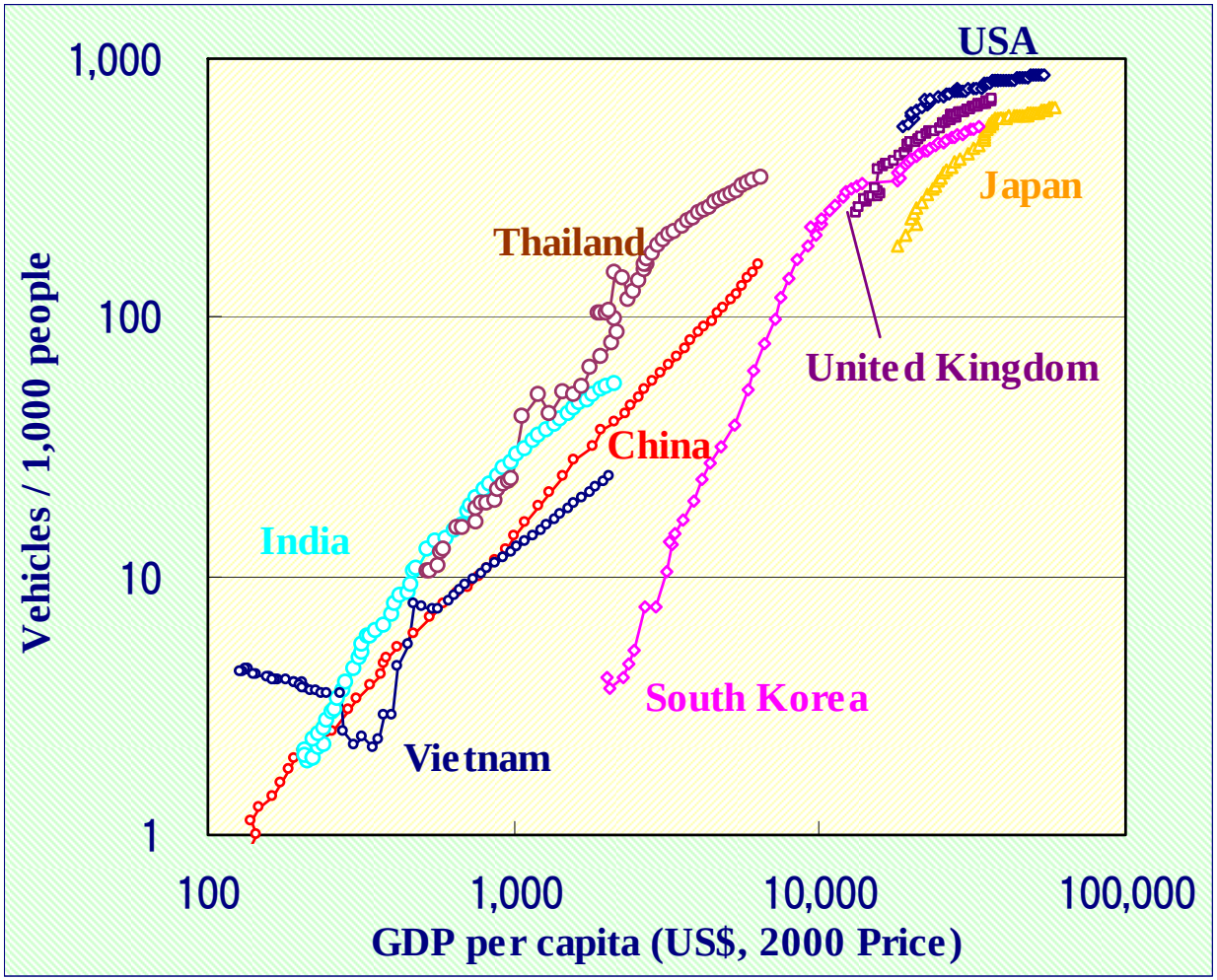
(20 mbd inc.)

	2007	2035
China	7.4 mbd	19.0 mbd
India	2.9 mbd	7.0 mbd
Japan	4.8 mbd	3.4 mbd

Though the continuous improvement of fuel efficiency of automobile and deployment of advanced vehicle is expected, oil demand in China will boost from 7.4 million B/D in 2007 to 19.0 million B/D in 2035, due mainly to its escalating vehicle possession. The share of China and India together in Asian oil demand will grow from 46% to 61%

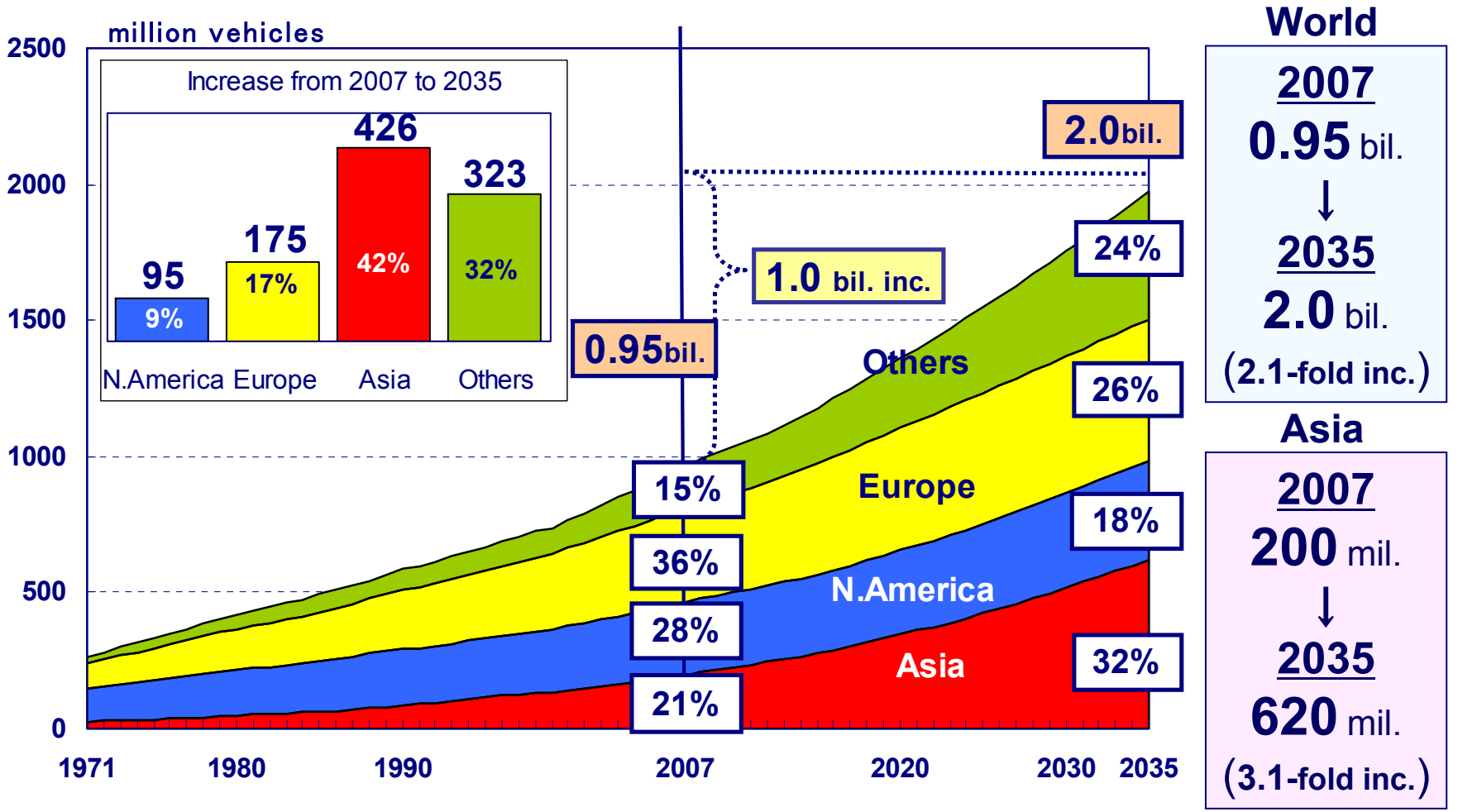
Vehicle Intensity (Selected Countries)

* Including actual data and forecast results, 1971-2035



In China and India, the automobile holding rate will increase steadily with growing income.

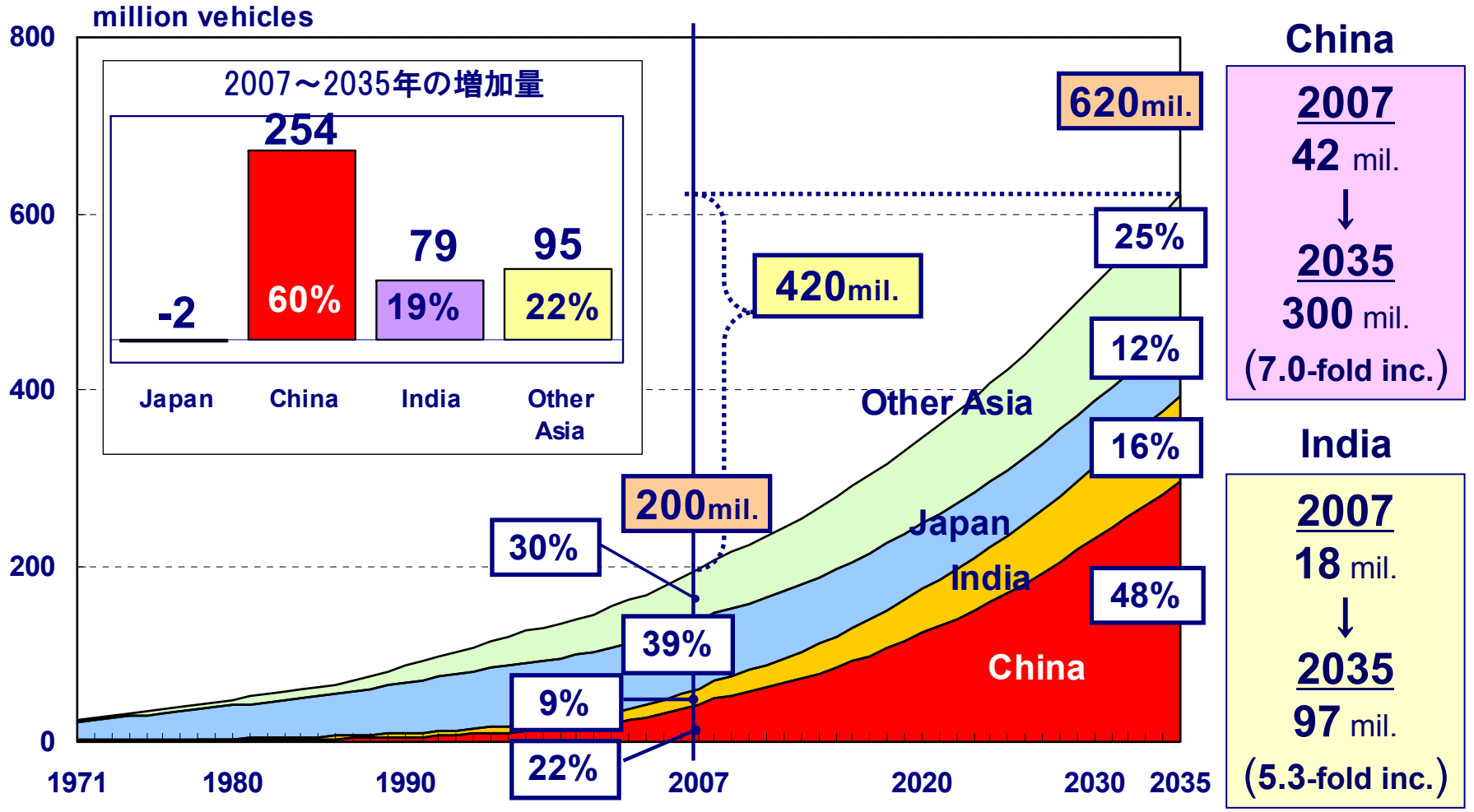
Number of Vehicles (World)



■Approximately 40% of global automobile increase concentrates on Asia, with vehicle number increase in developed countries showing saturation trend.

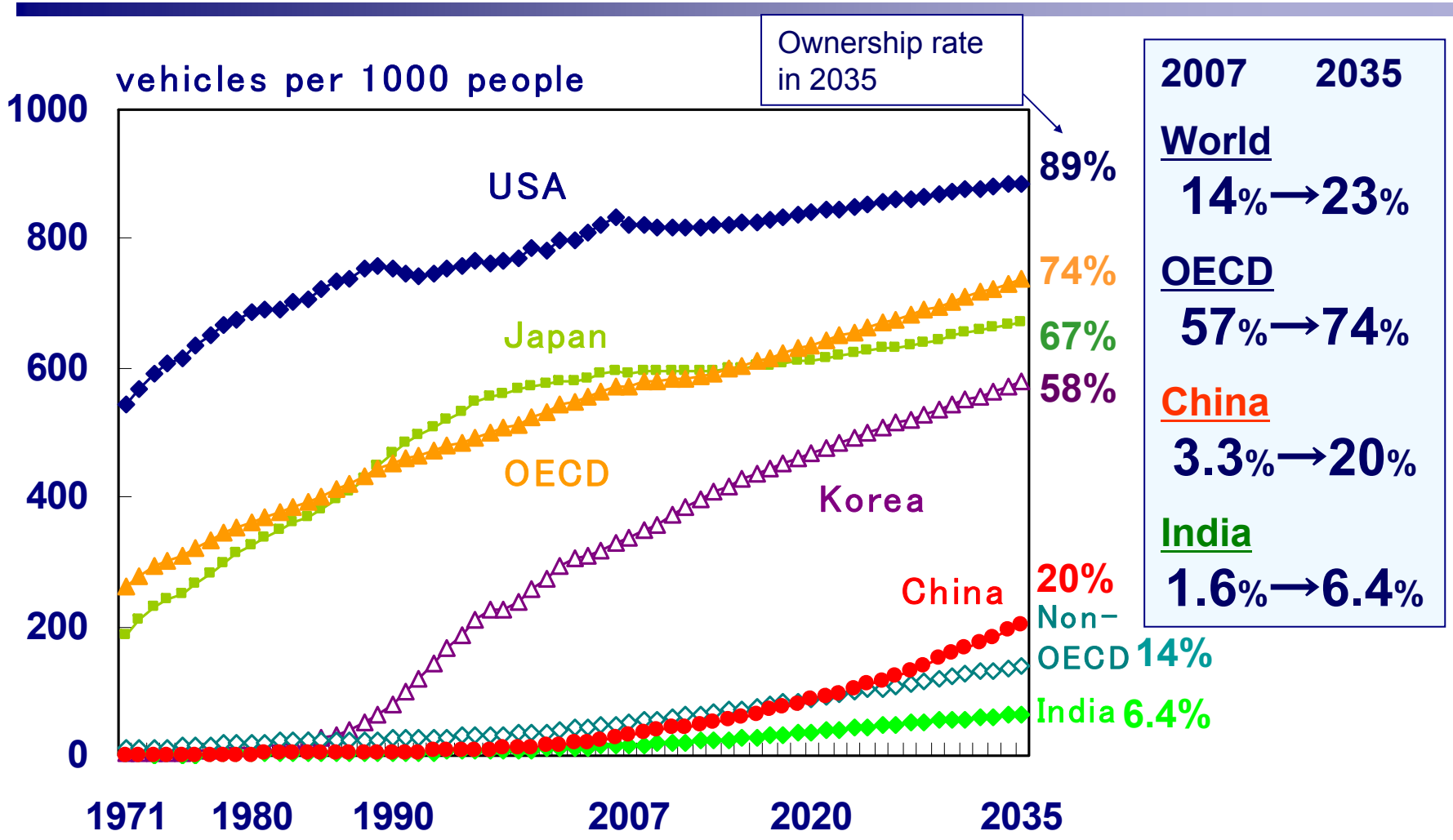
■The share of automobile ownership (stock) in OECD will decline from 71% in 2007 to 49% in 2035; Non-OECD will increase from 29% to 51%. The stock in Non-OECD will outstrip OECD by 2035.

Number of Vehicles (Asia)



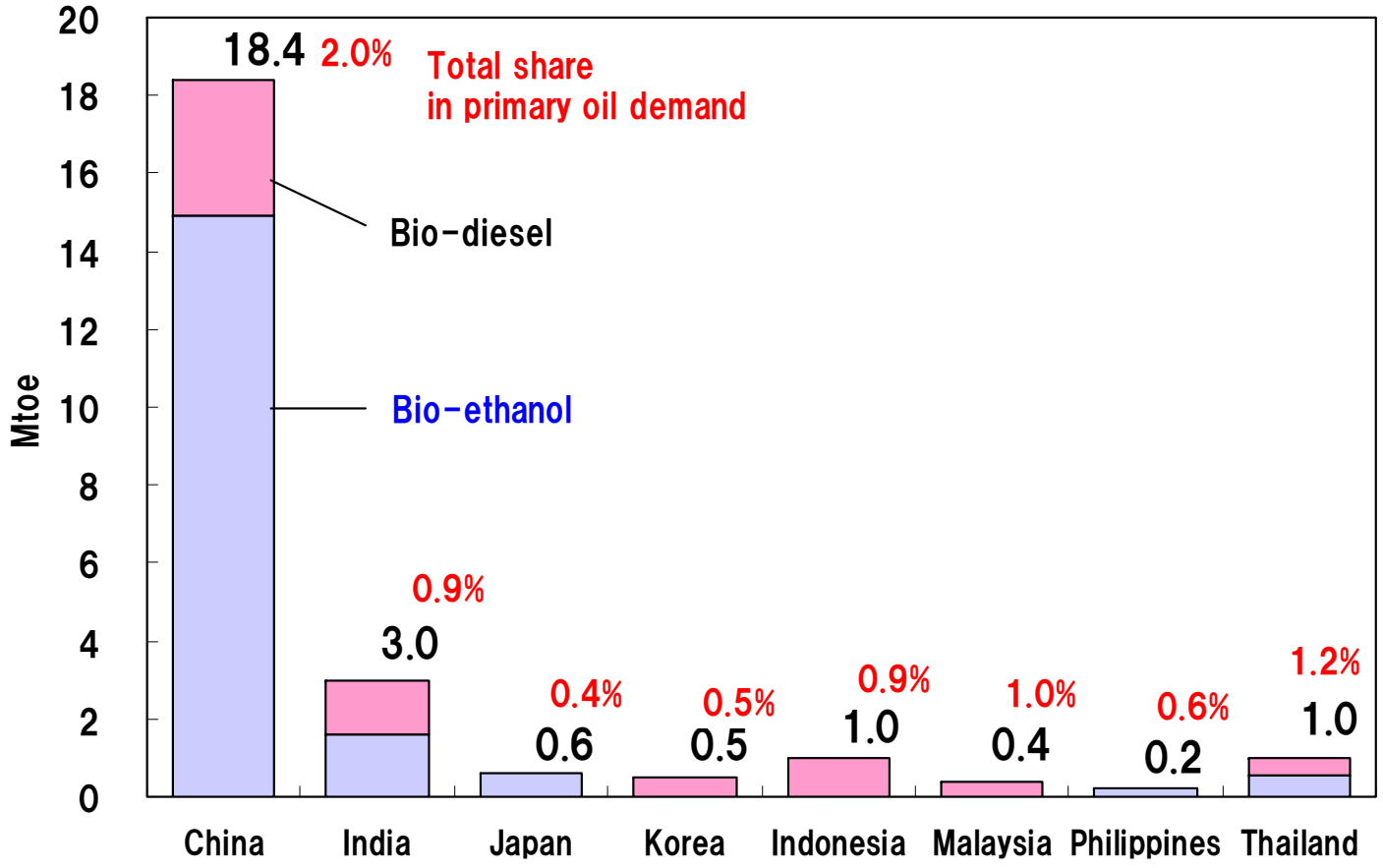
Considerable growth of vehicles is expected in China and India. In Japan, it grows only slightly.

Vehicle Ownership Rate



- Vehicle ownership rate will make progress mainly in Asian nations, the majority of which achieve high economic growth during 2007-2035.
- Although the number of vehicles is projected to expand vigorously in China and India, the vehicle ownership rates will still remain well below developed countries; As a result, these countries have a large potential to grow still after 2035.

Biofuel Outlook in Asia and World (2035)



World

2007
37 mil. toe
↓
2035
160 mil. toe
(**4.4**-fold inc.)

Asia

2007
2 mil. toe
↓
2035年
25 mil. toe
(**13**-fold inc.)

- Bio-fuel in the world is expected to grow to 160 million toe by 2035 mainly in North America, Europe and Latin America. 25 million toe will be introduced by 2035 in Asia.
- The share of bio-fuel in global liquid fuel in 2035 will amount to 3%.
- In Asia, bio-ethanol will be introduced in China, India and Japan and other countries, while biodiesel will be introduced in Korea ,Indonesia, Malaysia etc.

Oil Production Outlook

mbd	2007	2020	2030	2035	2007-2035
OPEC	34	46	56	62	28
Middle East OPEC	23	32	39	43	20
Other OPEC	11	15	17	19	8.0
Non-OPEC	47	48	51	53	5.6
N.America	9.9	11	11	11	1.4
L.America	7.2	7.2	8.9	10	2.7
Europe(inc. Russia)	18	18	20	20	2.2
Middle East	1.5	1.3	1.2	1.2	▲ 0.3
Africa	2.4	2.5	2.7	2.8	0.4
Asia	7.4	7.4	7.0	6.7	▲ 0.6
China	3.9	4.2	3.8	3.7	▲ 0.2
Malaysia	0.7	0.7	0.7	0.7	0.0
Thailand	0.3	0.1	0.1	0.1	▲ 0.2
Vietnam	0.4	0.3	0.3	0.3	▲ 0.1
India	0.9	1.0	1.0	1.0	0.1
World	81	94	107	114	33

OPEC

2007
34 mbd
↓
2035
55 mbd
(21 mbd inc.)

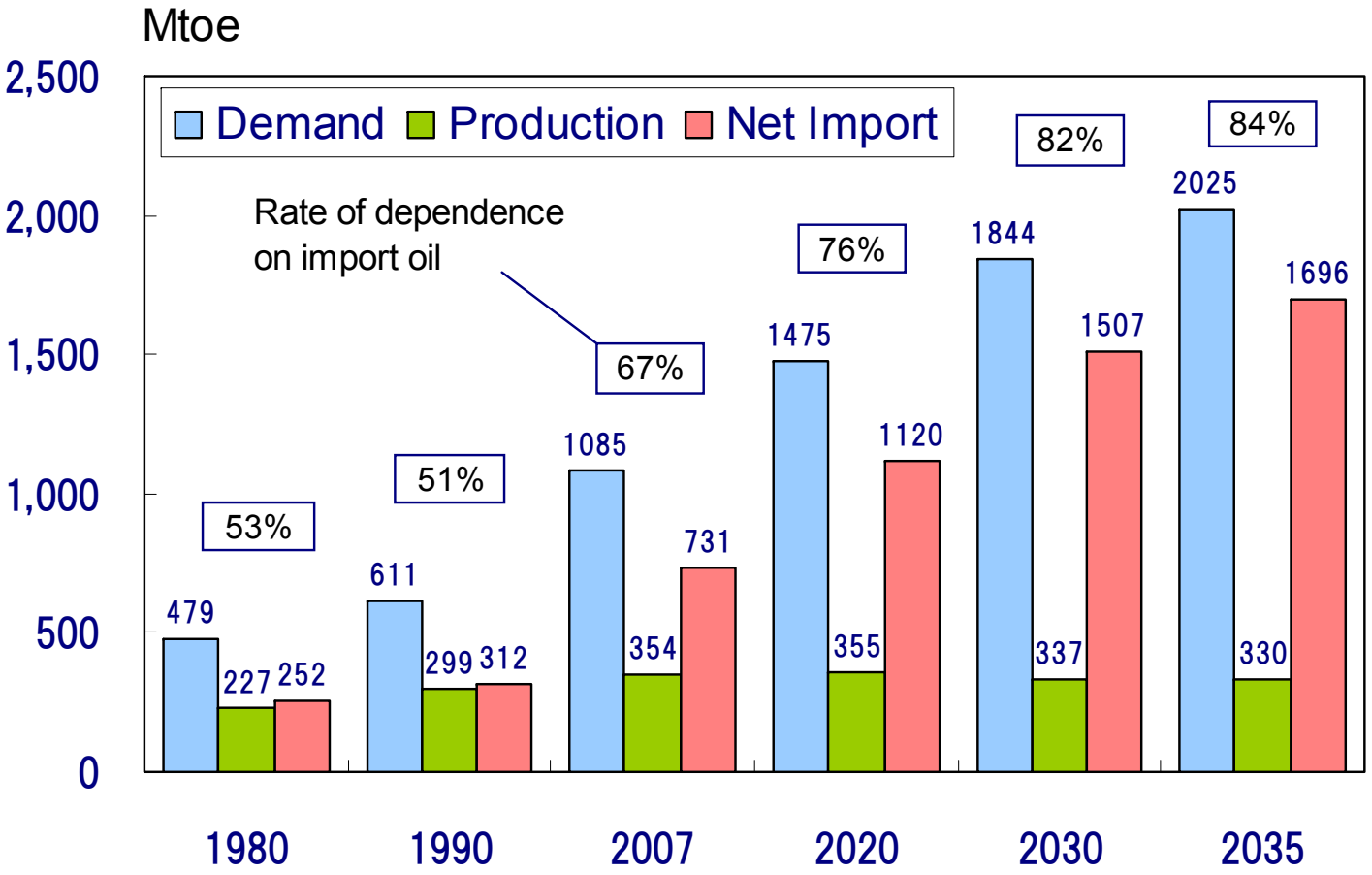
Non-OPEC

2007
47 mbd
↓
2035
58 mbd
(11 mbd inc.)

Share in world oil production growth from 2006-2030
OPEC 67% (21mbd)
Non-OPEC 33% (11mbd)

- In Asian regions, oil production is projected to be flat.
- Approximately 70% of world oil production increase will be dominated by OPEC; OPEC share in the world oil production is likely to expand to 49% by 2035.
- In leading oil production countries such as Middle East OPEC, oil exploration and development are constrained for the international oil company due to legal restriction of participation for IOC to the domestic oil development and more serious socio-economic situation in the Middle East. Unless the adequate upstream investment is not channeled into global oil production, international oil market will become tightened for the future.

Oil Demand and Supply in Asia

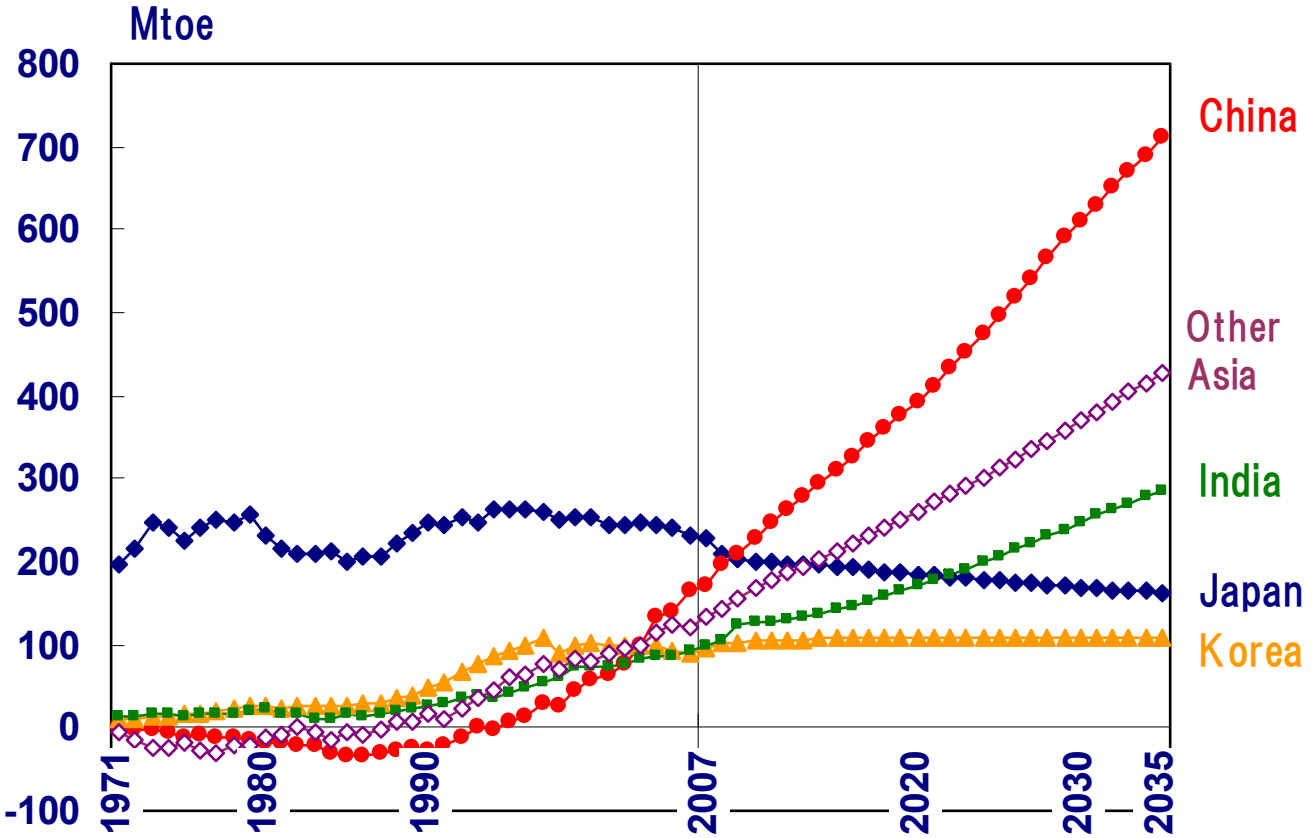


Net Oil Import

2007
15 mbd
↓
2035
35 mbd
(**2.3**-fold inc.)

- Net import in Asia will expand from 15 mb/d (731 Mtoe) to 35 mb/d (1,696 Mtoe) .
- Since oil production in Asia (such as China, India and Indonesia) will exhibit marginal growth, the rate of dependence on imported oil will increase to 84% by 2035.

Net Oil Import in Asia



■ Net oil import in China is likely to grow from 3.6 mbd in 2007 to 14.8 in 2035, nearly 4-fold increase.
■ Net oil import in China will surpass that of Japan around 2010. India will also outstrip Japan by 2020.

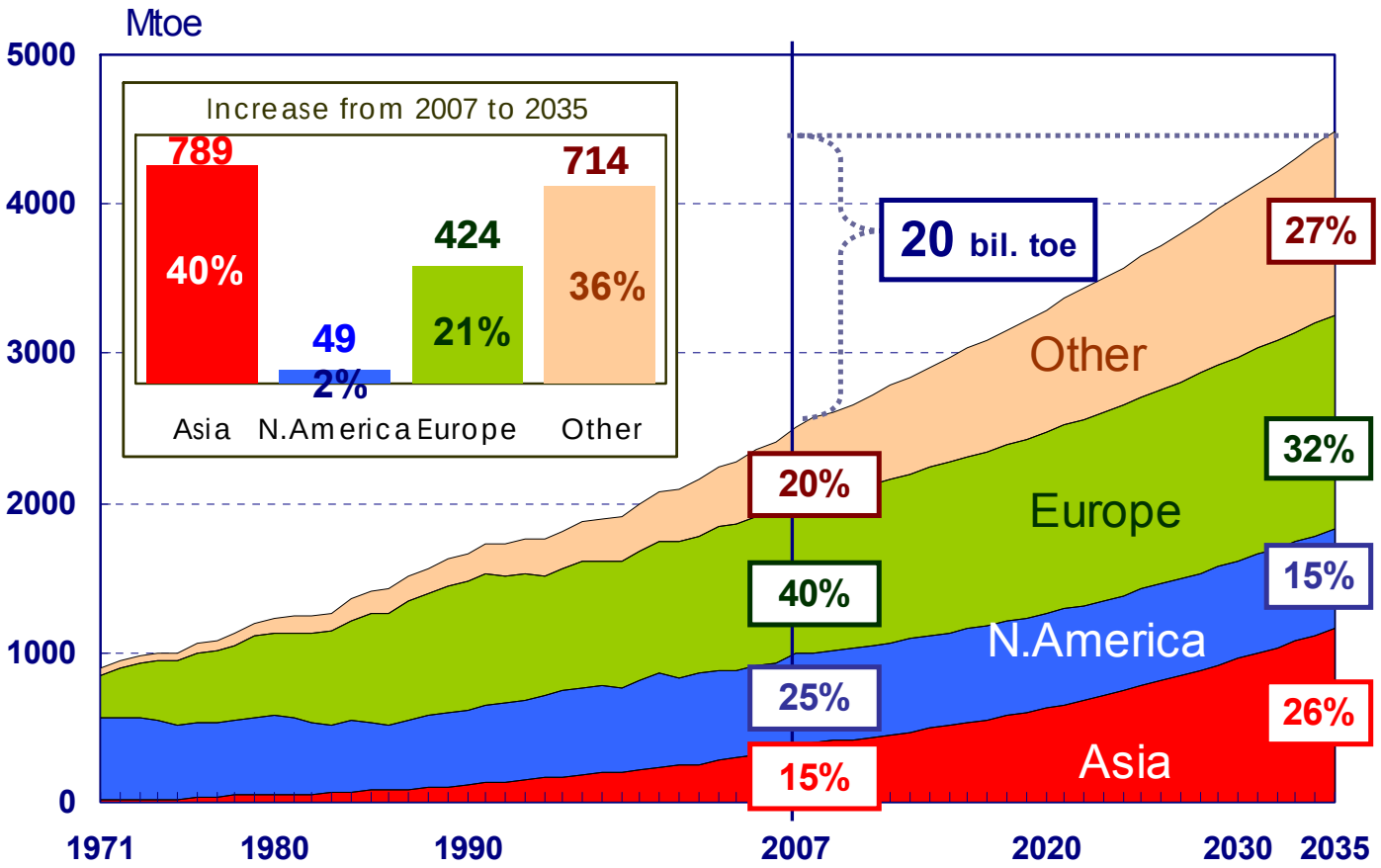
Dependency Rate on Imported Oil in Asia

(Net import、"▲" means net export)

	2007	2020	2030	2035
China	48%	66%	76%	79%
Indonesia	23%	42%	61%	65%
Malaysia	▲ 30%	19%	40%	44%
Thailand	66%	90%	92%	93%
India	69%	78%	84%	86%
Vietnam	28%	50%	65%	72%
Asia	67%	76%	82%	84%

Urbanization, Industrialization and motorization will accelerate oil demand growth in Asia. Combined with limited growth of domestic oil production, net oil import in Asia will substantially expand towards 2035.

Gas Demand by Region (World)



2007
2.5 billion toe
(2.8 trillion m³)
(2.0 bil. tonnes LNG)

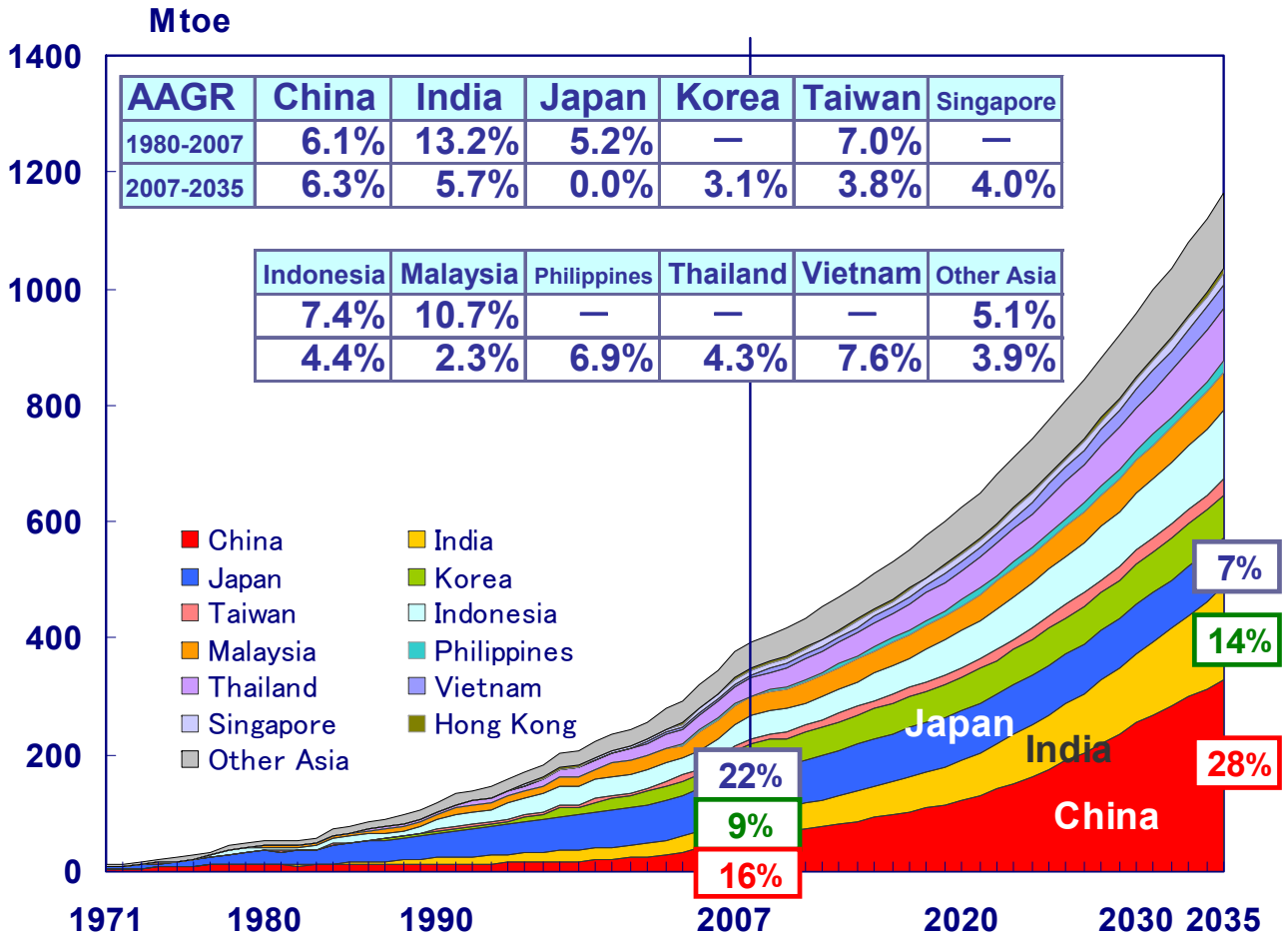
↓

2035
4.5 billion toe
(5 trillion m³)
(3.6 bil. tonnes LNG)

1.8-fold increase
(2.2 tril. m³ inc.)
(1.6 bil. tonnes LNG inc.)

- World gas demand is expected to increase from 2,800 bcm in 2007 to 5,000 bcm in 2035, 1.8-fold increase.
- Of incremental growth in global natural gas from 2007 to 2035, Non-OECD will dominate 83%; World gas demand will grow around Non-OECD countries.

Gas Demand by Region (Asia)



AAGR	China	India	Japan	Korea	Taiwan	Singapore
1980-2007	6.1%	13.2%	5.2%	—	7.0%	—
2007-2035	6.3%	5.7%	0.0%	3.1%	3.8%	4.0%

Indonesia	Malaysia	Philippines	Thailand	Vietnam	Other Asia
7.4%	10.7%	—	—	—	5.1%
4.4%	2.3%	6.9%	4.3%	7.6%	3.9%

2007

0.38 billion toe

(420 billion m³)

(0.31 bil. tonnes LNG)

↓

2035

1.17 billion toe

(1.29 trillion m³)

(0.95 bil. tonnes LNG)

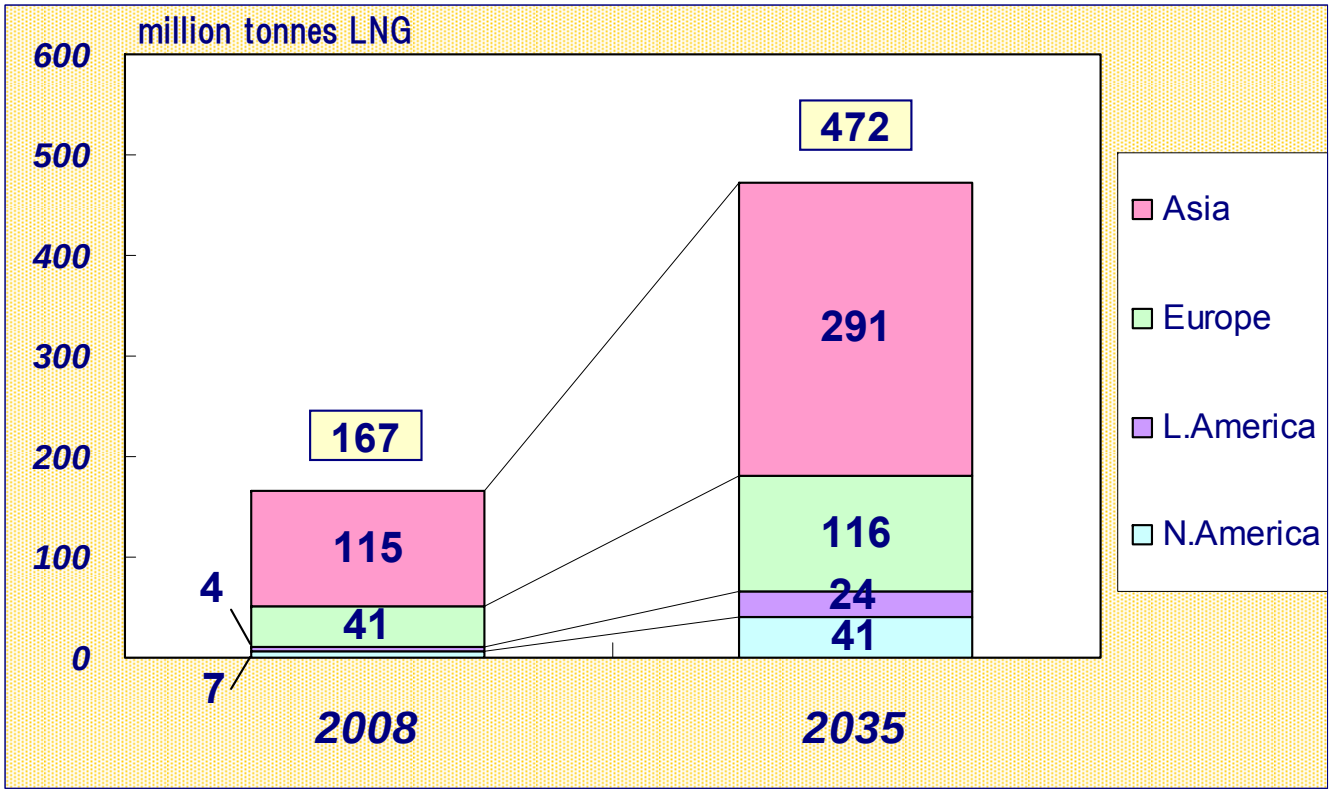
3.1-fold increase

(880 bil. m³ inc.)

(640mil. tonnes LNG inc.)

Gas demand in China will considerably increase mainly due to increasing demand for power generation, municipal gas use and its environmental premium. India also represents approximately 5-fold increase.

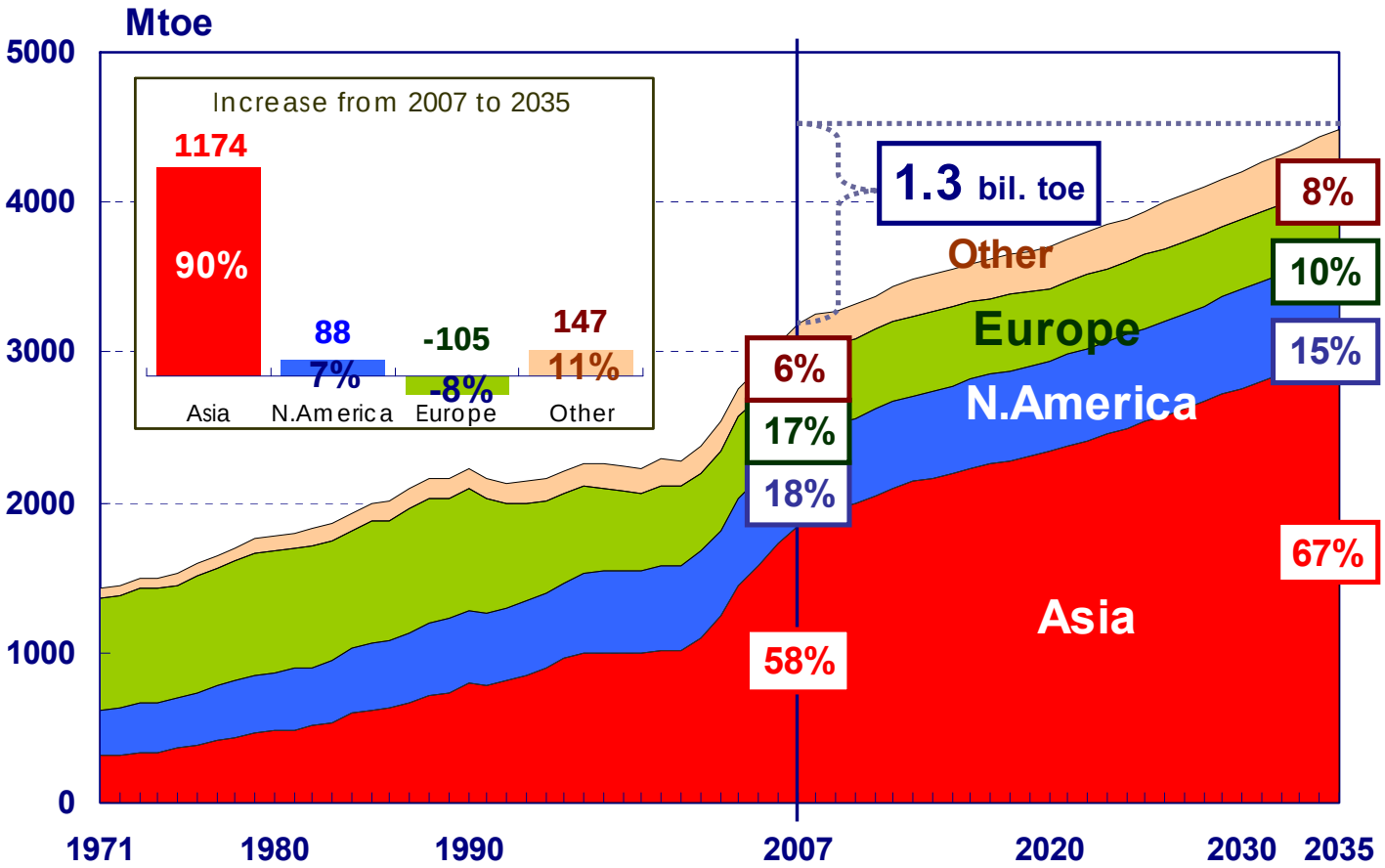
LNG Demand Outlook (World)



■ World LNG demand will expand from 167 million ton in 2008 to 472 million ton in 2035, achieving 2.8-fold growth. LNG demand in Asia-pacific region continues to be dominant throughout 2035.

■ Global LNG demand and supply are forecast to be balanced to 2035. If the development of future LNG project is stagnated, world LNG market will become tightened after 2010; The development of LNG project is major challenge in order to ensure world LNG market.

Coal Demand by Region (World)



2007
3.2 billion toe
(4.6 billion tce)
↓
2035
4.5 billion toe
(6.4 billion tce*)

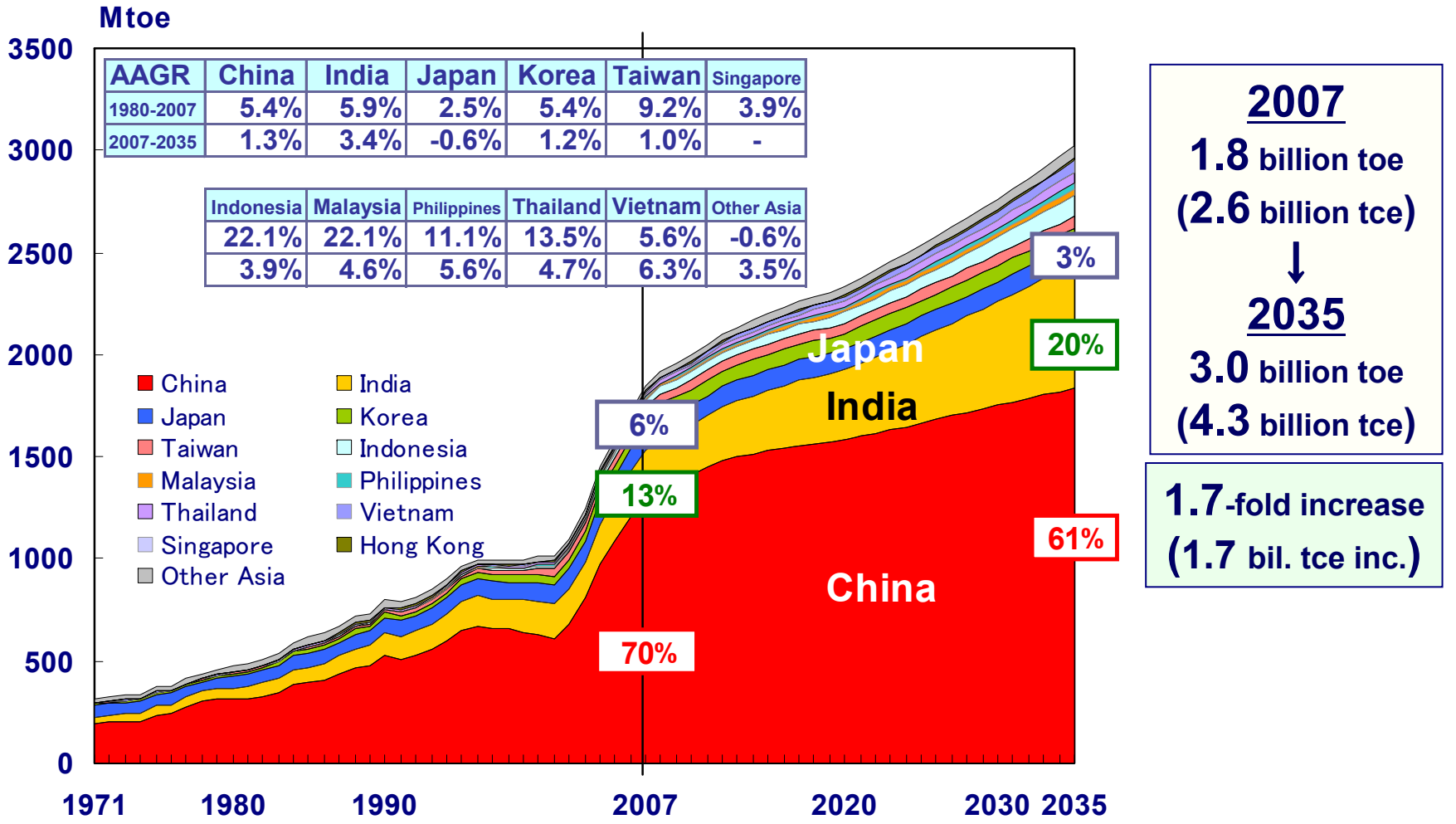
1.4-fold increase
(1.8 billion tce inc.)

*Tons of coal equivalent

■ 90% of global coal demand increase is derived from Asia, and the share of Asia in total coal demand eventually expands to 67%. Non-OECD is responsible for 96% of the increase in world coal demand.

■ 35% of the increase in global CO2 emissions from 2007 to 2035 is from coal combustion in Asian region; In order to address global warming problem, environmentally compatible coal use is quite important agenda in Asia.

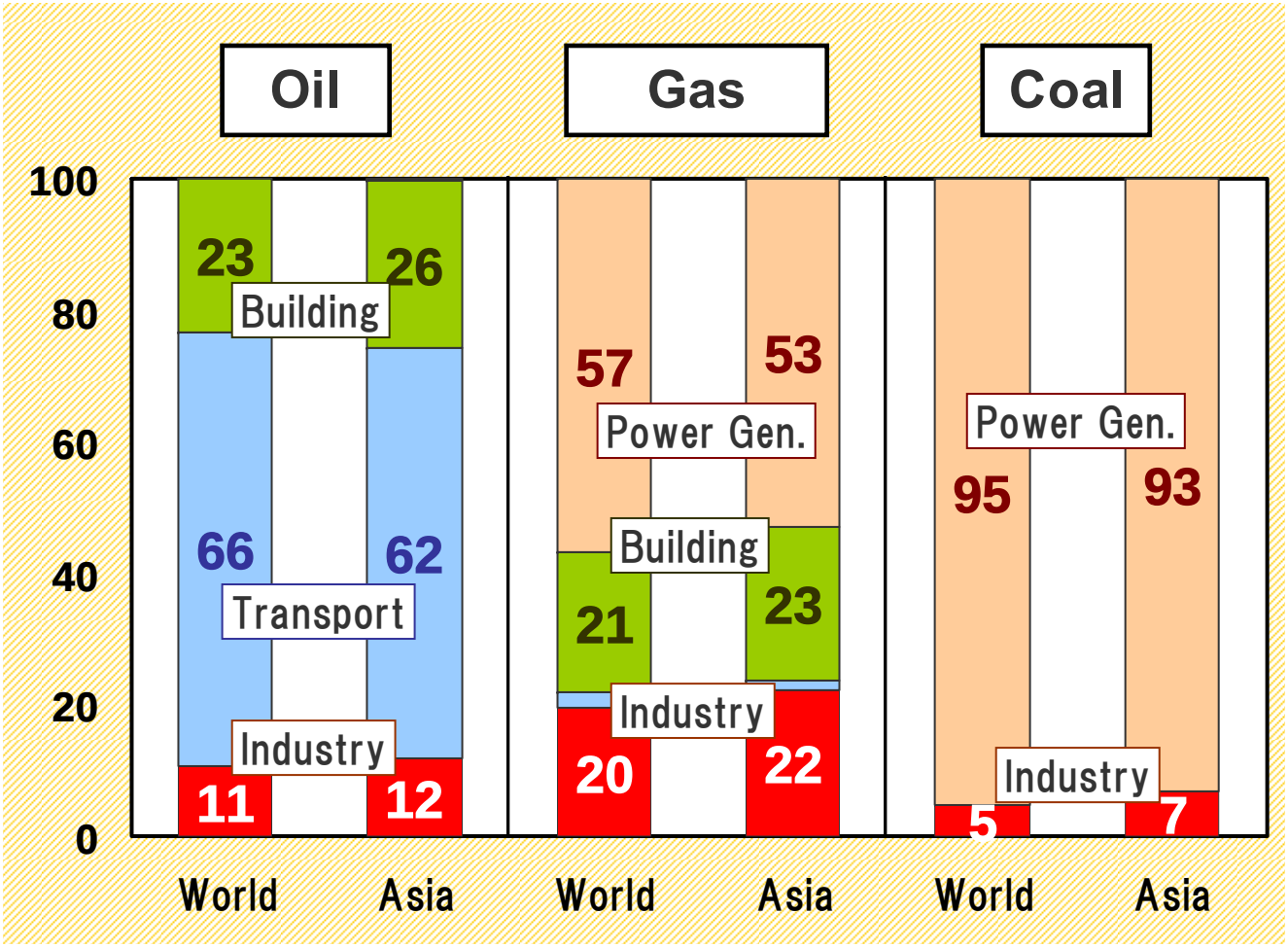
Coal Demand by Region (Asia)



Coal will be consumed in the power sector in order to meet growing electricity requirements, particularly in China and India, both of which have abundant availability of domestic reserves

Increase in Fossil Fuel Demand by Sector

【Increase by sector,2007-2035】



Majority of oil will be used for transportation,
while gas and coal will be consumed mainly for power generation.

Electricity Demand (Asia)

2007-2035 AAGR(%)	Electricity demand	Total Final Energy Demand
China	3.2	2.7
India	5.7	3.9
Korea	1.5	1.5
Indonesia	5.6	3.3
Malaysia	4.6	2.5
Thailand	4.4	3.4
Philippines	5.4	4.6
Asia (exc. Japan)	3.7	2.9
Japan	0.7	-0.3
OECD	1.2	0.4
Non-OECD	3.4	2.6
World	2.3	1.6

Asia

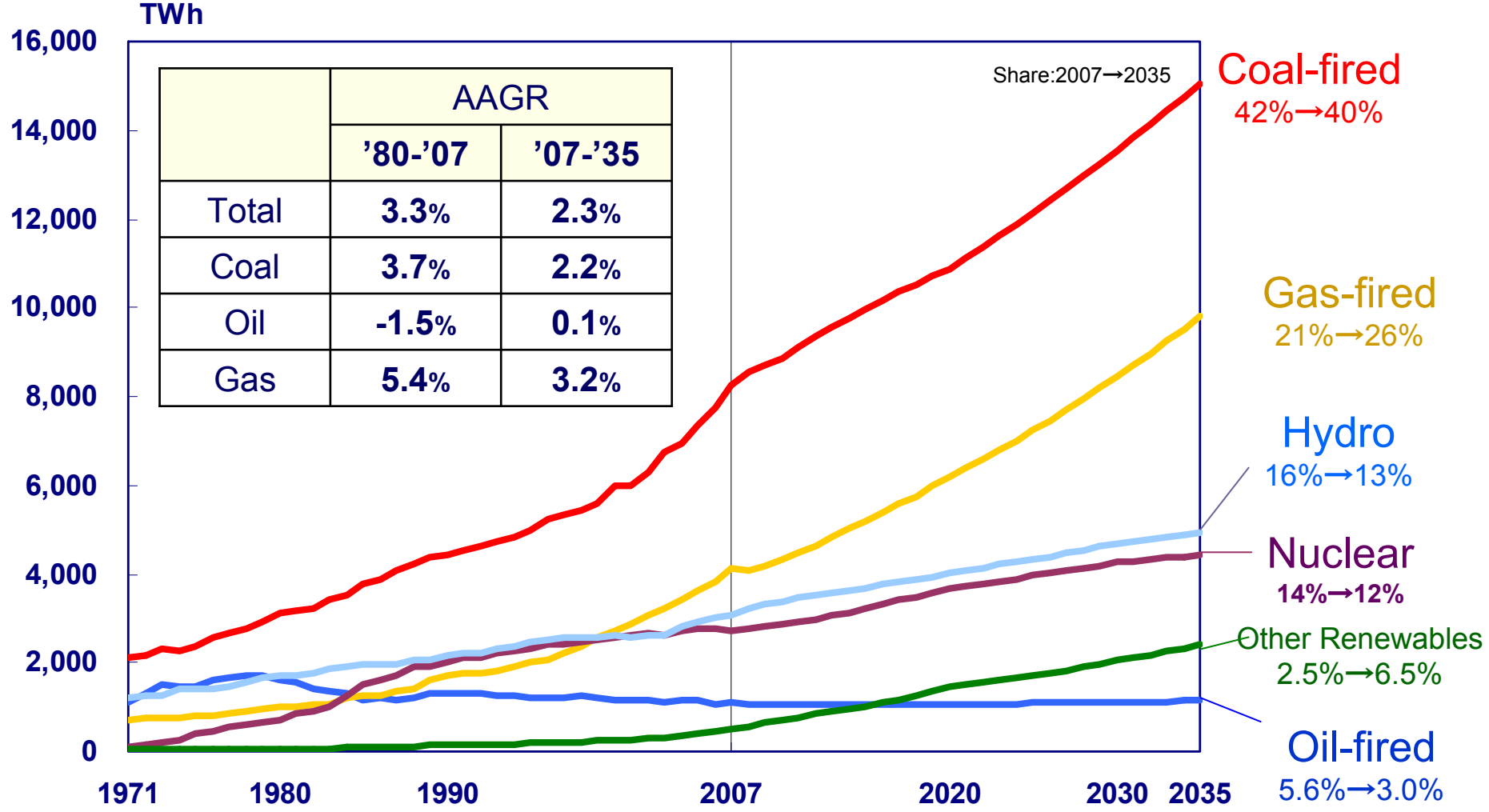
2007
6,700TWh
↓
2035
16,500TWh
(**2.5**-fold inc.)

China / India

2007
3,300TWh **800**TWh
↓
2035
7,700TWh **3,500**TWh
(**2.3**-fold inc.) (**4.4**-fold inc.)

■ Electricity demand in Asia will increase rapidly by sophistication of energy utilization driven by the improvement of life style.

Power Generation Mix by Fuel (World)



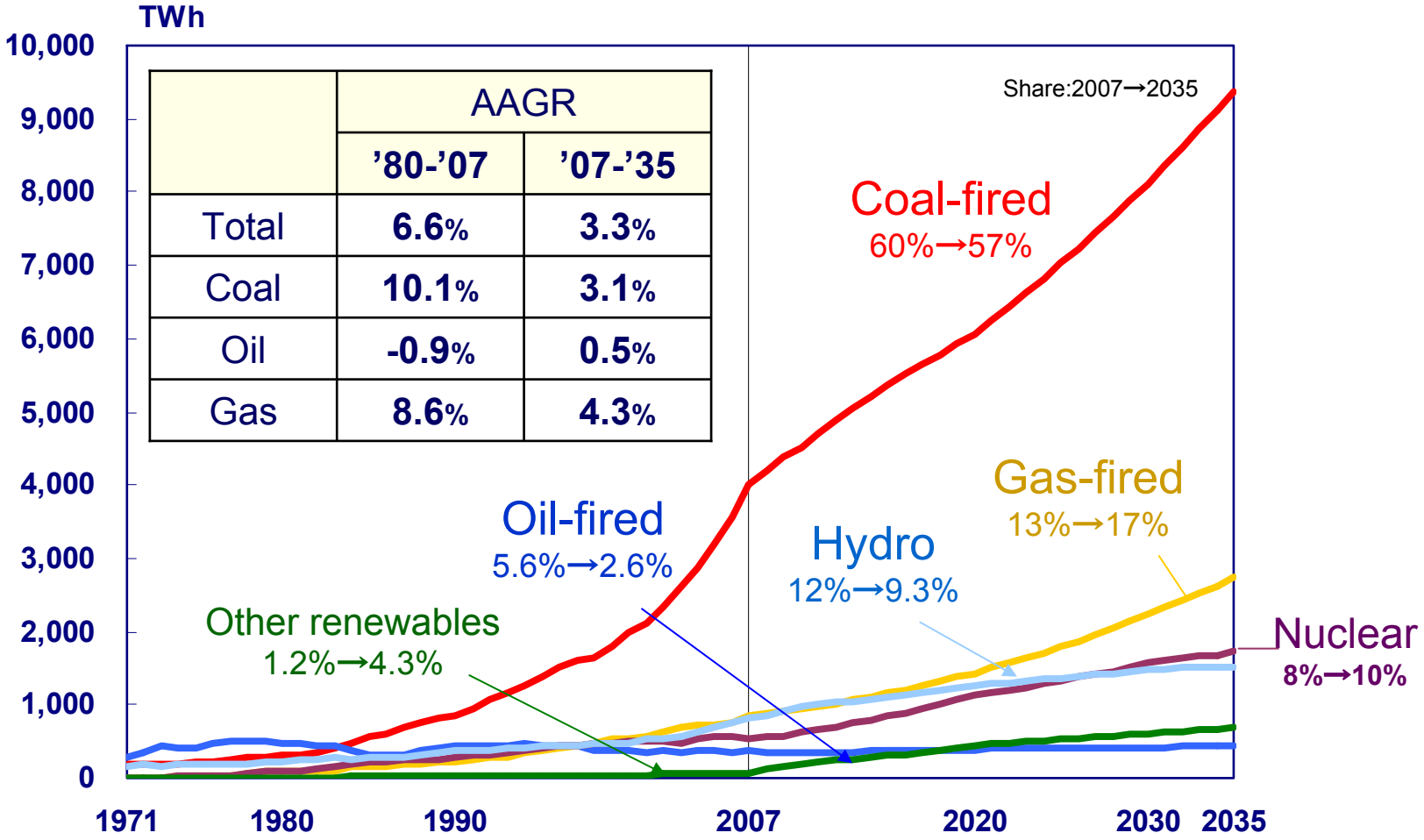
	AAGR	
	'80-'07	'07-'35
Total	3.3%	2.3%
Coal	3.7%	2.2%
Oil	-1.5%	0.1%
Gas	5.4%	3.2%

■Coal-fired power generation still remains dominant power supply option by 2035. Natural gas-fired power generation is projected to increase significantly worldwide at the highest rate among fossil fuels.

■Renewables excluding hydro will expand its share in power generation mix to 6.5% by 2035 from 2.5% in 2007.

■The CO2 emissions from coal-fired power generation currently dominates about 30% of global CO2 emissions. CO2 emissions from coal-fired generation will increase from 8.2 Gt-CO2 in 2007 to 12.6 Gt-CO2 in 2035. Clean coal technology (CCT) is expected to play an important role in addressing GHG issues.

Power Generation Mix by Fuel (Asia)

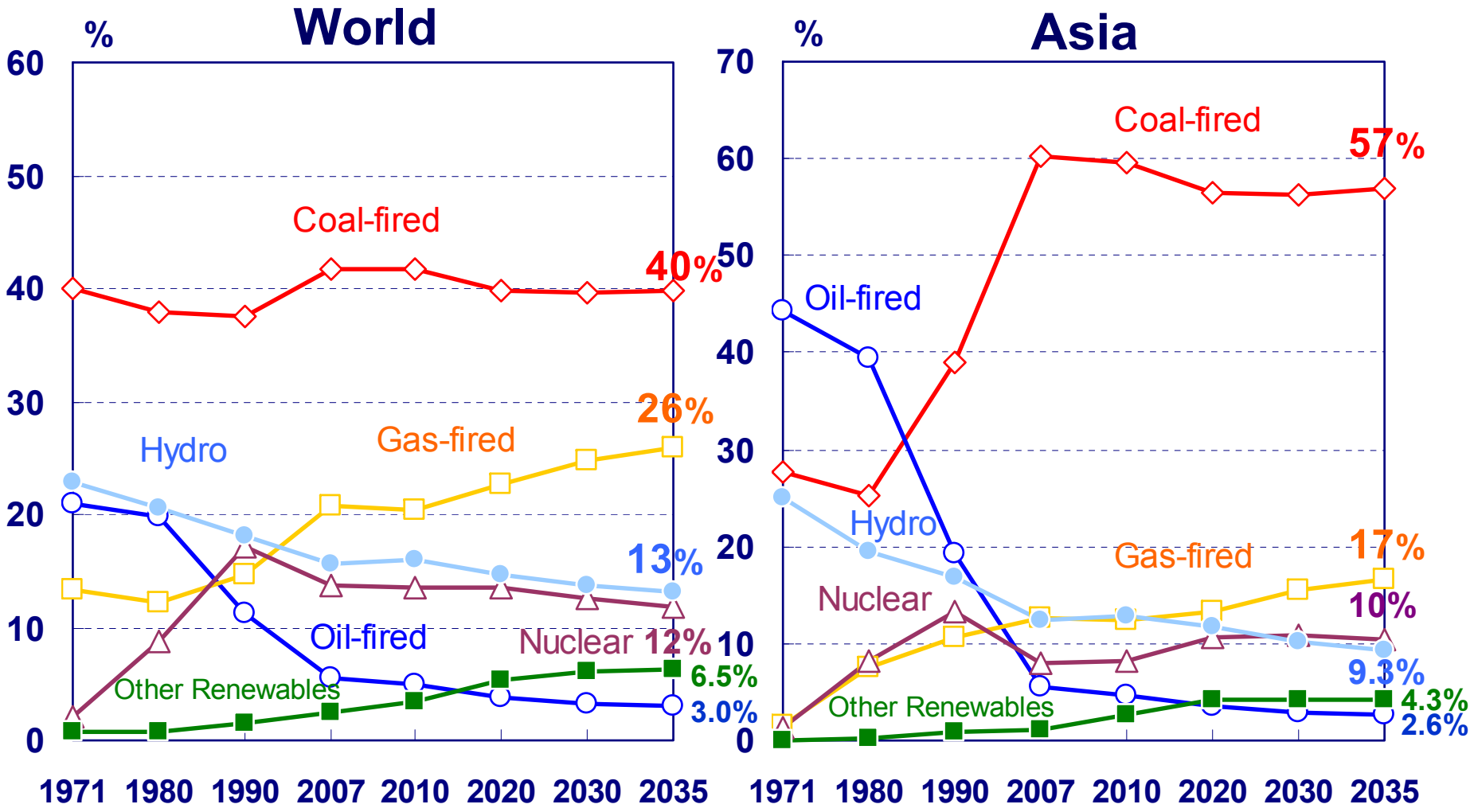


	AAGR	
	'80-'07	'07-'35
Total	6.6%	3.3%
Coal	10.1%	3.1%
Oil	-0.9%	0.5%
Gas	8.6%	4.3%

■The share of coal use in Asia will remain larger than 50%, reflecting abundant resources and the economic advantages. Gas will show a growing trend, the share of which eventually expands to 17% by 2035.The share of nuclear power generation will increase from 8% to 10%; Nuclear plays a important roll in power generation mix.

■The CO2 emissions from coal-fired power generation currently dominates about 30% of global CO2 emissions. CO2 emissions from coal-fired generation in Asia will expand by 3.8 Gt-CO2 from 4.1 Gt-CO2 in 2007 to 7.9 Gt-CO2 in 2035, this growth being about 30% of global CO2 emissions increase. Clean coal technology (CCT) is expected to play an important role in addressing GHG issues.

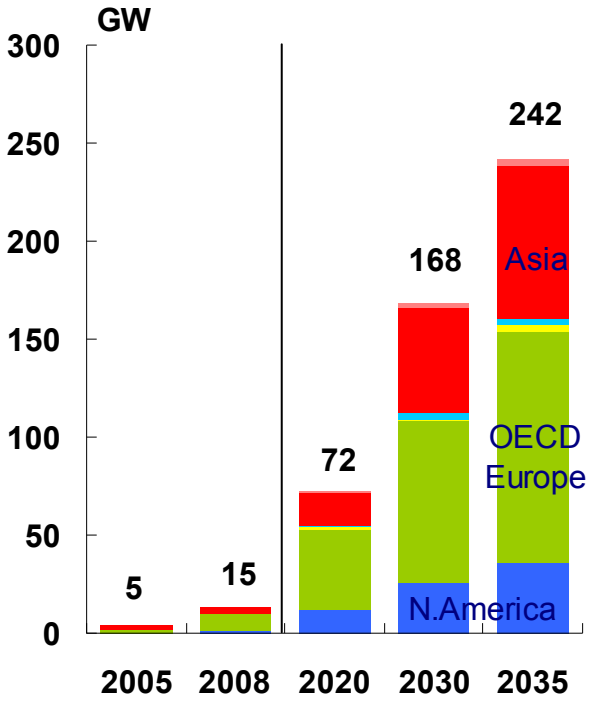
Power Generation Mix by Fuel (World and Asia)



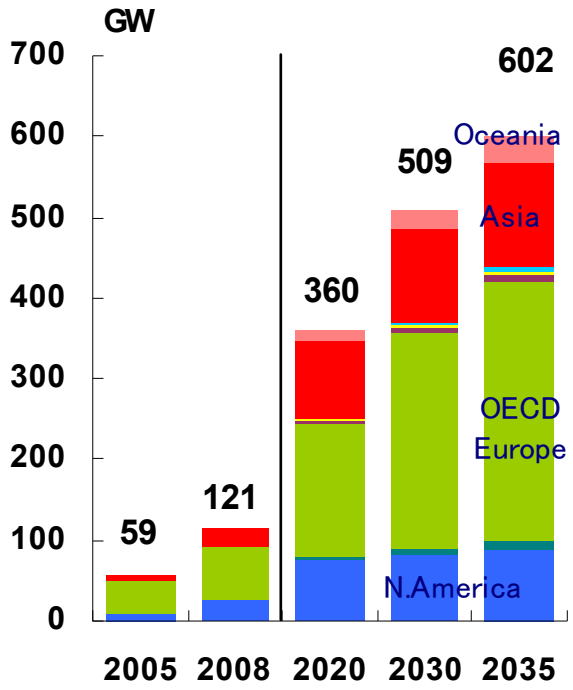
Coal-fired power plant is indispensable power supply option in both world and Asia with its economic advantages and the stable availability of its input fuel.

Photovoltaic、Wind Power (World)

Photovoltaic (PV)



Wind Power



Photovoltaic (PV)

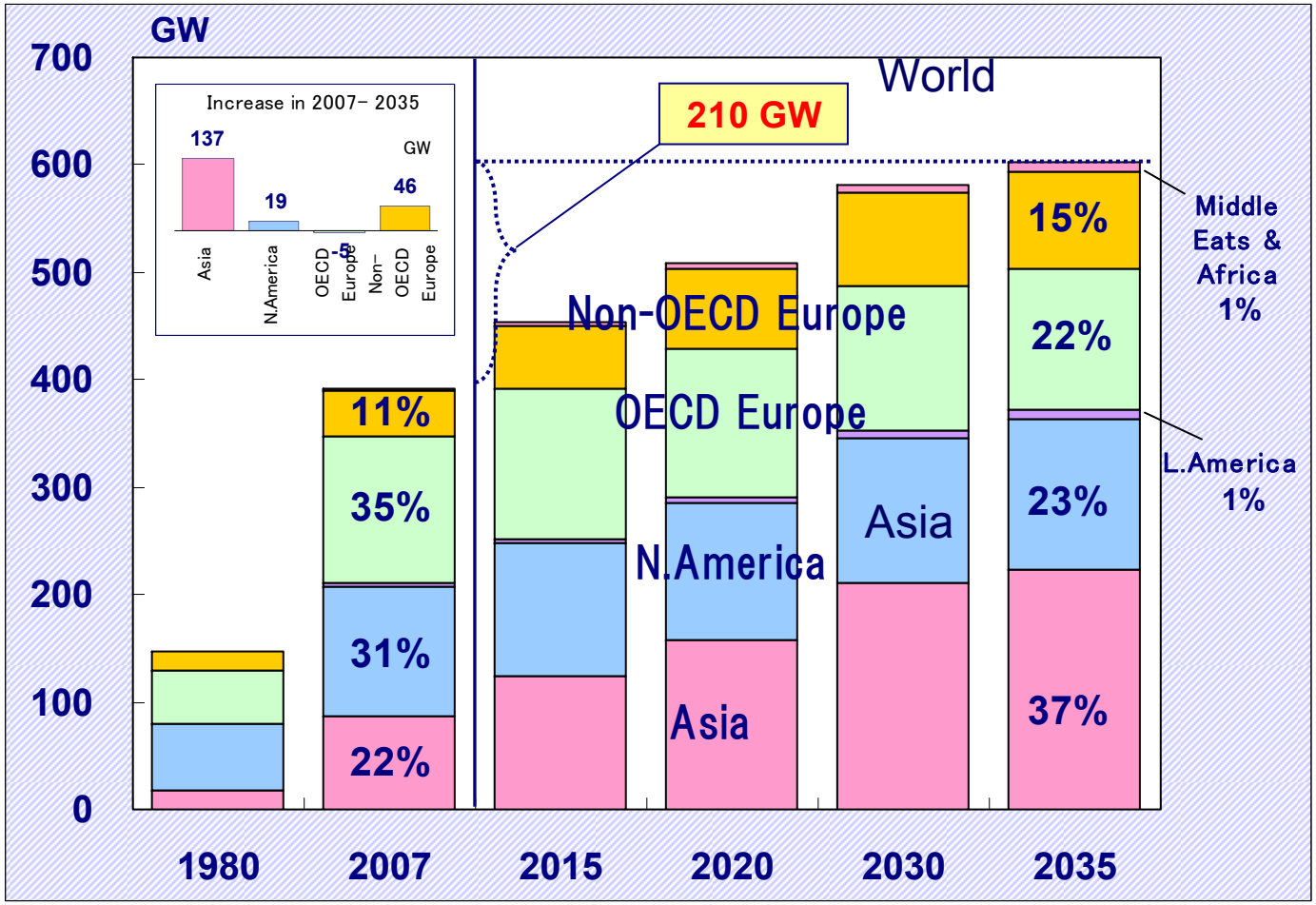
World	Asia
2008 15 GW ↓ 2035 242 GW (16-fold inc.)	2008 3 GW ↓ 2035 80 GW (29-fold inc.)

Wind Power

World	Asia
2008 121 GW ↓ 2035 602 GW (5-fold inc.)	2008 24 GW ↓ 2035 127 GW (5-fold inc.)

- Renewables are expected to expand due to technological advancement and supportive political measures such as FIT and subsidization.
- World PV capacity is likely to grow to 242GW by 2035 and world wind power capacity will boost to 602 GW.
- The share of power generation from wind and PV together in total global power generation will grow from 0.9% in 2007 to 3.6% in 2035.

Nuclear Power Generation Capacity (World)



World

2007
392 GW
↓
2035
602 GW
(**210**GW increase)

Asia

2005
86 GW
↓
2030
224 GW
(**137**GW increase)

■ Nuclear capacity is projected to grow from 392GW in 2007 to 602GW in 2035 (210 GW growth).

■ The largest increase in the nuclear capacity is expected in Asia (137GW growth). Asian countries will develop nuclear energy most actively and channel the largest investment into nuclear power requirement.

Nuclear Power Capacity in Asia

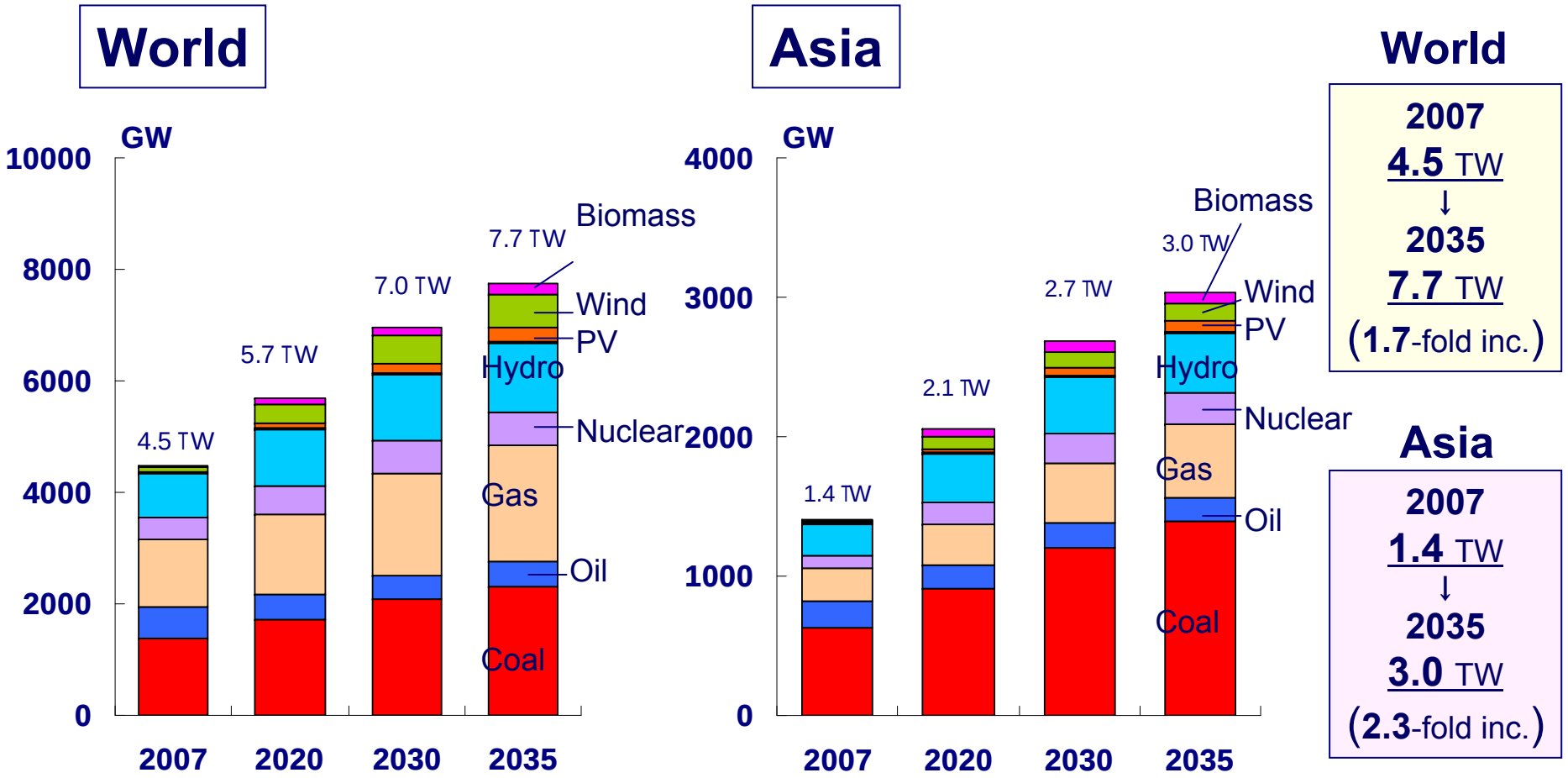
(GW)

	2007	2020	2035
China	9	41	81
Japan	50	60	63
Taiwan	5	8	6
Korea	18	27	31
ASEAN	0	0	5
India	4	20	36
Asia	86	157	224

■Currently in Asia, India, Pakistan, China, Korea and Japan install nuclear power plant. Vietnam, Indonesia and Thailand are considering to newly build nuclear power plant.

■The share of nuclear power in total power generation mix in 2035 is 7% in China and 7% in India.

Power Generation Capacity (World and Asia)



World

2007
4.5 TW
↓
2035
7.7 TW
(**1.7**-fold inc.)

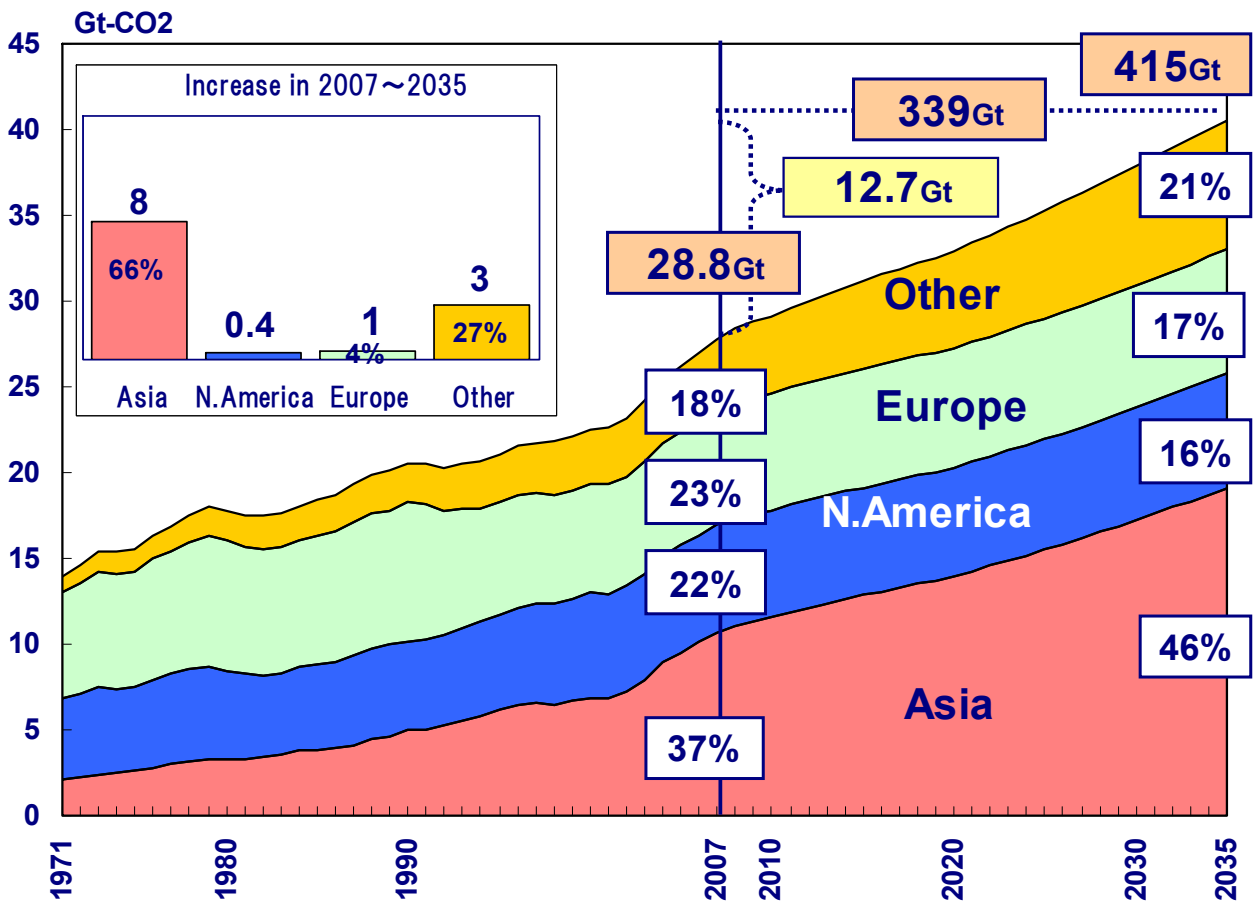
Asia

2007
1.4 TW
↓
2035
3.0 TW
(**2.3**-fold inc.)

■World power generation capacity is projected to grow from 4.5TW in 2007 to 7.7TW in 2035 (3.2 TW growth).

■ The largest increase in world power generation capacity is expected in Asia (1.6TW growth, 50% of world capacity increase).

CO_2 Emission by Region (World)



World

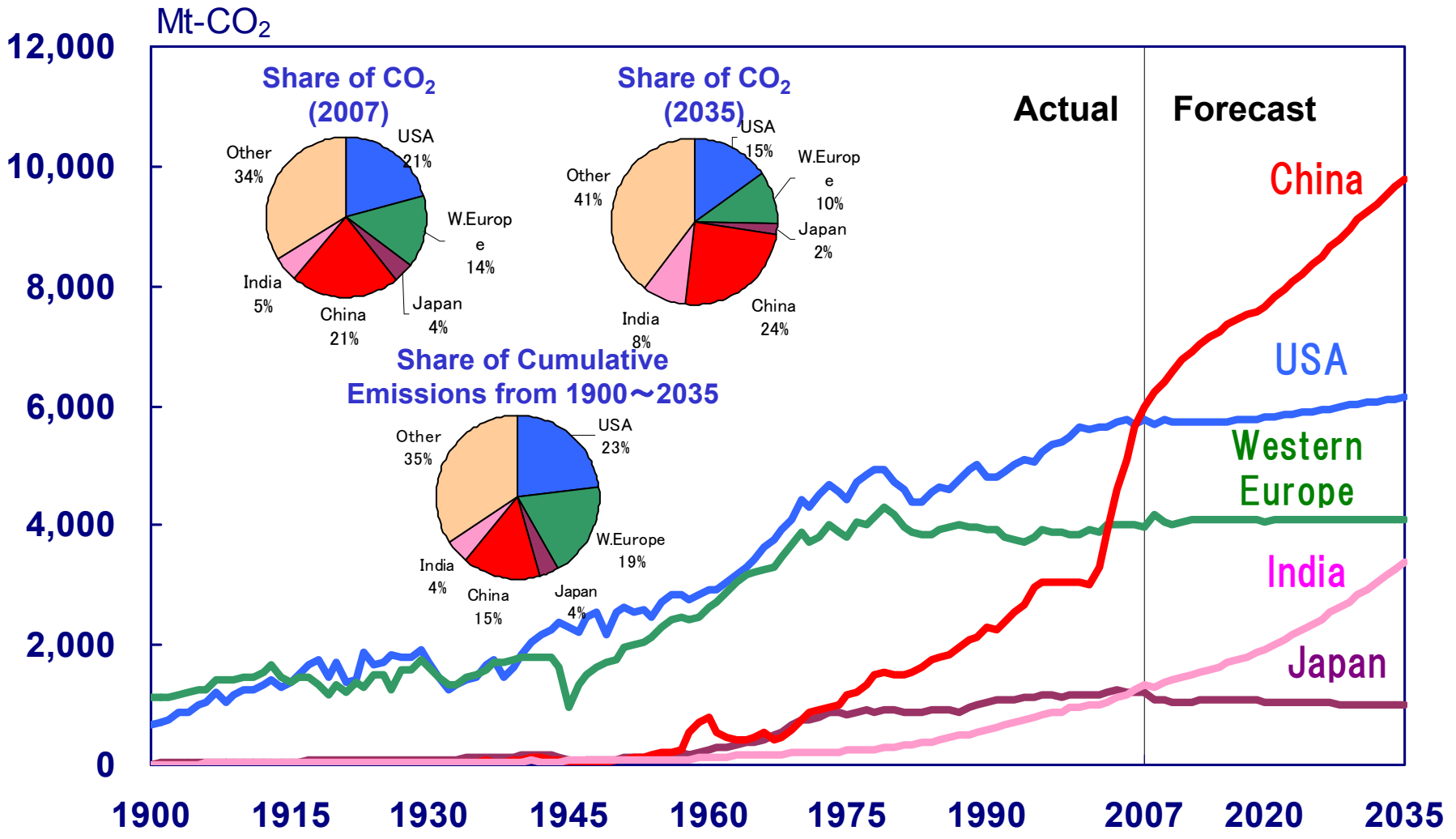
2007
28.8 Gt
↓
2035
41.5 Gt
(**1.4**-fold inc.)

Asia

2007
10.7 Gt
↓
2035
19.1 Gt
(**1.8**-fold inc.)

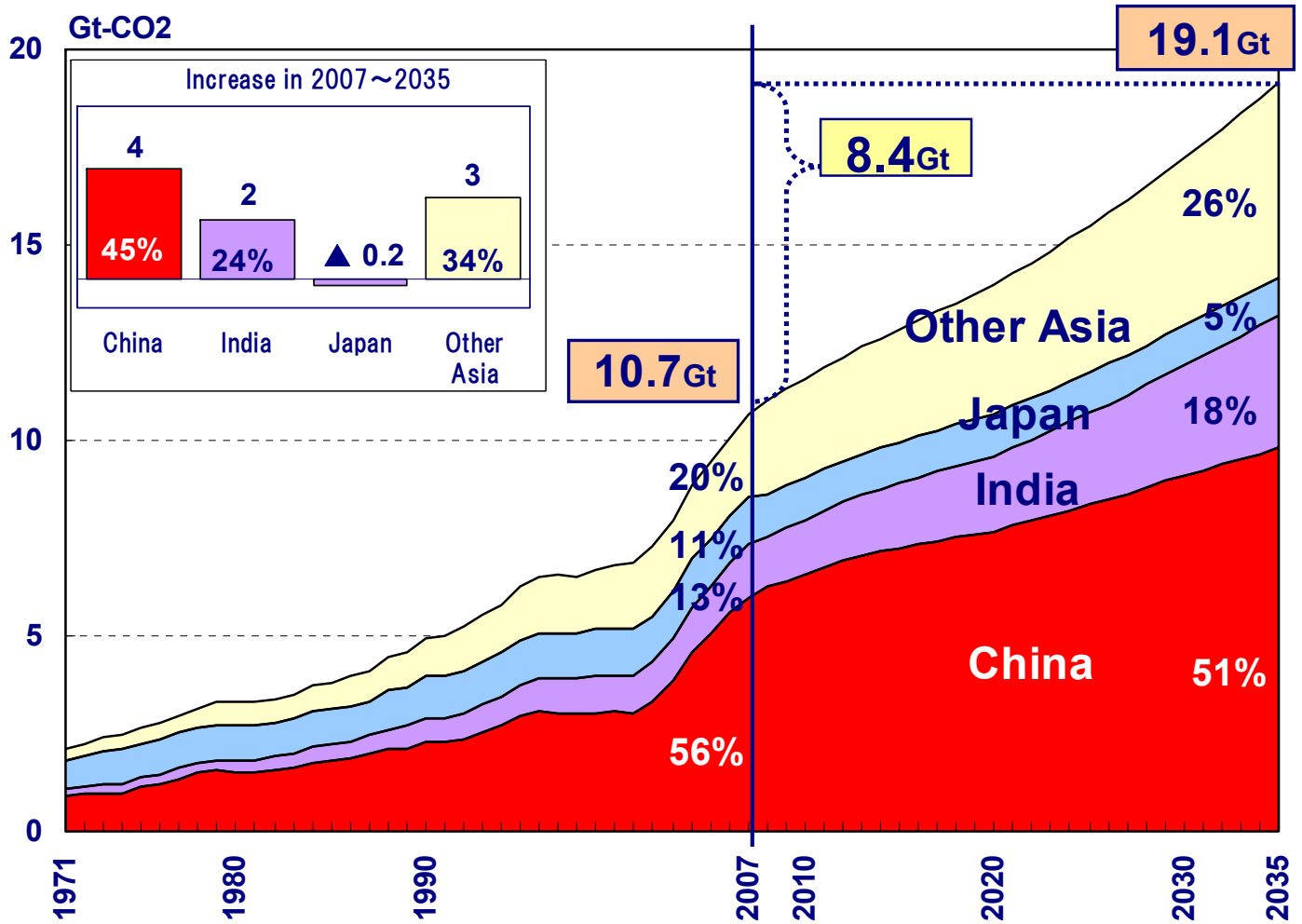
Increase in Asia will account for 66%, with North America and Europe together responsible for only 4%.

CO_2 Emissions (World)



Cumulative CO_2 emissions from 1990 of India will outstrip that of Japan by 2030

CO_2 Emission by Region (Asia)



China

2007
6.0Gt
↓
2035
9.8Gt
(1.6-fold inc.)

India

2007
1.4Gt
↓
2035
3.4Gt
(2.4-fold inc.)

CO_2 emissions of China and India will steadily increase driven by coal consumption, the share accounting for 70% together in Asia.

Technologically Advanced Scenario (Tech. Adv. Scenario)

Assumptions on Technologically Advanced Scenario

Countries all over the world more strengthen the numerous measures contributing to ensuring energy security and mitigating global warming issues. Combined with that, technological development and international transfer of technology will be promoted and advanced technology internationally becomes commercially available as a result.

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

【Demand Side Technology】

■ Industry

Best available technology on industrial process such as steel making, cement, paper, oil refinery etc. become internationally penetrated

■ Transport

Clean energy vehicles (high fuel efficient vehicle, Hybrid vehicle, Plug-in hybrid vehicle, Electric vehicle, Fuel cell vehicle) globally expand.

■ Building

Efficient electric appliance (Refrigerator, TV etc.), High efficient water-heating system (heat-pump etc.), Efficient air conditioning system, Efficient lighting, Strengthening heating insulation

【Supply Side Technology】

■ Renewable

More expansion of Wind, PV, CSP, Biomass power generation, Bio-fuel

■ Nuclear

Acceleration of more nuclear power plant, Enhancement of operating ratio

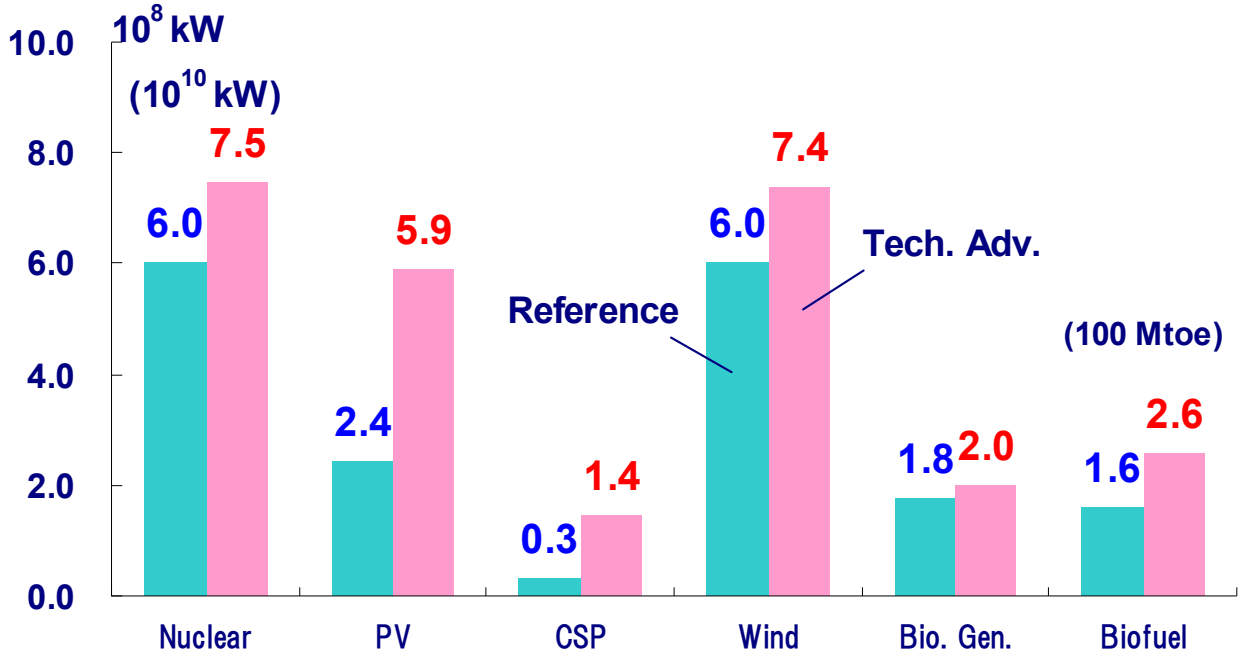
■ High Efficient Fossil-fired Power Plant

More expansion of Coal-fired power plant (USC, IGCC, IGFC), Natural gas MACC

■ CCS

Introduction in power generation (coal-fired, gas-fired) and industrial sector

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



Non-fossil fuel (Mtoe)

2007
1,300 Mtoe
↓
2035

Reference	Tech. Adv.
2,500 Mtoe	**3,000 Mtoe**
(2-fold inc)	(2.3-fold inc)

Share of non-fossil fuel

2007
12%
↓
2035

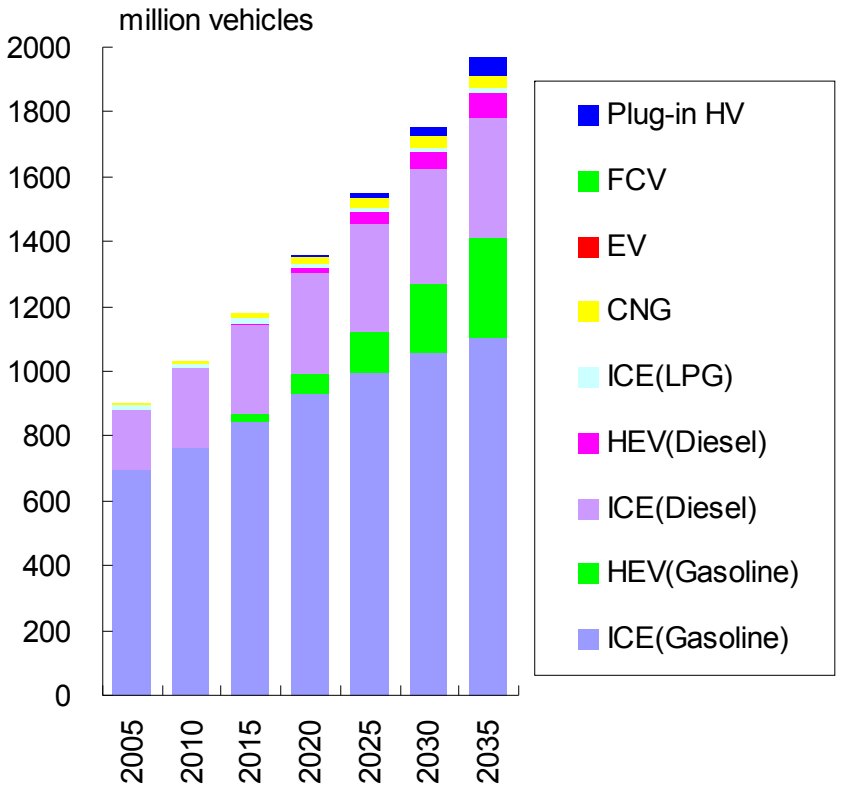
Reference	Tech. Adv.
15%	**21%**

- Further expansion of nuclear and renewables is likely to be realized on the basis of global electricity demand increase.
- Biofuel will more boost if cellulosic biofuel, which is not competitive with food production and land use, becomes commercially viable.
- Industry sector, building sector and transport sector respectively achieves 300Mtoe(9% saving), 500 Mtoe (14% saving) and 400 Mtoe (14% saving) of energy saving in 2035 compared with reference scenario.
- Average efficiency of fossil fuel-fired power generation reach 47% at 2035 in Tech. Adv. Scenario while that in reference scenario shows 42%

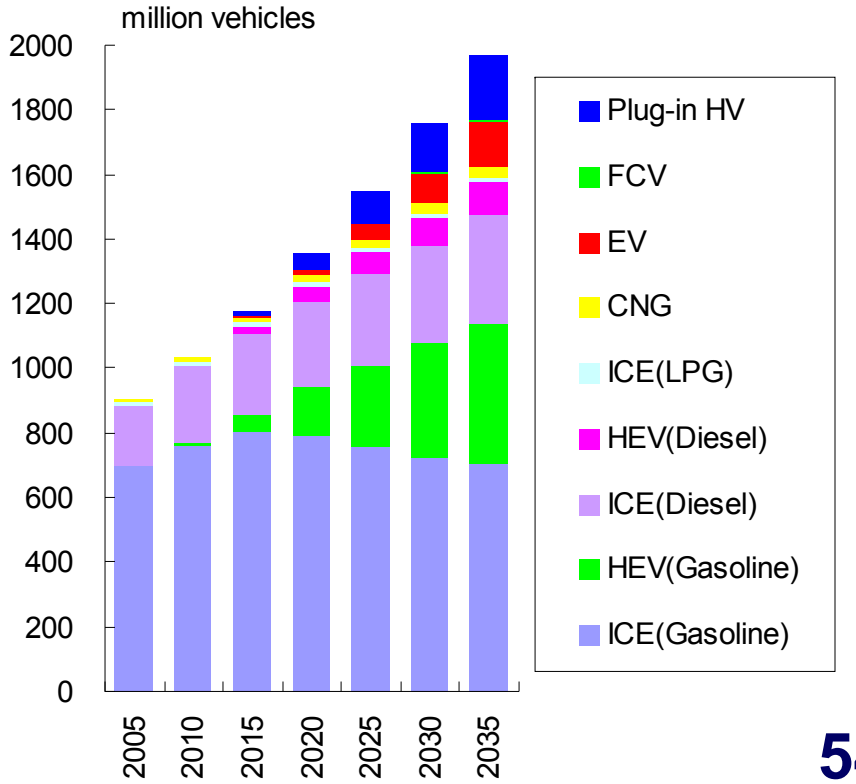
Automobile Ownership (World)

- Global ownership of hybrid vehicles (HEV) in 2035 expands to 390 millions in Reference scenario and 540 millions in Tech. Adv. Scenario.
- Plug-in hybrid vehicles (Plug-in HV) in 2035 will grow to 50 millions in Reference scenario and 200 millions in Tech. Adv. Scenario.
- Electric vehicles (EV) in 2035 will boost to 140 millions in Tech. Adv. Scenario.

Reference

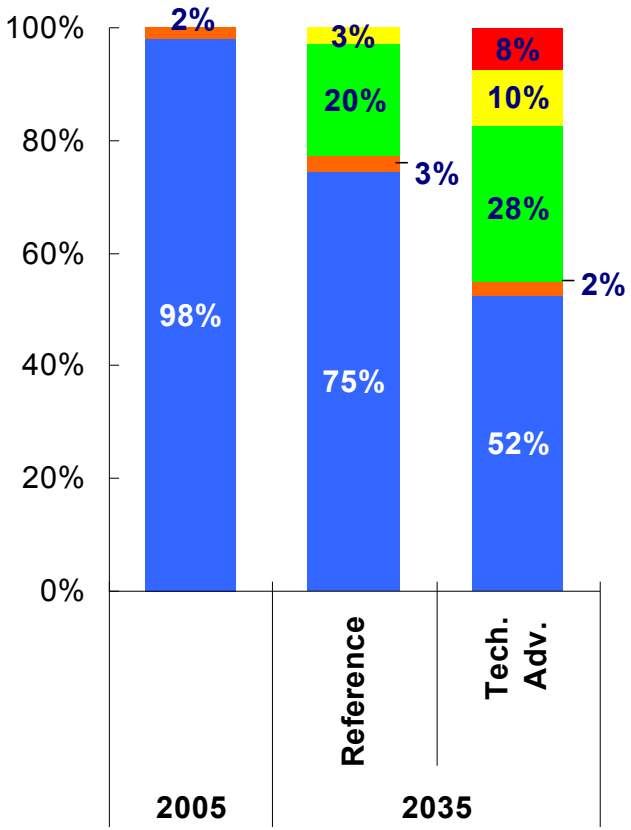


Tech. Adv.

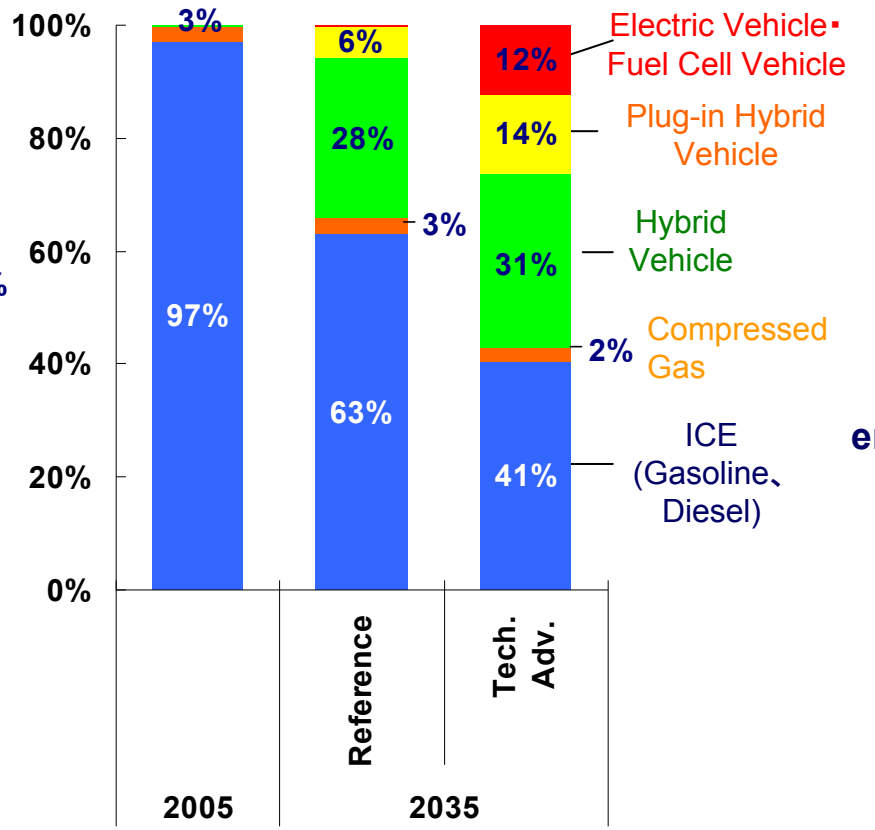


Outlook on Automobile (World)

【Breakdown of Automobile Stock (World)】



【Breakdown of Annual Sales (World)】



Share of clean energy vehicle on total stock (2035)

Reference **23 %**
Tech. Adv. **46 %**

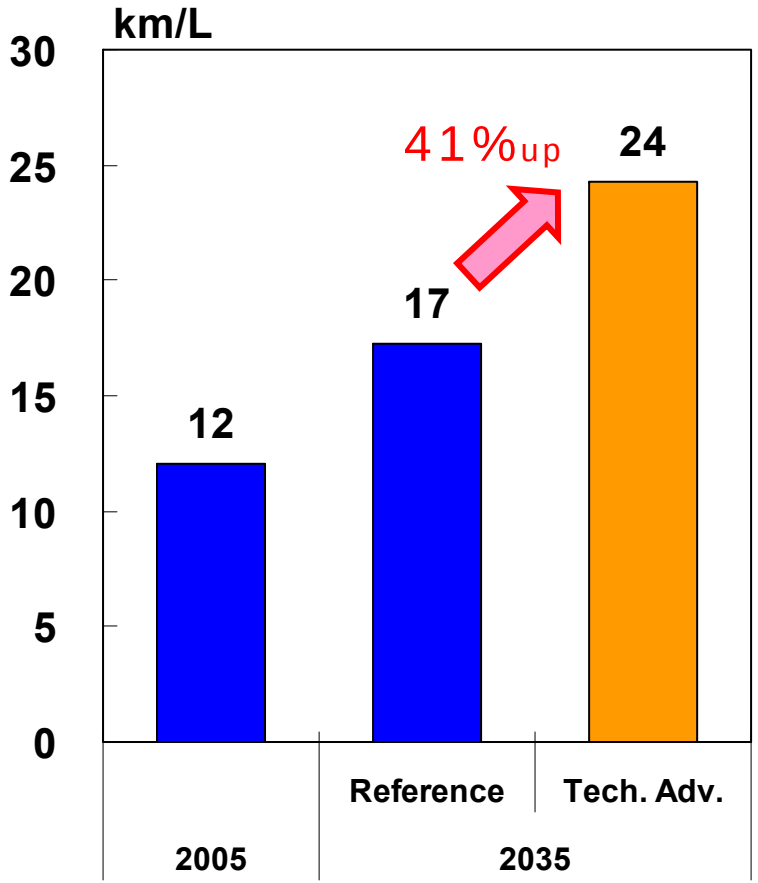
Share of clean energy vehicle in annual sales (2035)

Reference **34 %**
Tech. Adv. **57 %**

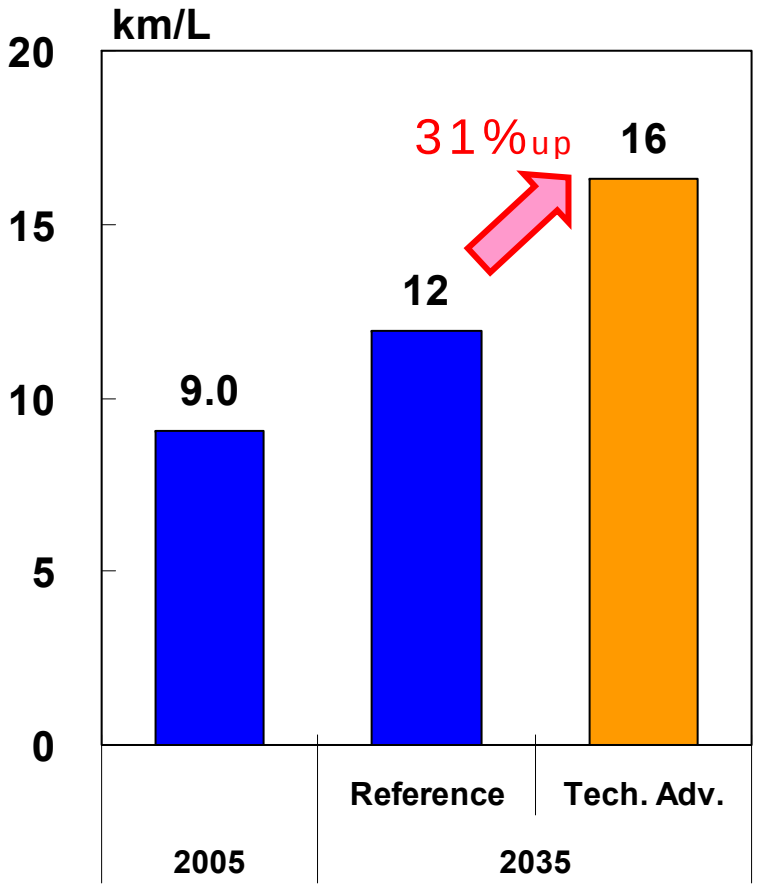
In Tech. Adv. Scenario, approximately 50% of total stock in 2035 is composed of clean energy vehicle.

Fuel Efficiency of Passenger Vehicle (World)

Fuel Efficiency on Annual Sales basis



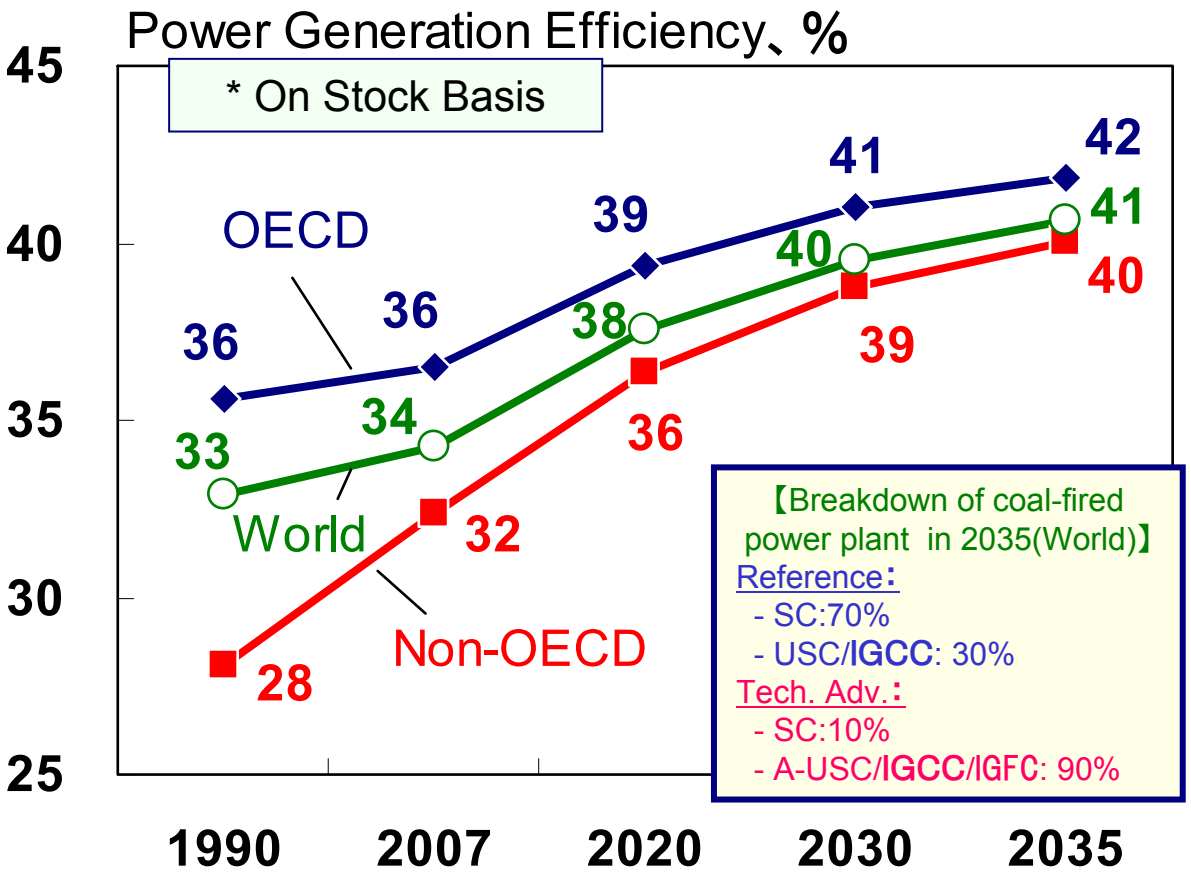
Fuel Efficiency on Stock basis



Fuel efficiency of passenger stock at 2035 in Tech. Adv. Scenario exhibit 31% improvement in comparison with Reference Scenario.

Clean Coal Technology (CCT): Power Generation Efficiency of Coal-fired Power Plant

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

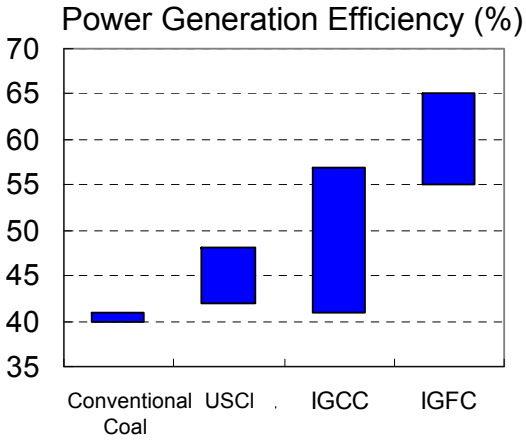


Stock-based Efficiency of Coal-fired Power Plant (World)

2007
34 %
↓
2035

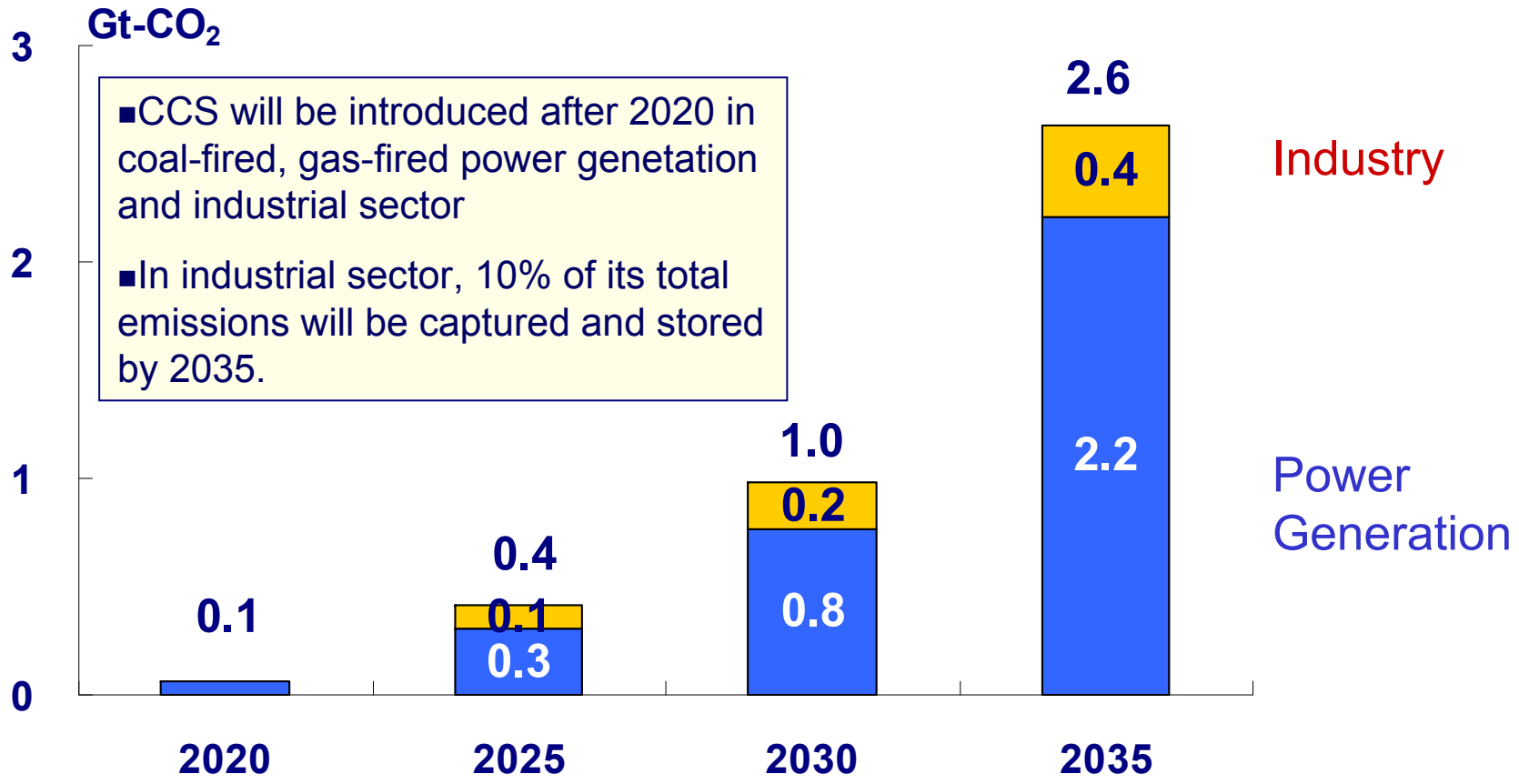
Reference	Tech.Adv.
41 %	**45 %**
(7points up)	(11points up)

Advanced Coal-fired Plant



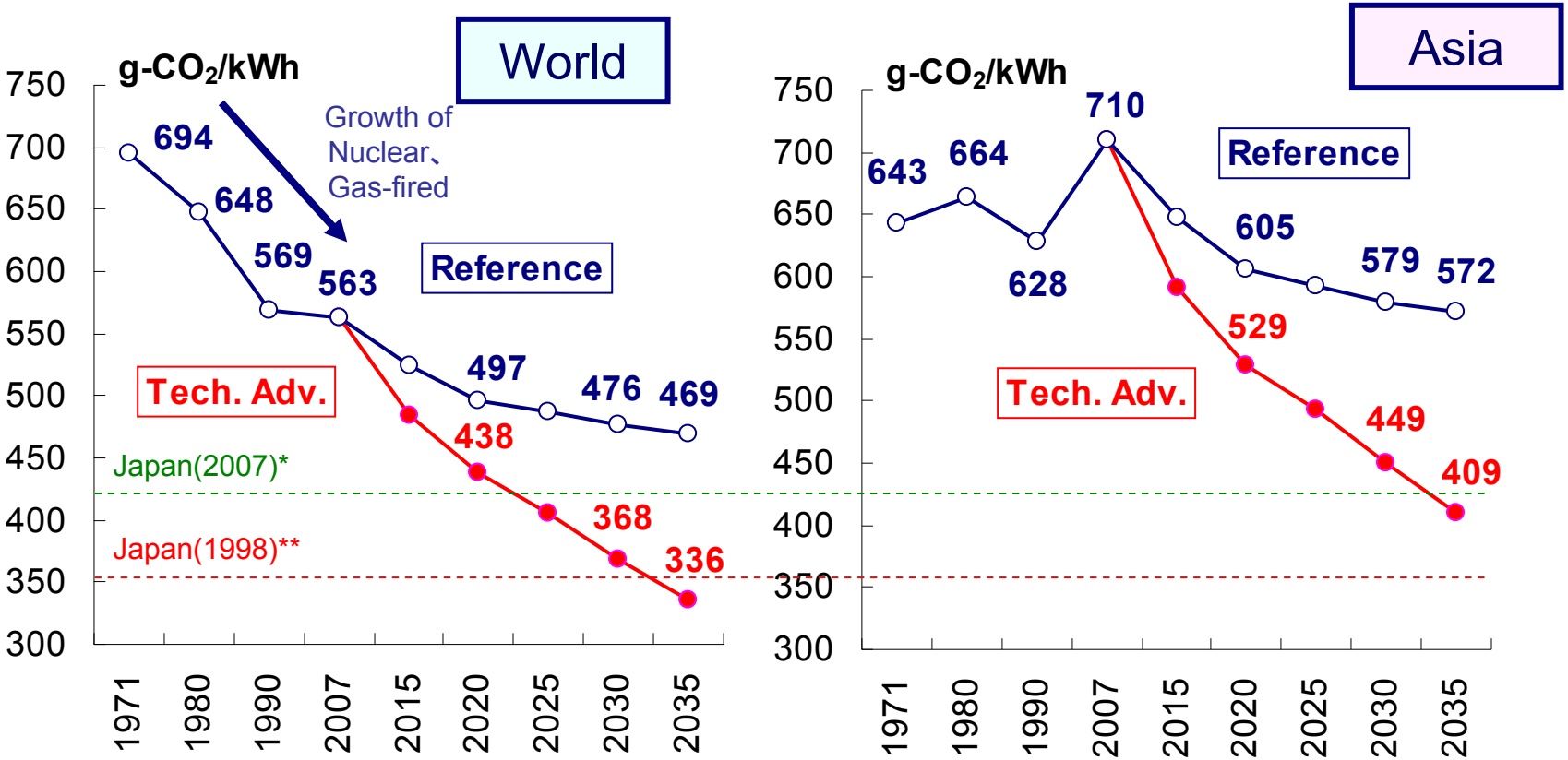
In Tech. Adv. Scenario, additional 1.0 Gt-CO2 will be reduced due to the enhancement of power generation efficiency compared with Reference Scenario.

Clean Coal Technology (CCT): CO_2 Capture & Storage (CCS)



■ Cumulative captured and stored CO2 from 2020 to 2035 amounts to 14 Gt-CO2.Theoretical potential of CCS in geological structure is estimated to 10 trillion ton, and that of depleted gas field, oil field and coal field, 1 trillion ton, which is sufficient to accommodate the captured CO2 in Tech. Adv. Scenario.

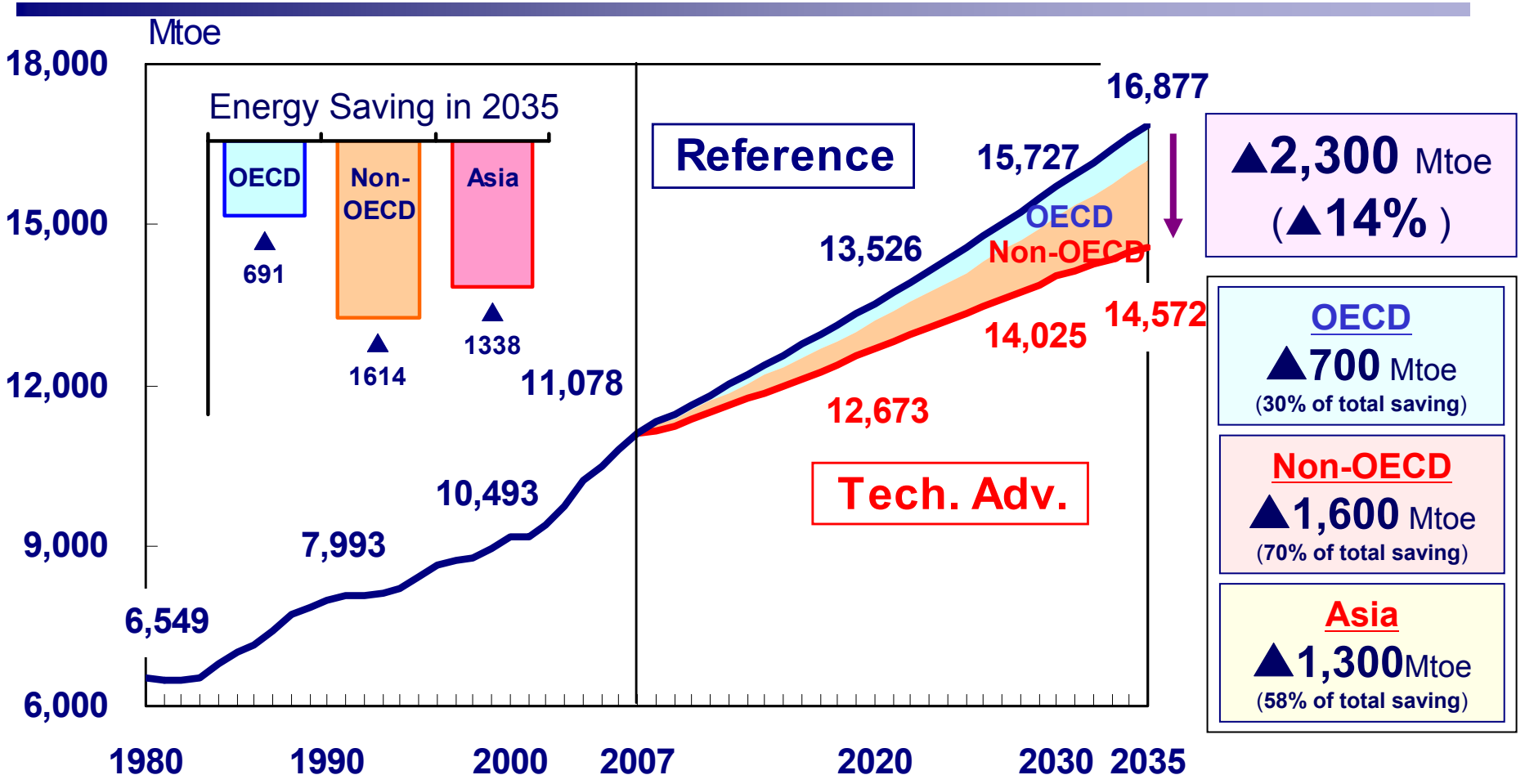
Carbon Intensity of Electricity (CO_2 Emissions per kWh)



*420g-CO2/kWh **350g-CO2/kWh

■In Tech. Adv. Scenario, CO2 emissions per kWh represents dramatic reduction due to the further expansion of nuclear, renewable and improvement of efficiency of fossil-fired power generation.

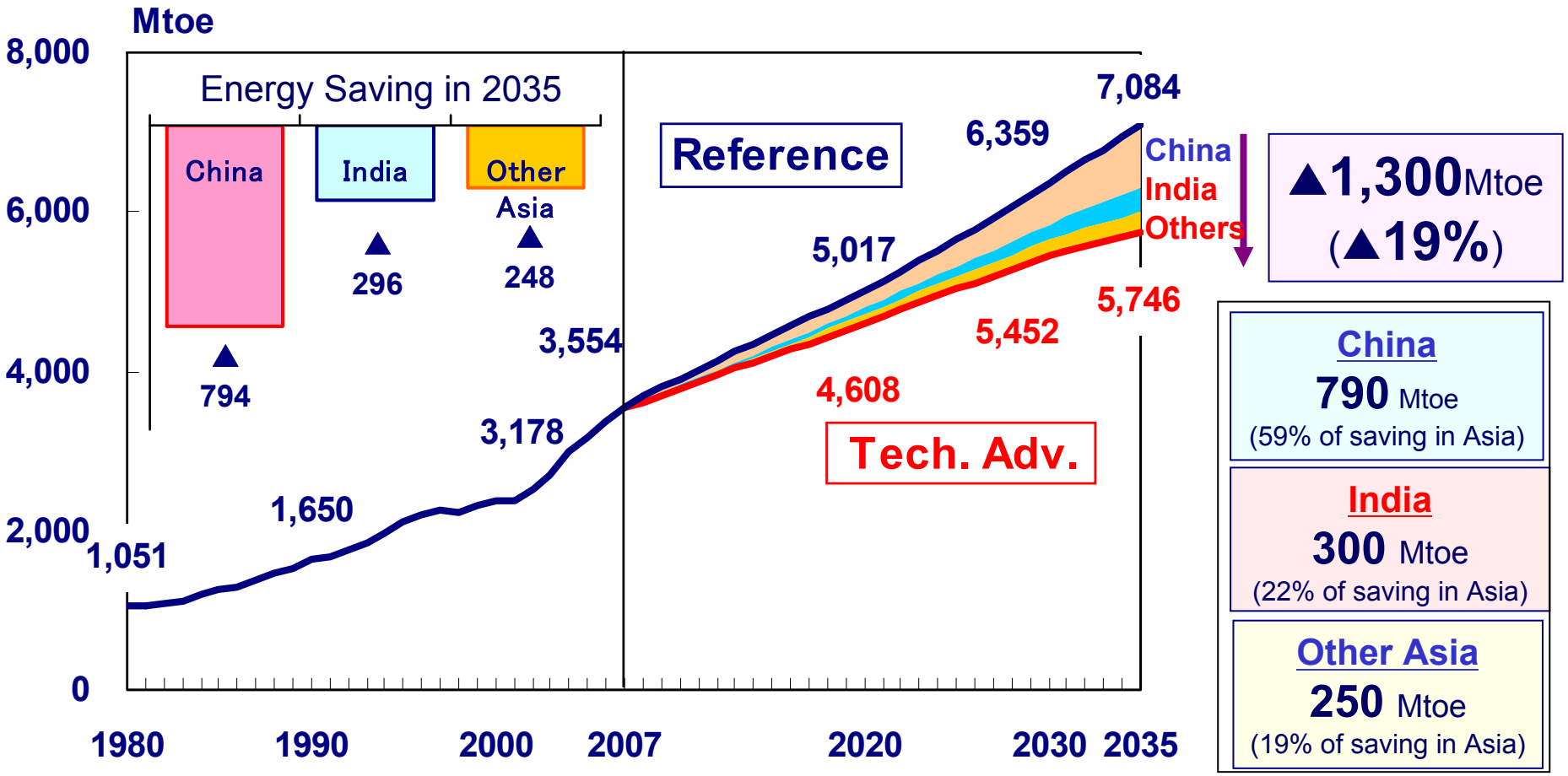
Primary Energy Demand (World)



■ In 2035, world total primary energy demand in Tech. Adv. Scenario decreases by 2,300 Mtoe in comparison with Reference Scenario. 2,300 Mtoe is approximately 4 times as much as TPES of Japan.

■ TPES saving of Non-OECD in 2035 is almost double as large as that of OECD. The saving potential in Asia is particularly immense amount.

Primary Energy Demand (Asia)

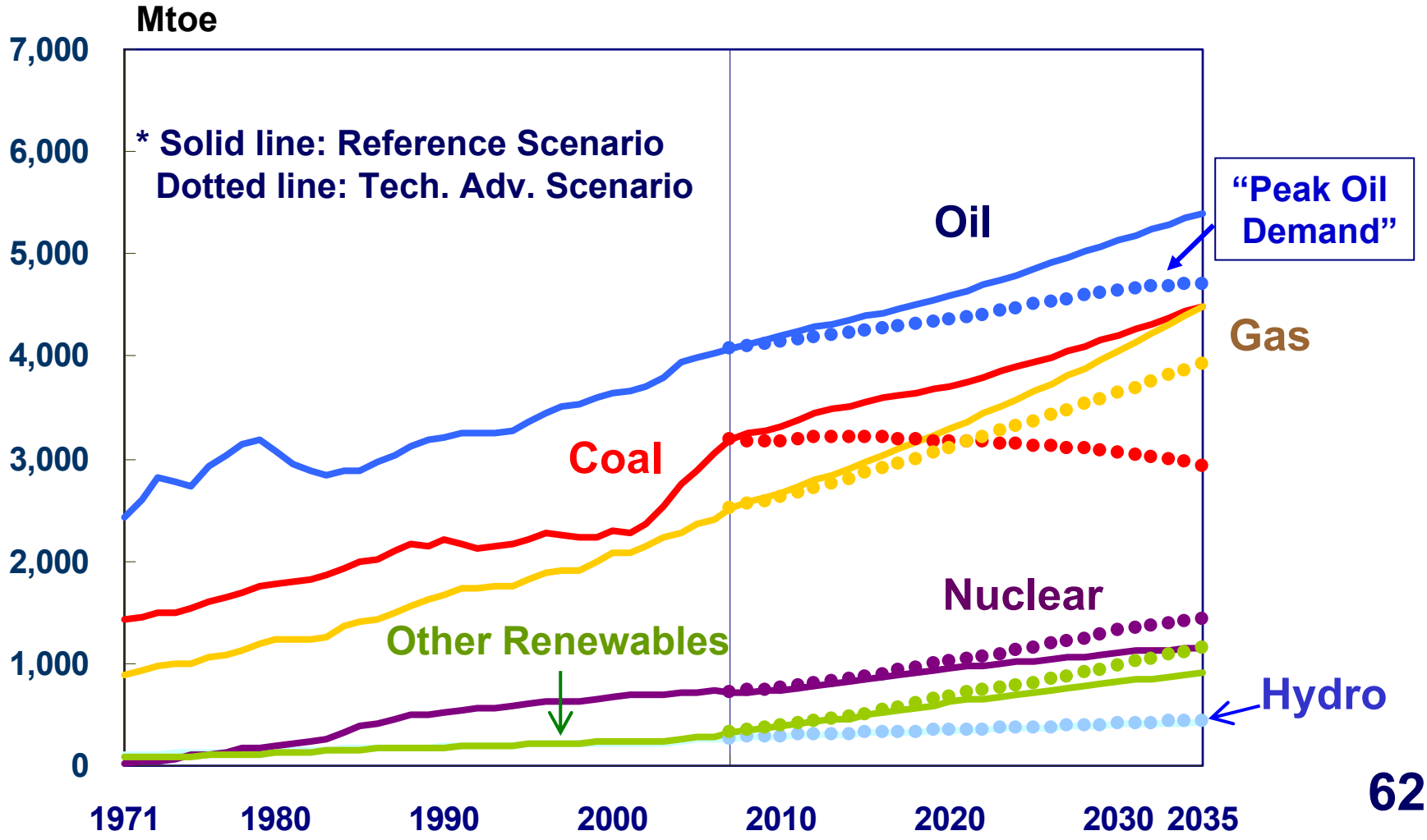


In 2035, TPES of Asia in Tech. Adv. Scenario decreases by 1,300 Mtoe in comparison with Reference Scenario. 1,300 Mtoe is approximately twice as much as TPES of Japan. The saving potential in China and India is quite large.

Primary Energy Demand (World)

■ Coal demand is most susceptible to technological advancement such as clean coal technology, showing 35% reduction compared with Reference scenario .

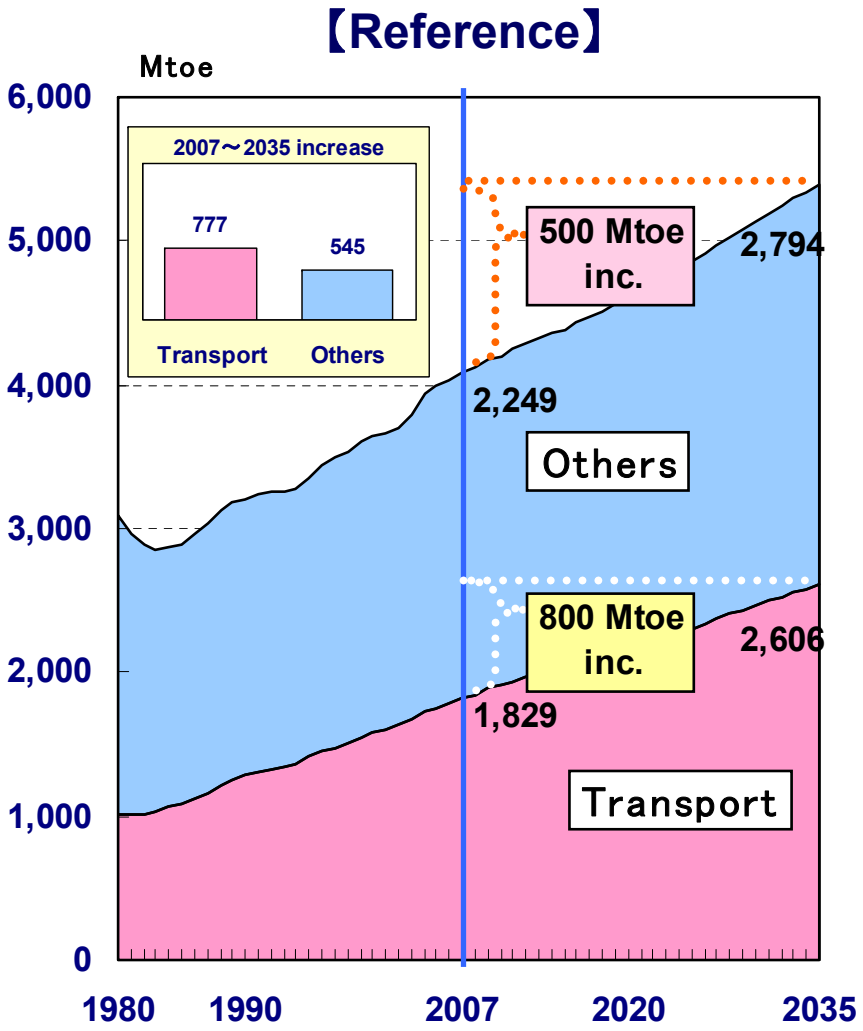
■ Due to the substantial penetration of clean energy vehicles, global oil demand will almost peak out around 2030. “Peak oil demand” will likely arise before “Peak oil supply” encouraged by innovative automobile technology.

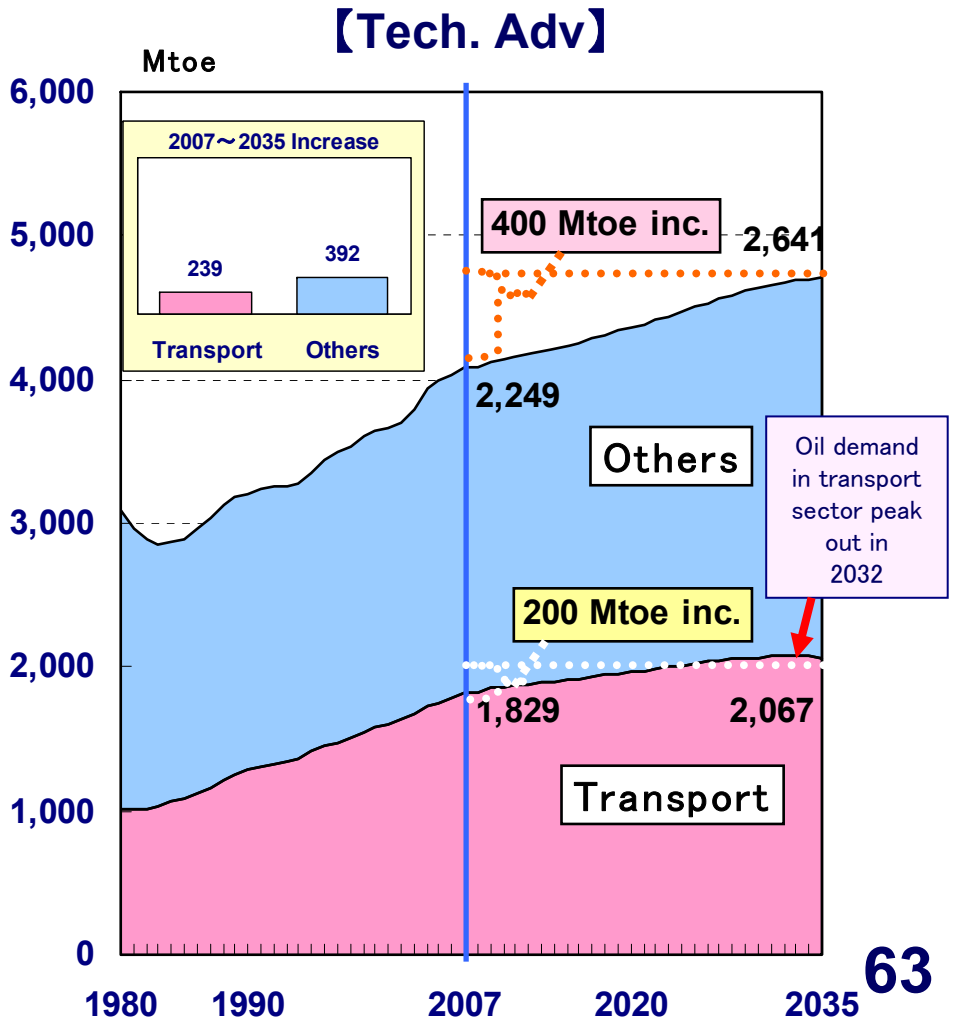


Oil Demand (World)

■In Reference Scenario, 60% of total oil demand growth from 2007 to 2035 is attributable to the demand increase in transport sector.

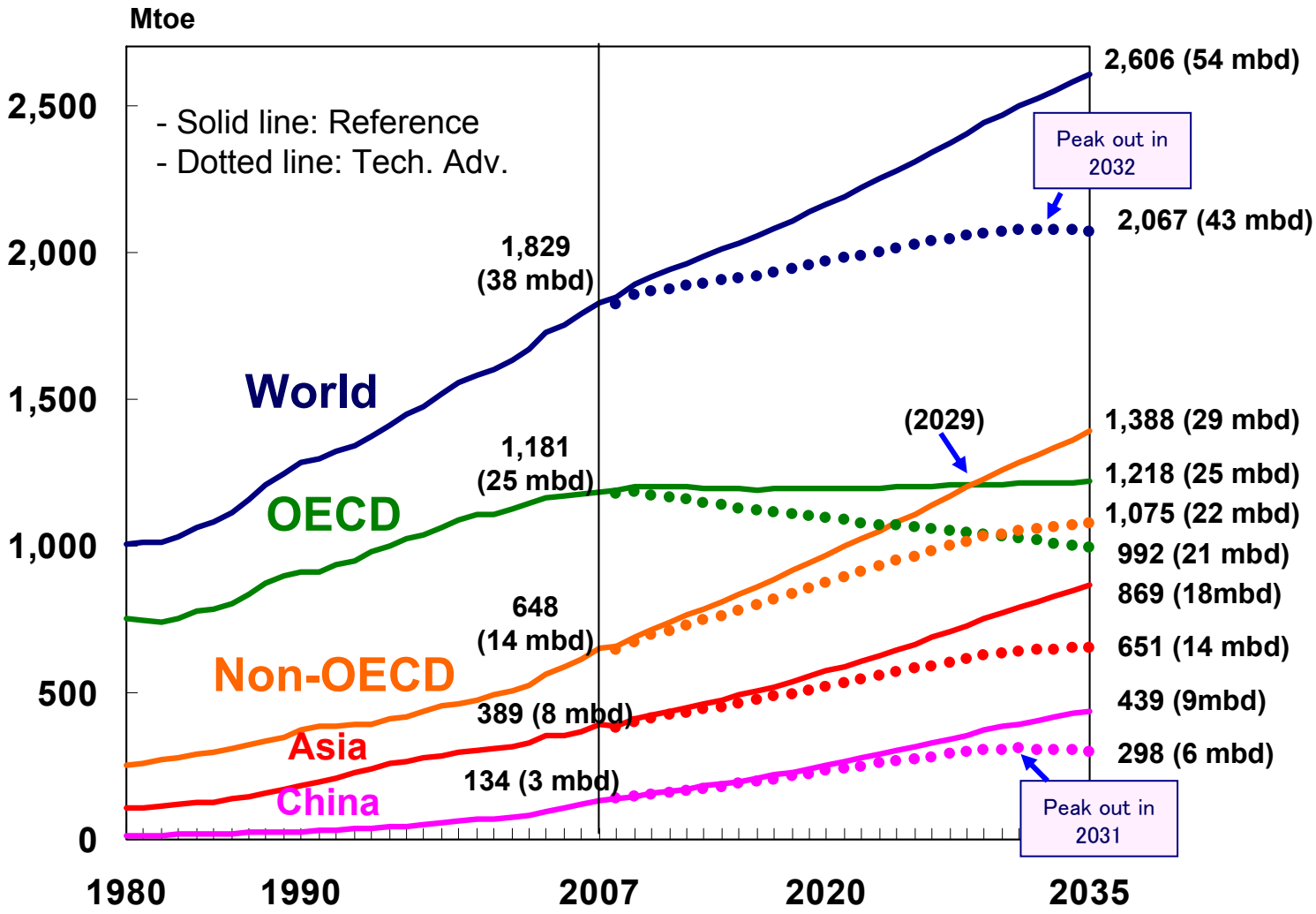
■In Tech. Adv. Scenario, oil demand growth in transport sector is heavily constrained and peak out around 2032.



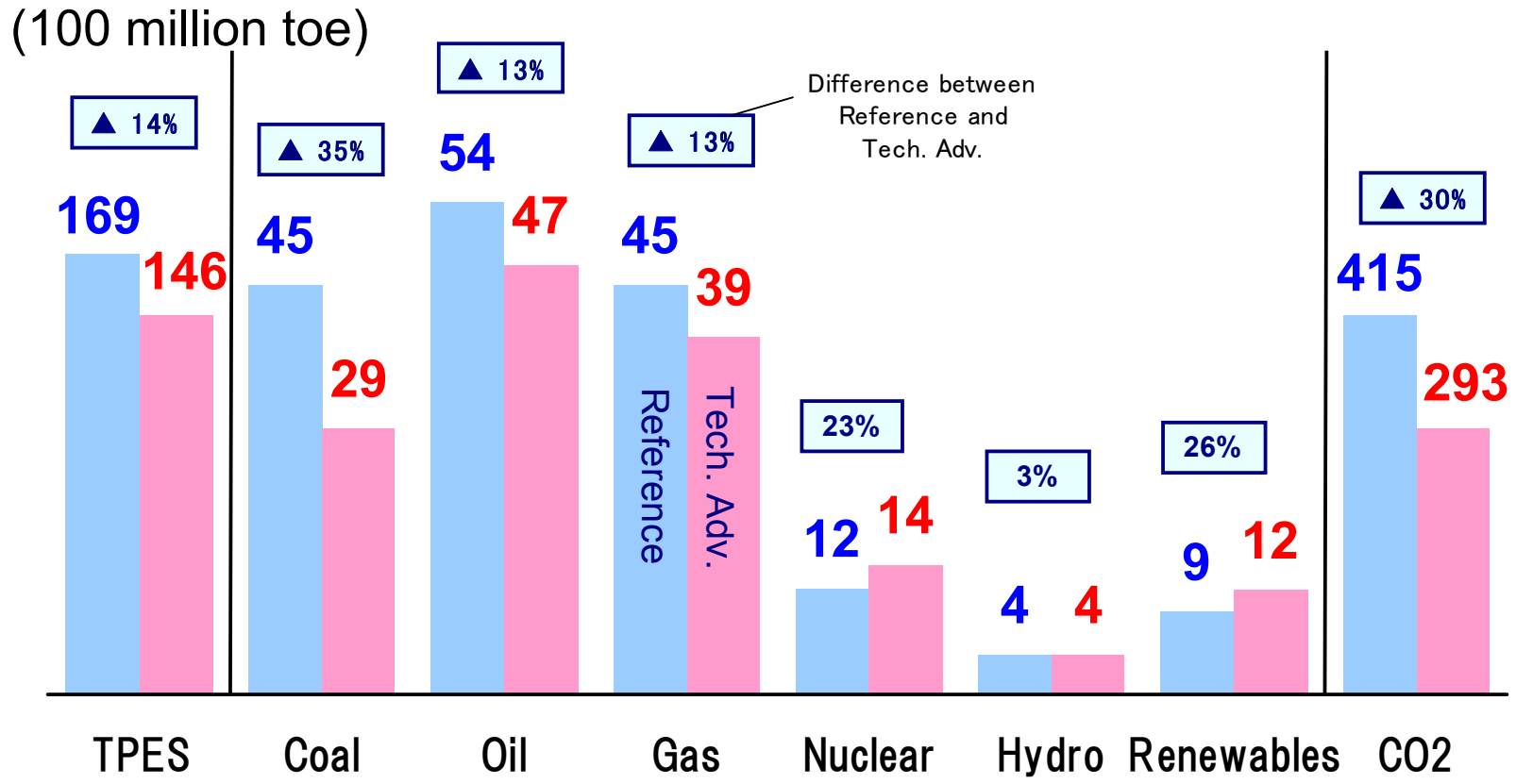


Oil Demand of Transport Sector (Selected Region)

Global oil demand growth is likely to be limited by massive deployment of clean energy vehicles.



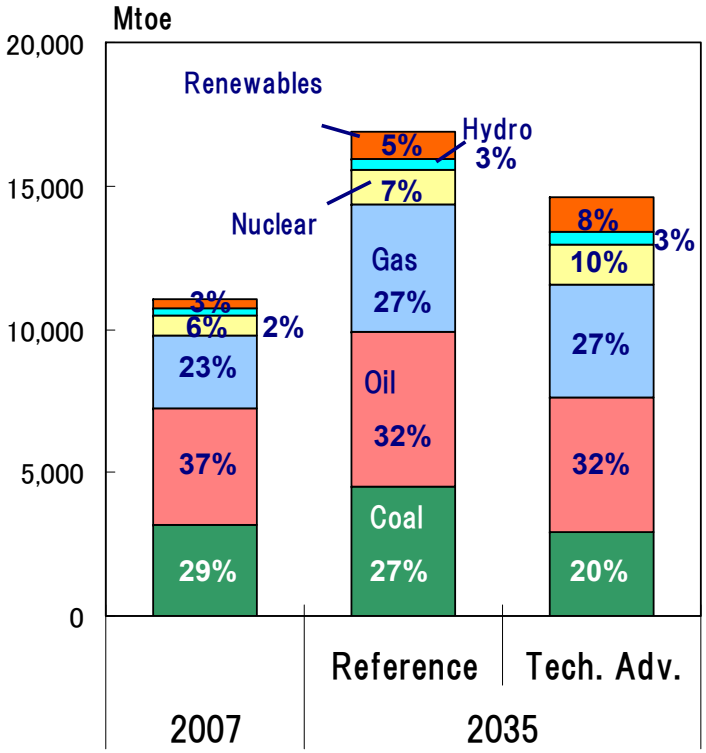
Reference and Tech. Adv. Scenario in 2035 (World)



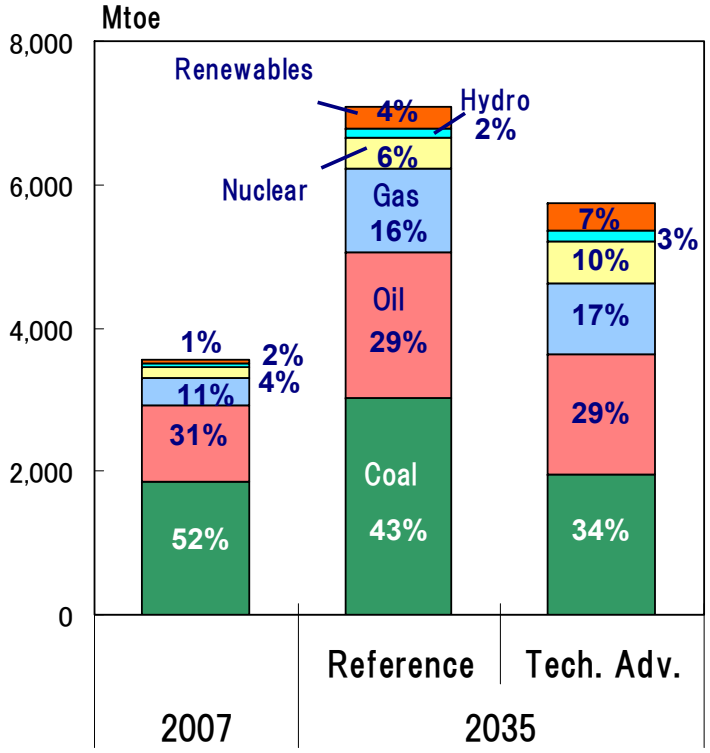
■Coal demand shows notable difference between Reference and Tech. Adv. scenario, due to the elaborate deployment of clean coal technology in Tech. Adv. Scenario.
■Global oil demand at 2035 is 113 mb/d in Reference scenario and 98 mb/d in Tech. Adv. Scenario.

Primary Energy Mix

【World】



【Asia】



Share of Non-fossil fuel in TPES (World)

2007
12 %
↓
2035

Reference	Tech.Adv.
15 %	**21 %**
(3points up)	(9points up)

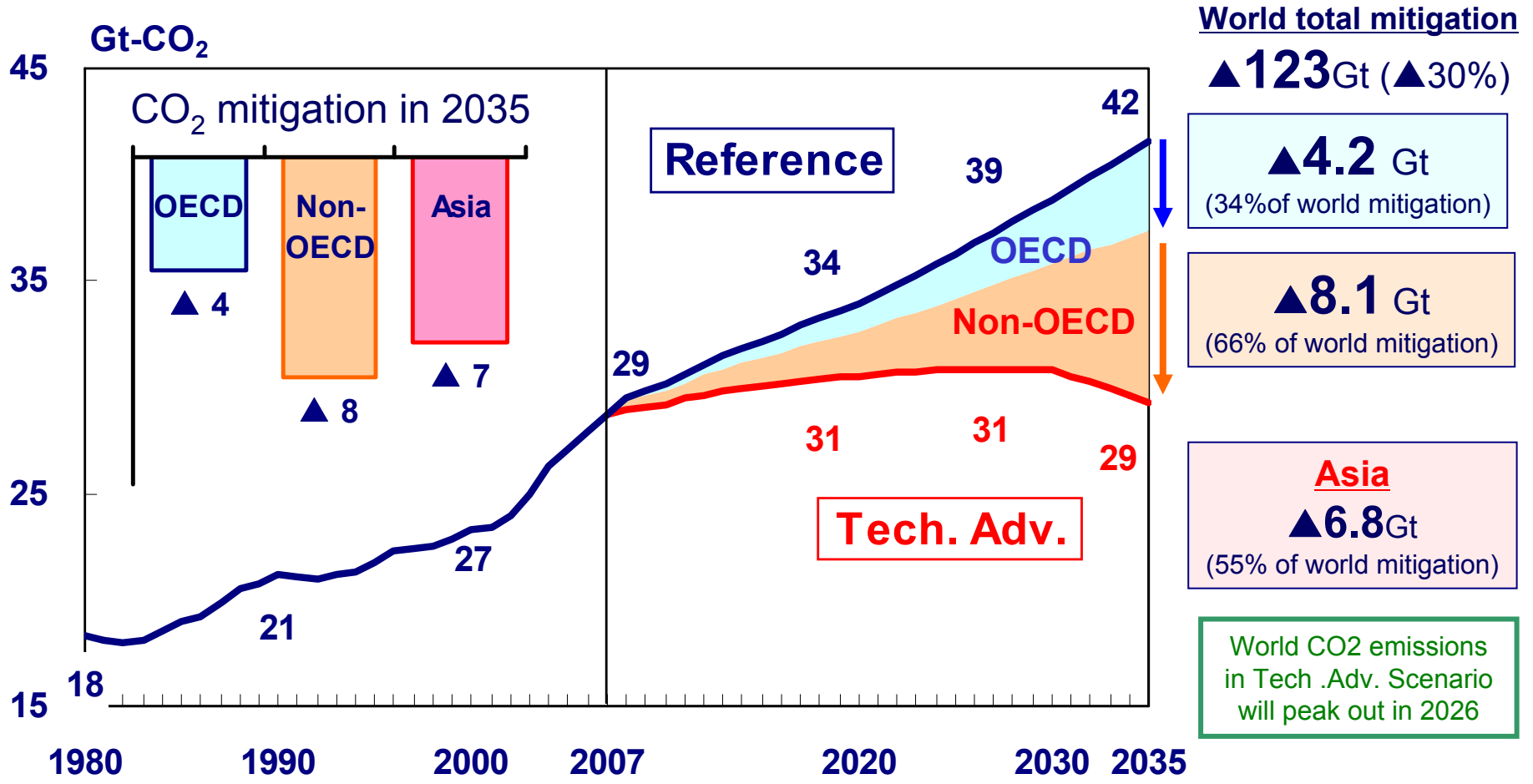
Share of Non-fossil fuel in TPES (Asia)

2007
7 %
↓
2035

Reference	Tech.Adv.
12 %	**19 %**
(5points up)	(12points up)

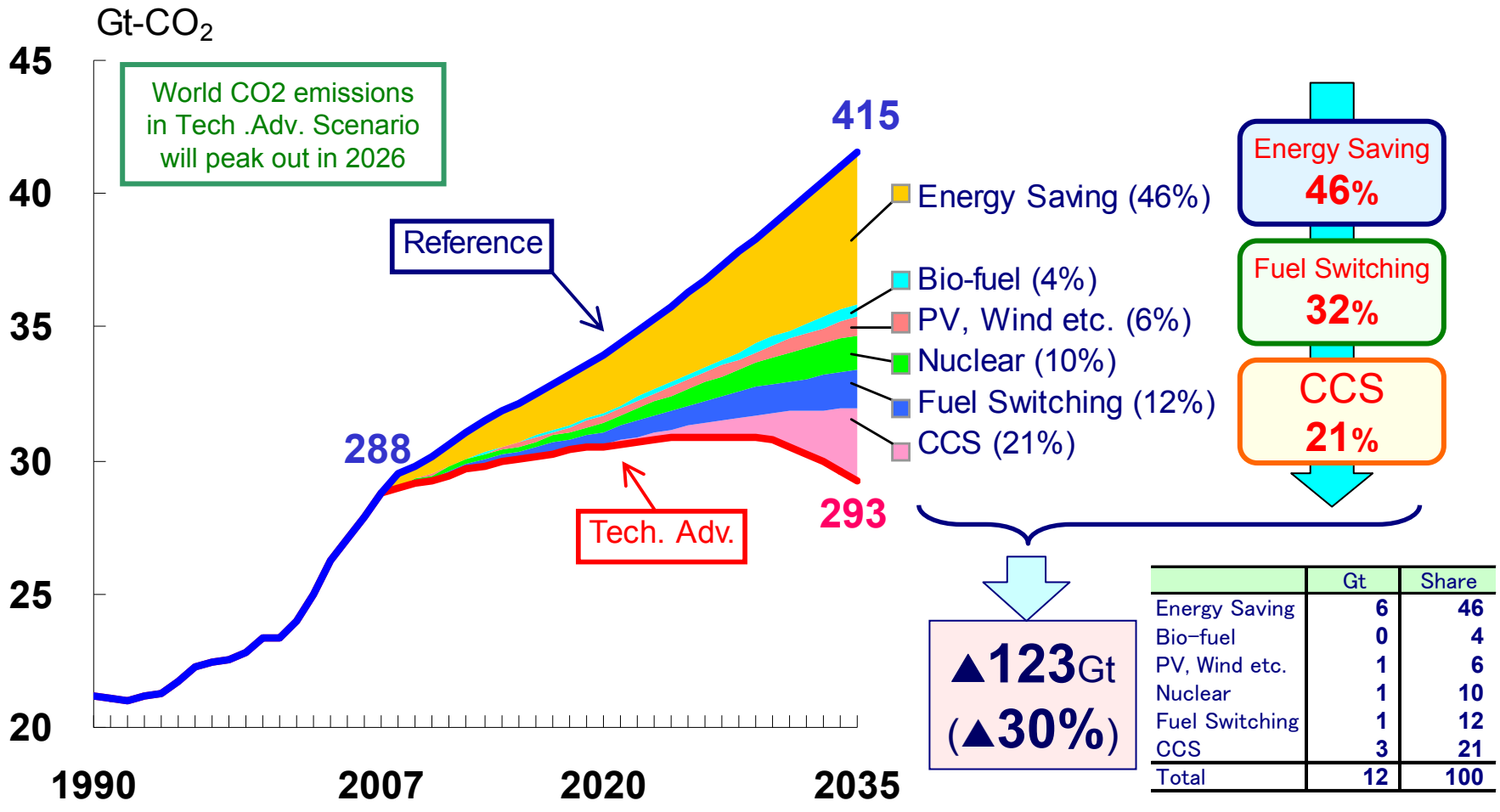
Even at 2035 in Tech. Adv. scenario, fossil fuel dominates about 80% of TPES in both Asia and the world and will play an important role.

CO_2 Emissions in Tech. Adv. Scenario (World)



- CO_2 mitigation of Non-OECD in 2035 is almost double as large as that of OECD. The saving potential in Asia shows particularly massive amount.
- Technology transfer and swift deployment of advanced technology in Asia is indispensable in order to address global warming problem.

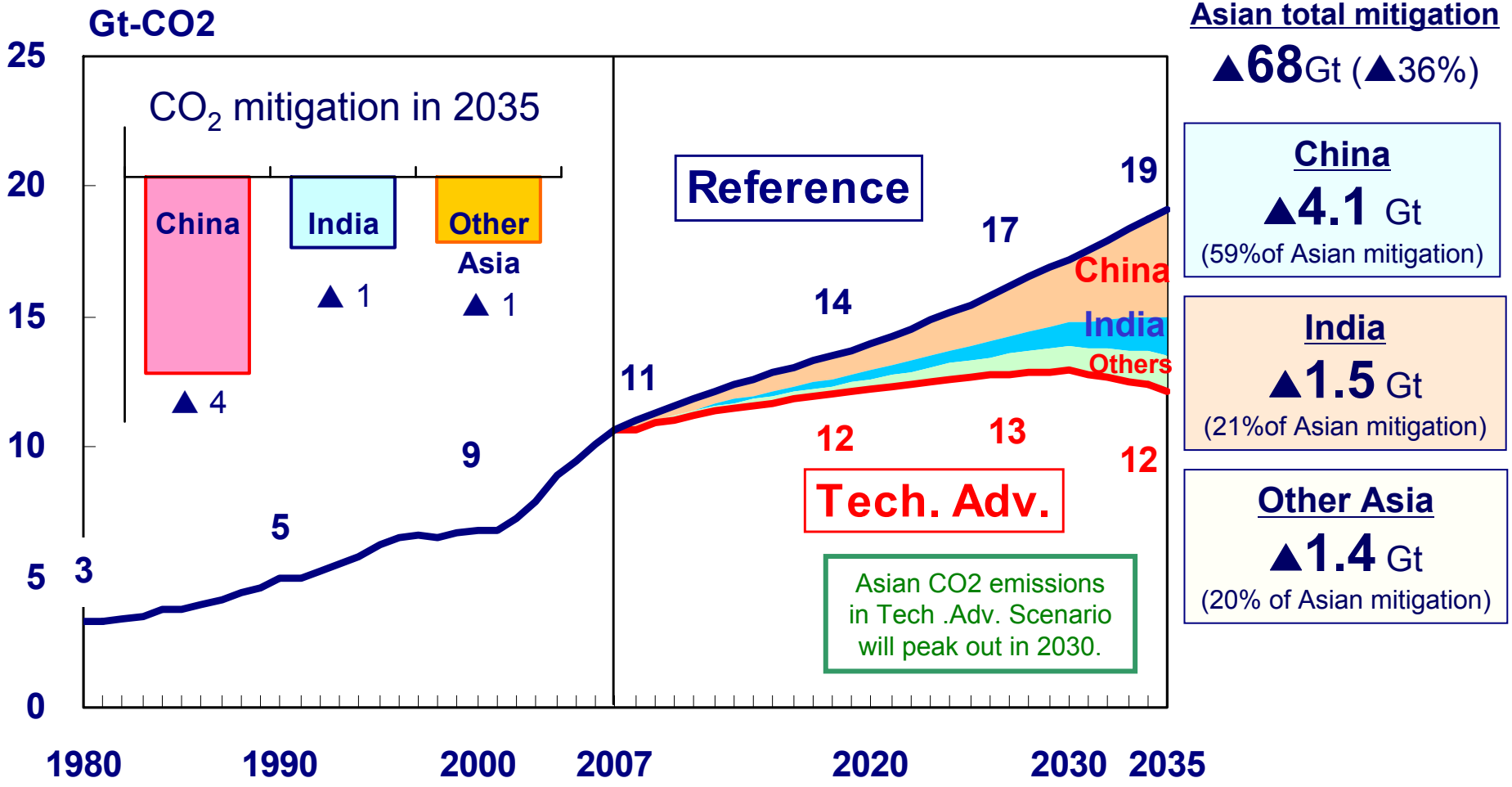
CO_2 Mitigation by Technology (World)



	Gt	Share
Energy Saving	6	46
Bio-fuel	0	4
PV, Wind etc.	1	6
Nuclear	1	10
Fuel Switching	1	12
CCS	3	21
Total	12	100

Multiple technological options, such as energy saving, enhancement of power generation efficiency, renewables, nuclear, fuel-switching and CCS together greatly contribute to massive CO2 mitigation.

CO_2 Emissions in Tech. Adv. Scenario (Asia)



Asian total mitigation

▲68 Gt (▲36%)

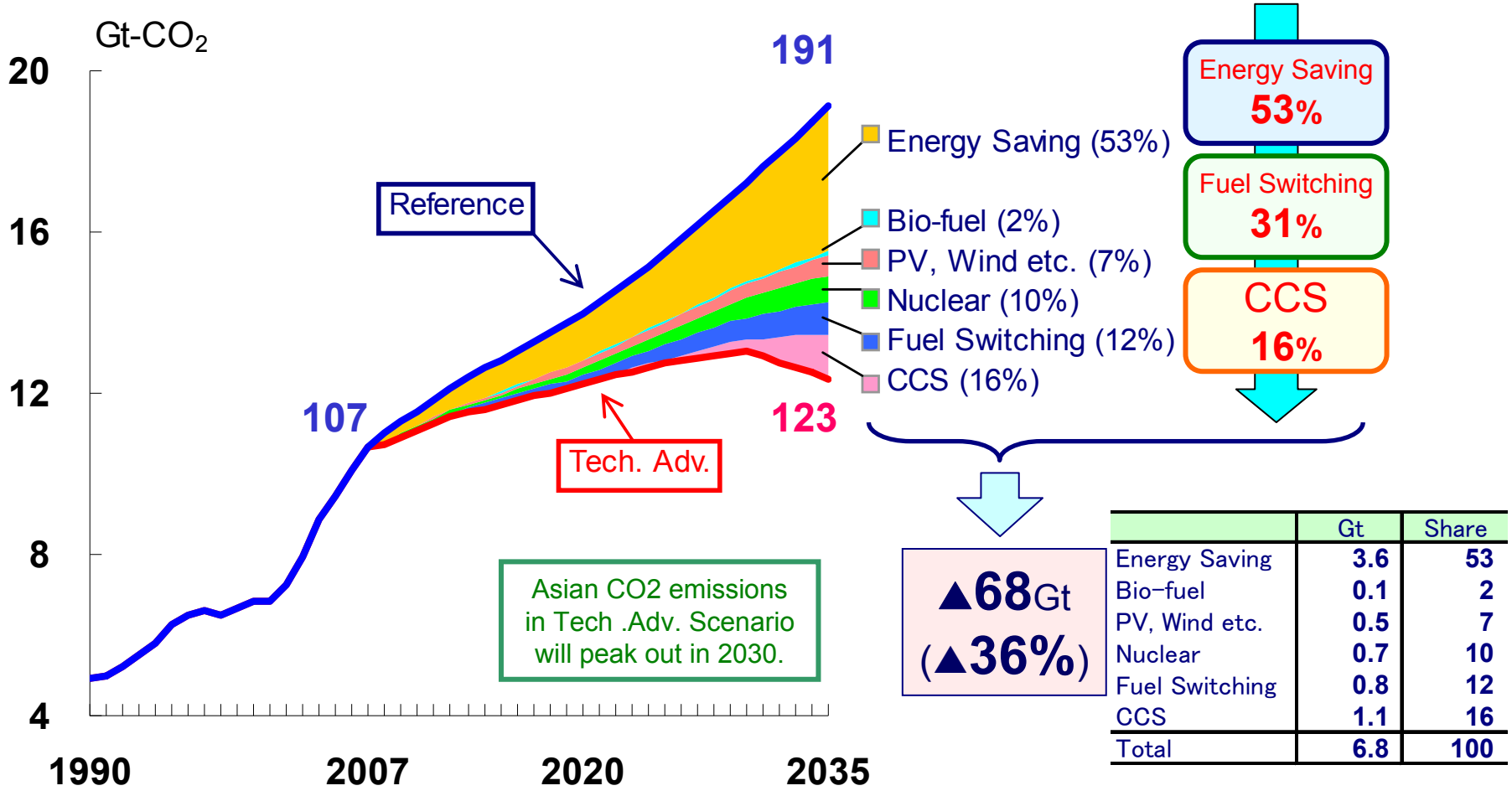
China
▲4.1 Gt
(59%of Asian mitigation)

India
▲1.5 Gt
(21%of Asian mitigation)

Other Asia
▲1.4 Gt
(20% of Asian mitigation)

CO_2 mitigation potential in China and India is quite large. CO_2 reduction in China dominates about 60% of Asian mitigation potential.

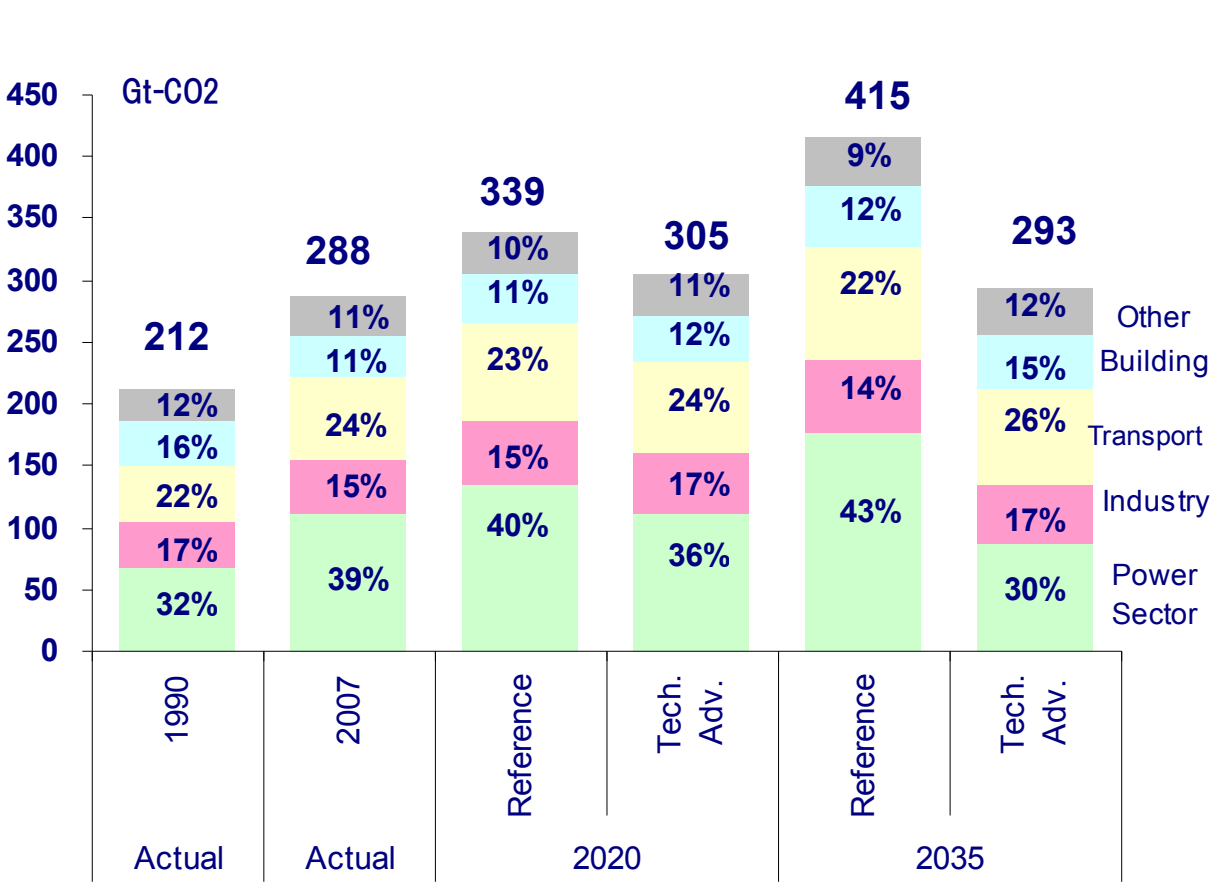
CO_2 Mitigation by Technology (Asia)

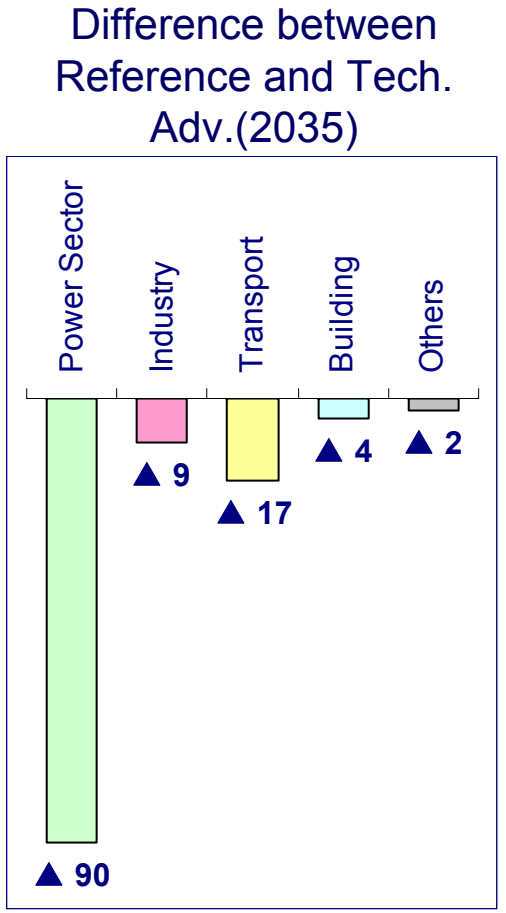


	Gt	Share
Energy Saving	3.6	53
Bio-fuel	0.1	2
PV, Wind etc.	0.5	7
Nuclear	0.7	10
Fuel Switching	0.8	12
CCS	1.1	16
Total	6.8	100

Aggressive development and deployment of advanced technology in Asia enables to considerably reduce CO2 emissions and realize its peak-out by 2030.

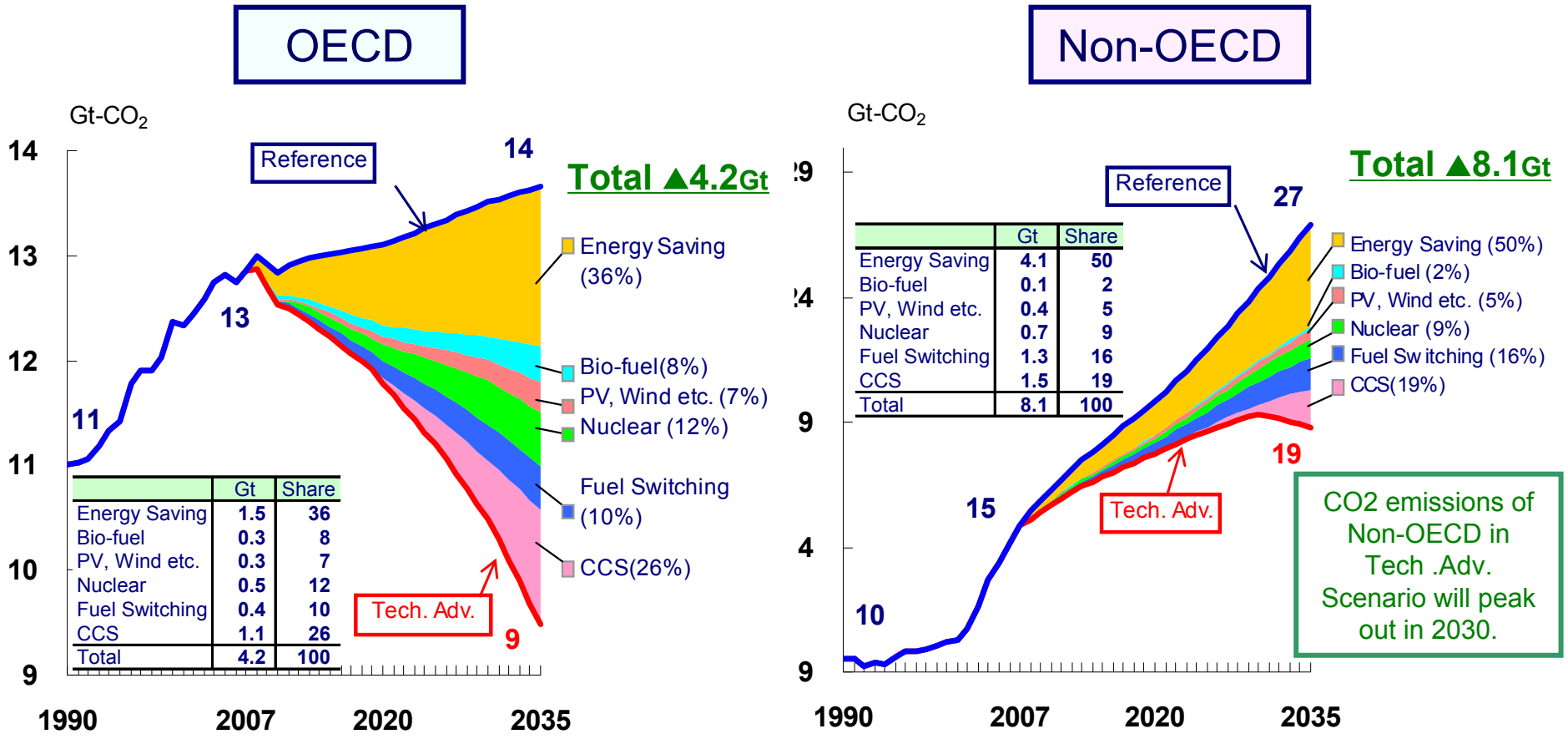
CO_2 Emissions by Sector (World)





Immense CO_2 mitigation potential is expected in power sector and transport sector

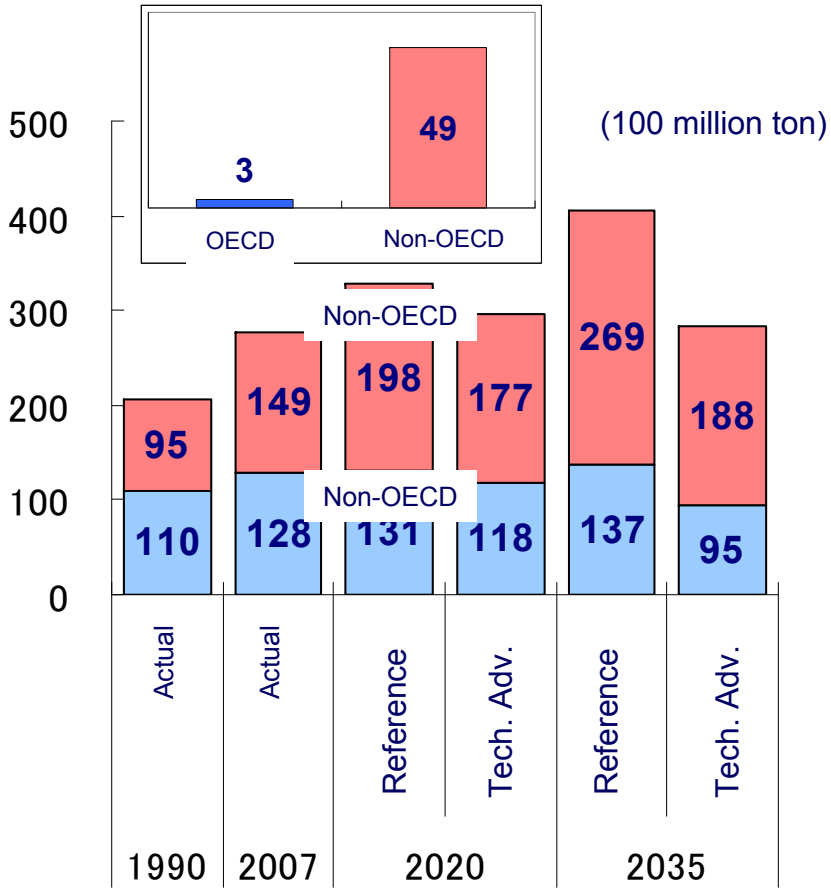
CO_2 Emissions in Tech. Adv. Scenario (OECD, Non-OECD)



Energy saving of Non-OECD in 2035 shows quite a large mitigation potential, 4.1 Gt-CO2 (around 30% of world total CO2 mitigation). Supportive measures concerning technology transfer and establishment of efficiency standards is important to realize substantial CO2 reduction as well as ensure energy security.

CO_2 Emissions (OECD/Non-OECD)

Increase from 2007 to 2020 (Reference)



CO_2 Growth (from 1990 level)

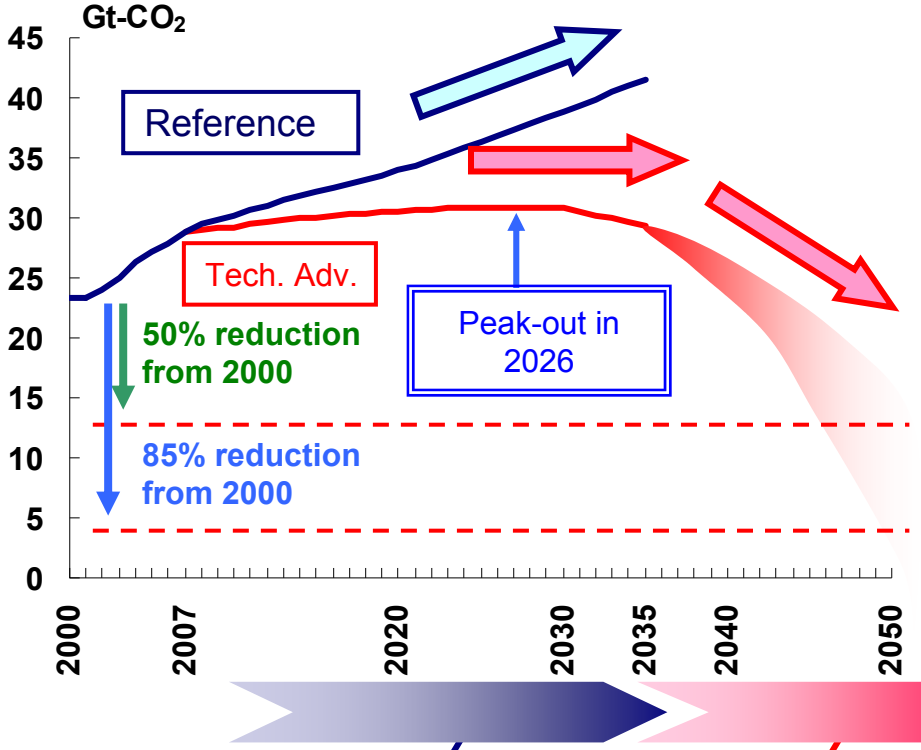
	2020	
	Reference	Tech. Adv.
World	+ 60%	+ 44%
OECD	+ 19%	+ 7%
Non-OECD	+ 108%	+ 86%
	2035	
	Reference	Tech. Adv.
World	+ 97%	+ 38%
OECD	+ 24%	▲14%
Non-OECD	+ 182%	+ 97%

*Include CO2 emissions from bunker fuel demand

In Tech. Adv. Scenario, CO2 emissions of OECD show 7% larger and that of Non-OECD represents 14% smaller than its 1990 emissions level.

Global CO_2 Emissions Path by 2050

Acceleration of the pace of mitigation after 2035 is required in order to achieve halving global CO2 emissions by 2050.



	GHG concentration	Peak-out	CO2 in 2050 (From 2000)	Global temp. rise
Ⅰ	445～490ppm	2000～2015	▲85% ～ ▲50%	2.0℃～2.4℃
Ⅱ	490～535ppm	2000～2020	▲60% ～ ▲30%	2.4℃～2.8℃
Ⅲ	535～590ppm	2010～2030	▲30% ～ ＋5%	2.8℃～3.2℃
Ⅳ	590～710ppm	2020 ～2060	＋10% ～ ＋60%	3.2℃～4.0℃
Ⅴ	710～855ppm	2050 ～2080	＋25% ～ ＋85%	4.0℃～4.9℃
Ⅵ	855～1130ppm	2060 ～2090	＋90% ～ ＋140%	4.9℃～6.1℃

*IPCC **4**th Report

<Technological Strategy towards 2035>
- Energy Efficiency(Industry、Building、Transport)
- Nuclear
- PV、WInd、Bio-fuel etc.
- Environmentally compatibe use of fossil-fuel (IGCC, CCS)
- Plug-in Hybrid、Electric Vehicle

<Technological Strategy towards 2050>
- Development of Innovative Technology (FBR, SPS, Innovative industrial Process, Geo-engineering)
- Distributed energy system
- Low Carbon Society
- Hydrogen Society

CO_2 Decomposition Analysis

Average annual growth rate: %

		Asia (excluding Japan)			China (2007-2035)		India (2007-2035)	
		1980-2007	2007-2035					
			Reference	Tech. Adv.	Reference	Tech. Adv.	Reference	Tech. Adv.
CO_2 Emissions	ΔC	5.2	2.4	0.7	1.8	▲ 0.1	3.3	1.3
Decarbonization	Δ(C/E)	▲ 0.3	▲ 0.4	▲ 1.3	▲ 0.6	▲ 1.6	▲ 0.4	▲ 1.3
Energy Saving	Δ(E/Y)	▲ 1.3	▲ 2.0	▲ 2.8	▲ 3.0	▲ 3.9	▲ 2.3	▲ 3.3
Economic Growth	ΔY	6.9	4.9		5.6		6.1	

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

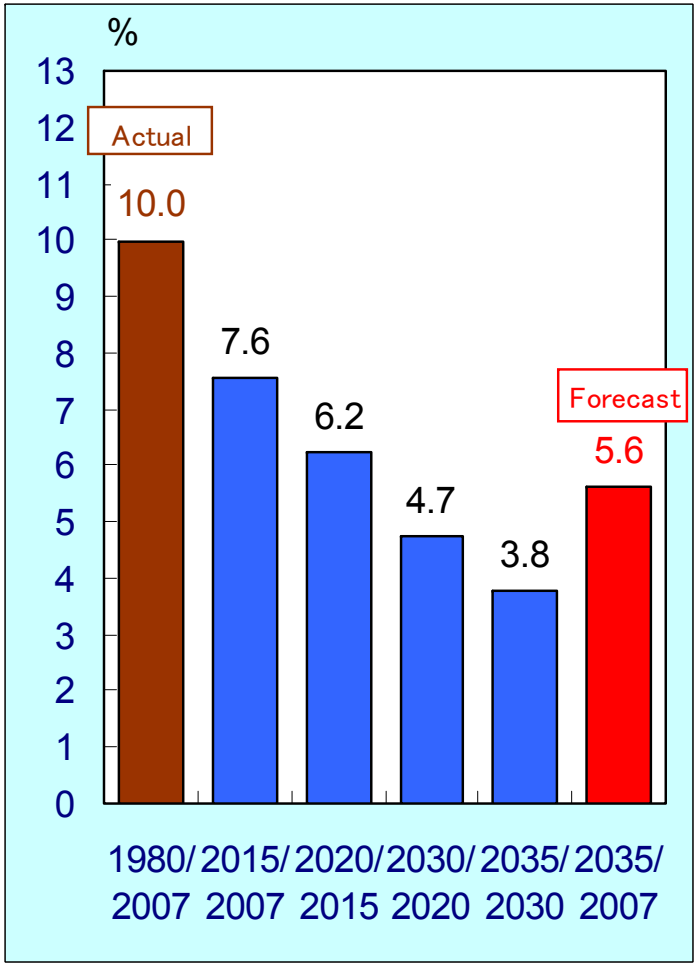
$$\Delta C = \Delta(C/E) + \Delta(E/Y) + \Delta Y$$

Decarbonization　Energy Saving　Economic Growth

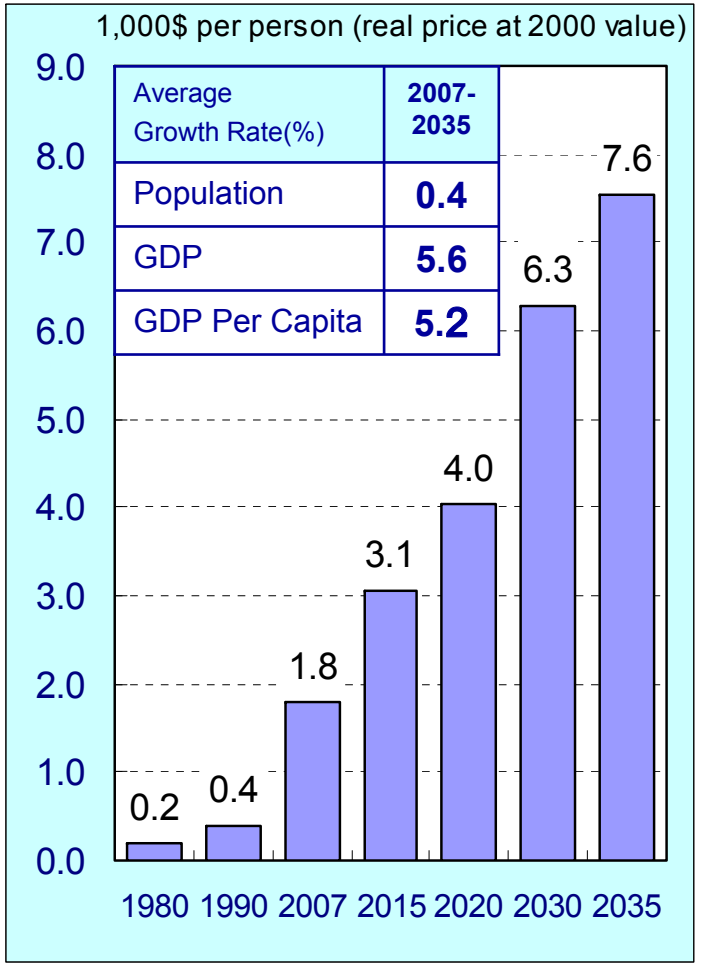
Energy Demand and Supply in China

GDP Growth of China

【 GDP Growth Rate 】



【 GDP Per Capita 】



GDP

2007
2.4 B.USD
↓
2035
11.0B.USD
(**4.6** times)

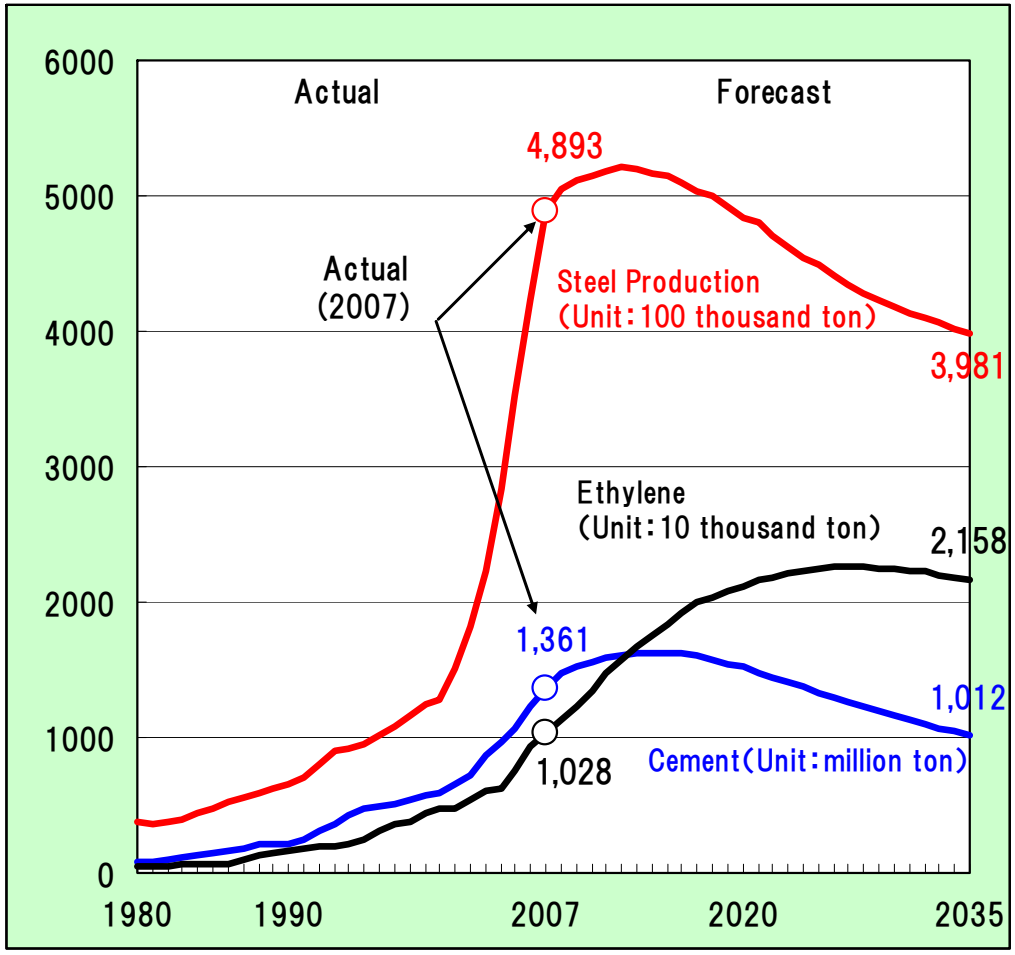
Urban Rate

2007
44.9%
↓
2035
63.7%
(**19.8**points up)

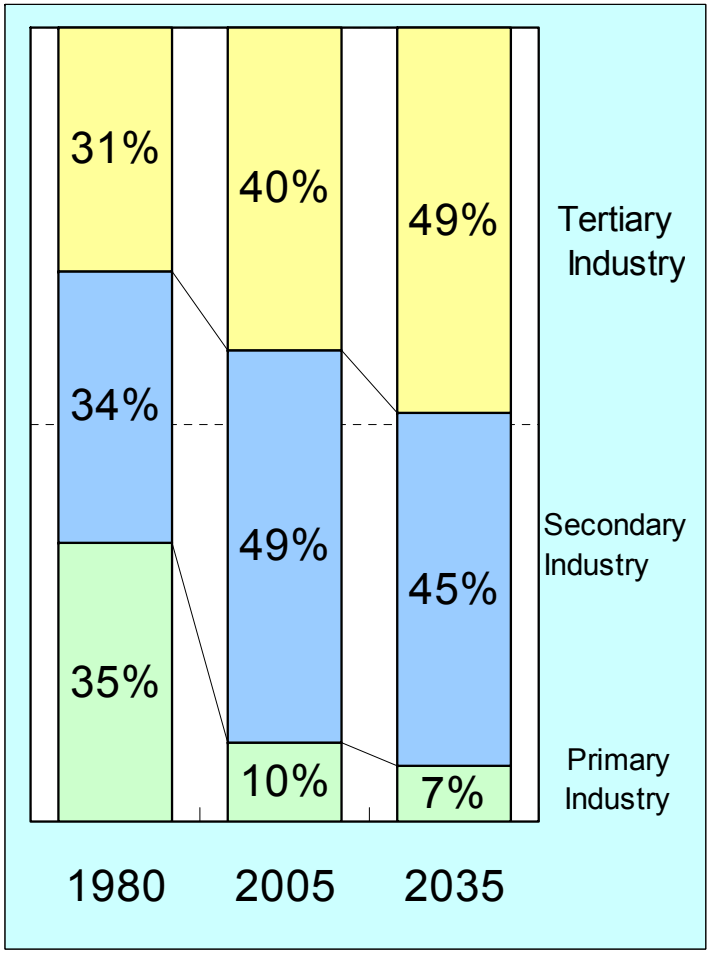
- In the long term point of view, Chinese economic growth gradually become moderate due to the shift from export and investment-driven growth to consumption-led growth. The rate of economic growth will slow down reflecting on labor force decrease, environmental consideration and resource constraints.
- GDP per capita (2005 price) is expected to become 7,600 USD, four times of 2007.

Raw Material Production and Industrial Structure in China

【 Raw Material Production 】

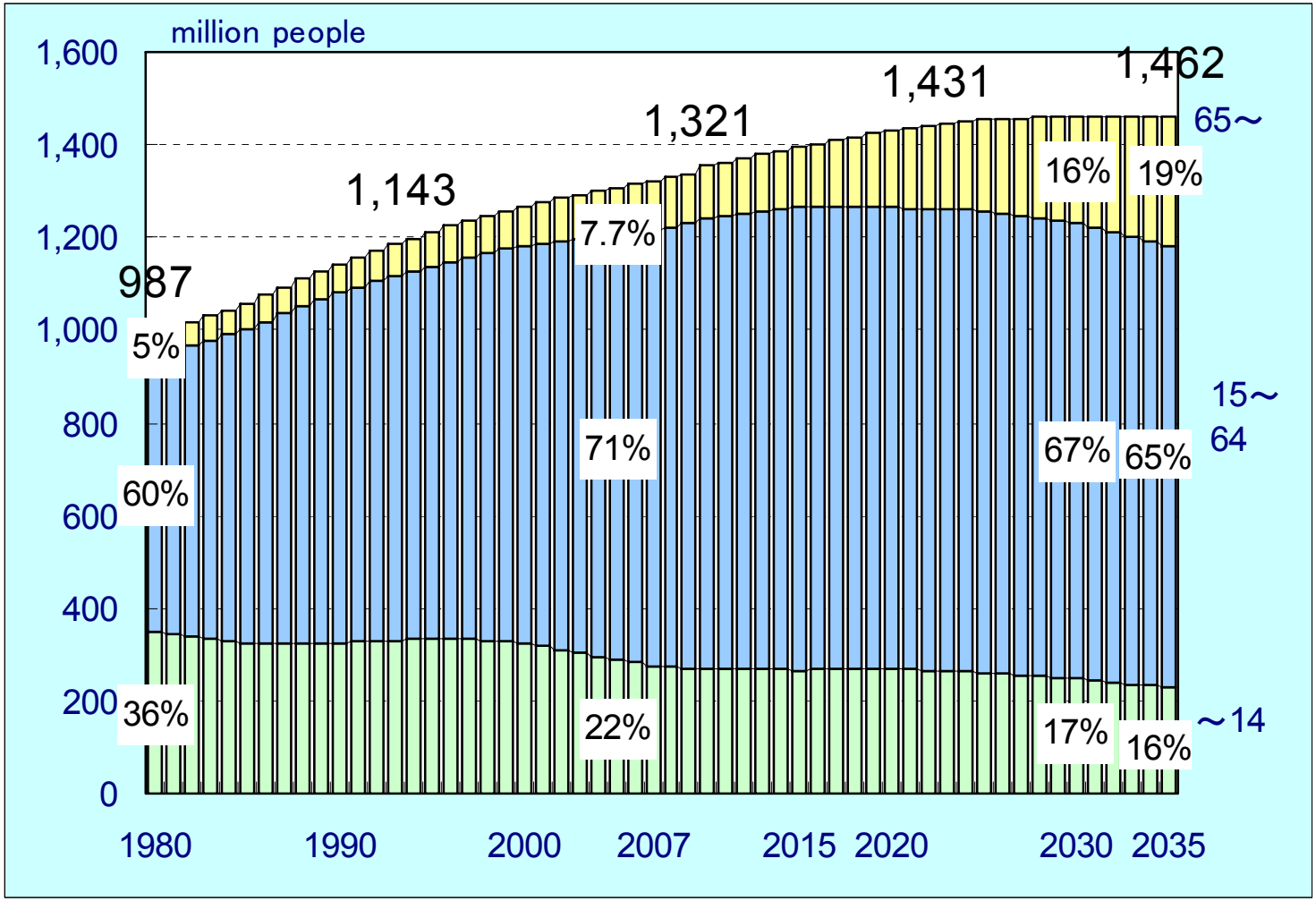


【 Industrial Structure 】



- Although raw material products currently increase sharply, they are forecast to peak out. Steel production will decrease from about 500 million ton at present,to lower 400 million ton which is assumed to reflect actual demand in 2035.
- Heavy industry is likely to decrease while the weight of secondary industry remains on the same level.

Population in China



Average Growth Rate (%)	2007-2035
Total	**0.4**
Over 65	**3.6**

Total Population(Million)

2007
1,310
↓
2035
1,460
(**1.1** times)

Urbanization Rate

2007
44.9%
↓
2035
63.7%
(**19.8**points up)

- Population increases at 0.4% annually and will peak at around 1,460 Million by 2030 and outnumbered by India.
- Aging population grow and people over 65 rises to 19.2% in 2035. Labor force will peak by 2015 and begin to decrease.

Energy Policies of China

【Main Goals of the 11th 5-Year Plan】

△Basic Energy Policy:

Prioritize energy saving, pioneering domestic demand, multidimensional development, elaborate focus on science & technology, environmental protection, enhance international mutual corporation, strive to construct the Stable, Economical, Clean and Safe energy supply system, support the sustainable economic and social development.

△Economic Growth Goal:

Increase GDP per Capita in 2020 to four times level in 2000

△Energy Saving Goal:

Mitigate energy intensity of GDP by 20%（between 2006 and 2010）

△Renewable Energy Goal:

Increase its ratio of TPE to 15% by 2020.

△Coal Industry development Goal:

Streamline minor coal mines, emphasize orderly development（in the 11th 5-Year Plan）

Renewable Energy Policies of China

【Goals of the 11th 5-Year Plan】

△Renewable Energy Goal

Increase its ratio of TPE to 10% by 2010, to 15% by 2020.

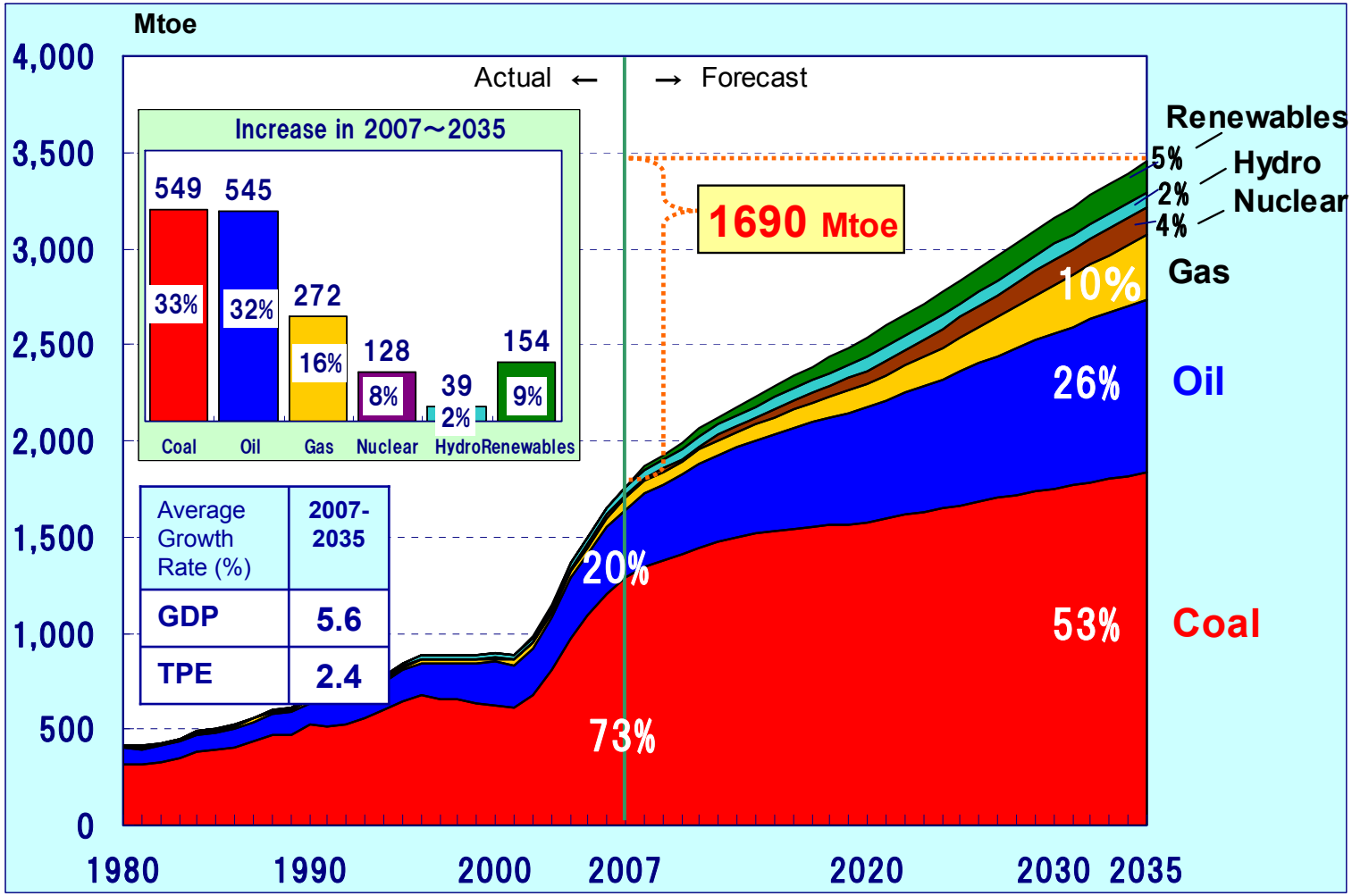
△Specific Target

	2010	2020
Hydro Power	190GW	300GW
Wind Power	10GW	30GW
Biomass Power	5.5GW	30GW
Biomass Fuel		
inedible ethanol	2Mt	10Mt
biodiesel	0.2Mt	2Mt
Photovoltaic	0.3GW	1.8GW

△Recent Movement

As for wind power, its target will be enhanced to higher value

Primary Energy Demand in China



TPE

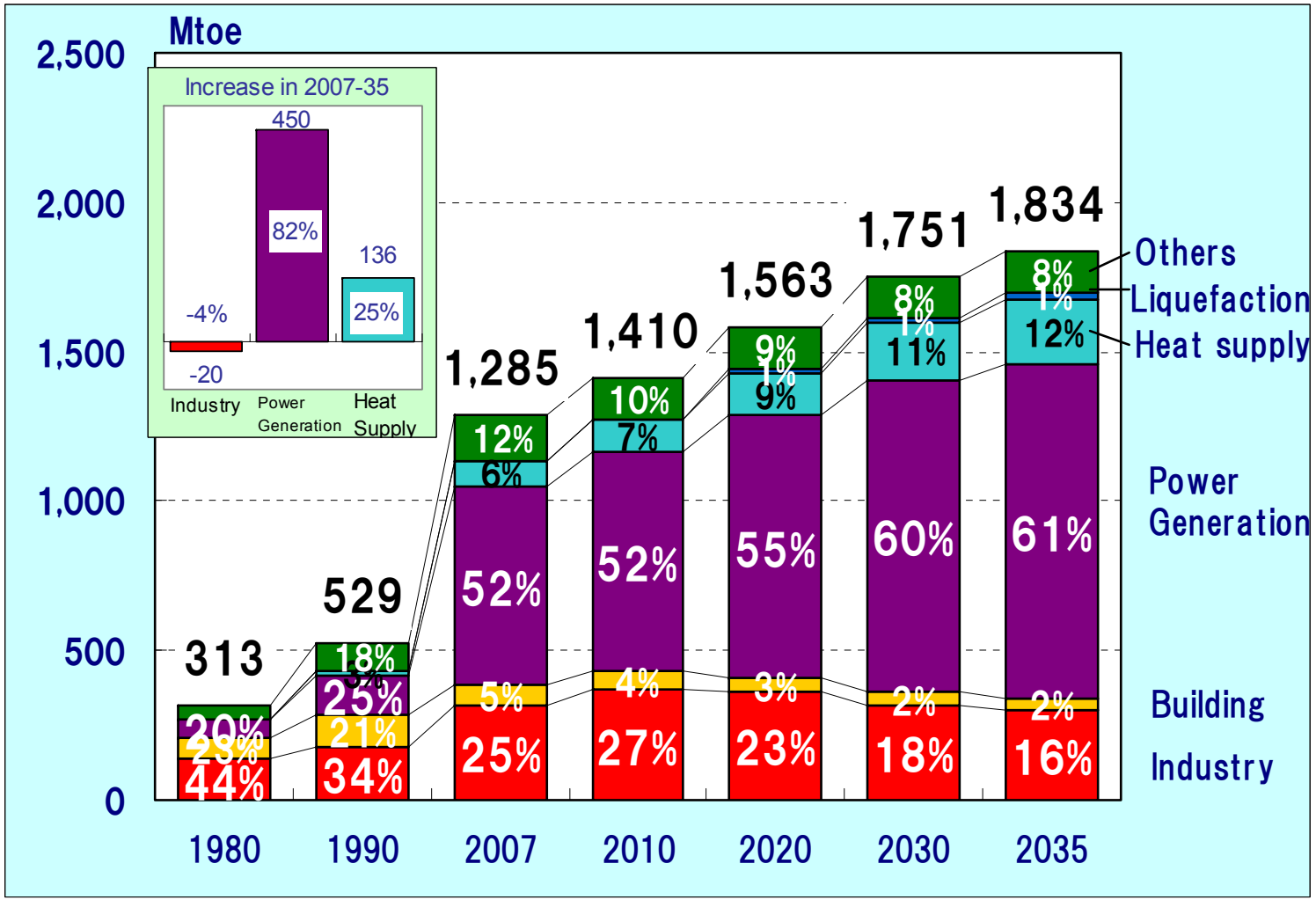
2007
17.7Mtoe
↓
2035
34.5Mtoe
(2.0times)

Oil Demand

2007
740 mb/d
↓
2035
1,880 mb/d
(2.5times)

- TPE will increases at annual rate of 2.4% and amount to 3,450 Mtoe in 2035, due to vigorous economic growth rate.
- Coal will grow particularly in power generation and oil will expand reflecting on motorization
- Gas will sharply grow in household and commercial usage, especially in urban area.

Coal Demand by Sector in China

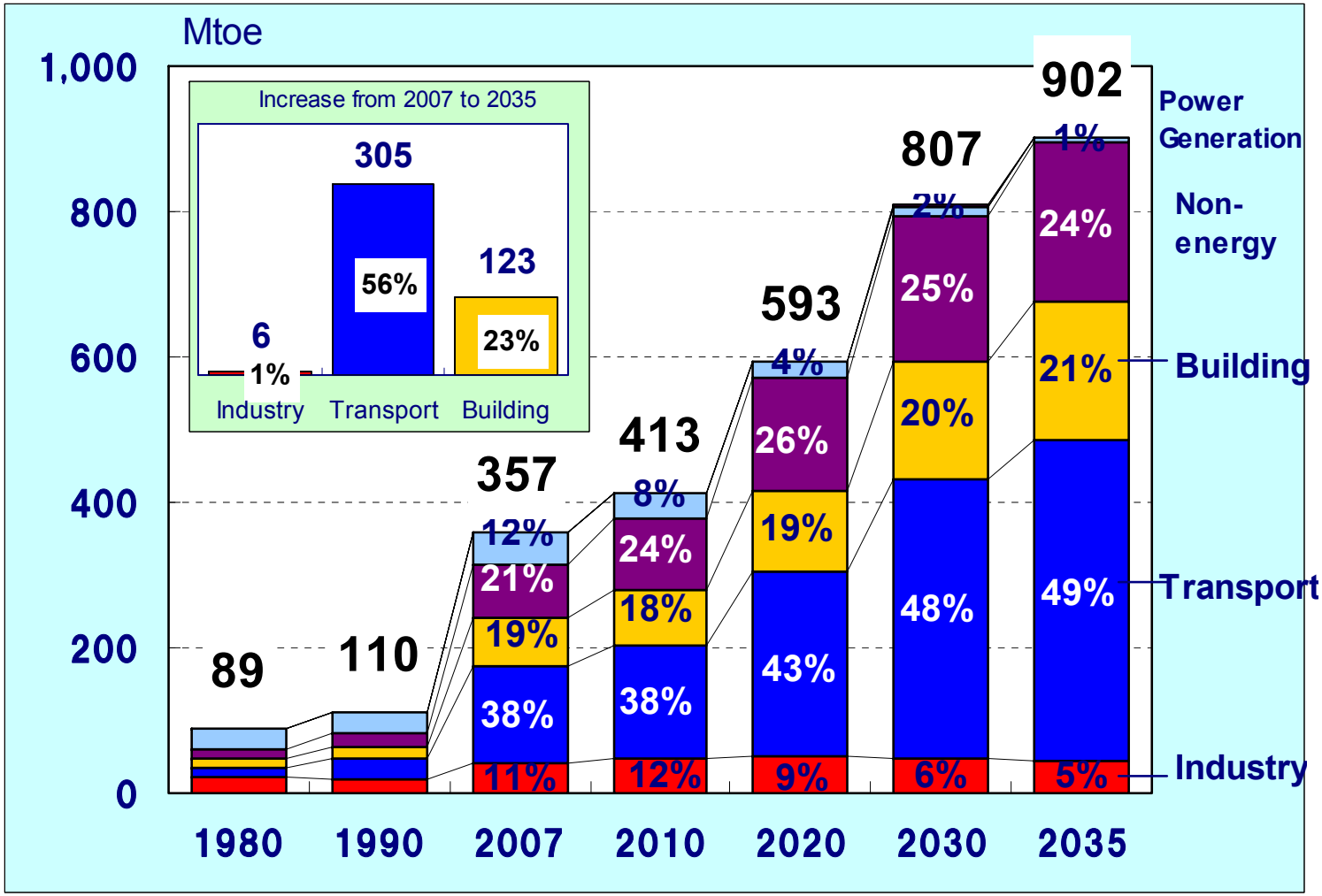


Coal Demand (Mtoe)

2007
1,290
↓
2035
1,830
(1.4times)

- Currently, 52% of coal demand is consumed by power sector. This ratio is expected to grow by 2035.
- Coal demand in industrial sector will remain on the same level because of slowing down of steel production.

Oil Demand by Sector in China

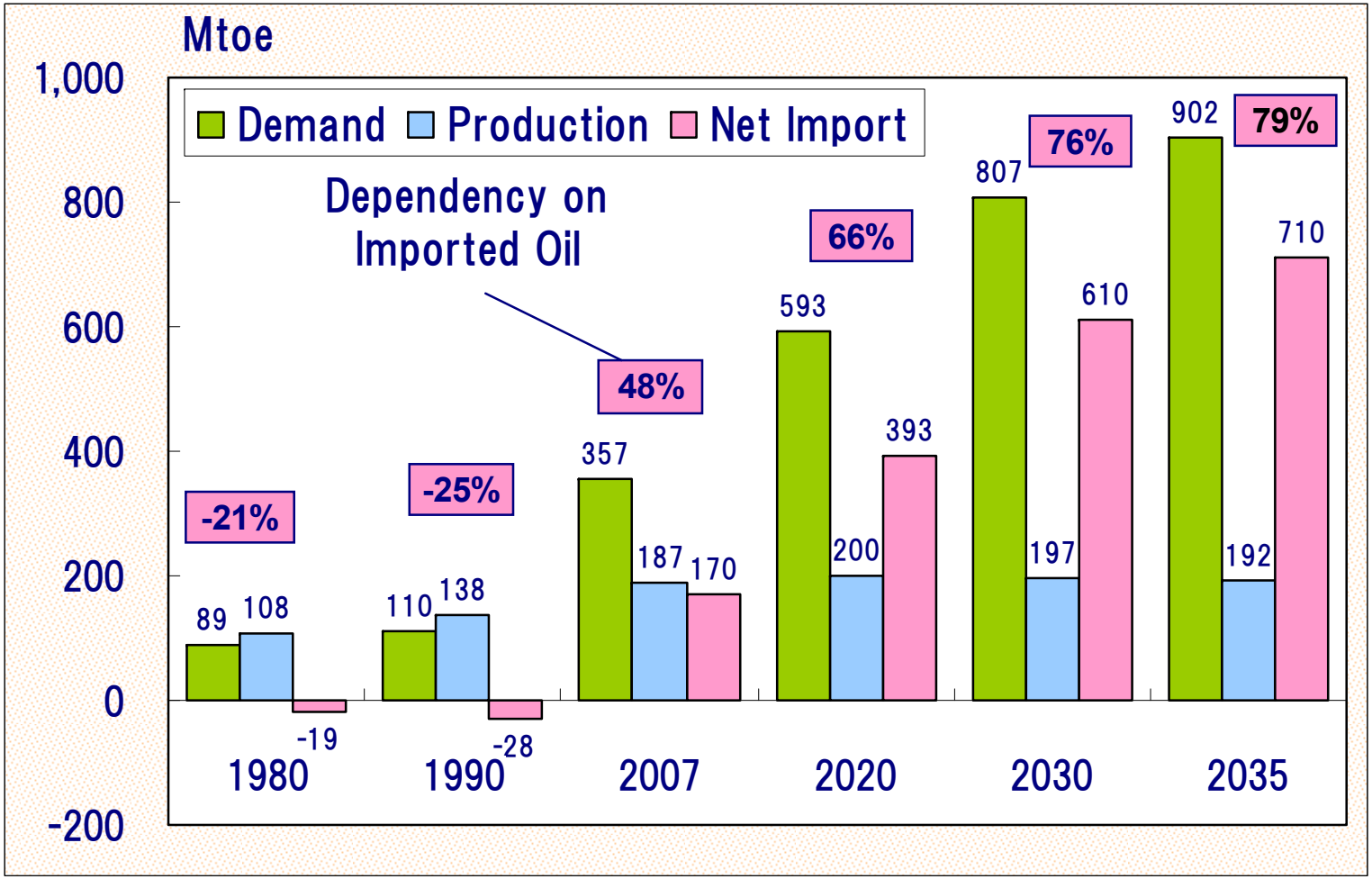


Oil Demand

2007
360 Mtoe
↓
2035
900 Mtoe
(2.5-fold inc.)

Oil demand growth will be driven mainly by motorization and the increase in fuel requirement in building sector.

Oil Demand and Supply in China



Net Oil Import

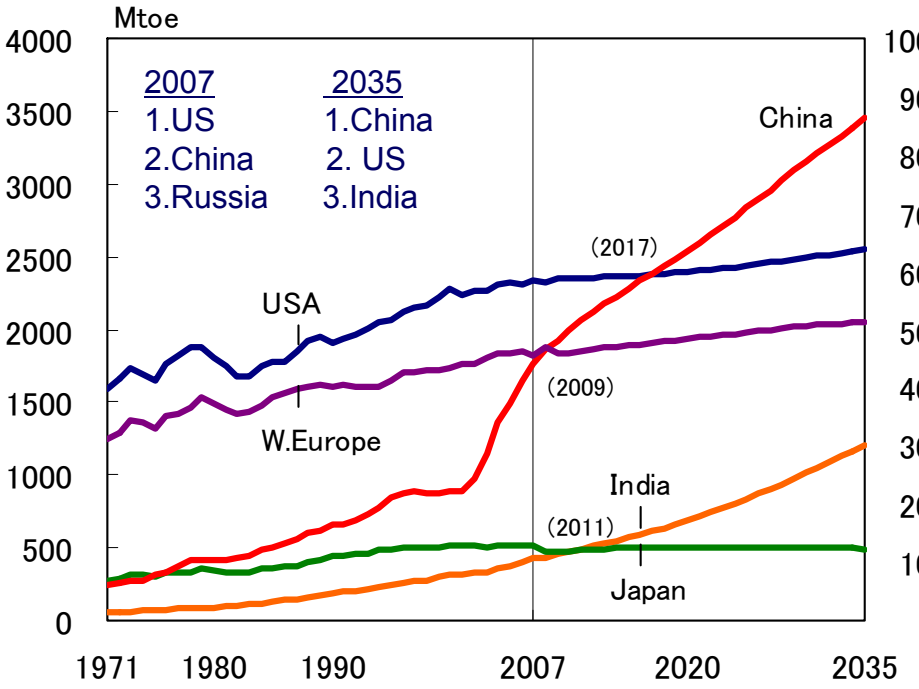
2007
3.6MB/D
↓
2035
14.8MB/D
(**4.1**times)

- Net oil import is projected to expand from 170 million ton (3.6 mb/d) in 2007 to 710 million ton (14.8 mb/d) in 2035.
- Elaborate exploration of oil field in west part of China and offshore field is expected in order to sustain domestic oil production.

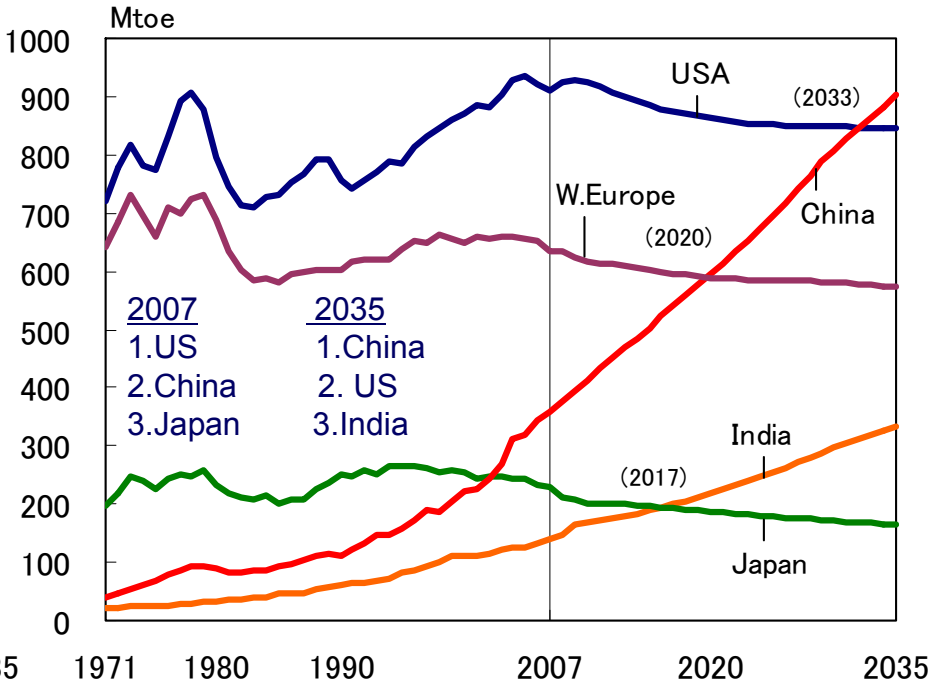
International Presence of China

- Chinese primary energy demand will overhaul western Europe in 2009, USA in 2017 and become the largest energy consuming country by 2035.
- Oil demand of China will outstrip western Europe in 2020, USA in 2033 and move up from No.2 in 2007 to No.1 by 2035. Share of Chinese oil demand over world oil demand is likely to expand from 9% in 2007 to 17% in 2035.

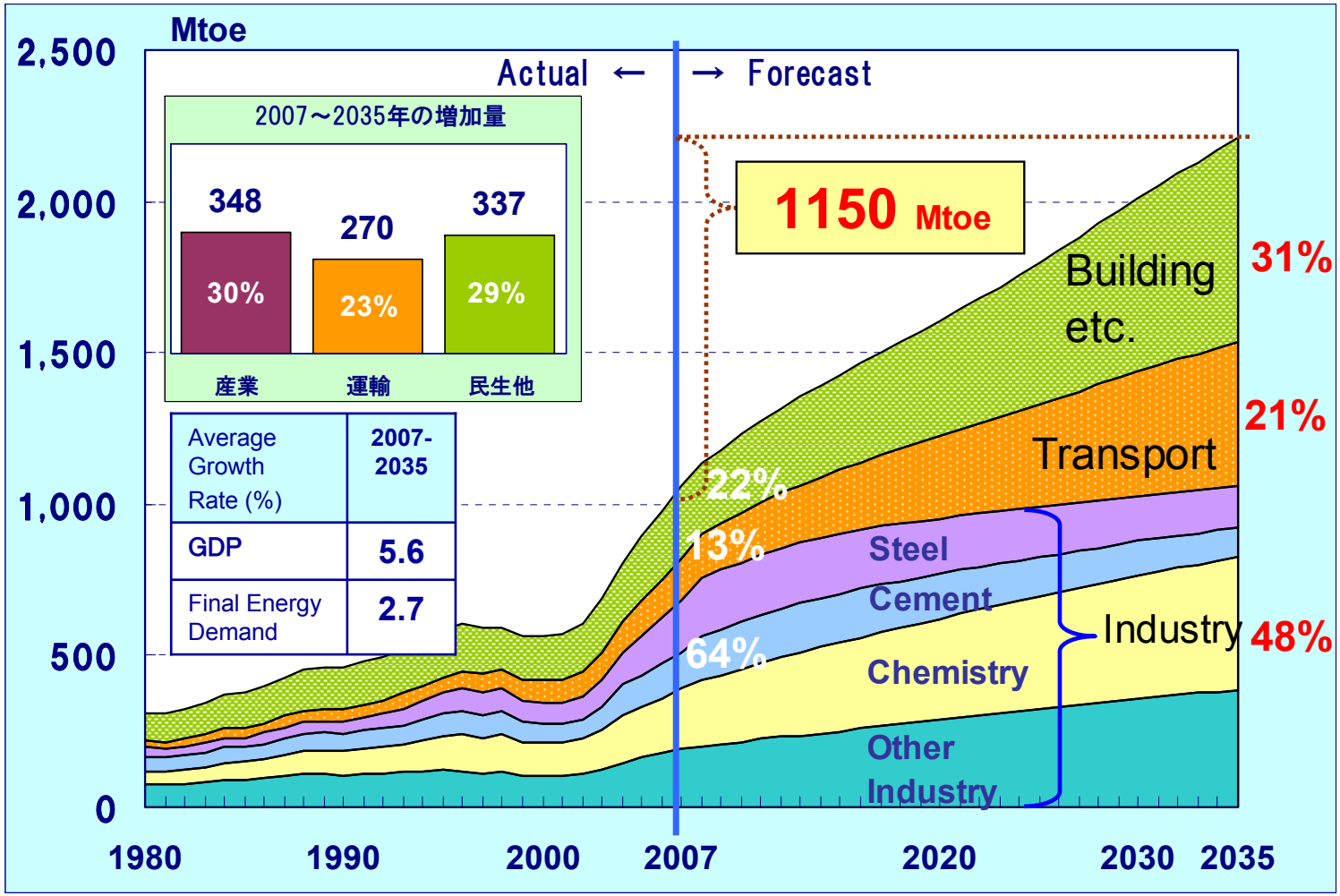
【Primary Energy Demand】



【Oil Demand】



Final Energy Demand in China



Final Energy Demand

2007
1,060Mtoe
↓
2035
2,210Mtoe
(2.1times)

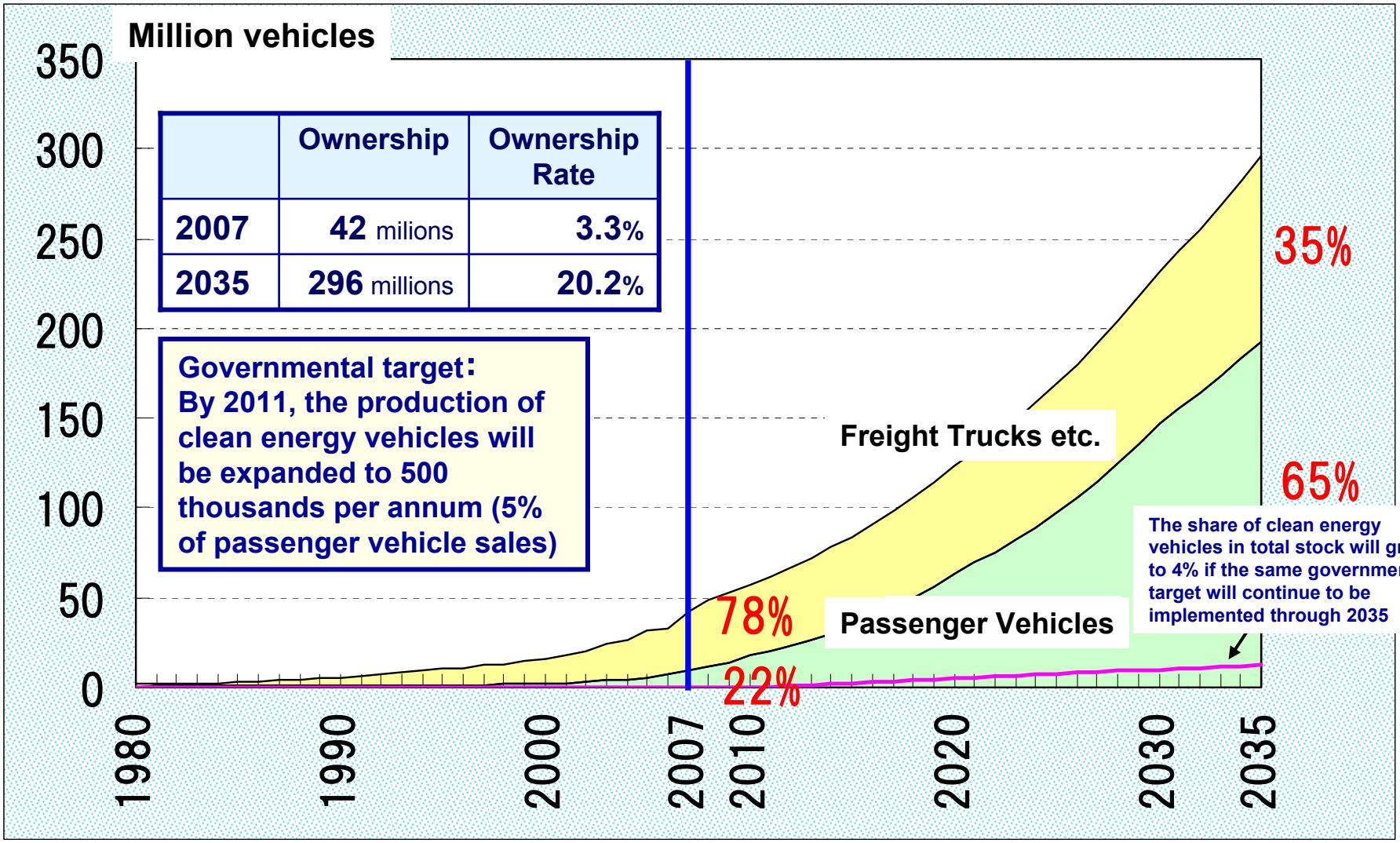
Electricity Demand

2007
2,680TWh
↓
2035
6,400TWh
(2.4times)

Note: industrial including non-energy usage.

- Energy demand growth of heavy industry will become saturated due to the sluggish growth of industrial activity such as raw material production.
- Energy demand on household sector, service sector and transport sector show significant growth. Its share will increase to one third of total energy demand by 2035, although per capital consumption in household and service sector is still lower level compared with international average.

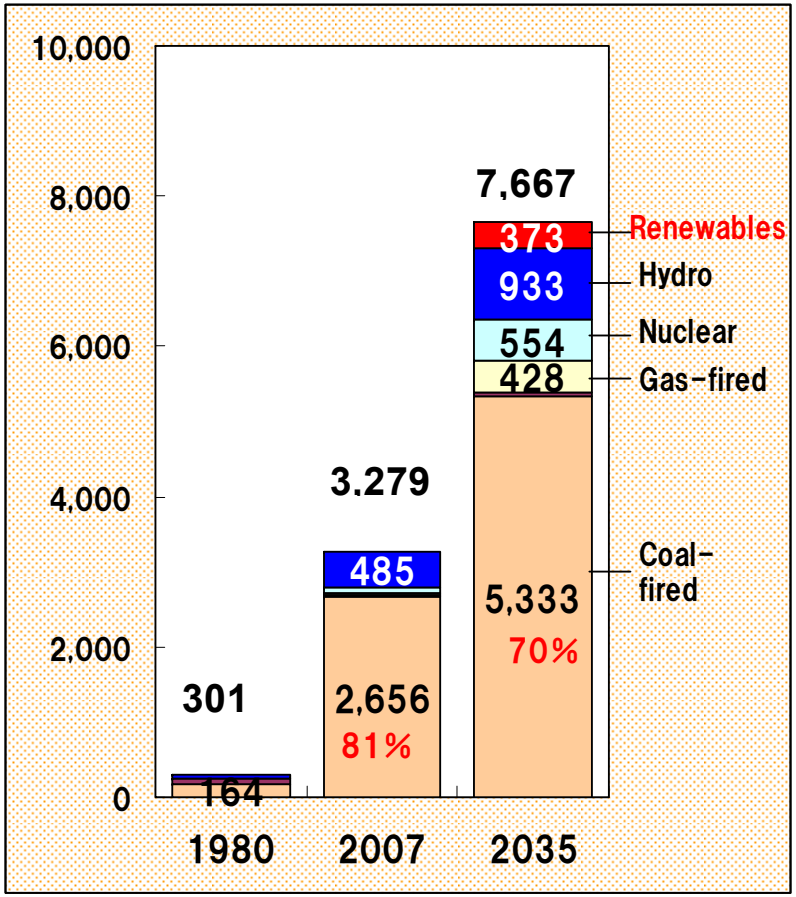
Automobile Ownership in China



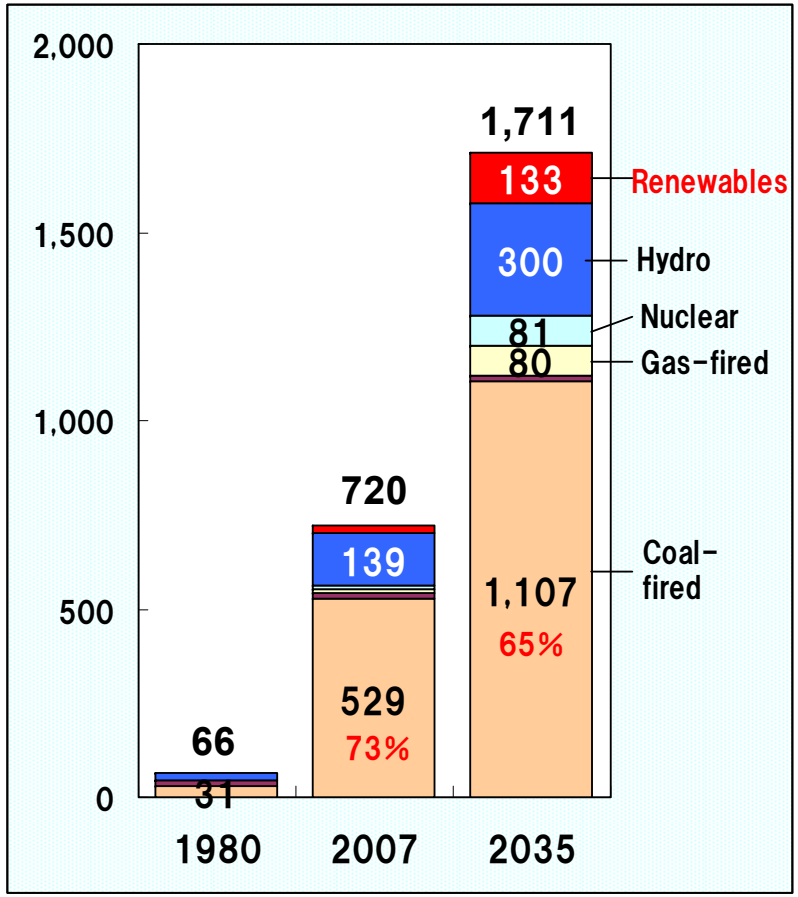
Automobile ownership in China will increase to about 300 millions in 2035. The stock of passenger vehicle will expand to 190 millions in 2035.

Power Generation Sector

【Power Generation(TWh)】

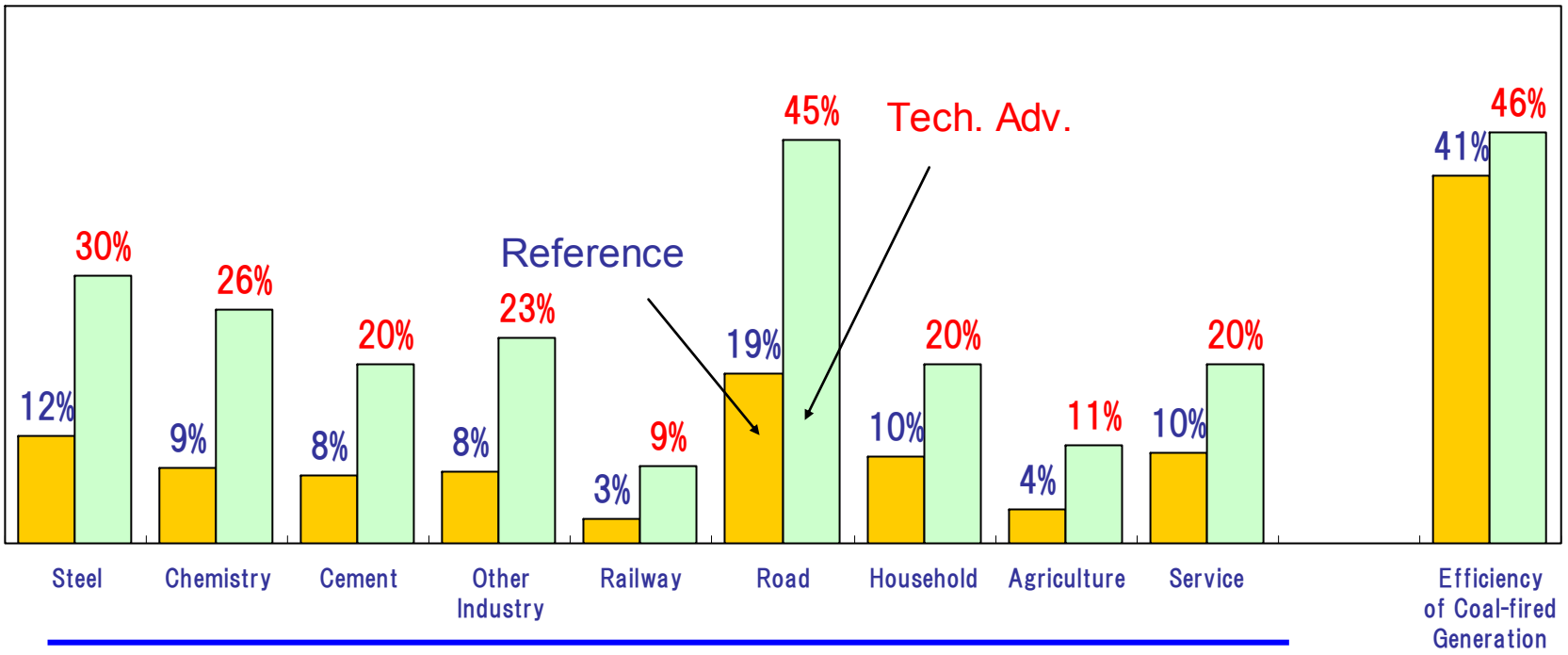


【Capacity(GW)】



- Total power generation capacity will increase from 700 GW in 2007 to 1,700 GW in 2035, showing average annual capacity growth at 35GW. The share of coal-fired power plant will gradually decline to 65%.
- Total power generation will increase from 3.3TWh in 2007 to 7.7TWh in 2035. the share of coal-fired will edge down from 81% to 70%.
- Power generation from gas-fired, nuclear and renewables will substantially increases, while hydro power represents sluggish growth.
- Coal-fired power generation capacity of China in 2035 accounts for almost half (48%) of the world coal-fired power generation capacity.

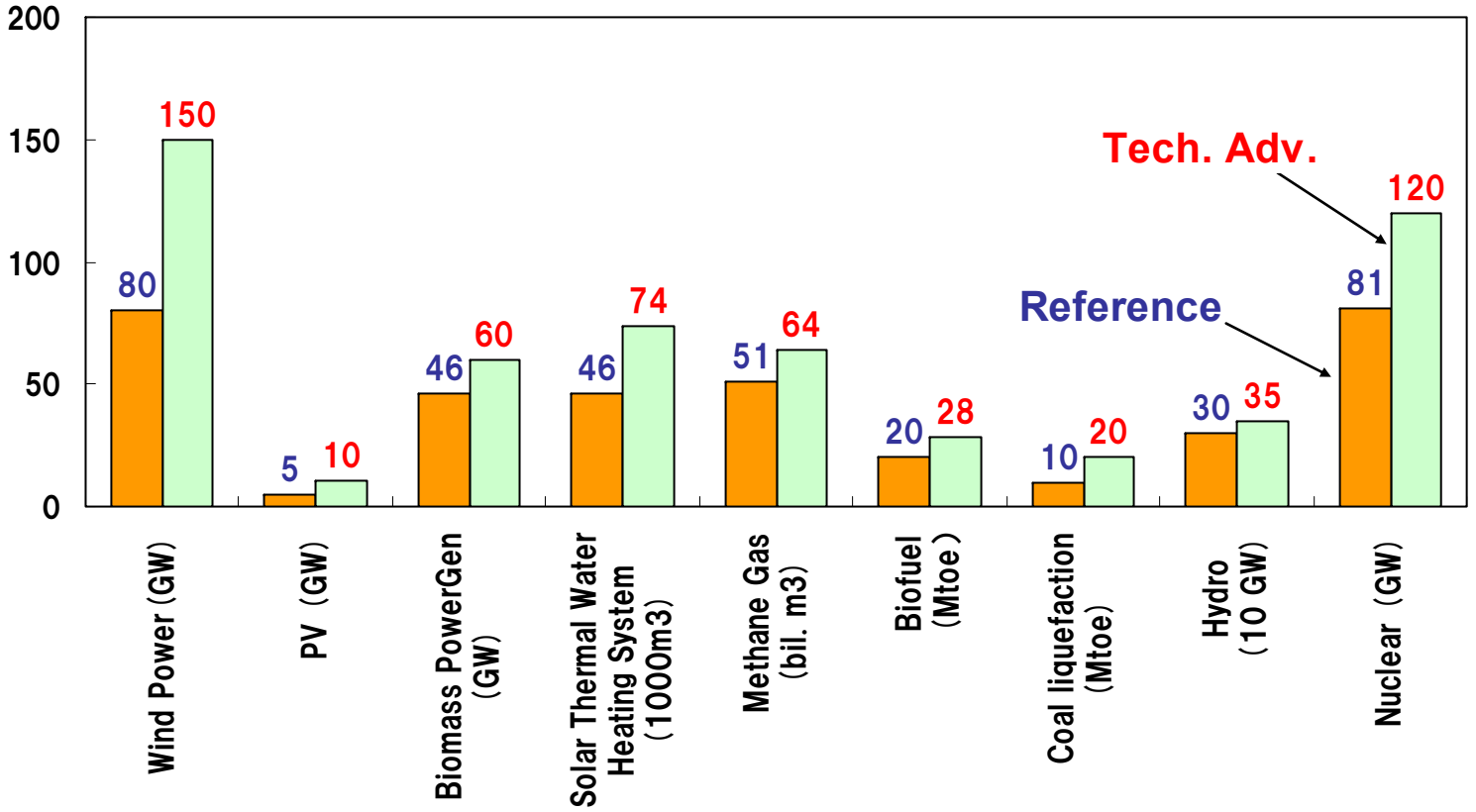
Energy Saving Rates



Energy saving ratio at 2035 from 2005

- In household and commercial sector, reforming heating price system and promoting energy labeling system is expected to play a key role.
- Enlarge production scale, improve production process efficiency and fuel switching of energy supply in chemical sectors is important.
- Increasing NSP rate in cement (50%→nearly 100%) and expanding waste-fired power generation will provide massive energy saving.
- In power generation sector, expanding average power generation capacity (60MW→ 350MW) and introduce advanced technology like IGCC will provide considerable saving of coal demand.

Non-fossil fuel forecast in China (2035)



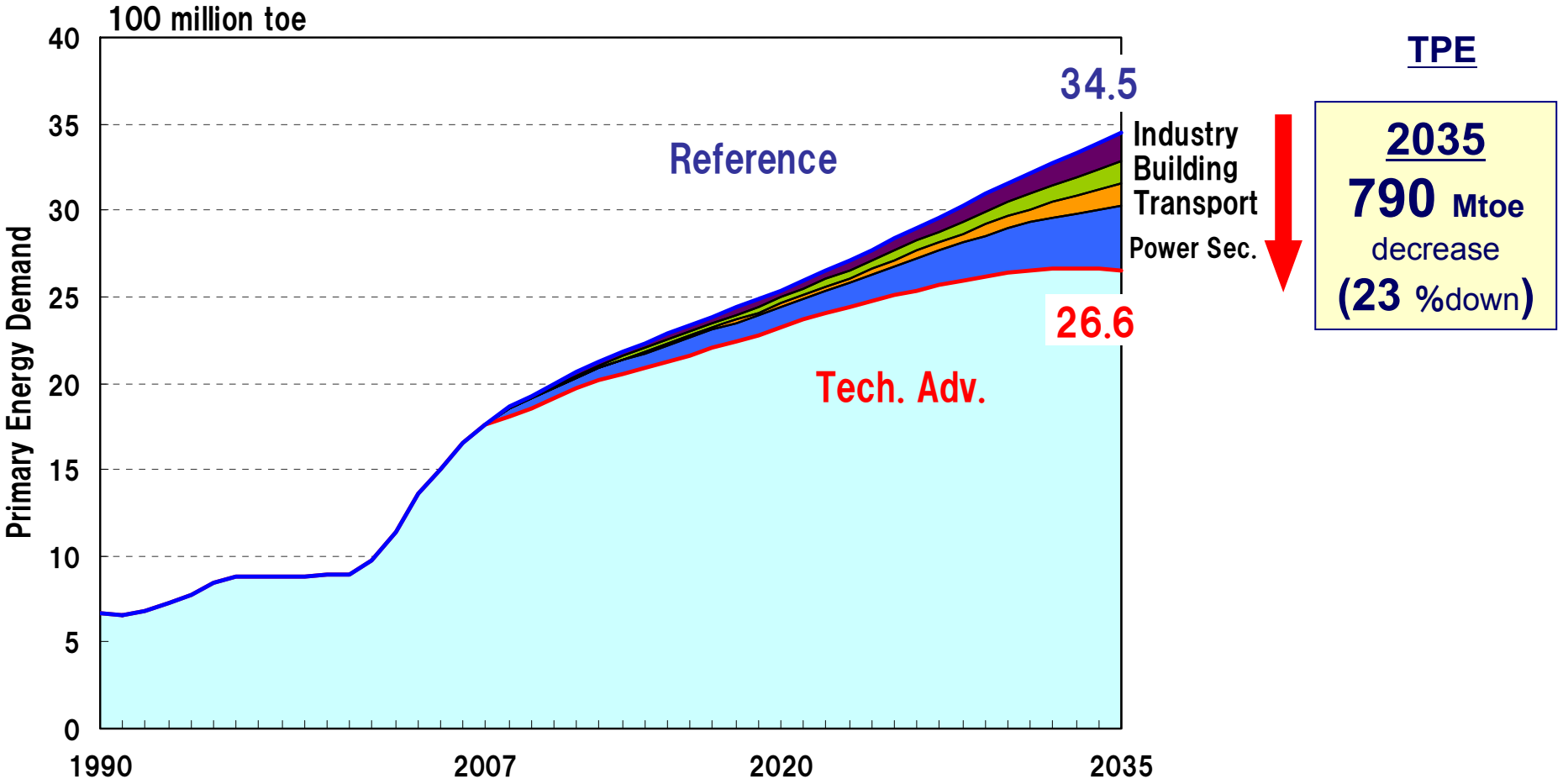
Non-fossil Fuel (2035)

Reference
380 Mtoe
Ratio of TPE
(11%)

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

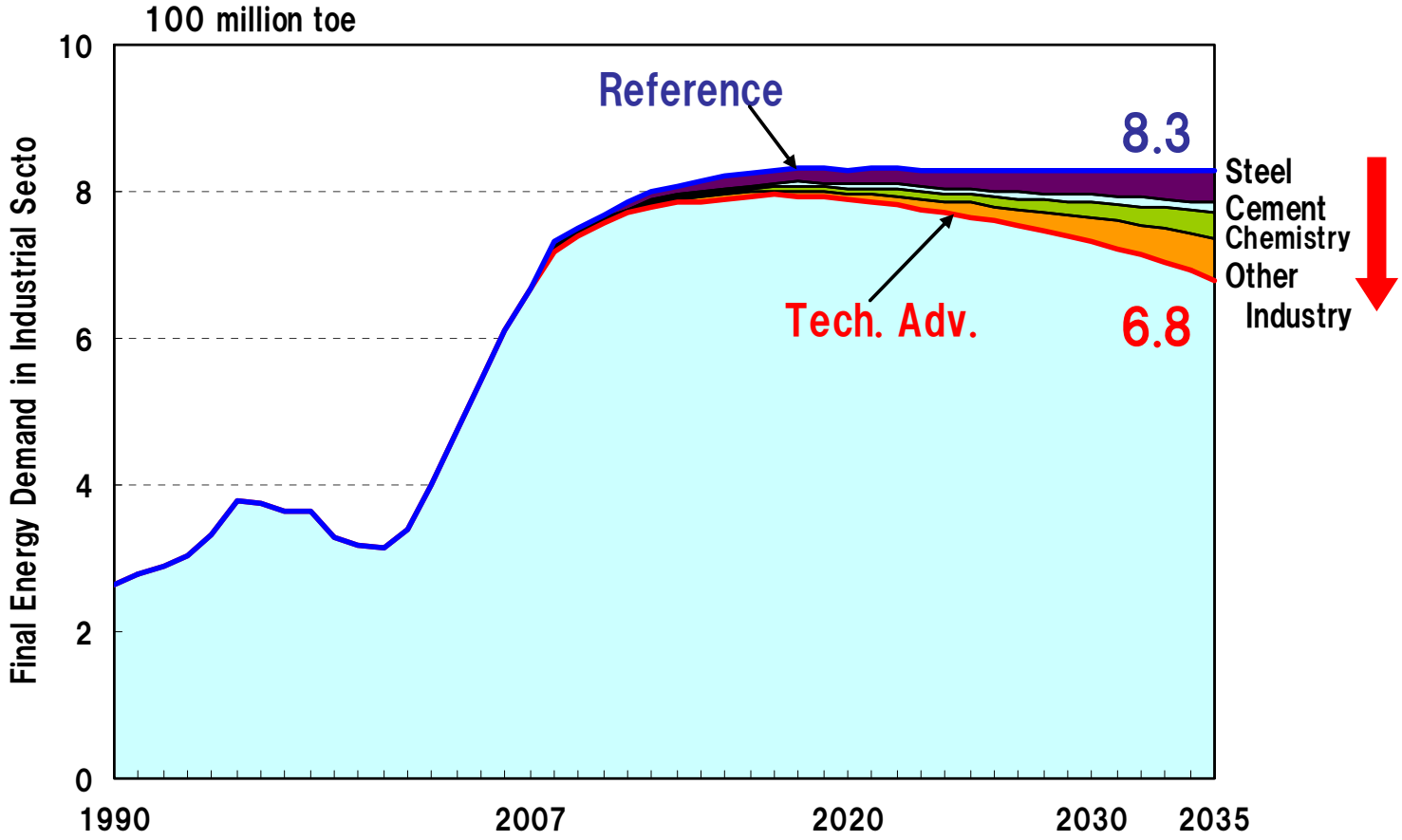
- Hydro expansion will be limited due to resource constraint and environmental consideration.
- Great expansion of nuclear and wind power is expected because of considerable electricity demand growth and environment protection.
- Non-fossil fuel supply will increase to 380 Mtoe in 2035, a ratio of 11% to TPE, and further boosts to 20% in Technologically Advanced Scenario.

Primary Energy Demand in China



In Technologically Advanced Scenario in 2035, TPE will decrease by 790 Mtoe, showing 23% reduction compared with Reference scenario. The primary energy demand will peak out in 2033. The energy saving potential rate in power sector will be relatively larger.

Final Energy Demand in Industrial Sector



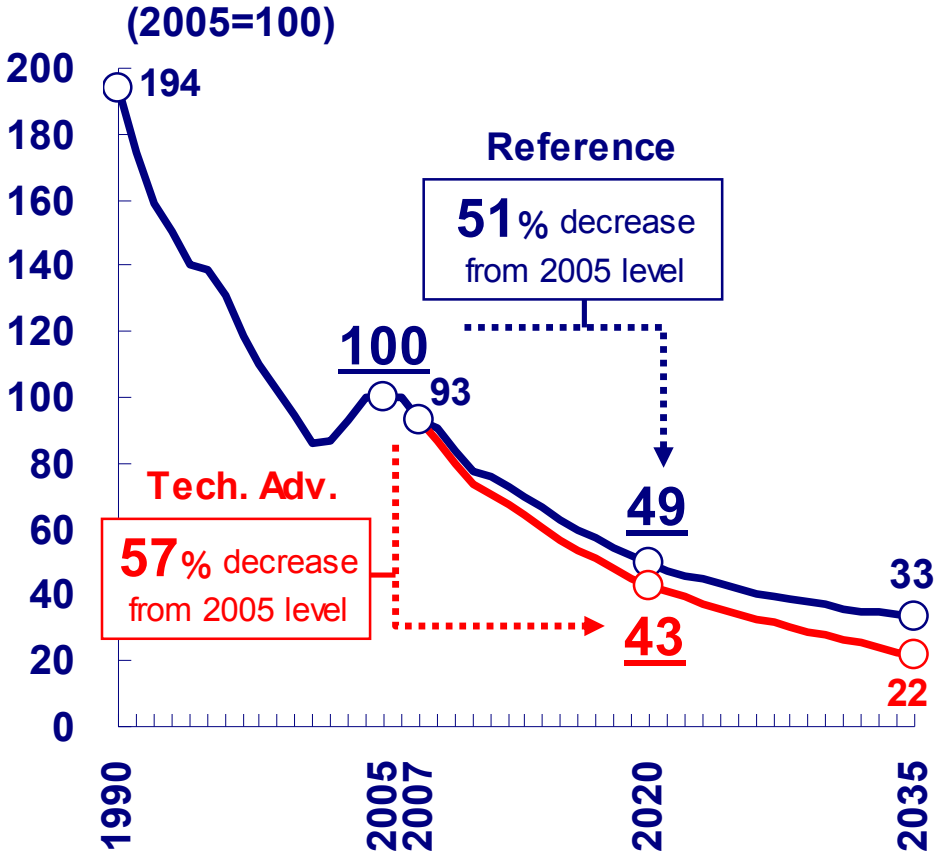
FED

2035
1.5 Mtoe
decrease
(18 %down**)**

Note: Include energy demand in coke-production process

- In Reference scenario, energy demand growth rate in industrial sector will become moderate at 0.1% annually after 2020, reflecting on energy saving and decreasing trend of raw material production.
- In Technologically Advanced scenario, final energy demand will decrease 1,500Mtoe(18%) in the industrial sector compared to Reference scenario in 2035.

CO_2 Emissions per GDP



Decomposition Analysis of CO_2 Emissions

		1990-2005	2005-2020	
			Reference	Tech. Adv.
CO_2 Emissions	ΔC	5.4	2.8	1.8
Carbon Intensity	Δ(C/E)	▲ 0.2	▲ 0.8	▲ 1.1
Energy Saving	Δ(E/Y)	▲ 4.1	▲ 3.9	▲ 4.4
Economic Growth	ΔY	10.1	7.7	

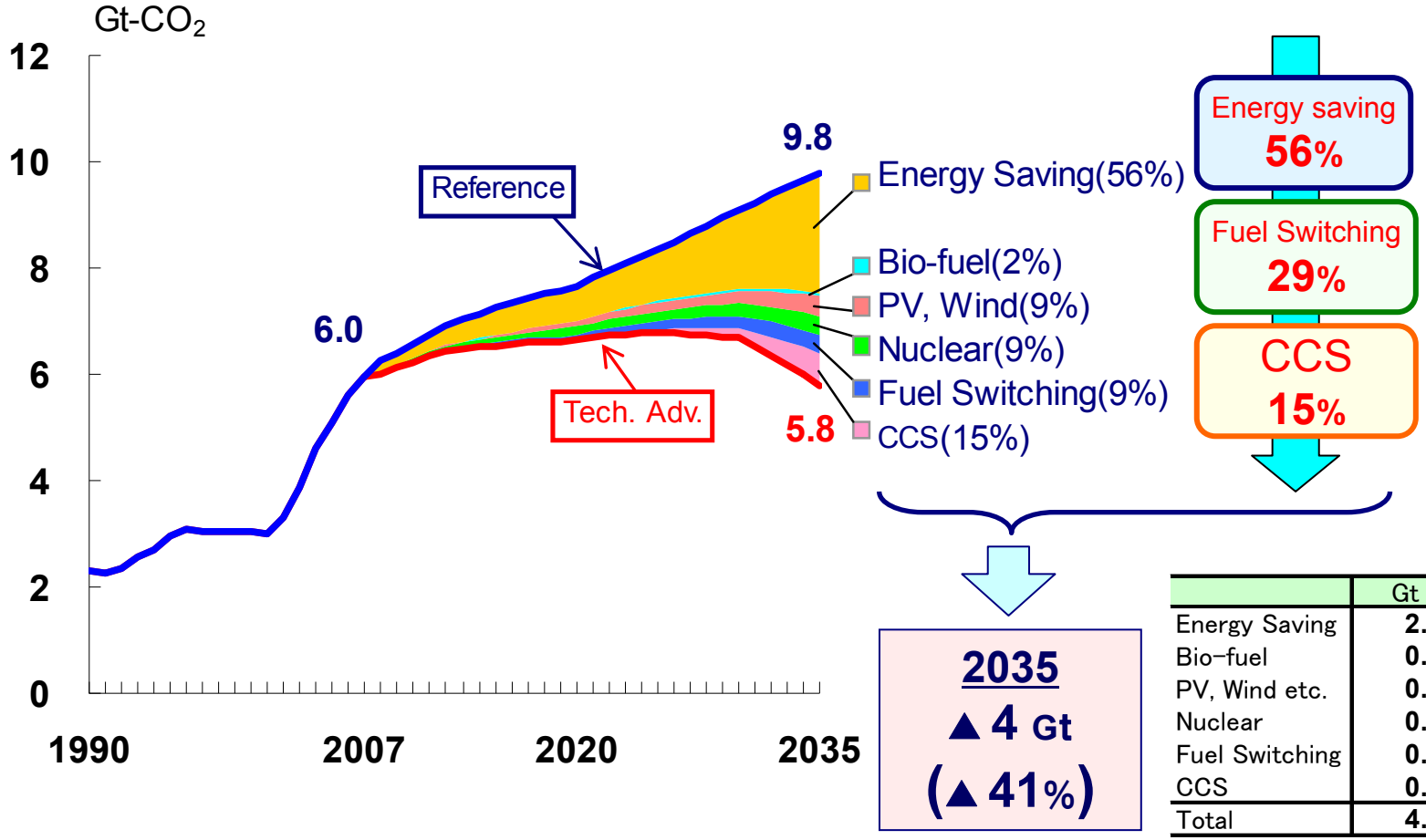
$$C = (C/E) * (E/Y) * Y$$

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

Decarbonization / Energy-Saving / Economic-Growth

- State Council of Chinese government decided to reduce CO_2 emissions per GDP by 40%-45% from 2005 level by 2020 in Nov. 25, 2009.
- Towards 2020, CO_2 emissions per GDP is projected to be reduced by 51% in Reference scenario, and by 57% in Tech. Adv. Scenario. Even in Reference scenario, CO_2 emissions per GDP will decrease more than the official target.

CO_2 Emissions in China



	Gt	Share
Energy Saving	2.3	56
Bio-fuel	0.1	2
PV, Wind etc.	0.4	9
Nuclear	0.3	9
Fuel Switching	0.4	9
CCS	0.6	15
Total	4.0	100

- In Reference scenario, CO_2 emission will increase by 3.8 Gt (about 60%Up) between 2007 to 2035.
- In Technologically Advanced scenario, it will decrease by 4.0 Gt (41%Down) in 2035, compared with Reference scenario.
- CO_2 emissions will peak around 2030 due to energy saving and expansion of renewable energy etc (it will peak out in 2025 if implementing CCS)

Energy Demand and Supply in India

Energy and Economic Situation in India

Vigorous economic growth and eventual energy demand rising

AAGR from 1990 to 2007

GDP: 6.3%、TPES: 5.1%、Coal: 5.0%、Oil: 5.1%、Gas：7.5%

CO_2 emissions

AAGR from 1990 to 2007: 4.9%

Electric power shortage

Lower energy efficiency than world average

TPES per GDP(2007) (toe per million $ at 2000 value)

India：556、World：276、Non-OECD：522、Japan：99、China：739

Rising trend of reliance on imported oil

Dependency on oil import (2007)：69%

Heavy reliance on coal

Share of coal on TPES: 56% (2007)

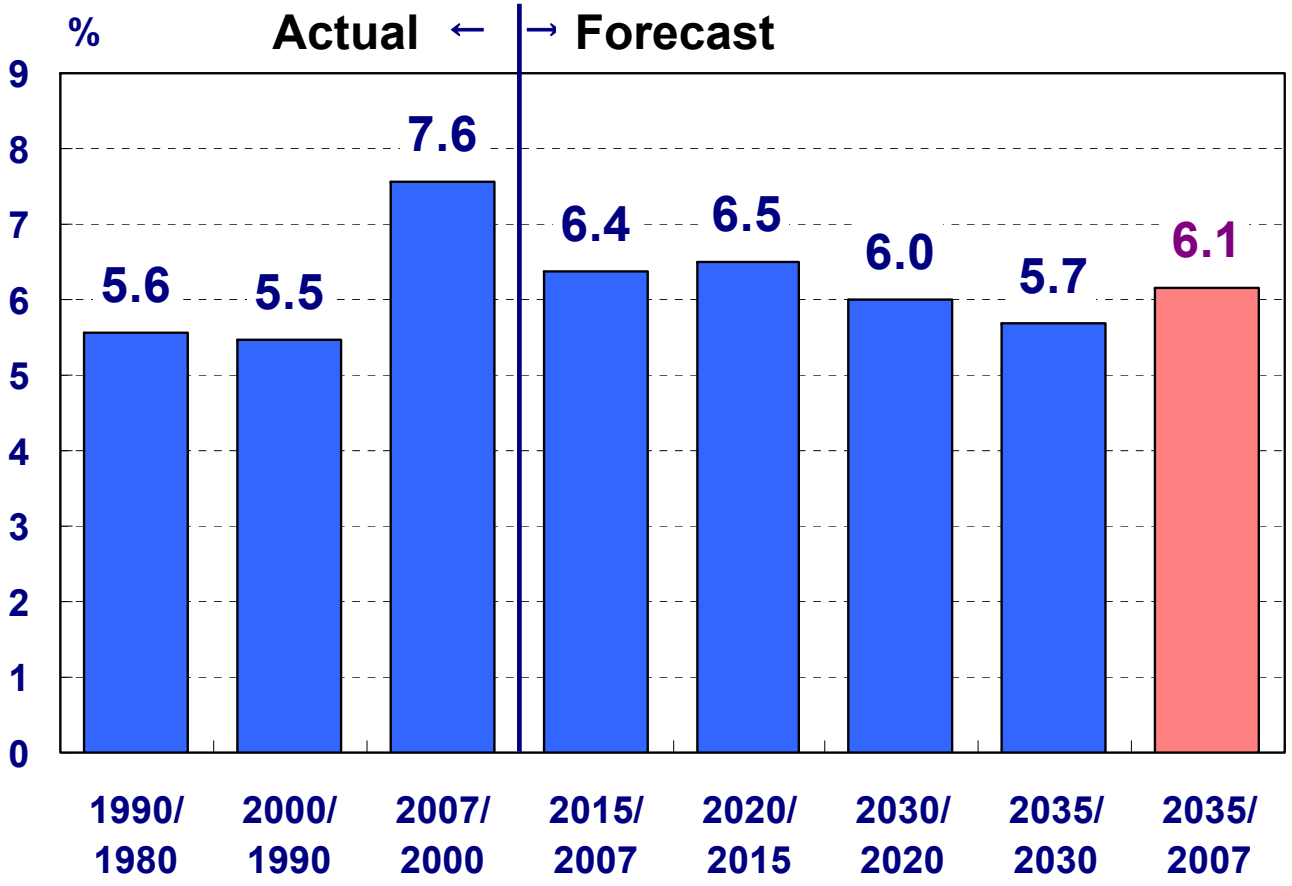
Energy Policy of India

Basic Agenda of Energy Policy on 11th 5 year Plan (2007/08～2011/12)

①Encouragement of electric power production and reform of electricity transmission sector ②Expansion of domestic coal production and infrastructure served for coal import ③Promotion of exploration and acquiring of foreign equity ④Reforming of energy sector and deregulation ⑤ Energy efficiency ⑥R&D ⑦Environmental protection ⑧Comprehensive approach for dealing with energy and environmental issues

GDP Growth

【GDP Growth Rate】



GDP

2007
0.78TUSD
↓
2035
4.14TUSD
(**5.3 folds**)

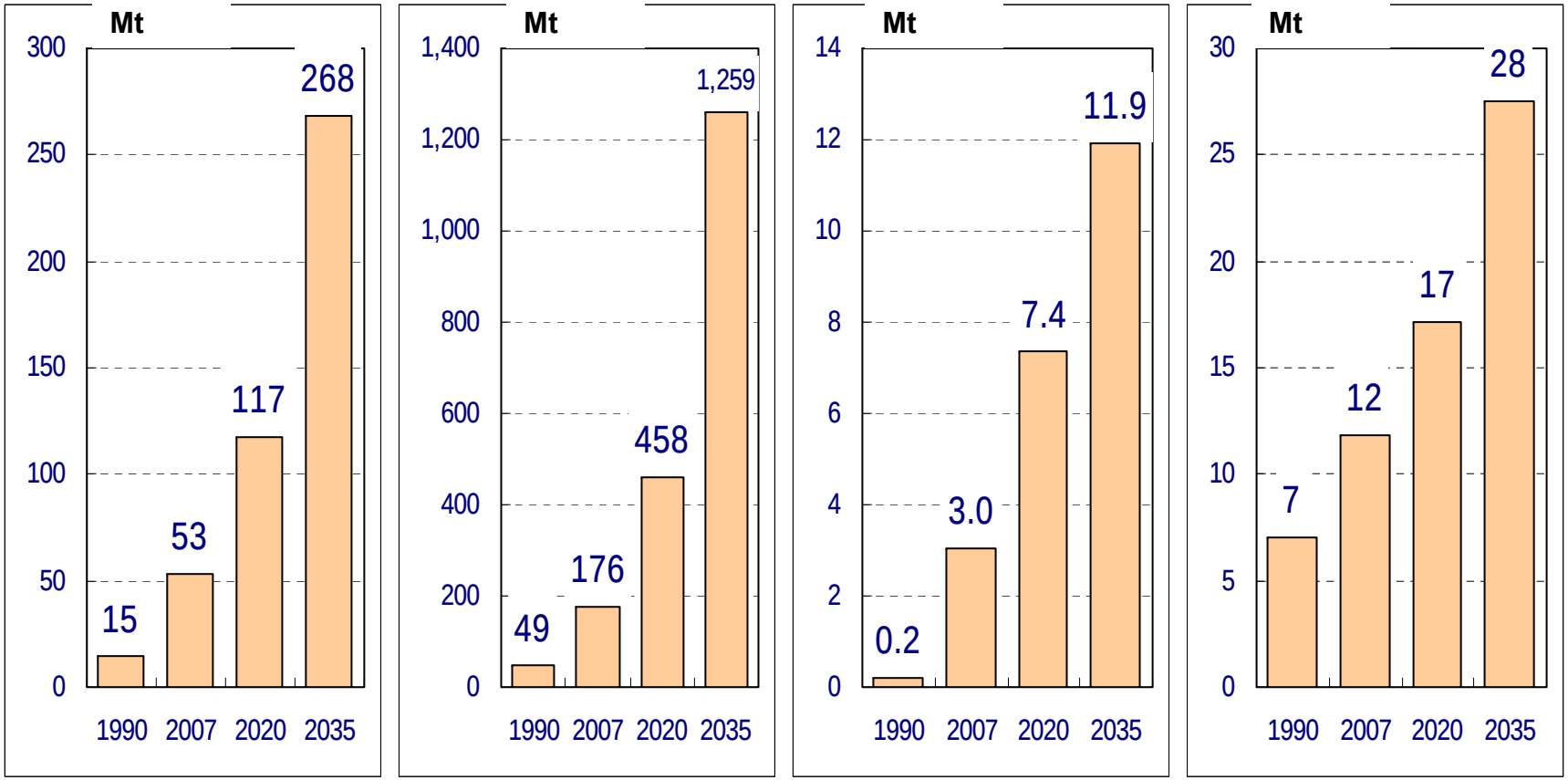
GDP per capita

2007
680USD
↓
2035
2,700USD
(**4.0** folds)

■ Higher GDP growth will be sustained due to increase in workforce population, improved quality of labor force, opening up of the market, growing FDI.
■ Downside factor on GDP growth is the shortage of infrastructure in electric power supply, transportation, port and railway.

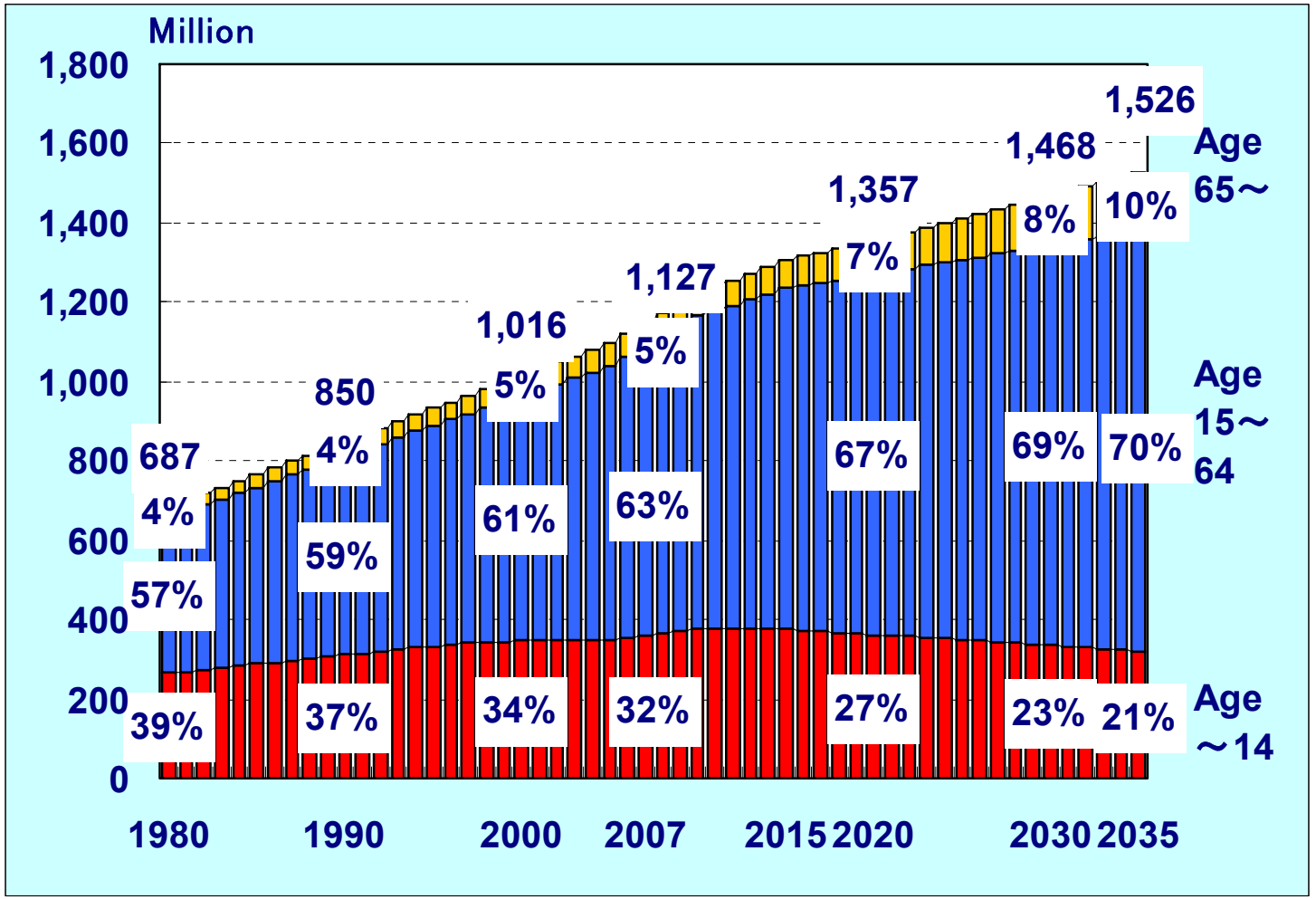
Production of Raw Material in India

【Crude Steel】 【Cement】 【Ethylene】 【Nitrogen Fertilizer】



- Infrastructure building and expansion of production in manufacturing will sharply increase production of crude steel, cement and ethylene.
- As the growth of productive activity in agriculture is relative gradual, production of nitrogen fertilizer will be about doubled.

Population in India



Total Population

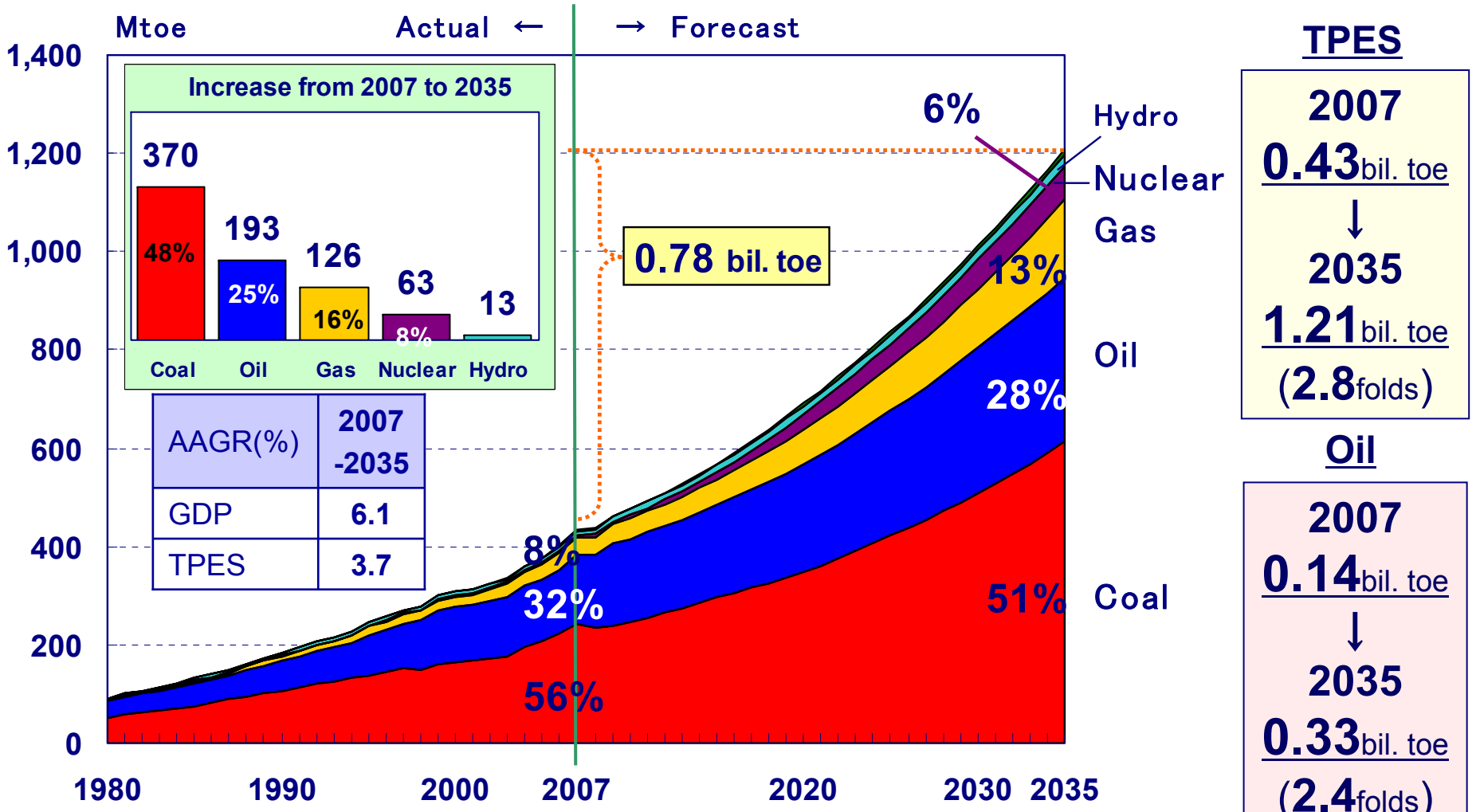
2007
1150 mil.
↓
2035
1530 mil.
(**1.3** folds)

Urban Rate

2007
29%
↓
2035
44%
(**15** points up)

- Total population will increase at an annual rate of 1.0% and India will have 1.5 billion people that will be the largest population in the world.
- Rate of productive population will continuously increase to 70% in 2035.
- People will be concentrated into urban areas but rural population will be in majority in the future.

Primary Energy Demand in India



TPES

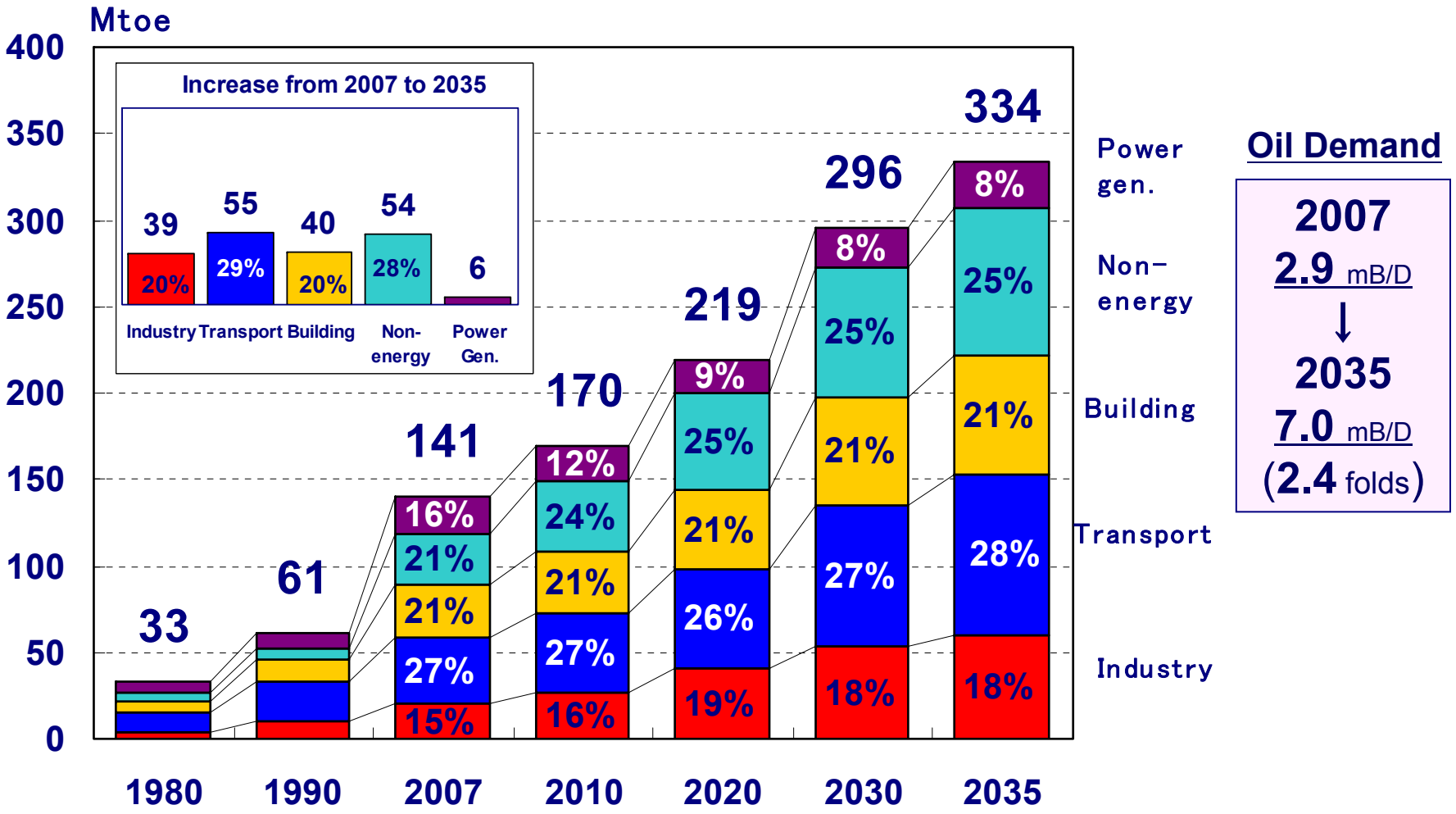
2007
0.43bil. toe
↓
2035
1.21bil. toe
(**2.8**folds)

Oil

2007
0.14bil. toe
↓
2035
0.33bil. toe
(**2.4**folds)

■Fossil fuels will cover 90% of rapidly increasing energy demand.
■Coal demand will increase mainly in power generation and industry. 370 million ton will be the largest increase in energy sources.
■Gas will be mainly in power generation and industry. However development of domestic resources will be expected, import will satisfy increase demand.

Oil Demand in India



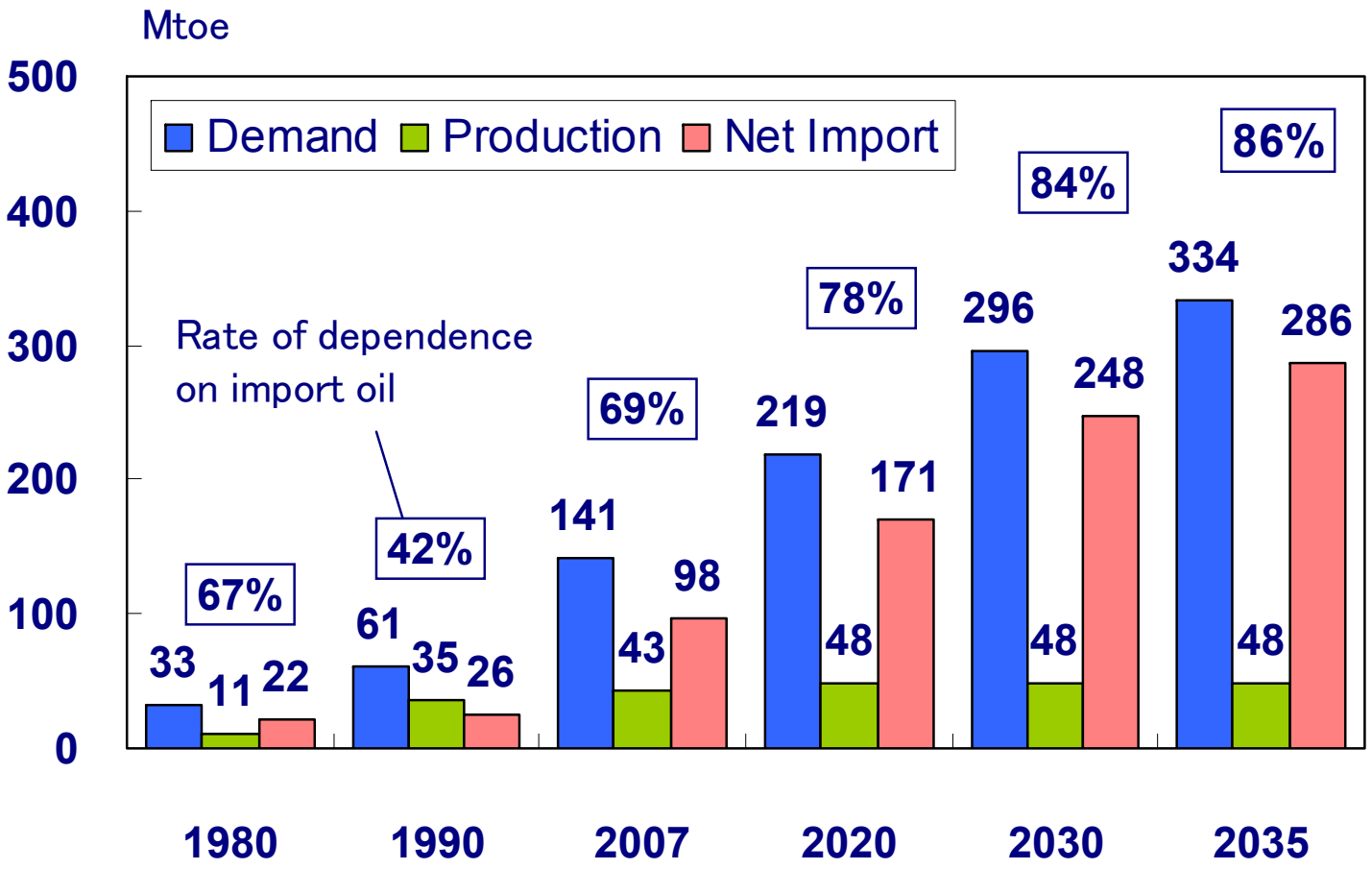
Oil Demand

2007
2.9 mB/D
↓
2035
7.0 mB/D
(2.4 folds)

■Oil demand will sharply increase in transportation sector due to motorization and in industry and residential/commercial sectors.

■Oil demand increase will be 4.1 mb/d in 2035 that will be equal to current oil consumption in Japan. India will be the world's third-largest oil consumer behind USA and China.

Oil Demand and Supply in India



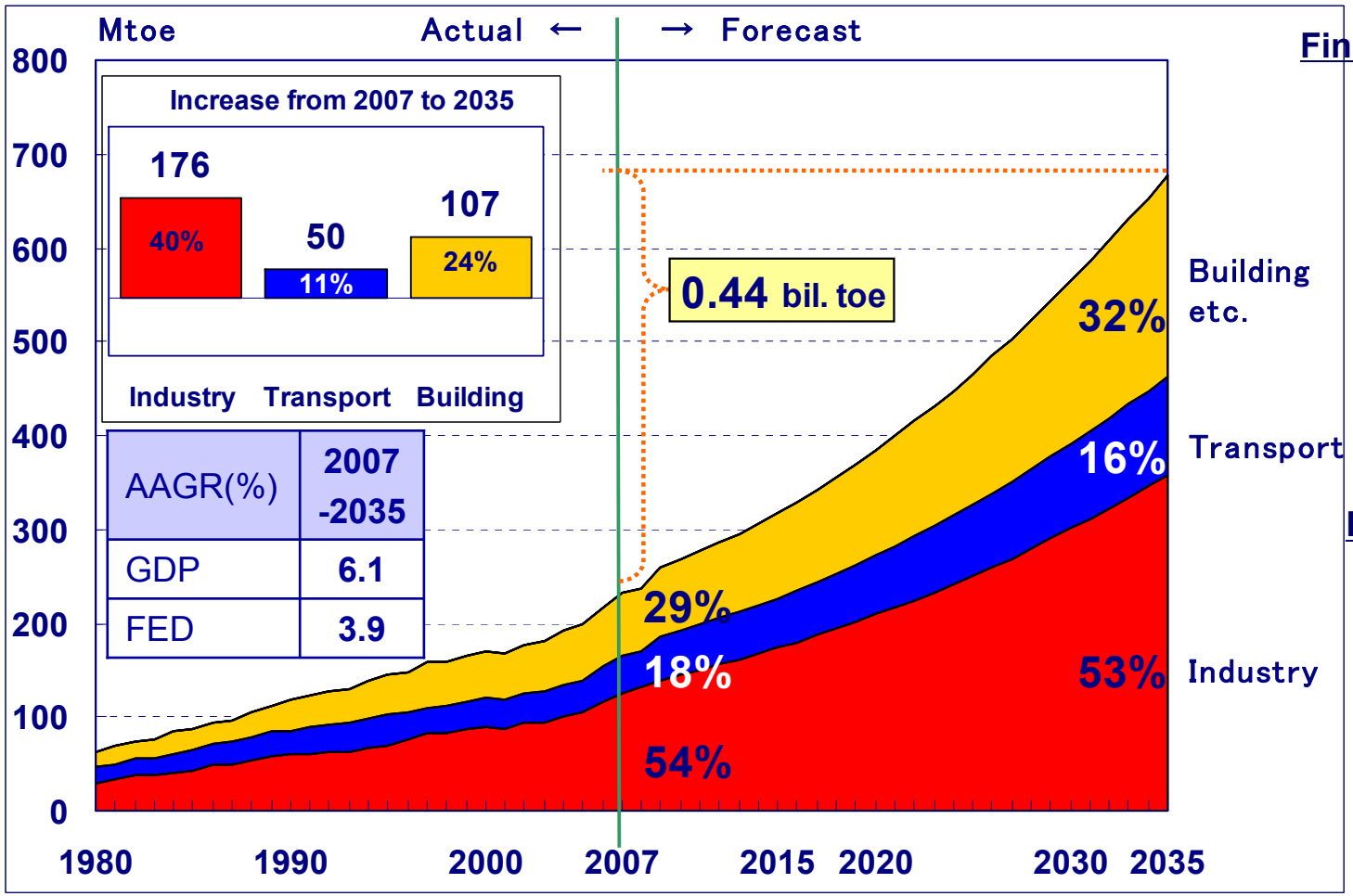
Net Oil Import

2007
2.0MB/D
↓
2035
6.0MB/D
(**3.0**folds)

■Oil demand will increase but domestic oil production will be expected to be decline from stagnation.

■Net oil import is projected to expand from 100 million ton (2.0 mb/d) to 290 million ton (6.0 mb/d) in 2035. Rate of import dependence will increase and exceed 86%.

Final Energy Demand in India



(The industry sector includes non-energy use)

Final Energy Demand

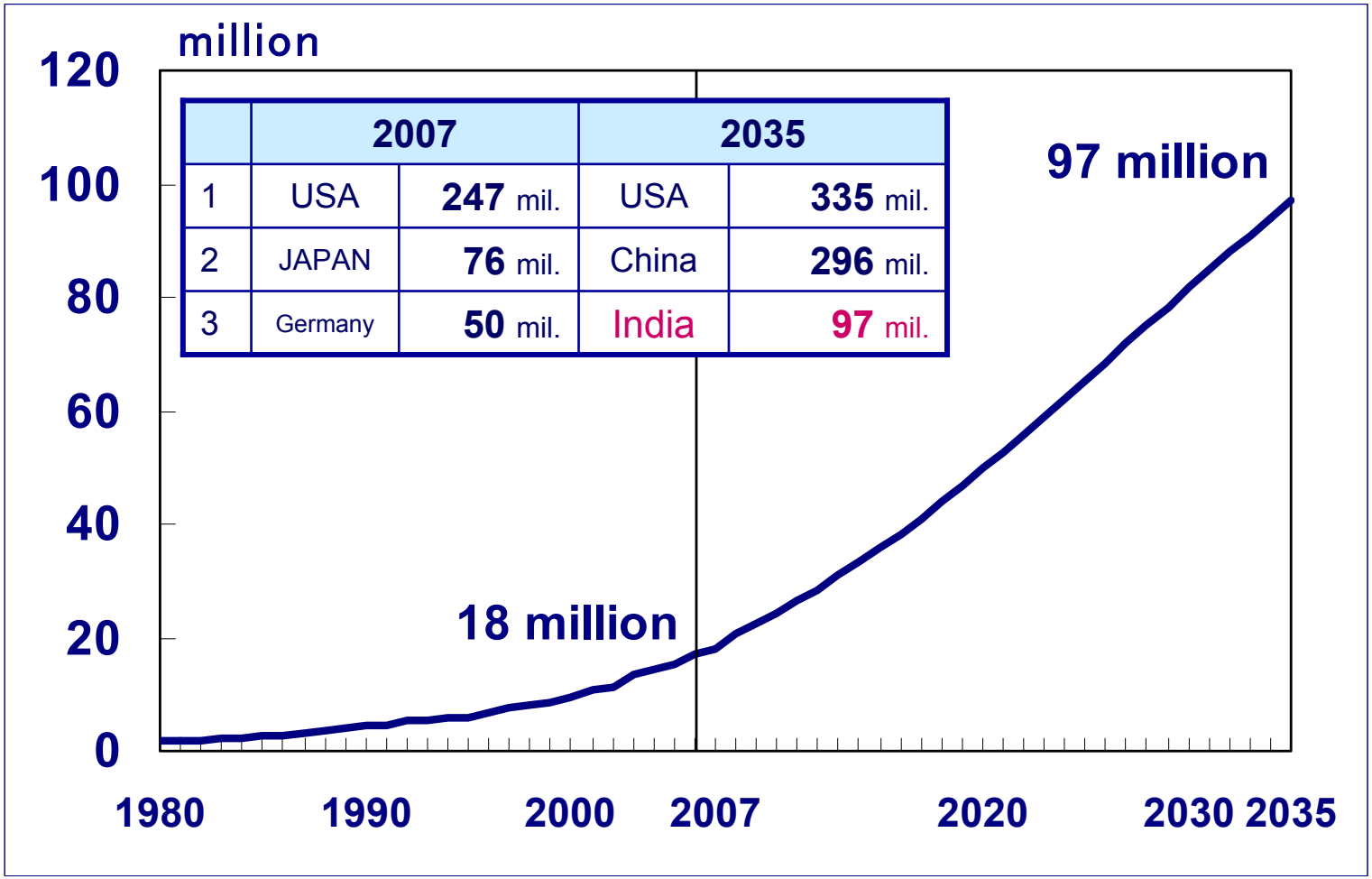
2007
0.23bil.toe
↓
2035
0.68bil.toe
(3.0folds)

Electricity Demand

2007
570TWh
↓
2035
2,700TWh
(4.7folds)

- Industry will be the largest increase by sector
- Residential/commercial and industry sector will make electricity demand increase at a 5.7% annual rate.
- Electricity consumption per capita will increase to 1800kWh in 2030 (20% of that of Japan).

Vehicle Ownership in India



	2007		2035	
1	USA	247 mil.	USA	335 mil.
2	JAPAN	76 mil.	China	296 mil.
3	Germany	50 mil.	India	97 mil.

Ownership

2007
18 mil.
↓
2035
97 mil.
(5.4 folds)

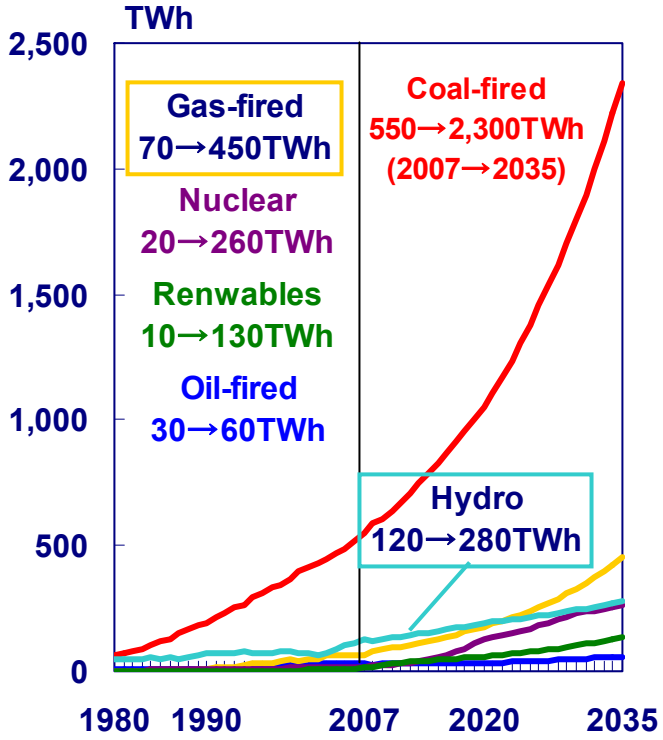
Ownership rate

2007
1.6%
↓
2035
6.4%

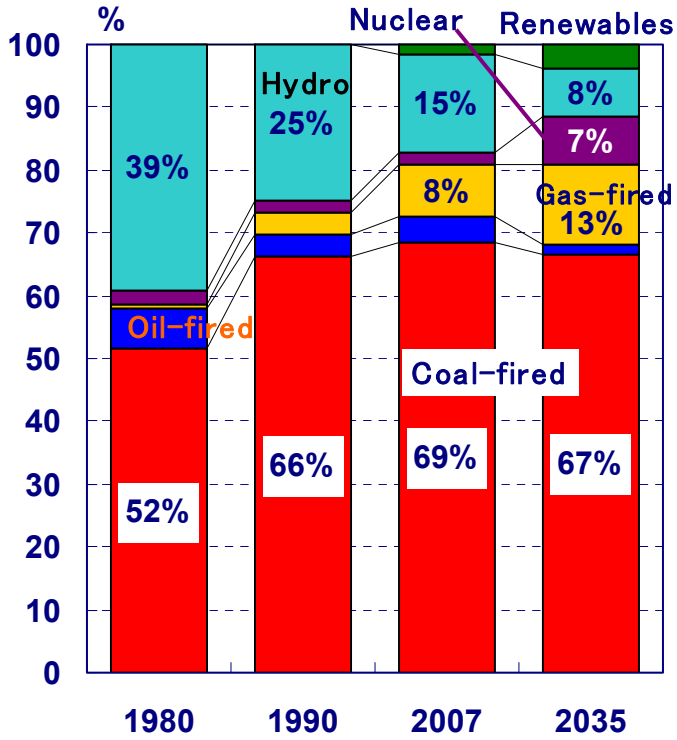
- India will be the world's third-largest vehicle owner behind USA and China.
- Ownership ratio will be still 6% in 2035. There will be great opportunity for further increase.

Power Generation Mix; India

【Power Generation】



【Power Generation Mix】

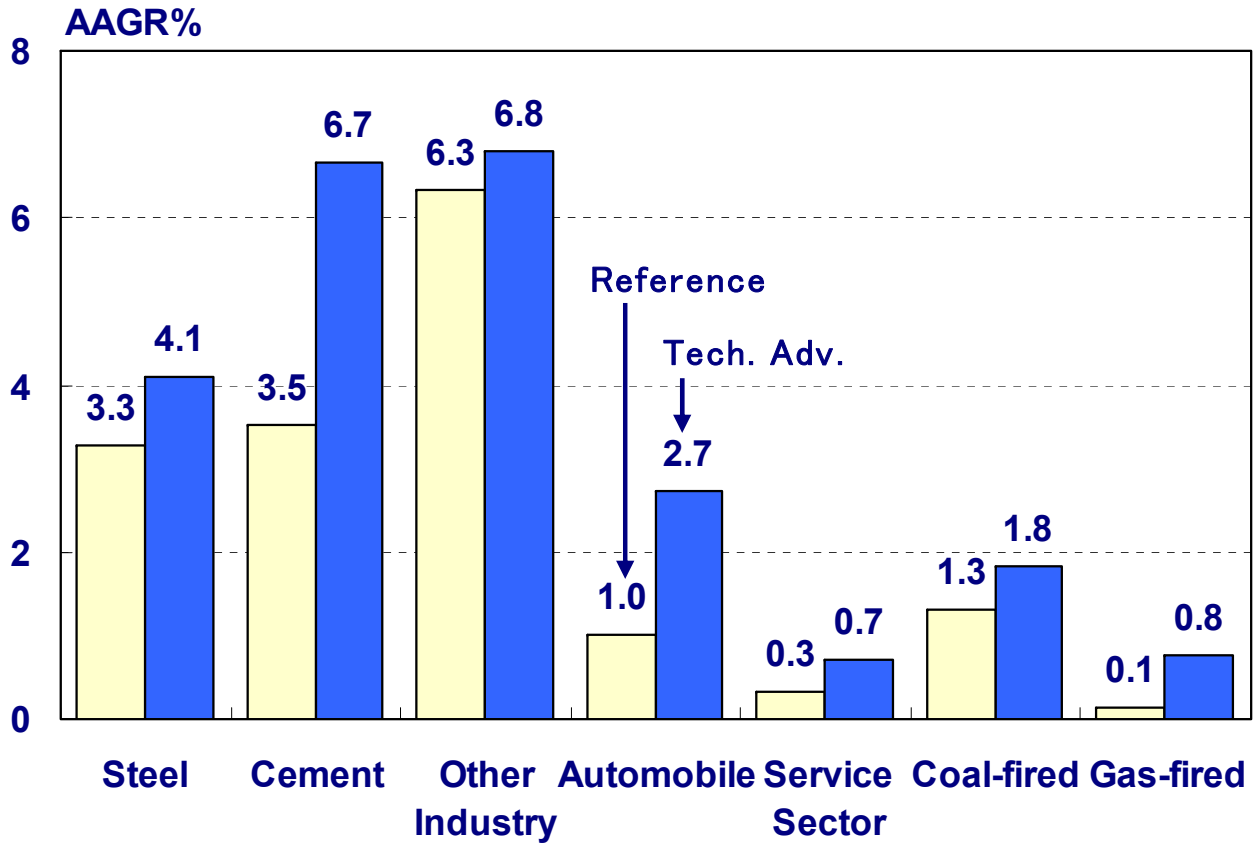


■In the future, coal-fired power plant will still take a major role in power generation such as "Ultra Mega Power Project" (constructing several 4GW-class super critical coal-fired power plants).

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

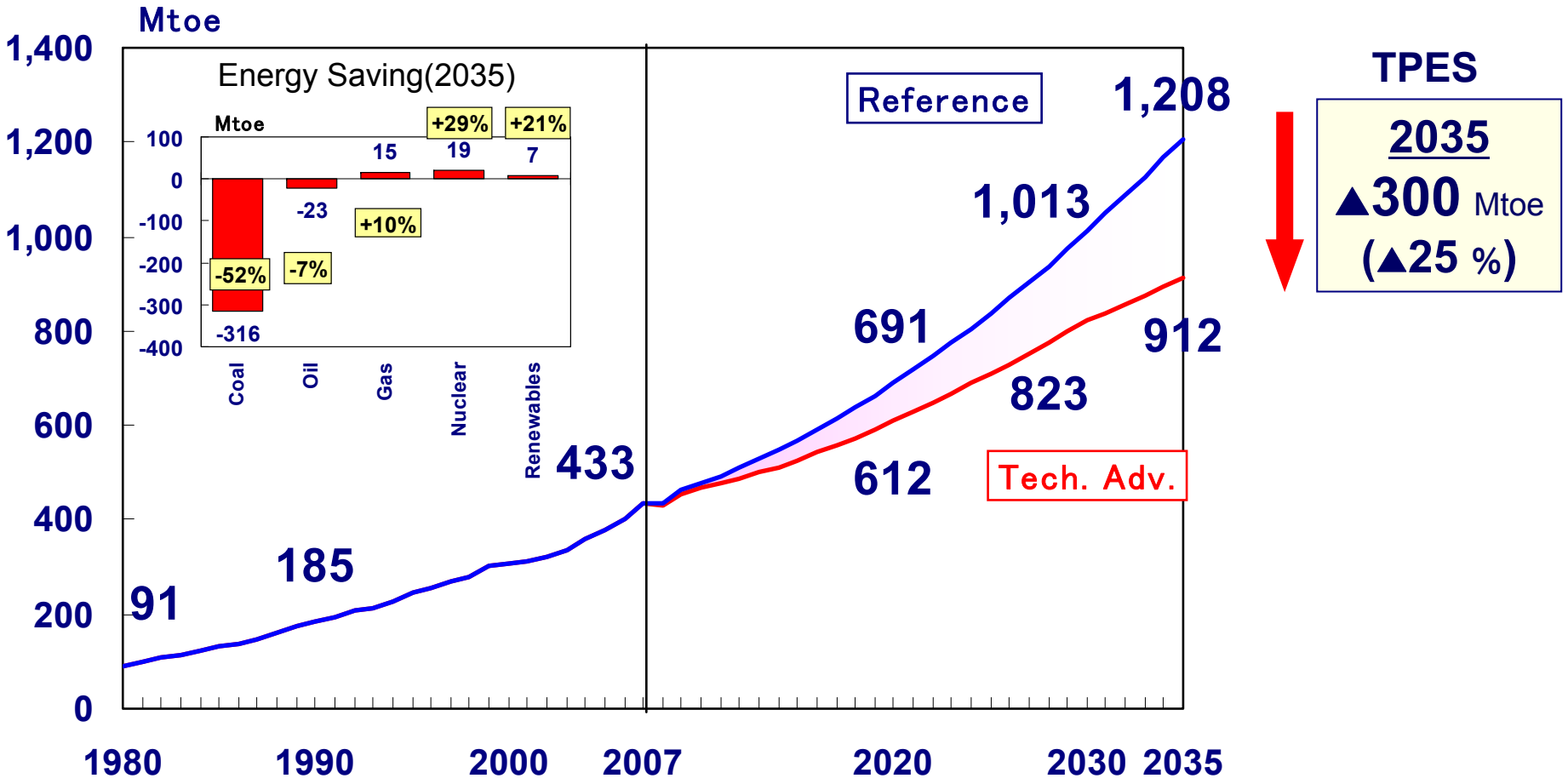
■Capacity of nuclear will increase from 4GW in 2007 to 36GW in 2035(9-fold).

Energy Efficiency improving rates



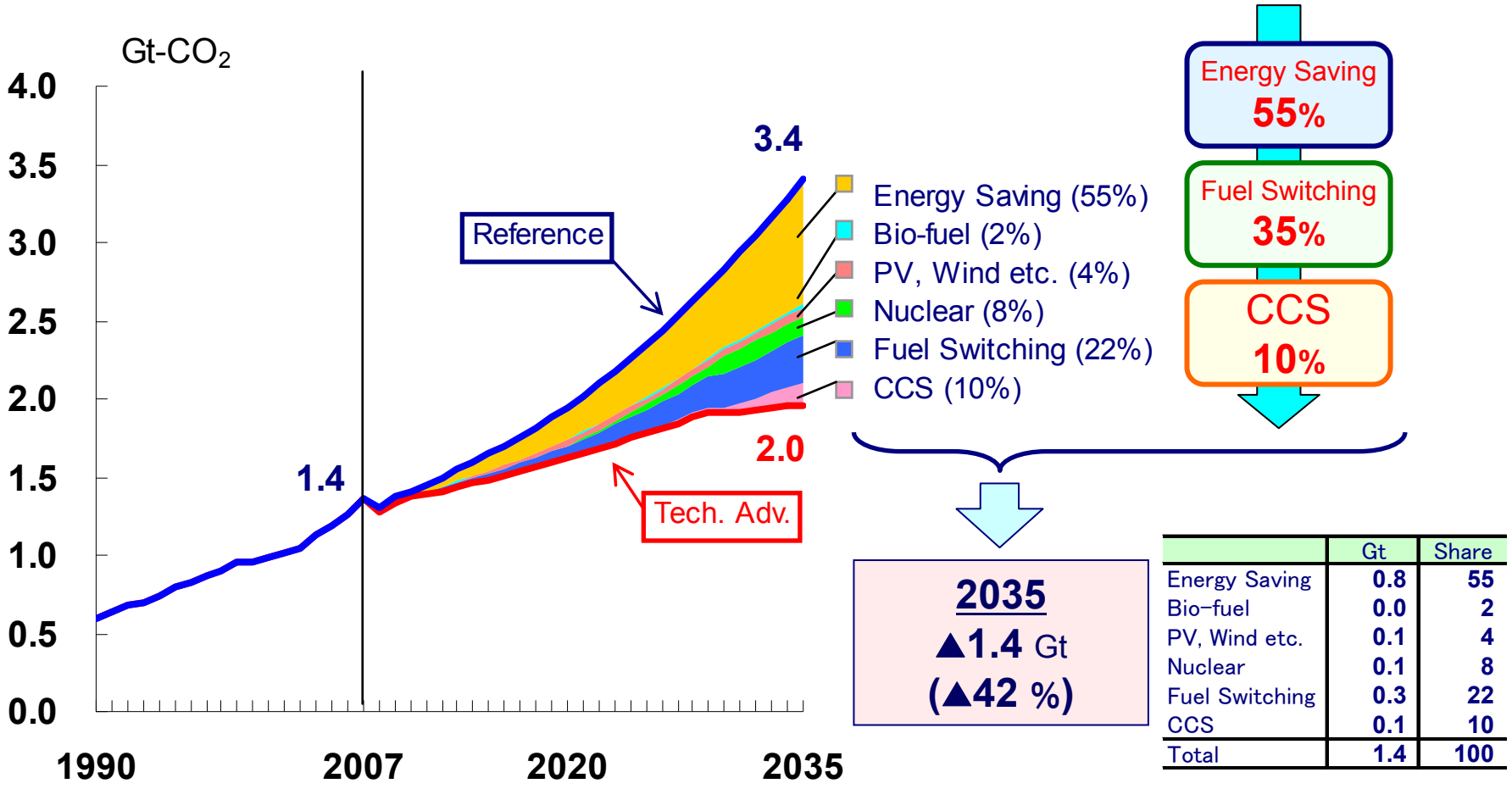
- Newly built factories in India have high energy efficiency, as compared with other countries.
- Making use of pulverized coal injection and blast furnace gas ,new type kilns, highly efficient furnaces / motors / boilers / motorcars / electronics is expected.
- Policies to induce people to buy high-efficient electronics, such as introducing energy efficiency label , are required.

Primary Energy Demand in India



- The Primary energy demand will be reduced by about 25% (300Mtoe) in 2035.
- Coal demand will decline by 52% (320Mtoe) due to the introduction of clean coal technology.

CO_2 Emissions Reduction in India



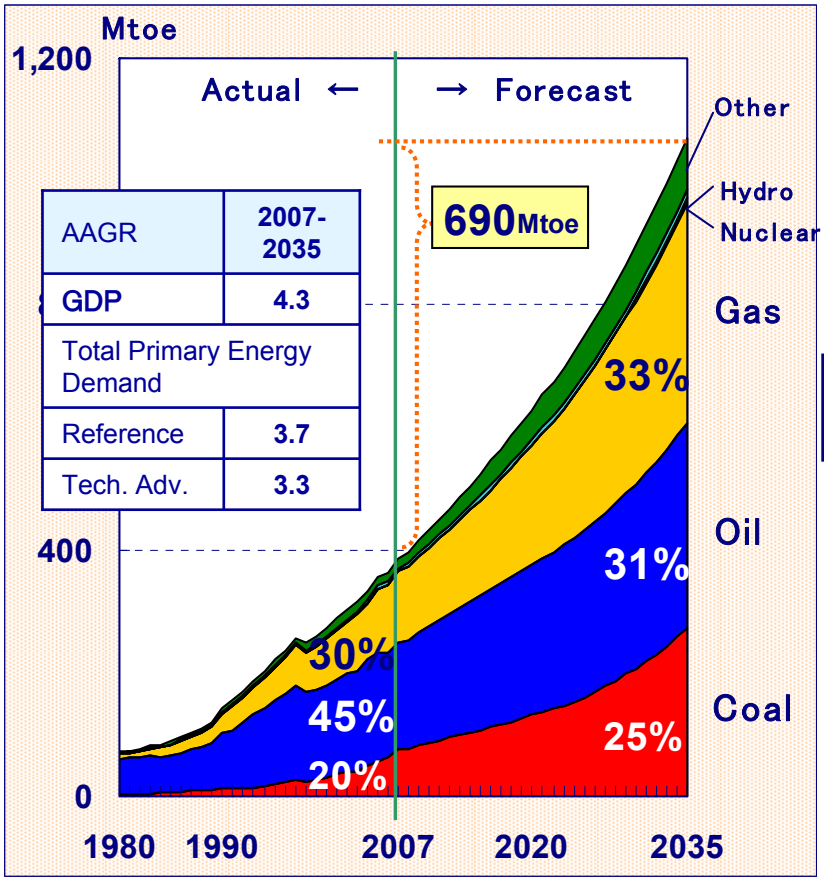
	Gt	Share
Energy Saving	0.8	55
Bio-fuel	0.0	2
PV, Wind etc.	0.1	4
Nuclear	0.1	8
Fuel Switching	0.3	22
CCS	0.1	10
Total	1.4	100

- In Tech. Adv. scenario, CO2 emissions will decrease by 1.4 Gt (42% decrease), and CO2 emissions will peak out at 2034 if CCS considered.

Energy Demand and Supply in ASEAN, USA

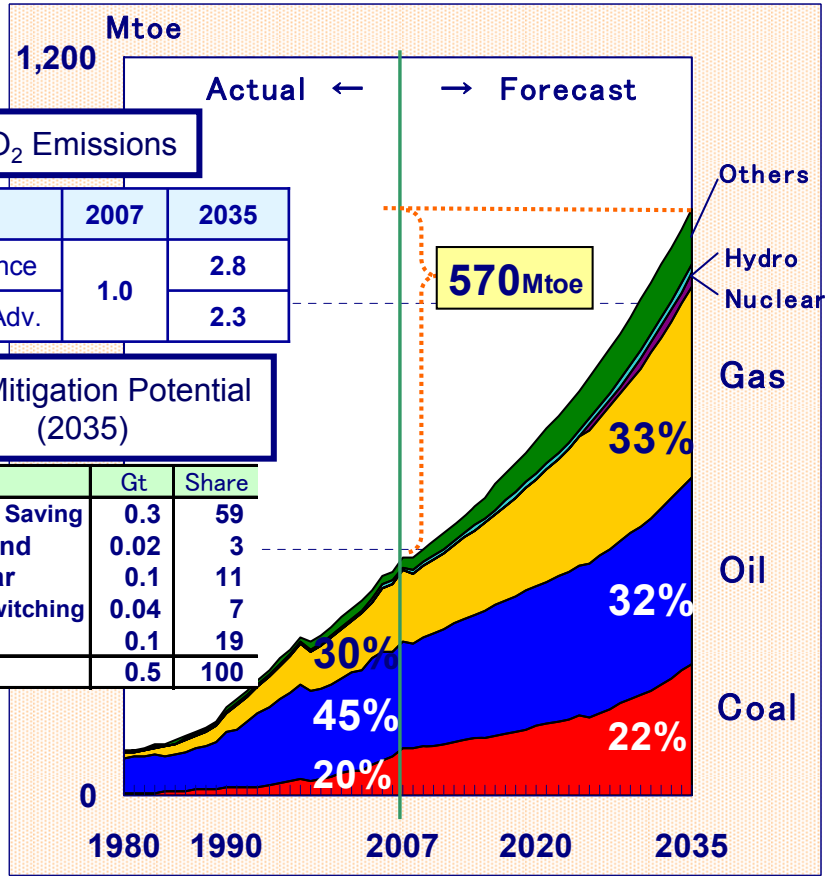
Primary Energy Demand (ASEAN)

【Reference Scenario】



AAGR	2007-2035
GDP	4.3
Total Primary Energy Demand	
Reference	3.7
Tech. Adv.	3.3

【Tech. Adv. Scenario】



CO_2 Emissions

Gt	2007	2035
Reference	1.0	2.8
Tech. Adv.		2.3

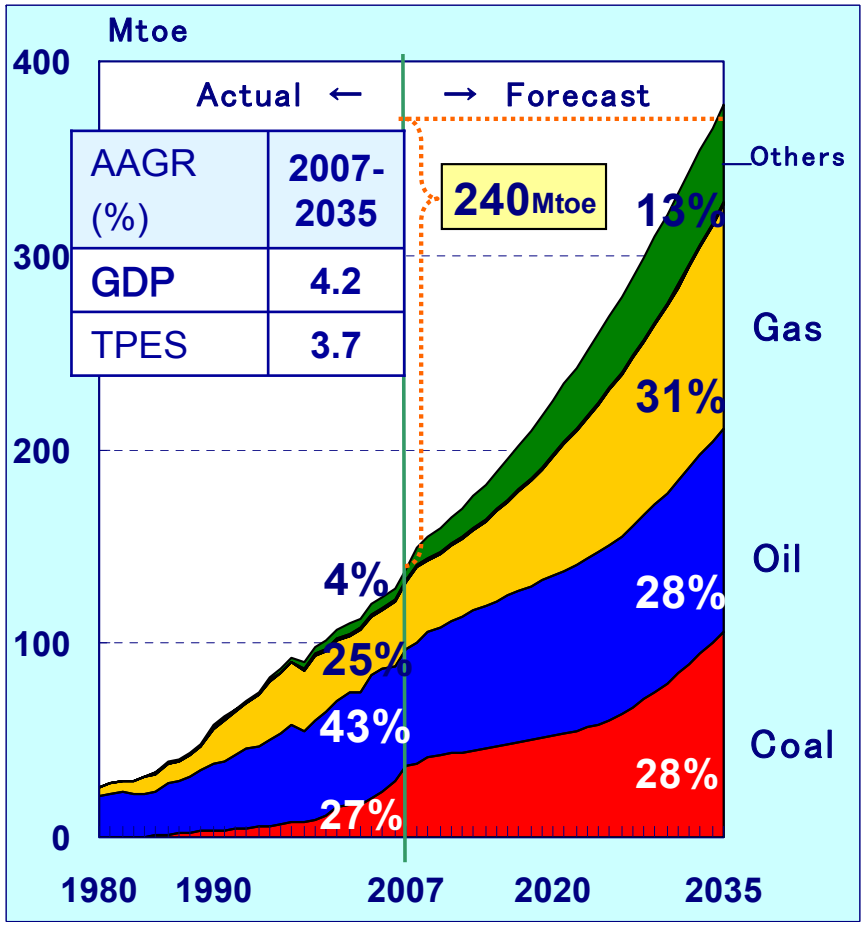
CO_2 Mitigation Potential (2035)

	Gt	Share
Energy Saving	0.3	59
PV・Wind	0.02	3
Nuclear	0.1	11
Fuel Switching	0.04	7
CCS	0.1	19
Total	0.5	100

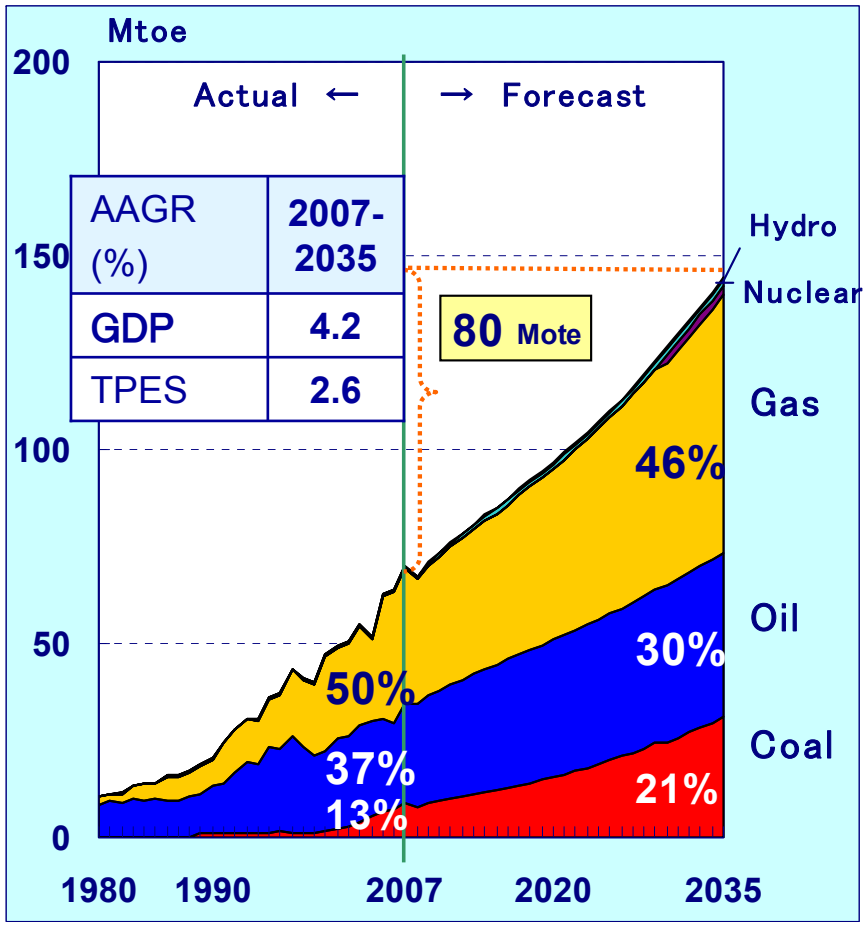
ASEAN countries have achieved vigorous economic growth reflecting on abundant labor force and exporting manufacturing product to international market, and eventually increase its energy demand. Electricity demand, in particular, represents astonishing growth and a couple of nuclear power plants is projected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

Primary Energy Demand (Indonesia、Malaysia)

【Indonesia】 (Reference)



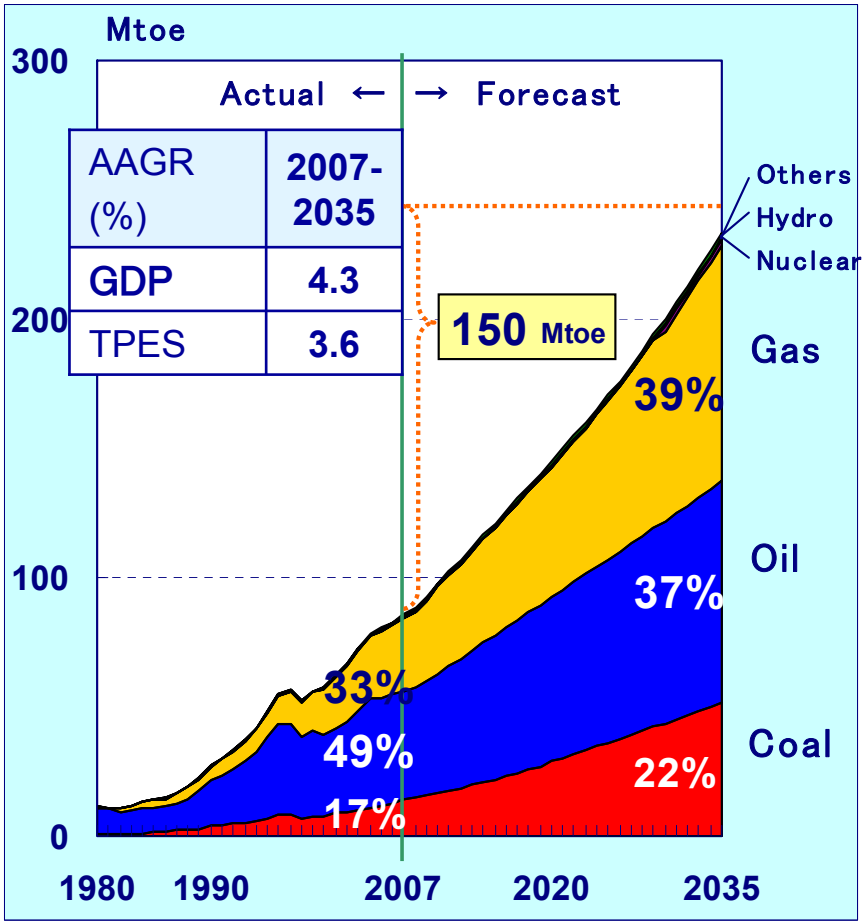
【Malaysia】 (Reference)



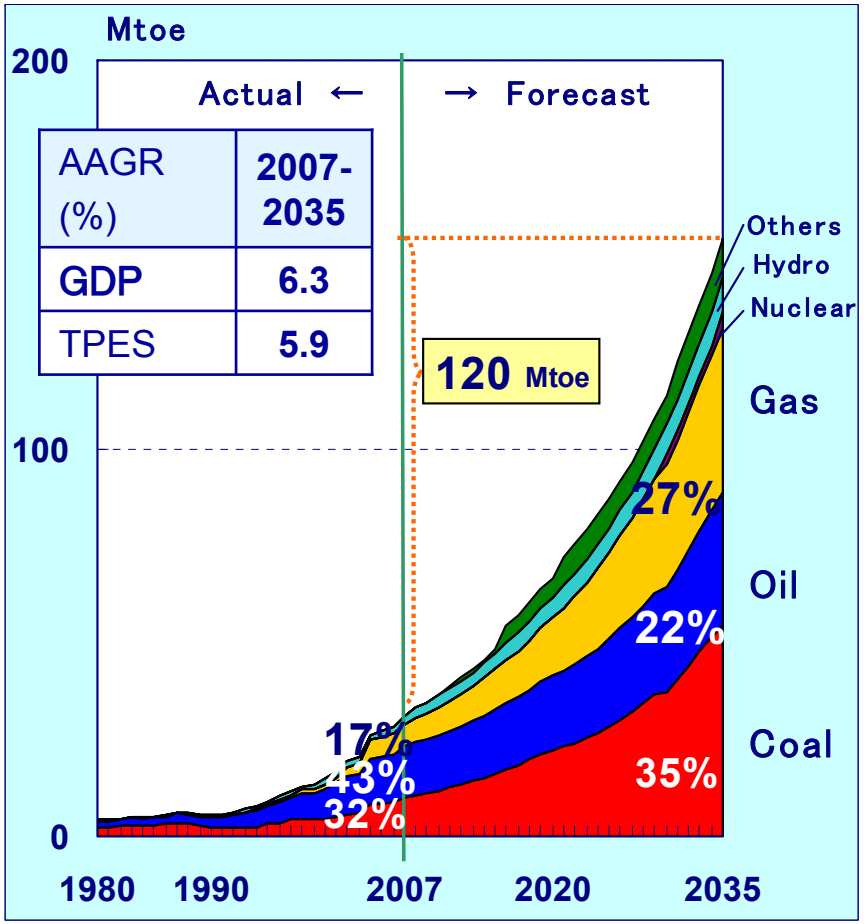
Indonesia: Major target of energy policy is composed of securing energy supply, exporting domestic energy resources at high value, managing domestic energy reserves, providing affordable energy to low-income people.
Malaysia: Political priority is emphasized on ensuring affordable energy supply and sustainable economic growth. Basic target is fuel diversification, energy efficiency and environmental protection.

Primary Energy Demand (Thailand、Vietnam)

【Thailand】 (Reference)



【Vietnam】 (Reference)



Thailand：Energy political emphasis is placed on “Energy supply security”, ”Appropriate energy price”, ”Alternative fuel”, ”Energy efficiency”, ”Environmental protection”

Vietnam：Political target is to arrange the opportunity of investment from abroad in order to ramp up domestic oil production which is oriented to export for acquiring foreign currency.

U.S. Energy Policy (Resolutions by New Administration)

In next 10 years, new administration attempt to invest 150 bil. $ and create 5 million employment

■Renewables

- Doubling renewable supply in next 3 years, enhancing its share in power generation mix to 10% by 2012, 25% by 2025
- Postponing production and investment tax credits, introducing smart-grid, supporting R&D

■Energy Efficiency

Supporting efficiency measures by local government, and heating insulation of low-income people and public building

■Innovative Vehicles, Biofuel

- Penetrating 1 million plug-in hybrid vehicles by 2015 and developing public transportation and innovative battery technology
- Pulling up CAFE standards to 36 mpg by 2016
- Enhancing RFS to 36 bil. Gallons of biofuel supply.

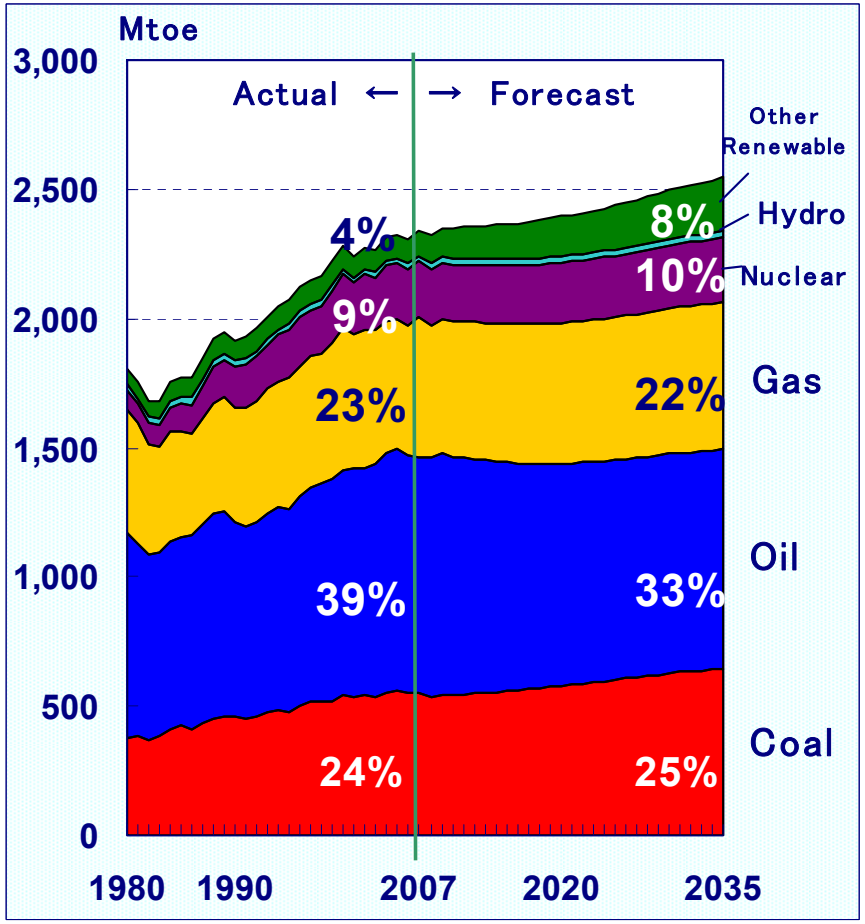
■Reducing GHG emissions

- Introducing C&T, reducing GHG emissions by 14% from 2005 level until 2020 and by 83% until 2050, and channeling the profit obtained by the sales of emissions cap into R&D of clean technology
- R&D of CCS and clean coal technology

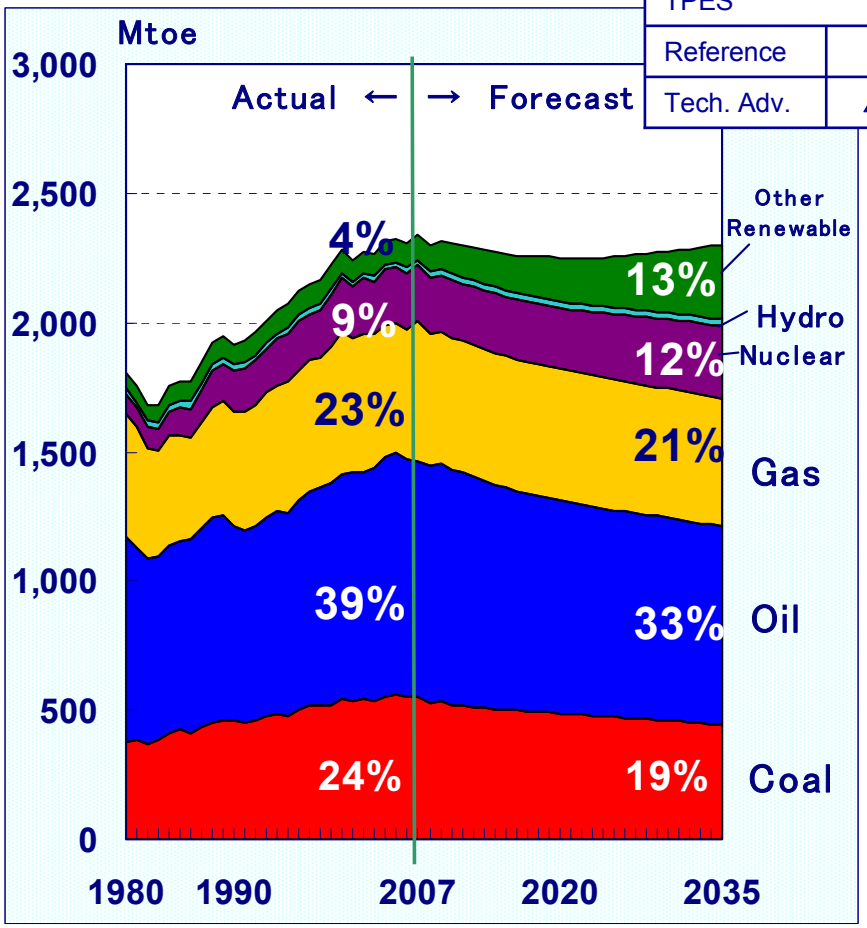
Primary Energy Demand in U.S.

AAGR(%)	2007-2035
GDP	2.3
TPES	
Reference	0.3
Tech. Adv.	▲0.1

【Reference】



【Tech. Adv.】

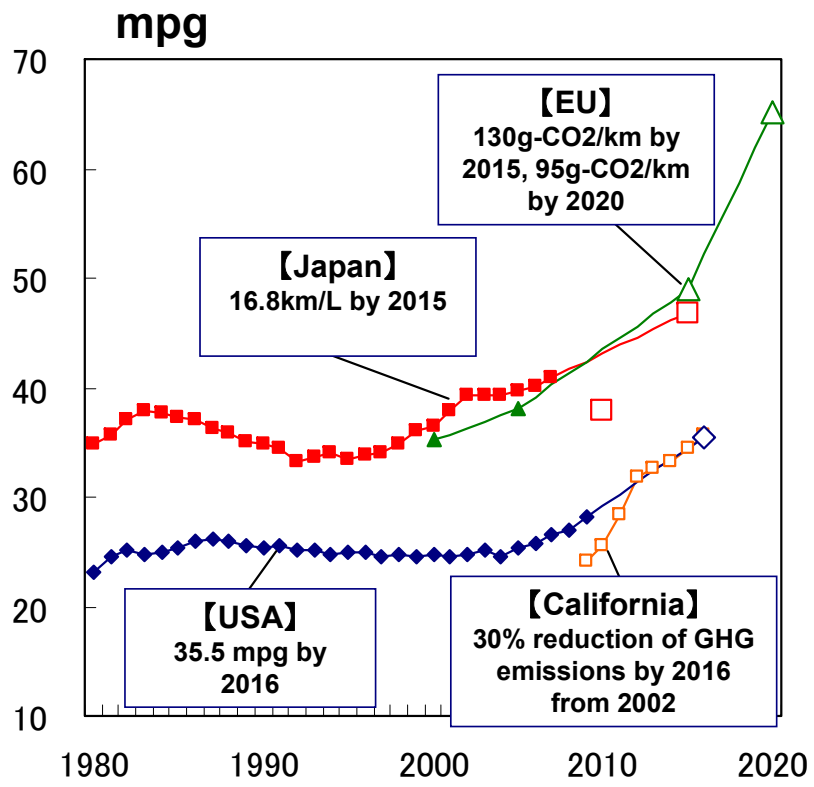


■ Oil demand will decrease due to the improvement of fuel efficiency and deployment of biofuel. Oil demand will decline from 19 mb/d in 2007 to 17.6 mb/d in Reference and 16.0 mb/d in Tech. Adv by 2035.

■ Renewable, particularly wind and biofuel, will considerably increases

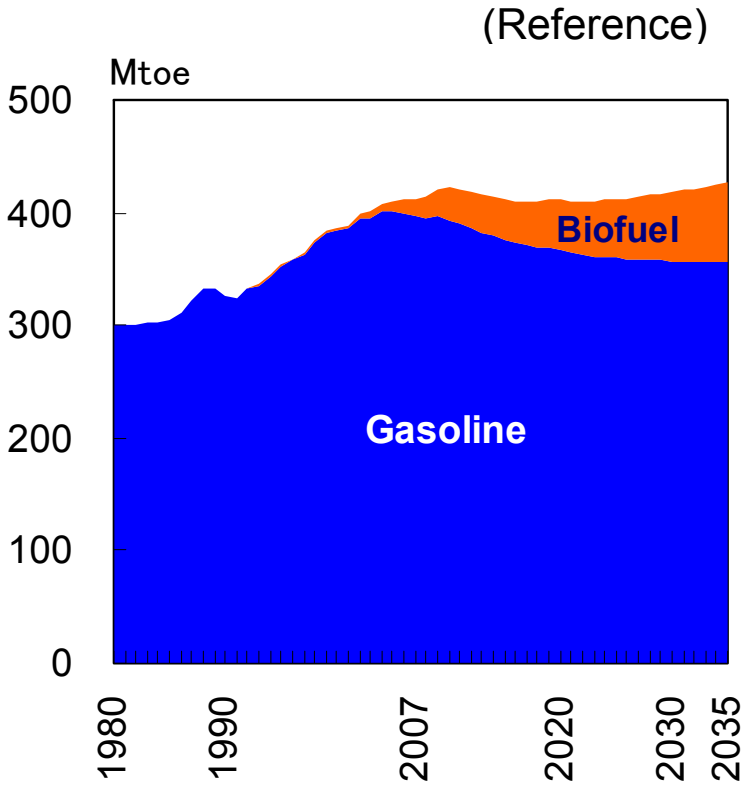
Gasoline Demand in U.S.

【 Fuel Efficiency Regulations 】



New Administration declared to raise CAFE standards to 35.5 mpg (15km/L) by 2016, almost equivalent to the standards in CA.

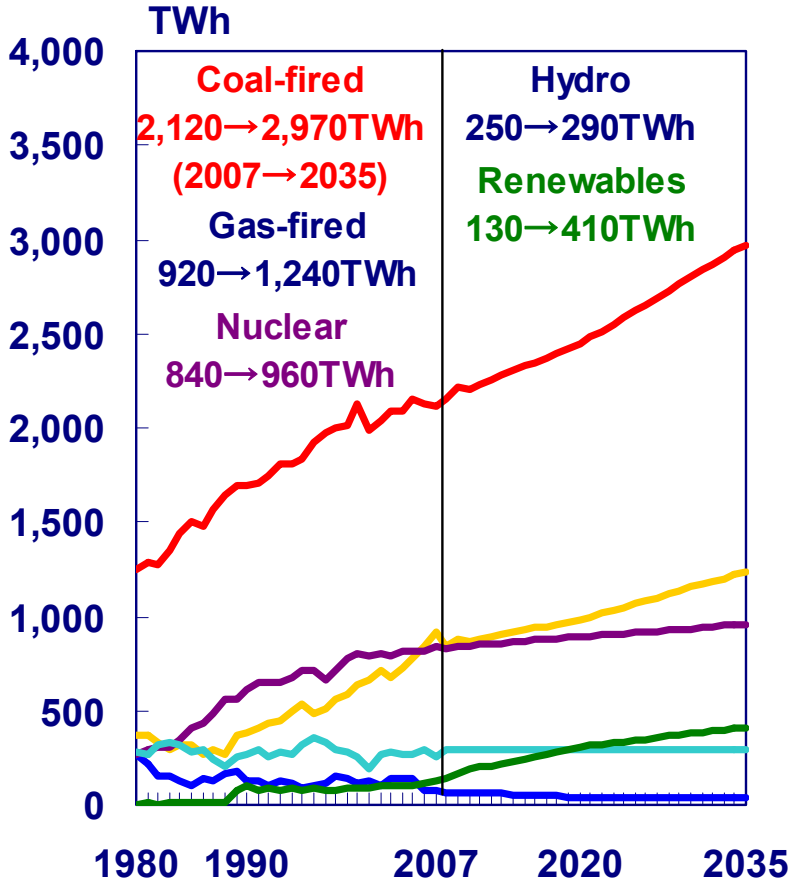
【 Gasoline Demand in US 】



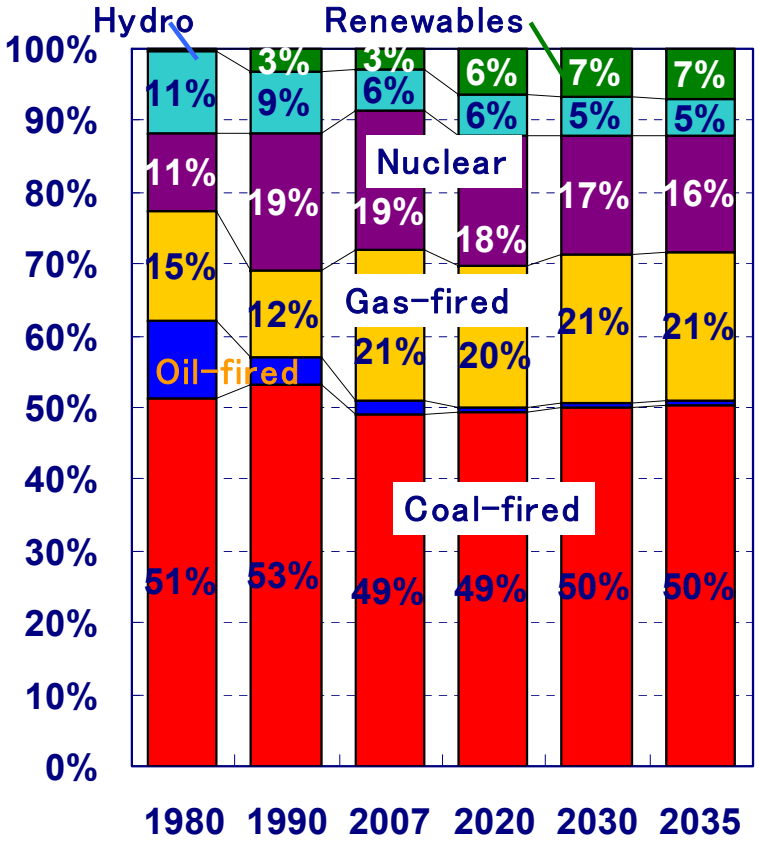
US Gasoline demand is forecast to decline reflecting on intensified CAFE standards and growing biofuel.

Power Generation Mix in U.S.

【Power Generation】 (Reference)

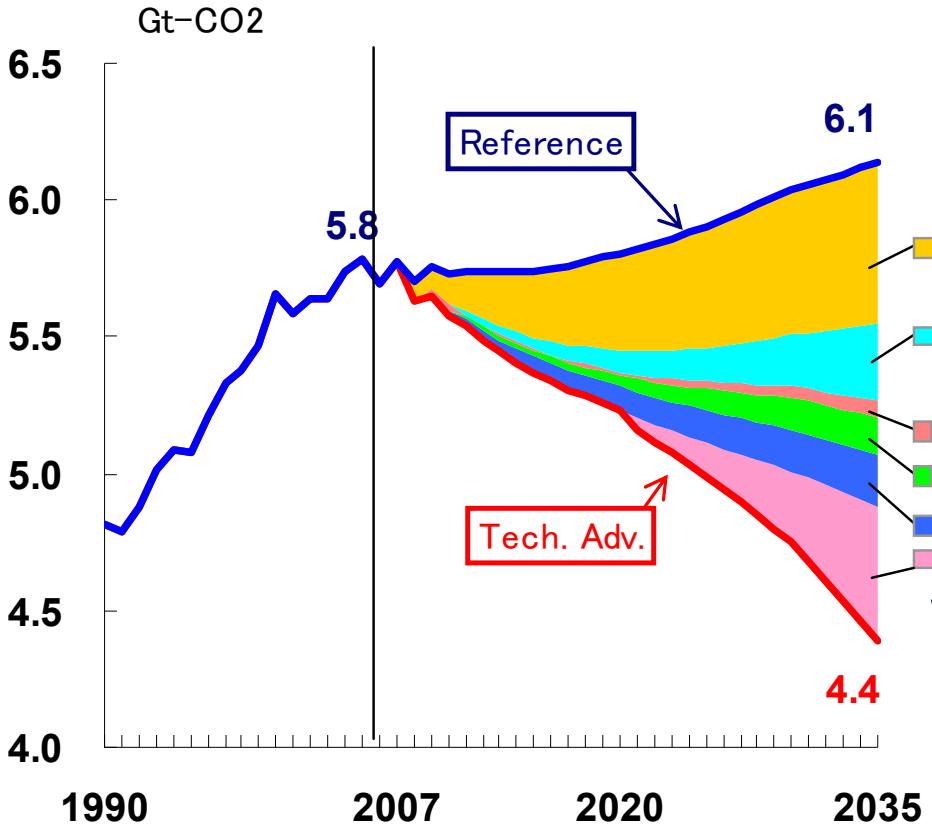


【Power Generation Mix】 (Reference)



Coal-fired is projected to play a important role in electricity supply and clean coal technology is expected to support its centrality.

CO_2 Emissions Reduction in USA



Energy Saving (34%)

Bio-fuel (15%)

PV, Wind etc. (5%)

Nuclear (8%)

Fuel Switching (11%)

CCS (28%)

Energy Saving 34%

Fuel Switching 38%

CCS 28%

2035
▲1.7 bil. toe
(▲28 %)

	Gt	Share
Energy Saving	0.6	34
Bio-fuel	0.3	16
PV, Wind etc.	0.1	3
Nuclear	0.1	8
Fuel Switching	0.2	11
CCS	0.5	28
Total	1.7	100

■CO2 emissions in Tech. Adv. In 2035 declines by 1.7 billion toe compared with Reference scenario.
■CO2 emissions of U.S. building sector in 2007 indicates 2.2 billion ton which is more than total emissions of Russia, 3rd largest emissions country. The emissions in this sector is likely to grow, which eventually lead to suggest that promoting energy efficiency and low emissions power generation is important challenge.

Implications

■Technological Transfer and Tackling Global Environmental Problems

The trend of rapid increase in CO2 emissions in China, India and other developing Asian countries underscores that a far larger overall cost-benefit would be delivered by mitigation of environmental load through transfer of technology to these countries. For our country, Japan, it is very important to contribute to improving those problems through doing the mentioned above, and to enforce domestic CO2 mitigation measures in order to accomplish the Kyoto Protocol target. China and other developing Asian countries have immense potential for energy conservation, and offer enormous margin for technical assistance through the Clean Development Mechanism (CDM) and other schemes; It is significant for the countries, which ratified the Kyoto Protocol, to implement CDM scheme in developing countries

■Assurance of Energy Security in Asia

Import dependence rate of oil in Asia will sharply rise, reflecting on the stagnation of regional crude oil production and rapid oil demand growth based on boosting vehicle ownership in China and India. Furthermore, oil dependence of Asia on Middle East, which is more economically available, is forecast to increase. Construction of a oil reserve scheme for response to emergencies and effective use of the existing infrastructure to deal with short-term crises such as supply suspensions will play a key role. While it is naturally important for the individual countries to make efforts to secure their own energy supplies, there is also a possibility that excessive pursuit of the national interest by any single country could damage the energy security of the rest of the region. It is consequently becoming increasingly important for the issue to be treated as one in which all countries in the region have a common stake.

■Challenges towards best energy mix

Ensuring a stable supply of fossil fuels and their effective use

Fossil resources are ultimately finite, and their consumption is accompanied by greenhouse gas emissions. Nevertheless, when economic rationality, practicality and the lead time for the commercialization of innovative technology are considered, it is important to strive toward the effective utilization of fossil energy. In addition to ensuring a stable supply of fossil fuels, using them in a clean and highly efficient fashion is essential from the perspectives of energy security, environmental conservation.

[Oil]

A substantial expansion in oil production cannot be expected in the Asian region, and its dependence on imports for oil supply will rise to 84% in 2035. Covering some 50% of Asia's oil consumption increase will be the Middle Eastern OPEC members that are rich with oil resources and more cost competitive than other oil-exporting countries. Steady investment in oil production capacity expansion to meet the rise in demand will be the key to the stability of the international oil market. On the demand side, an important issue will be to strive for the effective use of oil through the introduction of clean energy automobiles, whose full-fledged practical use is expected over the medium to long term.

[Natural gas]

Natural gas production in the Asian region will peak while gas demand will increase due to fuel switching in the electricity generation and building sectors. Therefore, demand will expand for LNG and gas transported from Russia and central Asia via pipelines. As with oil, smooth investment toward the expansion of production and transportation capacity will be the key to the stabilization of natural gas demand and supply.

[Coal]

Coal demand will increase for electricity generation due to its economic affordability and abundant resource endowment. In order to help prevent climate change, the development and introduction of high-efficiency coal-fired power generation and clean coal technology such as CCS are urgently required.

Nuclear power:

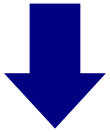
Nuclear energy will play a major role in Asia, where ensuring energy security will become increasingly important due to fast-growing energy demand. Nuclear power, which is also important for helping to tackling global warming, should be increasingly introduced as a stable and core energy supply source,.

Technology development of renewable energy:

Wind power and photovoltaic power generation are an important option among measures to prevent global warming. The introduction of biofuels is expected to improve automobiles' fuel efficiency and help reduce CO2 emissions in the transportation sector. It is necessary to enhance systems for effective and efficient promotion of renewable energy diffusion and introduce innovation-supporting policies to further expand the use of renewable energy. It will also become important to consider the time frame with regard to technology development that contributes to ensuring energy security and enhancing measures against global warming. If we look to around 2020, progress in technology development and change in the energy supply and demand structure will be limited. However, since current technology development and supply-demand structural change are expected to bear fruit around 2030, technology strategies with a long-term outlook beyond 2030 are required.

Conclusion

For Asia to simultaneously achieve its "3E" goals (Energy Security; Environment; Economy), each Asian country should accelerate the decarbonization of energy supplies through diversification of energy supply sources, energy-conservation and a shift to alternative fuels and strengthen its efforts toward achieving the best energy mix.

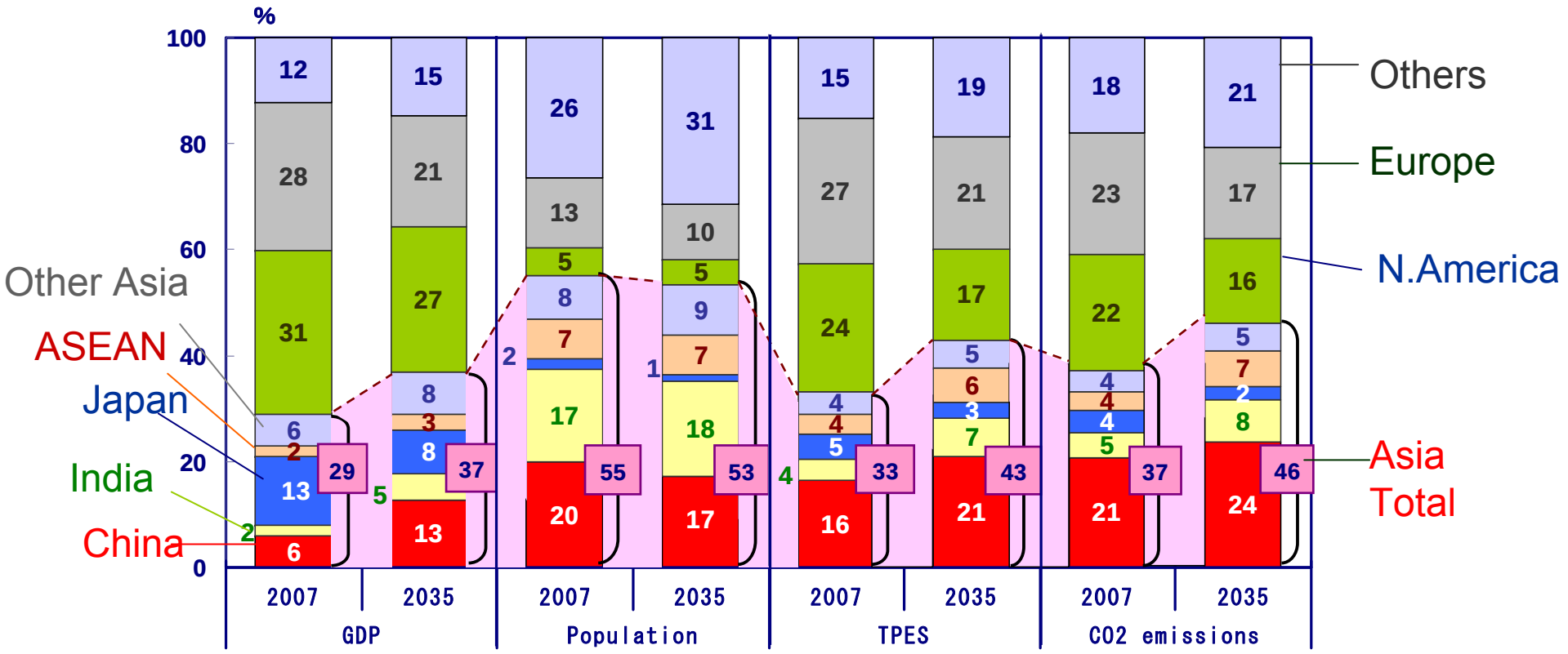


In this context, Japan will have a tremendous role to play in Asia, with its advantages in terms of technology, economic power and legislative design. It is of great importance for Japan to make concerted efforts to further develop and utilize energy-saving and environmental preservation technologies as well as the technologies and know-how. With these advanced energy-conservation and environmental technology, it is crucial for Japan to achieve sustainable economic growth through extensive use of its technology, and to contribute to Asian economy and environment.

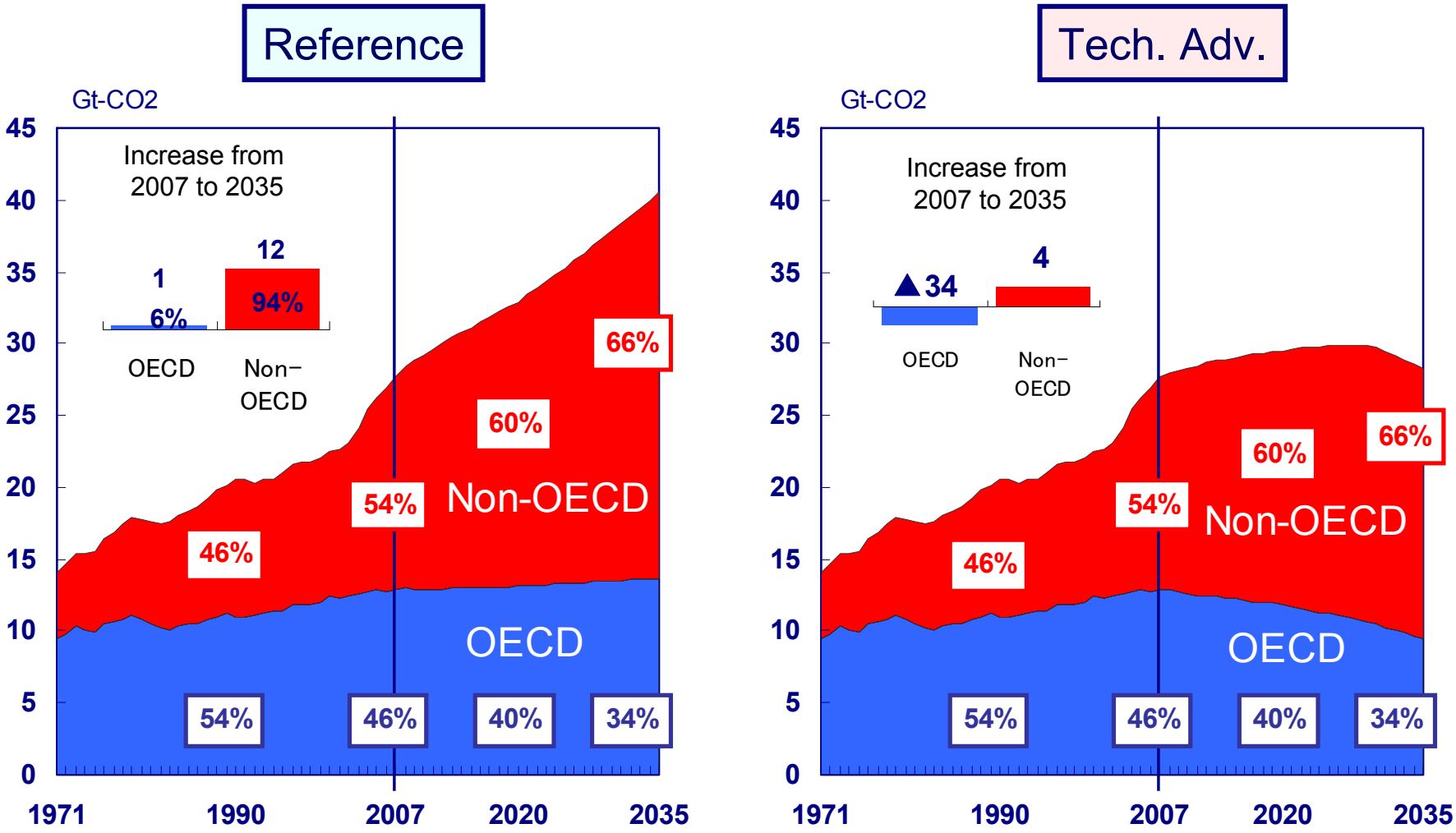
＜Reference Material＞

Presence of Asia in Energy and Economy

(Reference)



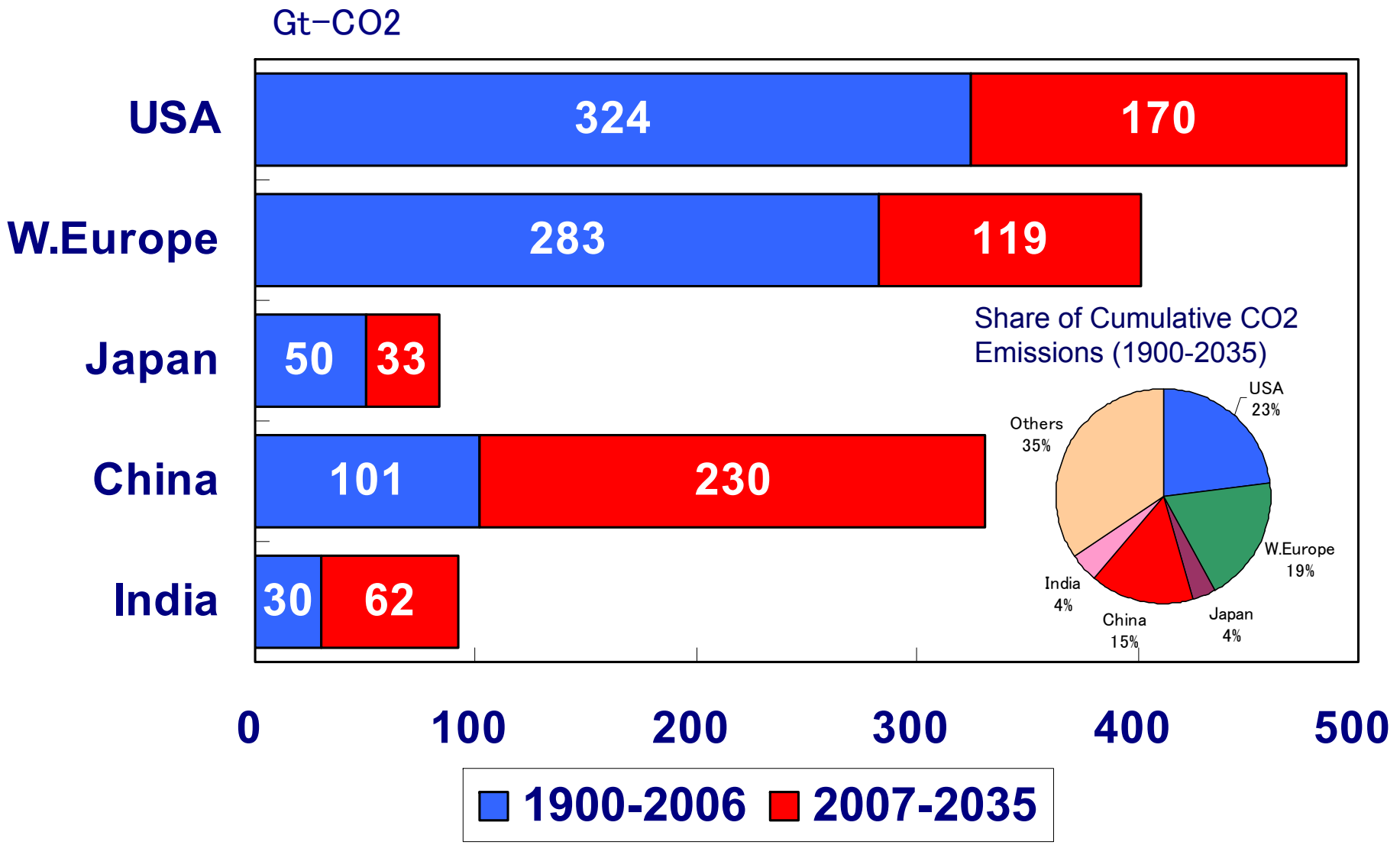
CO_2 Emissions (Developed & Developing Countries)



Non-OECD shows massive CO2 missions growth to 2035

Cumulative CO_2 Emissions(1900～2035)

(Reference)

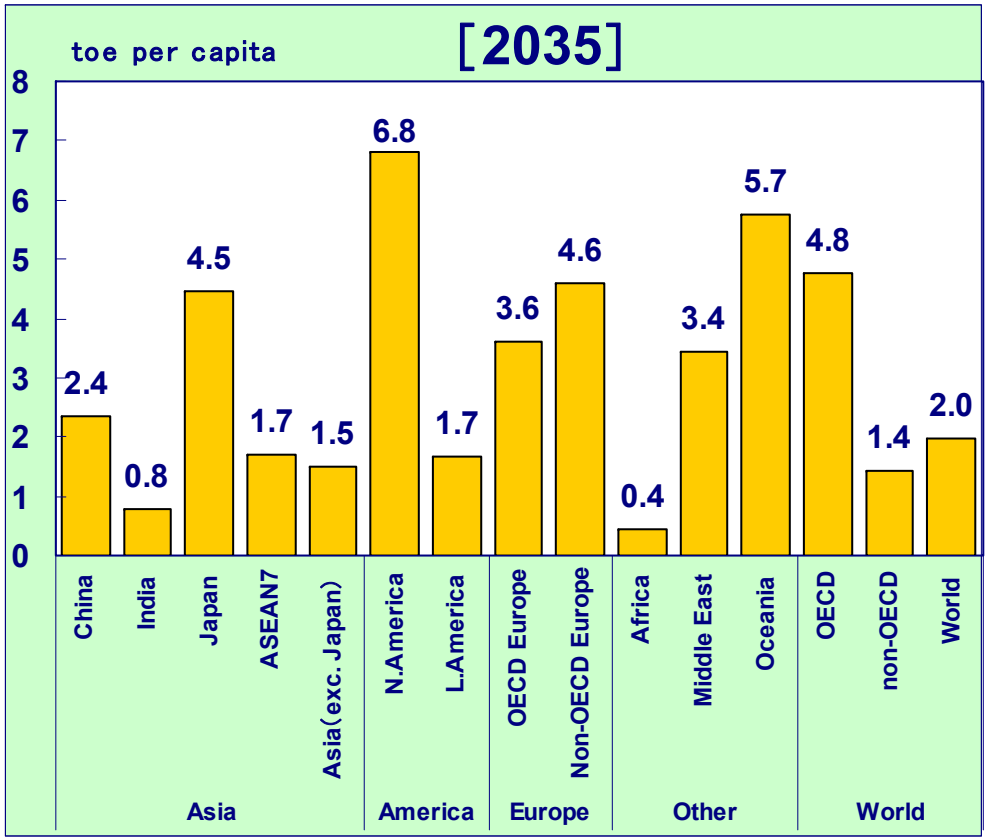


Primary Energy Demand per Capita

(Reference)

(toe per capita)

	1980	2007	2035
China	0.4	1.3	2.4
India	0.1	0.4	0.8
Japan	3.0	4.0	4.5
Korea	1.1	4.6	6.9
Taiwan	1.6	4.8	6.8
Indonesia	0.2	0.6	1.4
Malaysia	0.8	2.7	4.0
Philippines	0.3	0.4	0.9
Thailand	0.2	1.3	3.3
Vietnam	0.1	0.4	1.4
N.America	7.9	7.8	6.8
OECD Europe	3.2	3.4	3.6
OECD	4.2	4.7	4.8
non-OECD	0.7	1.0	1.4
World	1.5	1.7	2.0



※ASEAN7：Indonesia, Malaysia, Thailand, Philippines, Vietnam, Singapore, Brunei

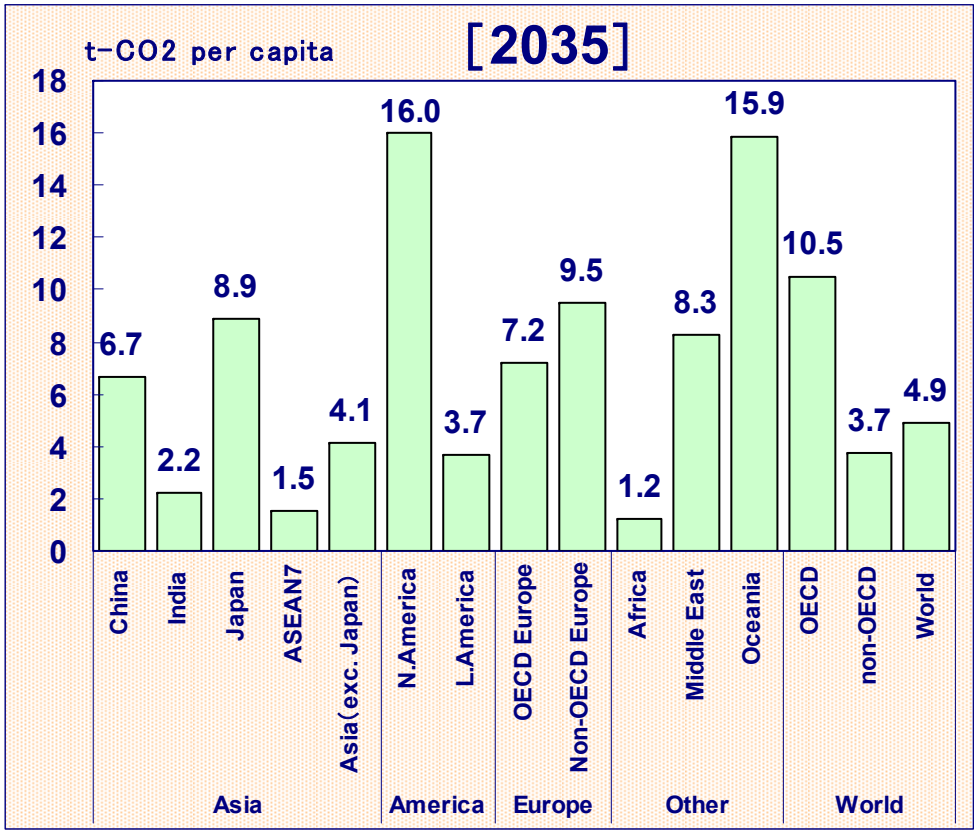
Primary energy demand per capita in China and India is still lower than OECD-average still in 2035

CO_2 Emissions per Capita

(Reference)

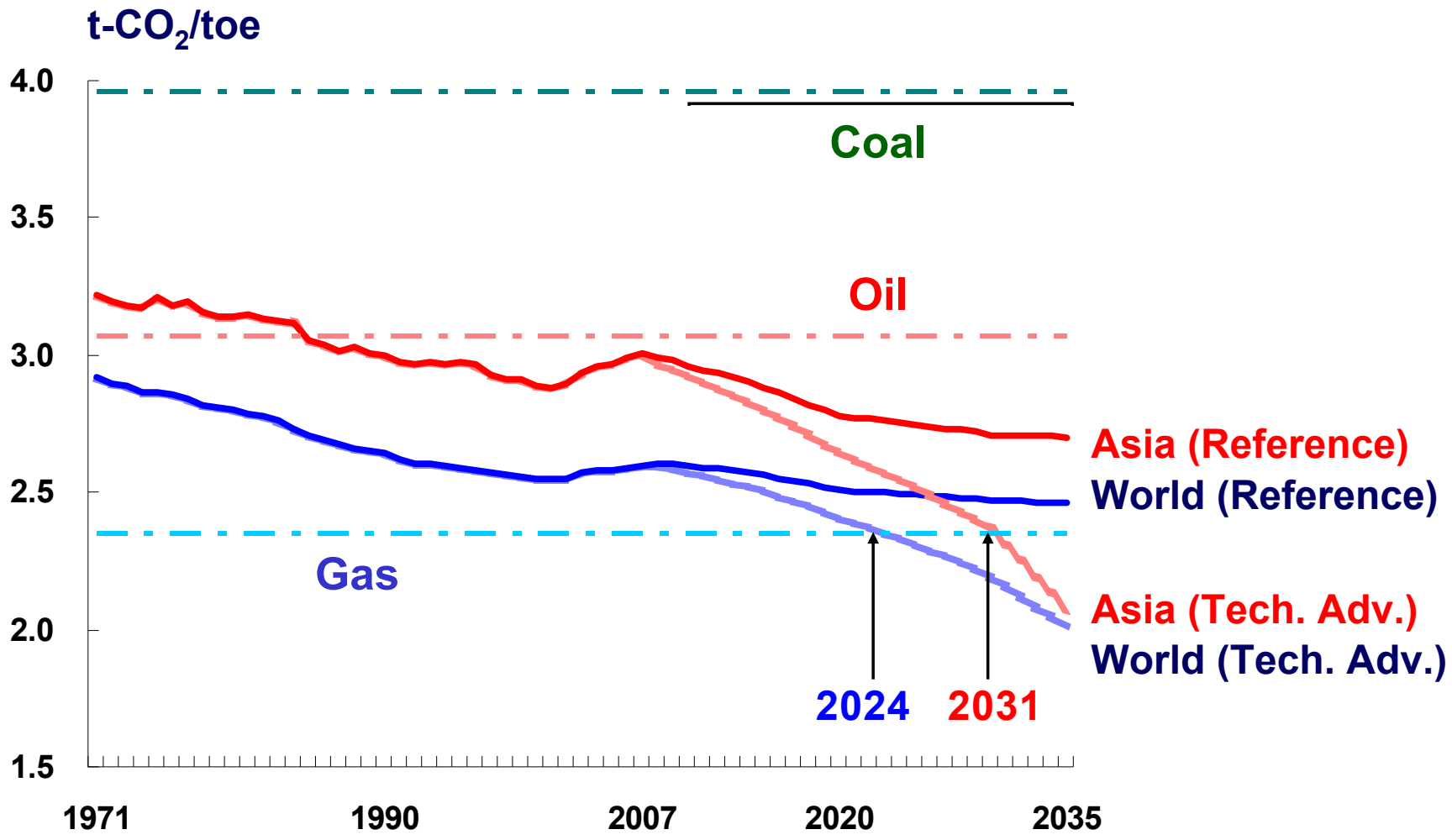
(t-CO2 per capita)

	1980	2007	2035
China	1.5	4.5	6.7
India	0.4	1.2	2.2
Japan	7.8	9.6	8.9
Korea	3.3	9.9	14.2
Taiwan	4.2	12.0	19.6
Indonesia	0.5	1.7	3.3
Malaysia	2.1	7.2	11.2
Philippines	0.7	0.8	2.2
Thailand	0.7	3.4	9.2
Vietnam	0.3	1.1	3.9
N.America	20.5	18.9	16.0
OECD Europe	8.9	7.4	7.2
OECD	11.3	10.9	10.5
non-OECD	2.0	2.8	3.7
World	4.1	4.4	4.9



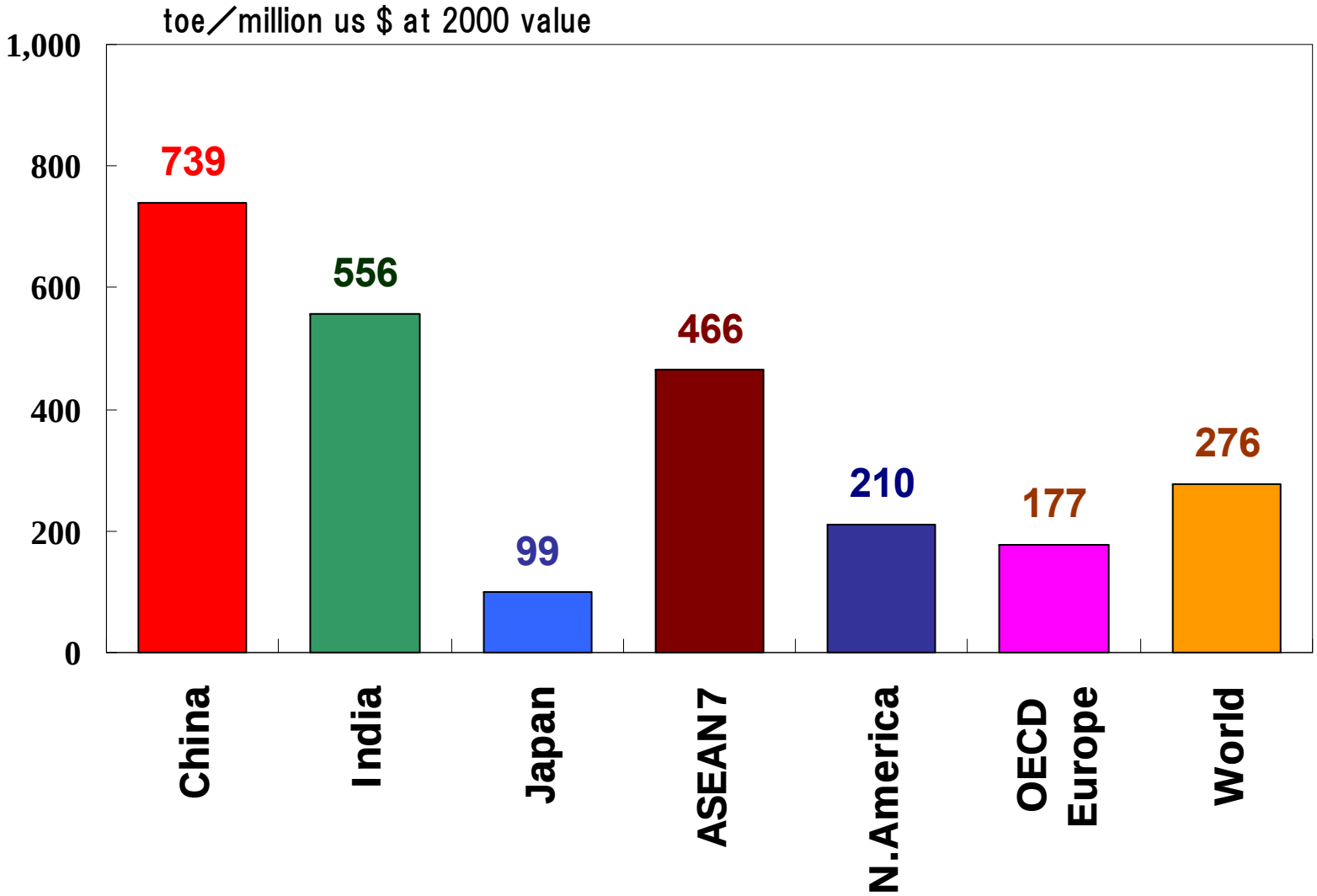
※ASEAN7：Indonesia, Malaysia, Thailand, Philippines, Vietnam, Singapore, Brunei

CO_2 Intensity: CO_2 Emissions per Primary Energy Demand



Primary Energy Demand per GDP(2007)

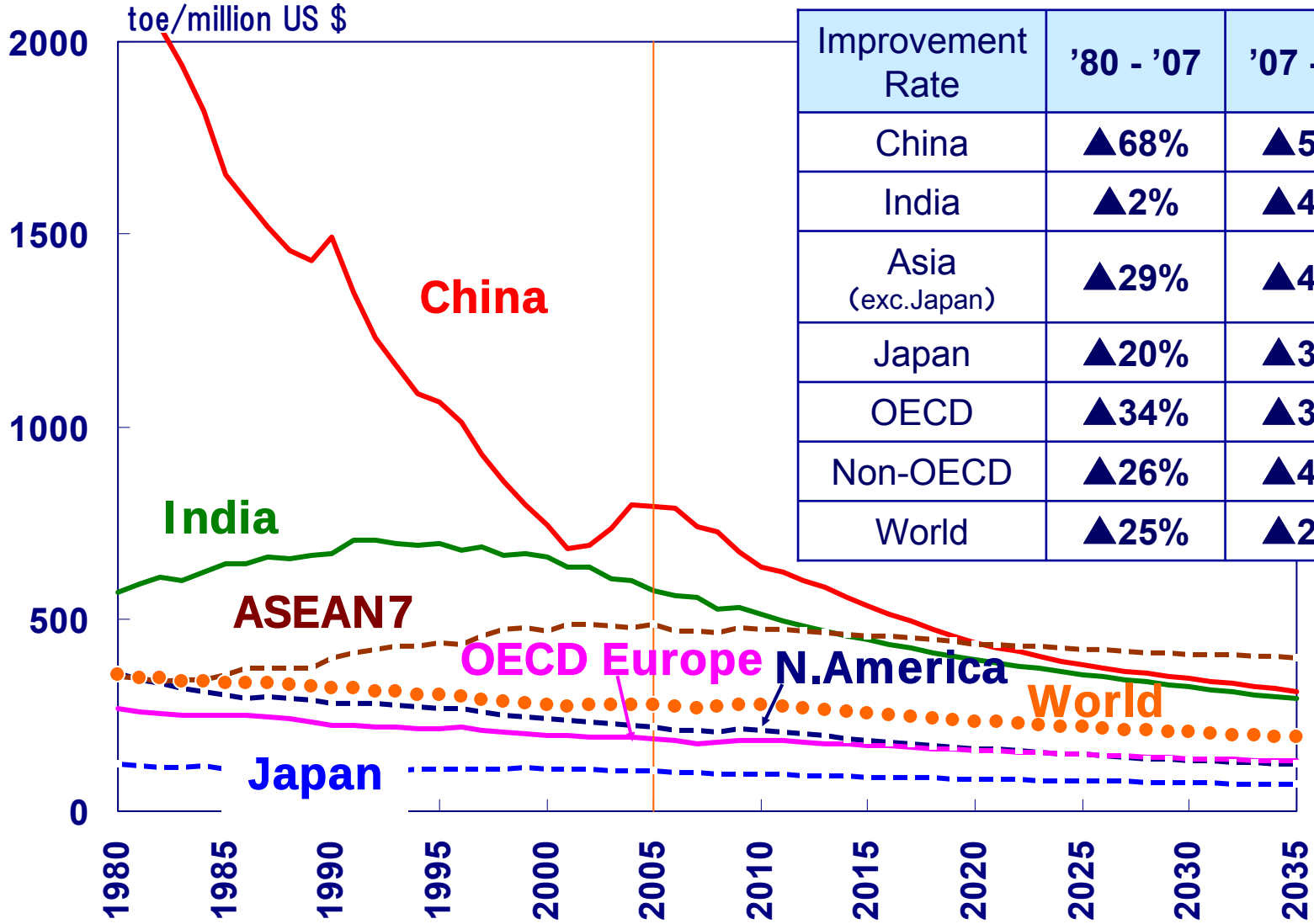
※ASEAN7：Indonesia, Malaysia, Thailand, Philippines, Vietnam, Singapore, Brunei



Primary Energy Demand per GDP

(Reference)

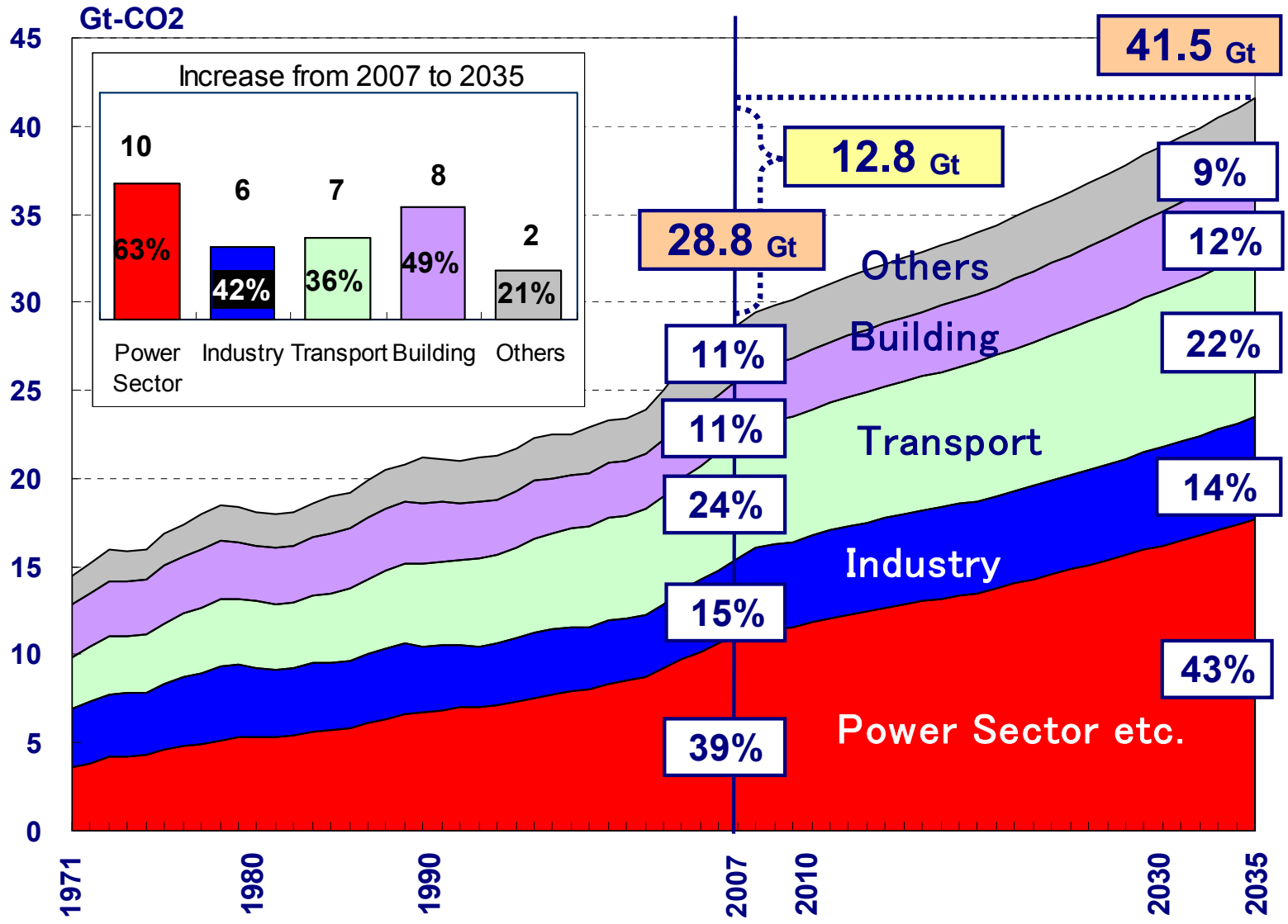
※ASEAN7：Indonesia, Malaysia, Thailand, Philippines, Vietnam, Singapore, Brunei



Improvement Rate	'80 - '07	'07 - '35
China	▲68%	▲58%
India	▲2%	▲48%
Asia (exc.Japan)	▲29%	▲43%
Japan	▲20%	▲30%
OECD	▲34%	▲34%
Non-OECD	▲26%	▲43%
World	▲25%	▲28%

CO_2 Emissions by Sector

(Reference)



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