

Originally Presented by Mr. Kokichi Ito, Managing Director, at the 399th Forum on Research Works, on 15 October 2007 , Tokyo, Japan

ASIA/WORLD ENERGY OUTLOOK 2007

—Focusing on China and India—

The Institute of Energy Economics, JAPAN(IEEJ)

Managing Director	Kokichi Ito
Senior Research Fellow, Director, EDMC	Yuji Morita
Director, Strategy and Industry Research Unit	Ken Koyama
Senior Researcher, EDMC	Shen Zhongyuan
Senior Researcher, EDMC	Akira Yanagisawa
Senior Researcher, EDMC	Shigeru Suehiro
Researcher, EDMC	Momoko Aoshima
Researcher, EDMC	Yuji Matsuo
Researcher, EDMC	Yu Nagatomi
and other IEEJ Researchers	

Contents

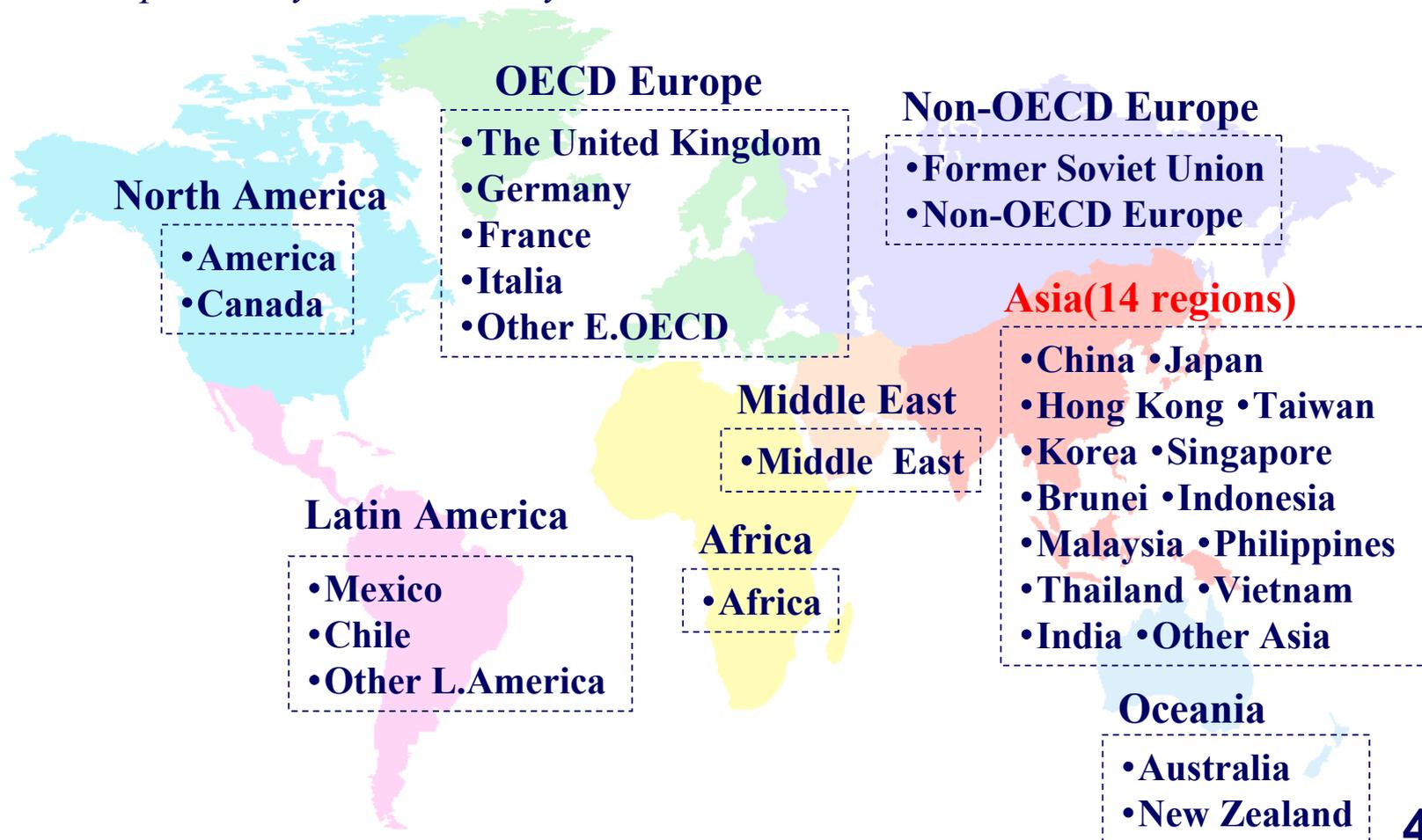
- **Projection Outline**
 - *Objective, Methodology, Major Assumptions*
- **Projection Results Overview : World and Asia**
 - *Primary Energy Demand, Final Energy Demand, Carbon Dioxide Emission*
 - *Motorization, Electrification, Power Generation Mix*
- **Projection Results : China and India**
- **Technologically Advanced Scenario**
- **Implication**

Projection Outline

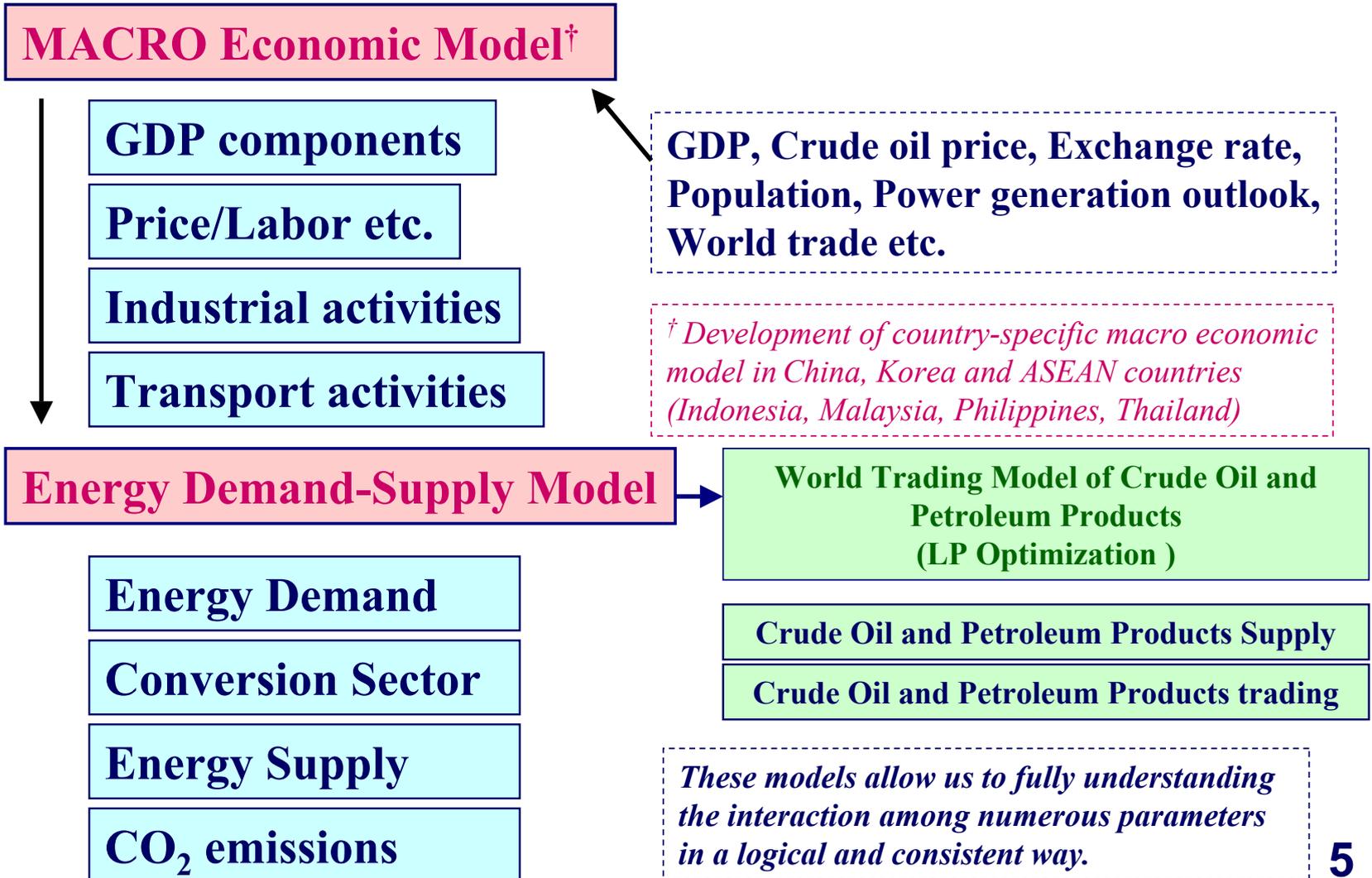
- **Objective:** *Attempt to quantitatively simulate realistic energy pictures in a fully logical and consistent way, with elaborate investigation into current status of socio-economic and energy fundamentals, in both world and Asian regions, and especially focusing on **China and India**.*
- **Projection Period:** *2006 ~2030*
- **Methodology:** *Macro-Economic Model, Energy Demand and Supply Model, both developed on the basis of econometric model*
- **Scenarios:**
 - **Reference**
Reference scenario anticipates highly probable assumptions based on current economic and political situations, which yields normative future evolution of energy demand and supply
 - **Technologically Advanced Scenario**
This scenario develops future picture, in which Asian countries take several technological advanced majors in order to secure energy supply and mitigate environmental problem.

Geographical Coverage

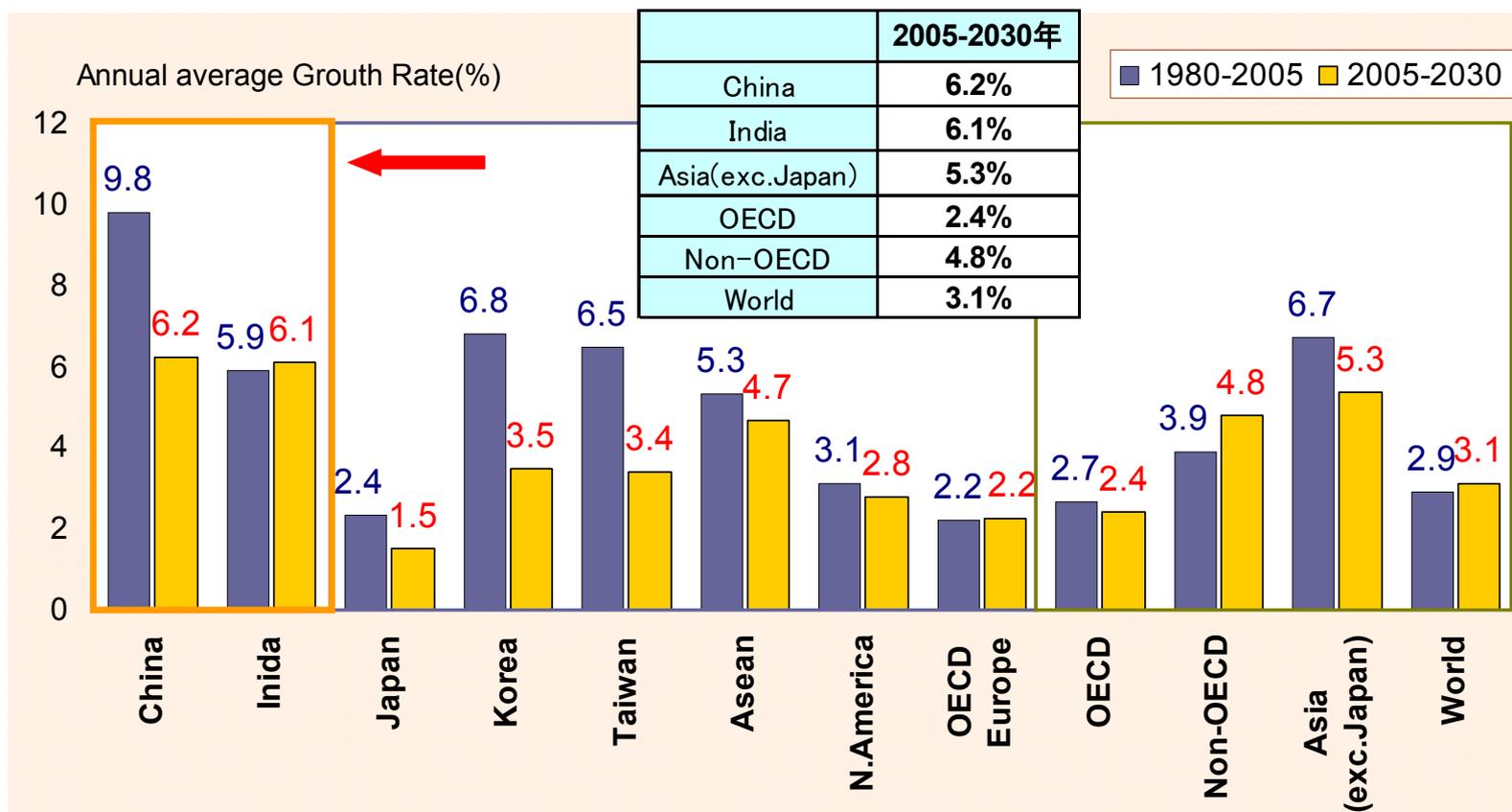
- *The whole world is geographically divided into 30 regions, Asia into 14 regions.*
- *Geopolitically detailed analysis into Asian countries.*



Basic Framework

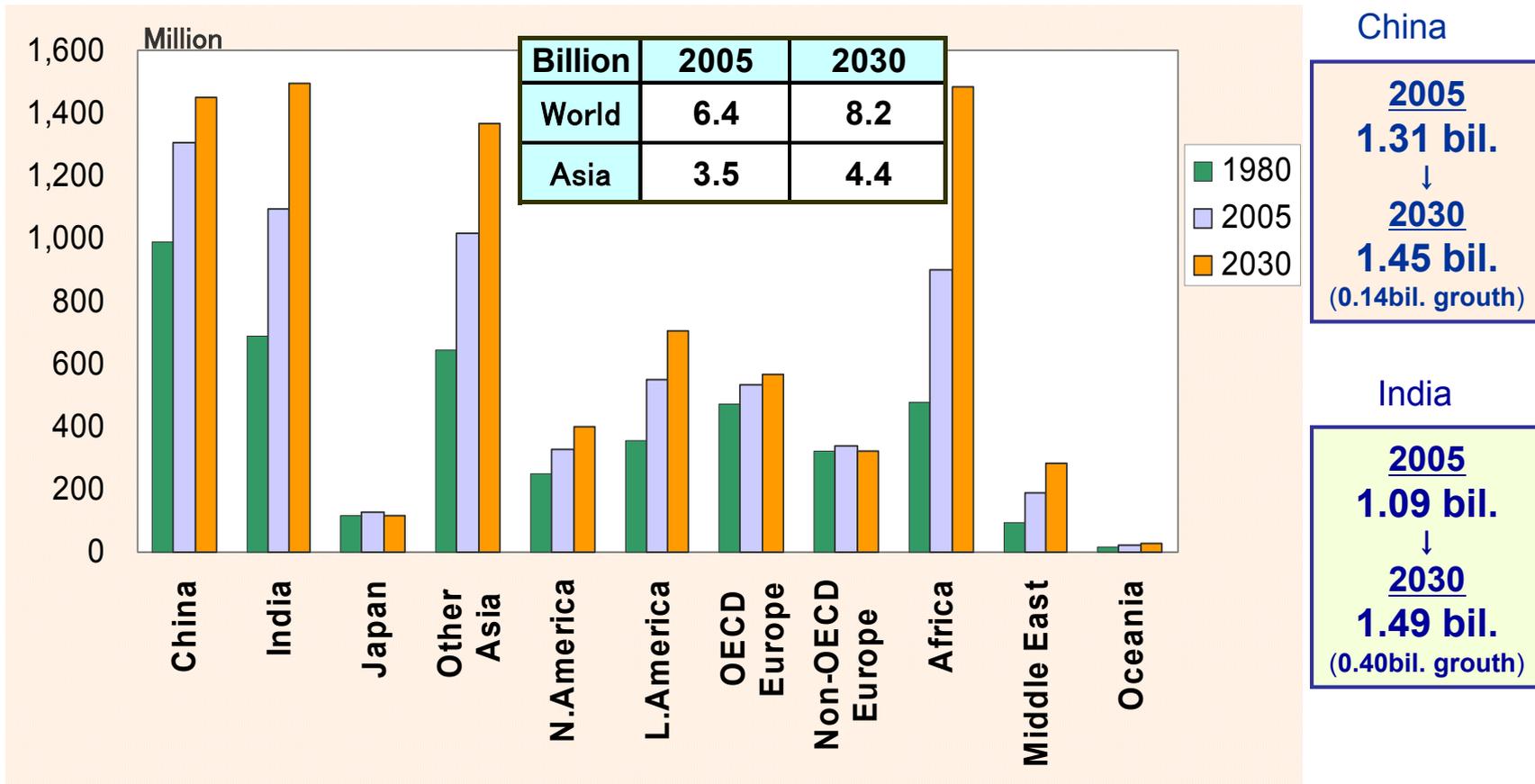


Basic Assumptions(1) - GDP Growth



- *World economy is projected to grow at 3.1% per annum, driven mainly by developing countries.*
- *GDP in China continues to achieve relatively high 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.*

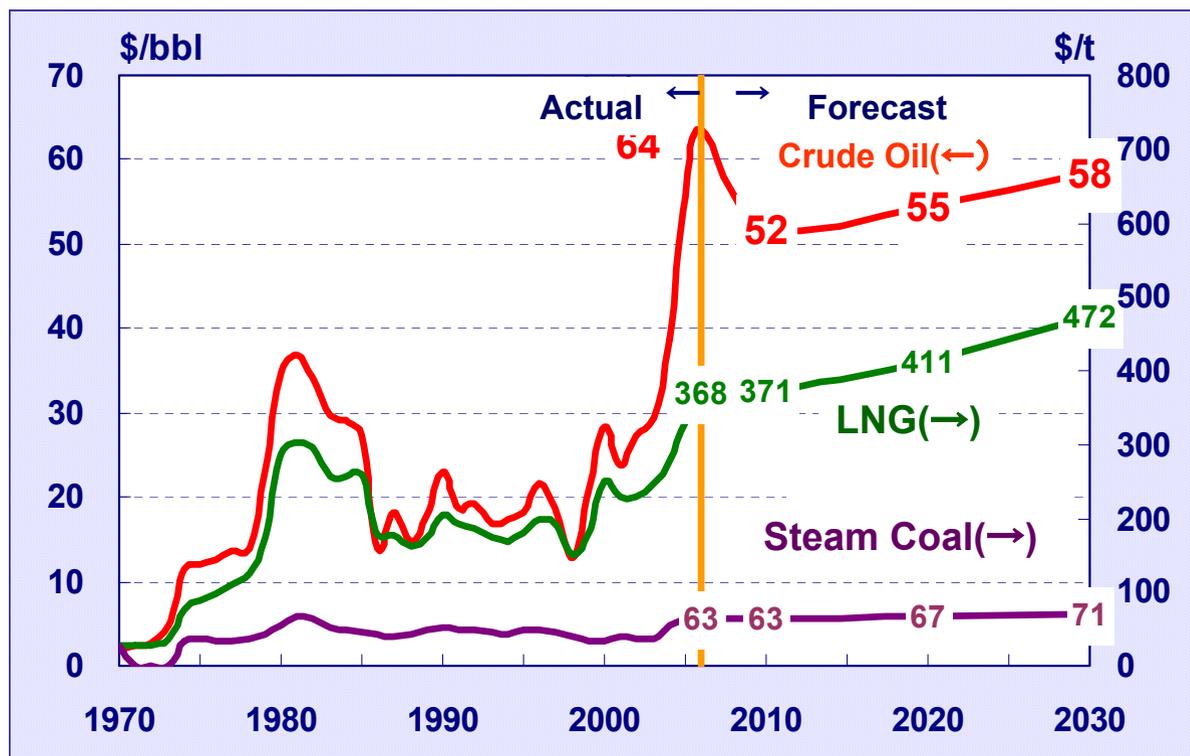
Basic Assumptions(2) - Population



*Based on UN world population outlook

Of the incremental increase in population over the period 2005-2030, roughly 90% derives from Non-OECD.

Basic Assumptions(3) – Primary Energy Prices



Cf. All the prices are calendar year data; In the graph, energy prices are explained by Japan's import energy price (CIF base).

- Present high price of crude(import CIF price) exhibits slowdown towards 2010. After 2010, international oil market is forecast to become tightened as a result of oil demand increasing mainly driven by Asia, besides stagnation of investment in upstream sector, boosting oil price higher for 2030
- LNG price is projected to rise in accordance with crude oil price.
- Coal price remains almost unchanged.

Primary Energy Prices

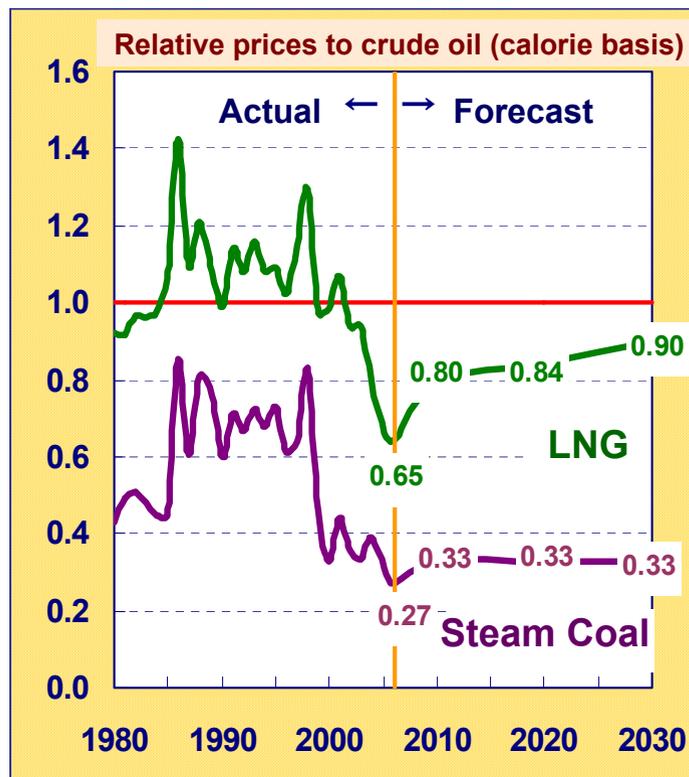
【Real and nominal prices】

		2000	2006	2010	2020	2030
Crude Oil \$/bbl	Real	32	64	52	55	58
	Nominal	28	64	56	72	94
LNG \$/t	Real	282	368	371	411	472
	Nominal	251	368	402	543	759
Steam Coal \$/t	Real	39	63	63	67	71
	Nominal	35	63	68	88	115

* Real prices are set in 2006.

* Inflation rates are assumed at 2% annually.

【Relative prices to petroleum】

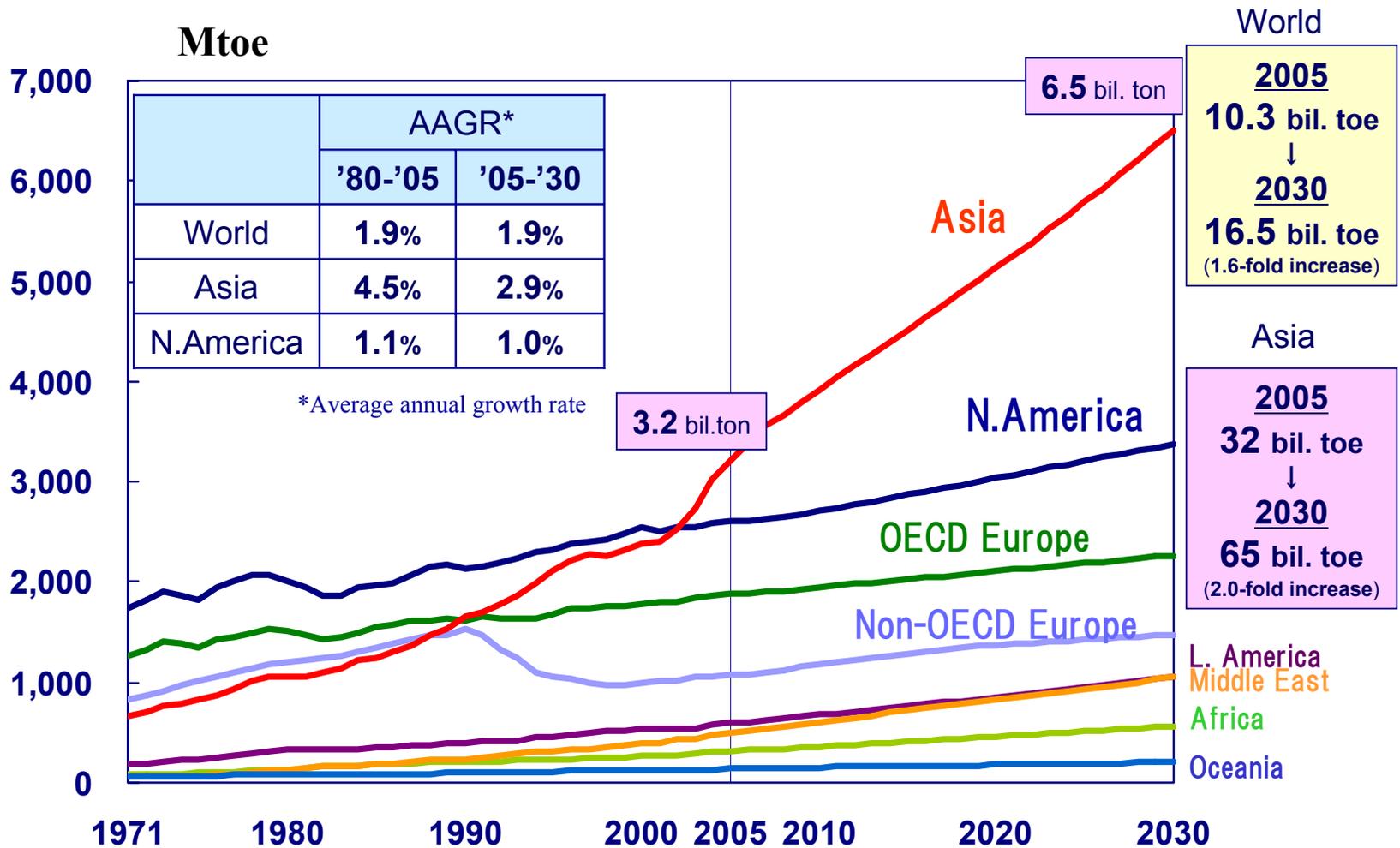


▪Currently, LNG price is cheaper compared with sharply rising petroleum price. For the long-term trend, the gap between crude oil and LNG will become smaller.

▪Coal relative price will remain roughly constant for 2030.

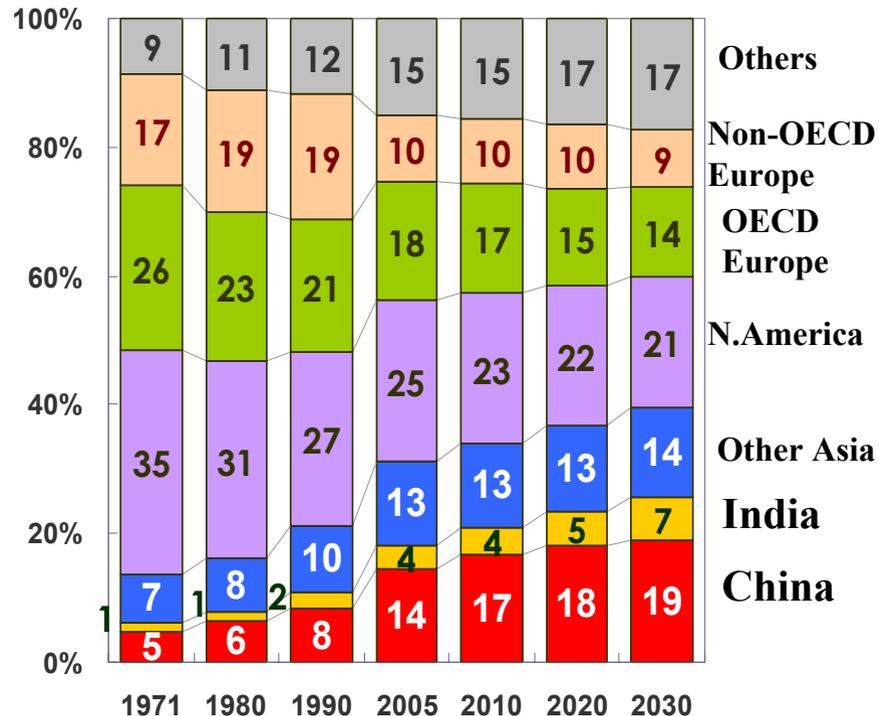
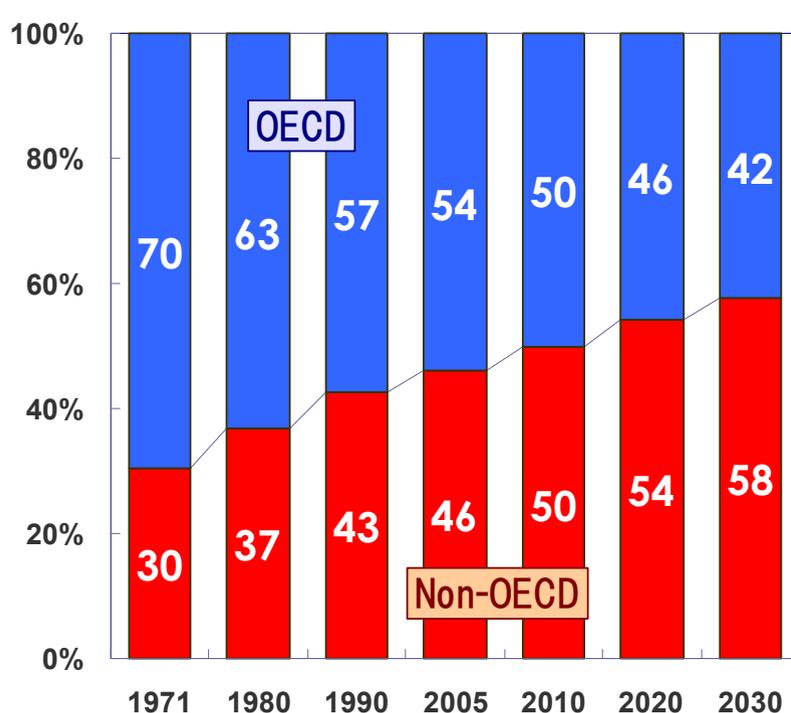
Projection Results Overview : World and Asia

Primary Energy Demand by region ; World



In 2030, primary energy demand of Asia achieves twice as much as current level, reflecting highly economic growth. 3.2 billion toe(2005) → 6.5 billion toe (2030)

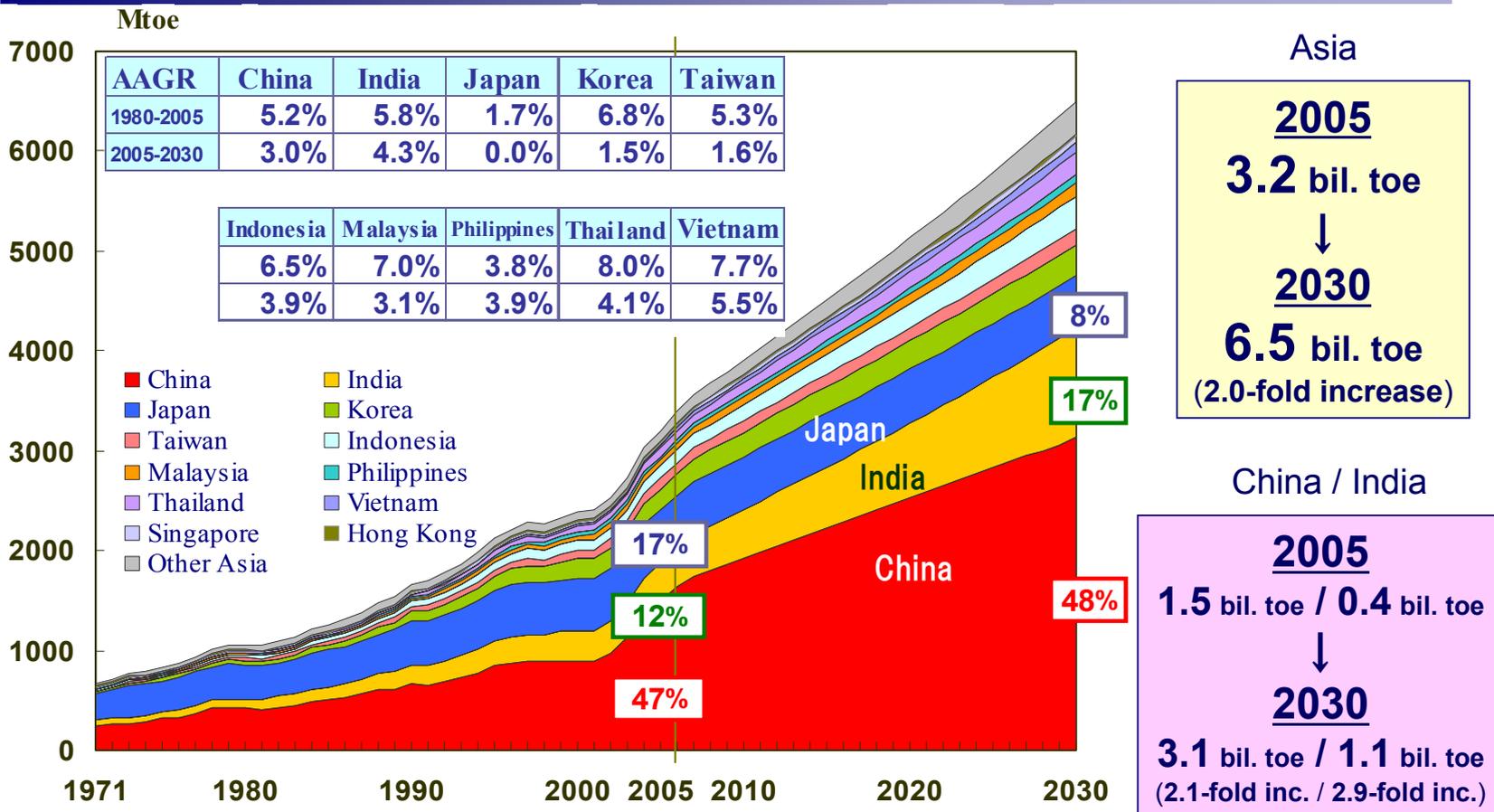
Primary Energy Demand (Regional Share)



• 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 2030.

• The share of China in world energy demand will increase to 19% by 2030, and India to 7%. The two countries together accounts for 26% of world energy demand.

Primary Energy Demand (Asia)



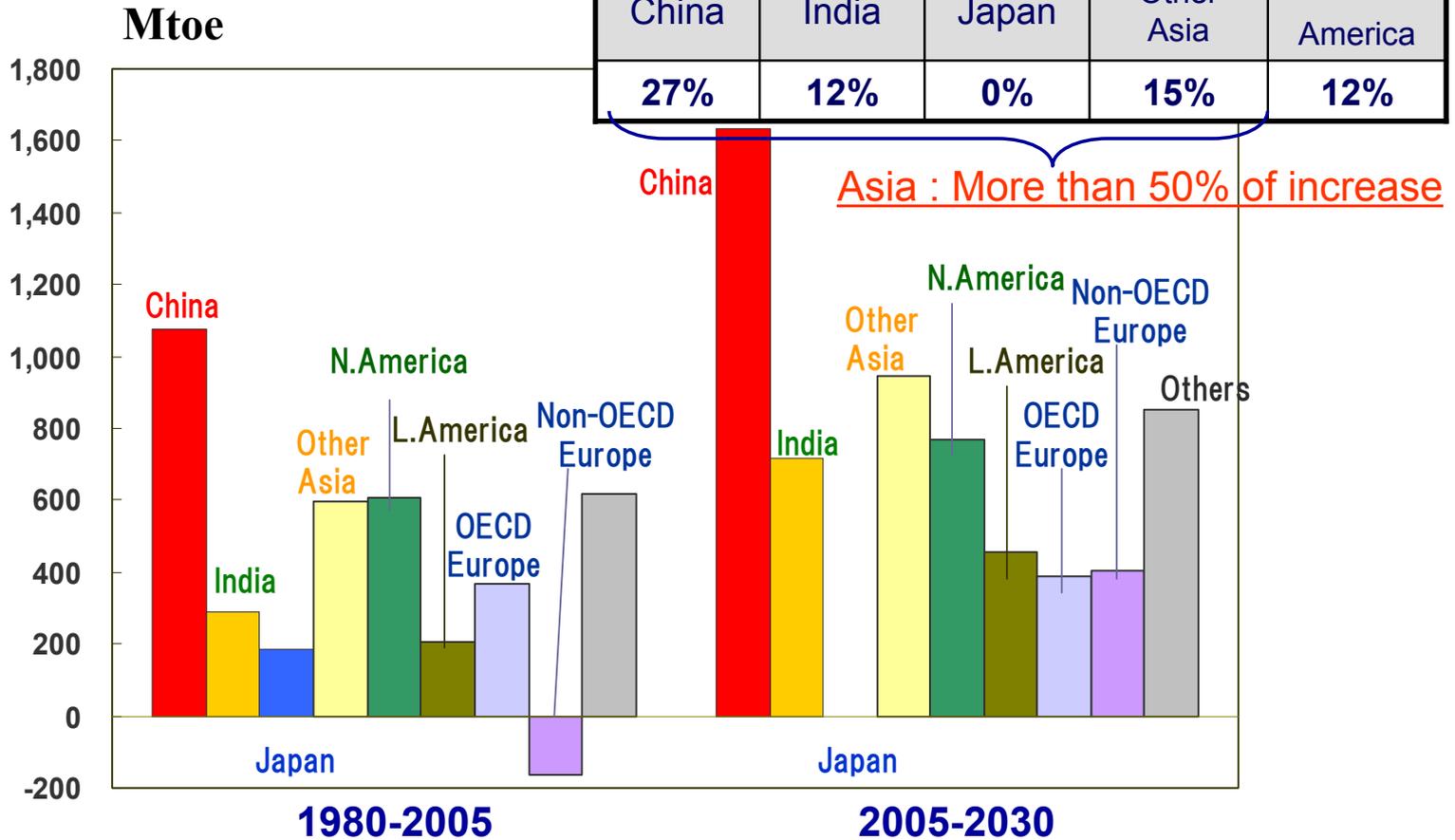
-Based on strong economic growth, share of China in Asia significantly increases to 48%, China and India together to 65%.

-Japan's energy share in Asia, with its slower-paced economic growth and depopulation, will decline from 17% in 2005 to 8% in 2030.

Increase in Primary Energy Demand by Region, 2005-2030

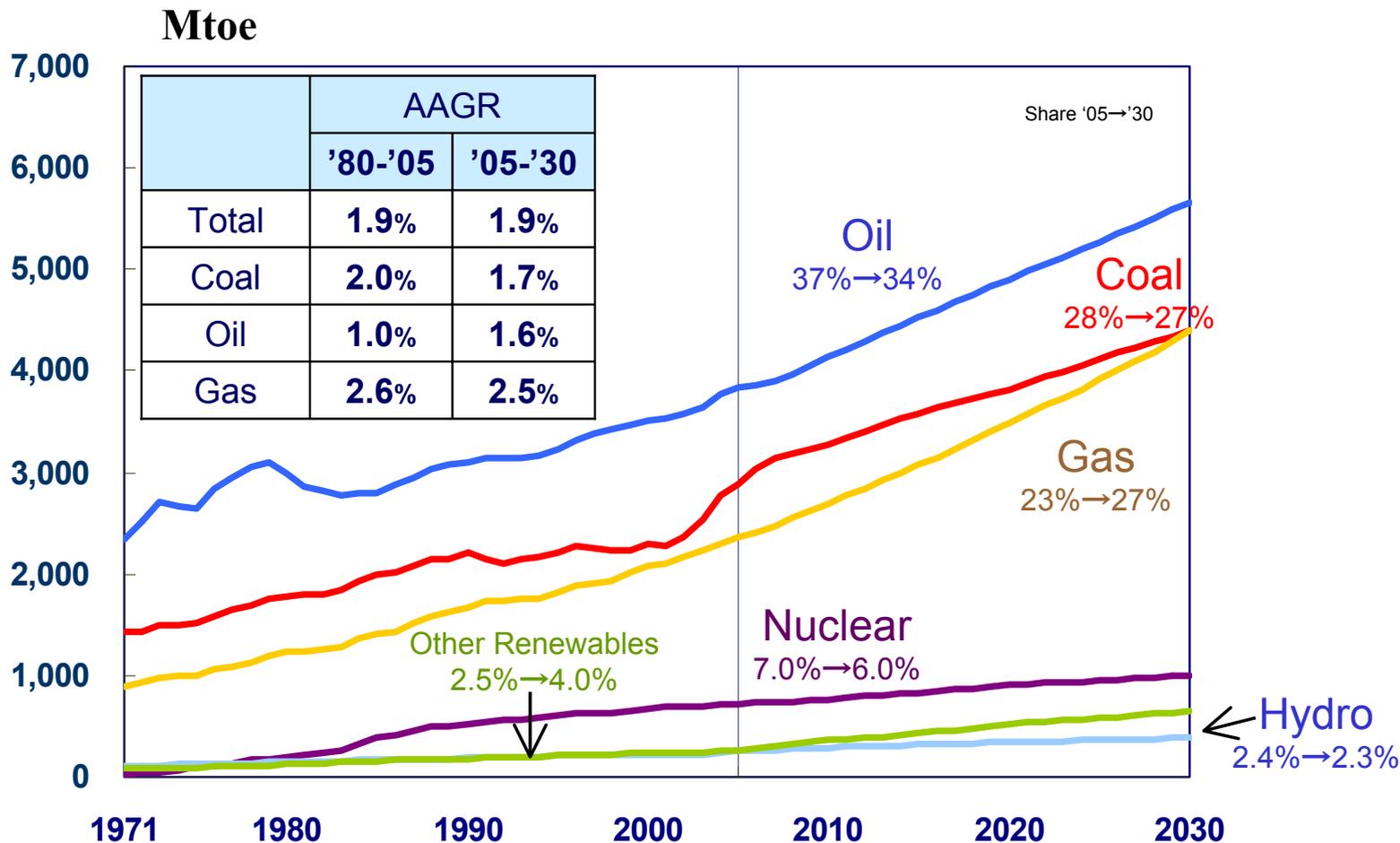
Share in increase, 2005-2030

China	India	Japan	Other Asia	N. America
27%	12%	0%	15%	12%



Approximately 50% of total increase is due to Asia.

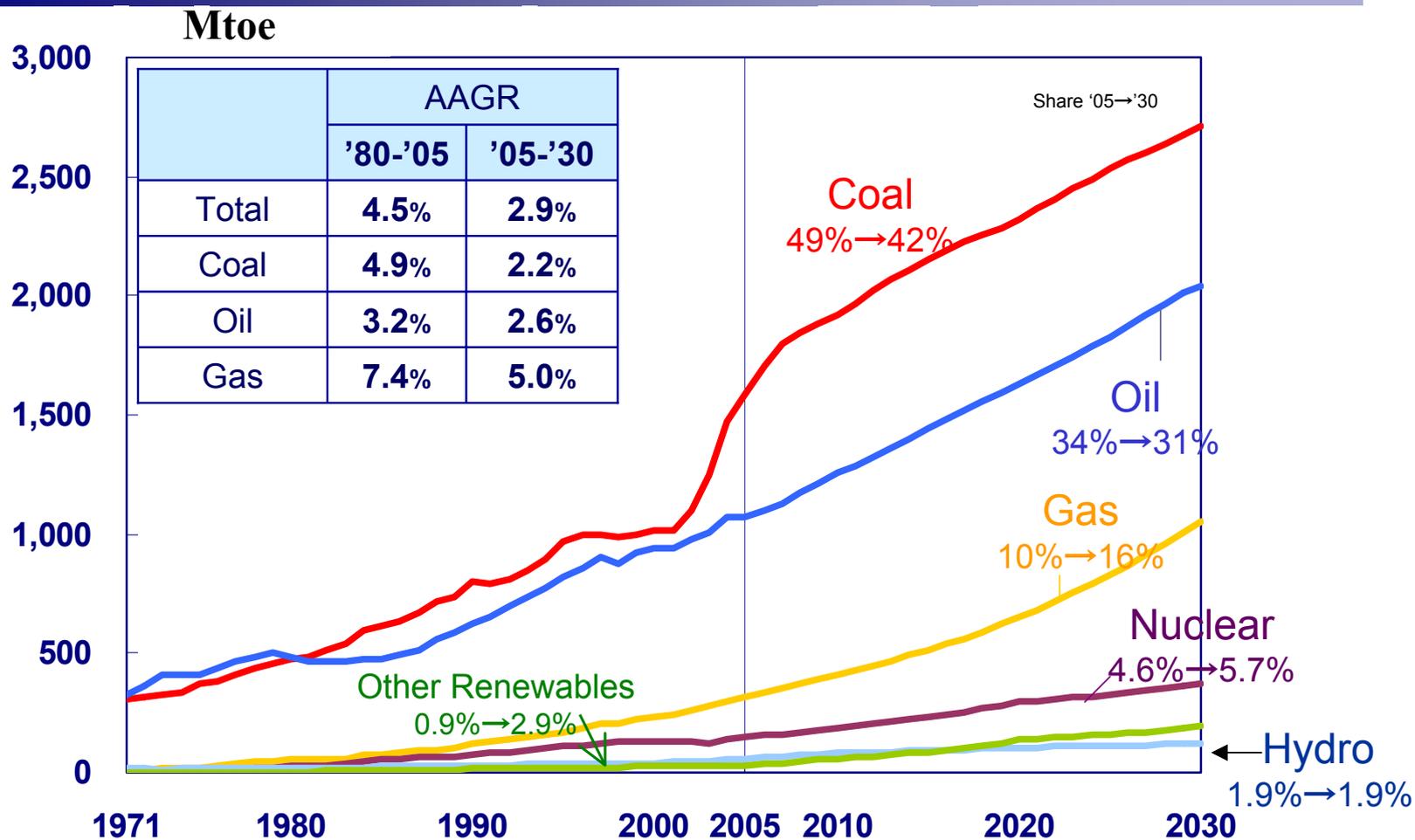
Primary Energy Demand by Fuel ; World



- Oil will remain the largest energy source in primary energy mix until 2030

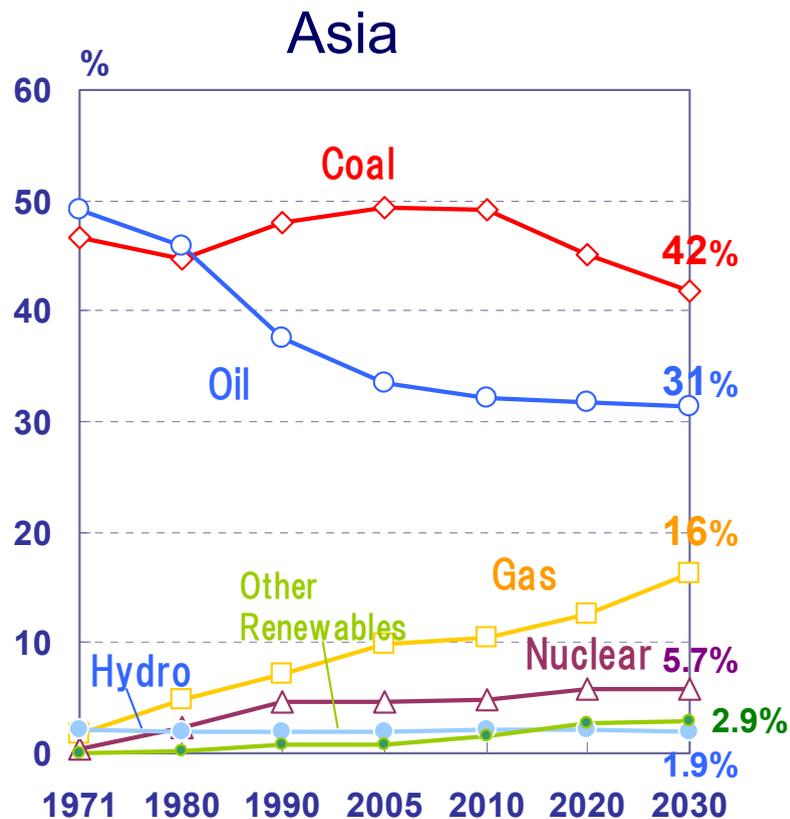
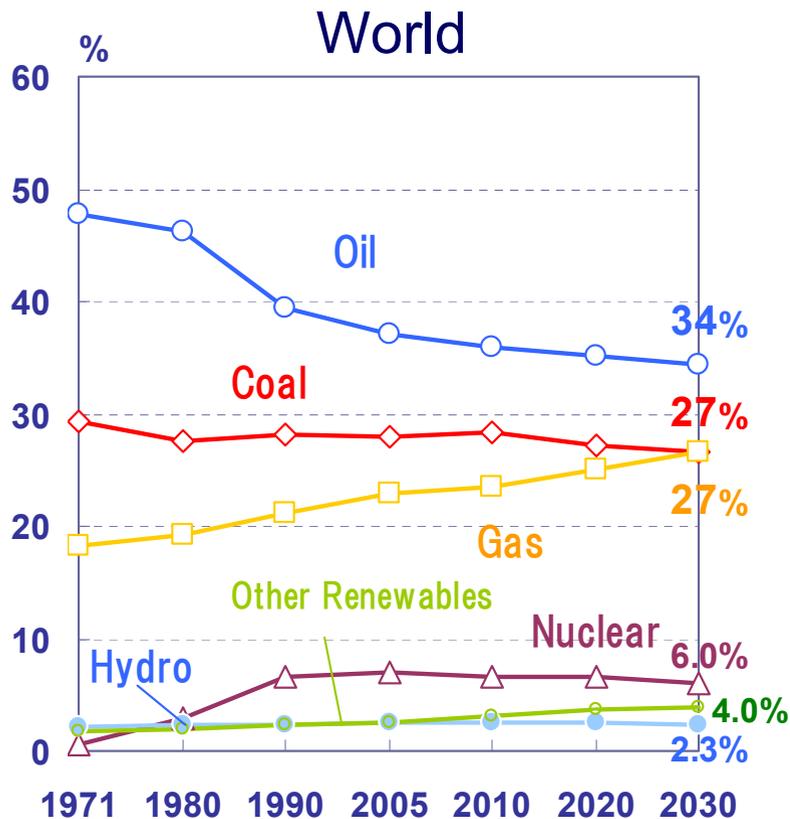
- Natural gas demand will grow with its future extensive use in various sectors, eventually catching up with coal around 2030.

Primary Energy demand by Fuel ; Asia



- Coal and Oil will continue to maintain its centrality over Asian energy demand until 2030
- The share of natural gas will grow substantially, driven mainly by power generation

Primary Energy Mix by Fuel ; World and Asia



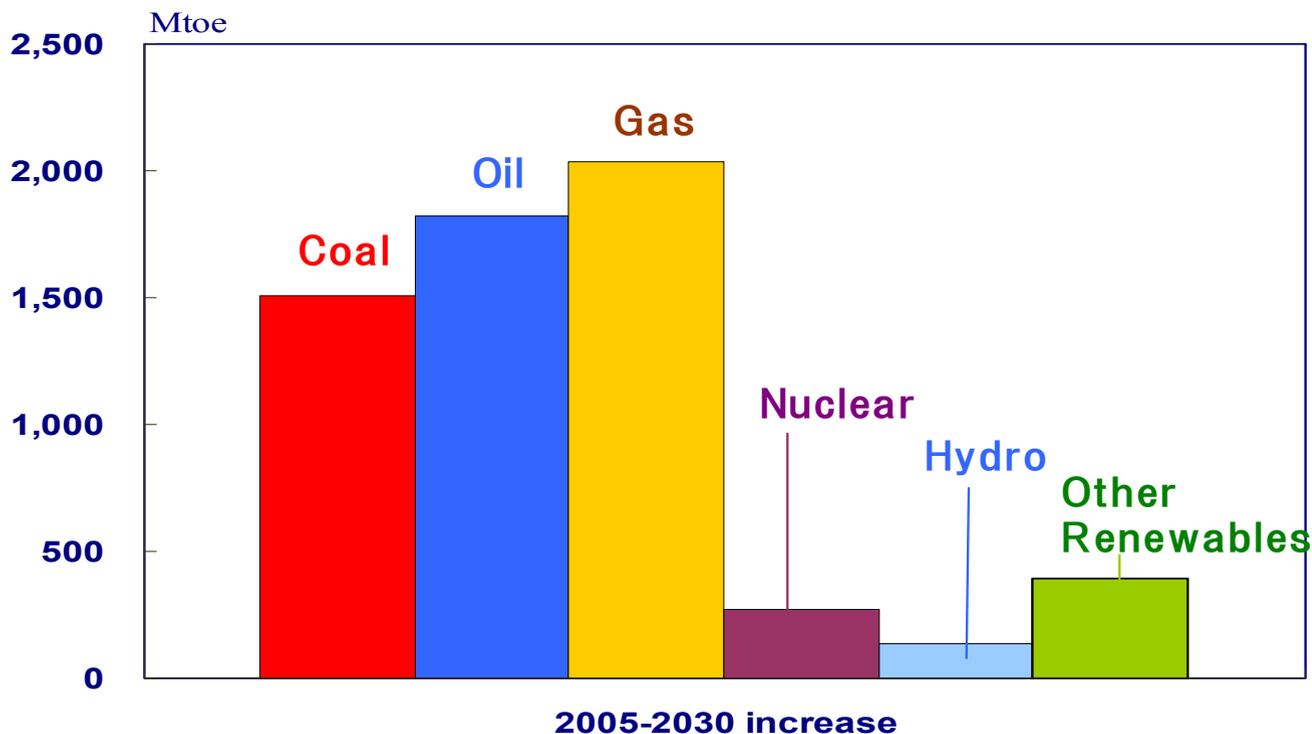
- In Asia, coal remains the largest of primary energy due to increasing electrical power demand until 2030. (Coal share in Asia: 2005:49% → 2030:42%)

- Nuclear share in Asia gradually increases with active building-up of nuclear power plants in China, India, Japan and South Korea.

Increase in Primary Energy Demand by Fuel ; World

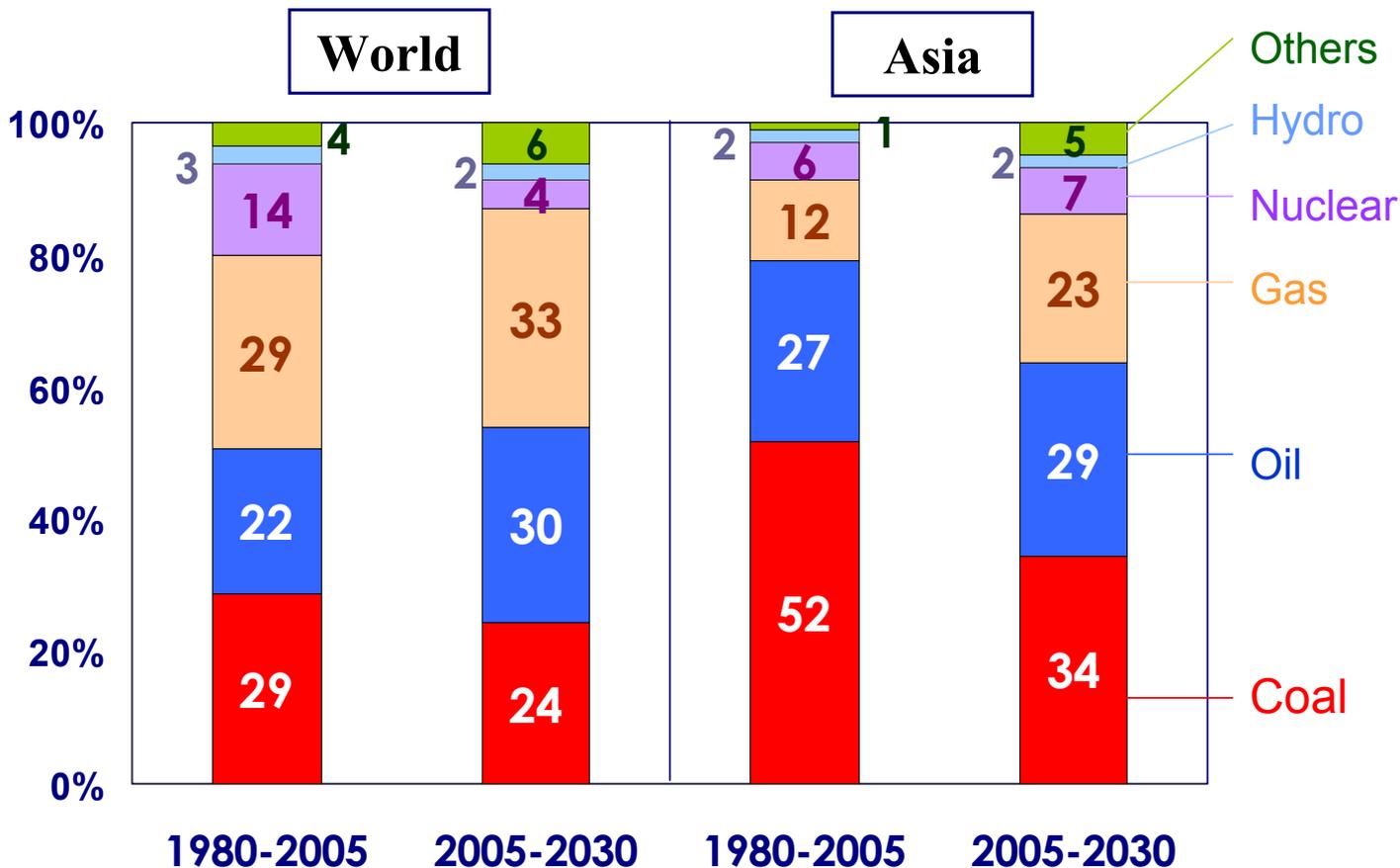
2005-2030 Increase

Coal	Oil	Gas	Nuclear	Hydro	Other Renewables
24%	30%	33%	4.5%	2.2%	6.4%



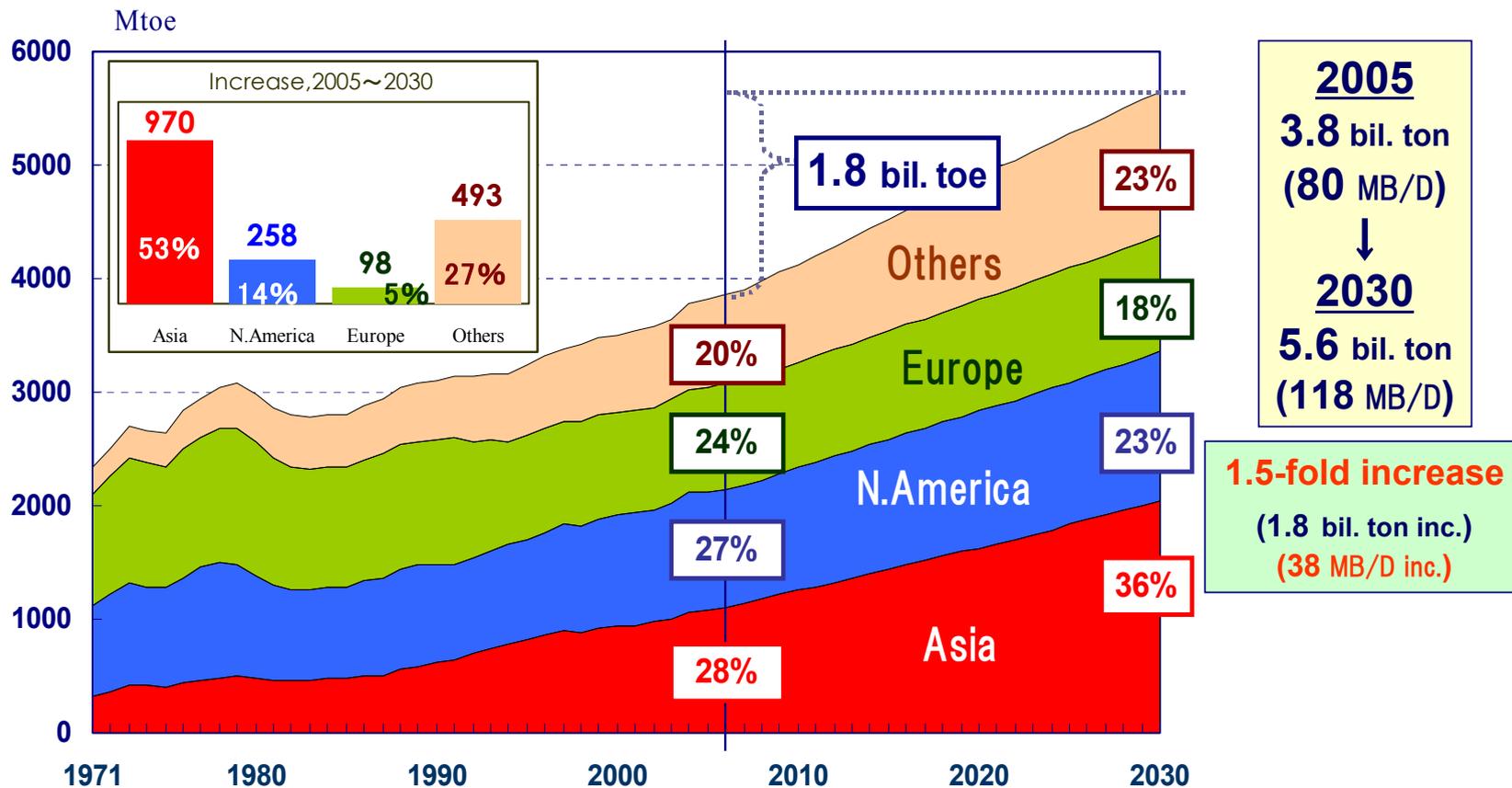
Approximately 90% of increase will be concentrated on fossil fuels

Share of Increase in Primary Energy Demand by Fuel World and Asia , 2005-2030



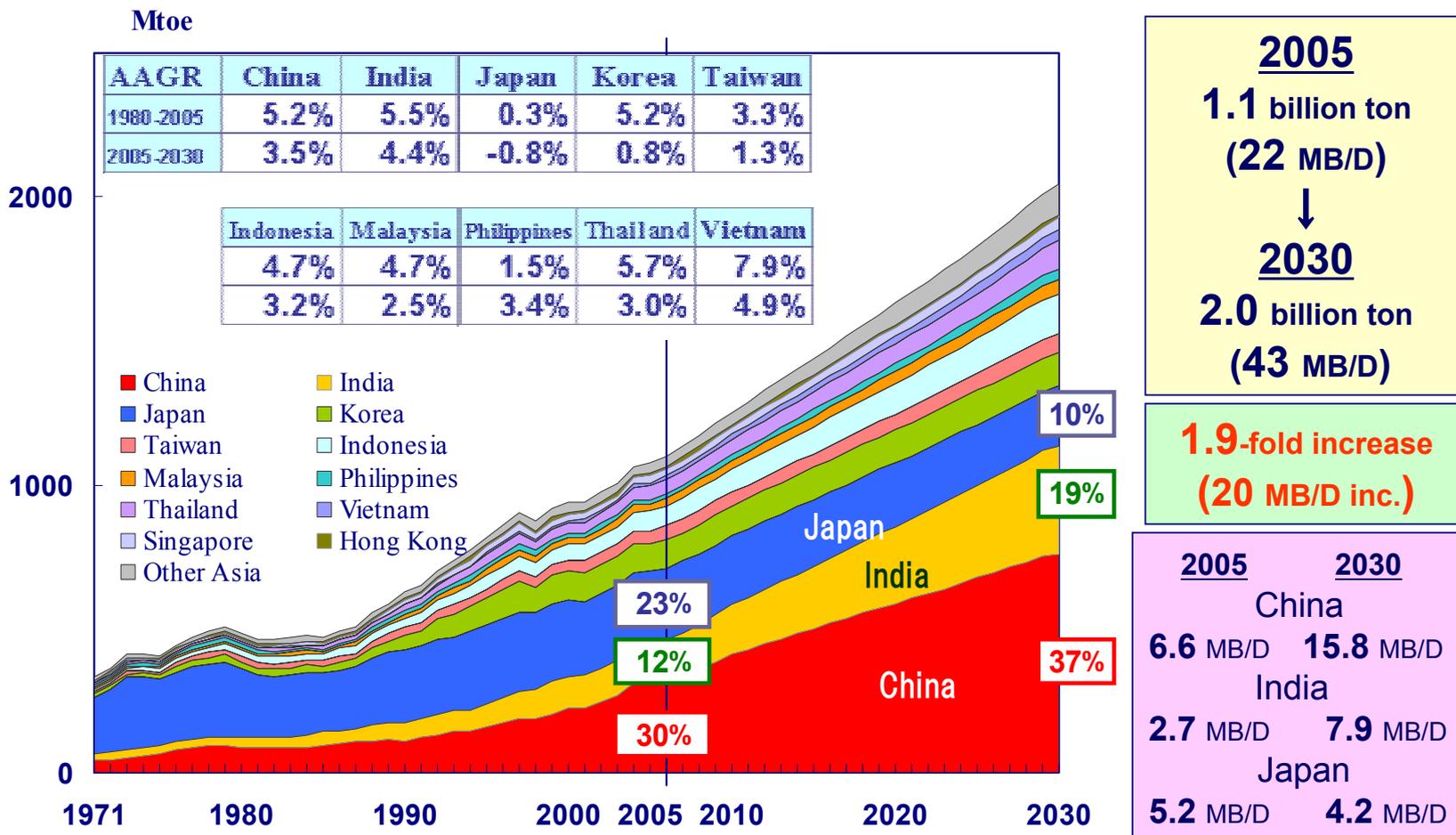
- Almost 90% of increase will come from fossil fuels both in world and in Asia.
- Coal will account for more than 30% in Asia.

Oil Demand by Region ; World



More than 50% of increase will be derived from Asia; Asia will become the centre of oil demand by 2030.

Oil Demand by Region ; Asia

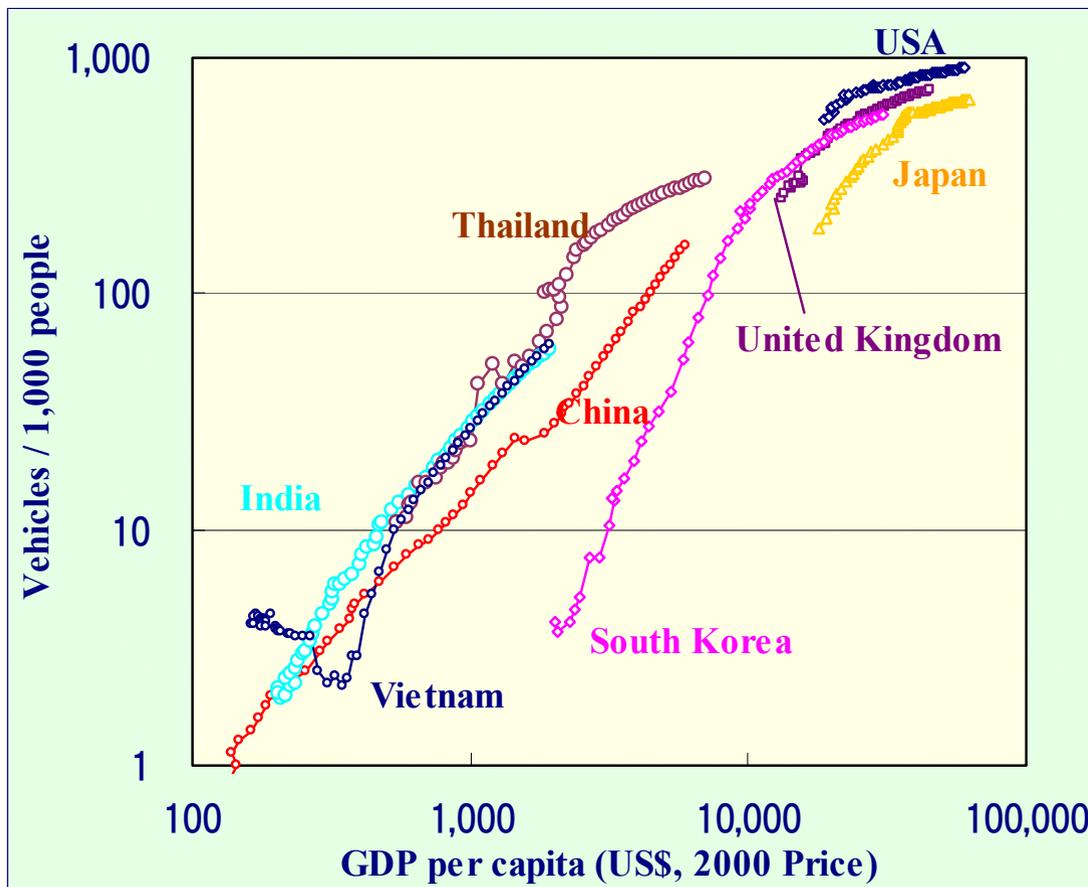


- Oil demand in China will boost from 6.6 million B/D in 2005 to 15.8 million B/D in 2030, due mainly to its escalating vehicle possession

- The share of China and India together will grow from 42% to 56%

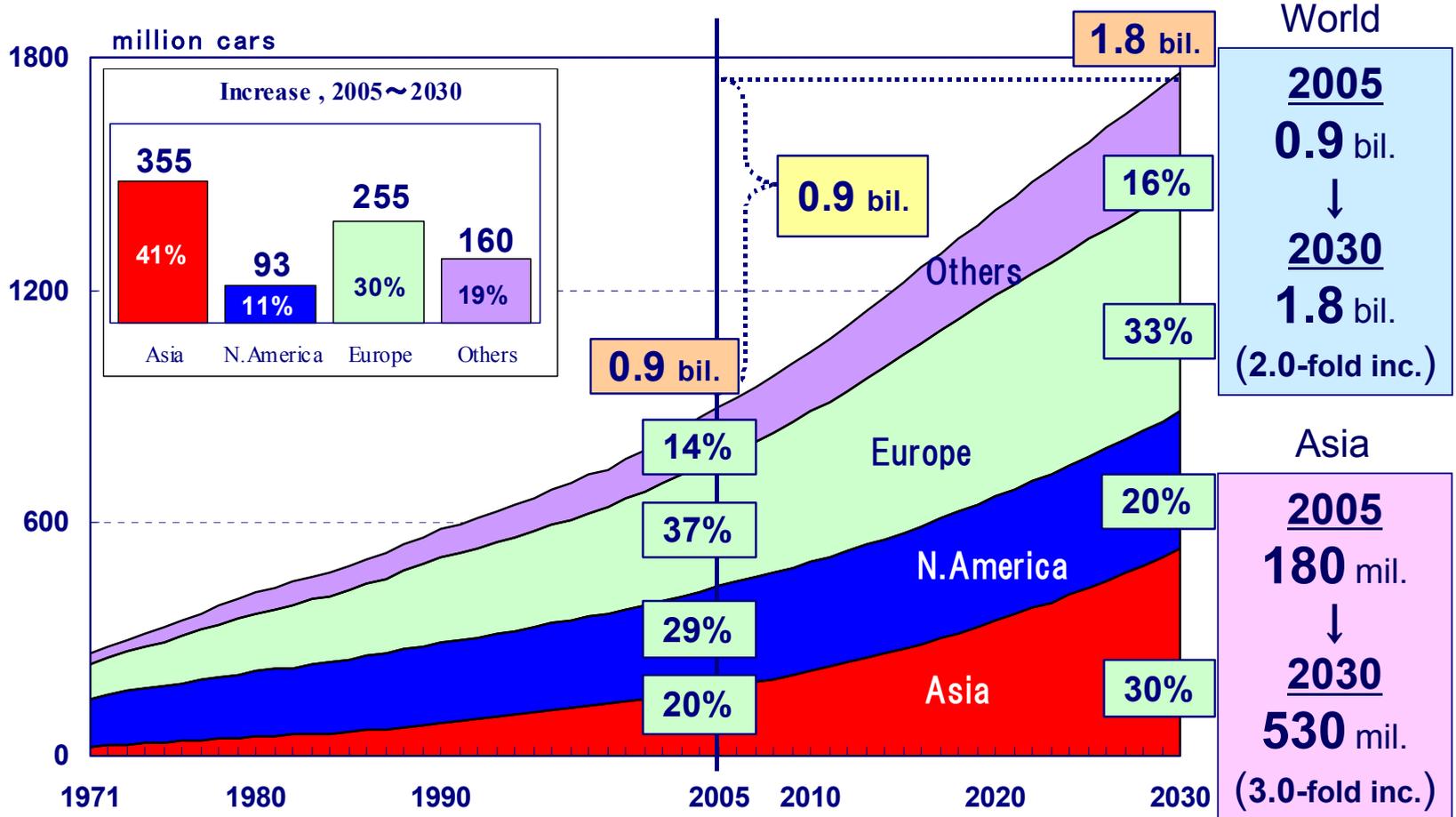
Vehicle Intensity (Selected Countries)

Including actual data and forecast results, 1971-2030



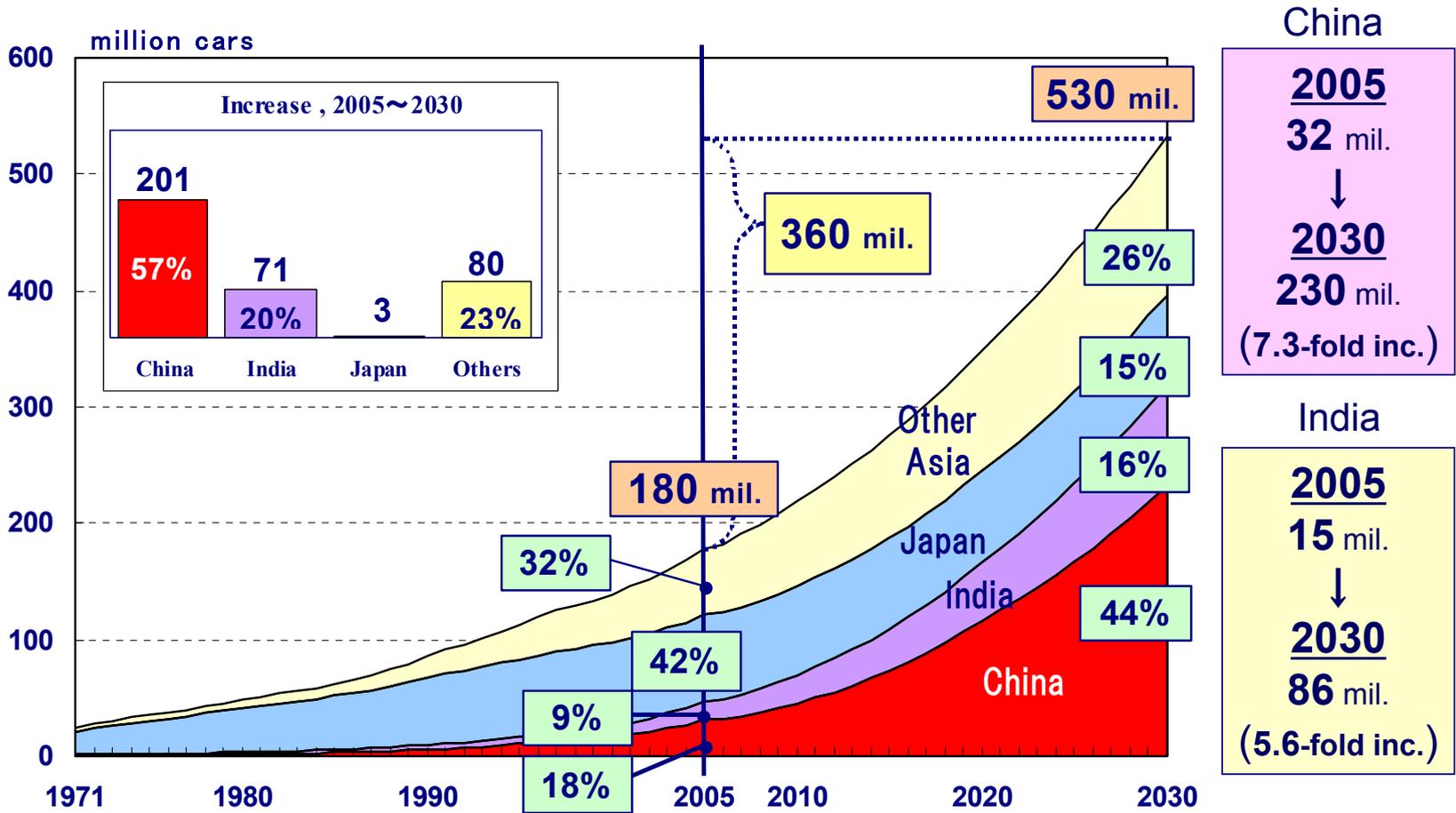
In China and India, the automobile holding rate will increase steadily with growing income.

Number of Vehicles ; World



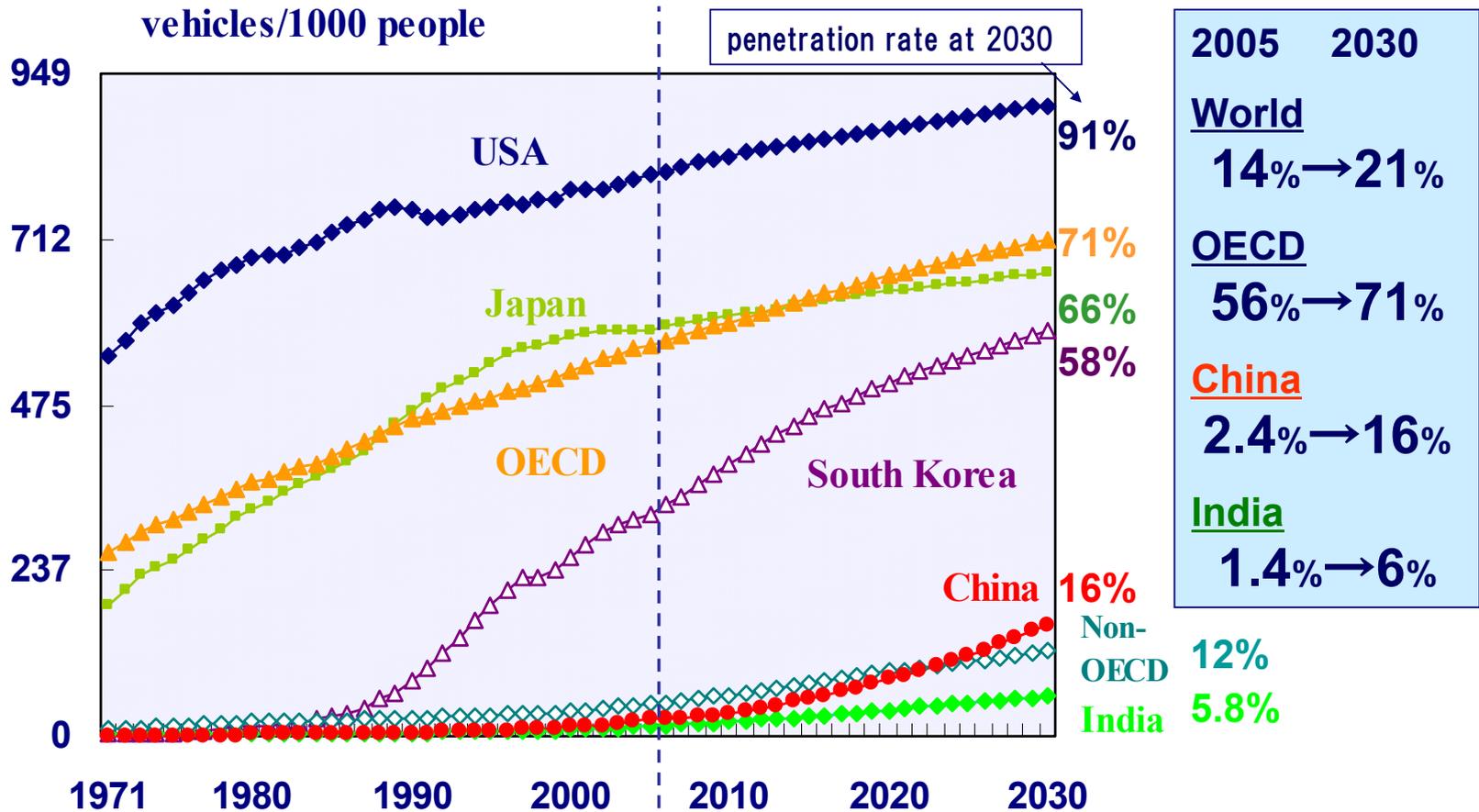
Approximately 40% of increase comes from Asia, with vehicle number increase in developed countries showing saturation trend.

Number of Vehicles ; Asia



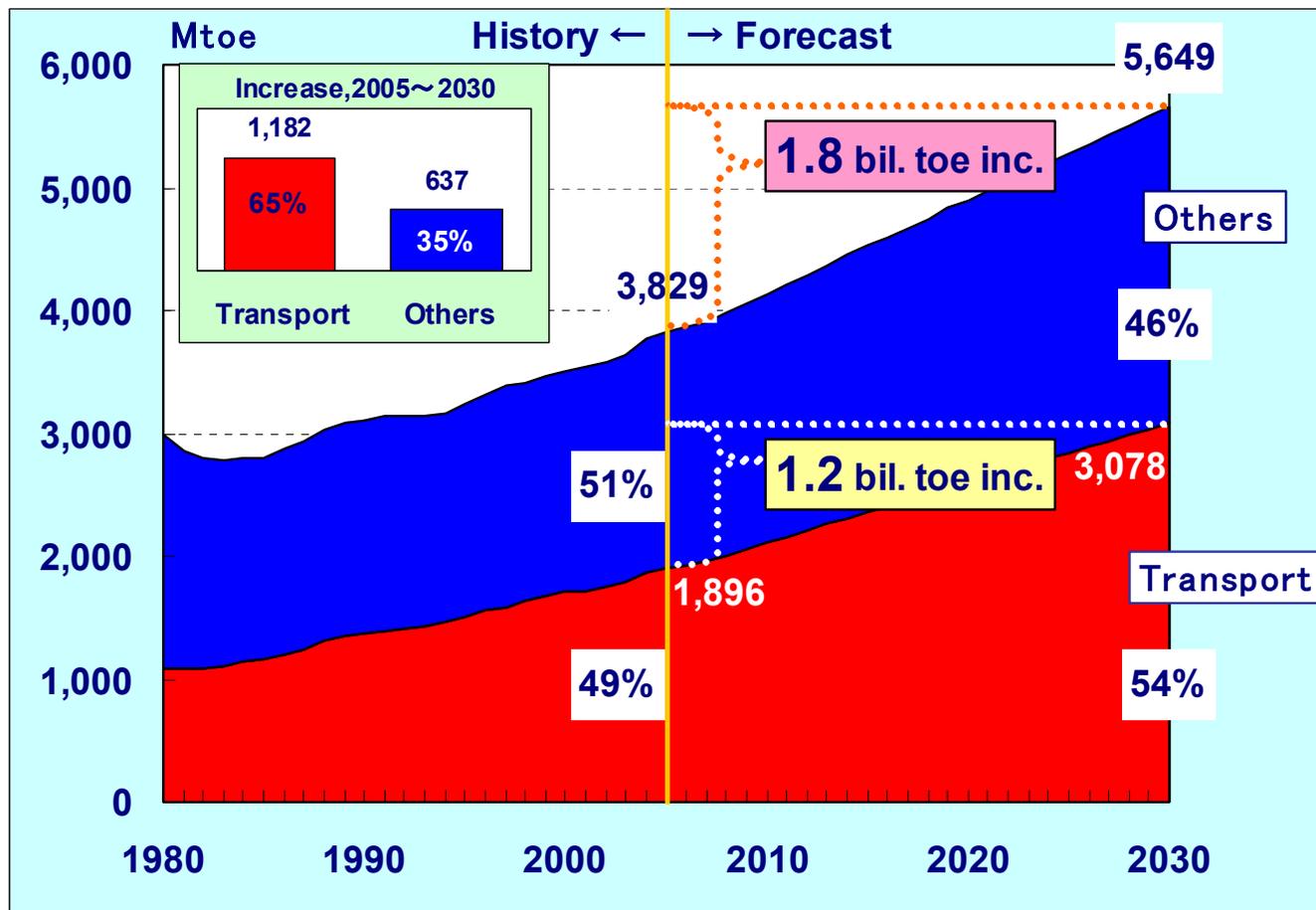
Number of vehicles grows significantly in China. In Japan, it grows only slightly.

Vehicle Possessing Rate



- Vehicle possessing rate will make progress mainly in Asian nations, the majority of which achieve high economic growth during 2006-2030.
- Although the number of vehicles is projected to expand vigorously in China and India, the vehicle possessing rates will still remain well below developed countries; As the result, these countries have a large room to grow still in 2030.

Oil Demand in Transport Sector ; World



Oil Demand
(Total)

2005

3.8 bil. toe



2030

5.6 bil. toe

(1.5-fold inc.)

Oil Demand
(Transport)

2005

1.9 bil. toe



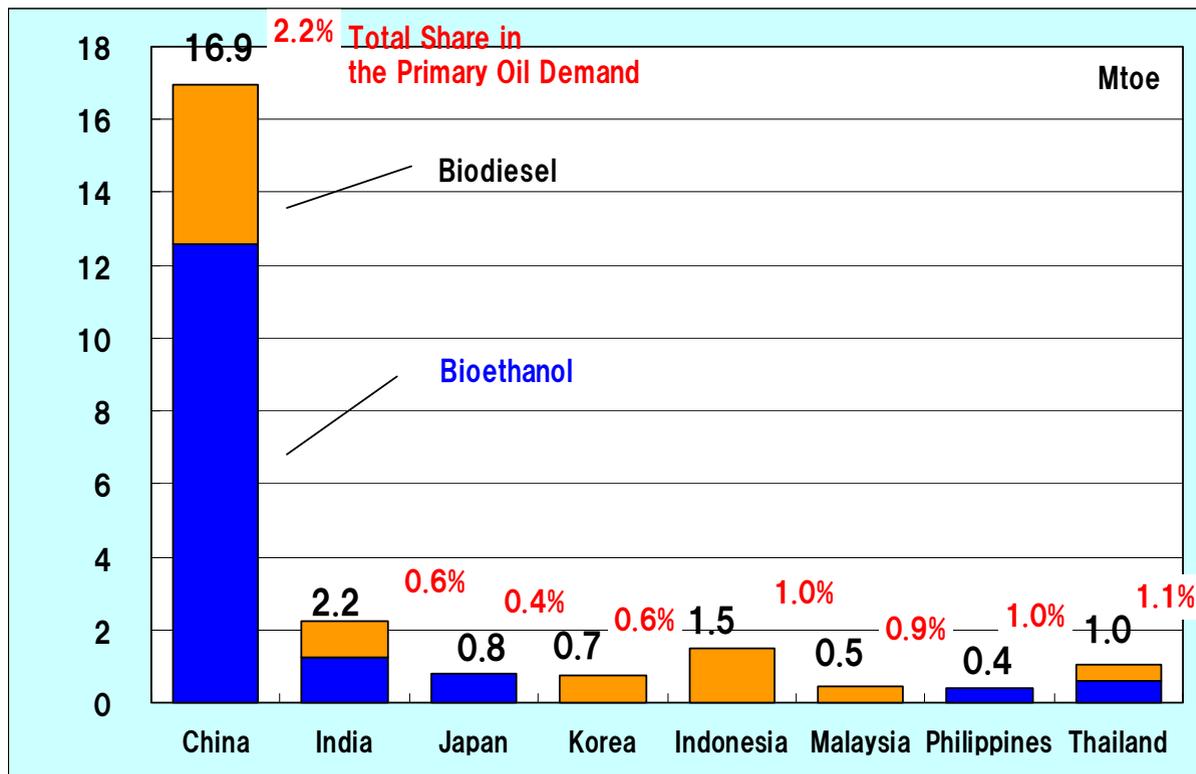
2030

3.1 bil. toe

(1.6-fold inc.)

- Two thirds of oil demand growth is attributed to transport sector.
- In 2030, transport sector will account for more than half of the total oil demand, and therefore light oil products will be more and more demanded.

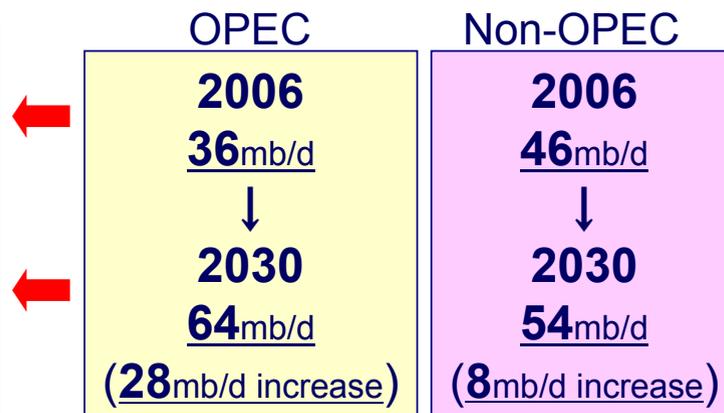
Biofuel Outlook



- *Biofuel (including biodiesel and bioethanol) will increase to 120 Mtoe in the world, mainly in Europe, North America, and Latin America.*
- *In Asia, biofuel will increase to 24 Mtoe. Bioethanol will be introduced in China, India and Japan and other countries, while biodiesel will be introduced in Korea , Indonesia, Malaysia etc.*

Oil Production Outlook

mb/d	2006	2010	2020	2030	2006-2030
OPEC	36	38	51	64	28
Middle East OPEC	25	27	37	46	21
Other OPEC	12	11	14	18	6.3
Indonesia	1.1	1.0	0.9	0.8	▲ 0.3
Non-OPEC	46	48	52	54	8.1
N.America	10.0	10.4	10.4	10.2	0.2
L.America	7.7	8.3	10	11	3.5
Europe (inc. Russia)	17	19	21	21	3.7
Middle East	1.6	1.1	1.0	0.8	▲ 0.8
Africa	2.3	2.3	3.2	4.1	1.8
Asia	5.9	6.2	6.0	5.7	▲ 0.2
China	3.7	3.8	4.2	3.8	0.1
Malaysia	0.7	0.9	0.9	0.9	0.1
Thailand	0.3	0.2	0.1	0.1	▲ 0.2
Vietnam	0.4	0.5	0.3	0.3	▲ 0.1
India	0.8	0.8	0.6	0.6	▲ 0.2
World Total	82	86	103	118	36



Share in world oil production growth from 2006-2030

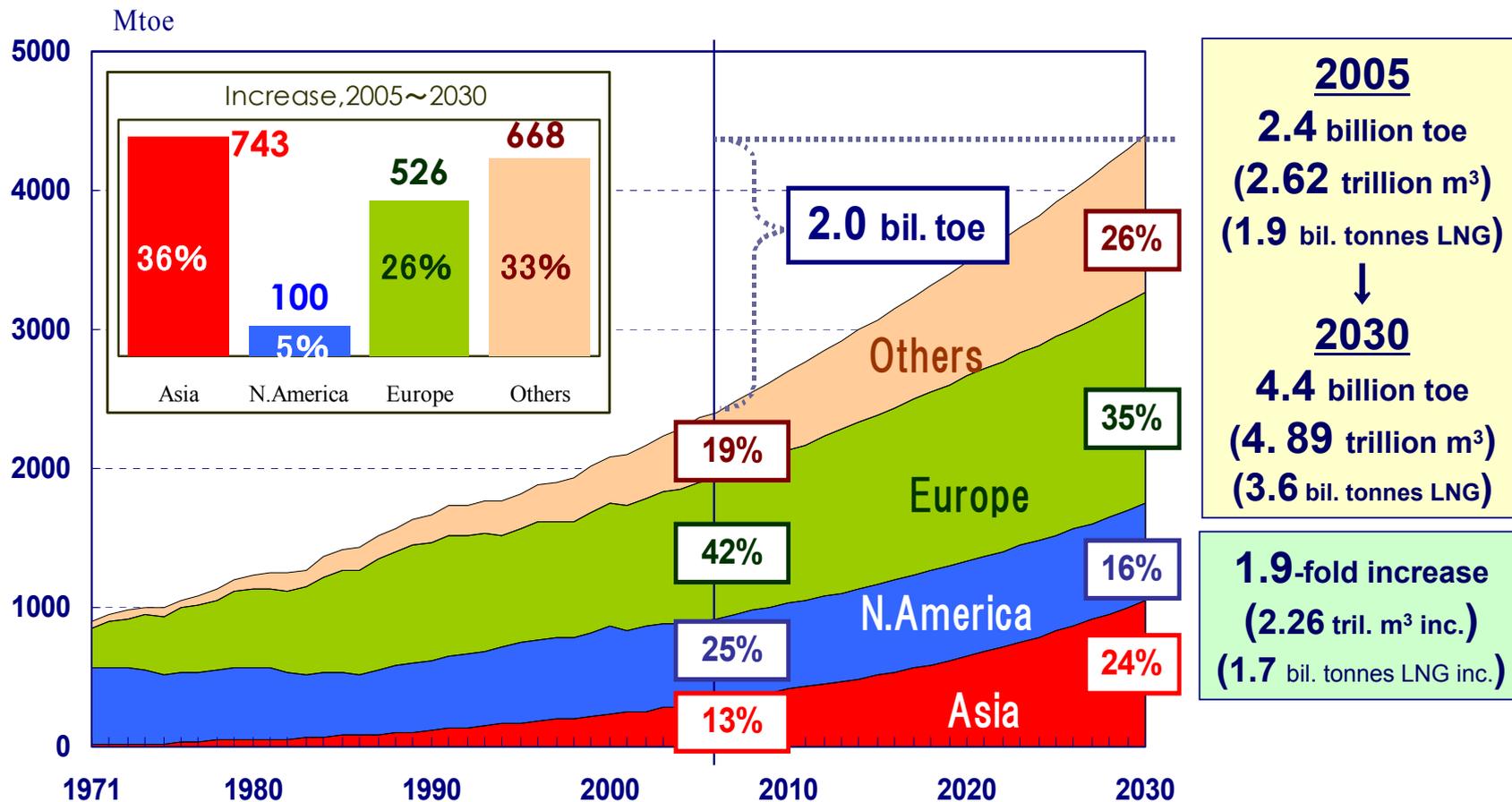
OPEC	77%	(28mb/d increase)
Non-OPEC	23%	(8mb/d increase)

▪In Asian regions, oil production is projected to be flat.

▪Approximately 80% of world oil production increase future will be dominated by OPEC; OPEC share in the world oil production is likely to expand over 50% by 2030.

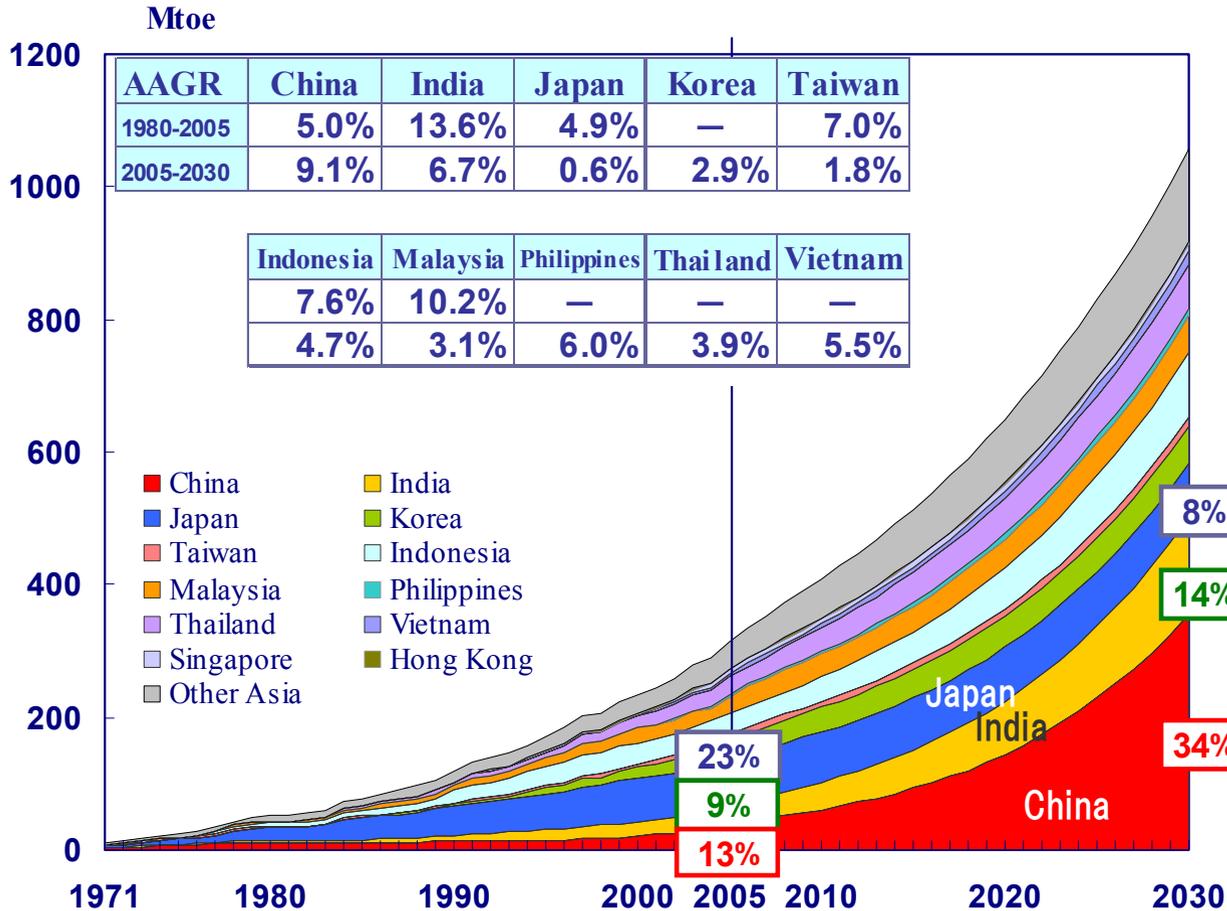
▪In promising oil production countries such as Middle East OPEC, oil exploration and development are constrained for the international oil company due to legal restriction of participation for IOC to the domestic oil development and more serious socio-economic situation in the Middle East. Unless the adequate upstream investment is not channeled into global oil production, international oil market will become tightened for the future.

Gas Demand by Region ; World



World gas demand is expected to increase from 2,620 bcm in 2005 to 4,890 bcm in 2030, 1.9-fold increase.

Gas Demand by Region ; Asia



2005
0.31 billion toe
(350 billion m³)
(0.26 bil. tonnes LNG)

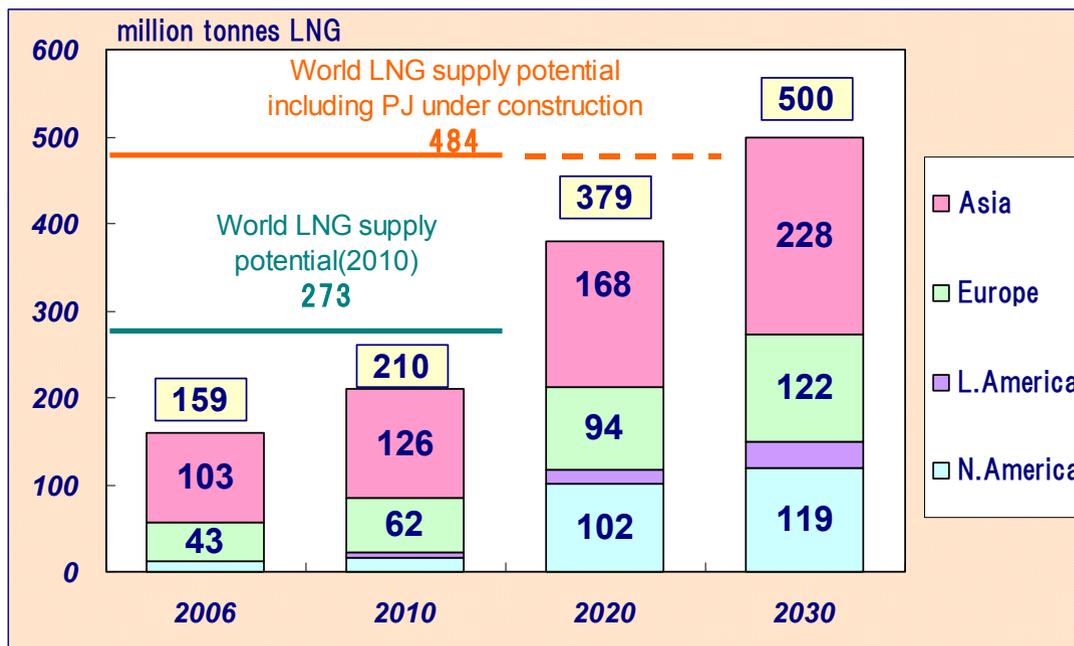
↓

2030
1.1 billion toe
(1.2 trillion m³)
(0.85 bil. tonnes LNG)

3.4-fold increase
(830 bil. m³ inc.)
(600mil. tonnes LNG inc.)

Gas demand in China will increase substantially, reflecting increasing demand for power generation and municipal gas use, and the environmental advantages

LNG Outlook ; World

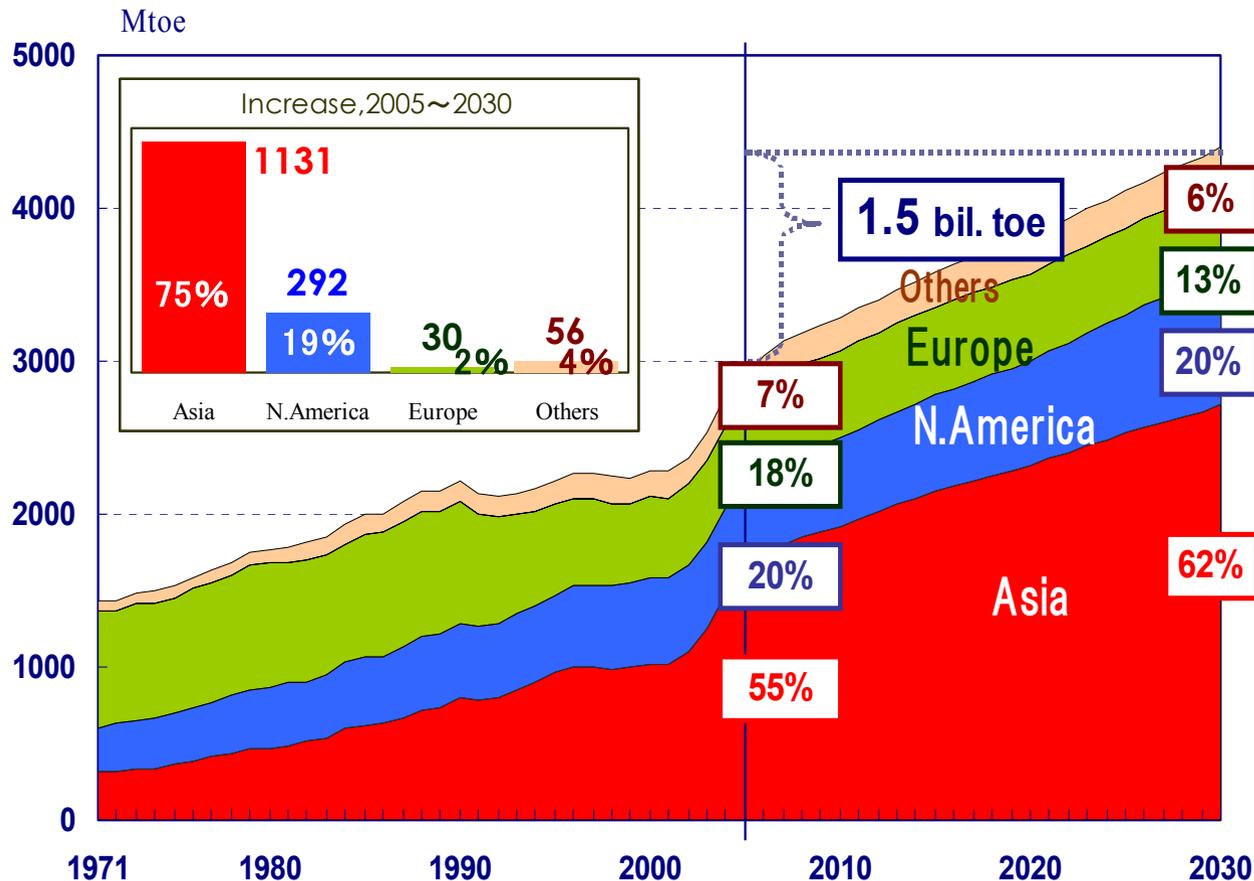


*“World LNG” supply potential(2010)” includes existing , constructing LNG PJ,and PJ contracted on SPA •HOA basis.
 “World LNG supply potential including all PJ under consideration” incorporates both “World LNG supply potential(2010)” and PJ under consideration for commercialization

•World LNG demand will expand from 159 million ton in 2006 to 500 million ton in 2030, achieving 3.6-fold growth. LNG import in Europe and USA is projected to increase rapidly, mainly because of growing gas demand in power generation sector and sluggish gas supply growth; LNG demand of Europe and USA will exceed that of Asia by 2020.

•World LNG demand and supply are forecast to be balanced in 2030. 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



2005
2.9 billion toe
(4.1 billion tce)

↓

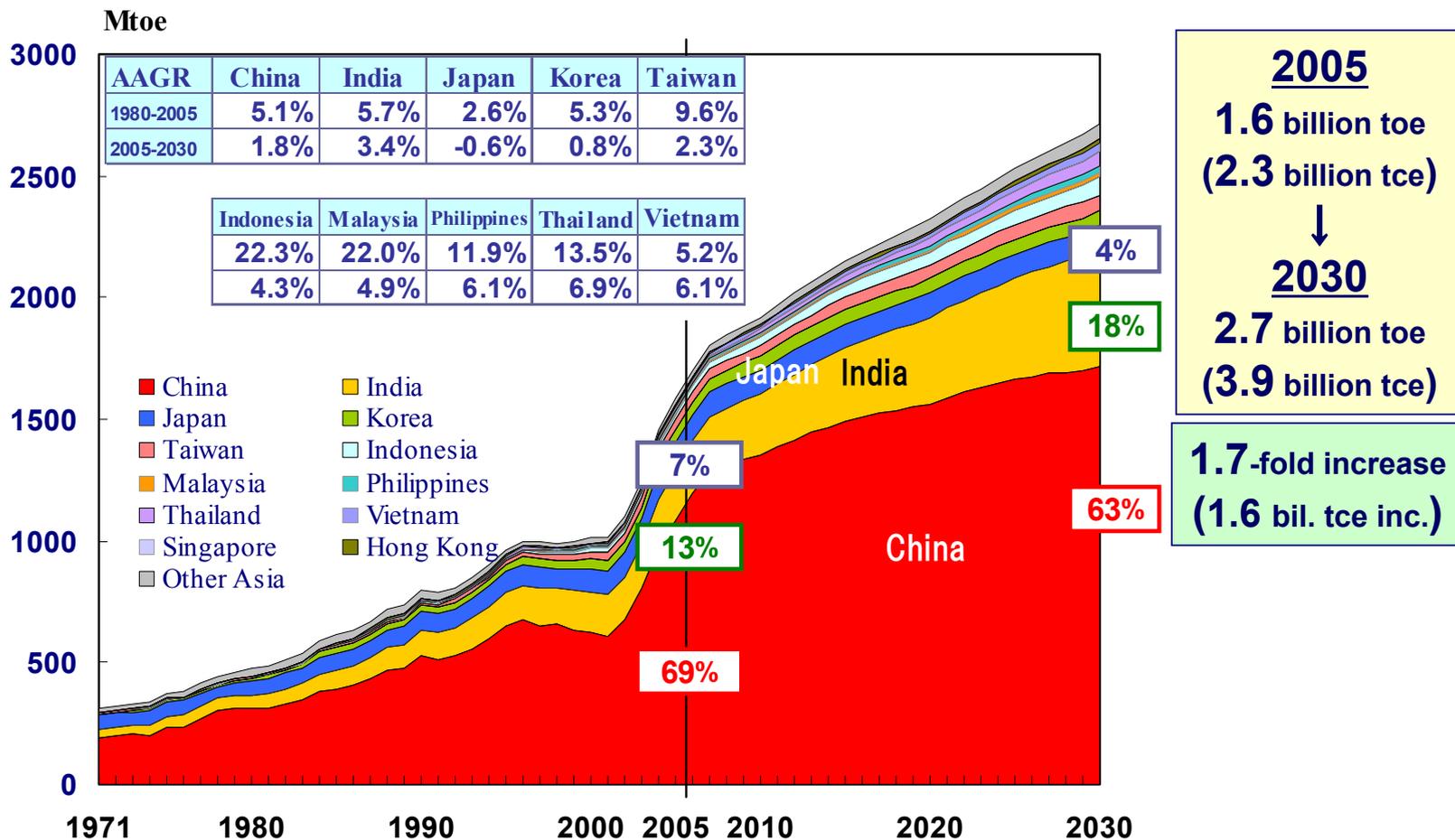
2030
4.4 billion toe
(6.3 billion tce*)

1.5-fold increase
(2.2 billion tce inc.)

*Tons of coal equivalent

About 75% of increase is from Asia, and the share in total coal demand eventually expands to more than 60% and still remain the centre of coal demand until 2030.

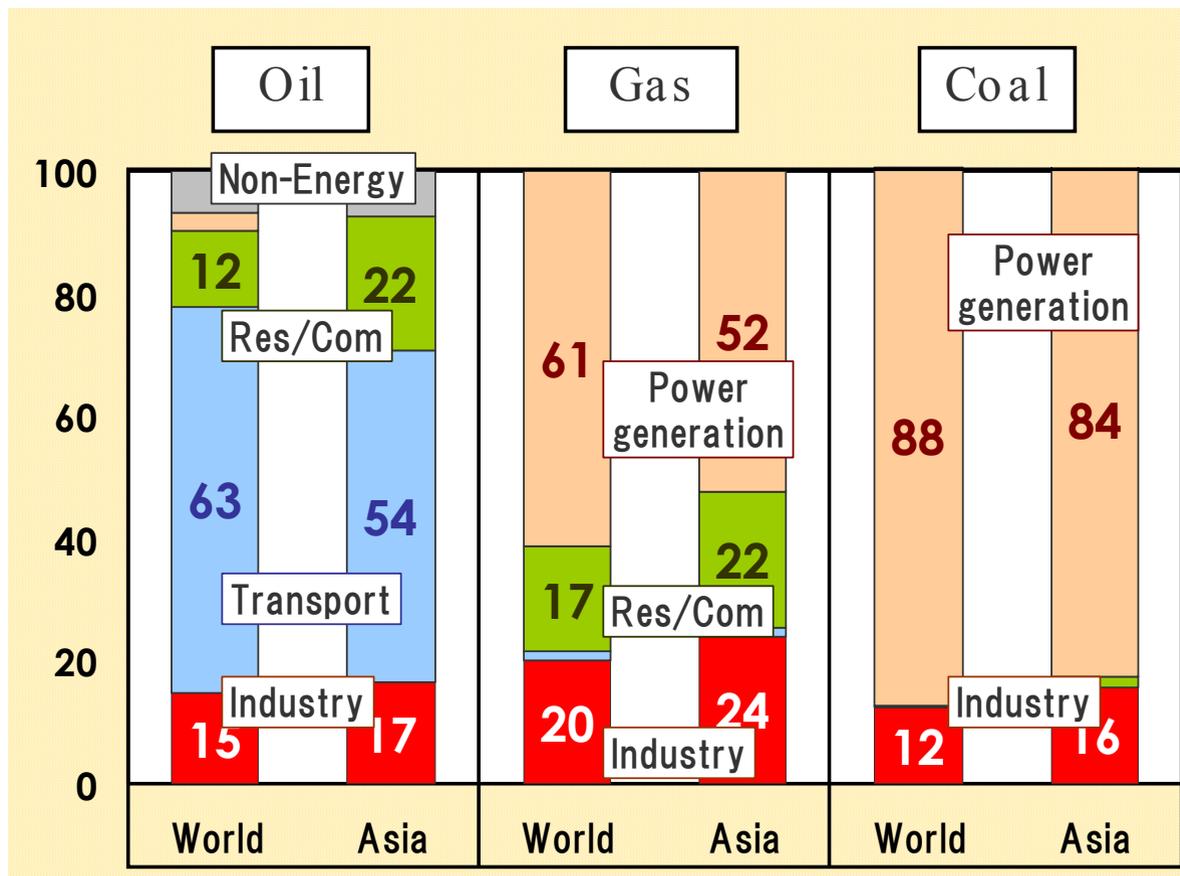
Coal Demand by Region ; Asia



Coal will be used 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 World Fossil Fuel Demand by Sector

Increase by sector, 2005-2030

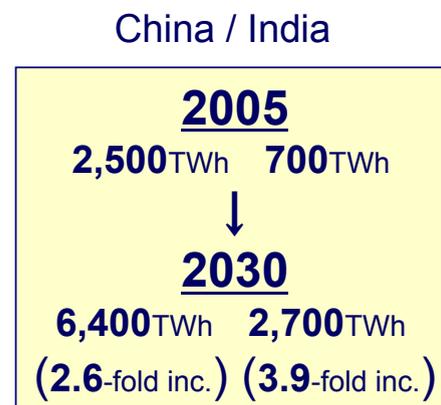
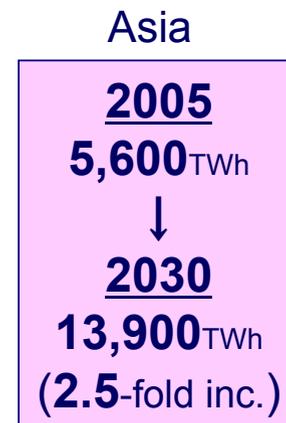


Majority of oil will be used for transportation, while gas and coal will be consumed mainly for power generation.

Electricity Demand ; Asia

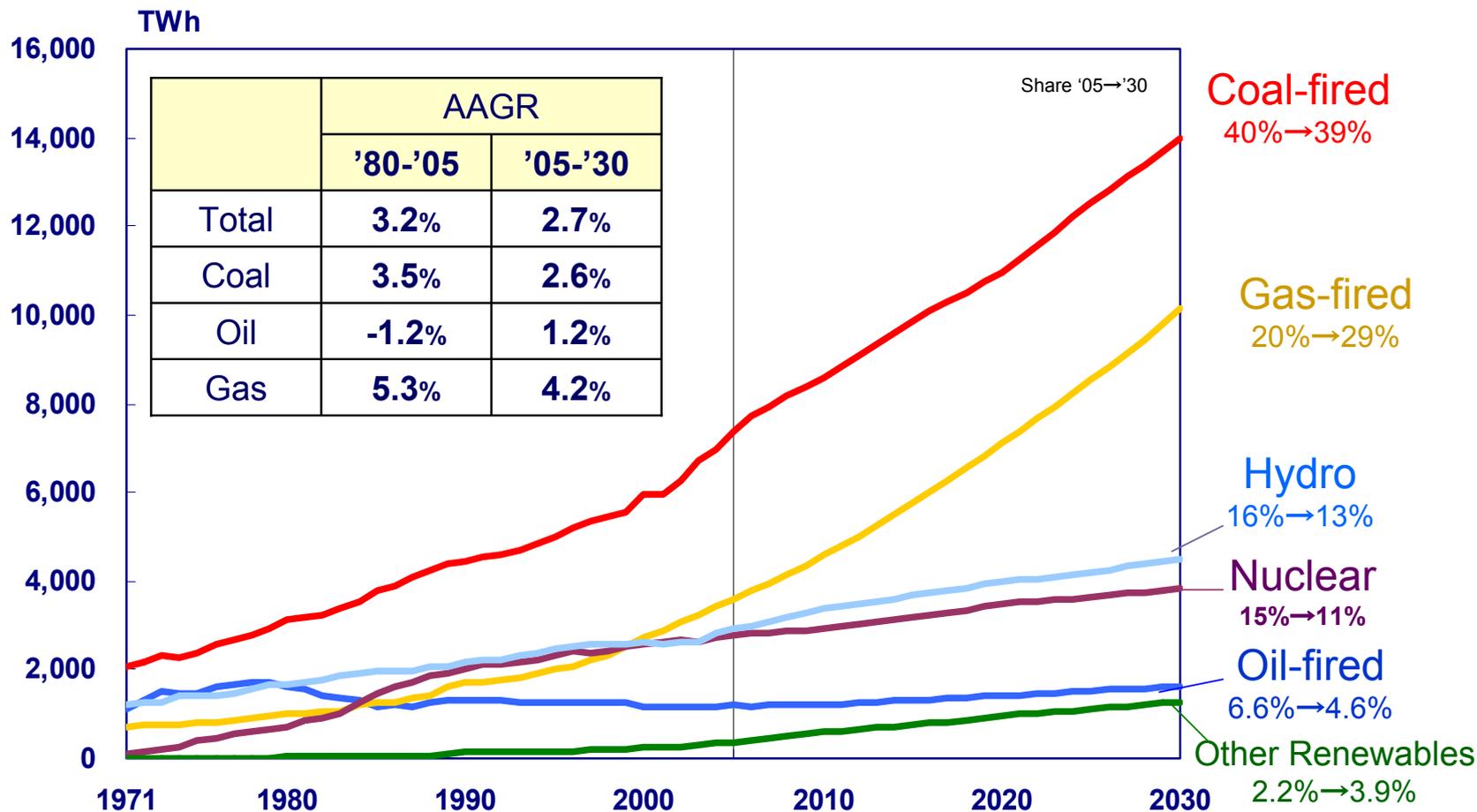


AAGR,%	Electricity Demand	Final Energy Demand
China	4.0	3.2
India	6.0	4.7
Korea	1.7	1.4
Indonesia	5.8	4.3
Malaysia	4.8	3.2
Thailand	5.7	4.3
Philippines	5.5	4.3
Asia(exc. Japan)	4.3	3.5
Japan	0.8	-0.2
OECD	1.6	0.9
Non-OECD	4.0	3.0
World	2.7	1.9



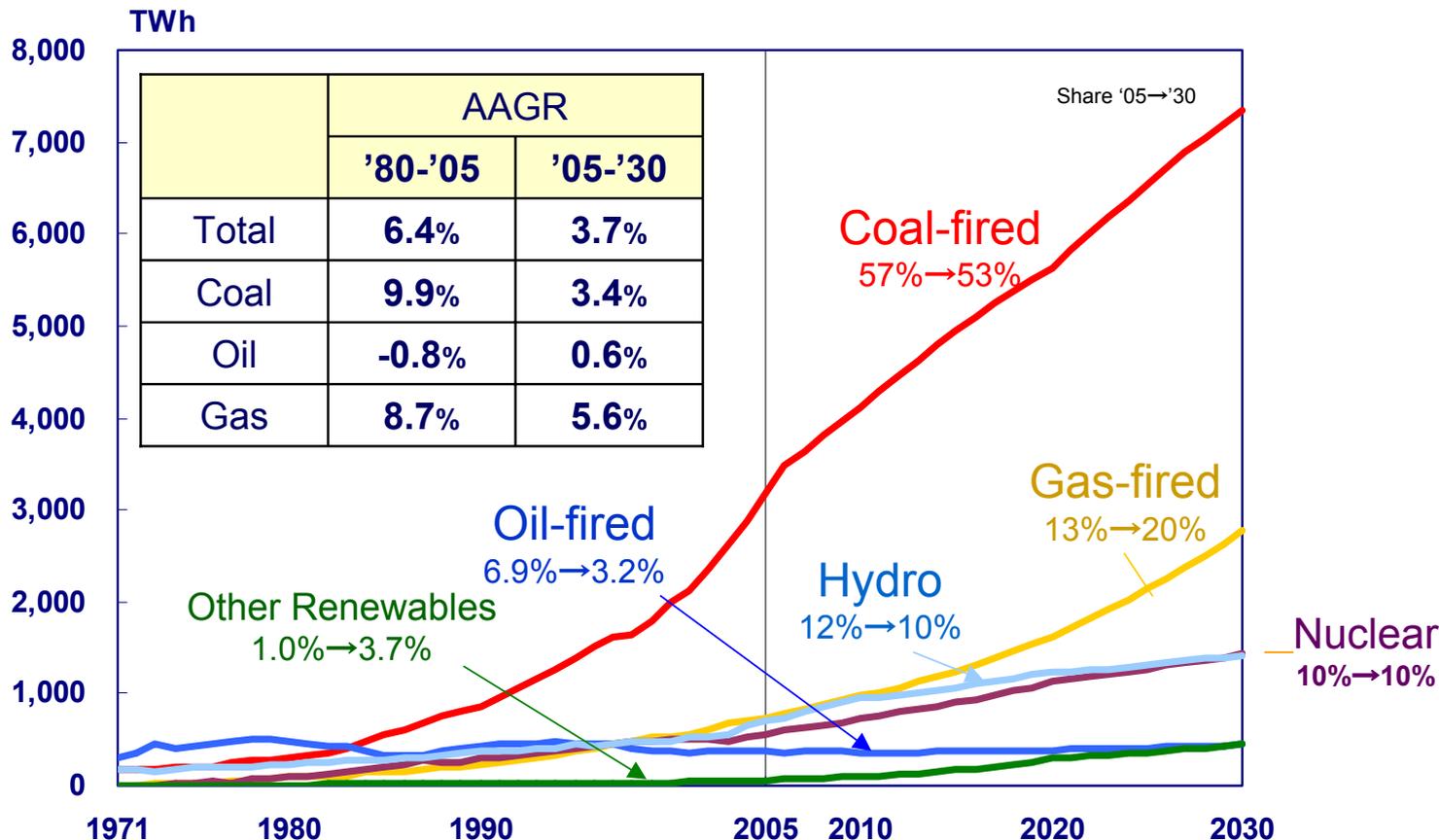
Asia's electricity demand will increase rapidly by sophistication of energy utilization driven by the improvement of life style.

Power Generation Mix by Fuel ; World



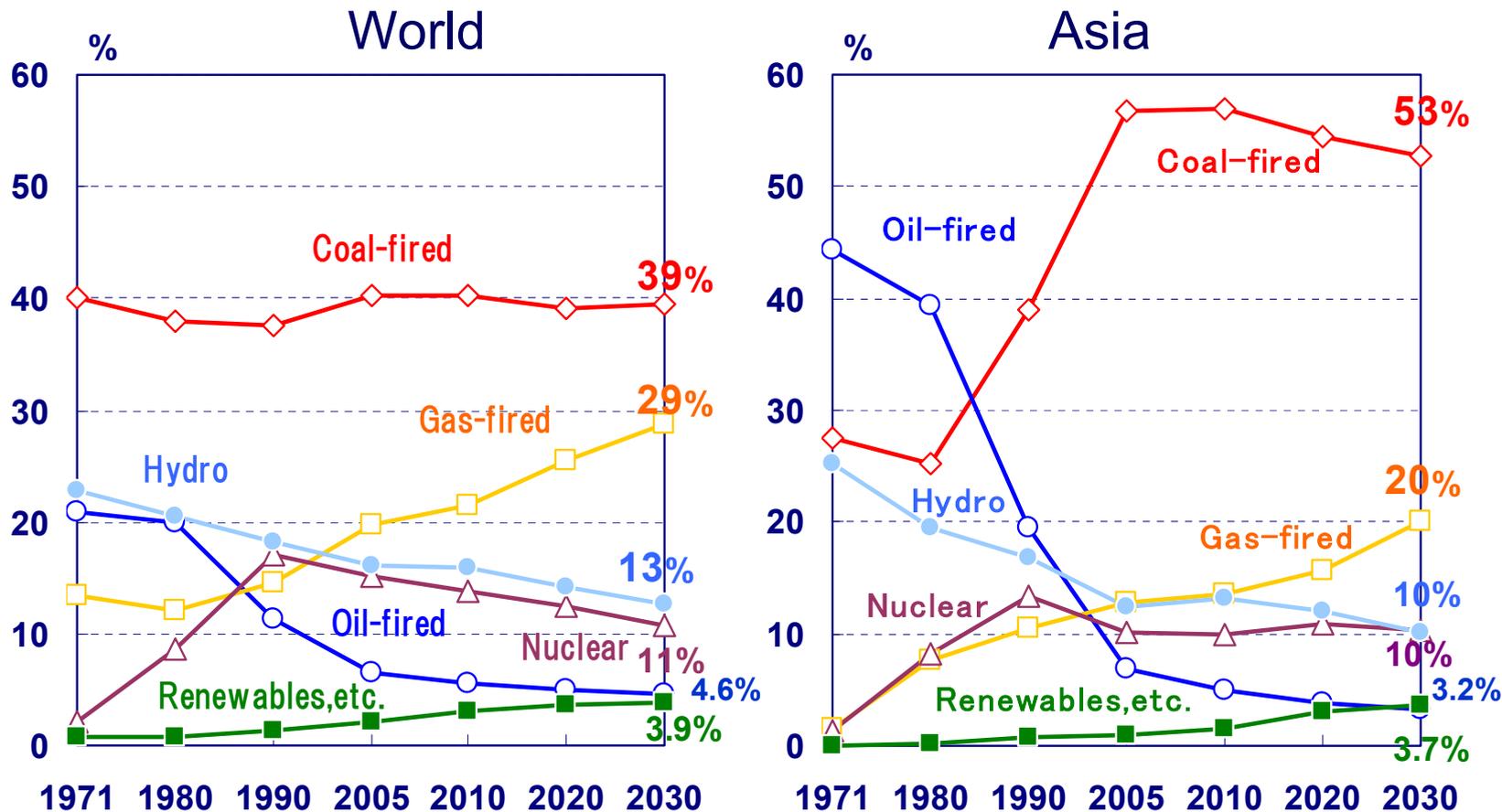
Natural gas-fired power generation is projected to increase significantly worldwide at the highest rate among fossil fuels, the installation of gas-fired combined cycle turbines being a preferred option.

Power Generation Mix by Fuel ; Asia



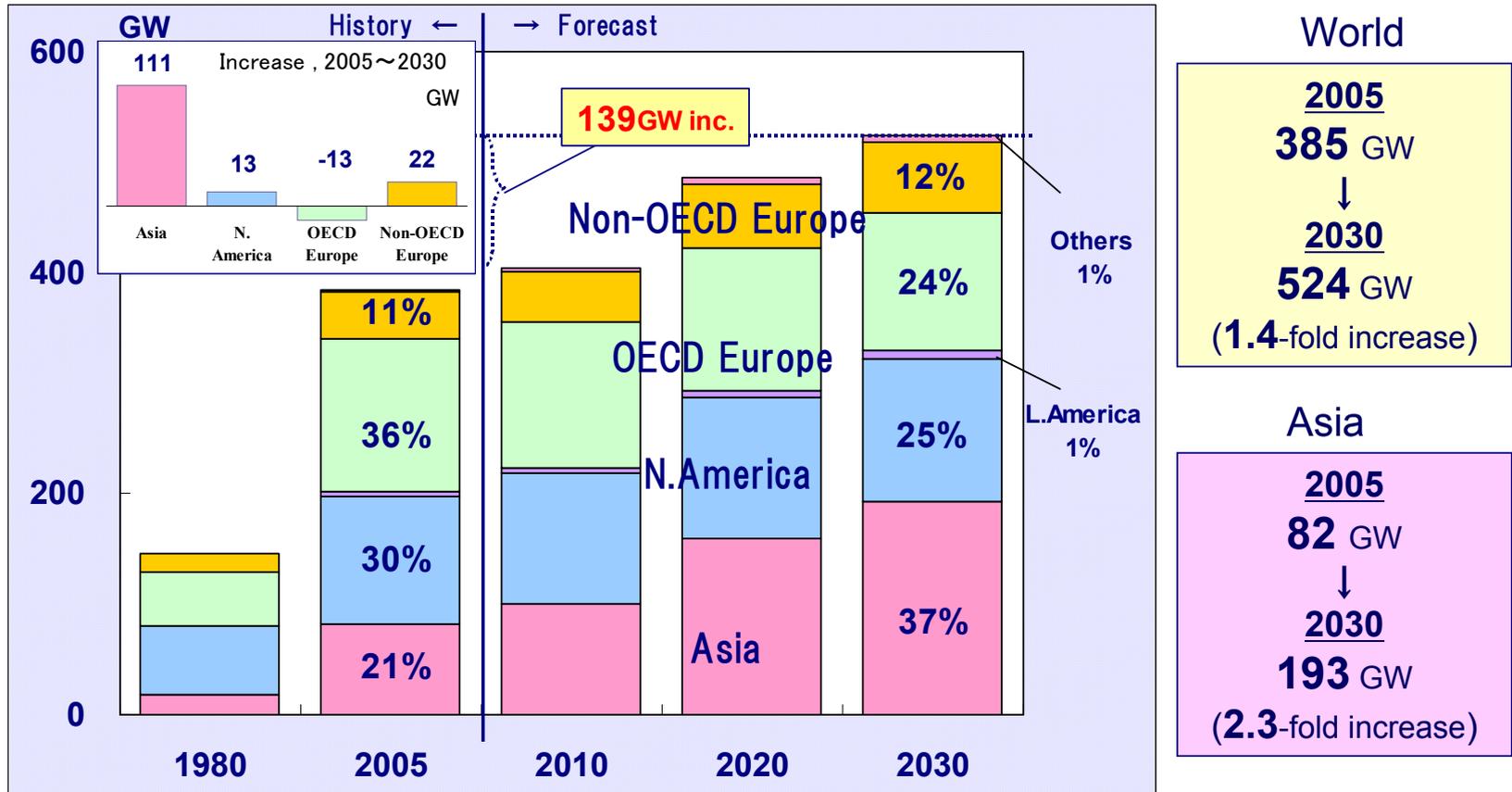
- The share of coal use in Asia will remain larger than 50%, reflecting abundant resources and the economic advantages.
- Gas will show a growing trend, the share of which eventually expands to 20% by 2030.
- The share of nuclear power generation also continue to remain 10% ; Nuclear plays a important roll in power generation mix.

Power Generation Mix by Fuel ; World and Asia



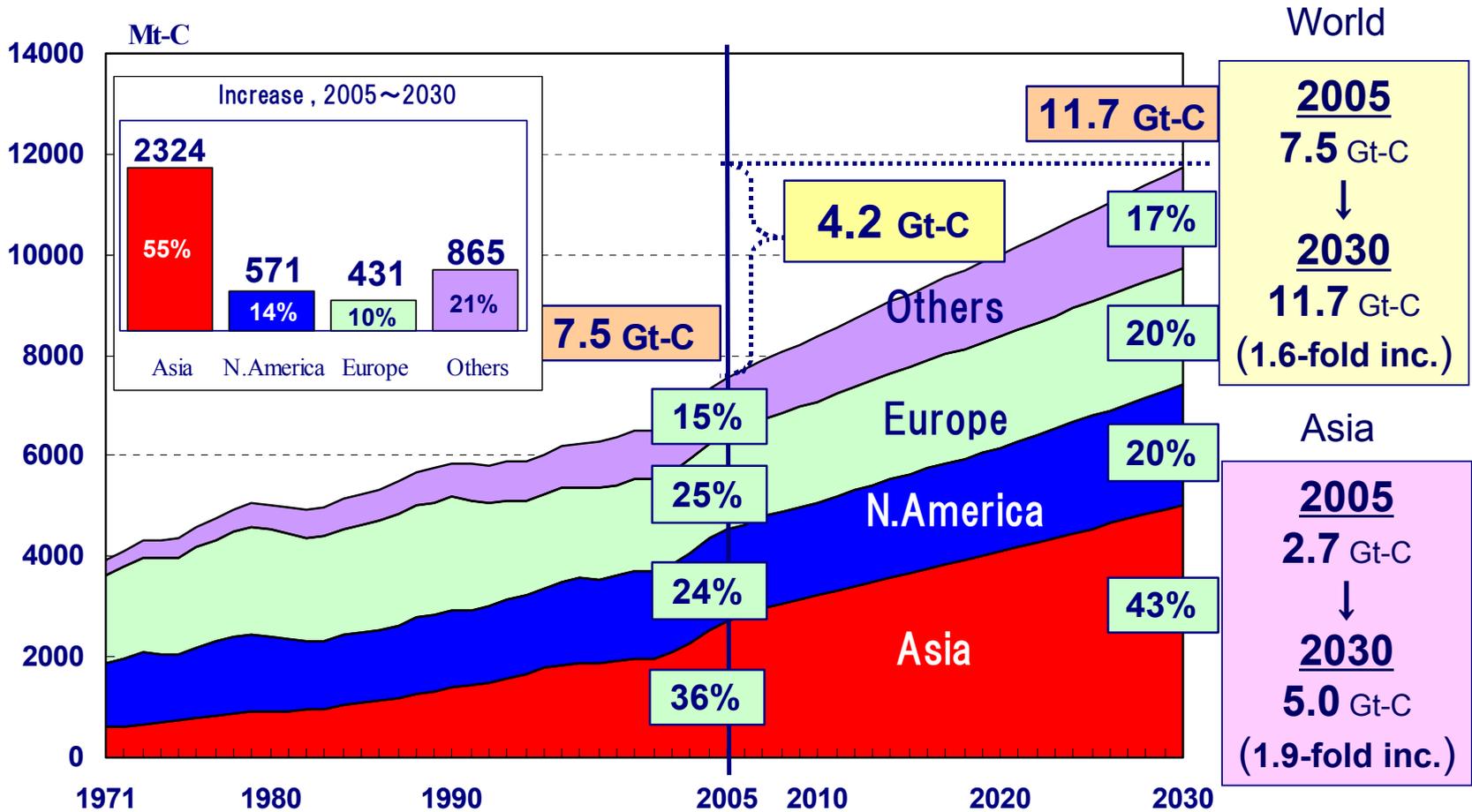
Asia will cope with rapid growth of electricity demand mainly by coal and gas.

Nuclear Power Generation Capacity



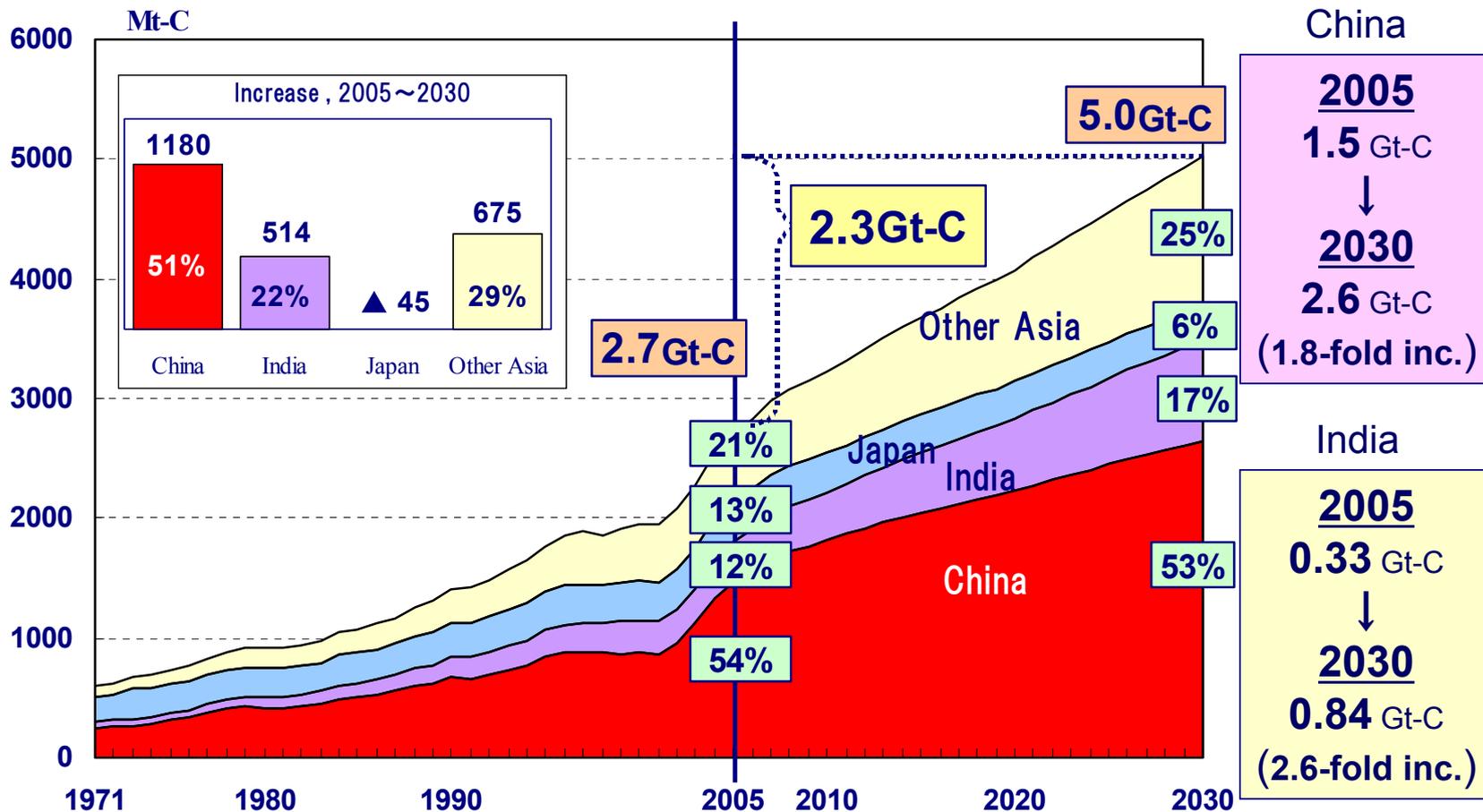
- Nuclear capacity is projected to grow from 385GW in 2005 to 524GW in 2030 (139 GW growth).
- The largest increase in the nuclear capacity is expected in Asia (111GW growth). Asian countries will develop nuclear energy most actively and channel the largest investment into nuclear power requirement.

CO₂ Emission by Region ; World



Increase in Asia will account for 55%, with N.America and Europe together responsible for 24%

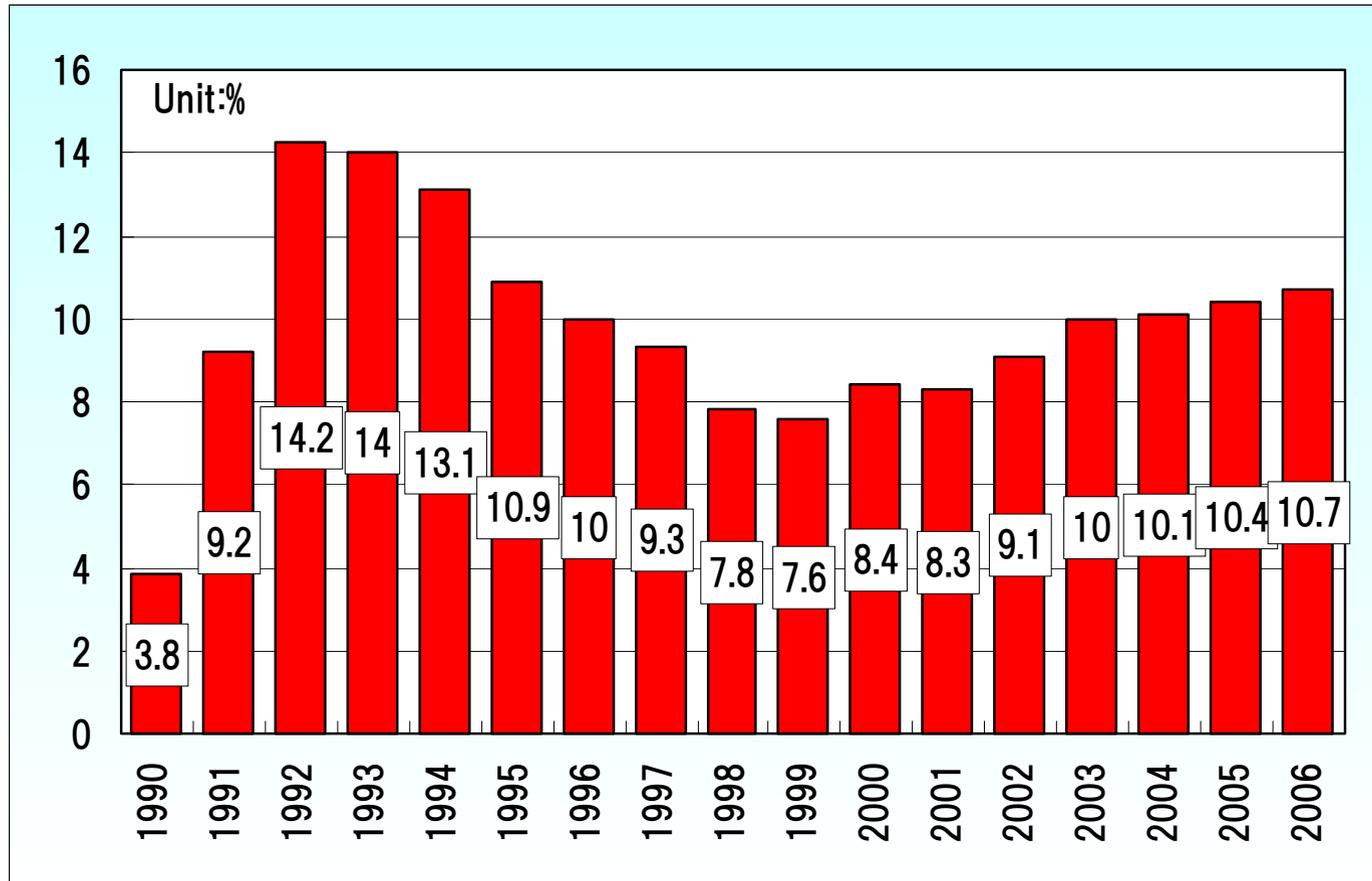
CO₂ Emission by Region ; Asia



CO₂ emissions of China and India will steadily increase driven by coal consumption, the share accounting for 70% together in Asia.

Forecast of Energy Demand and Supply in China

Historical GDP Growth of China

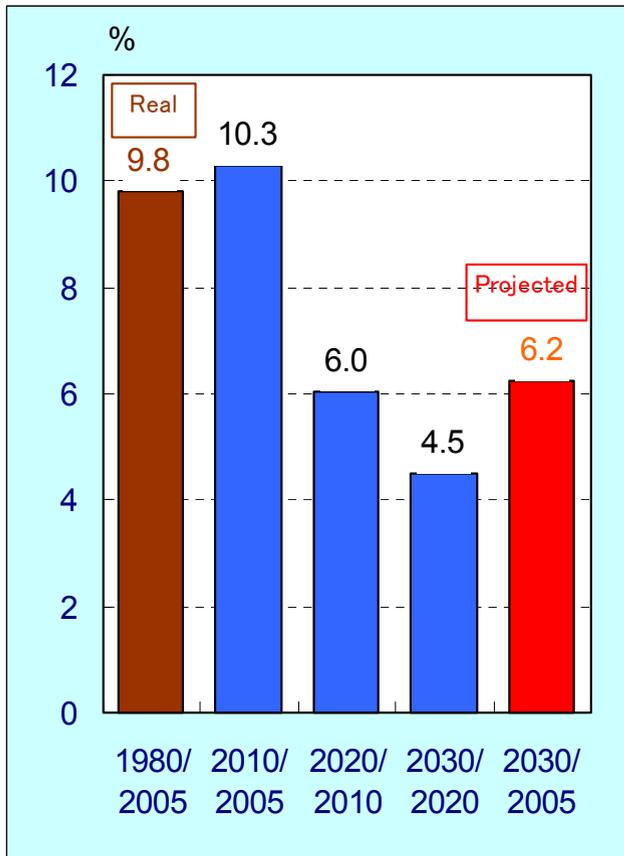


▪GDP growth rate has been over 10% for four consecutive years from 2003. It is expected to be over 10% this year.

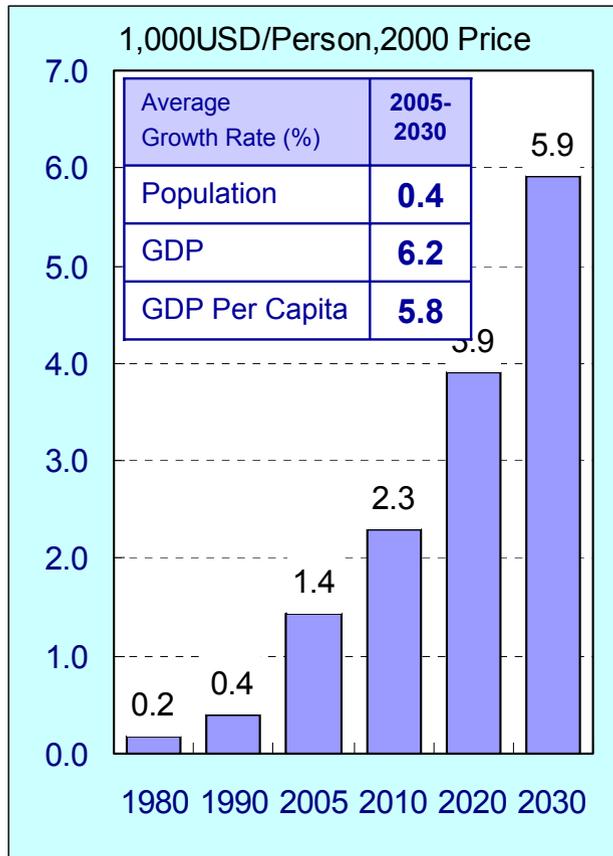
▪High GDP growth is sustained by high growth of export and investment.

Expectation of GDP Growth of China

【GDP Growth Rate】



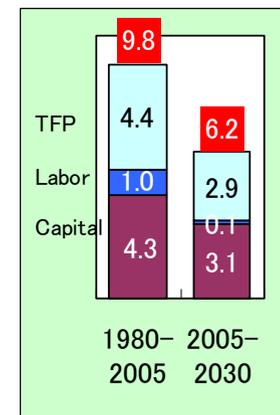
【GDP Per Capita】



GDP



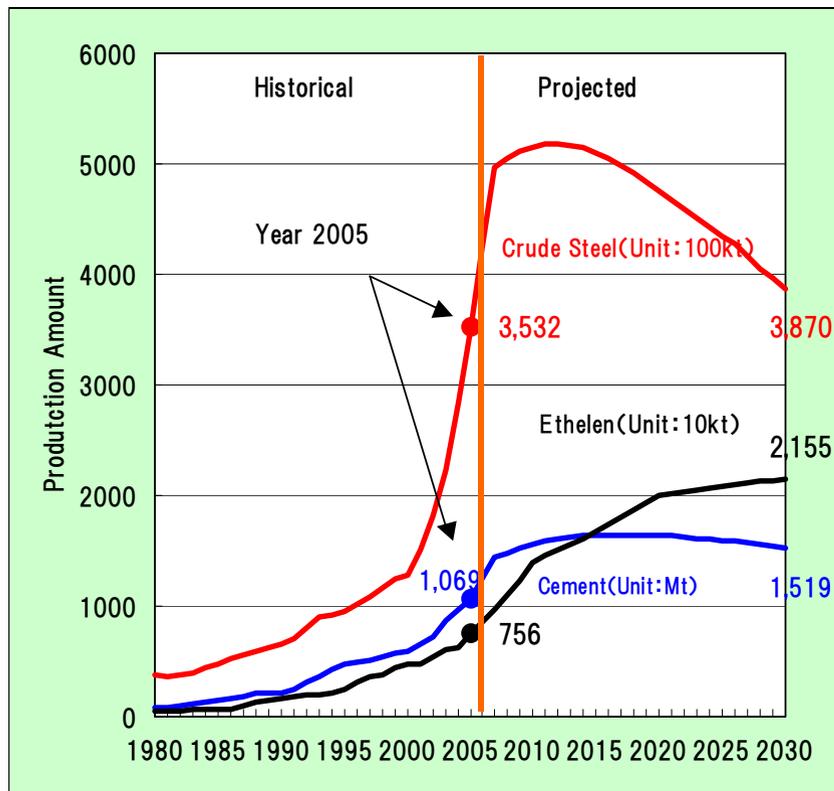
GDP Account



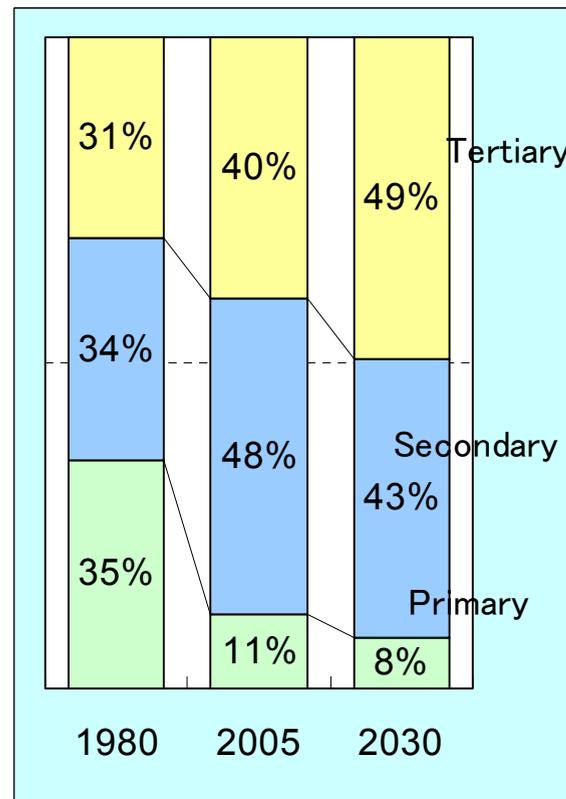
- GDP growth rate keeps high because of high investment and export. In the future, shift to domestic demand is expected.
- The economy is expected to slow down because of labor force decrease, environmental consideration and resource constraints.
- GDP per capita (2005 price) is expected to become 7,000 USD, four times of 2005.

Production of Raw Material and Industrial Structure in China

【Production of Main Sectors】



【Industrial Structure】

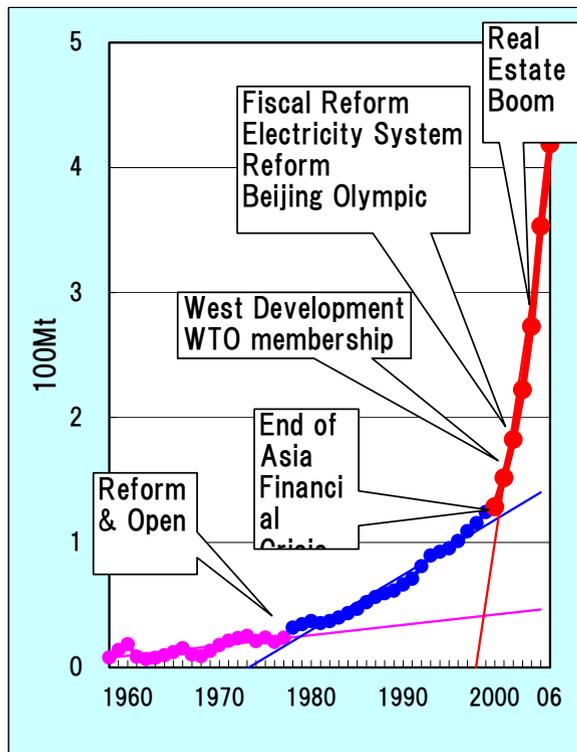


▪ Although raw material products increase sharply, they are forecasted to slow down.

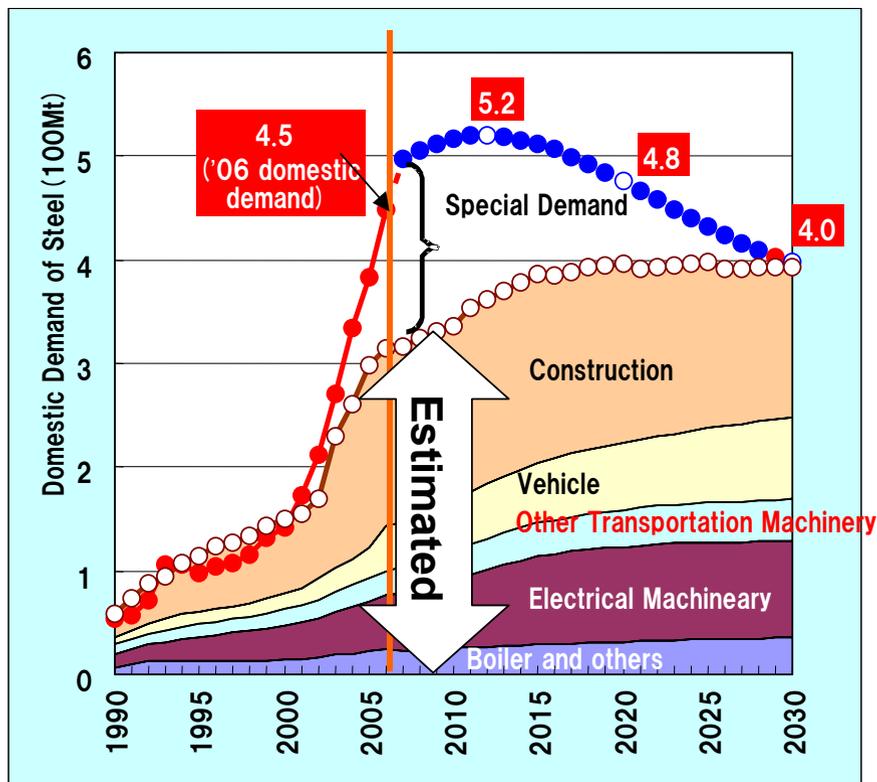
▪ Heavy industry is expected to decrease while the weight of secondary industry remains on the same level.

Projected Crude Steel Production of China

【Crude Steel Production(Historical)】



【Domestic Steel Demand(Projected)】

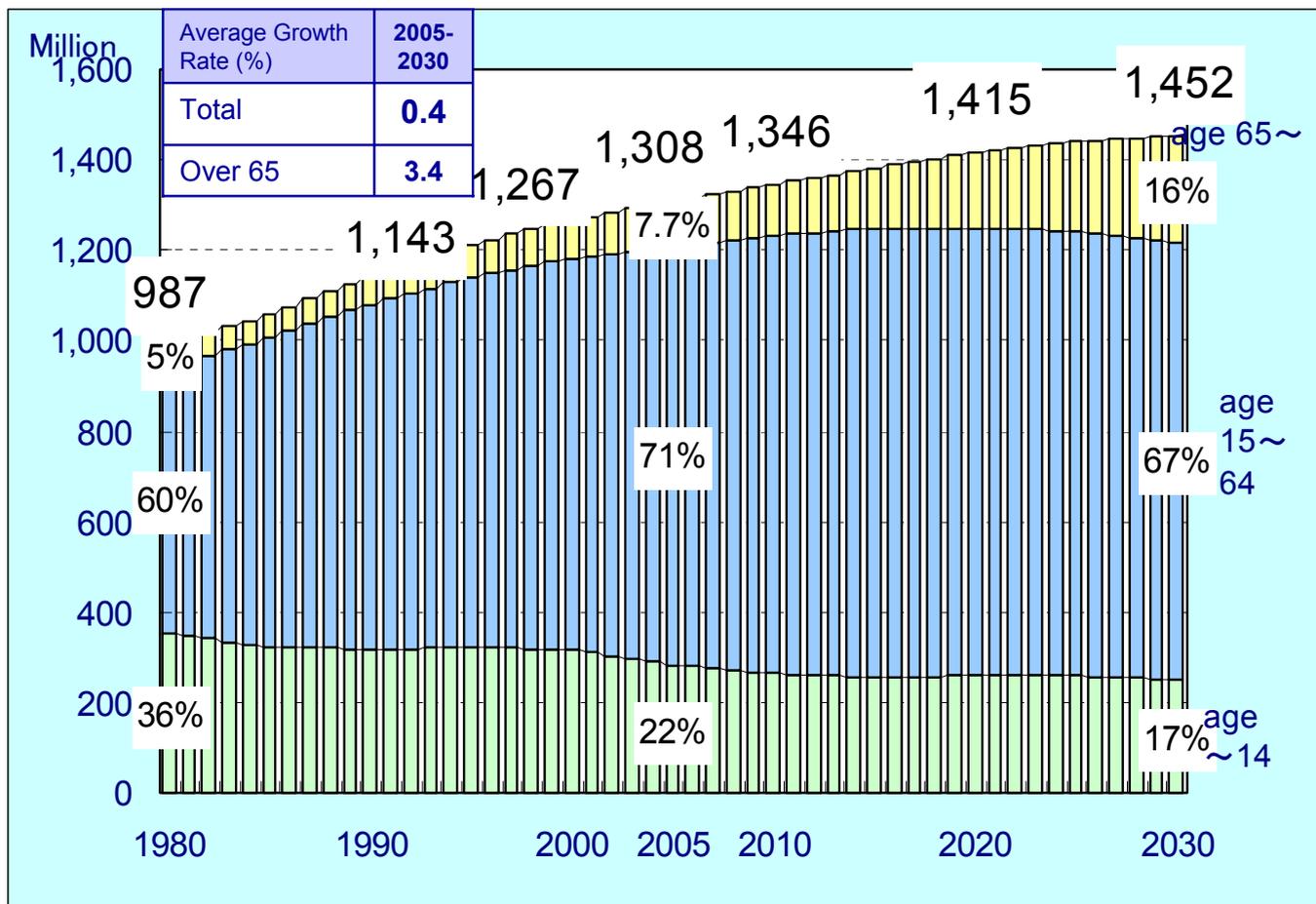


▪From 2003, the economy began to overheat, and raw material product such as crude steel increased sharply.

▪Crude steel product increased by 20% in 2006 and reached 420 Mt, or 1/3 of the world total.

▪However, the current sharp increase is projected to slow down in the future.

Expectation of Population of China



Total Population (Million)

2005
1,310
 ↓
2030
1,450
 (1.1 times)

Urban Rate

2005
43.0%
 ↓
2030
61.5%
 (18.5 points up)

- Population increases at 0.4% annually and will peak to 1,450 Million and outnumbered by India in 2030.
- Aging population rises to 16% in 2030, while labor force peaks in 2020 and begin to decrease.
- Urbanization progresses. Urban population increases by 13 Million every year.

Energy policies of China

【Main Goals of the 11th 5-Year Plan】

△Basic Policy:

Establish a “Resource Conservation and Environment friendship Society”

△Basic Energy Policy:

Keep coal as the base energy resource; Improve energy structure of being “Stable, Economical, Clean and Safe”

△Economic Growth Goal:

Annual rate of 7.5%(between 2006 and 2010)

△Energy Saving Goal:

Cut energy intensity of GDP by about 20% (same period)

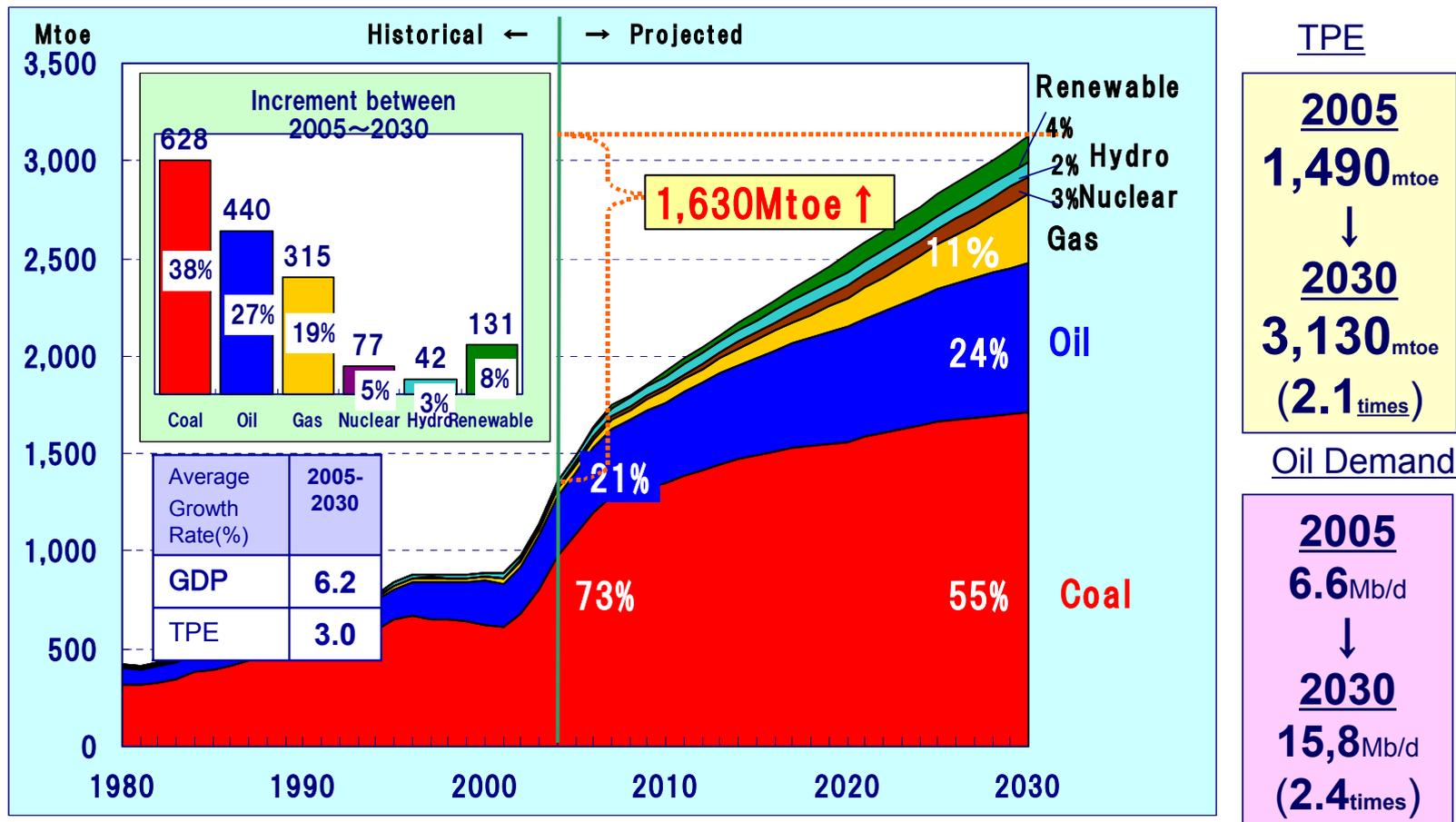
△Environment Protection Goal:

Cut main pollution material emission by 10%(same period)

△Renewable Energy Goal:

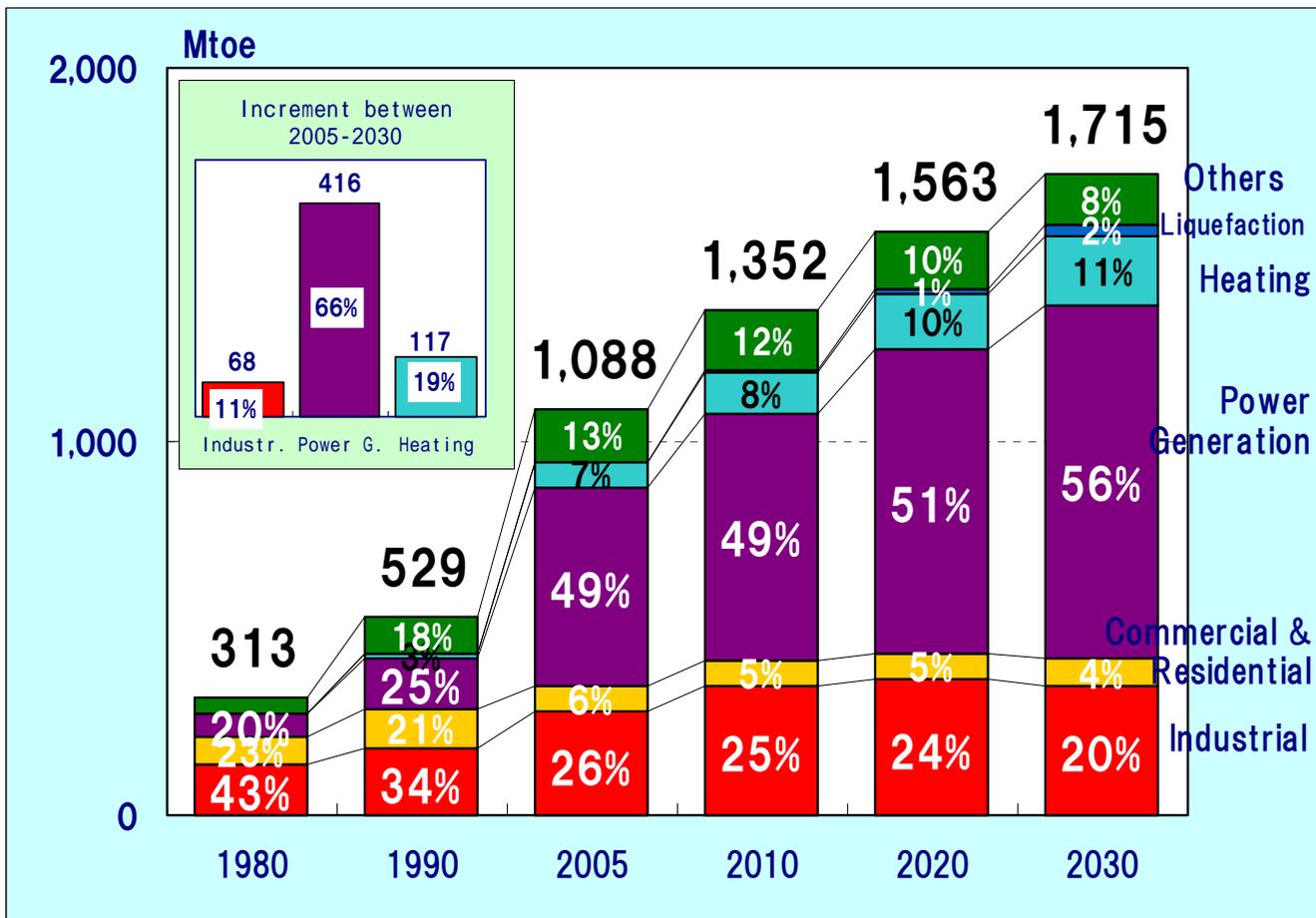
Increase the ratio to TPE to 15% by 2020.

Total Primary Energy Demand in China



- TPE increases at annual rate of 3.0% and reaches 3,130 Mtoe in 2030.
- Coal increases for power generation and oil for motorization.
- Gas increases for household and commercial usage, especially in urban area.

Coal Demand by Sector in China

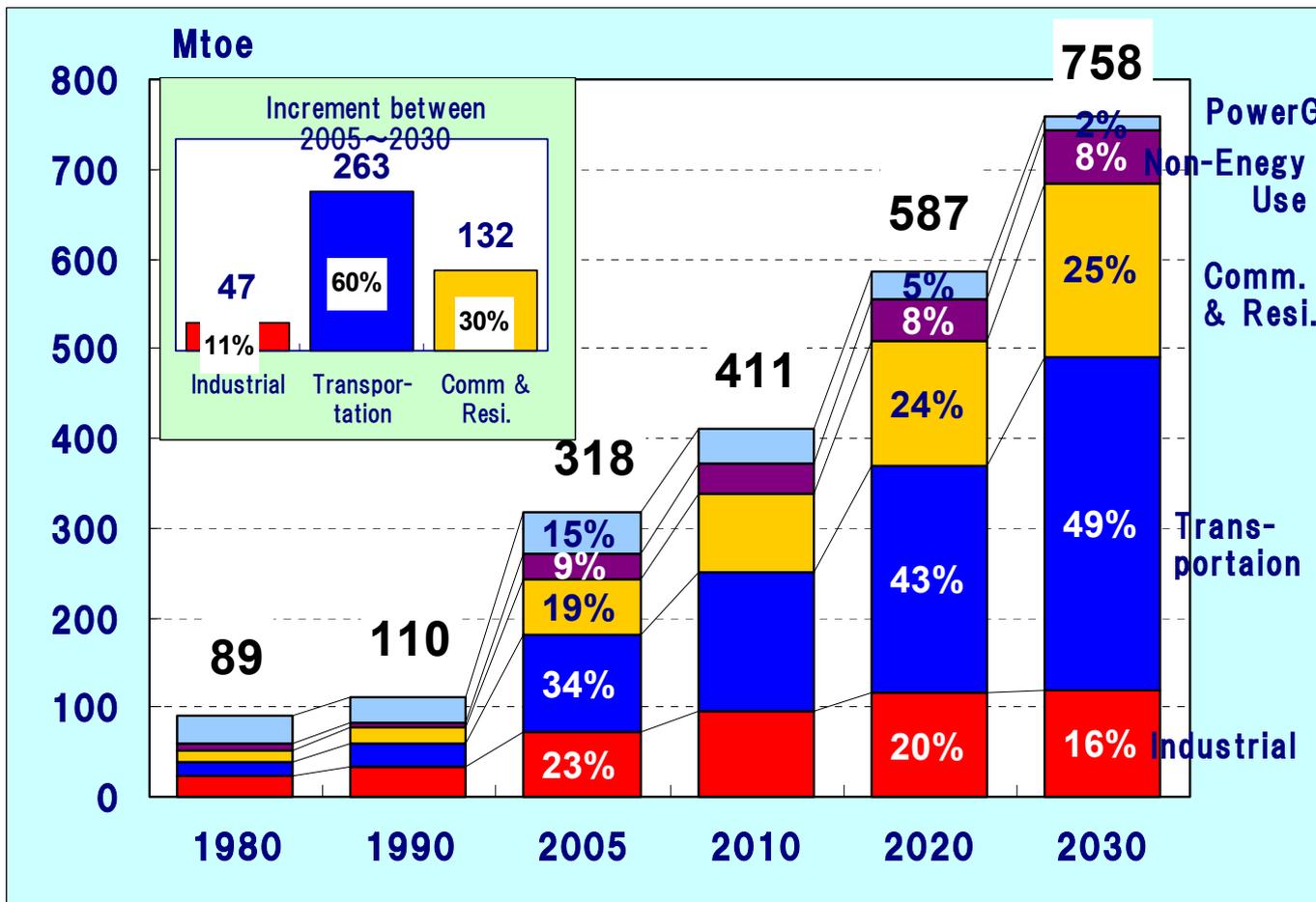


Coal Demand (Mtoe)

2005
1,090
 ↓
2030
1,720
(1.6times)

- Currently, 50% of coal is consumed by power sector. The ratio rises in 2030.
- Coal consumption by industry remains on the same level because of slowing down of steel product. The ratio goes down.

Oil Demand by Sector in China

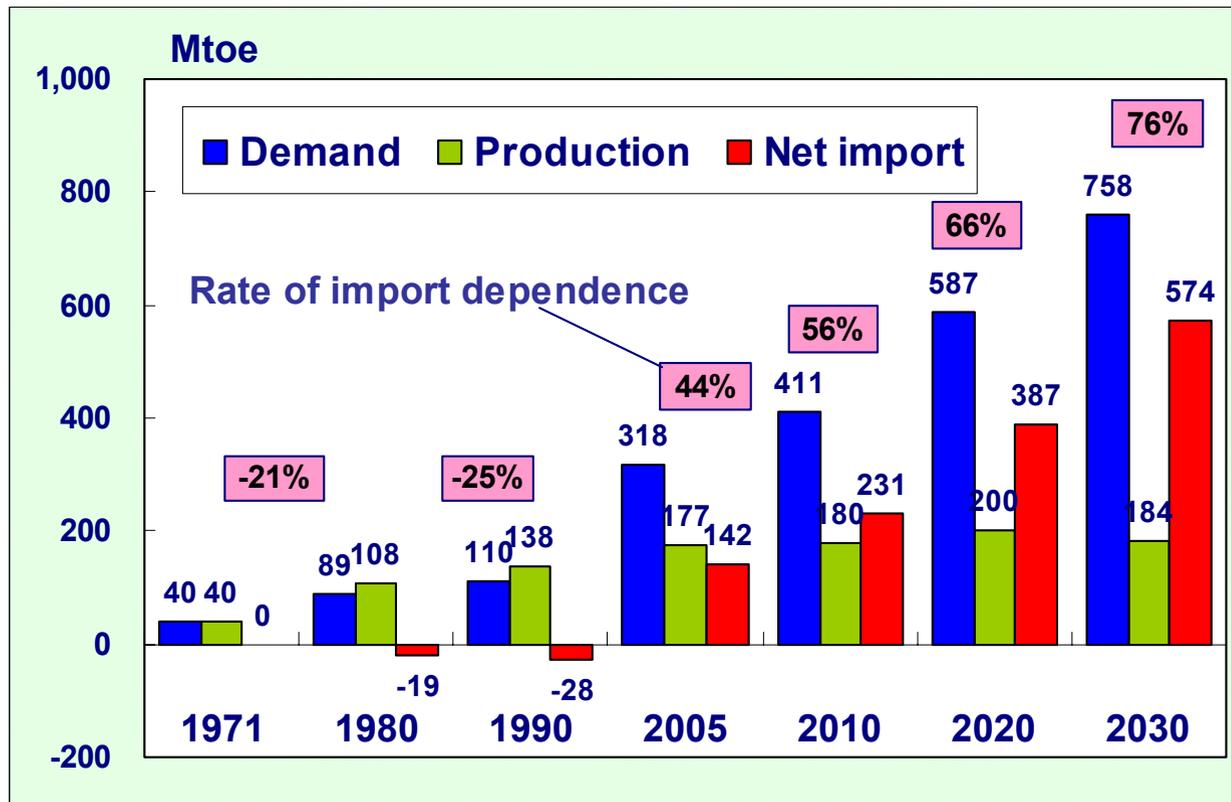


Oil Demand (Mtoe)

2005
320
↓
2030
7.6
(2.4times)

- Oil consumption increases at annual rate of 3.5% and reaches 760 Mtoe in 2030.
- Oil consumption increases because of motorization.

Oil Demand and Supply in China



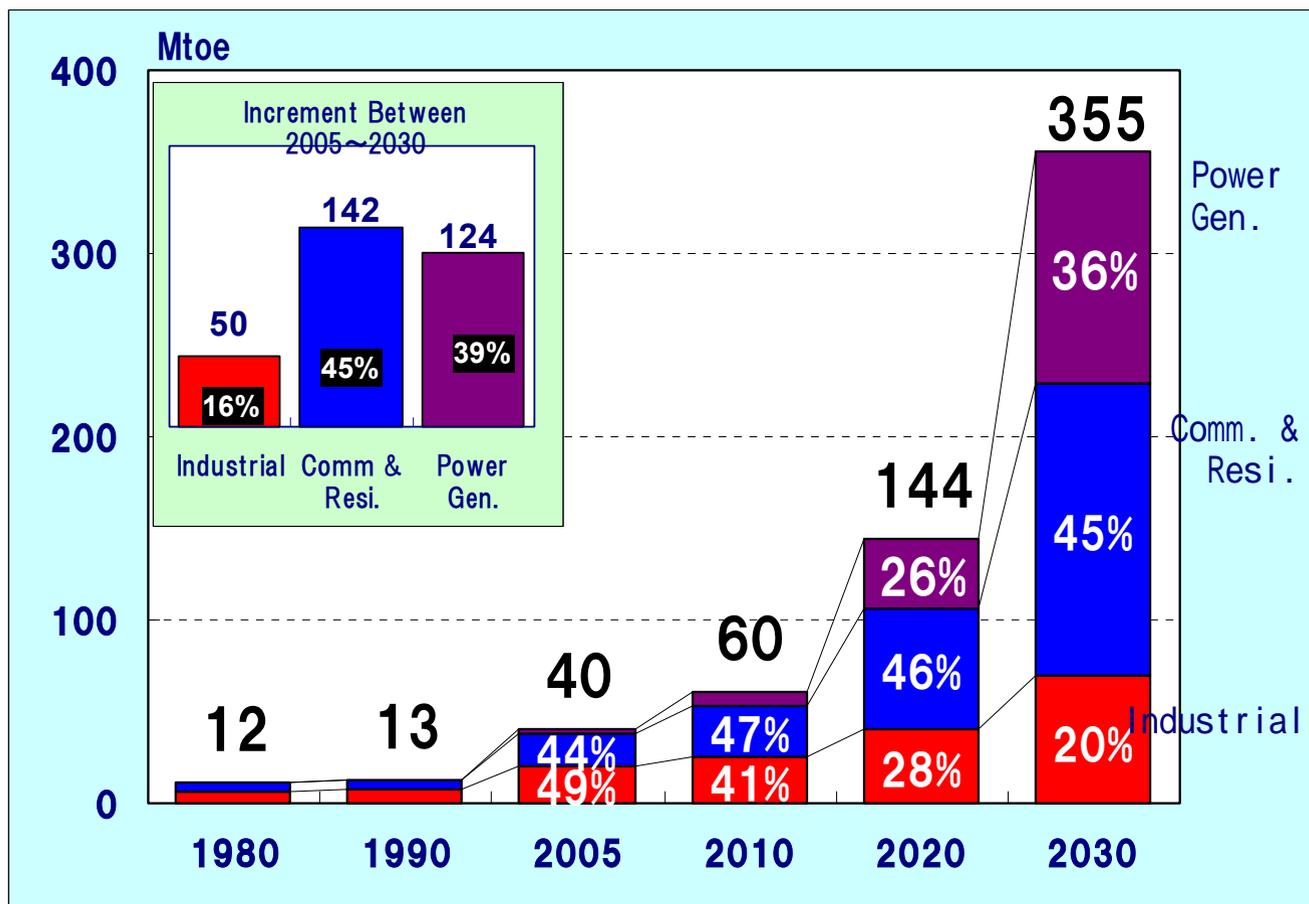
Net Oil Import

2006
3.4 Mb/d
 ↓
2030
12 Mb/d
 (3.5folds)

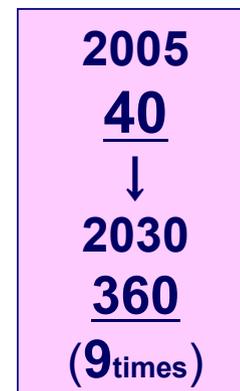
•Net oil import is projected to expand from 170 million ton (3.4 Mb/d) in 2006 to 574 million ton (12 Mb/d) in 2030.

•West exploration and offshore exploration is expected be strengthened in the future.

Gas Demand by Sector in China

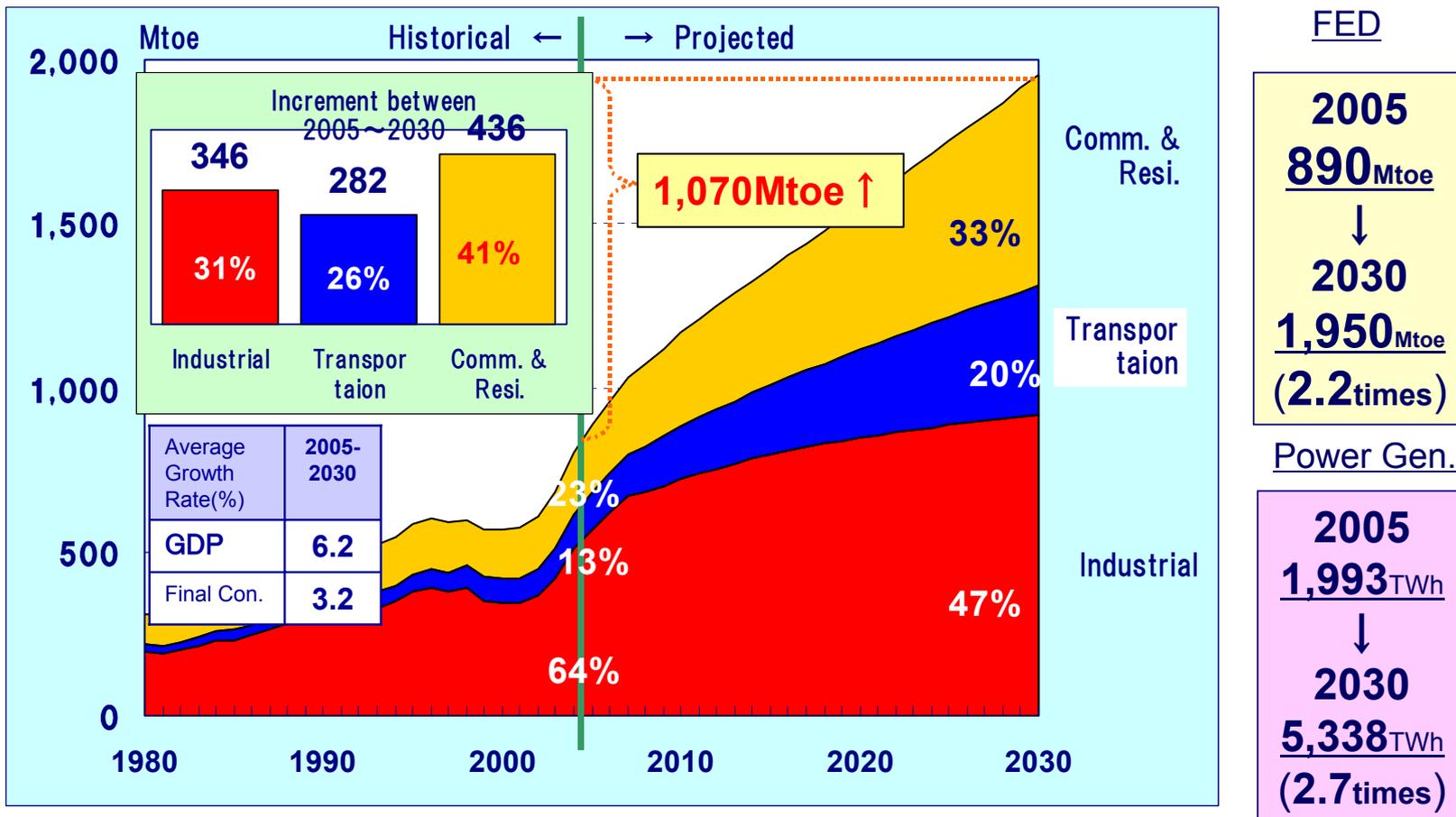


Gas Demand (Mtoe)



- Gas demand increases at 9.1% annually, and reaches 360 Mtoe in 2030.
- Household and commercial demand increases. Power generation demand also increases because of environmental consideration.

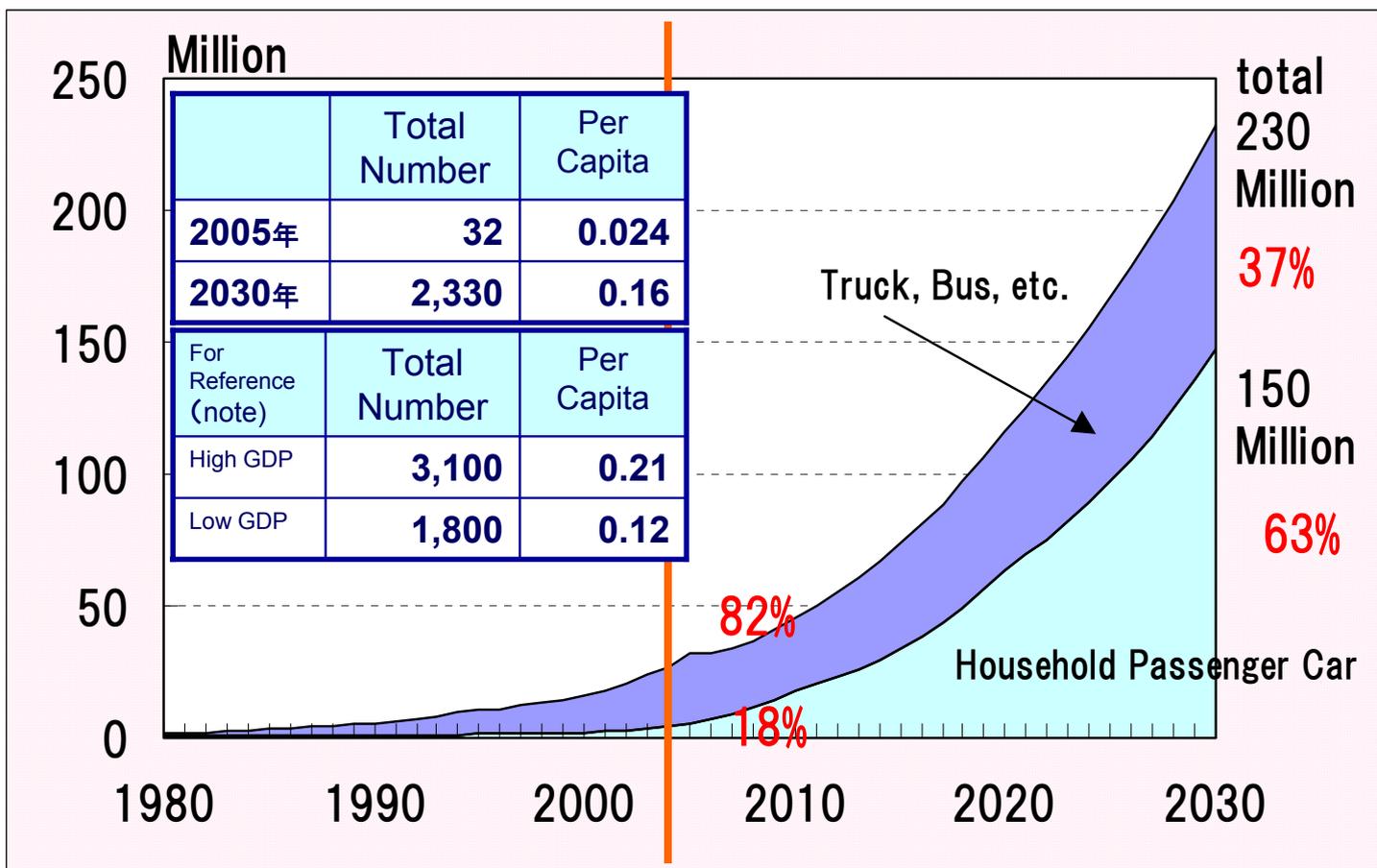
Final Energy Demand in China



Note: industrial including non-energy usage.

- Heavy industry slows down and industrial energy demand calms down.
- Commercial and household demand increases steadily. Its share increases to 1/3 in 2030, although per capital consumption is still low.

Car Ownership in China

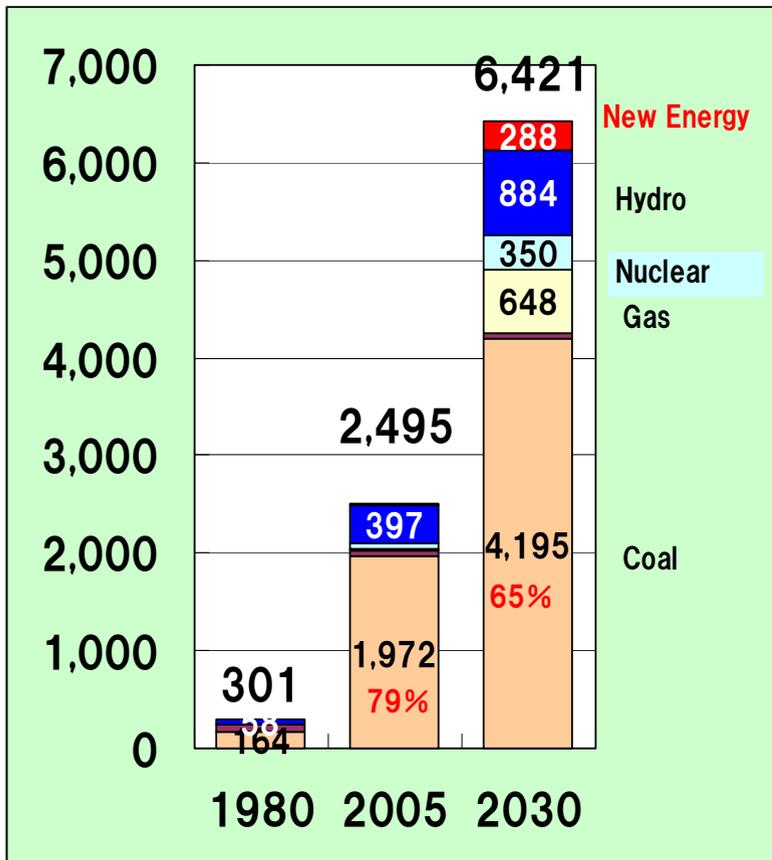


(Note)GDP growth rate assumption: Reference case, **6.2%**; High GDP case **7.2%**; Low GDP case **5.1%**。

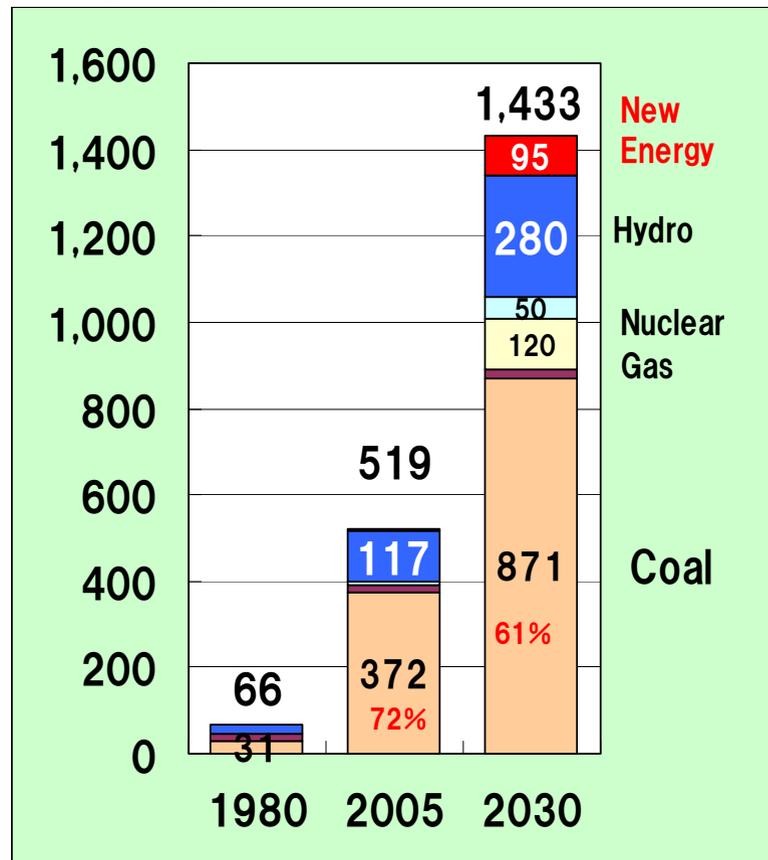
- Total car number reaches 2,300 million unit in 2030 at an annual rate of 8.3%. Elasticity to GDP is about 1.3.
- Household passenger cars reaches 1,470 in 2030 at an annual rate of 13.8%. Elasticity to GDP is about 2.2。

Power Generation Capacity and Output

【Output(TWh)】



【Capacity(GW)】



•Capacity rises at 4.2% annually and reaches 1,433GW in 2030. Coal thermal ratio slows down to 61%.

•Output rises at 3.9% annually and reaches 6,421TWh. Coal thermal ratio slows down to 65%.

•Power generation of gas, nuclear and new energy also increases greatly. Increase of hydro slows down.

Technologically Advanced Scenario for China

Energy Conservation in China

■ Existing Unsolved Issues in Energy Conservation

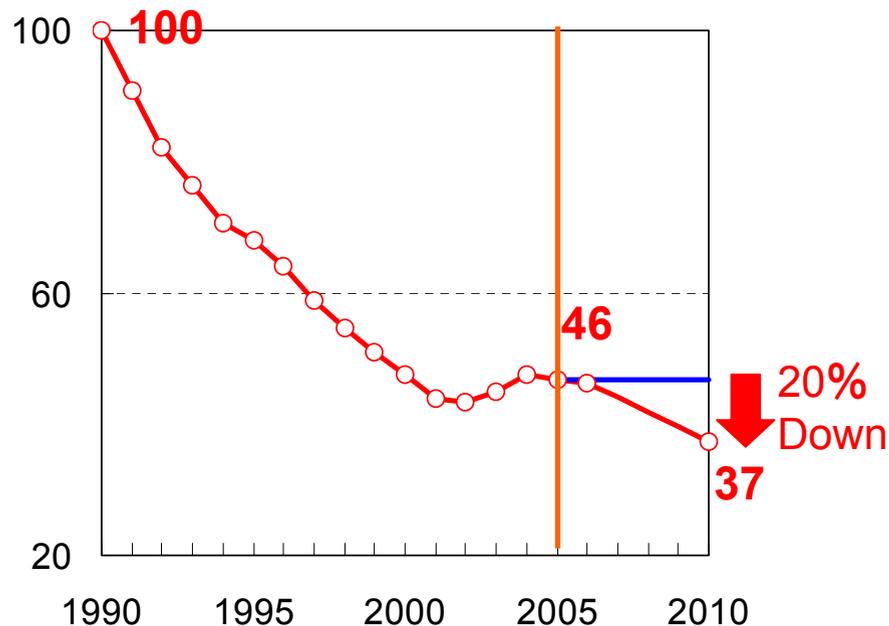
- Lack of relevant law and regulation, as well as strong operation and monitoring
- Lack of incentives of stakeholders.
- First goal of economical development

■ New energy conservation activity

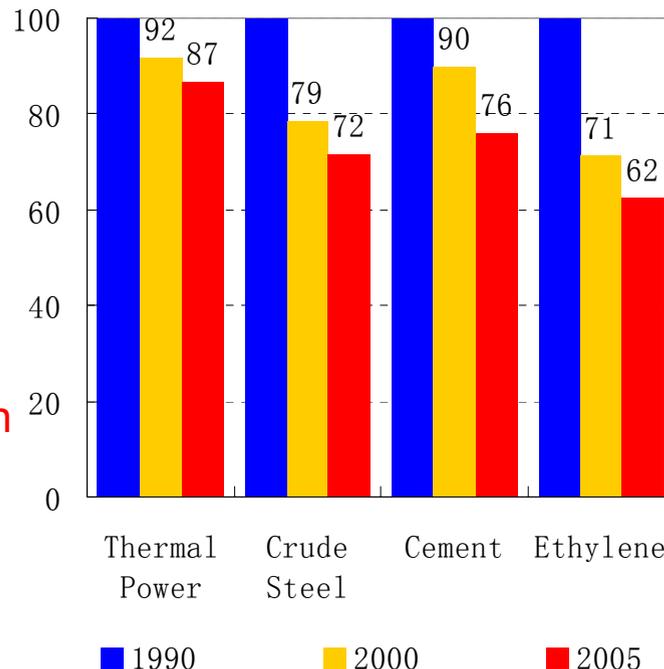
- **Short-term Goal:** Cut energy intensity by about 20% within 5 years.
- **Long term Strategy:** Establish a 「Resource Conservation and Environment friendship Society」
- **Organization:** Directed by state council, common activities by NDRC together with Ministry of Construction, Science and Technology, Finances
- **Main Activities:**
 - (04) 「Energy Saving Plan」、 「Fuel Efficiency」
 - (05) 「Industrial Structure Change Regulation」、 「Energy Efficiency Labeling」
 - (06) 「Renewable Energy Law」、 「Energy Saving Law」 (Modification)
 - (07) 「Energy Saving Strategy」、 「Heating Rate System Management」

Improvement of Energy Efficiency in China

Energy Intensity of GDP (CY1990=100)



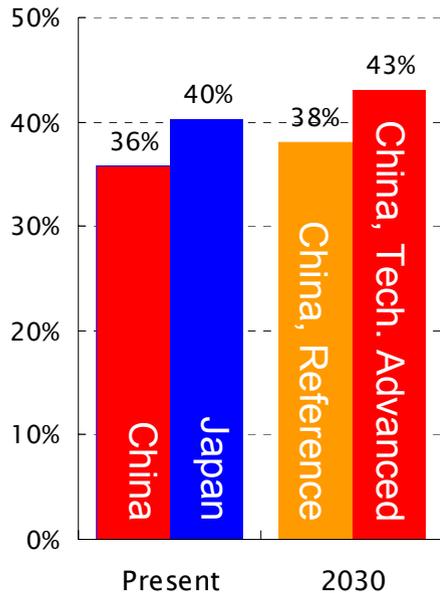
Energy Efficiency in Physical Unit (CY1990=100)



- Energy intensity of GDP improved greatly between 1980 and 2000, but worsened in 10th 5-year Plan period.
- The goal in 11th 5-year Plan is to cut it by about 20%. It decreased by 1.3% last year.
- Energy efficiency of power generation, steel, cement and chemicals is improving.

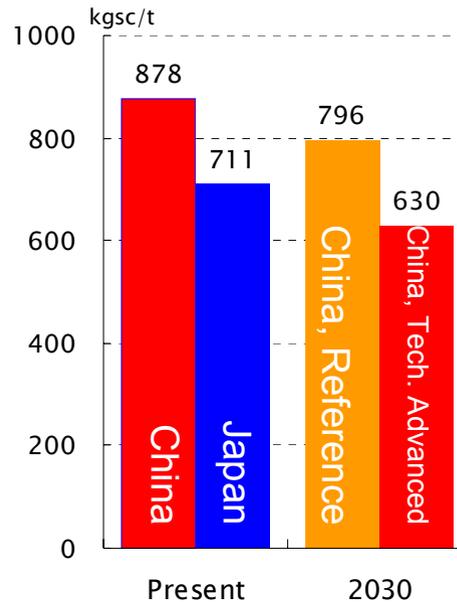
Comparison between China and Japan in Major Sector

Coal Thermal Efficiency



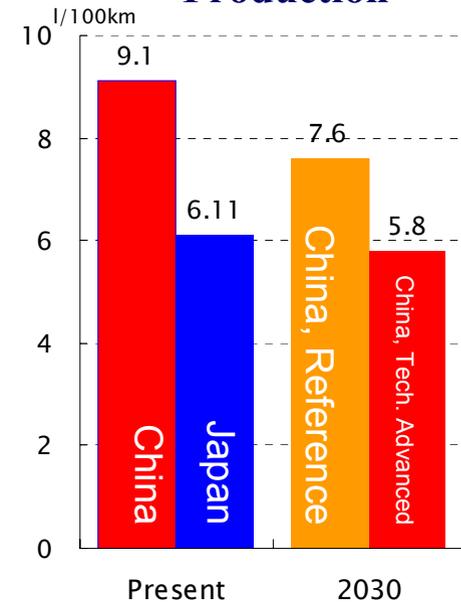
- Enlargement of Equipment Scale
- Higher temperature and Pressure
- Improvement of Daily Maintenance

Fuel Economy of Vehicle



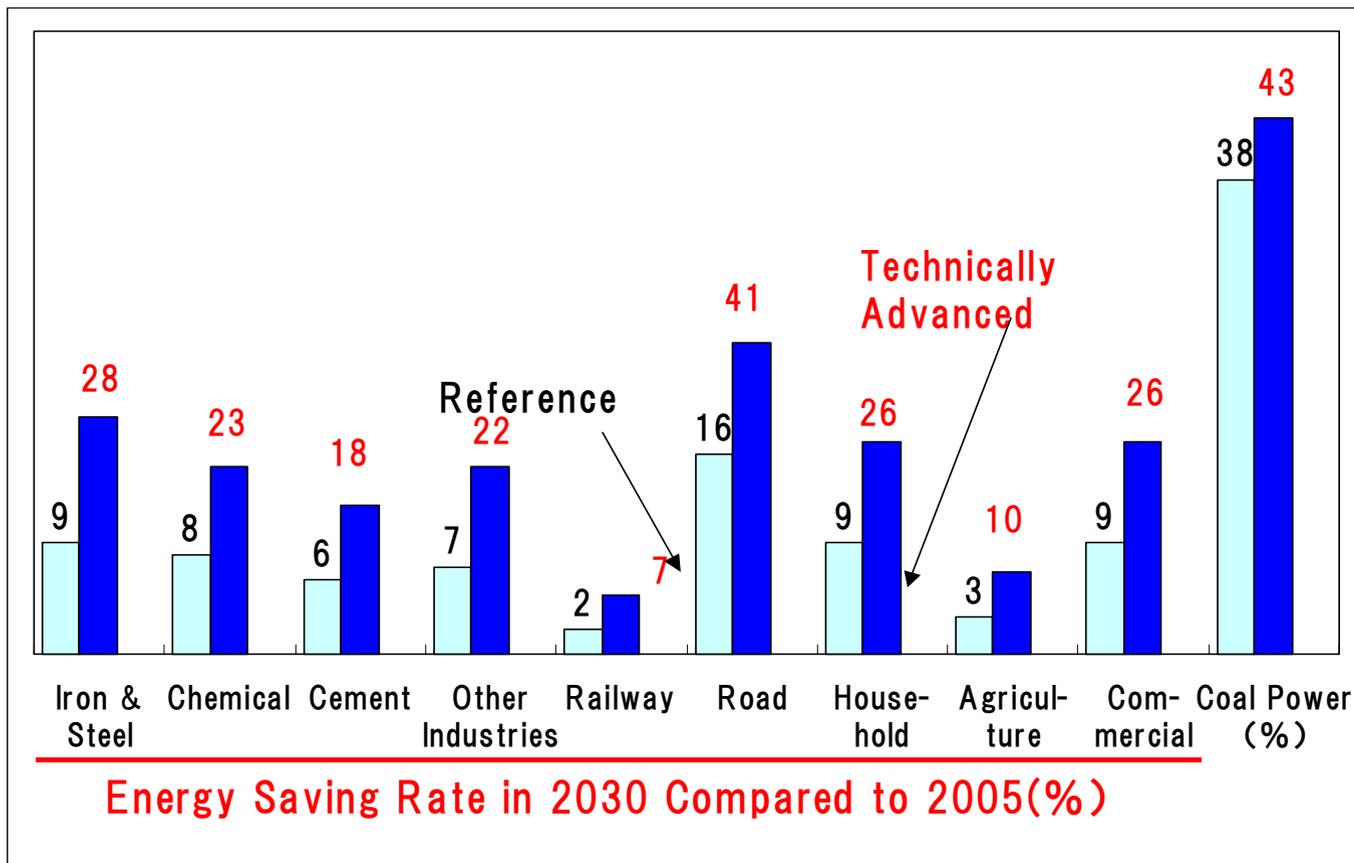
- More Usage of Technology
- Strengthen Fuel Economy Standards
- Improvement of Oil Product Quality

Efficiency of Crude Steel Production



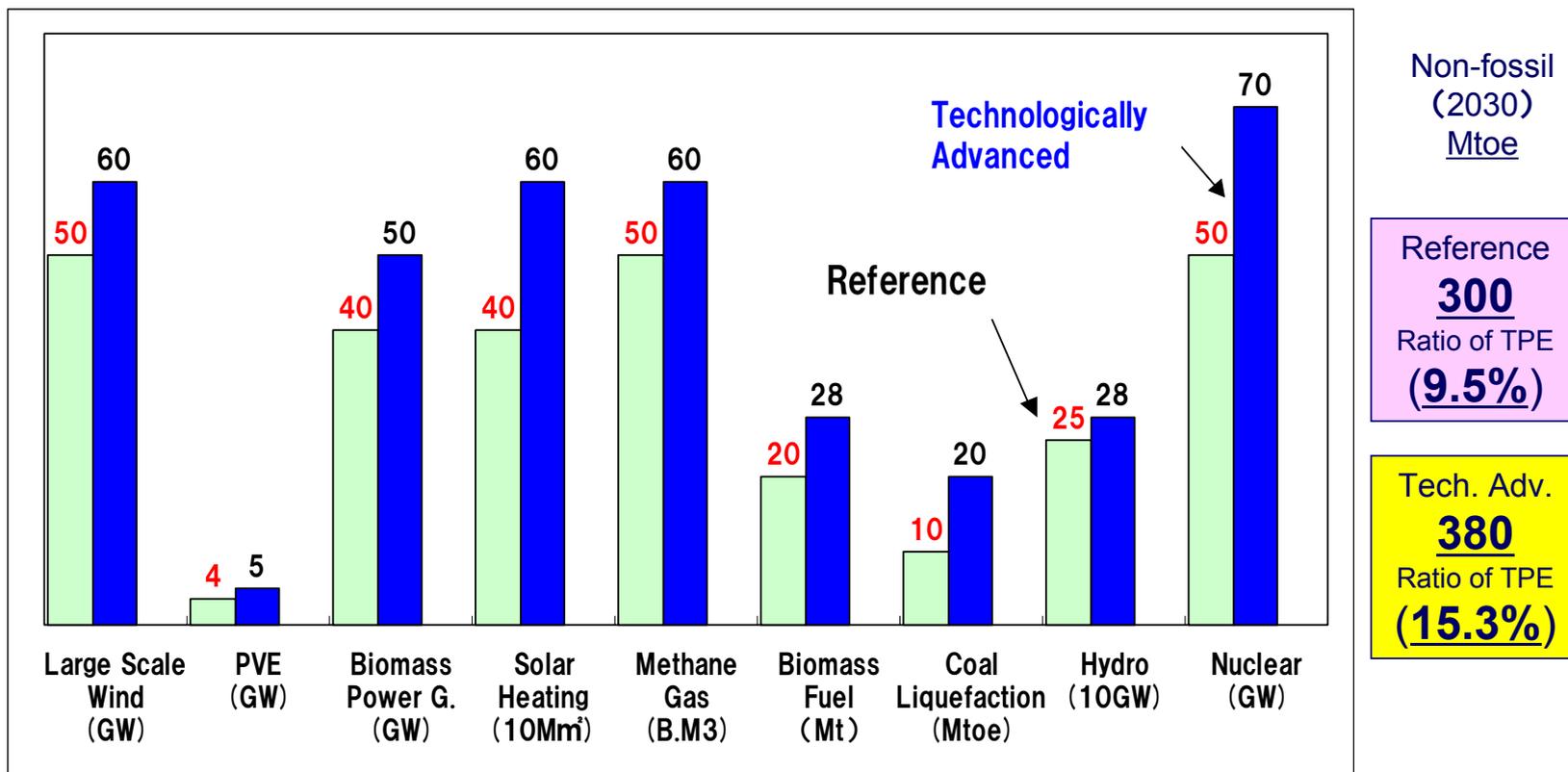
- Enlargement of Blast Furnace
- CDQ、TRT
- Reuse of Waste Gas

Comparison of Energy Saving Rates



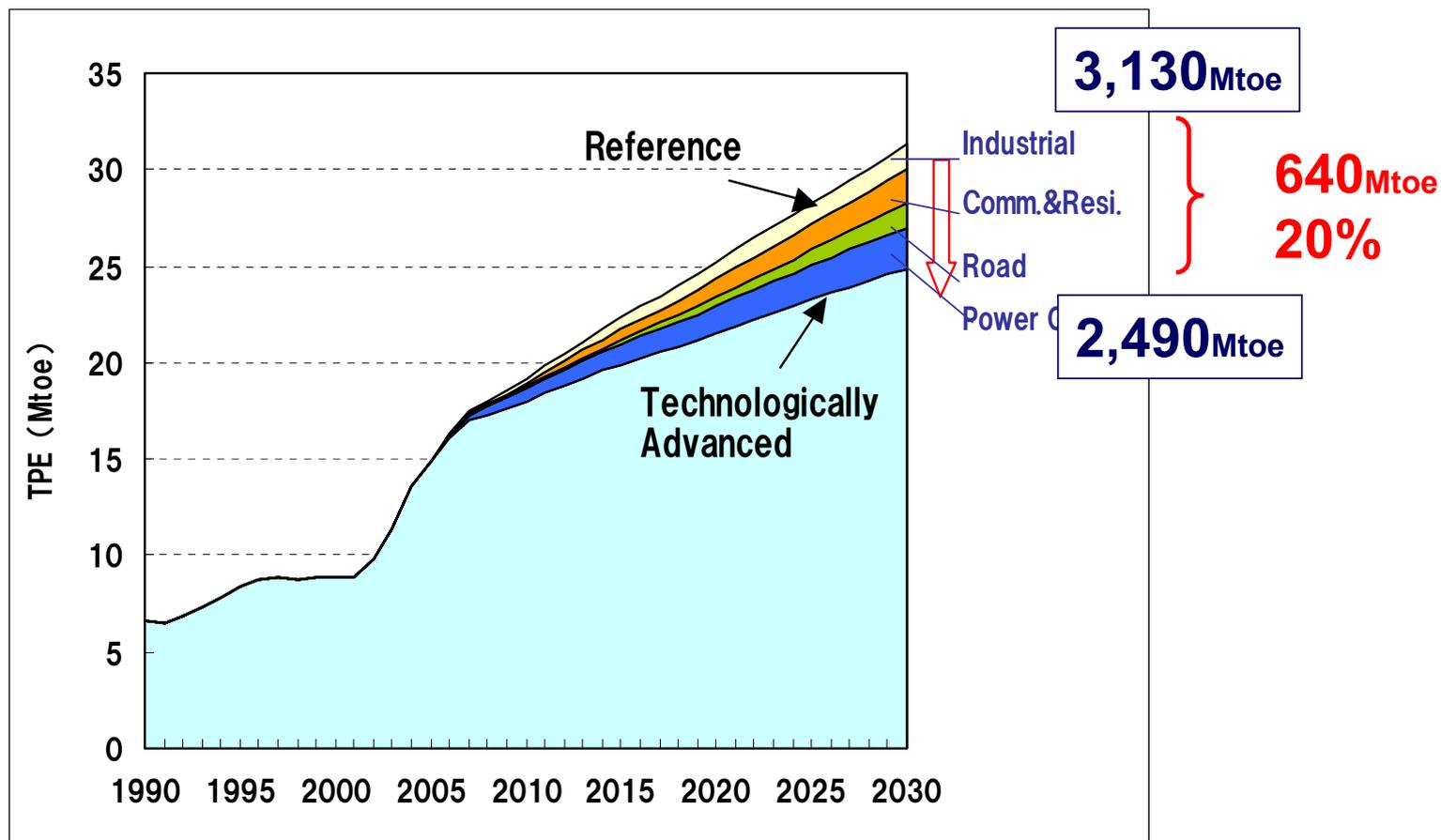
- Reform heating rate system and strength efficiency labeling system in household and commercial sector.
- Enlarge production scale, improve production process and change raw material in chemical sectors.
- Increase NSP rate in cement (50% → nearly 100%) and reuse waste electricity.
- Greatly enlarge average capacity (60MW → 350MW) in power generation sector.

Non-fossil fuel forecast in China (2030)



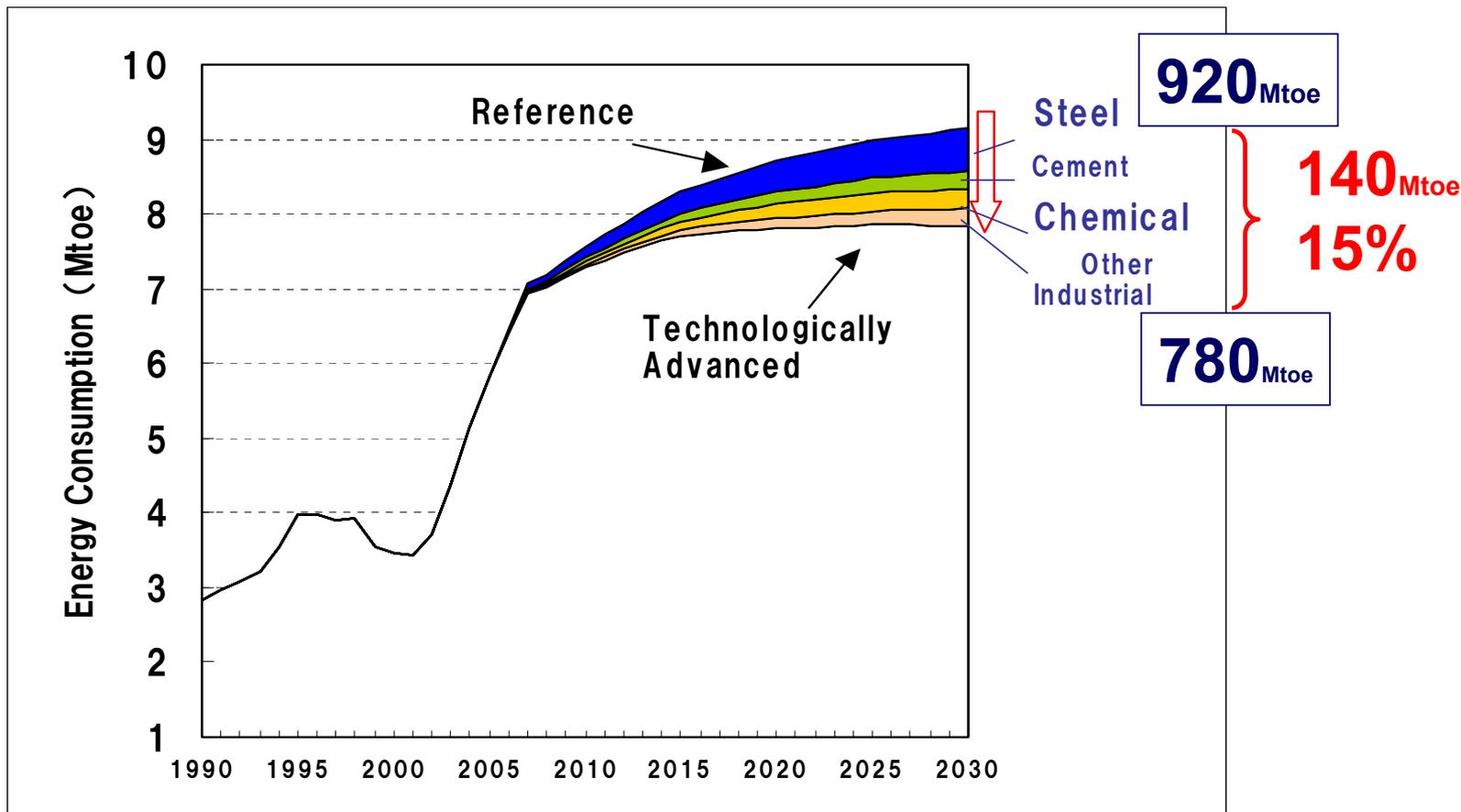
- *Limited hydro expansion because of resource and environmental consideration.*
- *Great expansion of nuclear because of electricity demand and environment protection.*
- *Non-fossil fuel usage increases to 300 Mtoe in 2030, a ratio of 9.5% to TPE, and further increases to 15.3% in Technologically Advanced case.*

Total Energy Saving Amount in China(TPE)



China can possibly save energy by an amount of 640 Mtoe. The energy saving potential rate of 20%.

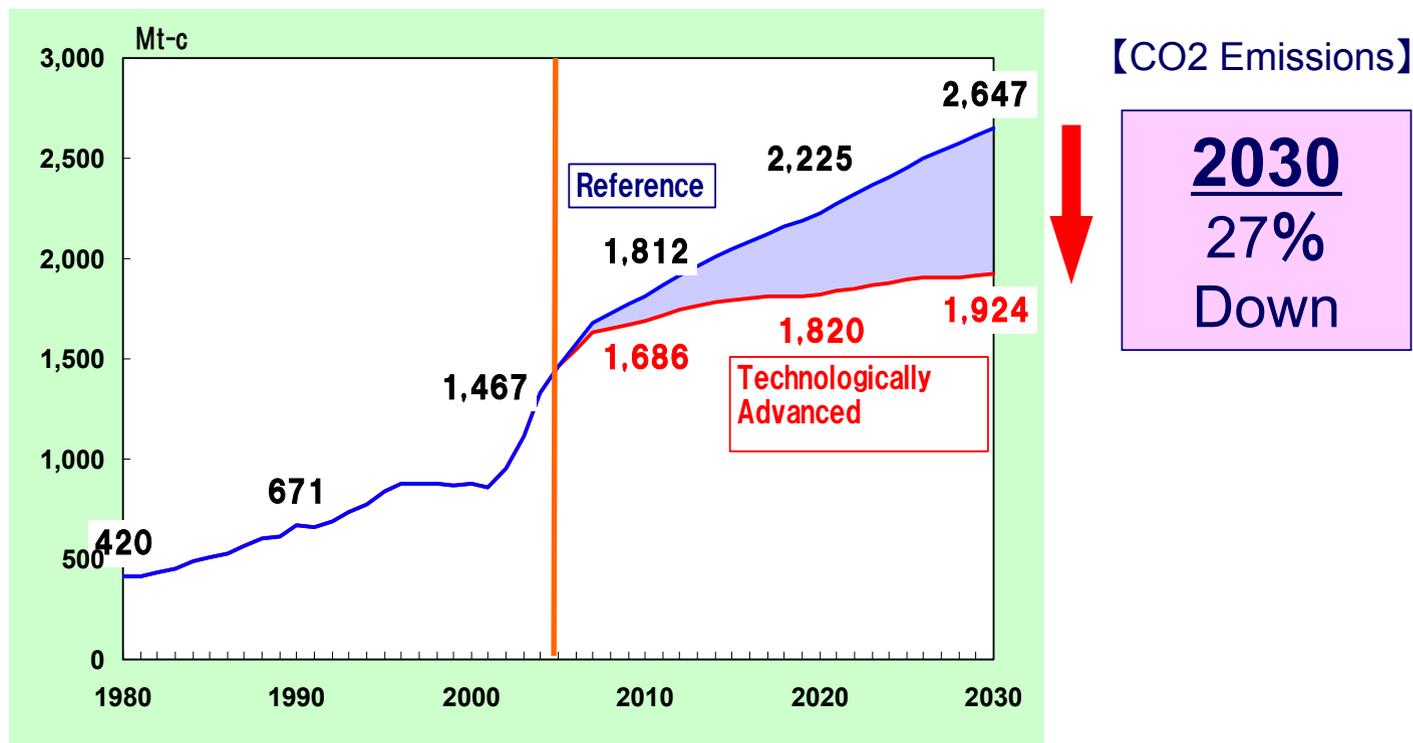
Energy Saving Amount in Industry of China



(Note) Steel includes energy consumption of coke production.

Energy saving amount in industry in China is 140Mtoe, or an energy saving rate of 15%.

CO2 Emissions in China



- *In Reference case, CO2 emission will increase by 1,180 Mt-c (81%Up) between 2005-2030.*
- *In Technologically Advanced case, it will decrease by 720 Mt-c (27%Down) in 2030, compared to Reference case.*

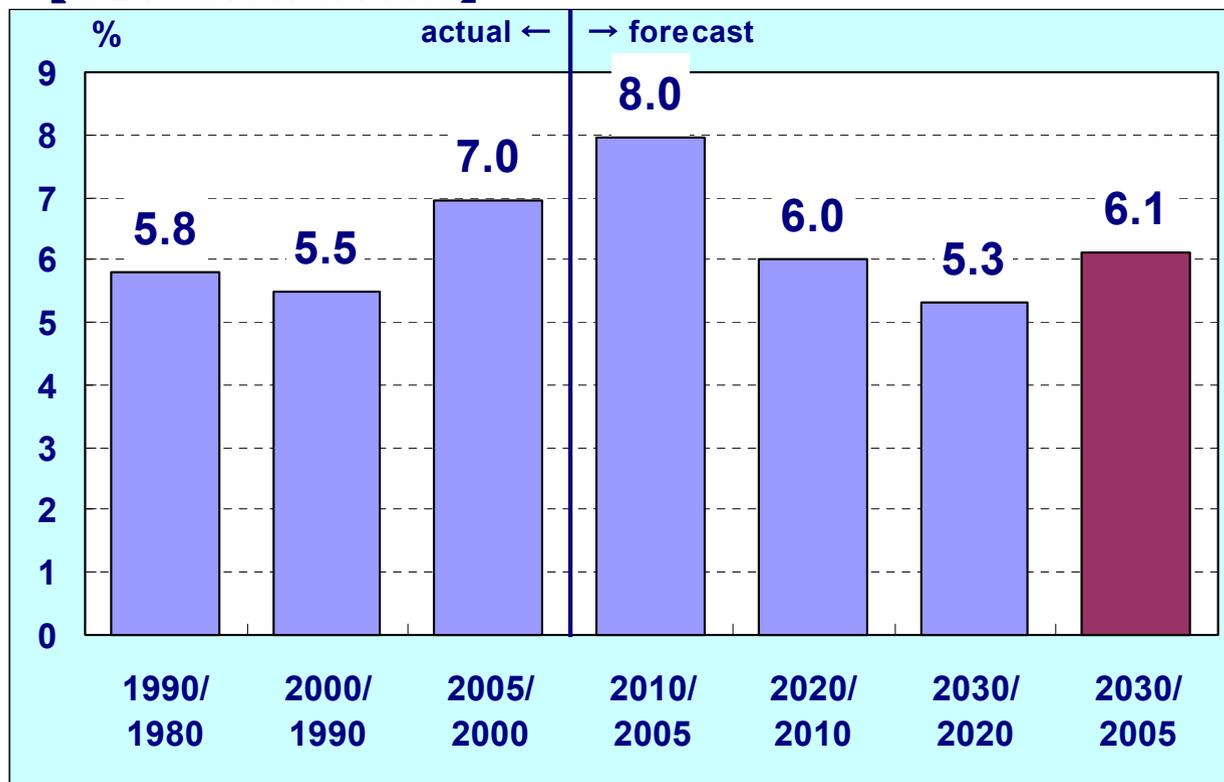
Forecast of Energy Demand and Supply in India

India's Energy Policies

- Energy demand is increasing as the economy grows rapidly.
 - 1990-2005 Annual average growth rate: GDP 6.0%, Primary energy demand 4.8%.
- Coal is mainly consumed. Oil consumption is also increasing recently.
 - Coal, oil and gas consumption is increasing mainly for the use of transport and electric power generation.
 - Non commercial sources of energy, including fuel wood and dung, are also used, amounting about 0.4 times the commercial energy consumption.
- Energy import, especially oil, is increasing as the demand grows.
- Shortage of energy supply is becoming a serious problem. Energy policies covering all sources of energy and considering all issues are needed.
 - Policies appearing in the 5 year plan were made by 5 separate ministries / departments, and were not always in harmony.
 - An expert committee was organized, which submitted “Integrated Energy Policy” in 2006, aiming at securing energy supply through institutional reforms and achieving high energy efficiency.

Forecast of Indian Economy(1)

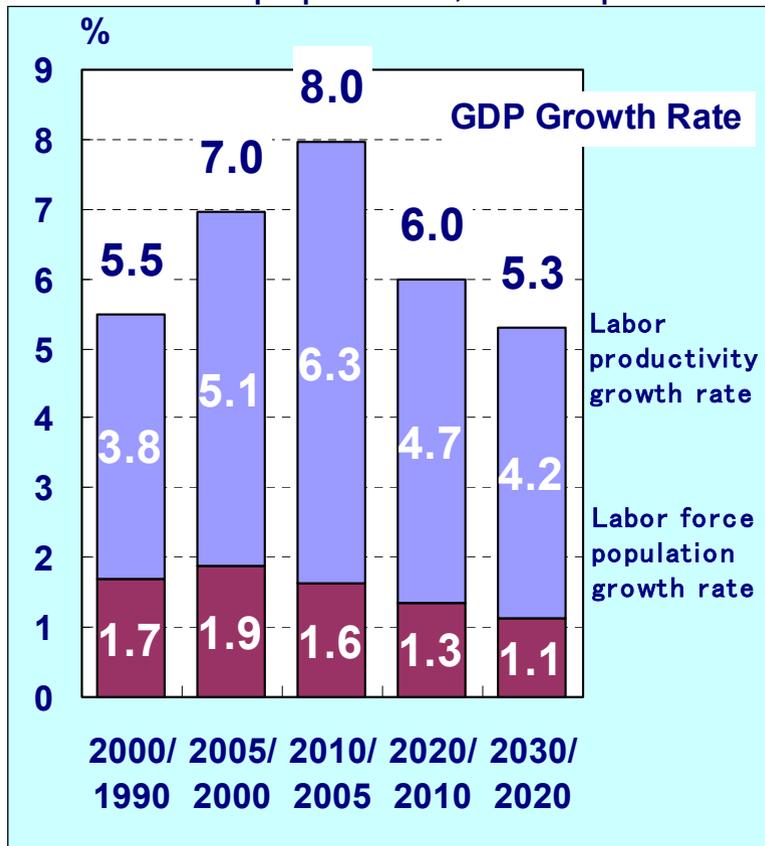
【GDP Growth Rate】



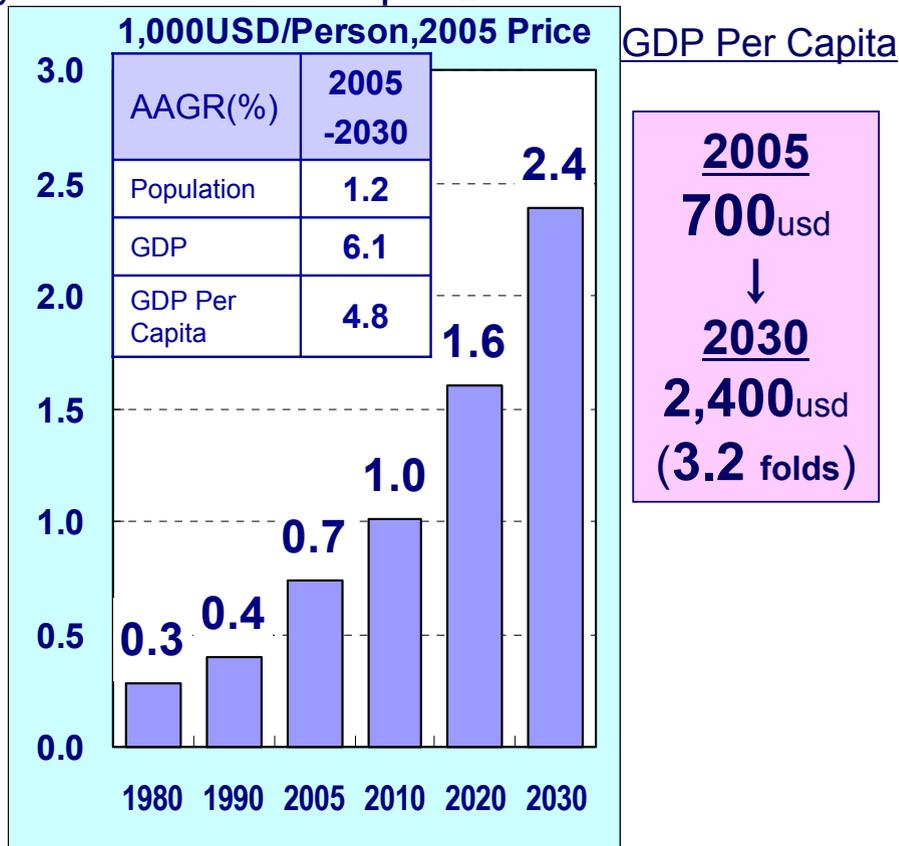
- *The new economic policy in 1991 made a stable economic growth.*
- *Growth of production in the service and the manufacturing will lead a economic growth in the future.*
- *GDP growth rate in the whole forecast period is approximately the same as that of China.*

Forecast of Indian Economy(2)

【Labor force population, Labor productivity】



【GDP Per Capita】



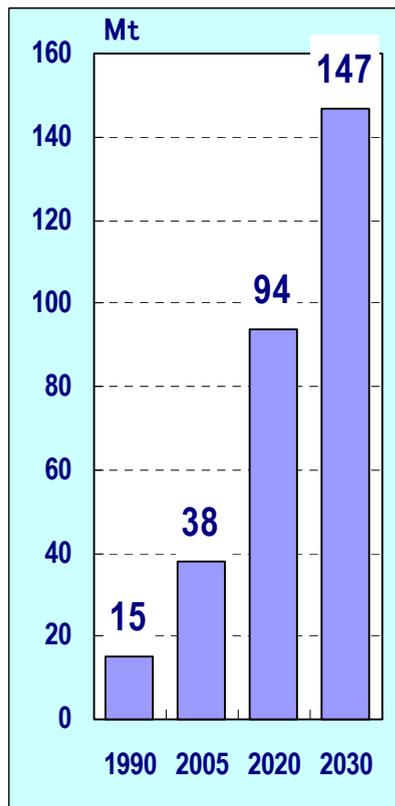
•Fulfilling quantity and quality of labor force, a development of opening the country to foreign business and increase direct foreign investments will keep a high growth in the future.

•On the other hand, absences of the infrastructure such as road, harbor, railway and electric power could be a constraint of the economic growth.

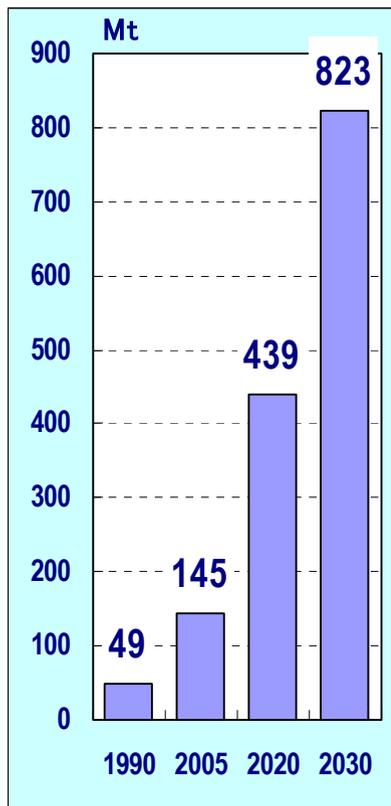
•GDP per capita will increase to 2,400\$ in 2030, but it will be about one-third of that of China.

Production of raw material in India

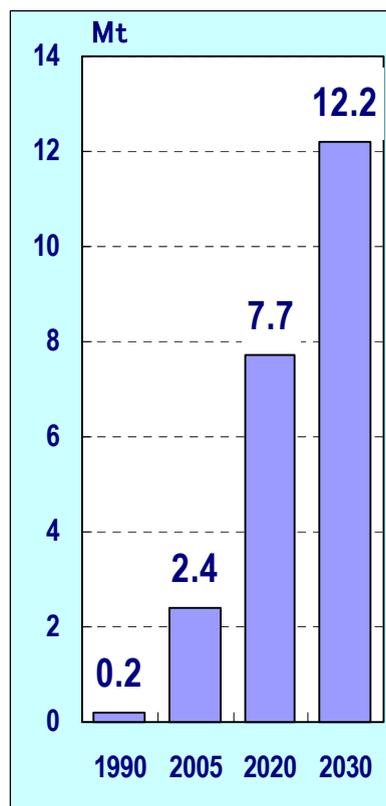
【Crude Steel】



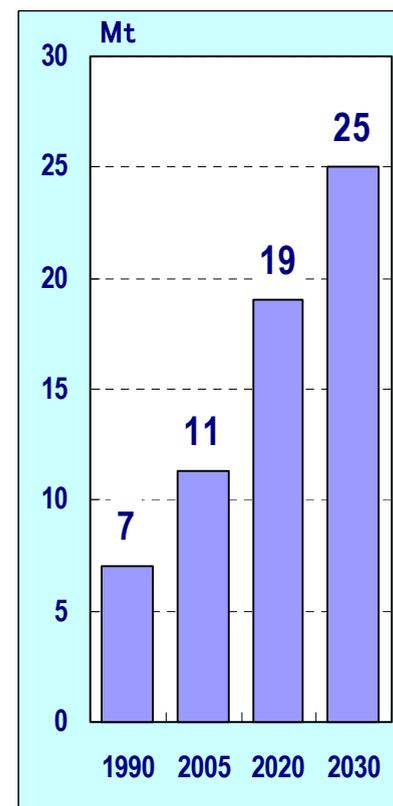
【Cement】



【Ethylene】



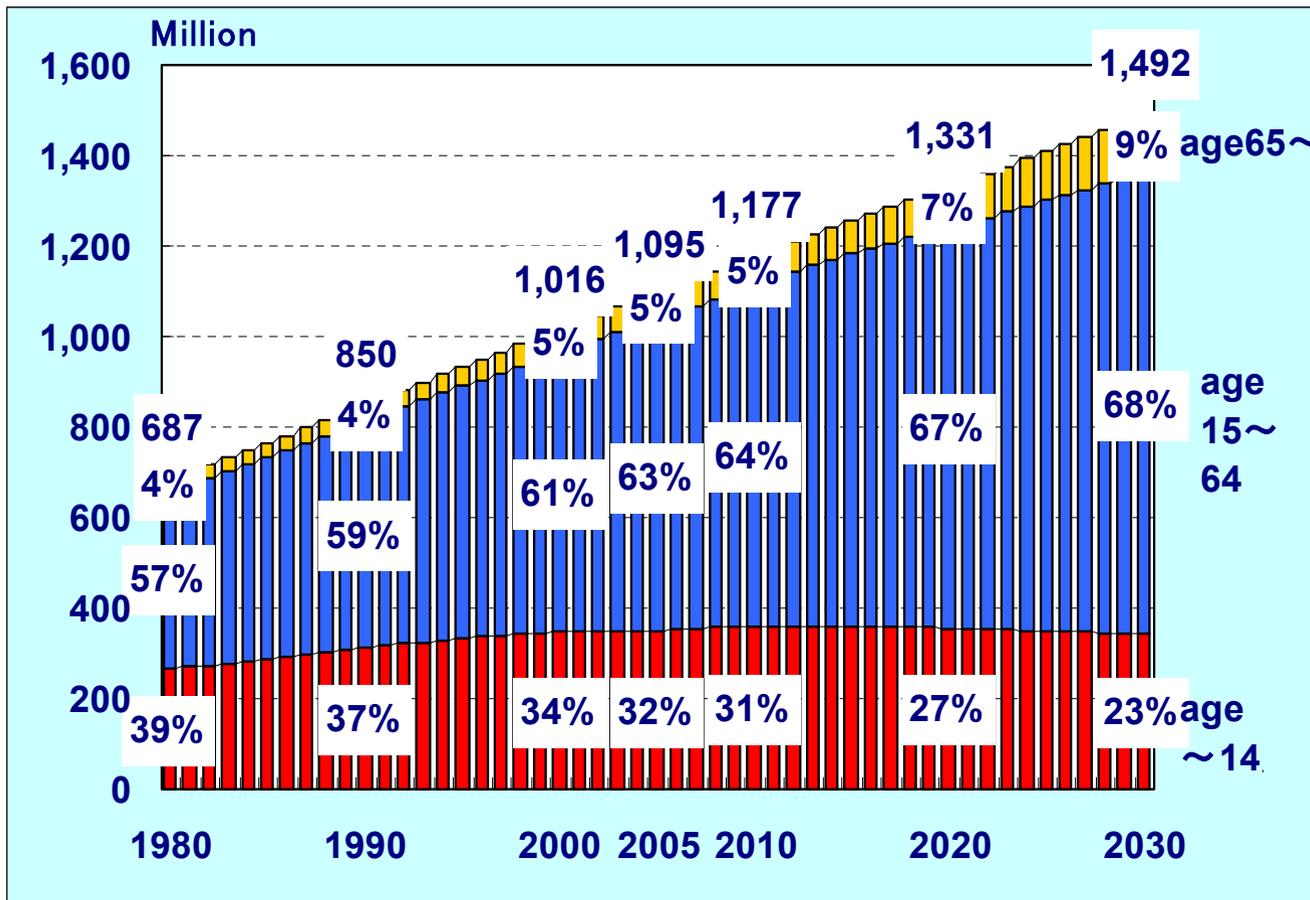
【Nitrogen Fertilizer】



▪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

2005
1095m
↓
2030
1492m
(1.4folds)

Urban Rate

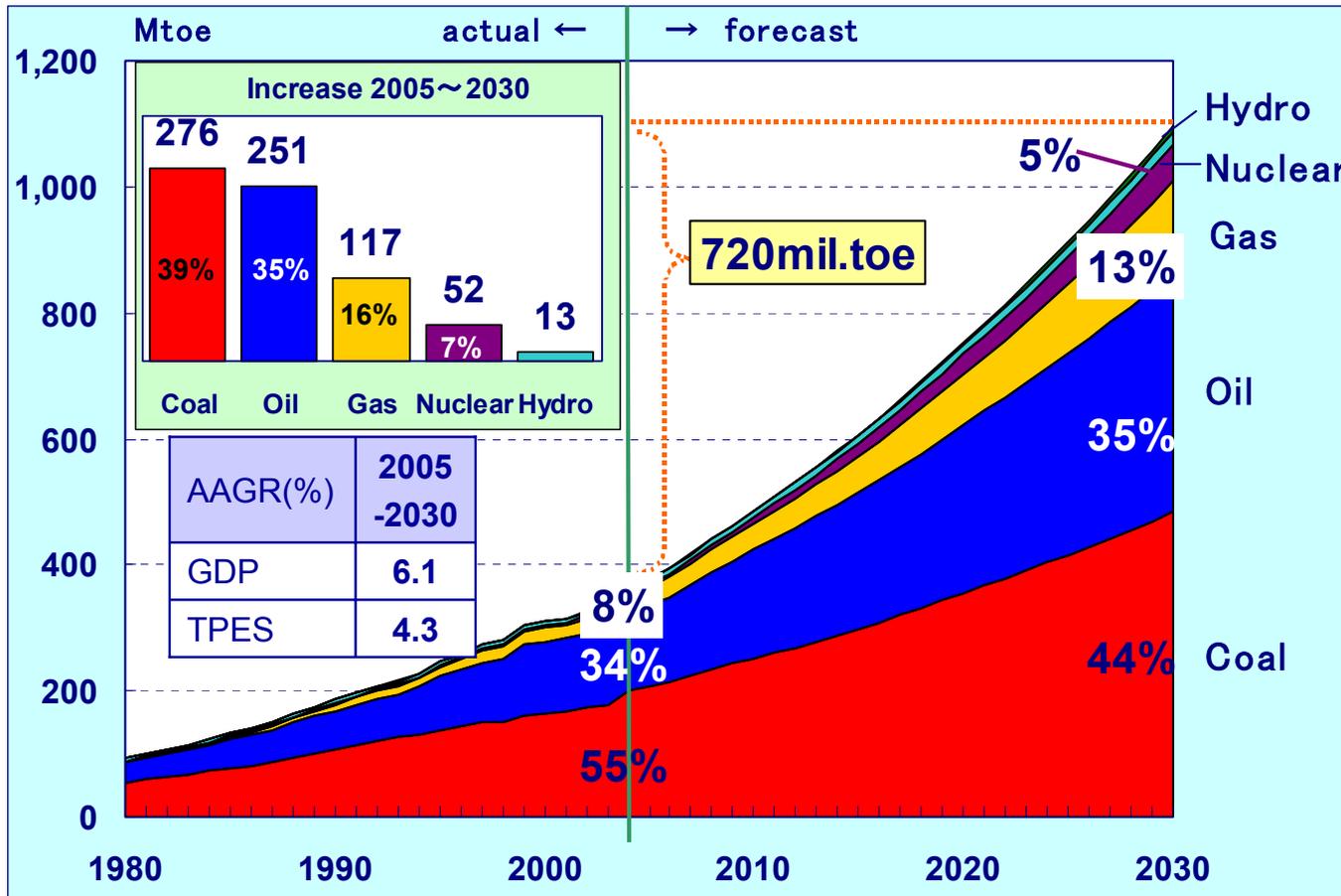
2005
29%
↓
2030
41%
(12points up)

•Total population will increase at an annual rate of 1.2% 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 68% in 2030.

•People will be concentrated into urban areas but rural population will be in majority in the future.

Primary Energy Demand in India



TPES

2005
0.38 billion toe

↓

2030
1.1 billion toe
(2.9-fold growth)

Oil

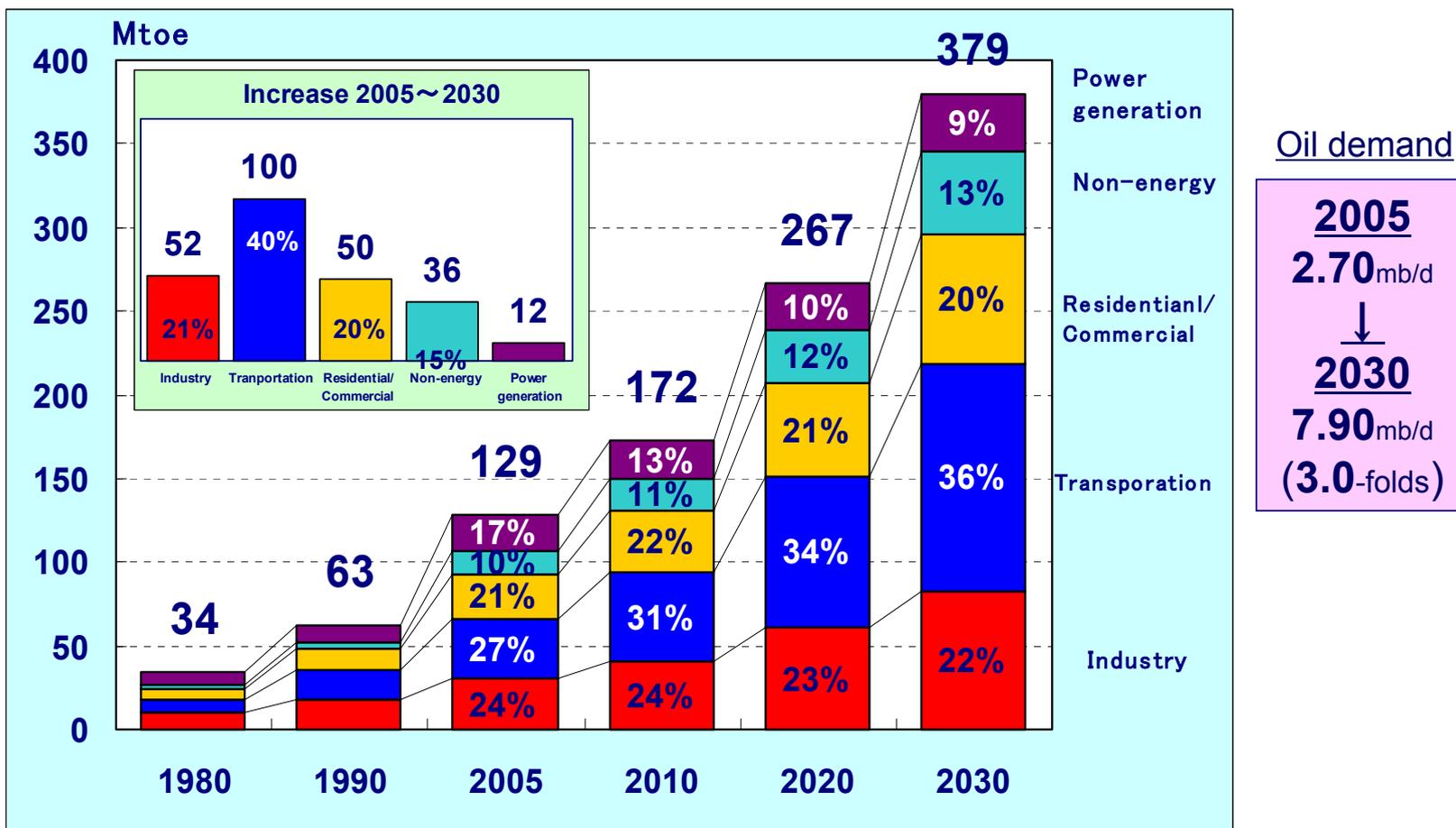
2005
0.13 billion toe

↓

2030
0.38 billion toe
(3.0-fold growth)

- Fossil fuels will cover 90% of rapidly increasing energy demand.
- Coal demand will increase mainly in power generation and industry. 280 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.

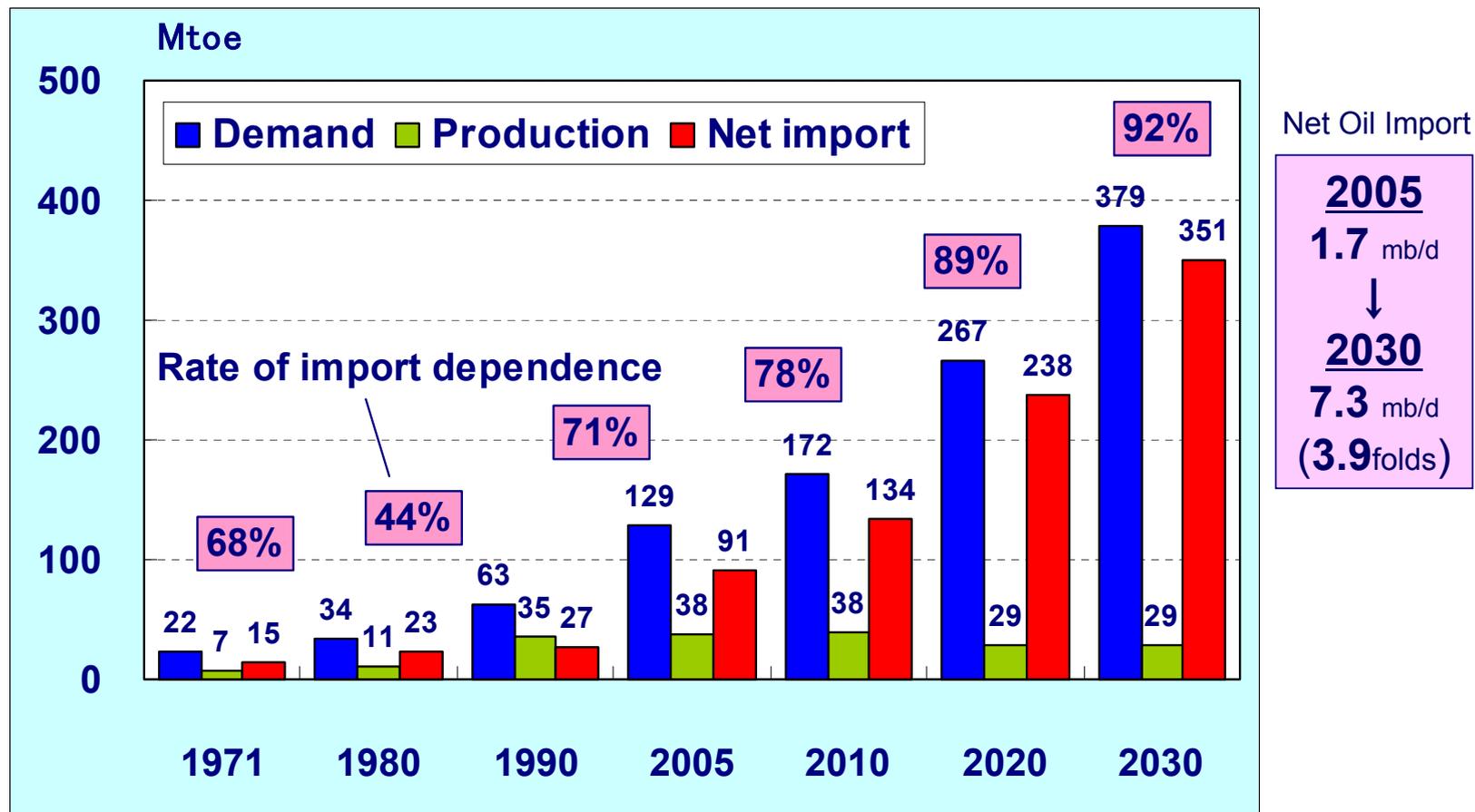
Oil Demand in India



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

•Oil demand increase will be 5.2 mb/d in 2030 that will be equal to current oil consumption in Japan. India will be the world's third-largest oil consumer behind USA and China.

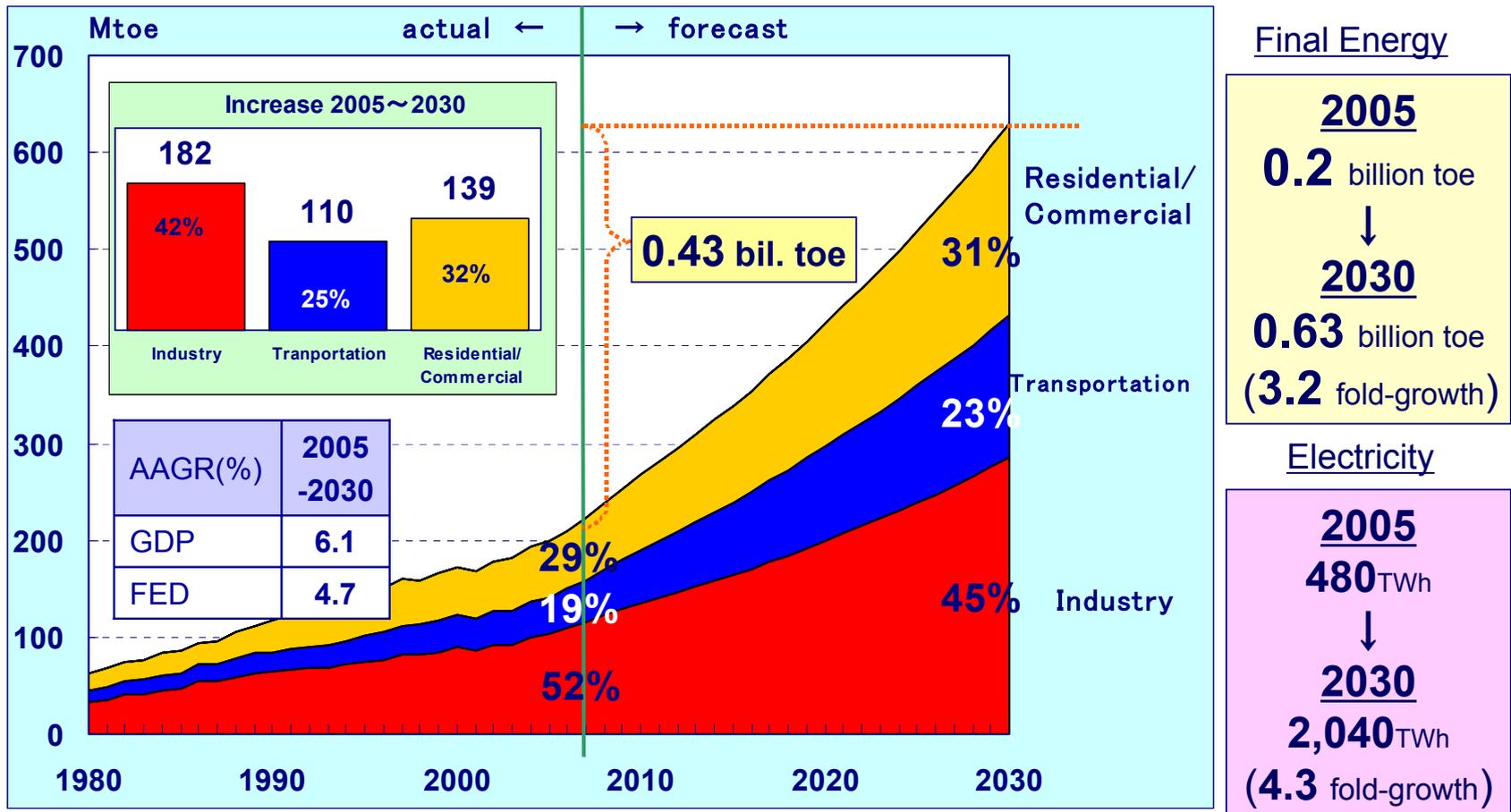
Oil Demand and Supply in India



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

•Net oil import is projected to expand from 90 million ton (1.7 mb/d) to 350 million ton (7.3 mb/d) in 2030. Rate of import dependence will increase and exceed 90%.

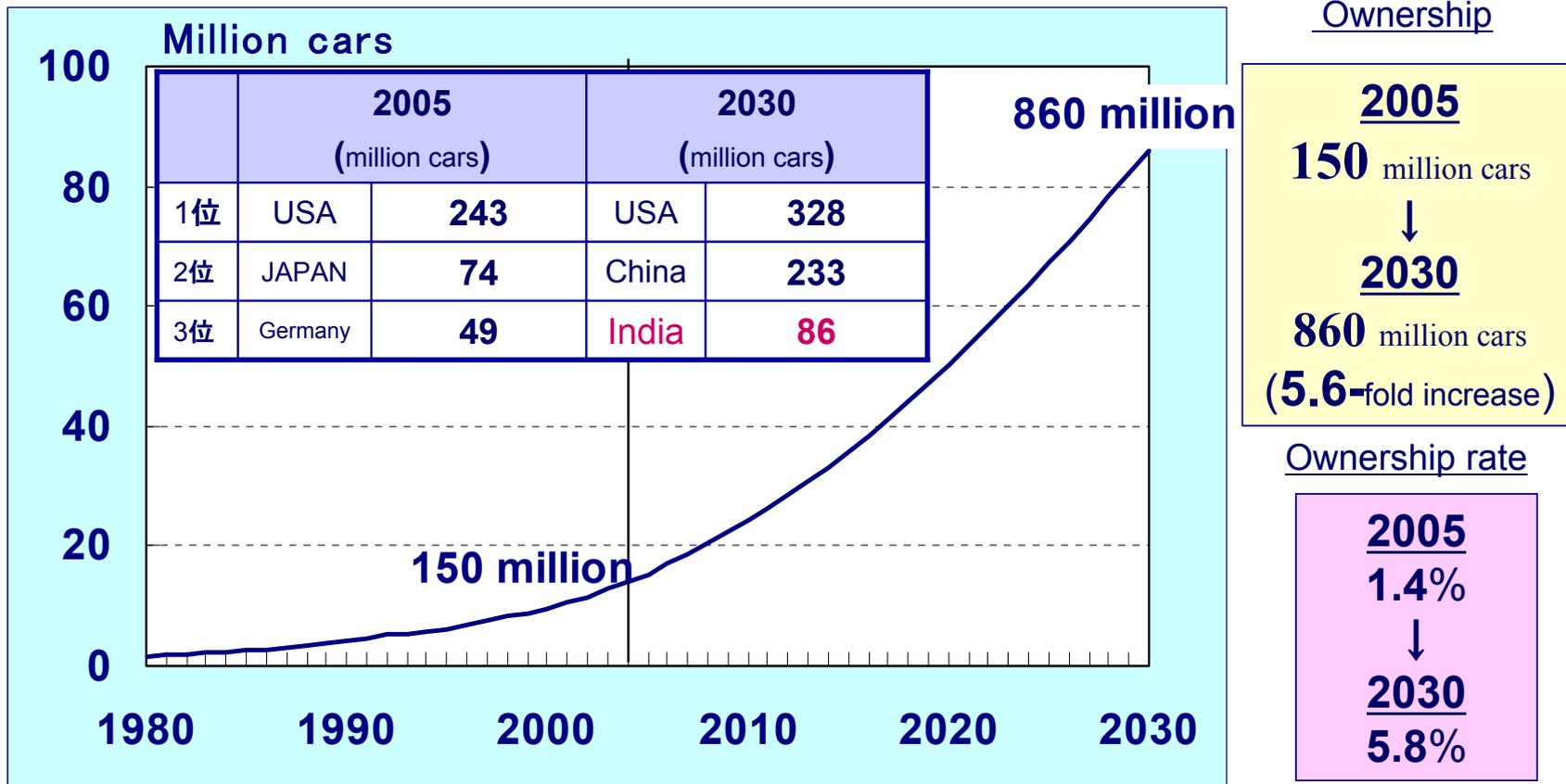
Final Energy Demand in India



(The industry sector includes non-energy use)

- *Industry will be the largest increase by sector but increase rate of industry will be the smallest and composition ratio of industry will fall to 45%.*
- *Residential/commercial and industry sector will make electricity demand increase at a 6% annual rate.*
- *Electricity consumption per capita will increase to 1400kWh in 2030 (20% of that of Japan).*

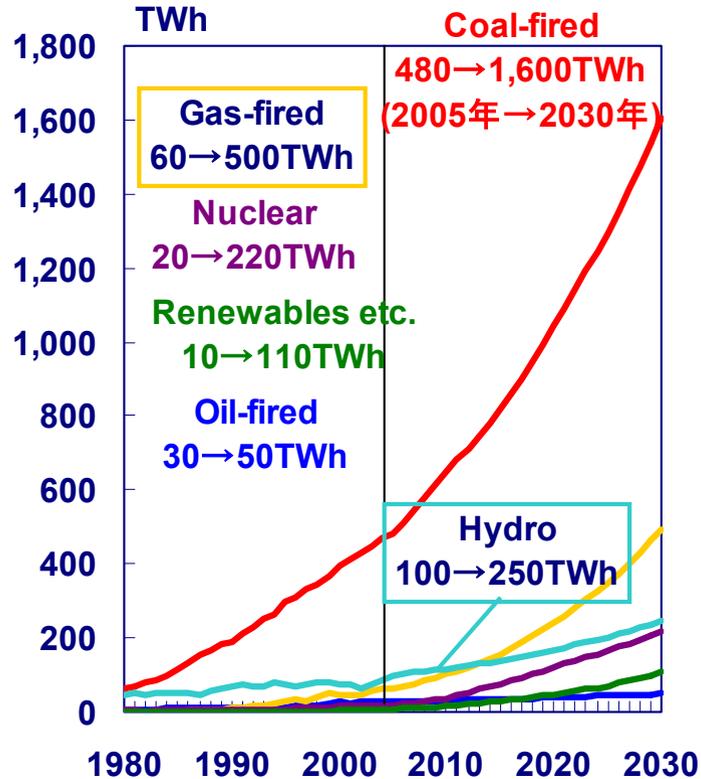
Vehicle Ownership in India



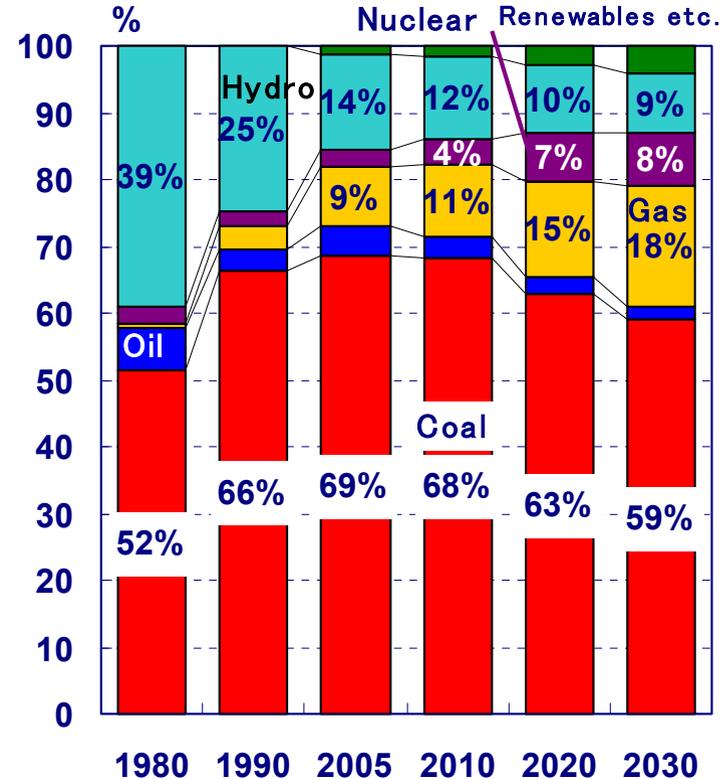
- *India will be the world's third-largest vehicle owner behind USA and China.*
- *Ownership ratio will be still 6% in 2030. There will be room for further increase.*

Power Generation Mix by Fuel ; 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 multifaceted.
- Capacity of nuclear will increase from 3.3GW in 2006 to 33GW in 2030(10-fold).

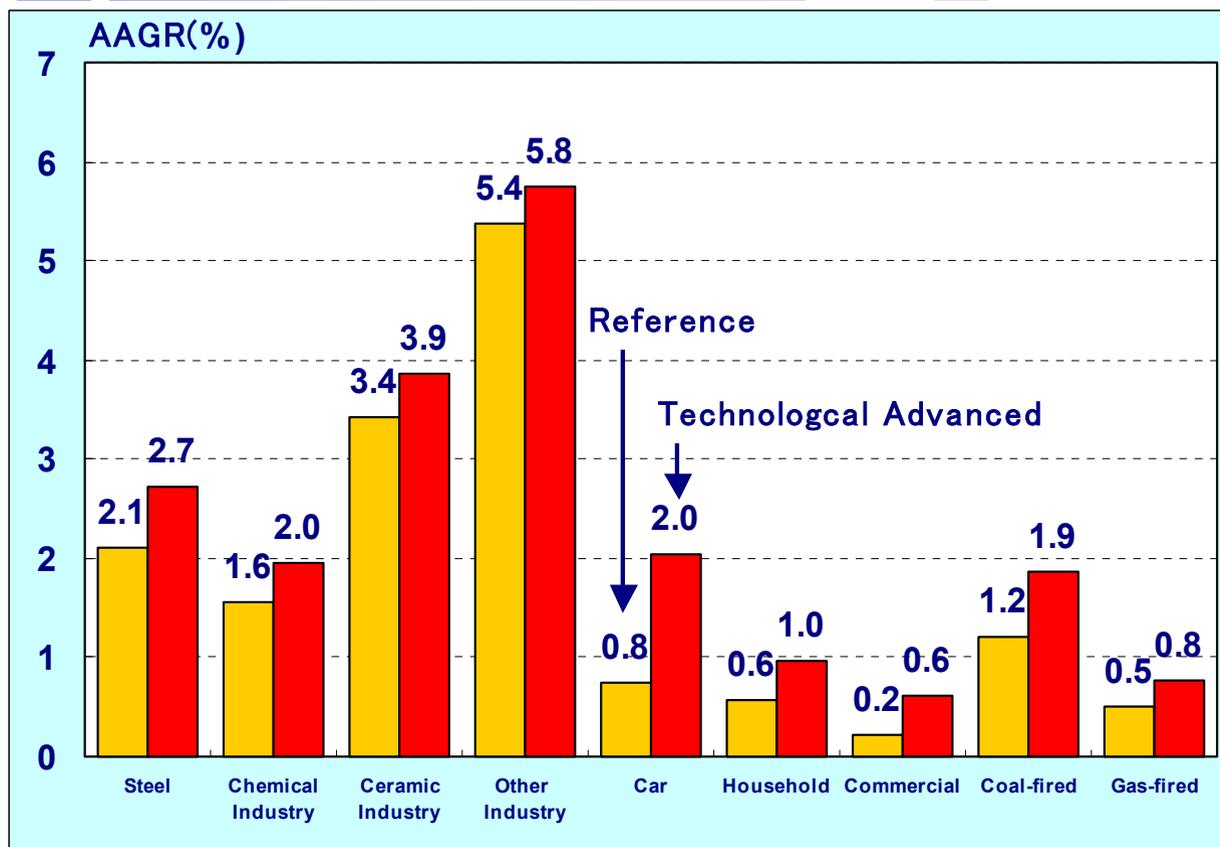
Renewable energy (India)

- *Promoting introduction of renewable energy as countermeasure against energy security and unelectrified village.*
- *Solar, wind, hydro, biomass, etc. have adequate potential reserves. Improving domestic technologies for development further resources.*
- *As for biofuels, India aim to introduce B5 in 2012 and B10 in 2017.*

	Indian governmental calculation			Reference
	Mid term(2032) Potential	Installation (June.2007)	Power cost	Installation (2030)
	GW	GW	rupee/kWh	GW
Wind	45.2	7.2	3~4	27
Micro-hydro	15.0	2.0	2.5~3.5	-
Biomass power generation	21.9	1.2	2~4	5
Waste power generation	2.7	0.04	4~7.5	
Solar	-	0.002	15~20	3
Total	84.8	10.5	1 rupee =2.6 jpy	35 (exc. Micro-hydro)

Technologically Advanced Scenario for India

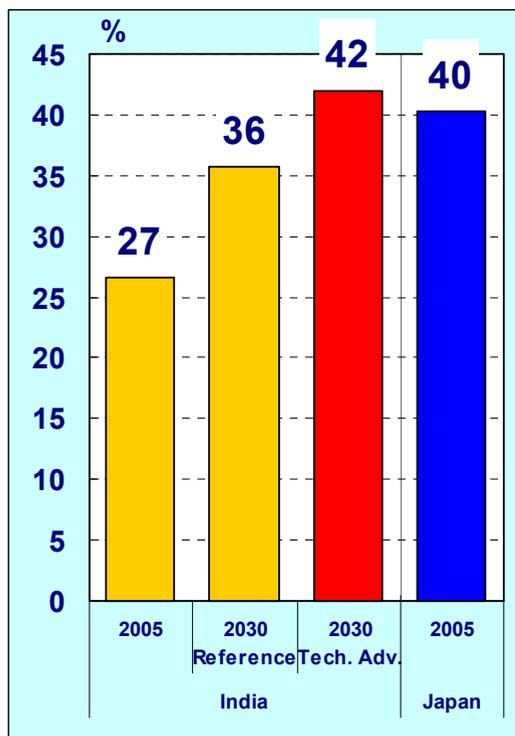
Energy Efficiency improving rates



- 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 needed.

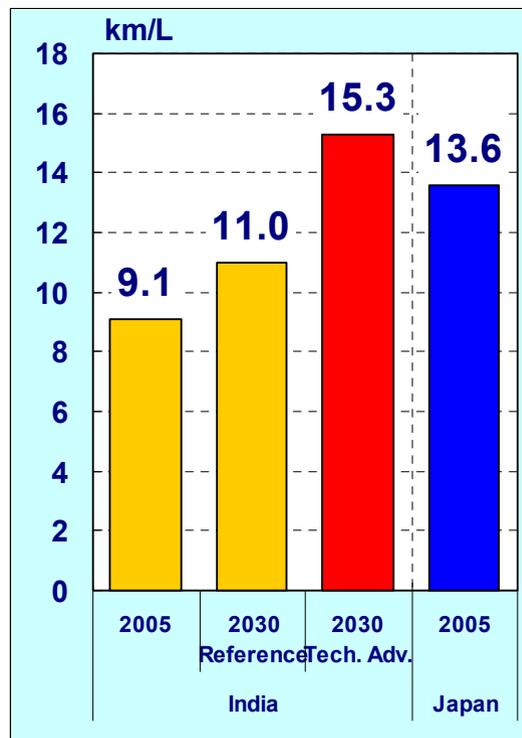
Energy Efficiencies in Reference and Tech.Advanced scenario

【Coal-fired Power Generation Efficiency】



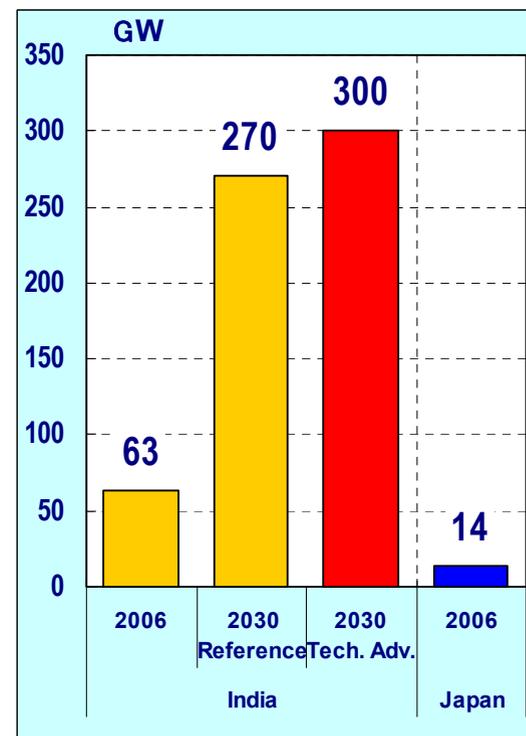
- Promotion of Integrated Gasification Combined Cycle (IGCC), Ultra supercritical technology, Pressurized Fluid-bed Boiler Combined Cycle (PFBC) etc.

【Car Fuel Consumption】



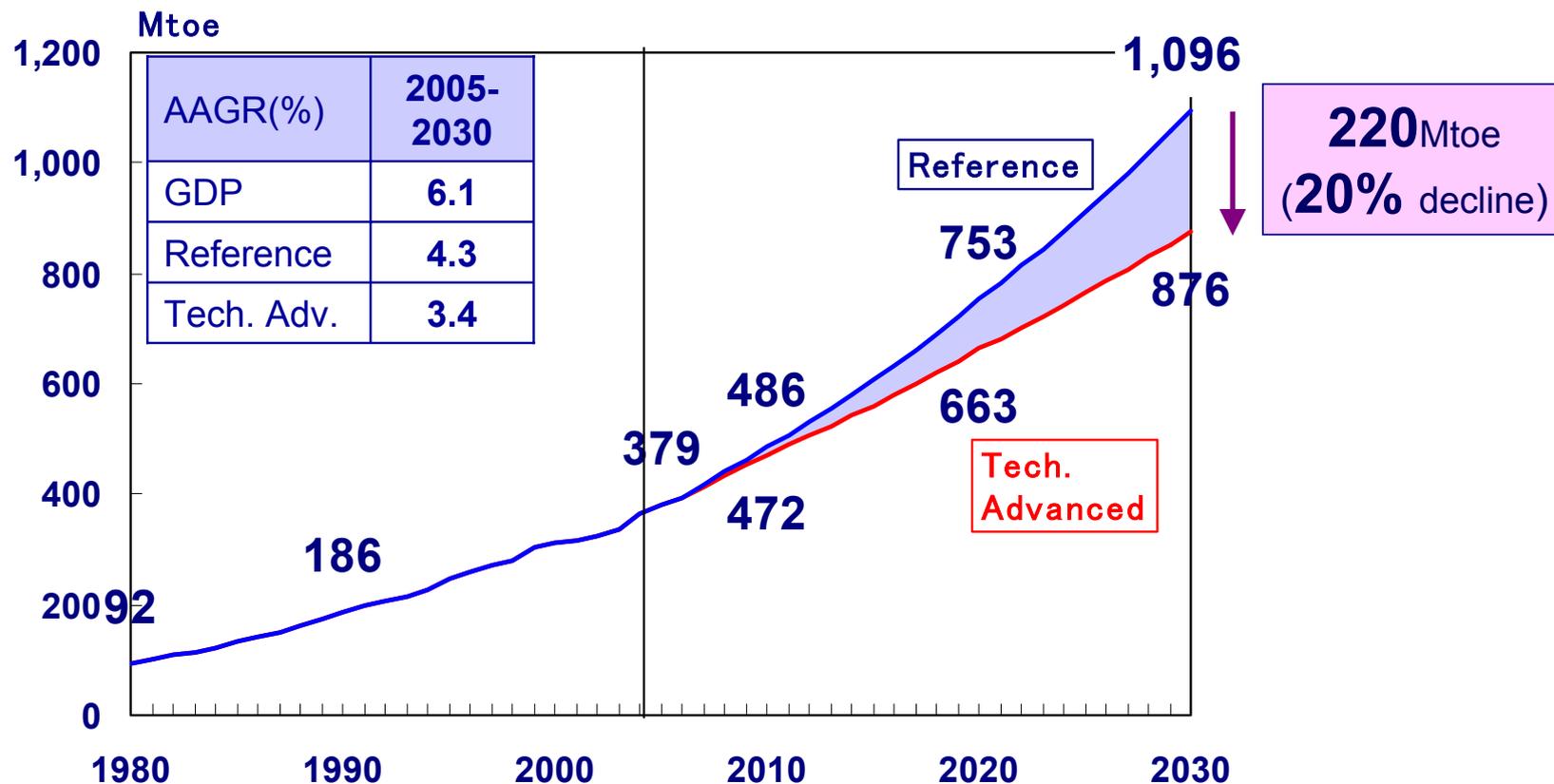
- Aiming to improve fuel efficiency by 50% for a newly purchased car.

【Wind Power Generation Capacity】



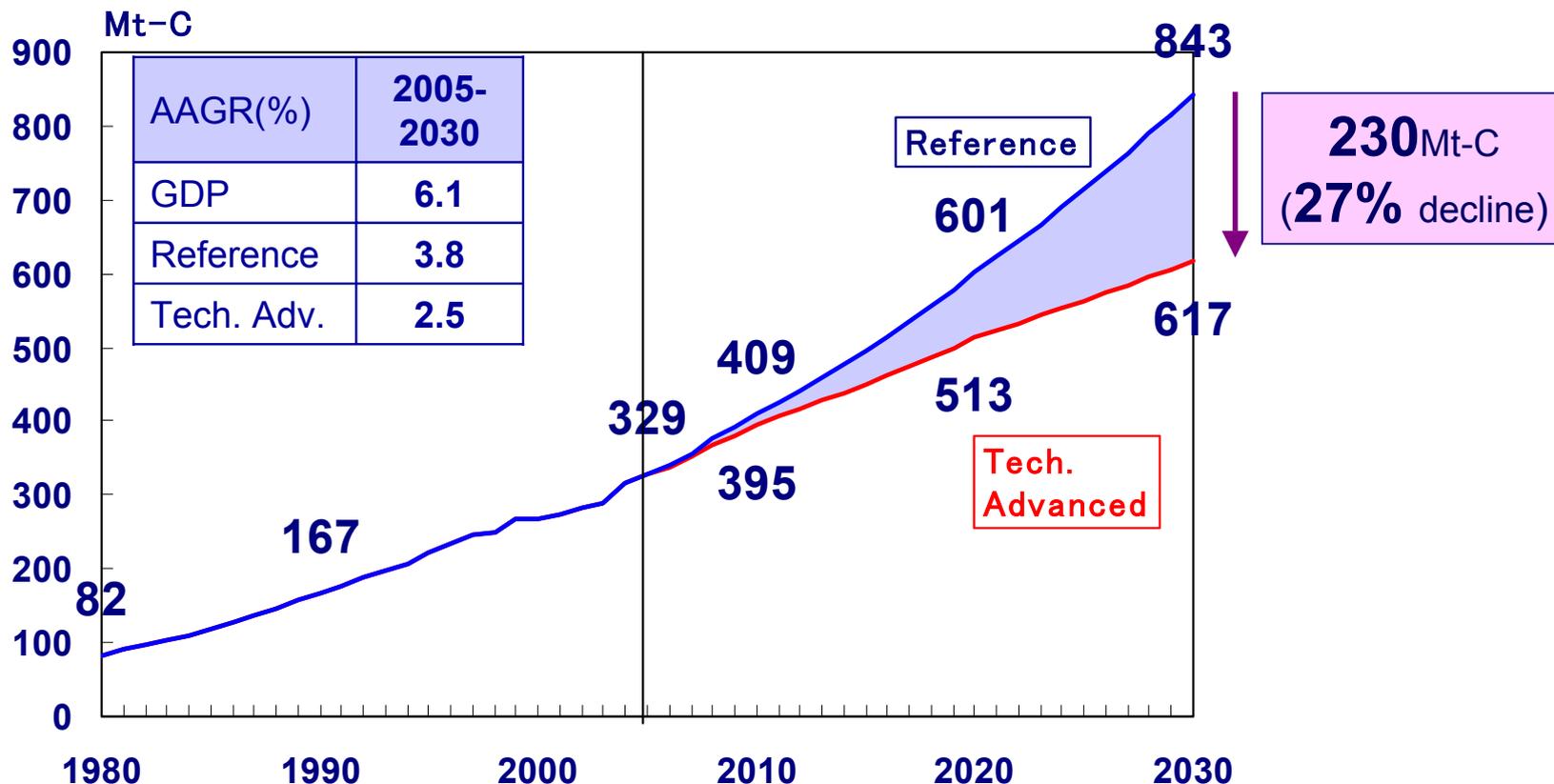
- The land is suitable for Wind power generation. As much as 65 GW installation is said to be possible.

Primary Energy Demand in India



The Primary energy demand will be reduced by about 20% (220Mtoe) in 2030.

CO₂ Emissions in India



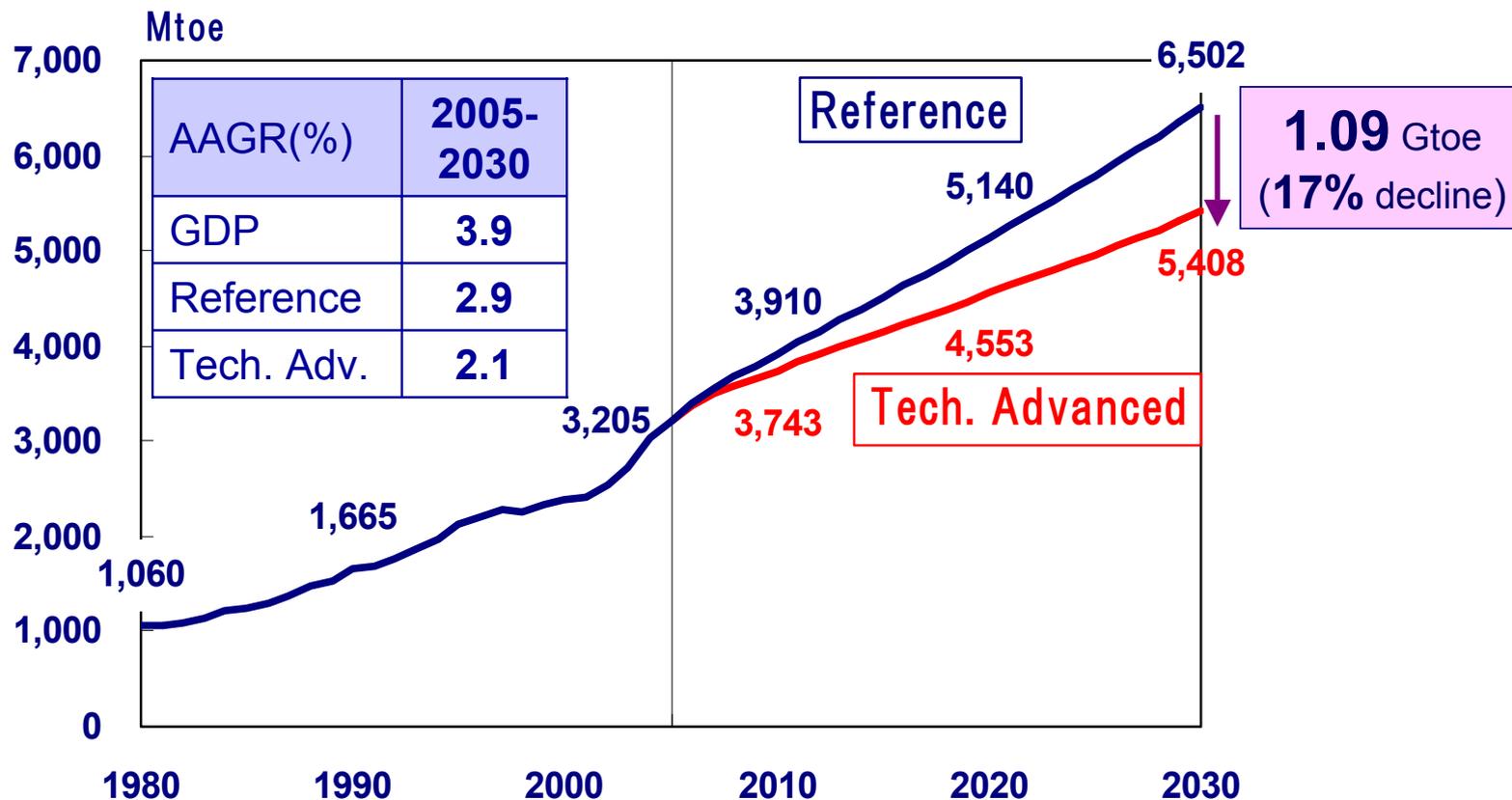
In the Technologically Advanced scenario, 27% of the total CO₂ emission (230Mt-C) will be mitigated in 2030. This amount is about 70% of the present CO₂ emission of India.

Technologically Advanced Scenario (Asia)

Energy Efficiency Conservation (EE&C) Policies in Asian Countries

	Energy Policies
Malaysia	<ul style="list-style-type: none"> – The 9th Malaysia Plan for EE&C provides the guidelines. – Provides fiscal incentives to energy services and companies.
Indonesia	<ul style="list-style-type: none"> – Strengthens the policy base for EE&C to achieve energy elasticity of less than 1 by 2025. – Prepares the draft Energy Law aiming to strengthen the country's policy on promoting EE&C.
Thailand	<ul style="list-style-type: none"> – Tax incentives are provided, and Standards and Labeling activities are conducted. – Revolving Fund Program has generated energy savings worth 36million US\$.
Vietnam	<ul style="list-style-type: none"> – Numeral Targets are specified in the National Strategic Programme. – Establishes the EE&C Office to promote the policies.
Philippines	<ul style="list-style-type: none"> – The National EE&C Program promotes EE&C in the household, commercial/industrial, transport and government sectors. – Alternative fuels and technologies, fuel economy run etc.

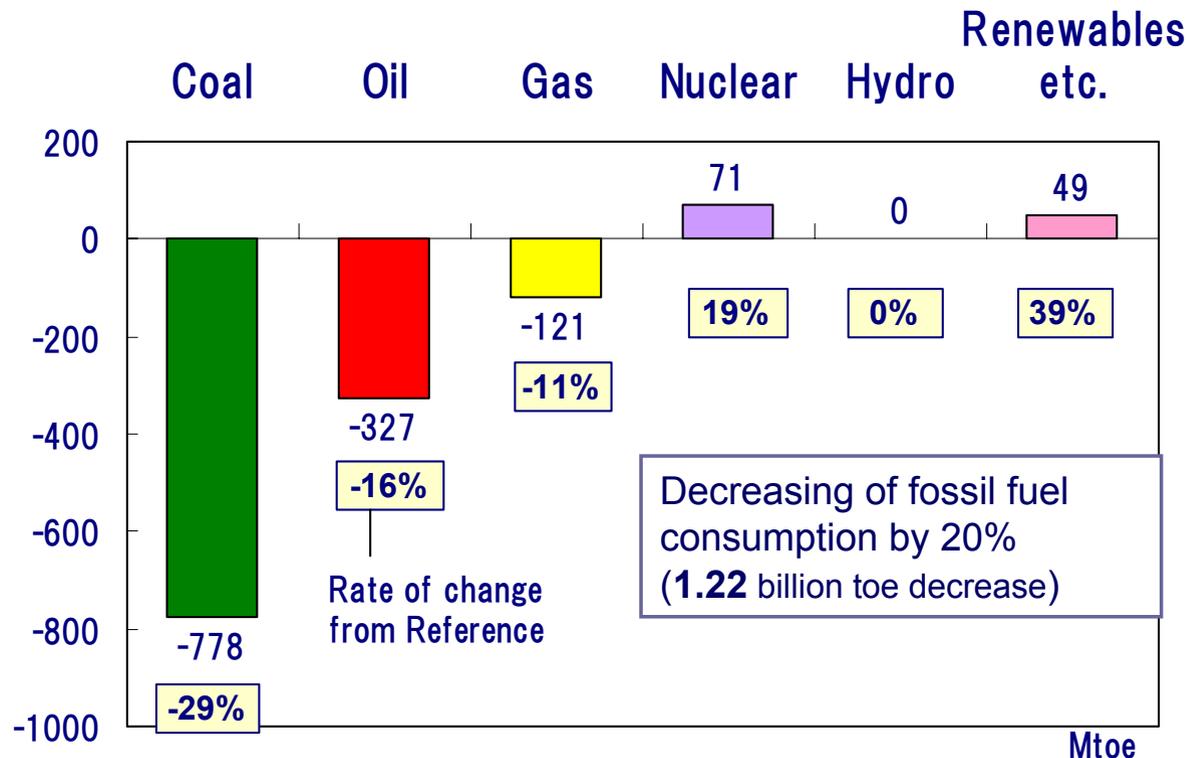
Primary Energy Demand (Asia)



In 2030, aggregate primary energy demand is reduced by around 17% (1.09 Gtoe, 2 times Japan's current primary energy demand)

Change in Energy Demand by Source (Asia)

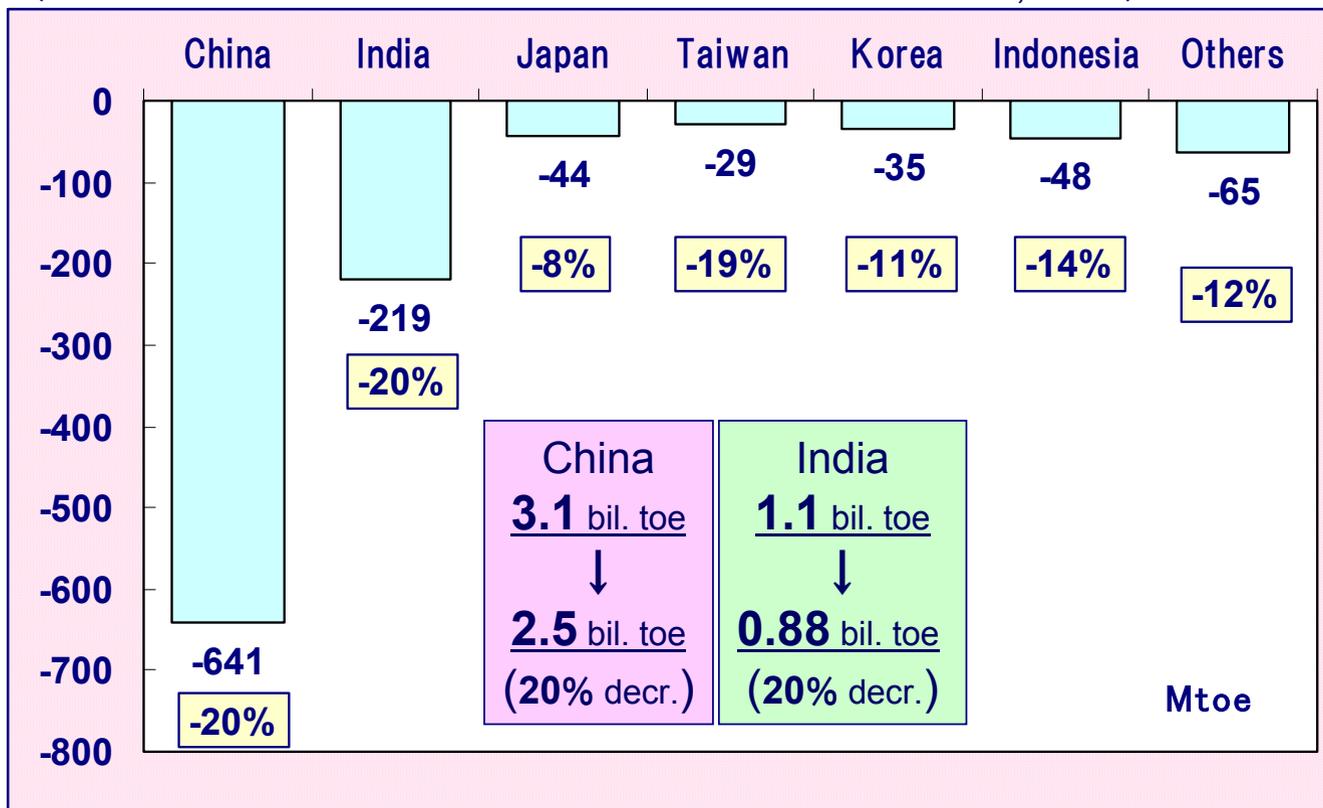
(Difference between Reference and Tech. Adv. scenario , 2030)



- *Coal consumption could be largely reduced by introducing highly efficient technology and clean coal technology (CCT)*
- *Enhancing efficiency in transport sector contributes to reduce oil consumption in Asia ,and is expected to stabilize international oil market*

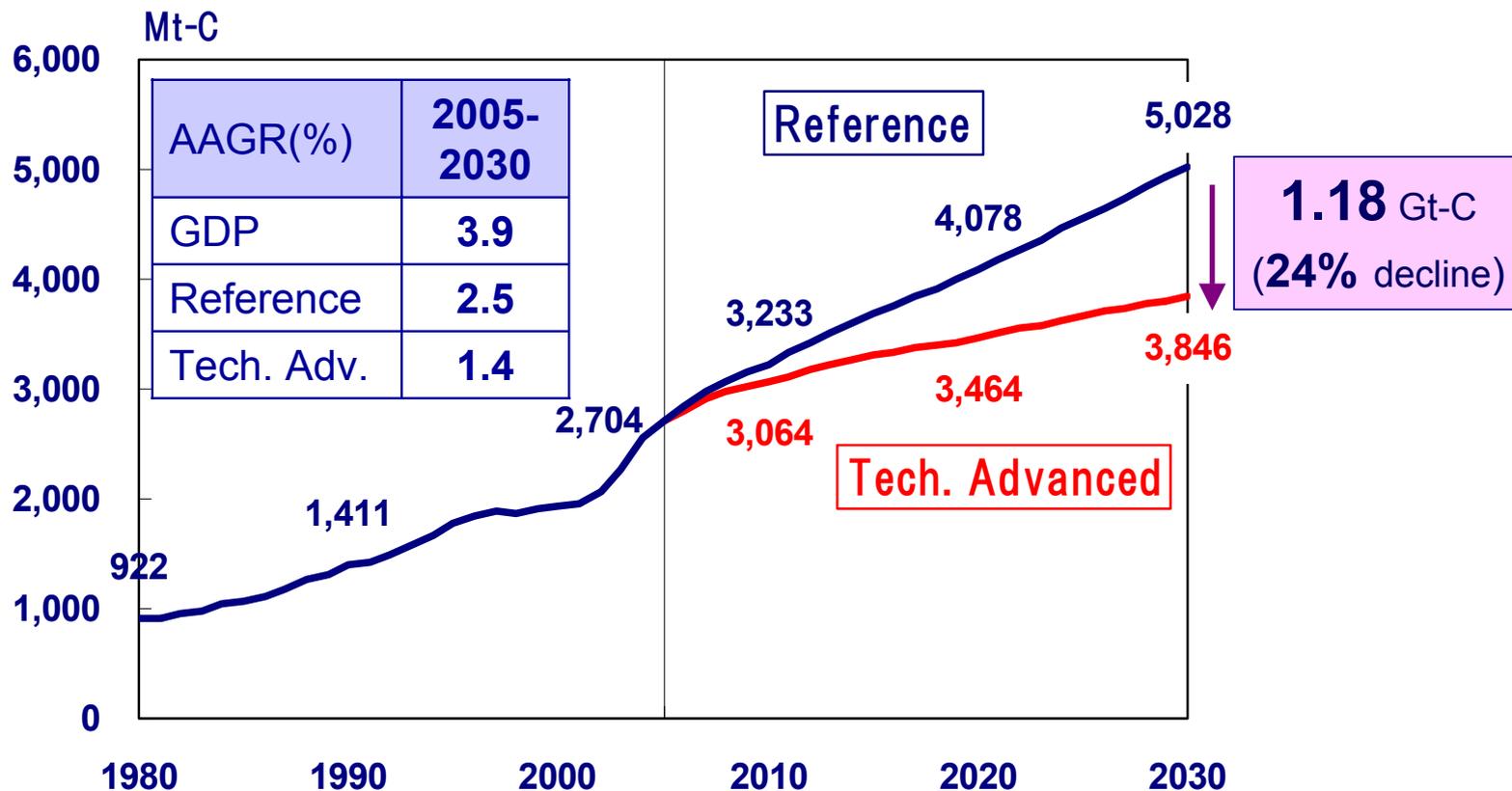
Change in Energy Demand by Region (Asia)

(Difference between Reference and Tech. Adv. scenario , 2030)



Potential of energy conservation is large in both China and India through enhancing energy consumption efficiency

CO₂ Emission ; Asia



In 2030, mitigation of CO₂ emissions achieves about 24%(1.18 Gt-C)、roughly equivalent to 3.5 times the emission of Japan

Decomposition Analysis of CO₂ Emission

Unit: average annual growth rate, %

		Asia (excluding Japan)			China (2005–2030)		India (2005–2030)	
		1980– 2005	2005–2030		reference	Tech. Advanced	reference	Tech. Advanced
			reference	Tech. Advanced				
CO ₂ change	ΔC	52	28	1.7	24	1.1	3.8	25
Fuel Switching	$\Delta(C/E)$	▲ 0.2	▲ 0.4	▲ 0.8	▲ 0.6	▲ 1.0	▲ 0.5	▲ 0.8
Energy Conservation	$\Delta(E/Y)$	▲ 1.2	▲ 2.0	▲ 2.7	▲ 3.1	▲ 3.9	▲ 1.7	▲ 2.5
GDP Growth	ΔY	6.7	5.3		6.2		6.1	
Energy Consumption ÷ GDP change, %		▲ 26	▲ 39	▲ 50	▲ 54	▲ 63	▲ 34	▲ 48

Decompose CO₂ emissions change into 3 factors

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

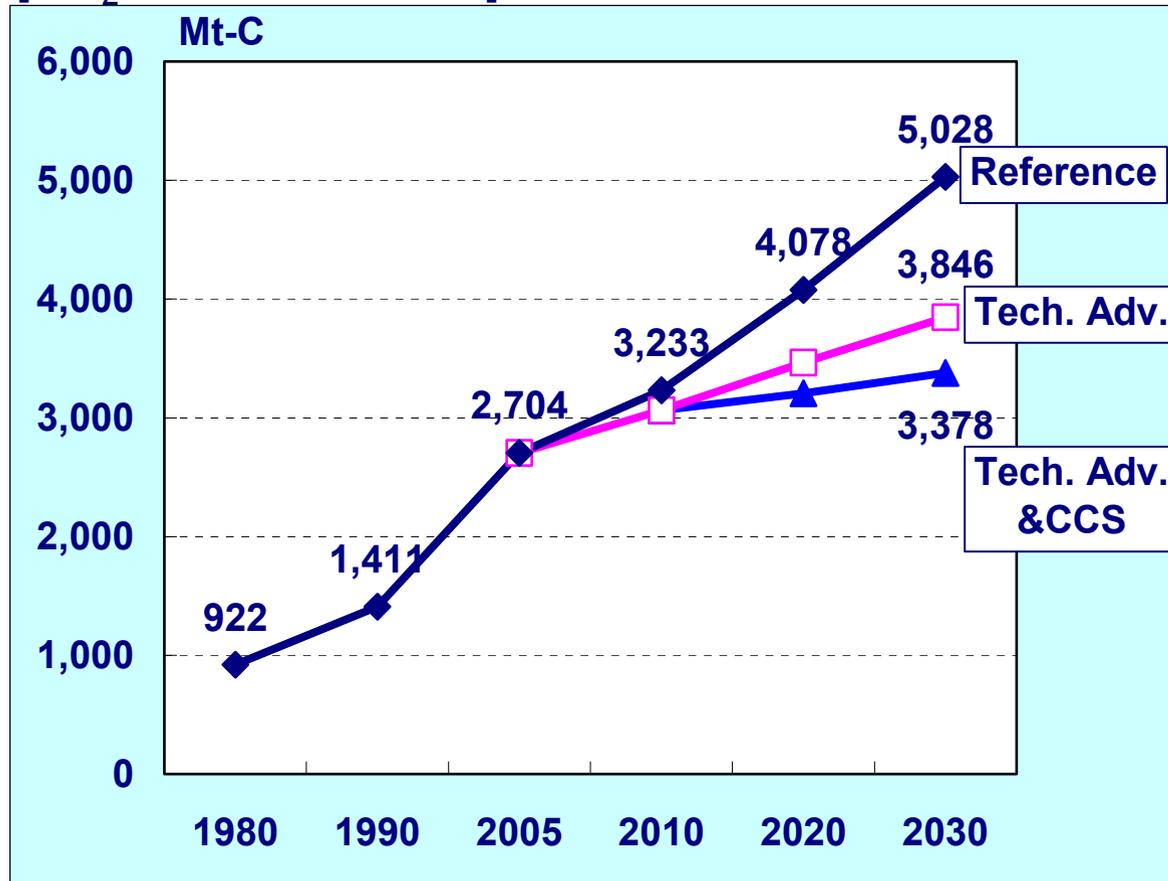
$$\Delta C = \Delta(C/E) + \Delta(E/Y) + \Delta Y$$



Decarbonization Energy Conservation GDP Growth

Role of CCS

[CO₂ Emission in Asia]



Tech. Advanced
1.18 Gt-C decline

+

CCS (capture ratio: 12%)
0.47 Gt-C decline

↓

Tech. Adv. & CCS
1.65 Gt-C decline
(14% of world emission)

Capture ratio
Power gen.: 22%
Industry: 13%
Comm. & Resi.: 8%

In addition to energy conservation and energy substitution, carbon capture and storage (CCS), the diffusion of which is expected in the second half of the 21st century, etc. will be required to restrain CO₂ emission.

Implications

Japan's relationship to China and India in view of energy security and environmental problems

Asian developing countries' fast-increasing CO₂ emissions indicate that the transfer of advanced energy conservation and environmental technologies to these countries to reduce environmental loads would be effective in terms of the cost-benefit analysis for the whole of Asia and contribute to environmental conservation.

*Progress in energy conservation in China and India hold the key to promotion of global energy consumption and measures against global warming. Both countries have great potential to promote energy conservation, but also have many problems to get over. In this view, Japan has a great role to play. In order to harmonize and simultaneously achieve both national and global interests, it should make use of its accumulated know-how, knowledge and technologies for energy assistance (**energy conservation is the most important**) to China and India under its international energy strategy.*

- Transfer of energy-saving and environmental conservation measures*
- Assistance in capacity building towards development of statistical data*
- Transfer of experiences and know-how for development of legal and other institutional system*
- Acceptance of trainees mainly in energy management*

Challenges towards best energy mix (1)

Each country should pursue the best energy mix towards securing the energy supply and environmental conservation, in accordance with its energy demand, energy resources, technological and economical situations, etc. Moreover, the best energy mix in the whole Asia should be sought for through the assistances of many countries.

Oil:

Asia has no room to substantially expand oil production and will have to depend on imports for as much as 84% of its oil demand in 2030. Covering some 80% 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 demand rise will be the key to the stability of international oil market.

Natural gas:

Asian natural gas production will peak out while gas demand will increase in the electricity generation and consumer sectors. Therefore, demand will expand for LNG and gas transported from Russia and central Asia via pipelines. As with oil, continuous investment in production and transportation capacities will be the key to the stability of the gas supply.

Challenges towards best energy mix (2)

Coal:

Demand will increase for cheap coal for electricity generation. In order to prevent global warming, clean coal technologies will have to be developed and introduced. At the same time, efforts should be made to commercialize carbon capture and storage technologies.

Nuclear power:

Nuclear energy will play a great role in Asia that has limited room to expand energy supply in spite of fast-growing demand. In order to help prevent global warming, it should be introduced as a stable core energy resource more and more, along with safety-enhancing technologies.

Renewable energies:

Renewable energies are mostly produced domestically and are an important option among measures against global warming. Particularly, introduction of bioethanol and biodiesel, along with the improvement in automobiles' fuel efficiency, is expected to help reduce carbon dioxide emissions in the transportation sector. Asian countries should enhance systems for practical and efficient promotion of renewable energies and introduce innovation-supporting policies to further expand use of renewable energies.

Japan's desirable measures and strategy

The measures that Japan should take from the perspective of energy security will center on preemptive ones which will prevent various problems in China and India from emerging. These include :

- (1) promotion of policy talks,*
- (2) energy conservation assistance,*
- (3) environmental technology assistance,*
- (4) assistance in diversification of energy sources and expansion of energy supply capacity, and*
- (5) assistance in stockpiling oil.*

Japan may be able to utilize its accumulated know-how and technologies for such a wide range of measures, most of which are also effective for environmental conservation. Particularly, Japan's assistance to other Asian countries is important in energy conservation, environmental conservation technologies and expansion of clean energy supply.

Regarding environmental conservation, the most important issue is to incorporate the two big greenhouse emitters into an international framework. A post-Kyoto Protocol framework should cover all major greenhouse gas emitters while securing fairness, effectiveness and efficiency.

Conclusion

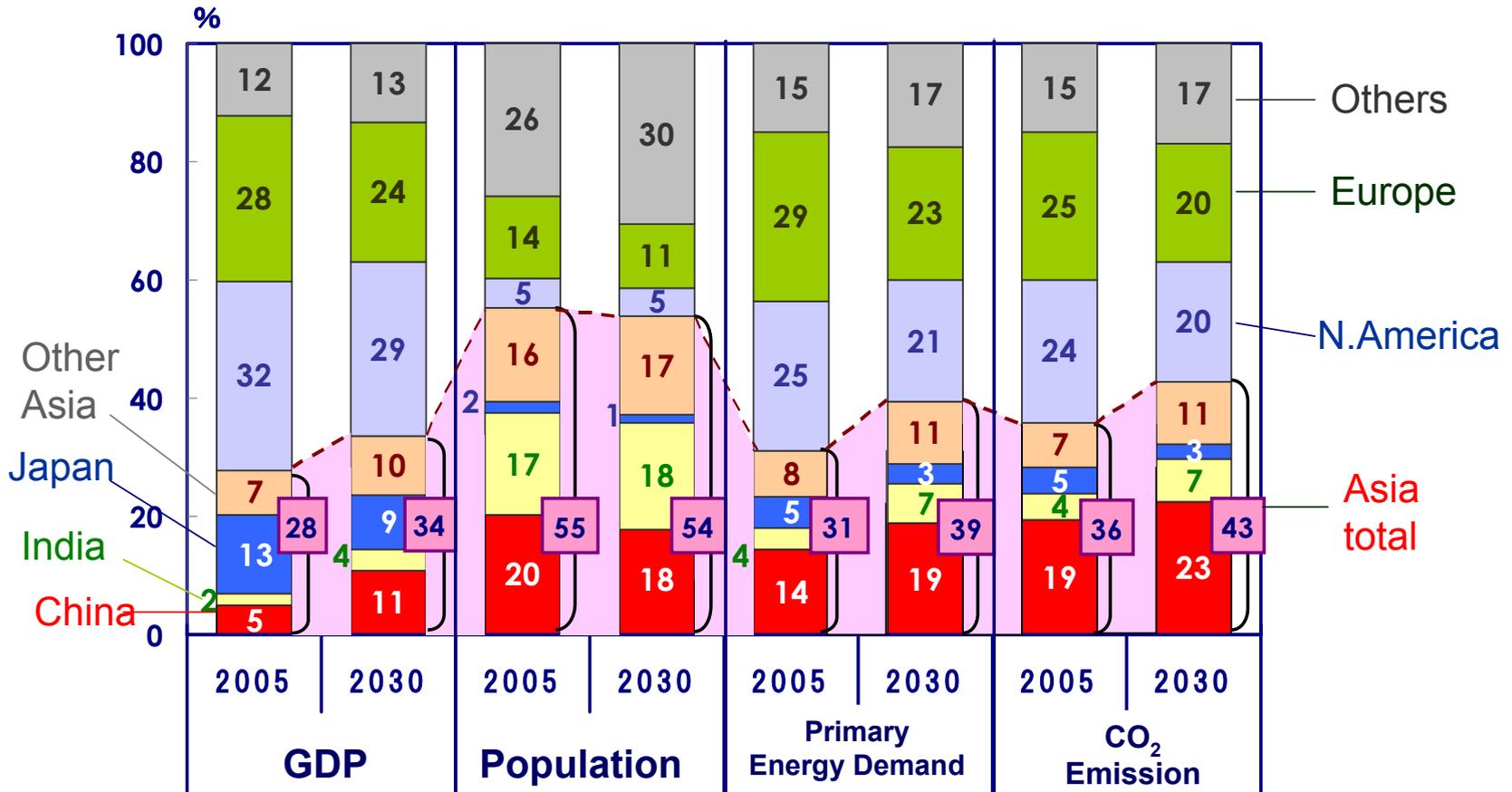
For Asia to simultaneously achieve its “3S” goals (security of supply; sustainability by solving global environmental problems; and stability of the market), each Asian country, in a manner that befits the energy supply-demand structure of the country and the prevailing state of economic development, 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 the context of these efforts, Japan will have a tremendous role to play in Asia, with its advantages in terms of technology, economic power and legislative design. Of pivotal importance in the context of Japan’s international energy strategy will be our efforts to further develop and utilize energy-saving and environmental preservation technologies, in which we already excel, as well as the technologies and know-how unique to Japan which is a leading country in the area of nuclear power generation. With these advanced energy-conservation and environmental technology, it is crucial for Japan to support the advancement of its economy through extensive use of its undepletable resource - its technology, and to contribute to Asian economy and environment.

<Appendix>

<Appendix> Importance of Asia in World Economy and Energy Economics



- Asian share of GDP expands from 28%(2005) to 34% (2030), primary energy demand from 31% (2005) to 39%(2030), and CO₂ emissions from 36% (2005) to 43%(2030).
- Asian population remains about 50% in the world.

Technological Advanced Scenario

In technological advanced scenario, we develop energy demand projection where Asian countries implement various energy and environmental policy to secure energy supply and mitigate carbon dioxide emissions

Basically, these policies are assumed reflecting on actual policy in each Asian country. In country where concrete energy policy does not exist, we assume that energy efficiency improve more rapidly than reference case due to technology transfer from developed countries.

Assumed measures:

■ Energy conservation in industry and residential/commercial sector

High efficiency boiler, Coke Dry Quenching equipment(CDQ), Top Gas Pressure Recovery Turbine(TRT), IT-based energy management system, Thermal insulation, High efficiency heat pump etc.

■ Energy-efficiency in transport sector

Hybrid-vehicle, ITS(Intelligent Transport System) etc.

■ Renewables

Bio-fuel for automobile, photovoltaic, Wind-power, Biomass power generation etc.

■ Nuclear

Building new nuclear power plant, Enhancement of operating ratio and safety control etc.

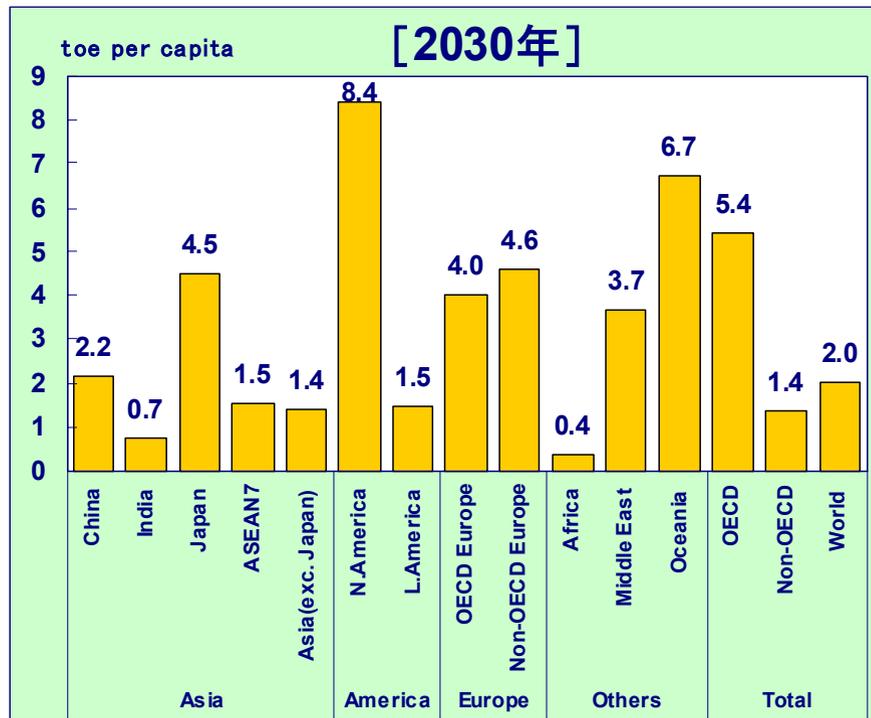
■ Energy-efficiency in power generation sector

Coal-fired IGCC/IGFC, Gas-fired MACC etc.

<Appendix> Primary Energy Demand Per Capita

(toe per capita)

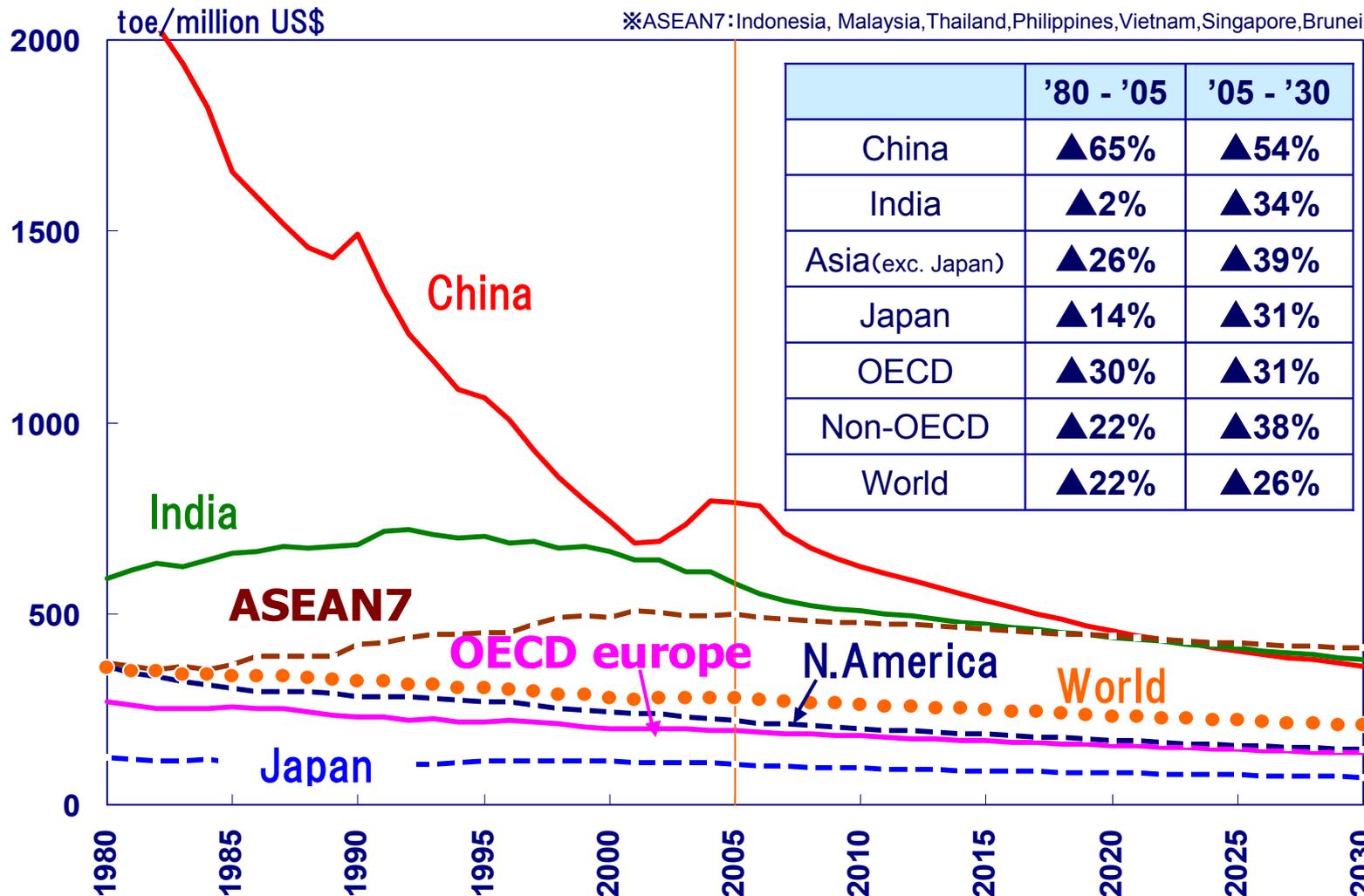
	1980	2005	2030
China	0.4	1.1	2.2
India	0.1	0.3	0.7
Japan	3.0	4.2	4.5
Korea	1.1	4.4	6.3
Taiwan	1.6	4.6	6.8
Indonesia	0.2	0.6	1.2
Malaysia	0.8	2.3	3.6
Philippines	0.3	0.4	0.7
Thailand	0.3	1.3	3.2
Vietnam	0.1	0.3	1.0
N.America	8.0	7.9	8.4
OECD Europe	3.2	3.5	4.0
OECD	4.2	4.8	5.4
Non-OECD	0.7	0.9	1.4
World	1.5	1.6	2.0



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

- Energy demand per capita increases as the lifestyle improves.
- Even in 2030, energy demand per capita remains relatively small as compared with OECD countries.

<Appendix> Primary Energy Demand per GDP, 2005



- Energy demand per GDP improves steadily. In asian countries, it remains larger than in OECD countries.

<Appendix> Primary Energy Demand per GDP, 2005

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

