6th Meeting The Energy Charter

Task Force on Regional Cooperation
July 9, 2010　Ulaanbaatar, Mongolia

Multilateral Cooperation and Best Practices Scenario

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

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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.

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

● **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

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

This scenario develops future picture which assumes;

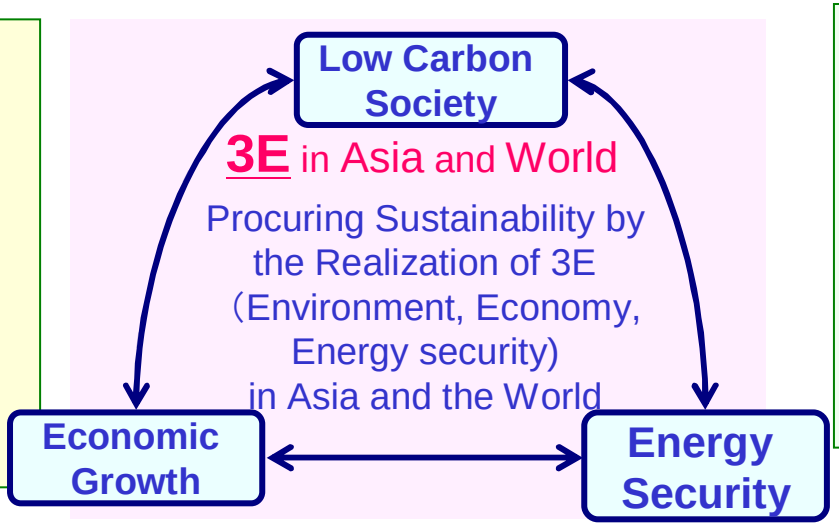
- Accelerated R&D encourages global deployment of advanced technology.
- Global technology cooperation and technology transfer from developed to developing countries are promoted.
- All the countries of the world take technological advanced measures in order to secure energy demand and supply.

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 addressing 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.

- ■Accelerate R&D for Advanced Technology towards 2030 & 2050
- ■Transfer low carbon technology and knowledge on building energy policy to other countries.
- ■Achieve economic growth by establishing new energy & environmental industry

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

2020 2030 2035 2050

- ・Nuclear
- ・Solar PV, Wind, Bio-fuel
- ・Environmentally compatible use of fossil fuel
  - Clean Coal Technology
  - MACC
- ・Clean Energy Vehicles (Plug-in Hybrid Vehicles、EV)
- ・Battery technology、Power electronics .
- ・Fuel Cell
- ・Heat-Pump
- ・Smart Grid, Smart Meter

Energy demand expansion

Risk of extraordinary price escalation of fossil fuel

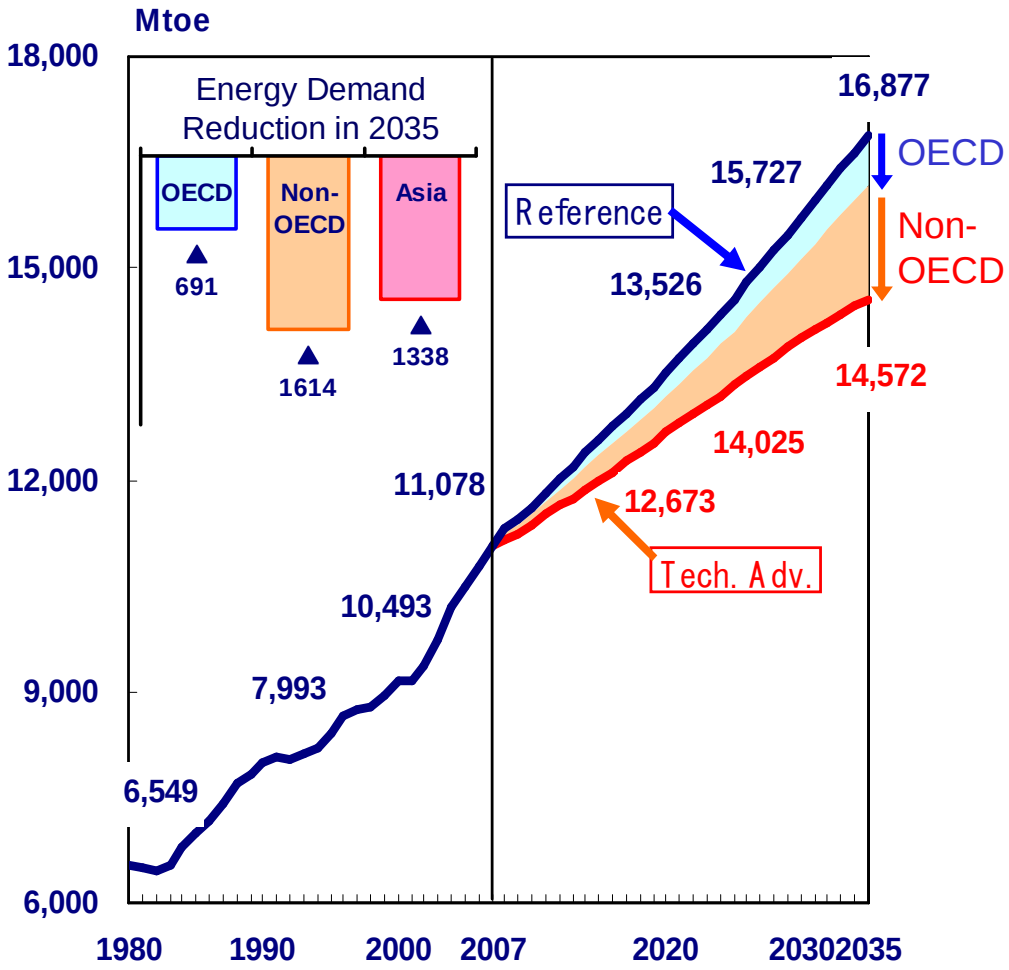
Innovative technology

Low carbon technology ⇒Sustainable economic growth

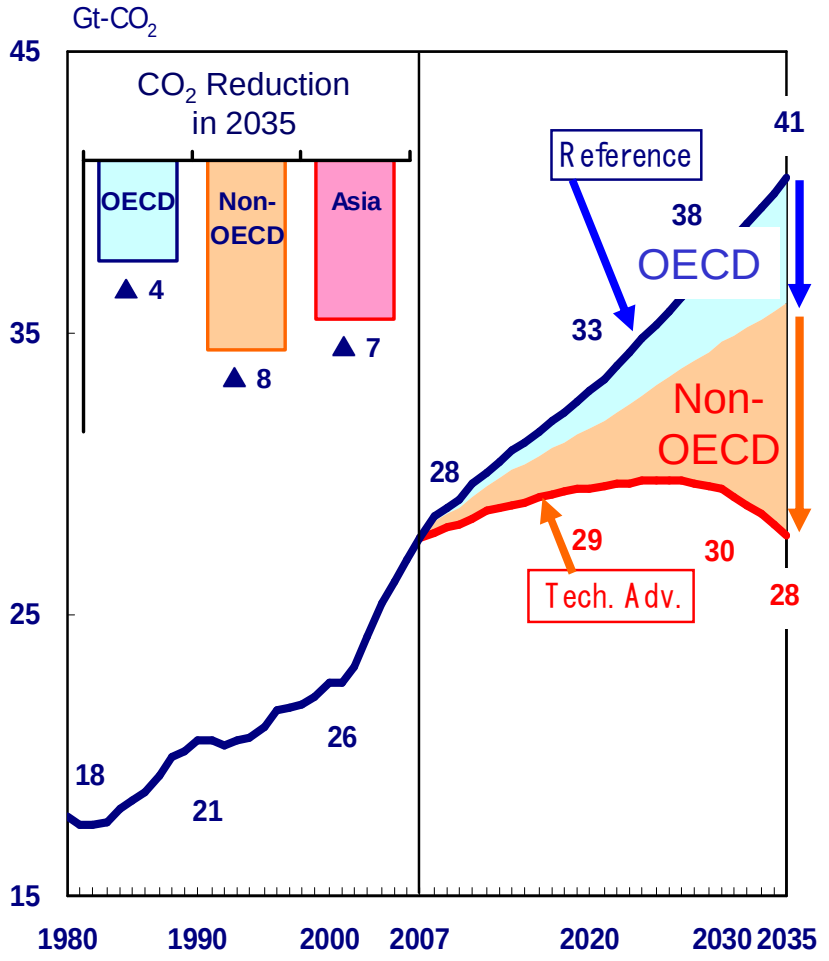
- ・Fast Breeder Reactor(FBR)
- ・Innovative industrial process
- ・Geo-engineering
- ・Distributed energy system
- ・Low carbon town
- ・Hydrogen society
- ・3R (reuse, reduce, recycle) technology

Primary Energy Demand & CO_2 Emissions

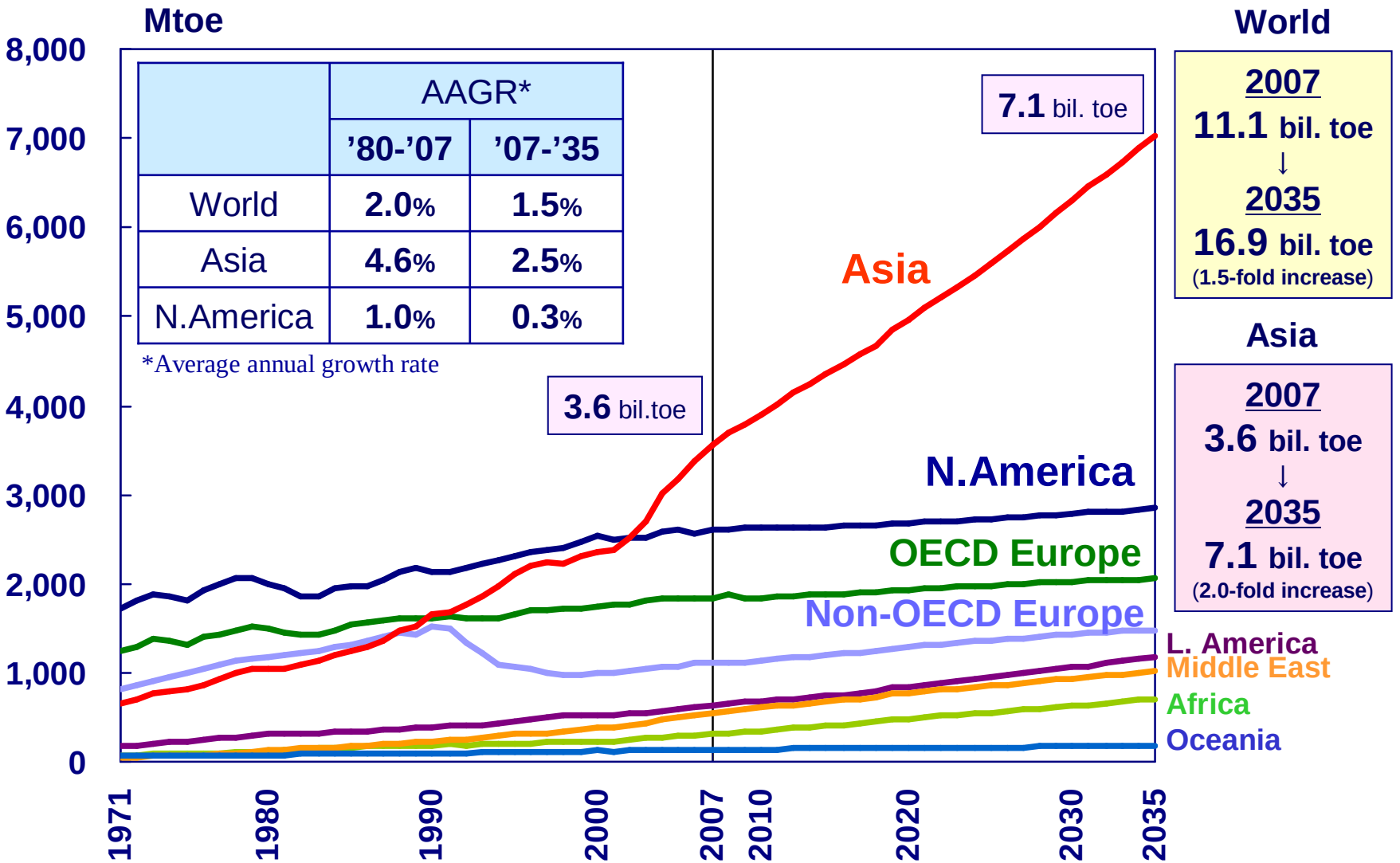
Primary Energy Demand



CO_2 Emissions



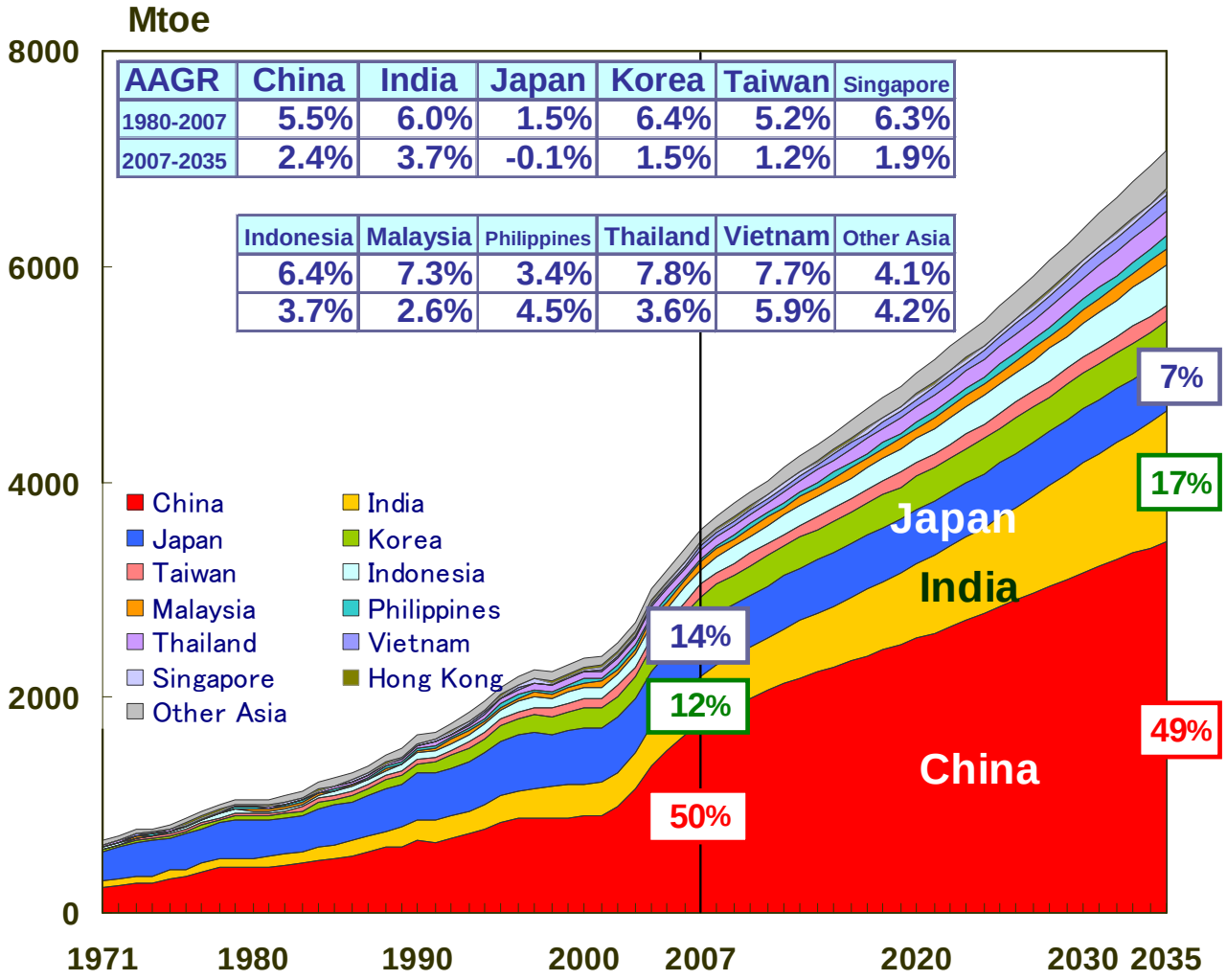
Primary Energy Demand by Region ; World



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

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

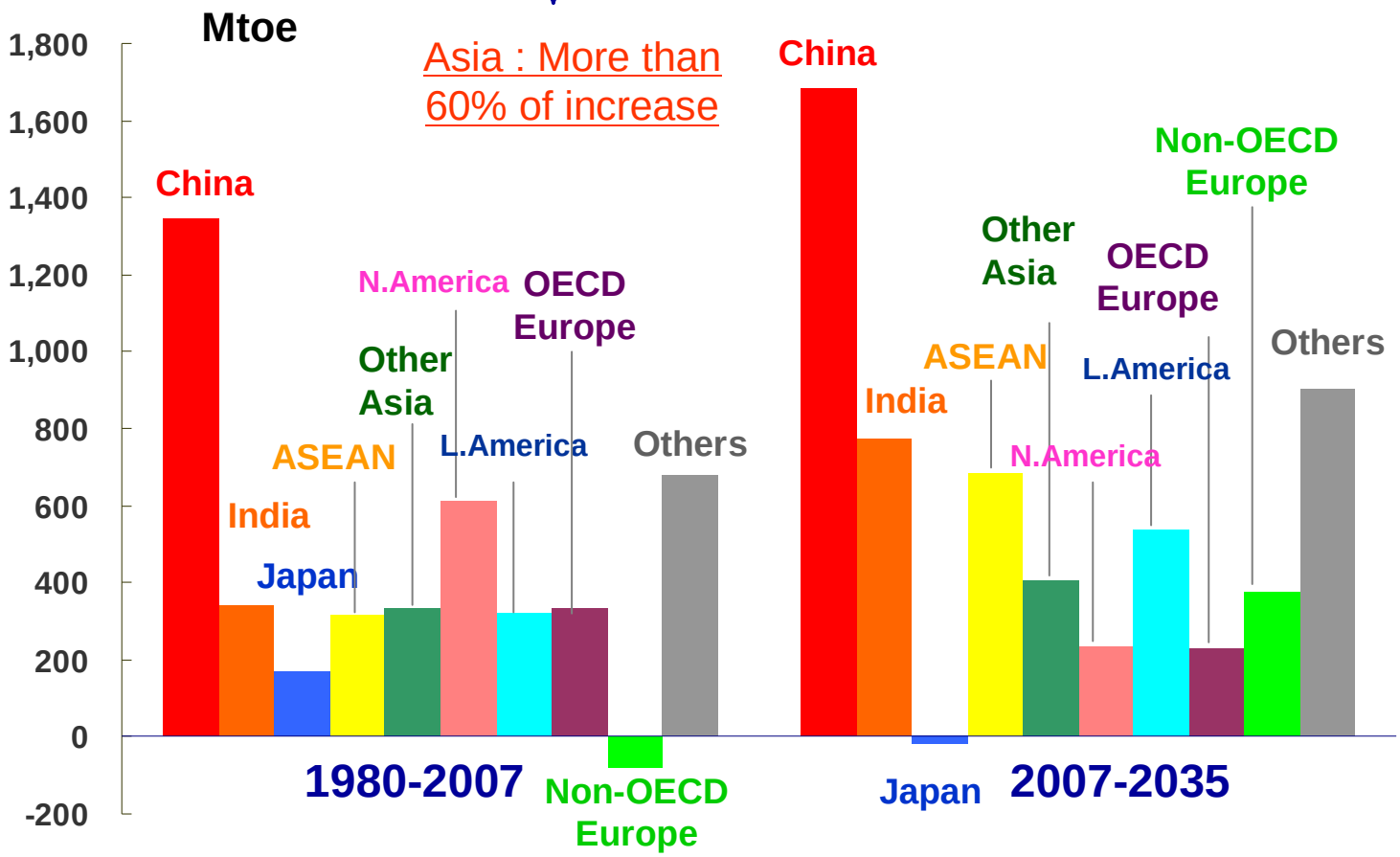
2007
1.8 bil. toe / 0.4 bil. toe
↓
2035
3.5 bil. toe / 1.2 bil. toe
(1.9-fold inc. / 2.8-fold inc.)

- Based on booming economic growth, the share of China and India in Asian primary energy demand will significantly increase 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

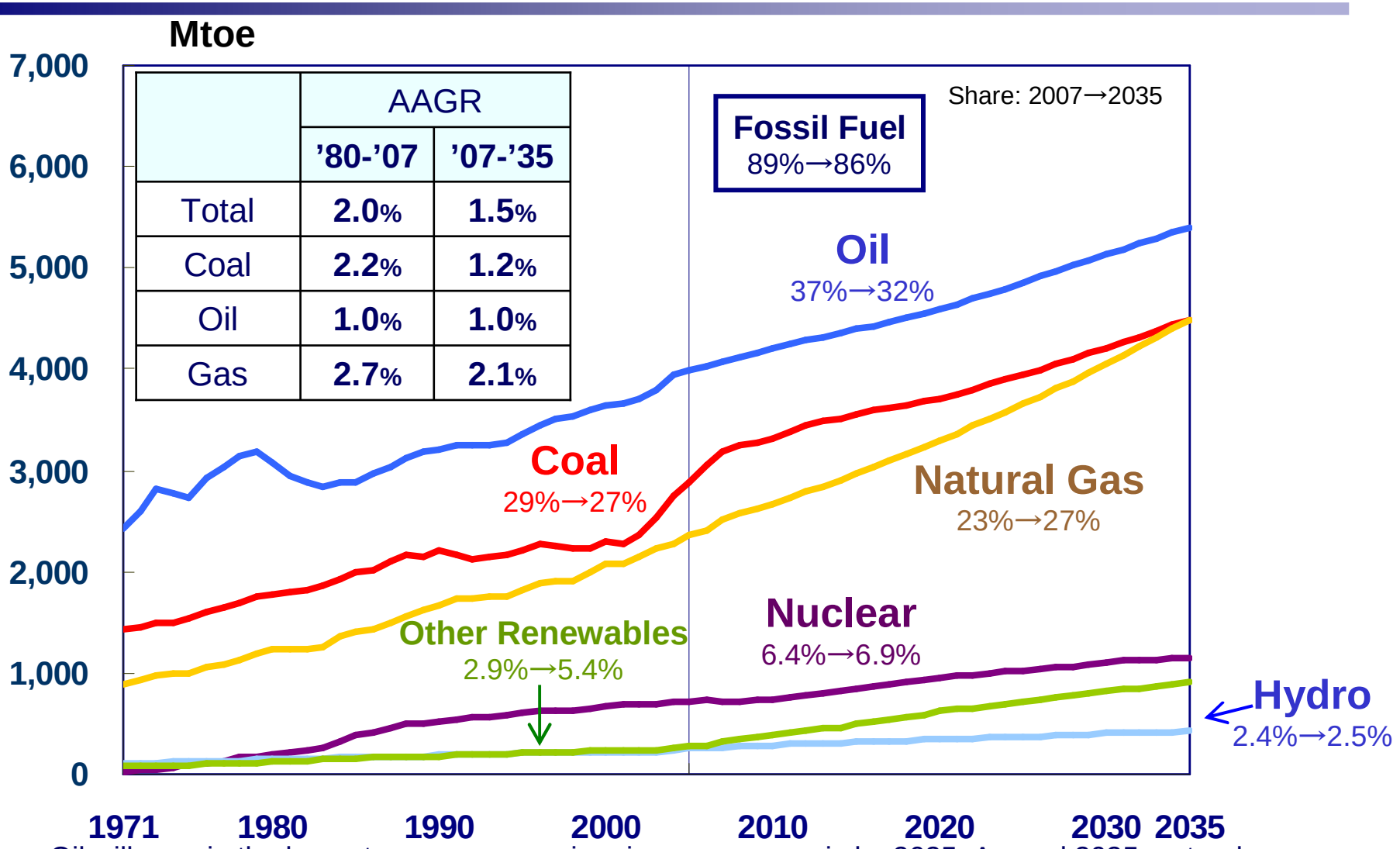
Share in increase, 2007-2035

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%.

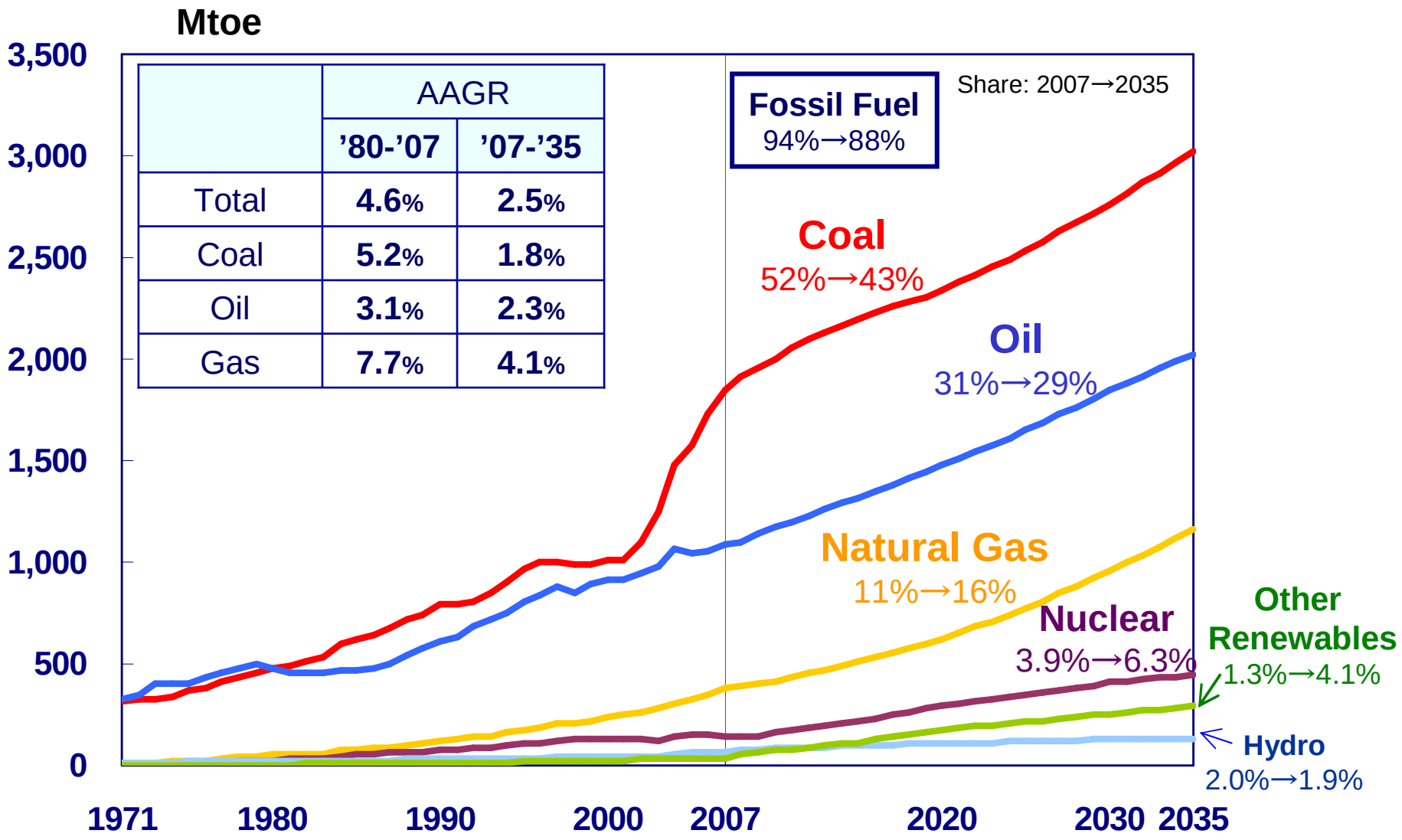
Primary Energy Demand by Fuel ; World



■ Oil will remain the largest energy source in primary energy mix by 2035. Around 2035, natural gas demand will grow with its future extensive use in various sectors, eventually catching up 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.

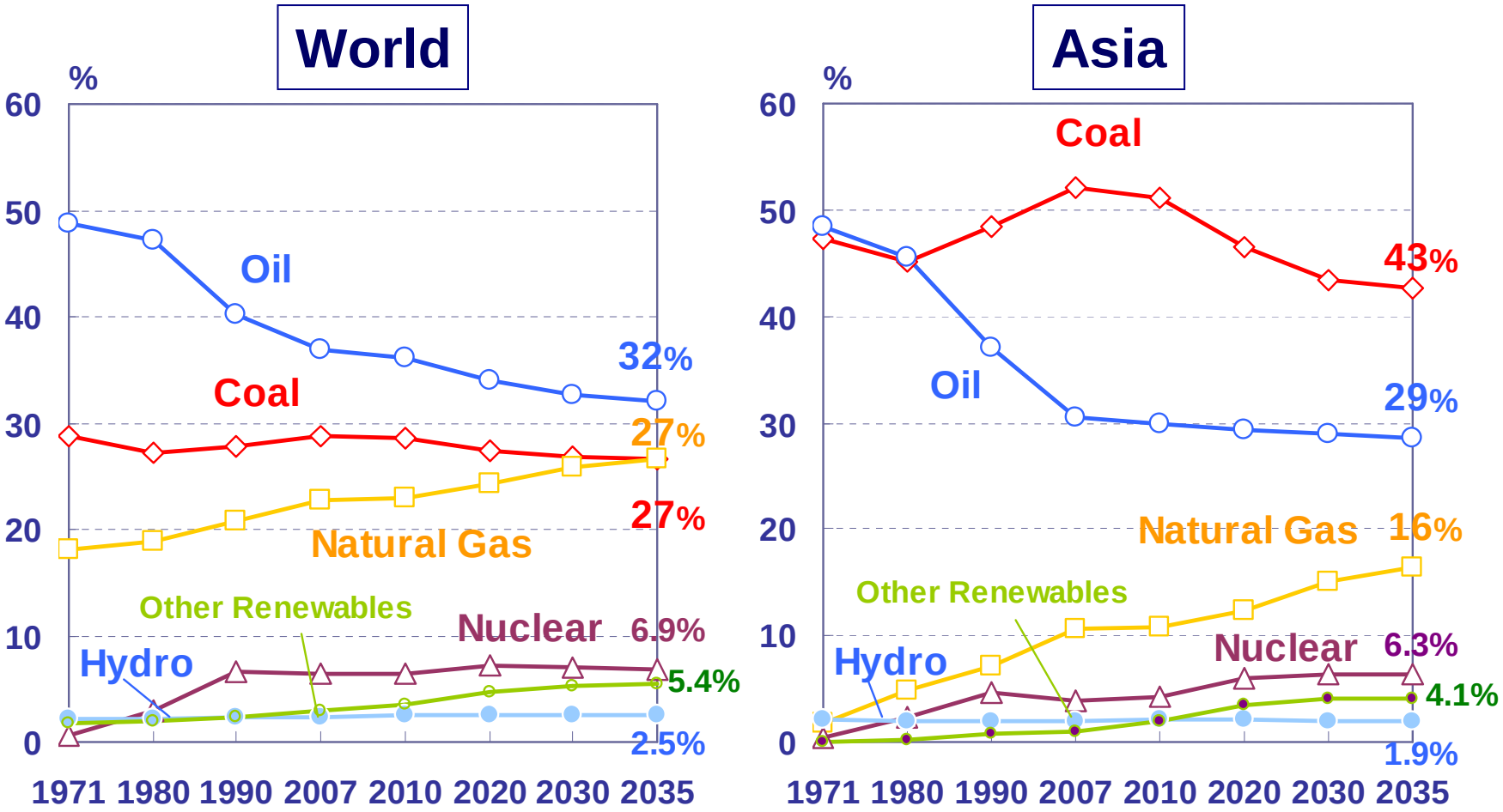
Primary Energy Demand by Fuel ; Asia



■ 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

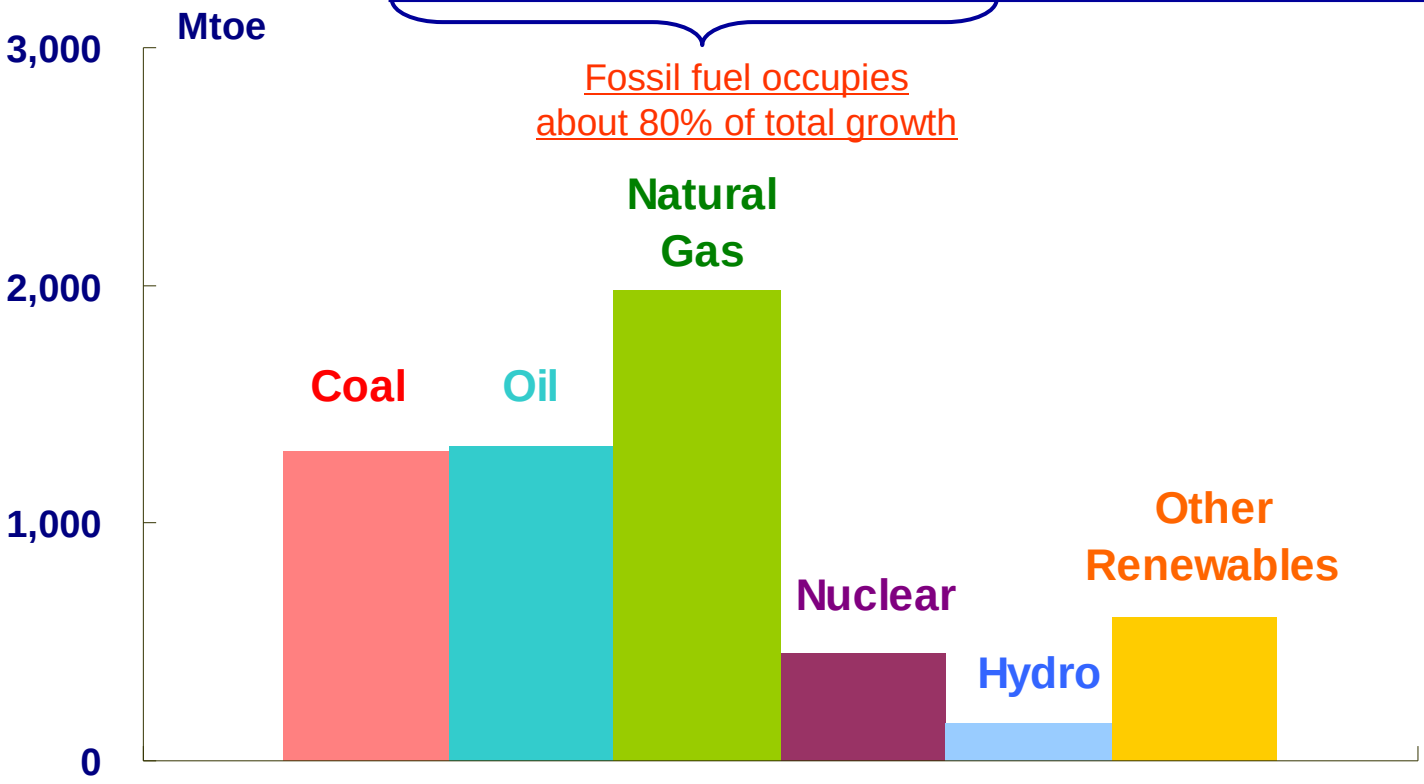


- In Asia, coal remains the largest of primary energy source reflecting on boosting electric power demand by 2035. Coal share in Asia: 2007: 52%→2035: 43%
- Nuclear share in Asia gradually expands with active building-up of nuclear power plants in China, India, Japan and South Korea.

Increase in Primary Energy Demand by Fuel ; World

2007-2035 Increase

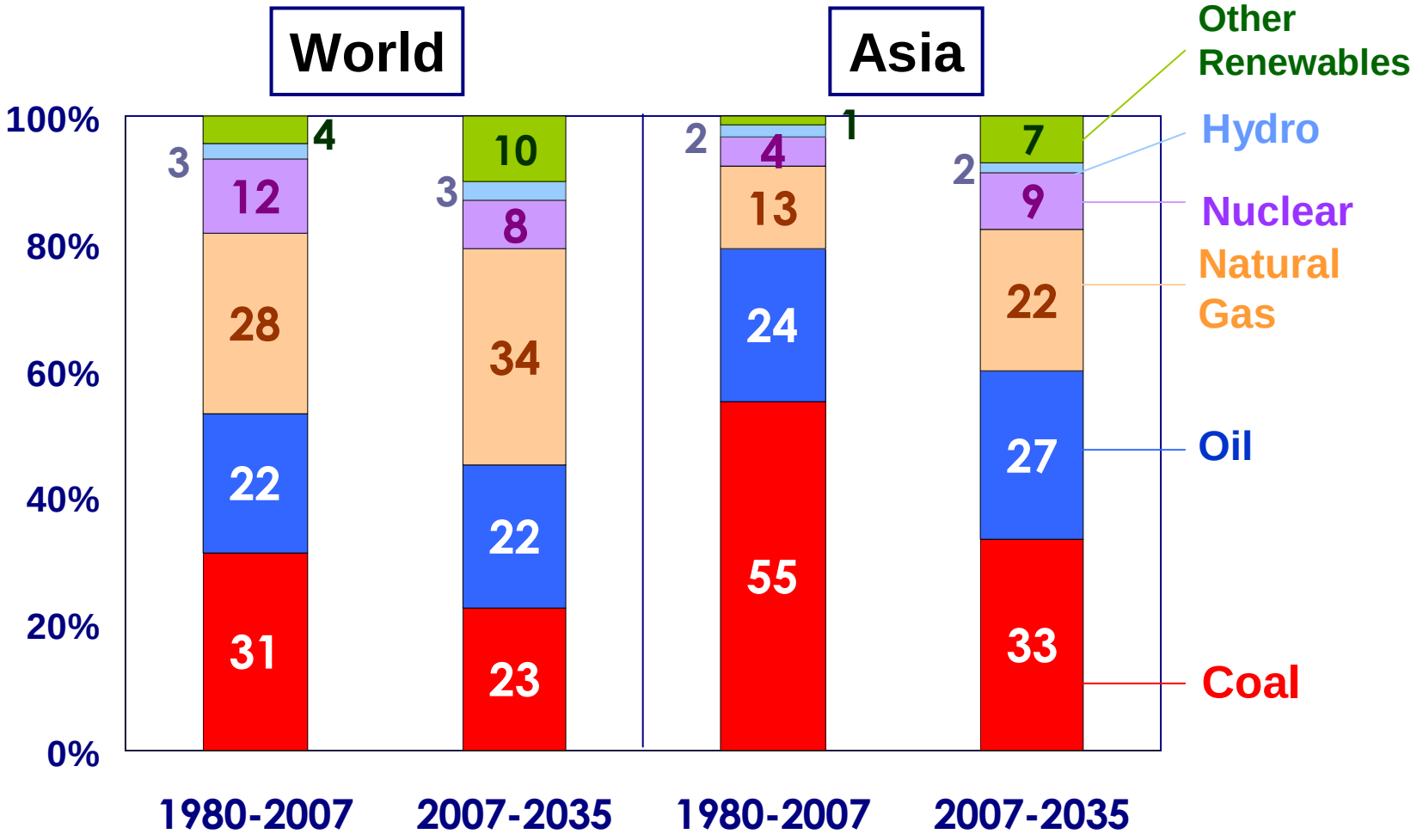
Coal	Oil	Gas	Nuclear	Hydro	Other Renewables
23 %	**22 %**	**34 %**	**8 %**	**3 %**	**10 %**



Increase from 2007 to 2035

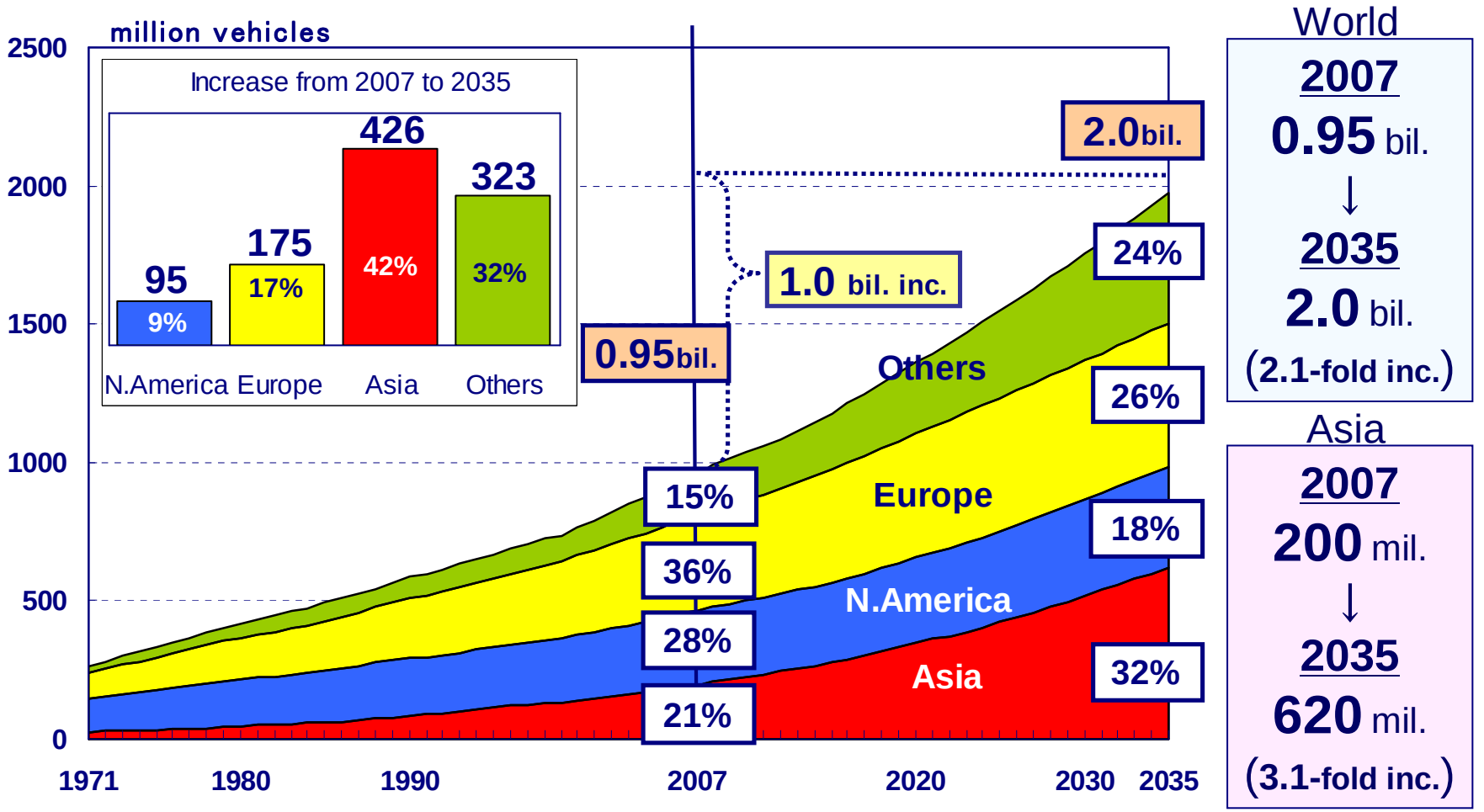
- 79% of global energy growth by 2035 will be concentrated on fossil fuels
- Fossil fuel demand growth to 2035 in Non-OECD will be responsible for about 90% of global fossil demand increasing.

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.

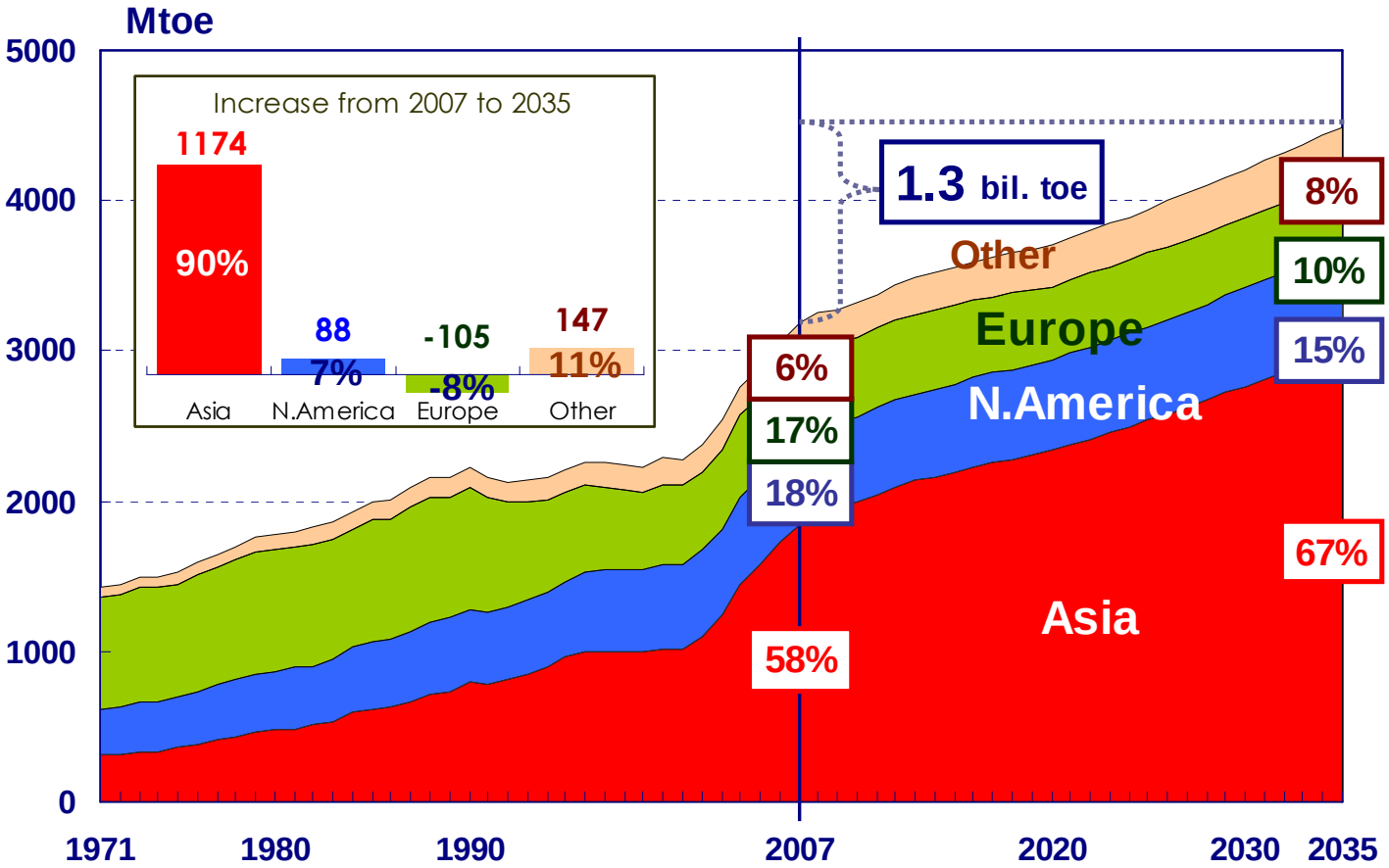
Number of Vehicles ; World



■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.

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

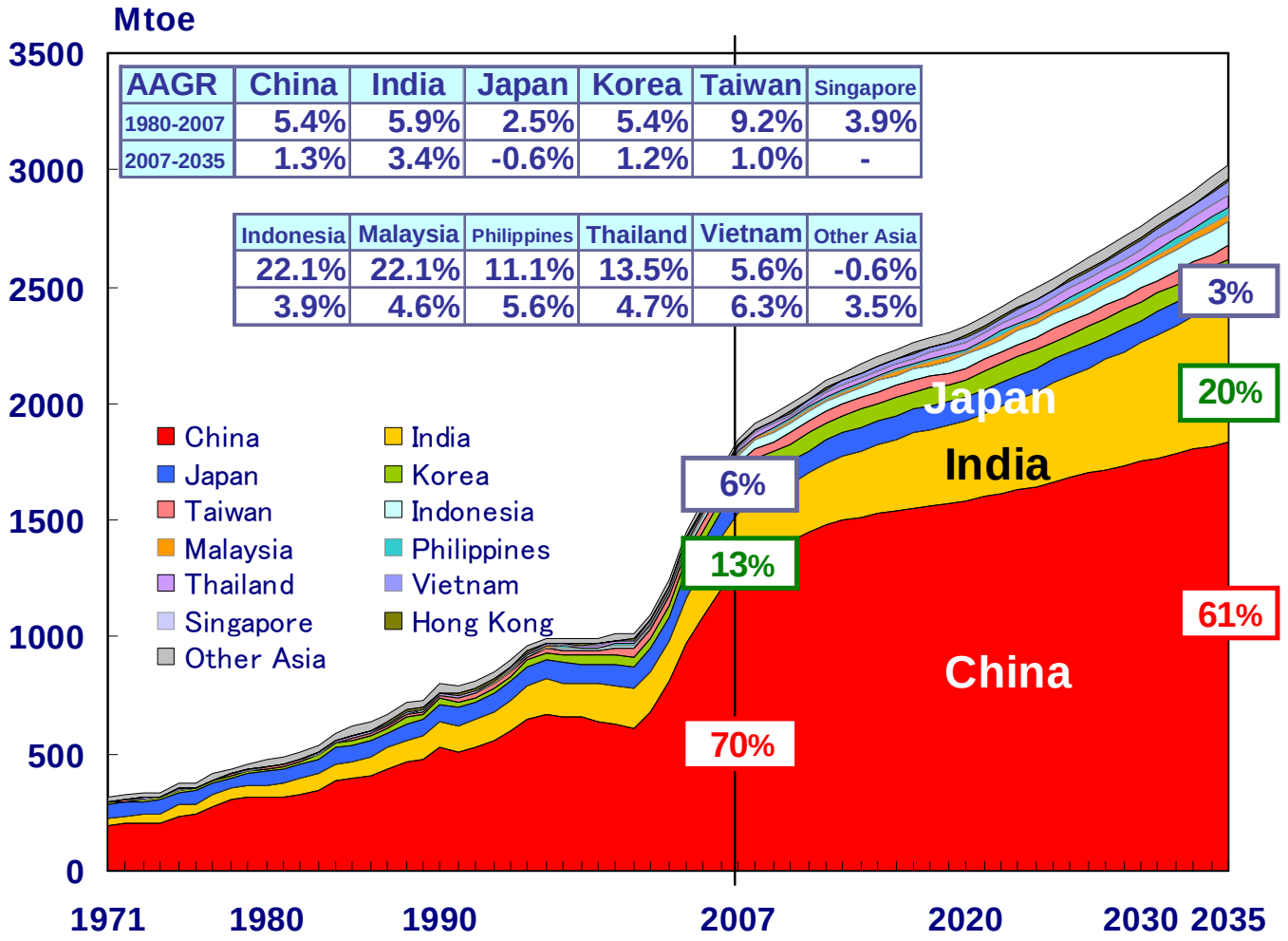
(1.8 billion tce inc.)

*Tons of coal equivalent

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

■ 35% of the increase in global CO2 emissions from 2007 to 2035 comes 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



AAGR	China	India	Japan	Korea	Taiwan	Singapore
1980-2007	5.4%	5.9%	2.5%	5.4%	9.2%	3.9%
2007-2035	1.3%	3.4%	-0.6%	1.2%	1.0%	-

Indonesia	Malaysia	Philippines	Thailand	Vietnam	Other Asia
22.1%	22.1%	11.1%	13.5%	5.6%	-0.6%
3.9%	4.6%	5.6%	4.7%	6.3%	3.5%

2007

1.8 billion toe

(2.6 billion tce)

↓

2035

3.0 billion toe

(4.3 billion tce)

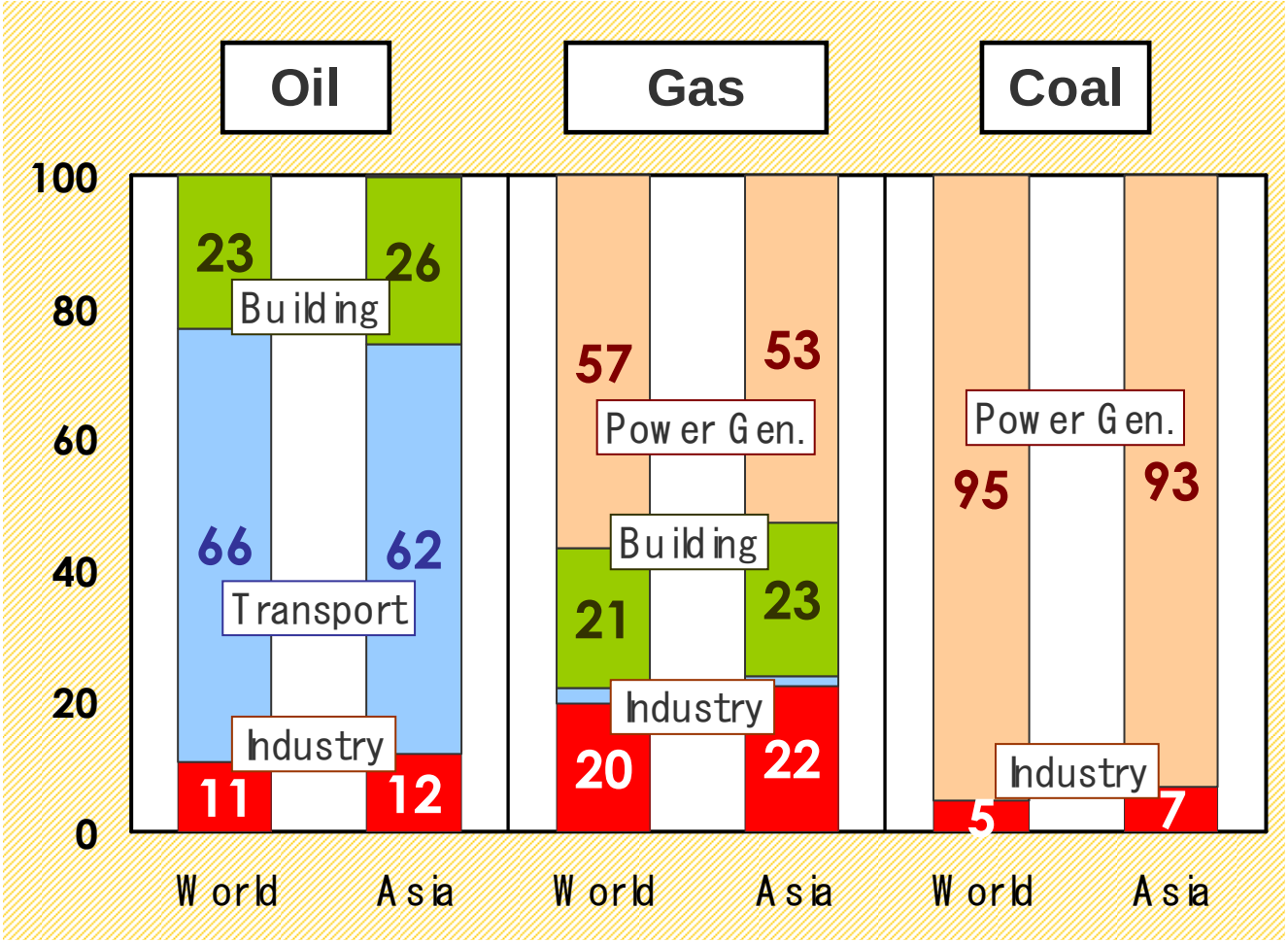
1.7-fold increase

(1.7 bil. tce inc.)

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 domestic reserves

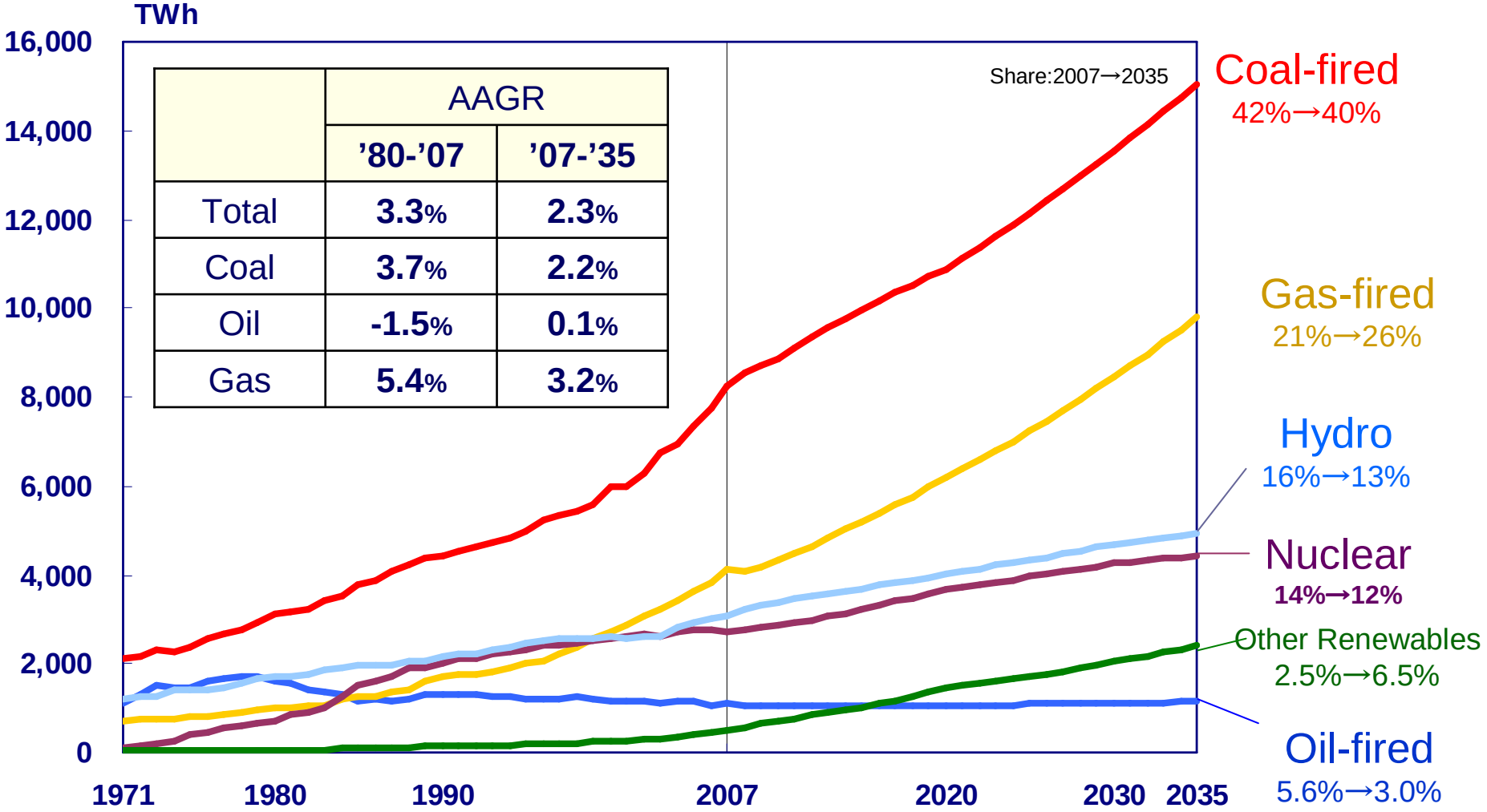
Increase in World Fossil Fuel Demand by Sector

【Increase by sector,2007-2035】



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

Power Generation Mix by Fuel ; World

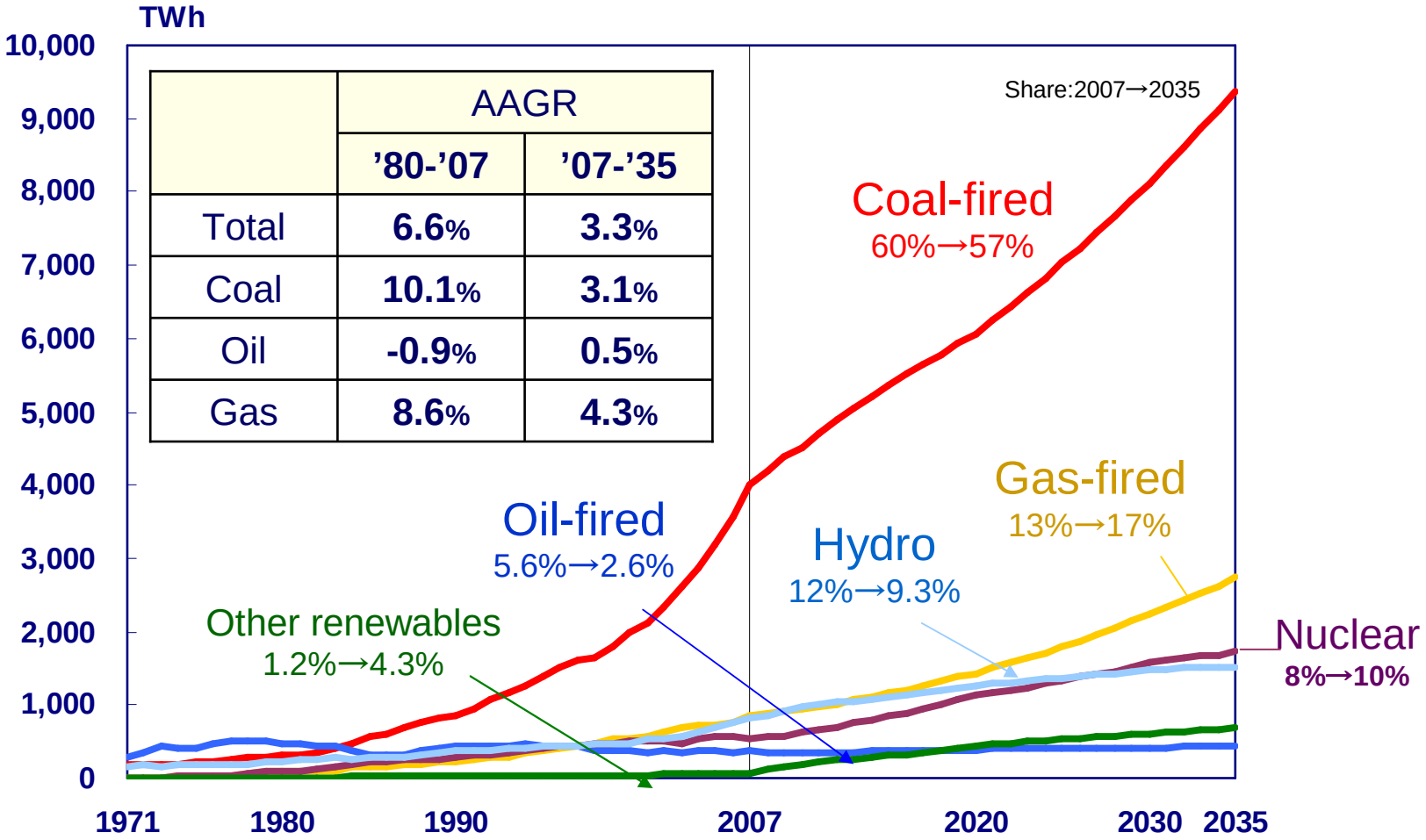


	AAGR	
	'80-'07	'07-'35
Total	3.3%	2.3%
Coal	3.7%	2.2%
Oil	-1.5%	0.1%
Gas	5.4%	3.2%

■Coal-fired power generation still remains dominant power supply option by 2035. Natural gas-fired power generation is projected to increase significantly worldwide at 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

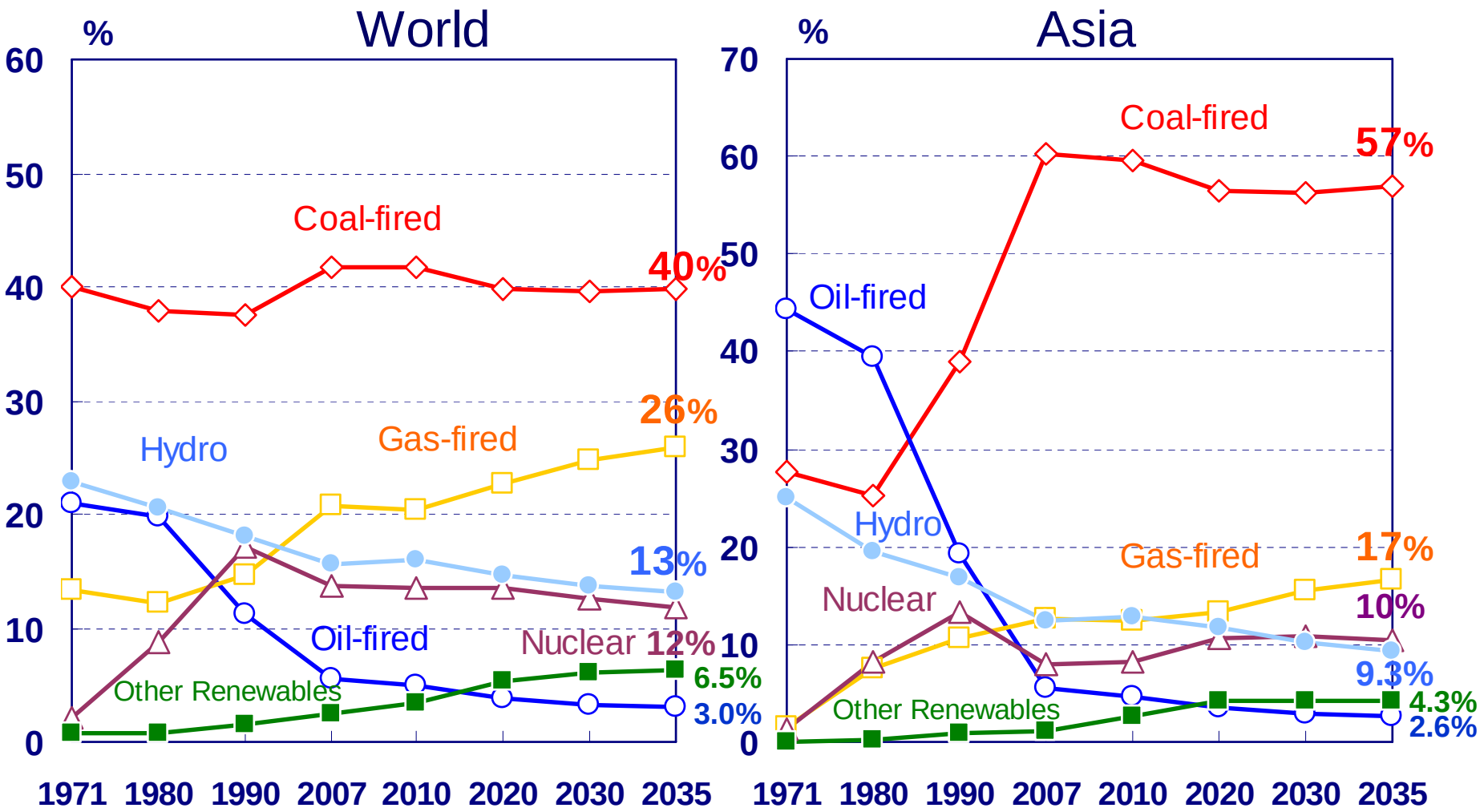
Power Generation Mix by Fuel ; Asia



■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 17% by 2035. The share of nuclear power generation will increase from 8% to 10%; Nuclear plays a important roll in power generation mix.

■ CO2 emissions from coal-fired generation in Asia will expand by 3.8 Gt-CO2 from 2007 to 2035, this growth being about 30% of global CO2 emissions increase.

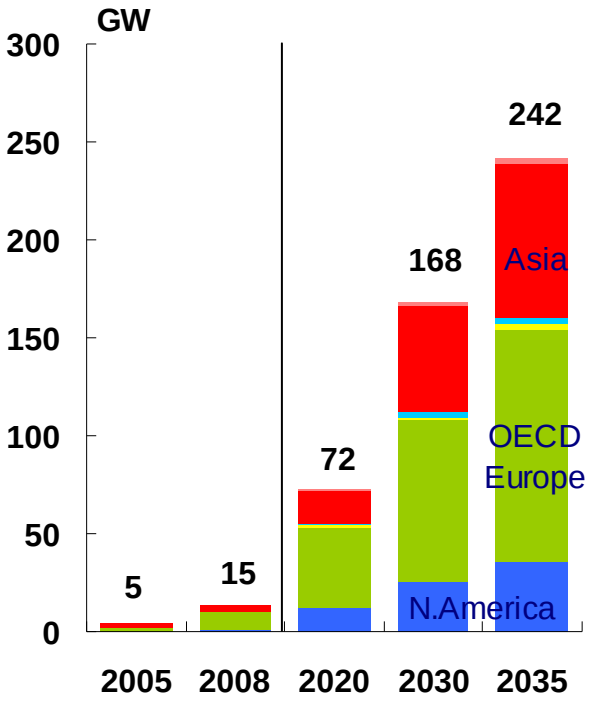
Power Generation Mix by Fuel ; World and Asia



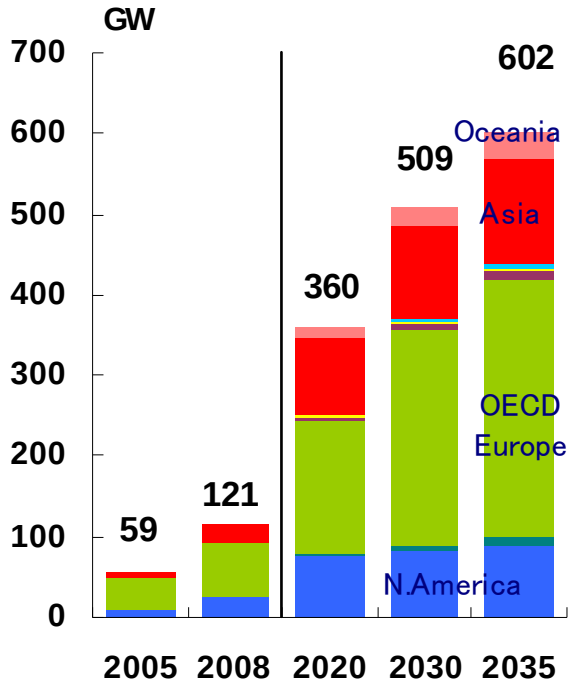
Coal-fired power plant is indispensable power supply option in both world and Asia with its economic advantages and the stable availability of its input fuel.

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

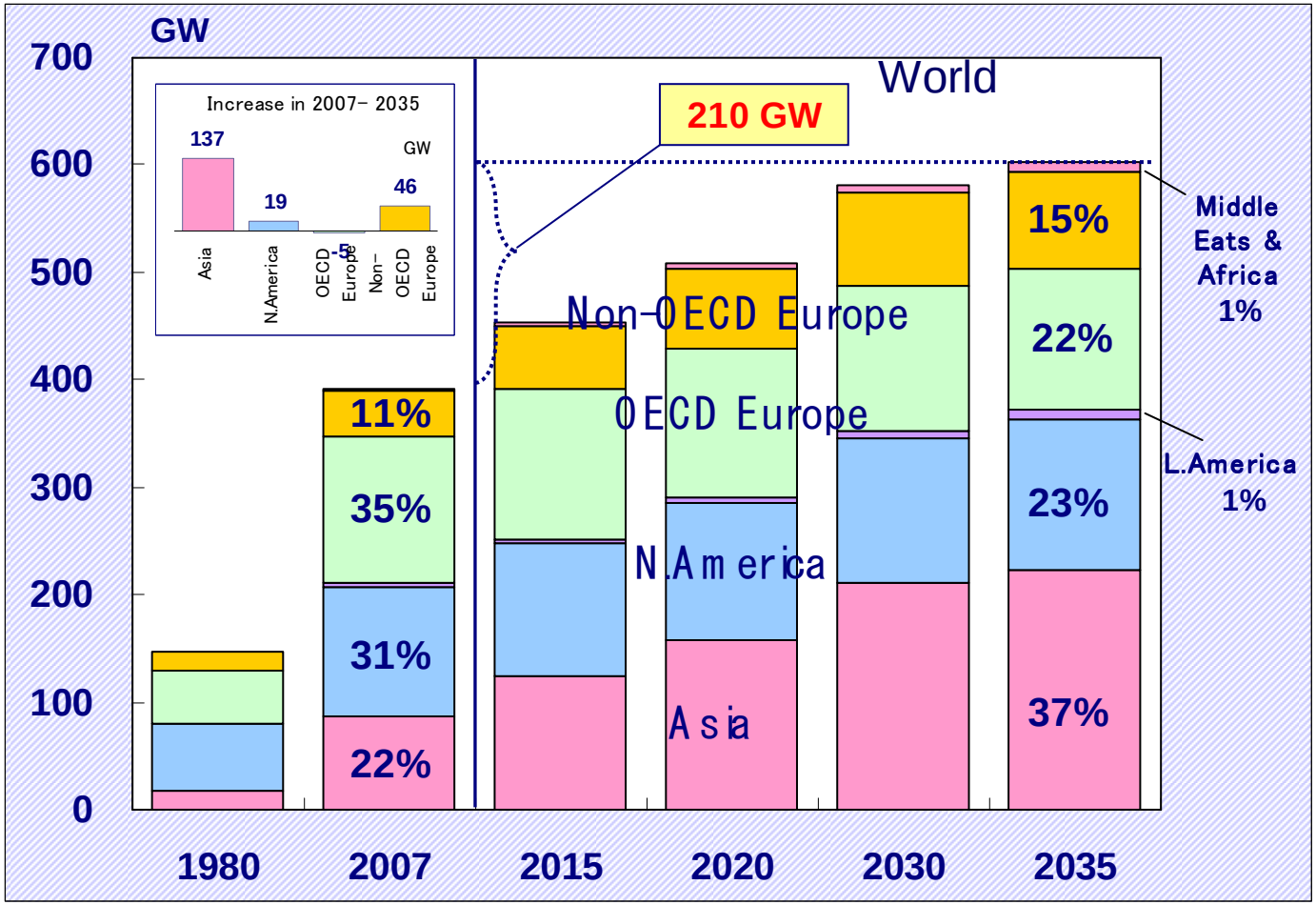
World	Asia
2008 **121** GW ↓ **2035** **602** GW (**5**-fold inc.)	**2008** **24** GW ↓ **2035** **127** GW (**5**-fold inc.)

■Renewables are expected to expand by technological advancement and supportive political measures such as Fuel In Tariff (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 in 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

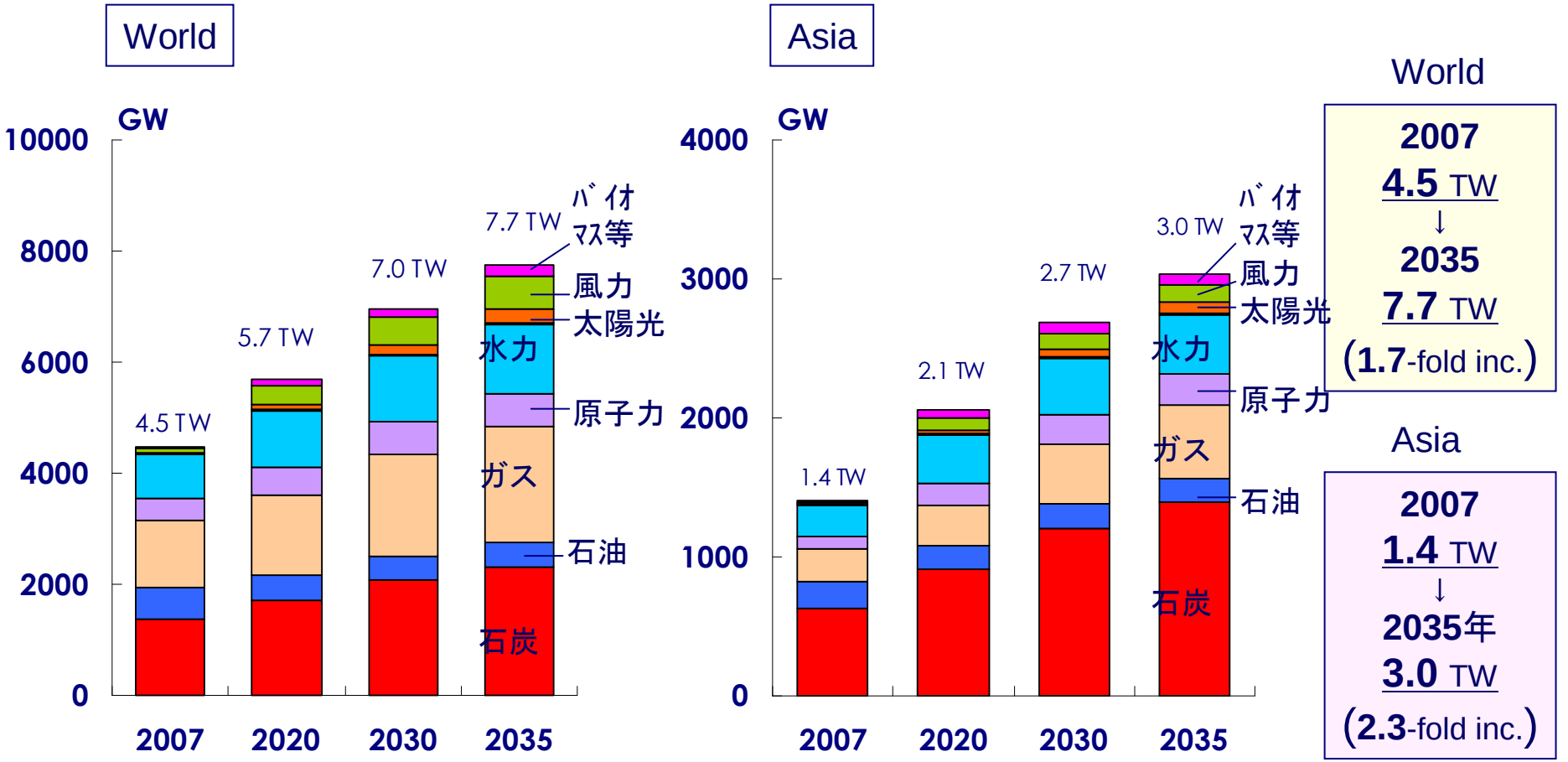
224 GW

(**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 challenge the largest investment into nuclear power requirement.

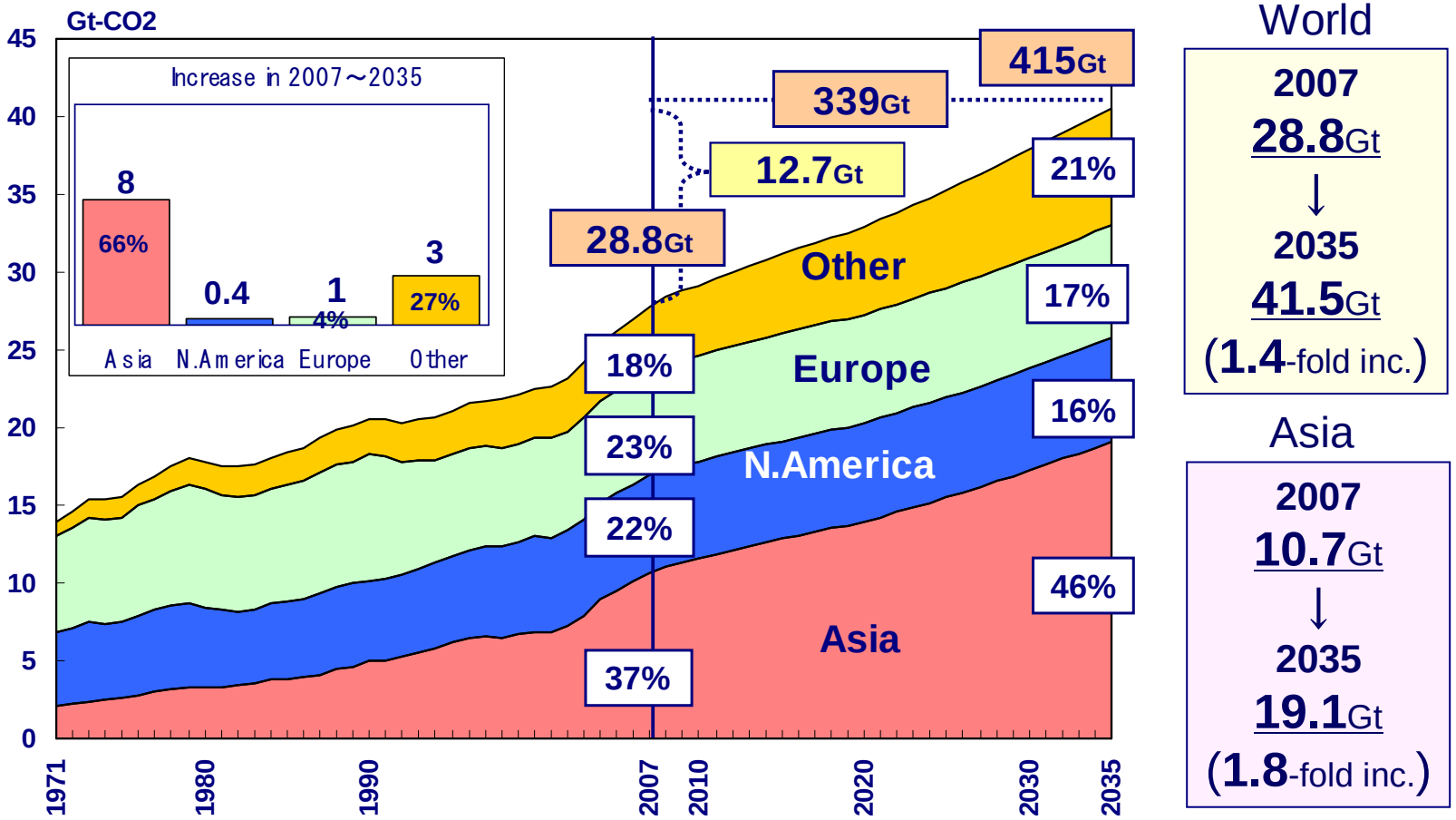
Power Generation Capacity; World and Asia



■World power generation capacity is projected to grow by 71% 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).

CO2 Emission by Region ; World



World

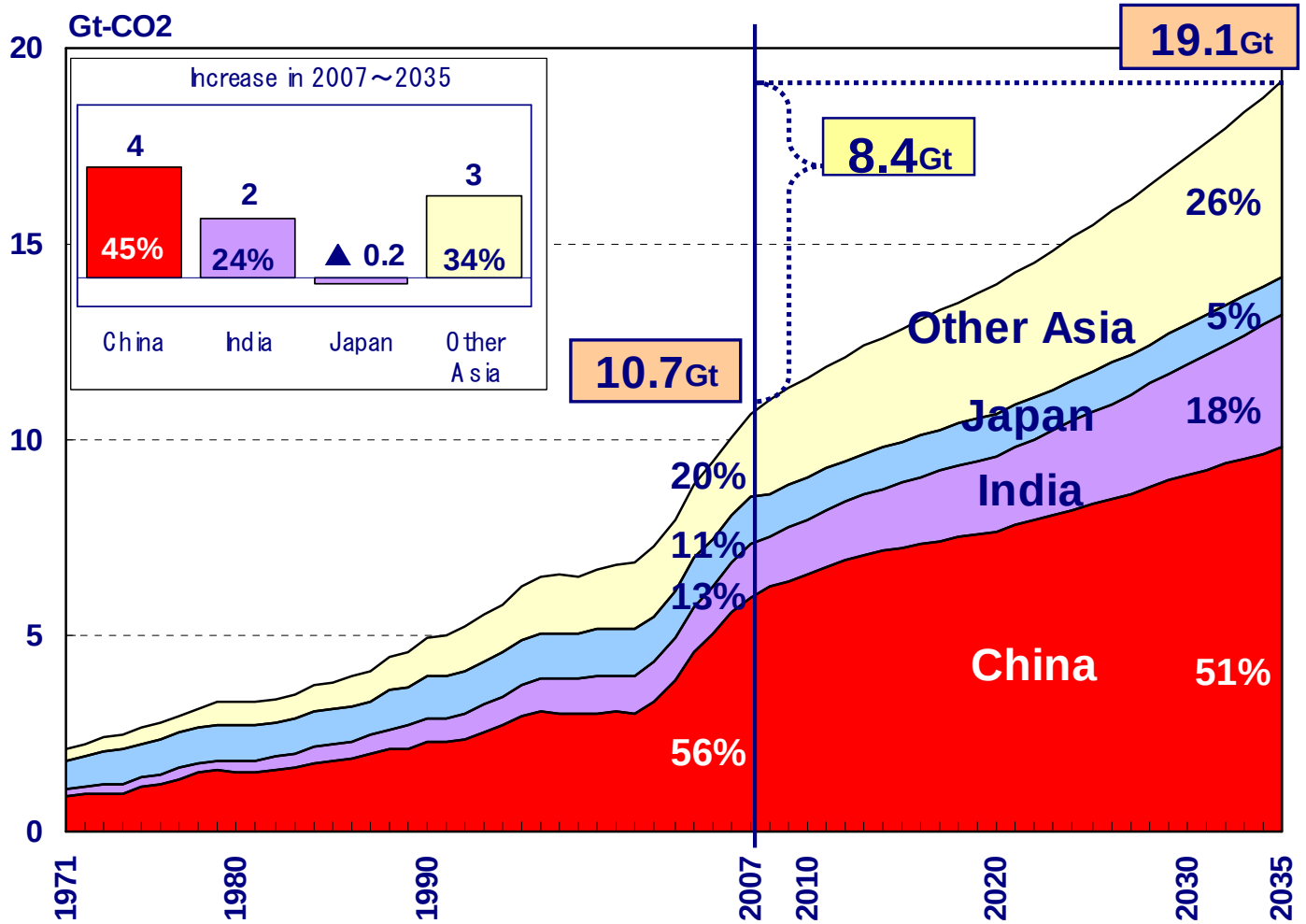
2007
28.8 Gt
↓
2035
41.5 Gt
(**1.4**-fold inc.)

Asia

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

■ Increase in Asia will account for 66%, in comparison with North America 3% and Europe 4%.

CO2 Emission by Region ; Asia



China

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

India

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

■ CO2 emissions of China and India will steadily increase driven by growing coal consumption, and their increase share will account for 70% in Asia.

Technologically Advanced Scenario

Assumptions on Technological Advanced Scenario

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

Regulation, National Target etc.

Carbon Tax, Emissions Trading, RPS, Subsidization、Feed In Tariff、Efficiency Standard, Automobile Fuel Efficiency Standard, Low Carbon Fuel Standard, Energy Efficiency Labeling, National Target

Promotion of R&D, International Cooperation

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, paper, oil refinery etc. become internationally penetrated

■ Transport

Clean energy vehicles (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, Biomass power generation, Bio-fuel

■ Nuclear

Acceleration of more nuclear power plant, Enhancement of operating ratio

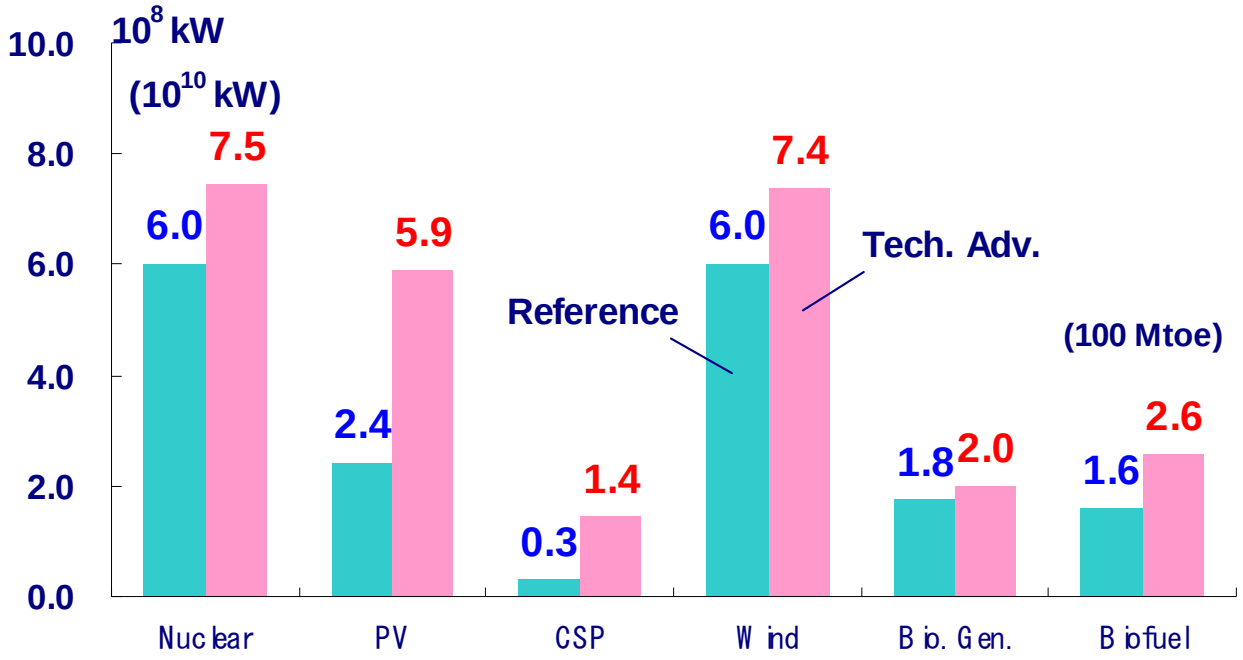
■ High Efficient Fossil-fired Power Plant

More expansion of highly efficient Coal-fired power plant (USC, IGCC, IGFC), Natural gas-fired power plant (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
1300 Mtoe
↓
2035

Reference	Tech. Adv.
2500Mtoe	**3000Mtoe**
(2-fold inc)	(2.3-fold inc)

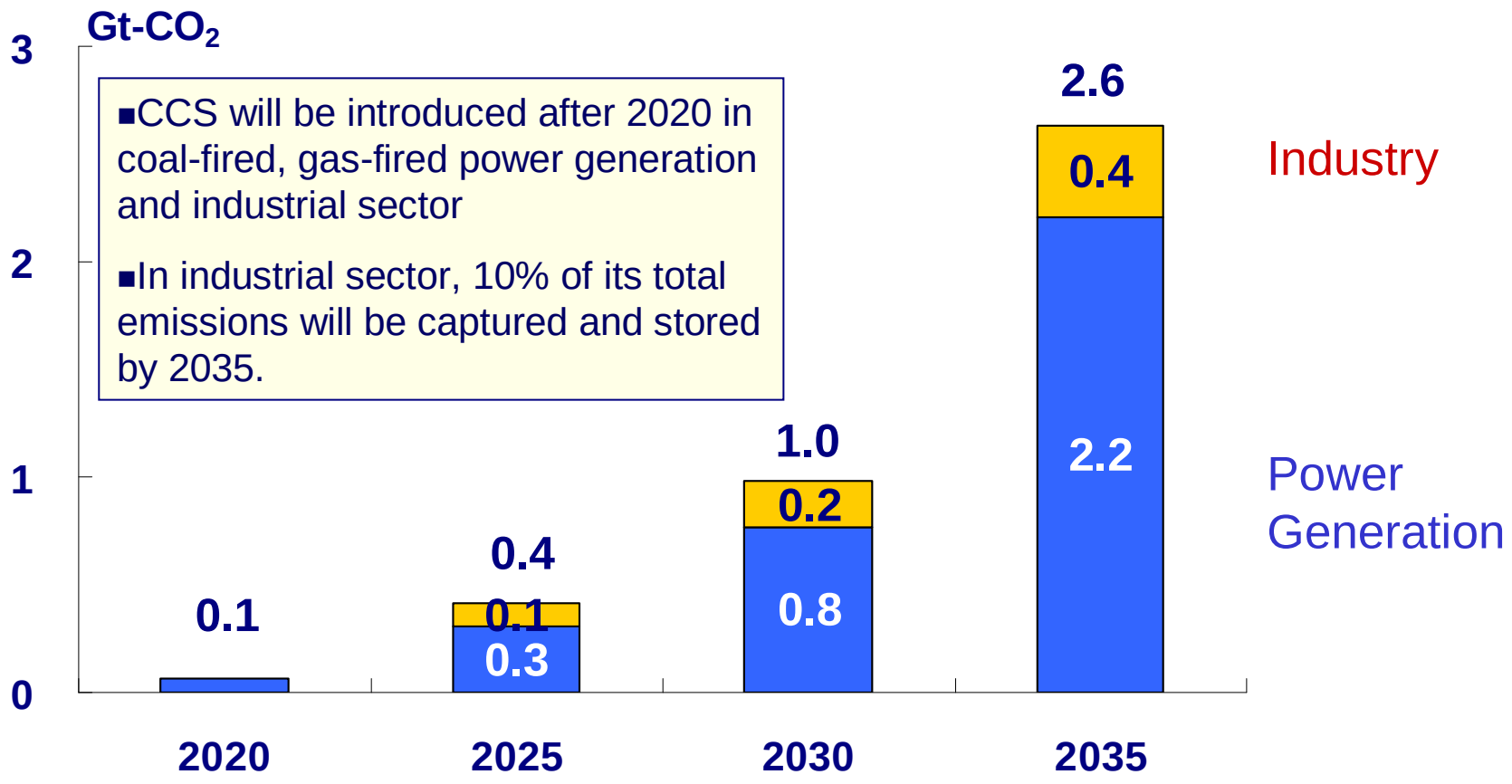
Share of non-fossil fuel

2007
12%
↓
2035

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

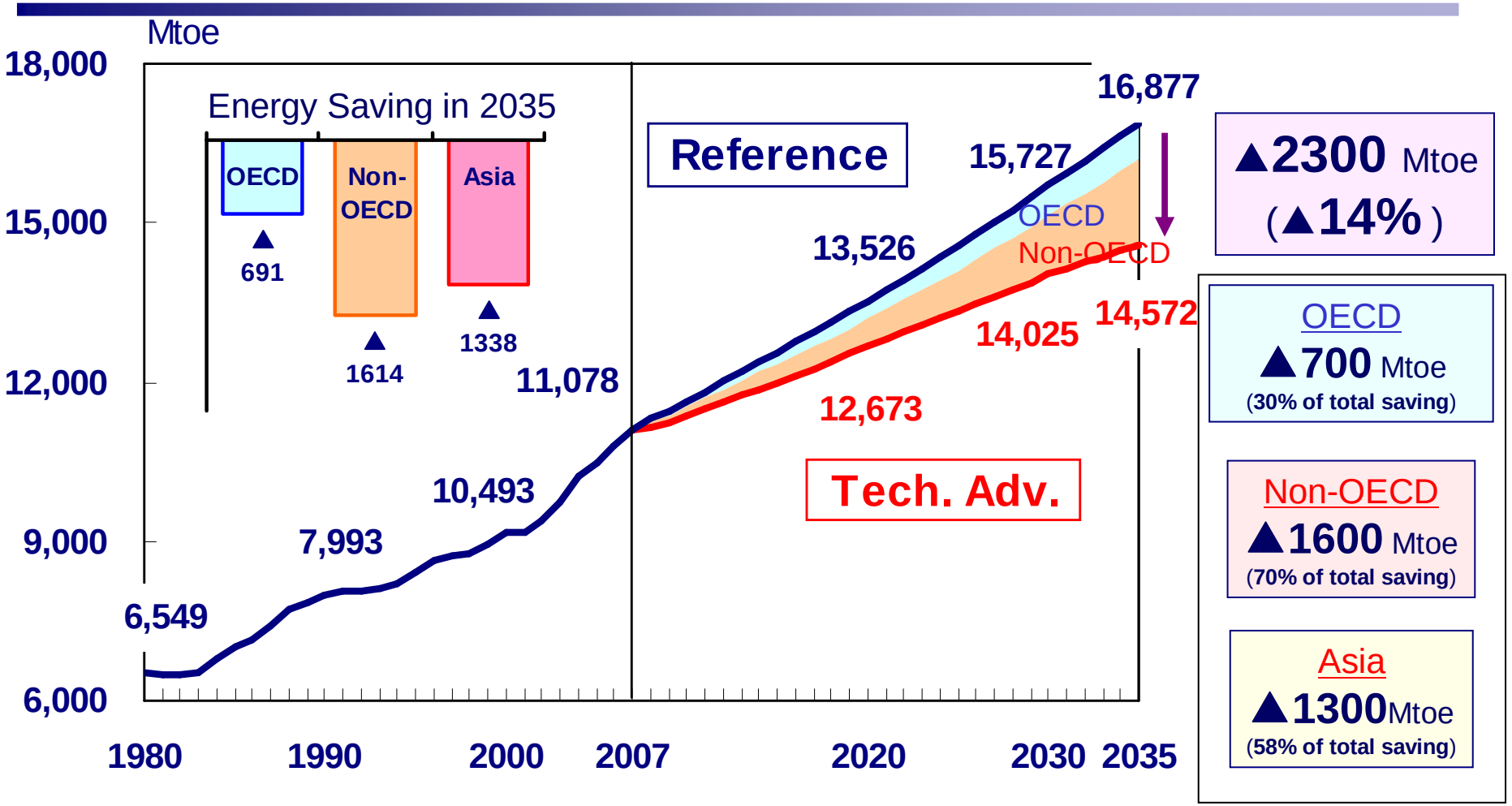
- Further expansion of nuclear and renewables is likely to be realized on the basis of global electricity demand increase.
- Biofuel will more boost if cellulosic biofuel, which is not competitive with food production and land use, becomes commercially viable.
- Industry sector, building sector and transport sector respectively achieves 300Mtoe(9% saving), 500 Mtoe (14% saving) and 400 Mtoe (14% saving) of energy saving in 2035 compared with reference scenario.

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 capacity of CCS in geological structure is estimated to 10,000 Gt, and that of depleted gas field, oil field and coal field is estimated 1000Gt, which is sufficient enough to accommodate the captured CO2 in Tech. Adv. Scenario.

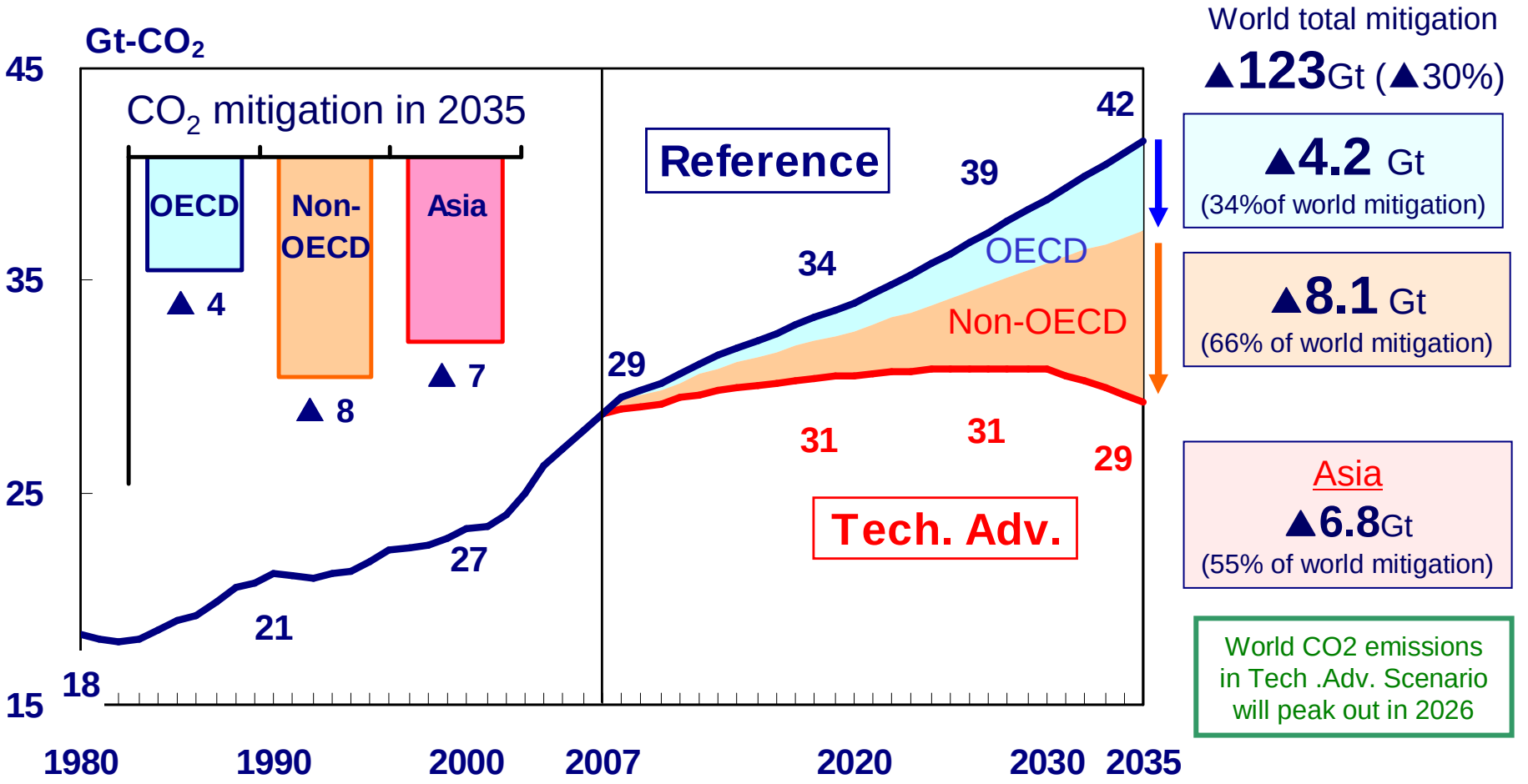
Primary Energy Demand (World)



■ In 2035, world total primary energy demand in Tech. Adv. Scenario decreases by 2300 Mtoe in comparison with Reference Scenario. 2300 Mtoe is approximately 4 times as much as total primary energy supply of Japan.

■ The saving potential in Asia is particularly immense amount.

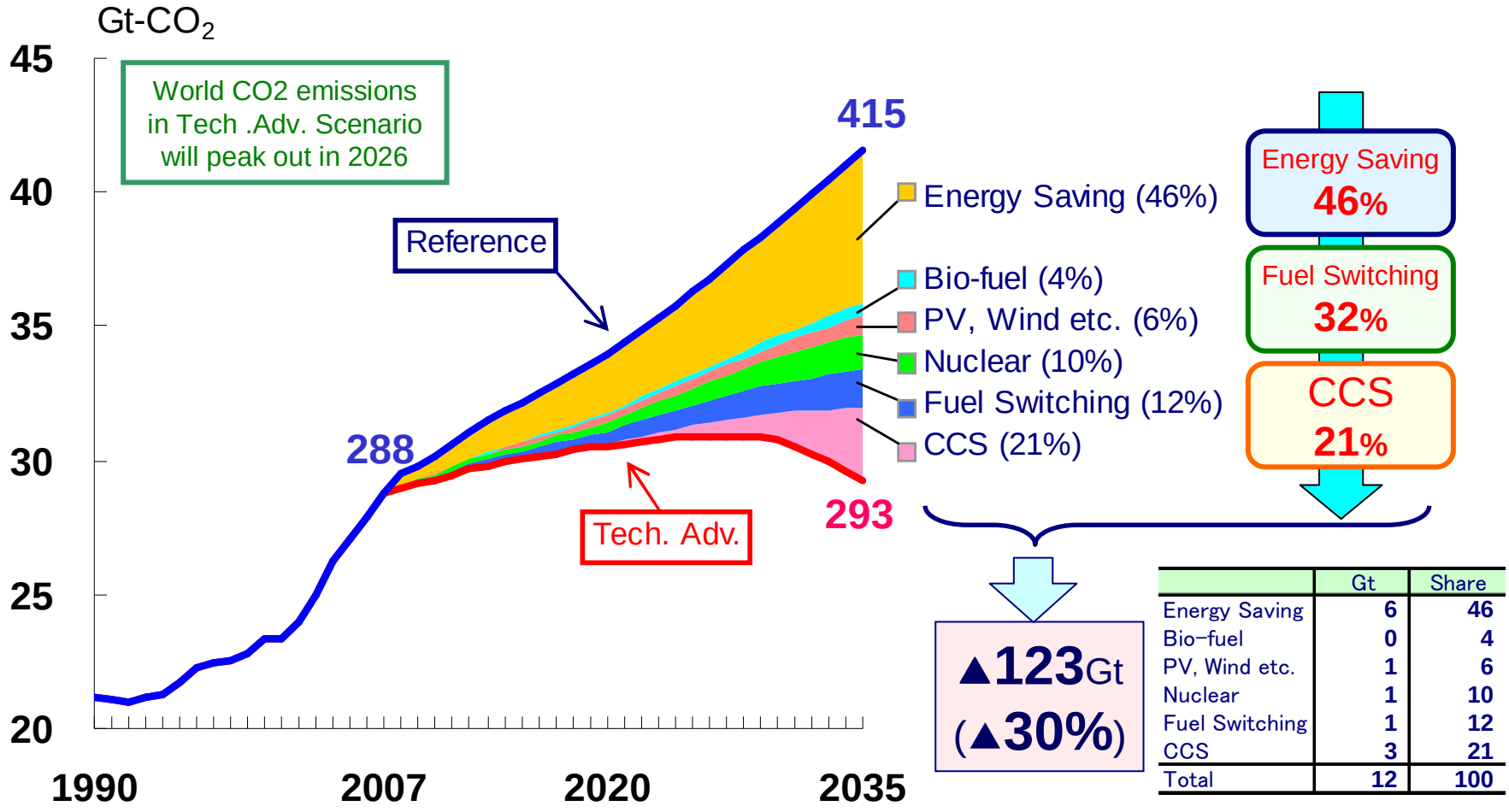
CO_2 Emissions in Tech. Adv. Scenario (World)



■ CO2 mitigation of Non-OECD will be almost double as large as that of OECD in 2035. The saving potential in Asia shows 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, renewable energy, nuclear power, fuel-switching and CCS will contribute greatly to massive CO2 mitigation.