

A light gray world map is centered in the background of the slide, showing the outlines of continents and major landmasses.

Reference materials

Energy outlook in Asia and the world 2013-2040

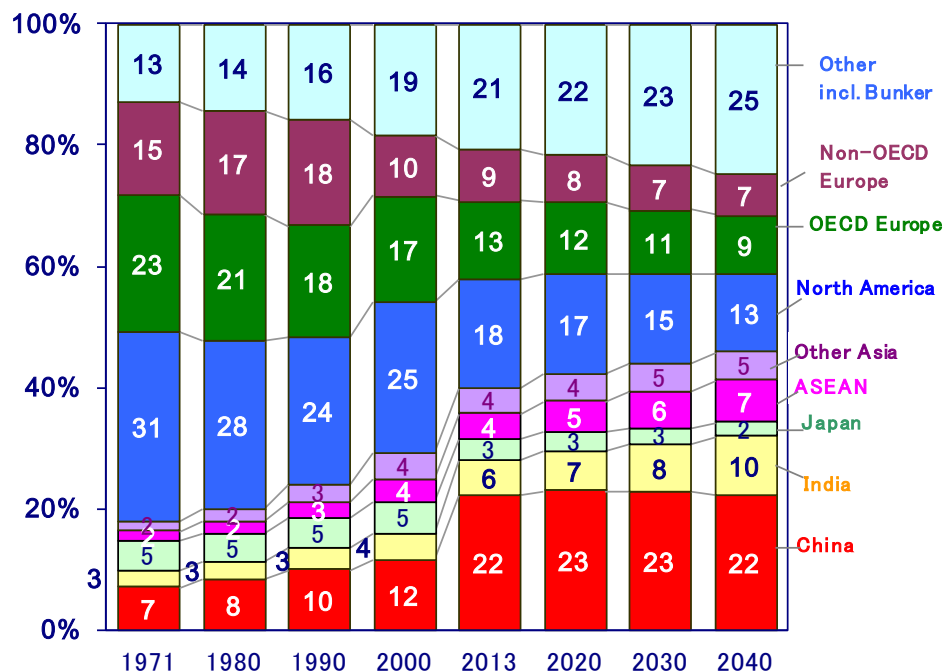
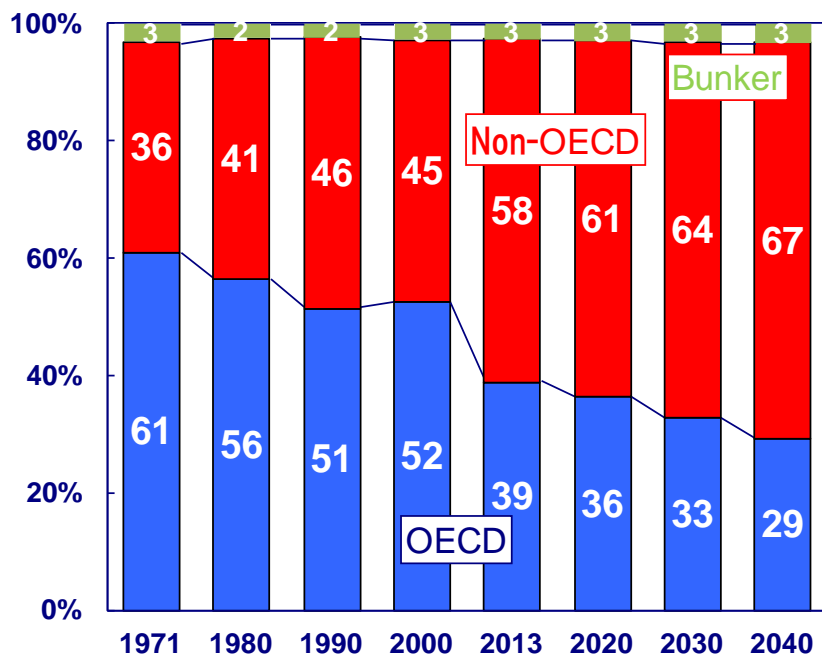
Primary energy consumption (regional share)

Reference Scenario

Share in increases (2013-2040)

China	India	Japan	ASEAN	Other Asia	N.America	OECD Europe
22%	20%	0%	14%	6%	0%	1%

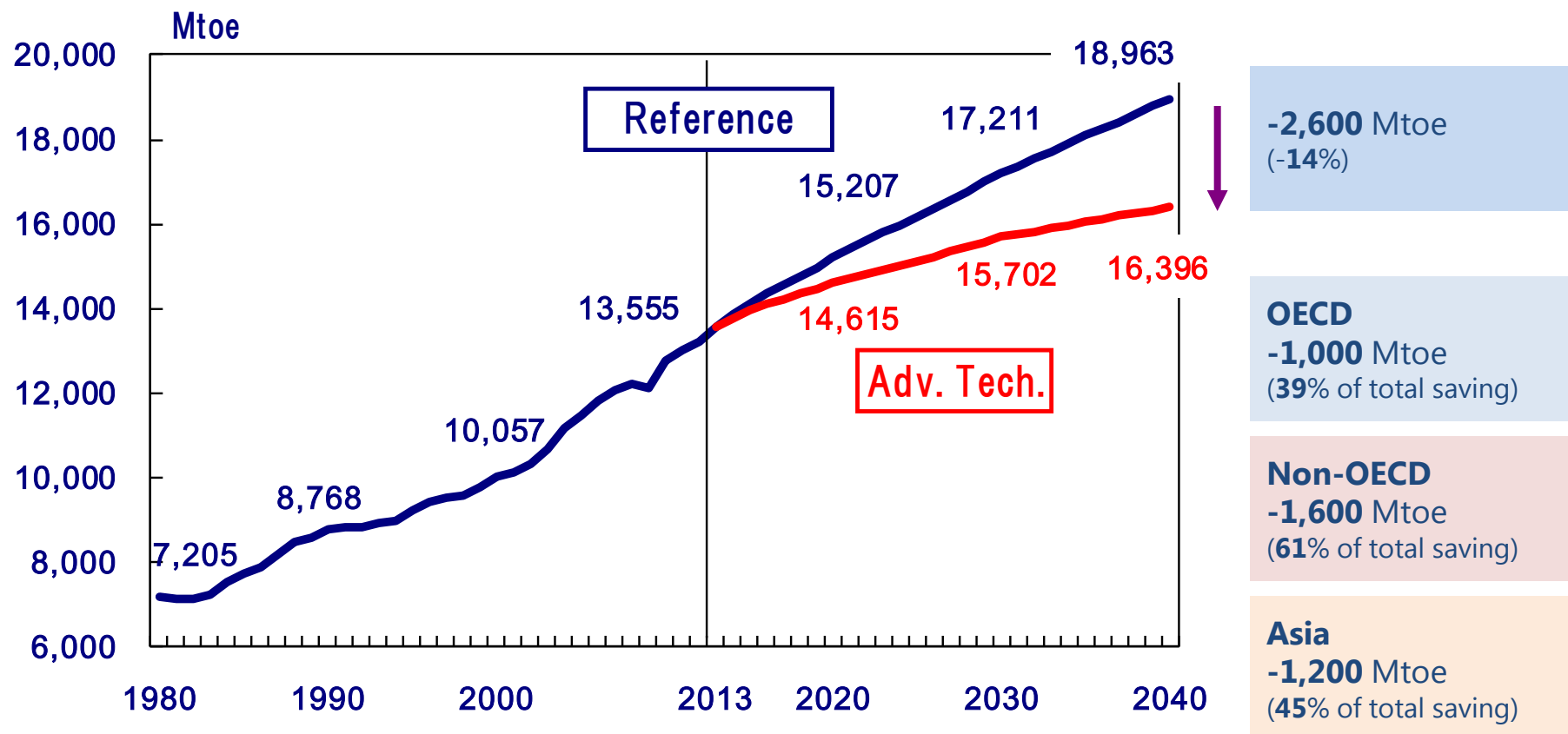
Asia accounts for more than 60% of total growth.



- Reflecting a steady economic growth, energy consumption in Non-OECD exceeds that of OECD.
- Energy consumption in Asia exhibits a rapid growth, with the share of Asia in the world energy consumption expanding from 40% in 2013 to 46% by 2040.
- By 2040, the share of China in the world energy consumption increases to 22%, and India to 10% (for a total of 32%). The share of Japan declines from 3% in 2013 to 2% of the world energy consumption in 2040.

Primary energy consumption (world)

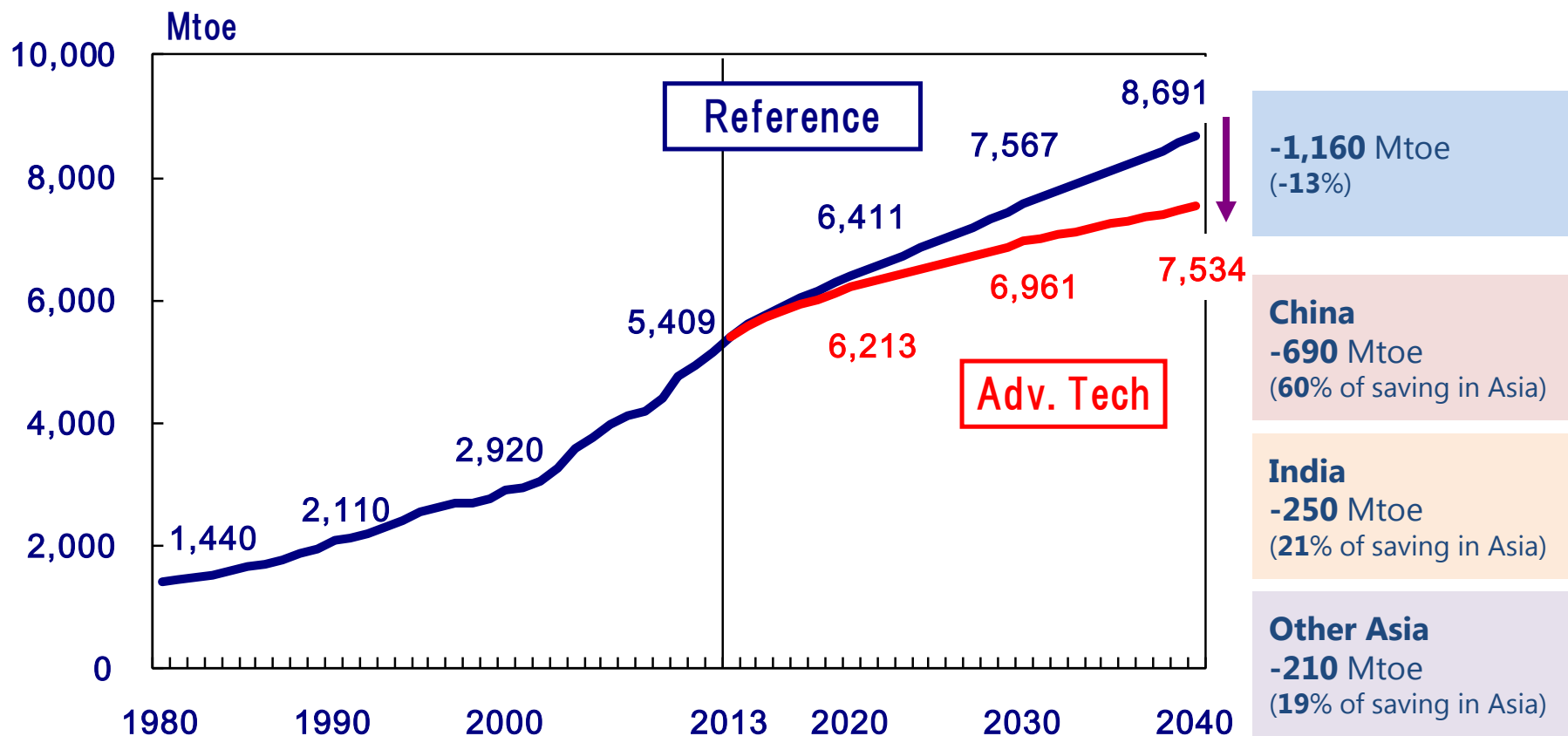
Reference Scenario
Advanced Technologies Scenario



- In 2040, total primary energy consumption in the Advanced Technologies Scenario is 2,600 Mtoe (about 14%) lower than the Reference Scenario. This saving is more than 5.6 times Japan's total consumption in 2013.
- In the Advanced Technologies Scenario, Non-OECD contributes to about 60% of the potential savings. The potential in Asia is particularly significant.

Primary energy consumption (Asia)

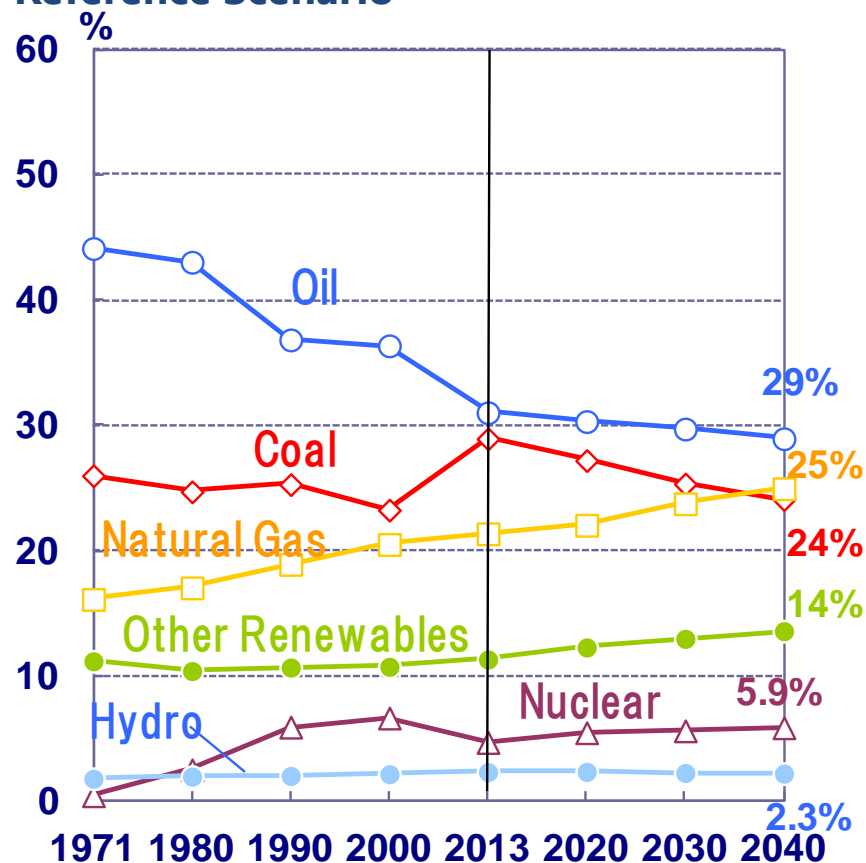
Reference Scenario
Advanced Technologies Scenario



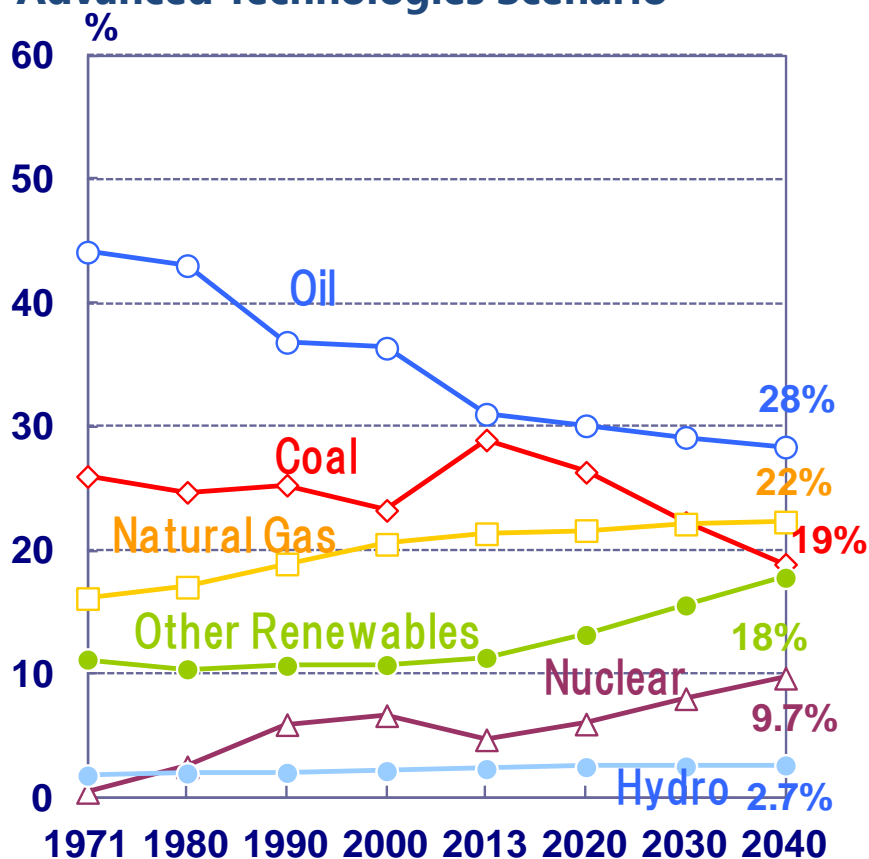
- The potential savings in Asia under the Advanced Technologies Scenario is 1,160 Mtoe (equivalent to about 2.5 times Japan's current consumption). China and India combined, which account for 70% of the Asia's consumption, have 81% of the saving potential.

Primary energy mix (world)

Reference Scenario



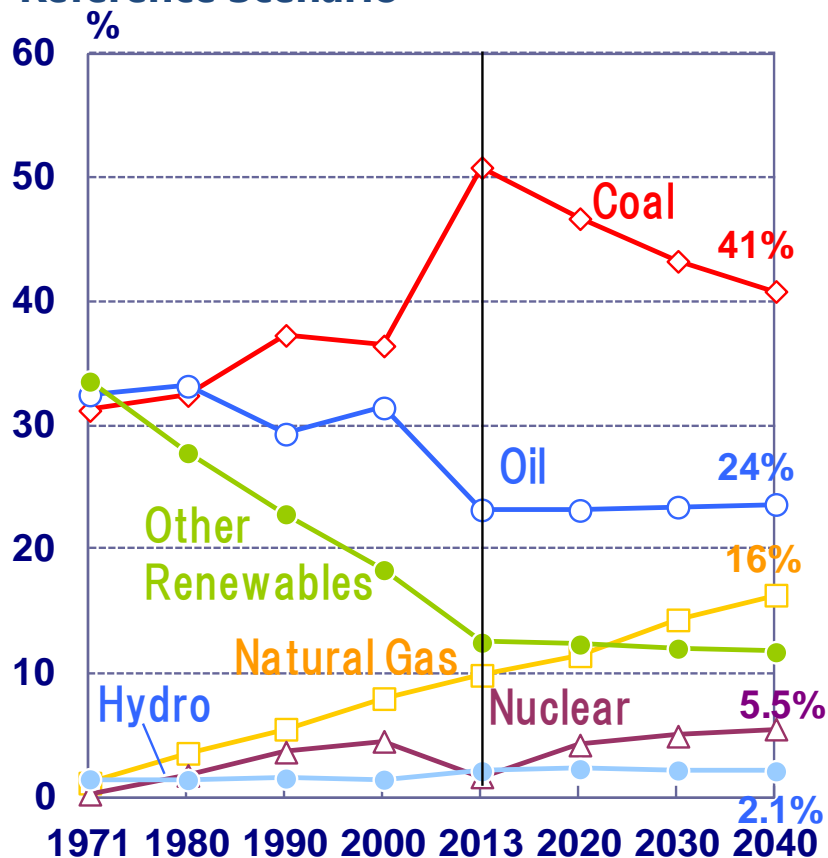
Advanced Technologies Scenario



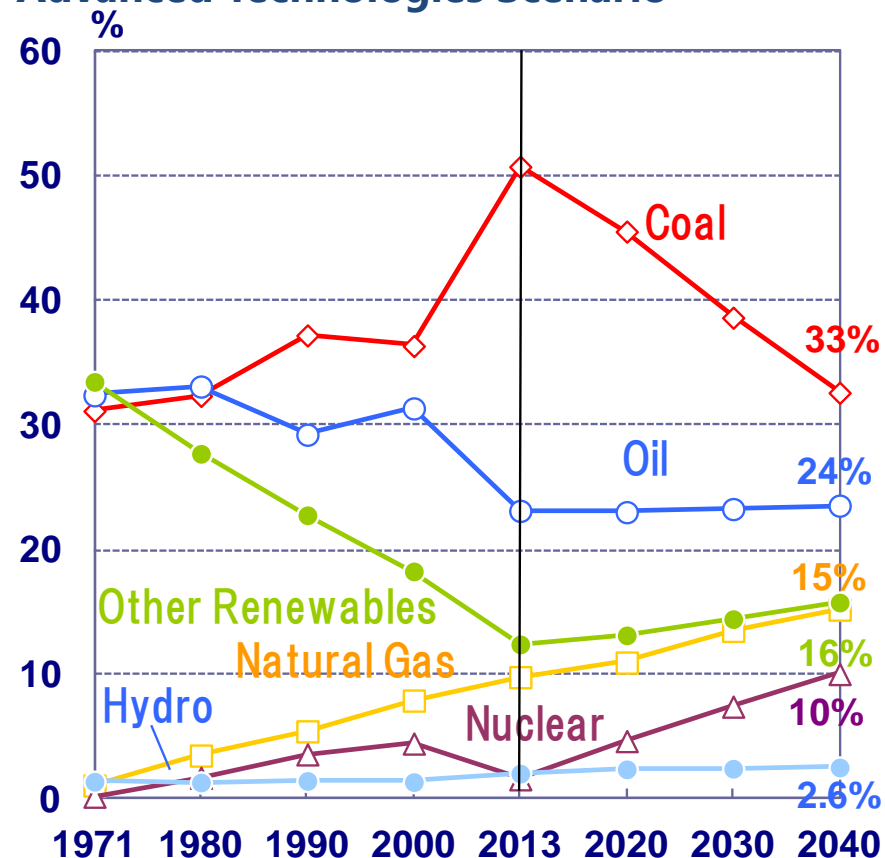
- In the Reference Scenario, the oil's share decreases substantially to 29%, while the shares for natural gas and renewables expand substantially.
- In the Advanced Technologies Scenario, coal significantly decreases mainly in Non-OECD while the shares for nuclear and renewables gradually expand. Fossil fuels, nonetheless, remain the most important source for energy in the primary energy mix in 2040, maintaining about 70% share.

Primary energy mix (Asia)

Reference Scenario



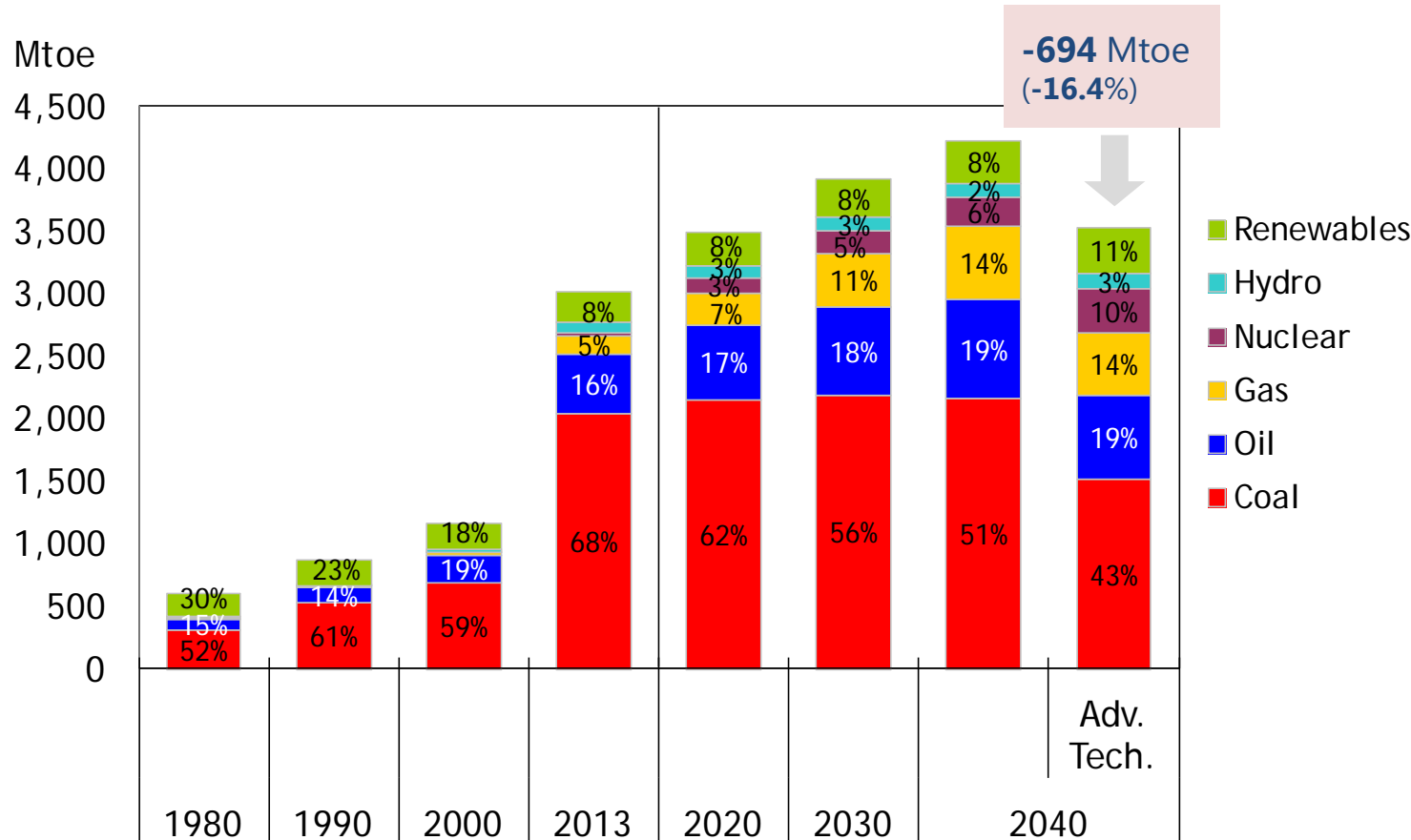
Advanced Technologies Scenario



- Coal keeps the biggest share of primary energy consumption driven by the power generation demand through 2040. The share drops from 51% in 2013 to 41% in 2040 in the Reference Scenario and to 33% in the Advanced Technologies Scenario.
- Natural gas continues to grow in both scenarios. In the Advanced Technologies Scenario, the share of nuclear gradually increases with additional nuclear power plants in China, India and Korea.

Primary energy consumption in China

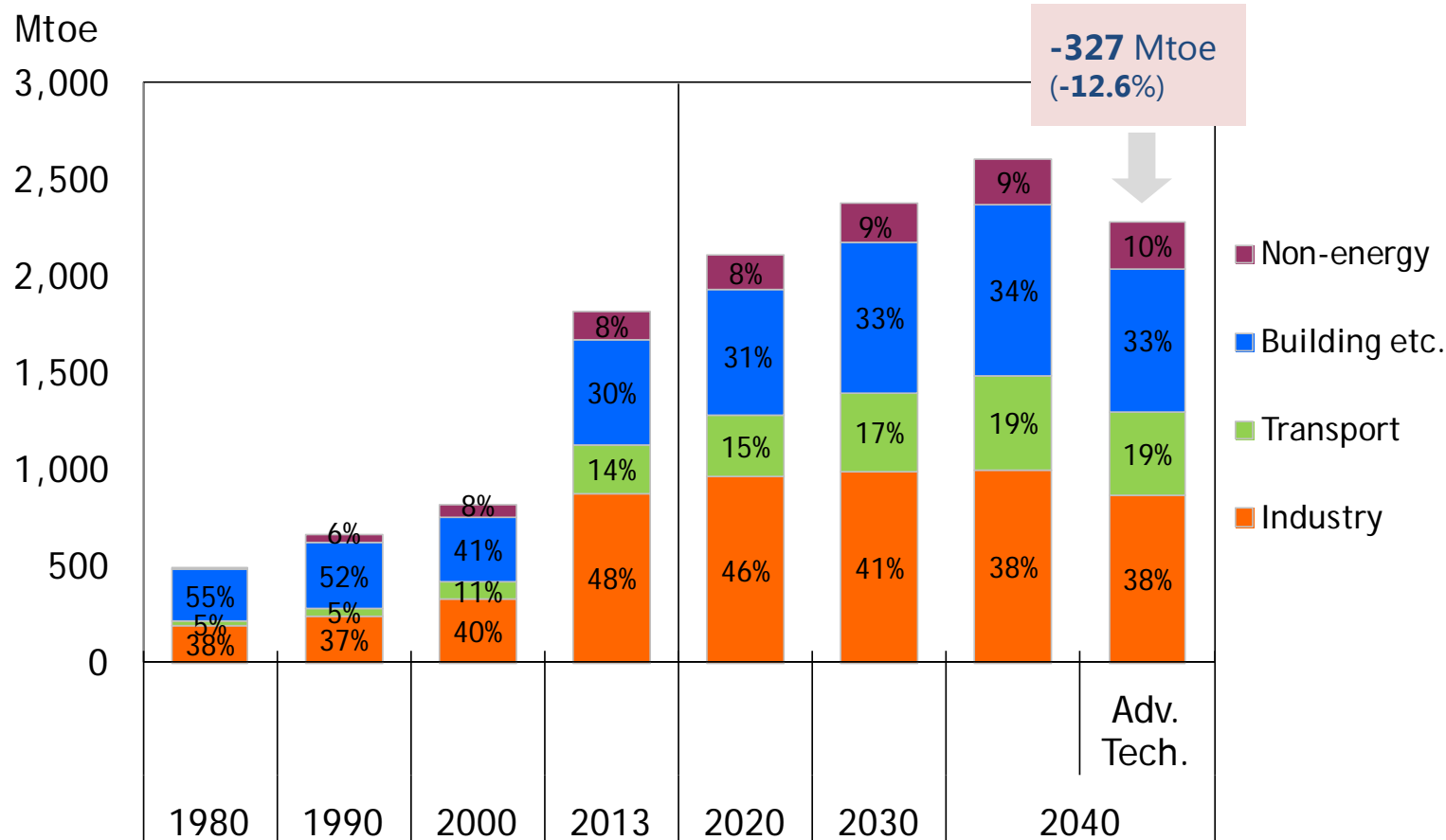
Reference Scenario
Advanced Technologies Scenario



- TPED increases at an annual rate of 1.3% in the Reference Scenario at the back of robust economic growth. Oil expands reflecting rapid motorization.
- Natural gas increases sharply for residential and commercial use, especially in urban areas.
- In the Advanced Technologies Scenario, coal consumption decreases, especially in power generation, TPED is 694 Mtoe, or 16.4% lower than that in the Reference Scenario in 2040.

Final energy consumption in China

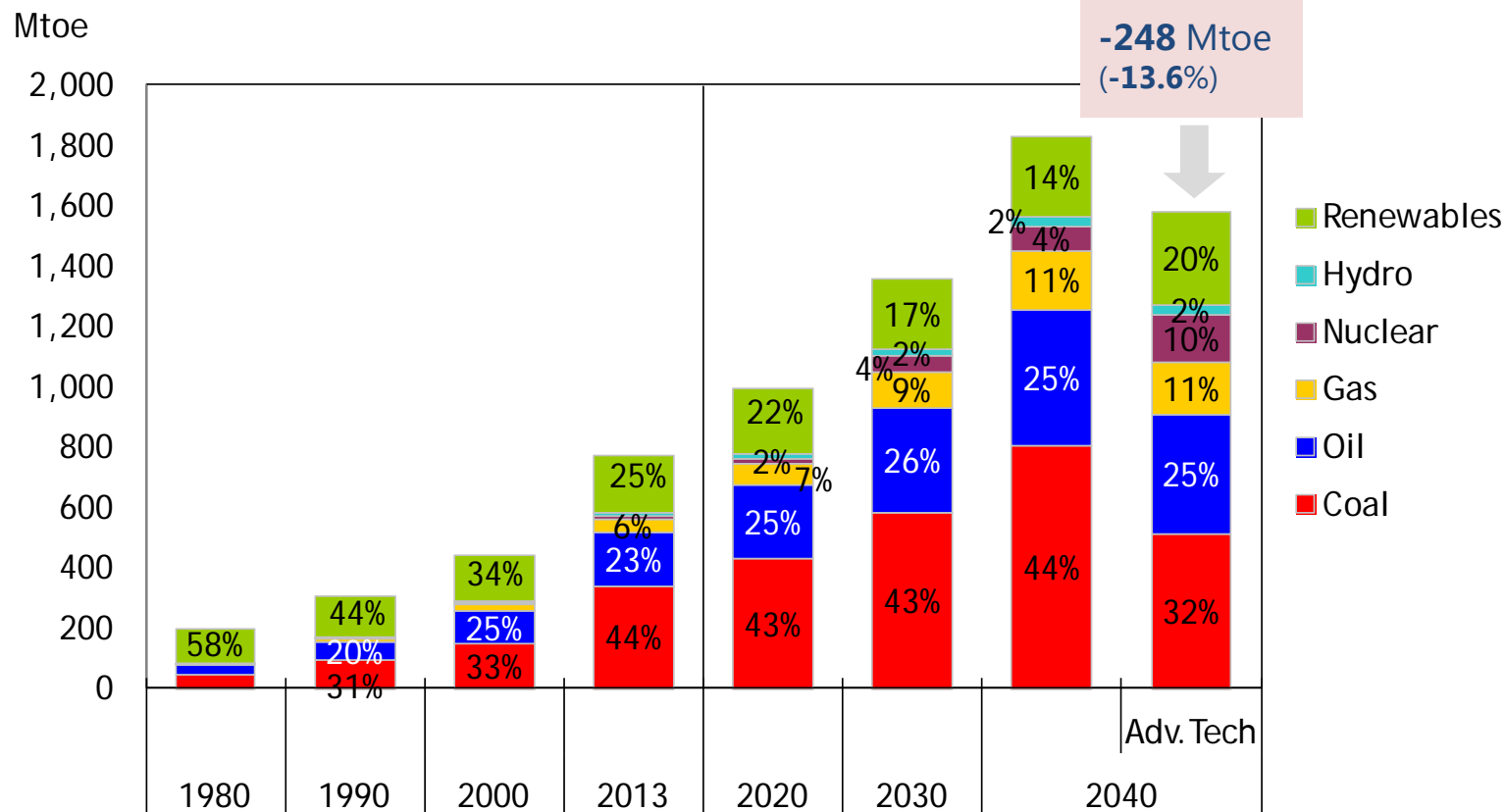
Reference Scenario
Advanced Technologies Scenario



- Final energy consumption increases strongly, reaching 2,604 Mtoe in 2040, from 1,814 Mtoe in 2013.
- Energy consumption of heavy industries which has been strong up until now grows relatively slowly in the future.
- By contrast, energy consumption of the buildings and transport sectors increase substantially. The share of the buildings sector reaches 34% in 2040 from 30% in 2013.
- In the Advanced Technologies Scenario, energy consumption of the buildings and industry sectors is expected to have large potential for reduction, final energy consumption is 327 Mtoe, or 12.6% lower than the Reference Scenario.

Primary energy consumption in India

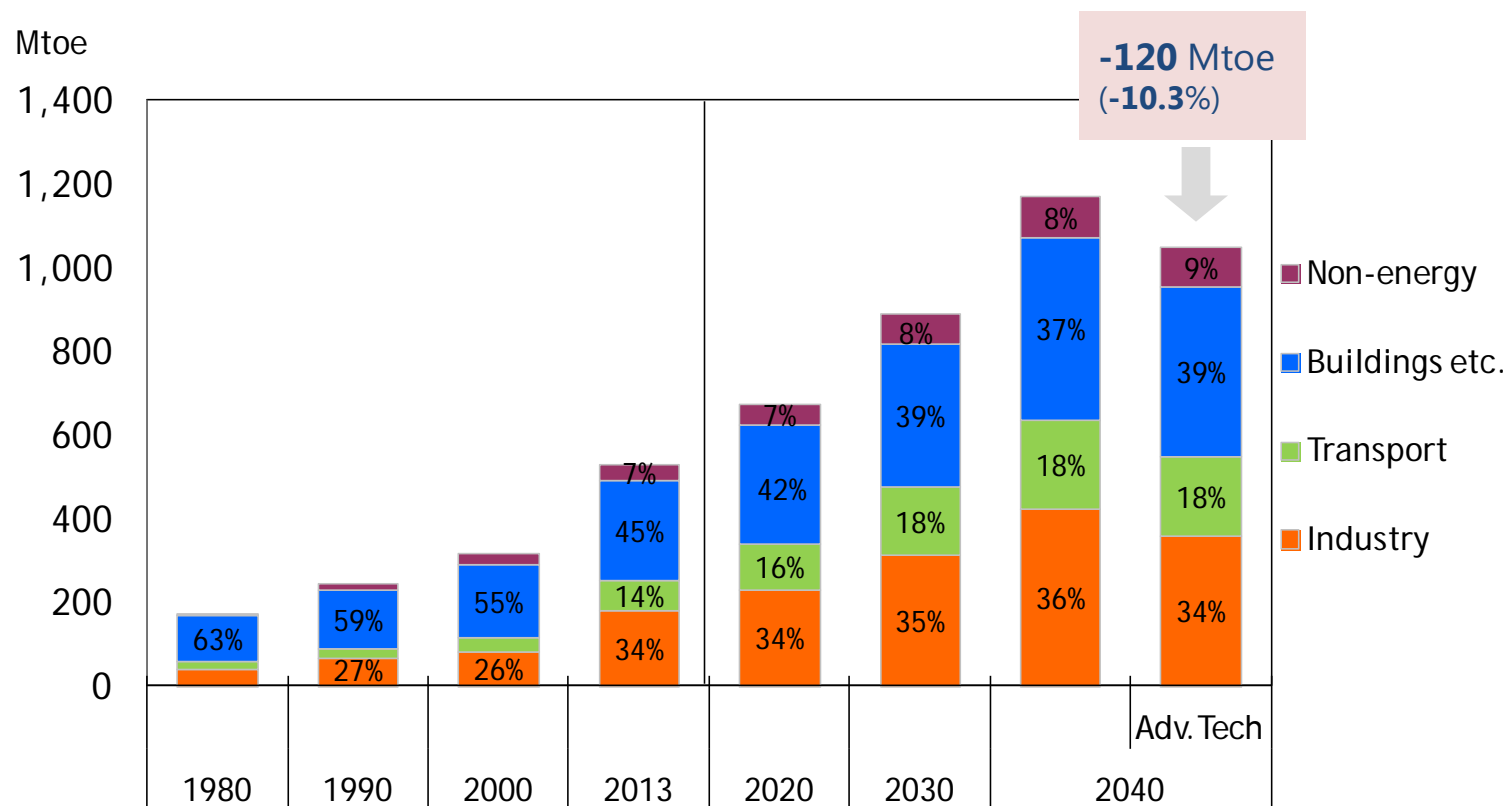
Reference Scenario
Advanced Technologies Scenario



- In the Reference Scenario, TPED increases at an annual rate of 3.2%. Fossil fuels account for 81% of the increases by 2040.
- Driven by the power generation and industry sectors, coal maintains the largest share at about 44% throughout the projection period. Coal increases to 464 Mtoe. This increase is equivalent to the TPED of Japan.
- The power and industry sectors also lead natural gas consumption growth. Although development of domestic resources is expected, much of the natural gas consumption should be met by imports.
- TPED in 2040 in the Advanced Technologies Scenario is 248 Mtoe, or 13.6% lower compared with the Reference Scenario.

Final energy consumption in India

Reference Scenario
Advanced Technologies Scenario

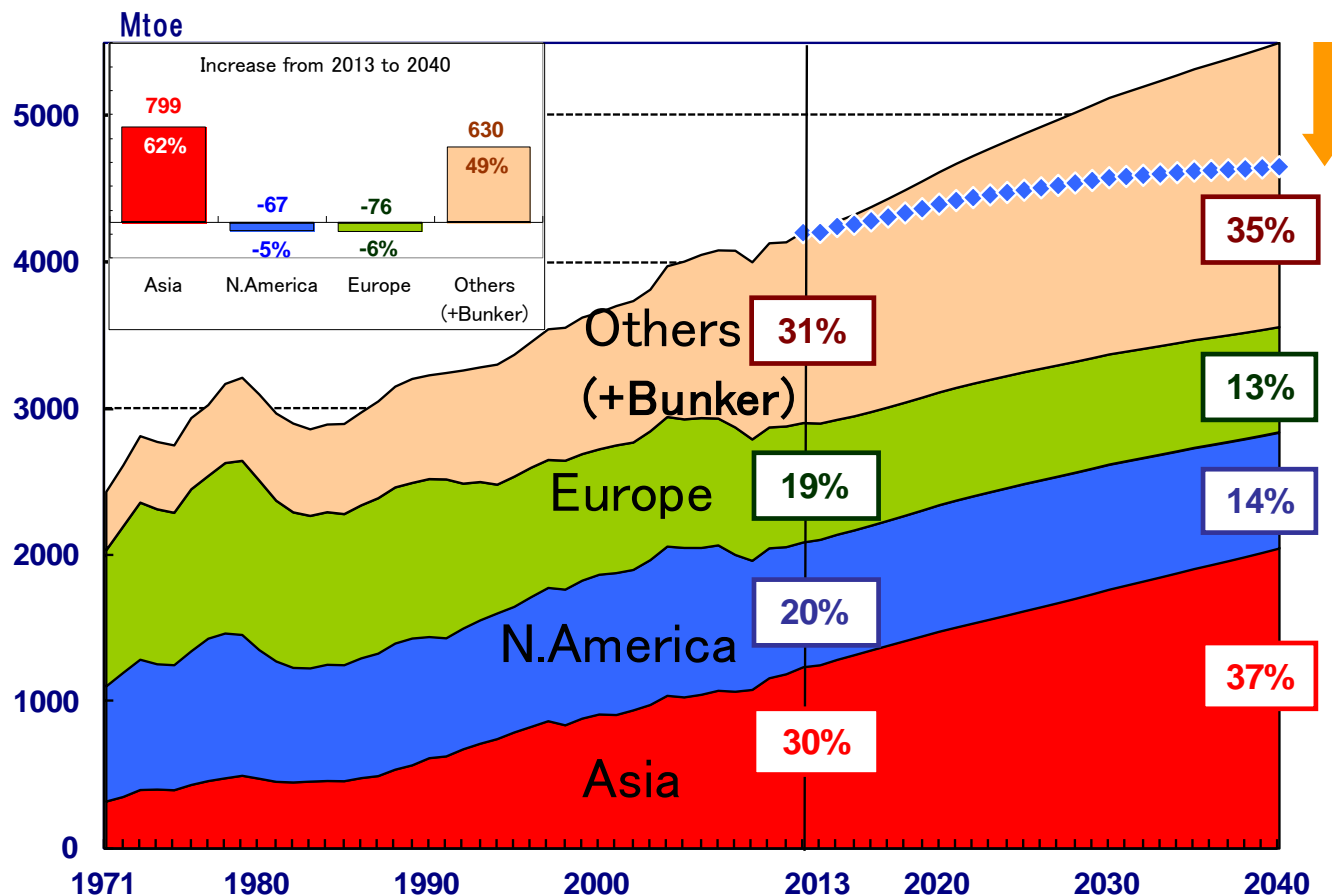


Note: The industry sector includes non-energy use.

- Industry increases rapidly due to industrialization and production increases from the heavy industry. Energy consumption for industry and transport sectors are 2.4 times and 2.8 times of current energy consumption, respectively.
- Electricity consumption grows at an annual rate of 5.0%.
- In the Advanced Technologies Scenario, energy consumption is 120 Mtoe, or 10.3% lower in 2040 compared to the Reference Scenario. Renovation with the India's developed ICT and industrialization will promote energy efficiency.

Oil consumption by region (world)

Reference Scenario (solid)
Advanced Technologies Scenario (dotted)



Saving:
839 Mtoe
(15%)

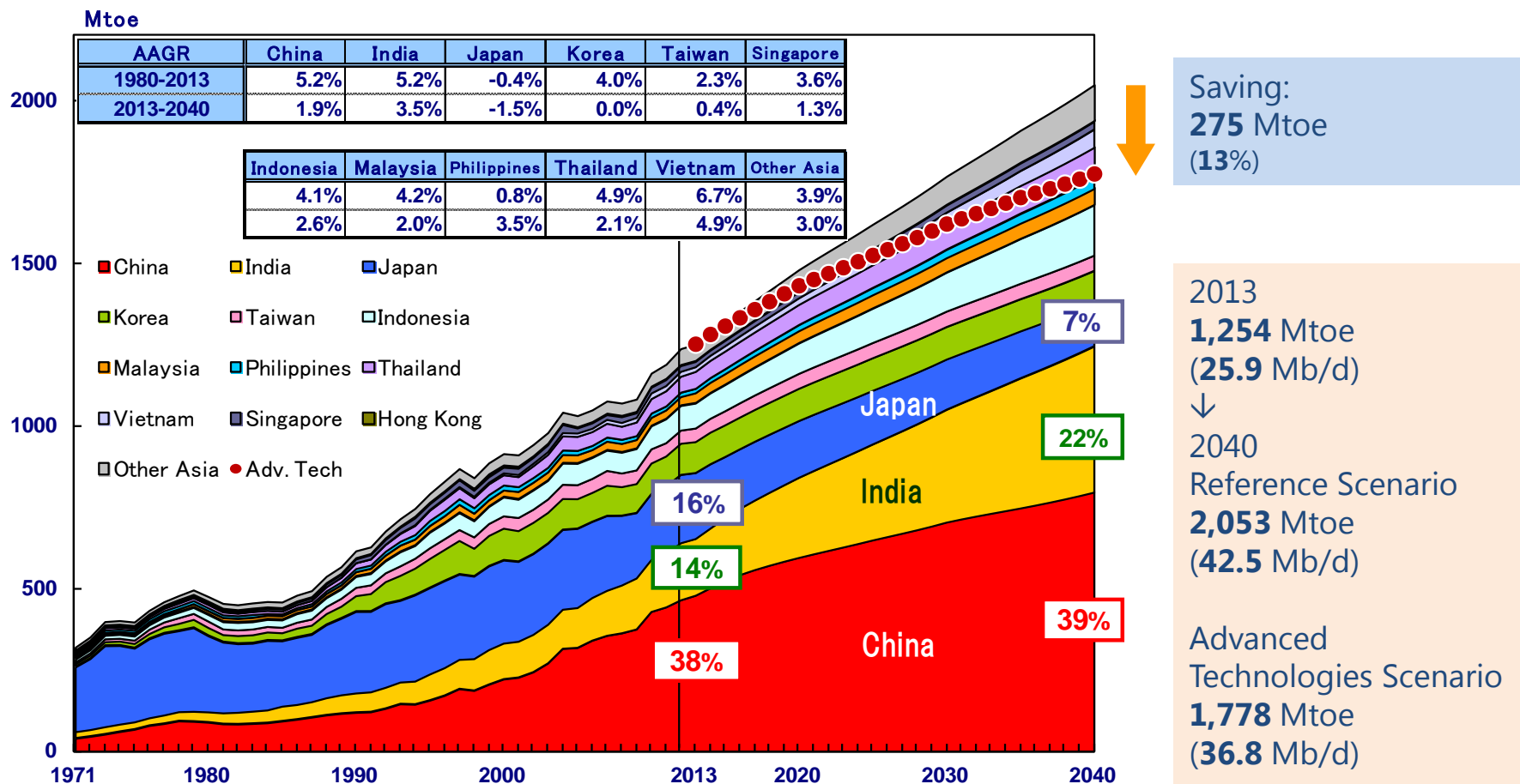
2013
4,210 Mtoe
(87 Mb/d)
↓
2040
Reference Scenario
5,496 Mtoe
(114 Mb/d)

Advanced Technologies Scenario
4,658 Mtoe
(96 Mb/d)

- The share of Asia in the world oil consumption increases from 30% in 2013 to 37% in 2040. About 62% of the global oil growth takes place in Asia.
- In the Advanced Technologies Scenario, the world oil consumption is 840 Mtoe (15%) lower in 2040 compared to the Reference Scenario.

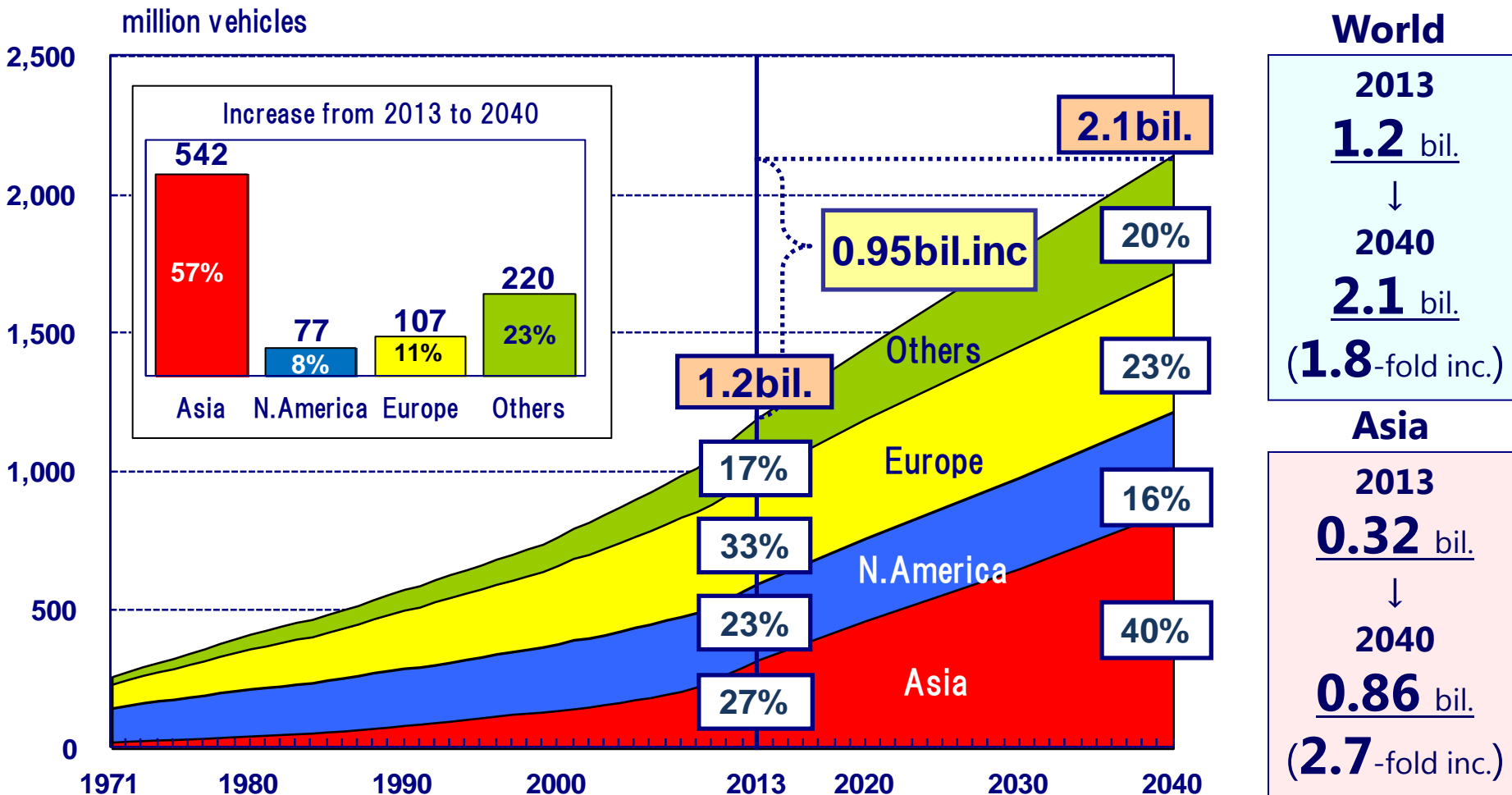
Oil consumption by region (Asia)

Reference Scenario (solid)
Advanced Technologies Scenario (dotted)



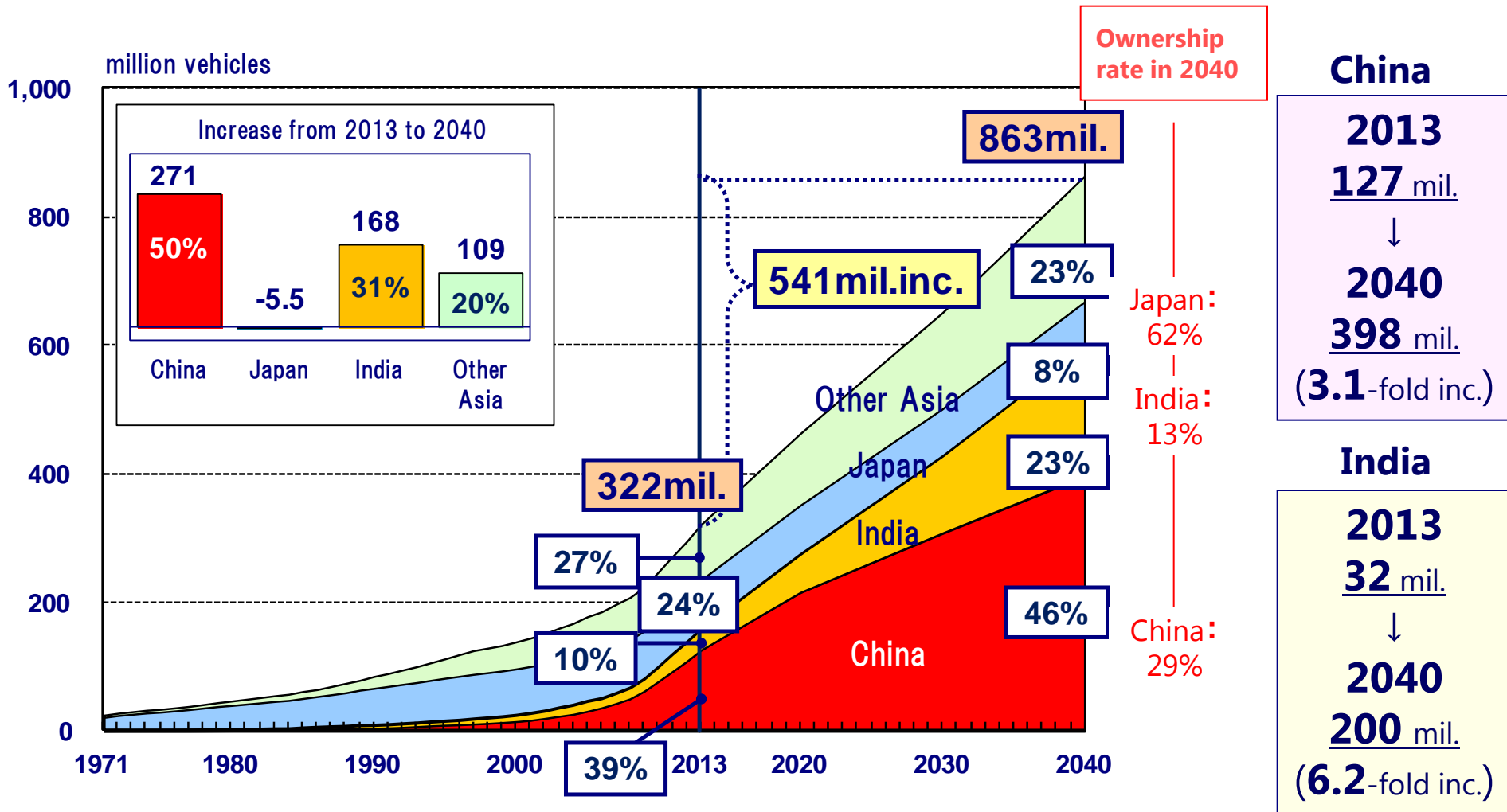
- Though the vehicles' fuel efficiency improves and clean energy vehicles expand, oil consumption in Asia expands from 25.9 million b/d in 2013 to 42.5 Mb/d in 2040, due mainly to its escalating vehicle ownership. The share of China and India combined in Asian oil consumption grows from 52% in 2013 to 61% in 2040.
- Oil savings in the Advanced Technologies Scenario are equivalent to 13% of the Reference Scenario in 2040.

The Number of Vehicles (World)



- 40% of the world vehicle stocks is concentrated in Asia in 2040.
- The share of vehicle stocks in OECD countries declines from 61% in 2013 to 43% in 2040. The stock in Non-OECD countries surpasses that of OECD by 2040.

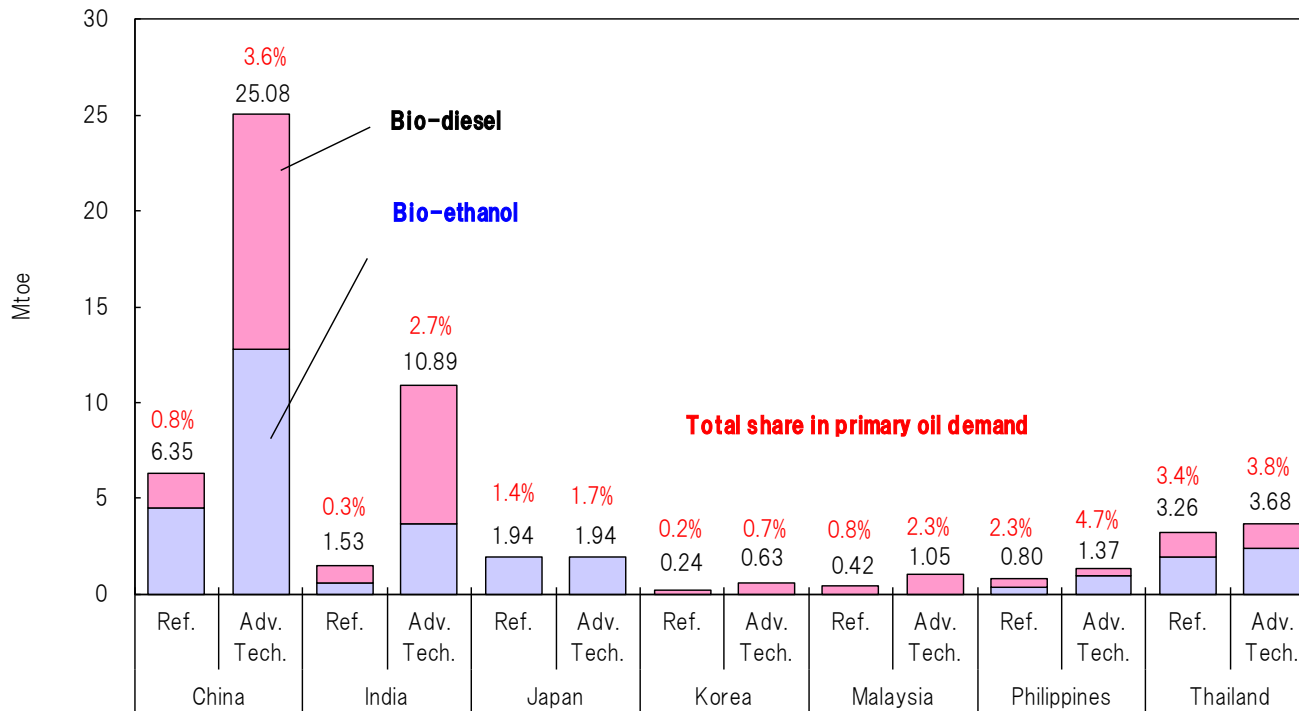
The Number of Vehicles (Asia)



- China vehicle stock expands substantially due to an increase in the income level. The stock of vehicle in China increases from 127 million units in 2013 to 398 million units in 2040. India's vehicle stock surpasses that of Japan around 2025, increasing from 32 million units in 2013 to 200 million units in 2040.

Biofuel Consumption in Asia and the World (2040)

Reference
Adv. Tech.



World

2013
68 mil.toe

↓

2040

Ref.	Adv.Tech
130 mil.toe	210 mil.toe
(1.8-fold inc.)	(3.1-fold inc.)

Asia

2013
5.0 mil.toe

↓

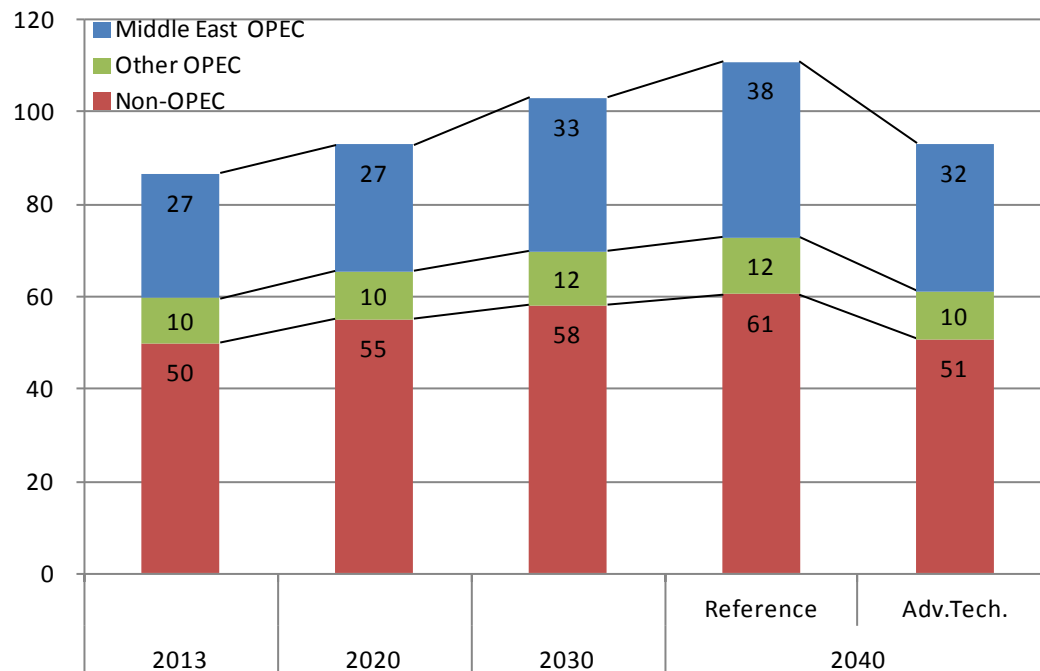
2040

Ref.	Adv.Tech
20 mil.toe	55 mil.toe
(4.1-fold inc.)	(11-fold inc.)

- In the Reference Scenario, the world biofuel consumption is expected to reach 130 Mtoe by 2040, mainly driven by the growth in North America, Europe and Latin America. Asia reaches 20 Mtoe of biofuel by 2040. The share of biofuel in global liquid fuel amounts to 3.1% in 2040.
- In Asia, ethanol consumption mainly increases in China, India and Japan, while biodiesel increases in Korea, and Malaysia.
- In the Advanced Technologies Scenario, the world biofuel consumption reaches 210 Mtoe by 2040, and that of Asia reaches 55 Mtoe.

Oil Production

Mb/d



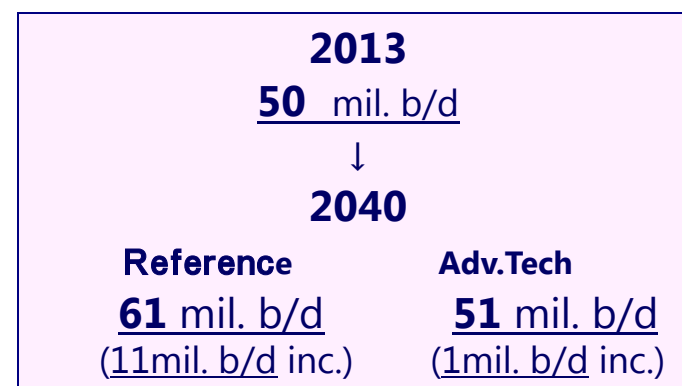
Share of the world oil production increase		Reference	Adv.Tech.
	Middle East OPEC	44%	68%
	Other OPEC	10%	7%
	Non-OPEC	42%	11%

- 50% of the increases in world oil consumption is met by OPEC. OPEC's share of world oil production in 2040 increases to 44%.
- However, the domestic oil consumption in the Middle East OPEC is also projected to increase significantly. Enhancement of production capacity and improvement of energy efficiency in the Middle East OPEC is necessary to ensure availability of oil supply to the world market.

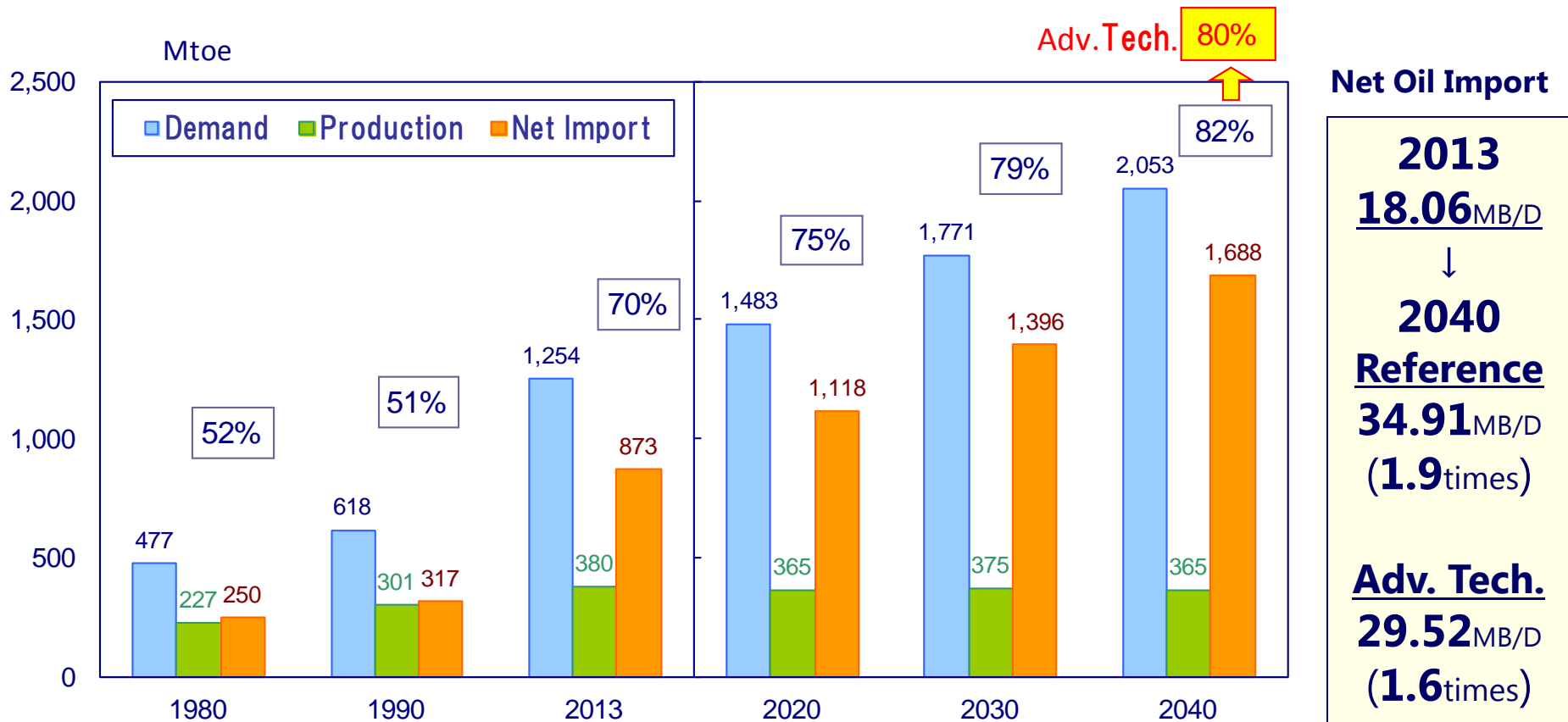
OPEC



Non-OPEC

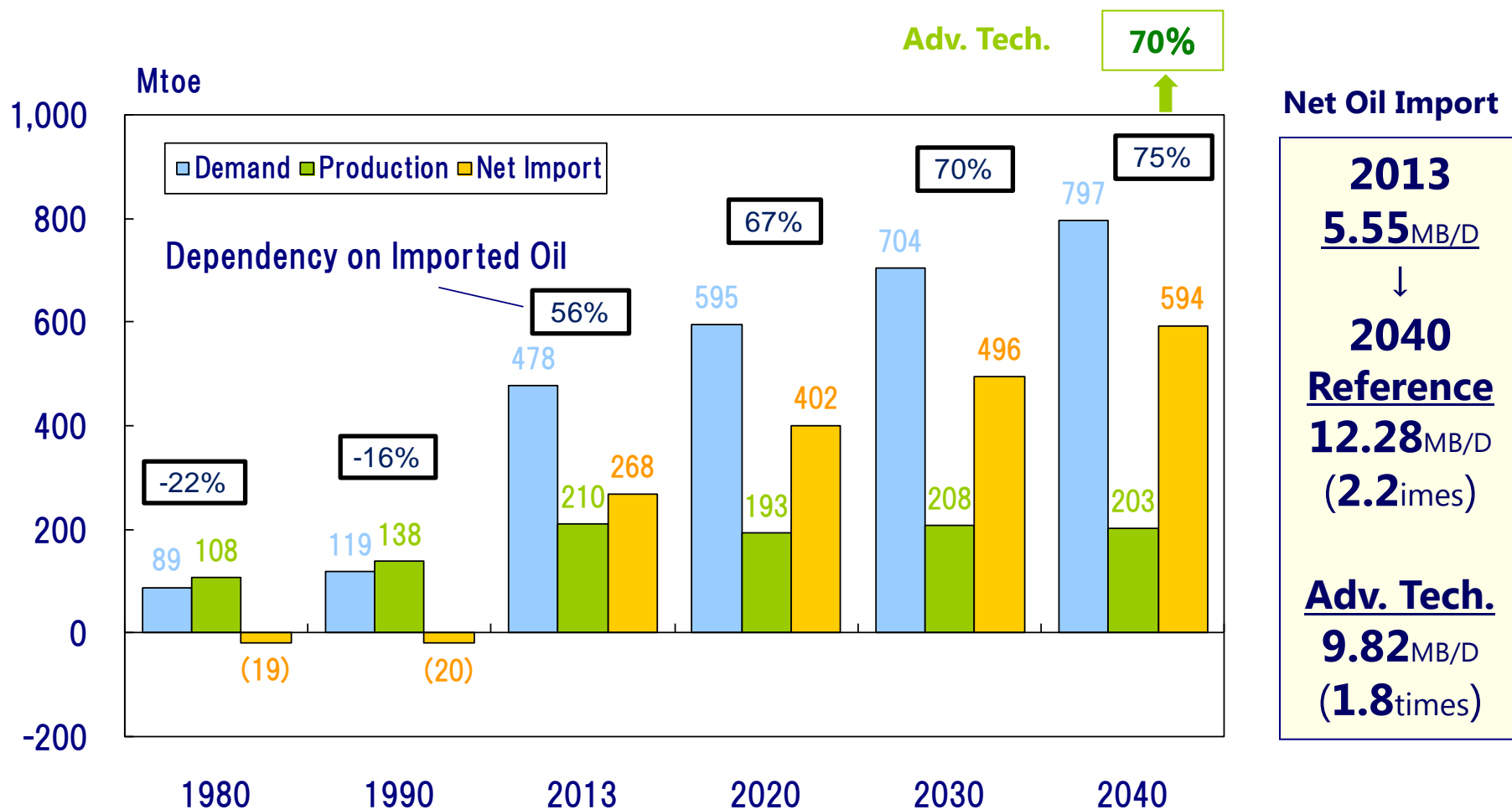


Oil Demand and Supply in Asia

Reference
Adv. Tech.

- In the Reference Scenario, net oil import is projected to expand to 1,688 million ton (34.91 mb/d) in 2040 from 873 million ton (18.06 mb/d) in 2013. With the sluggish oil production of in Asia area (China, India, Indonesia), net oil import ratio reaches 82% in 2040.
- In the Advanced Technologies Scenario, oil demand grows at a relatively slow rate, but net oil import ratio still increases to 80% in 2040.

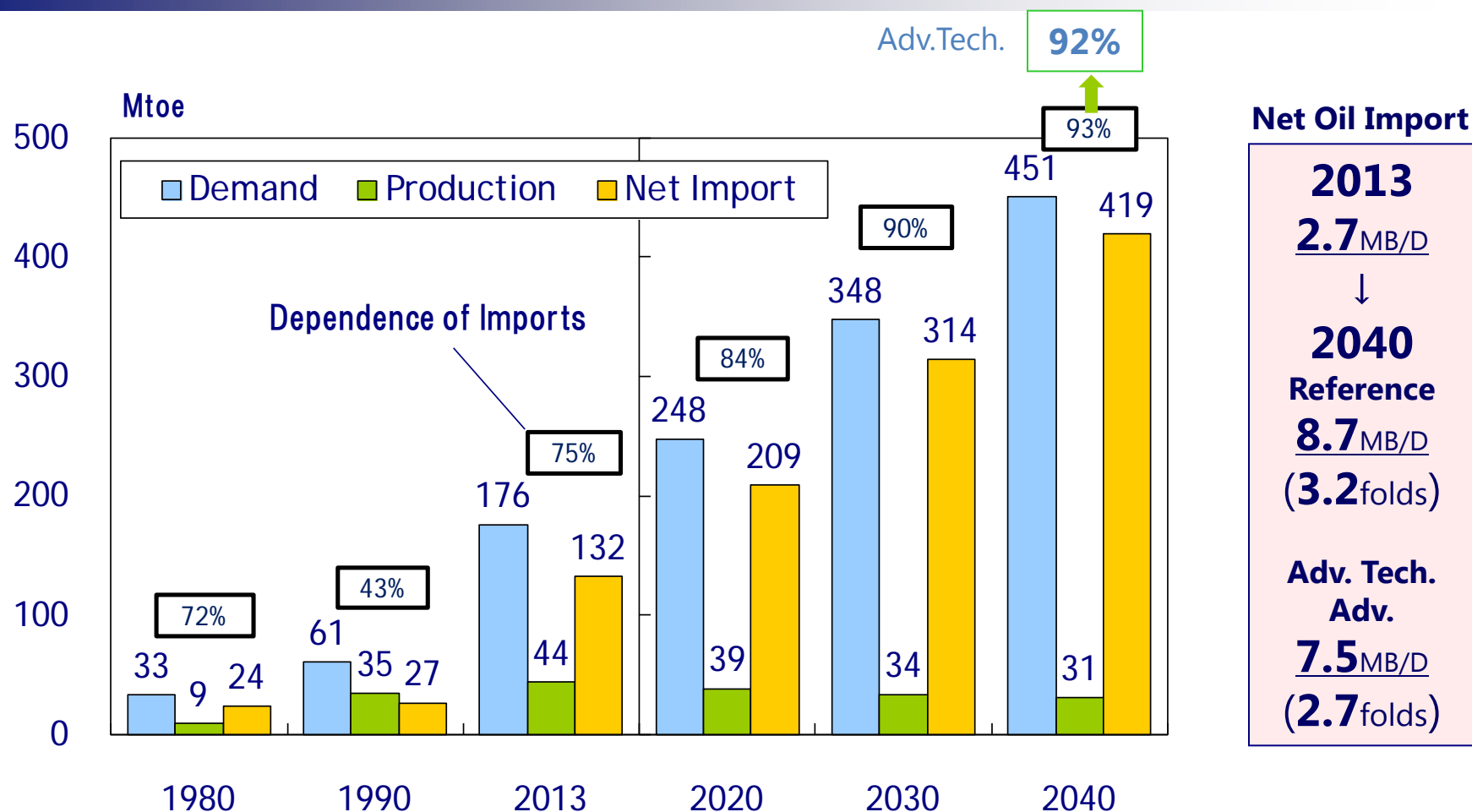
Oil Demand and Supply in China

Reference
Adv. Tech.

- Net oil import is projected to expand to 584 million ton (12.28 mb/d) in 2040. As a result, net oil import ratio reaches 75% in 2040.
- In the Advanced Technologies Scenario, oil demand grows at a relatively slow rate, but net oil import ratio still increases to 70% in 2040.
- In order to sustain domestic oil production, continued investments are required to explore and develop oil fields in the western part of China and offshore.

Oil Demand and Supply in India

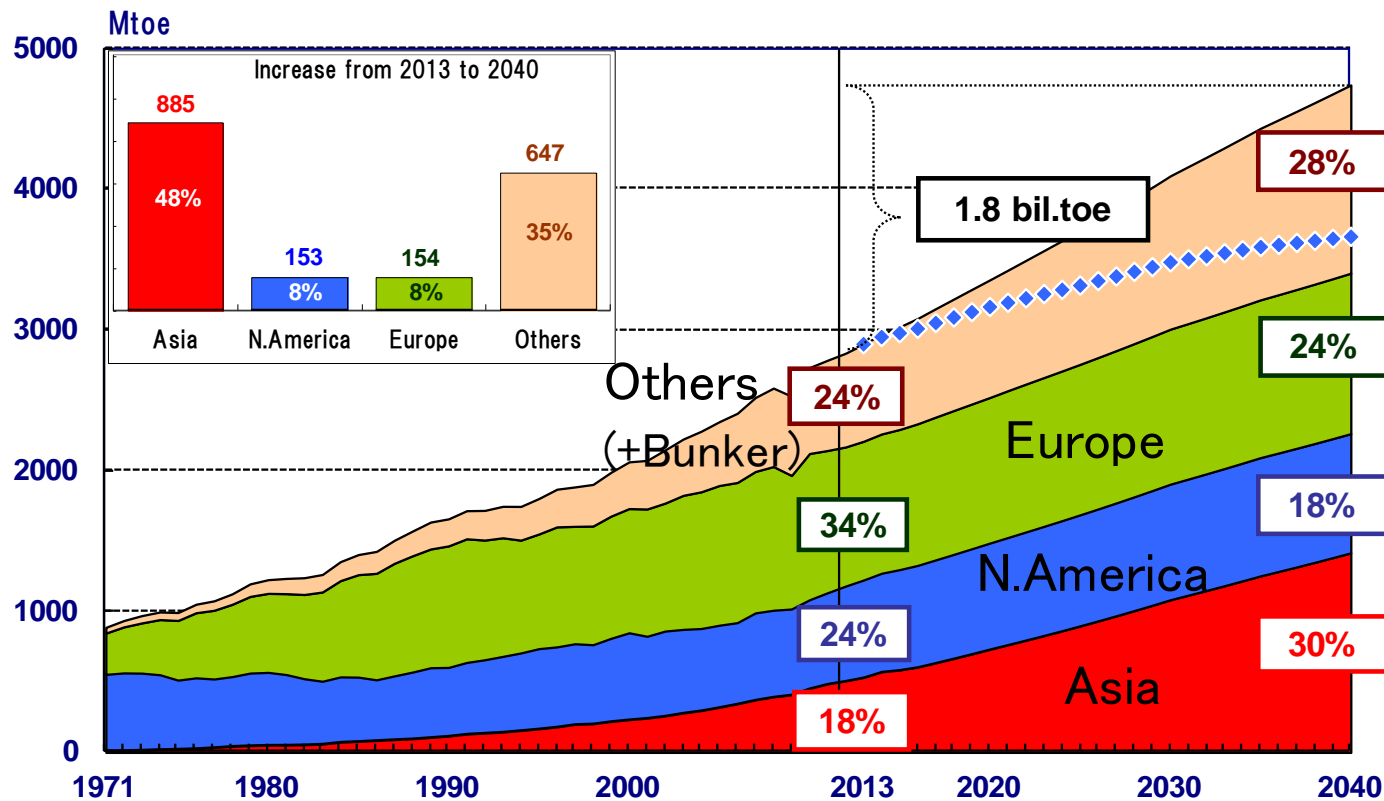
Reference
Adv. Tech.



- Net oil import is projected to expand from 132 million ton (2.7mb/d) in 2013 to 419 million ton (8.7 Mb/d) in 2040. Net oil import ratio reaches 93% in 2040.
- In the Advanced Technologies Scenario, net oil import ratio reaches 92% by 2040.

Natural Gas Consumption by Region (World)

Reference
Adv. Tech.



1.08 bil. toe
(23%)
Reduction

2013
2.9 billion toe
(3.5 trillion m³)
(2.4 bil. tons LNG)

↓

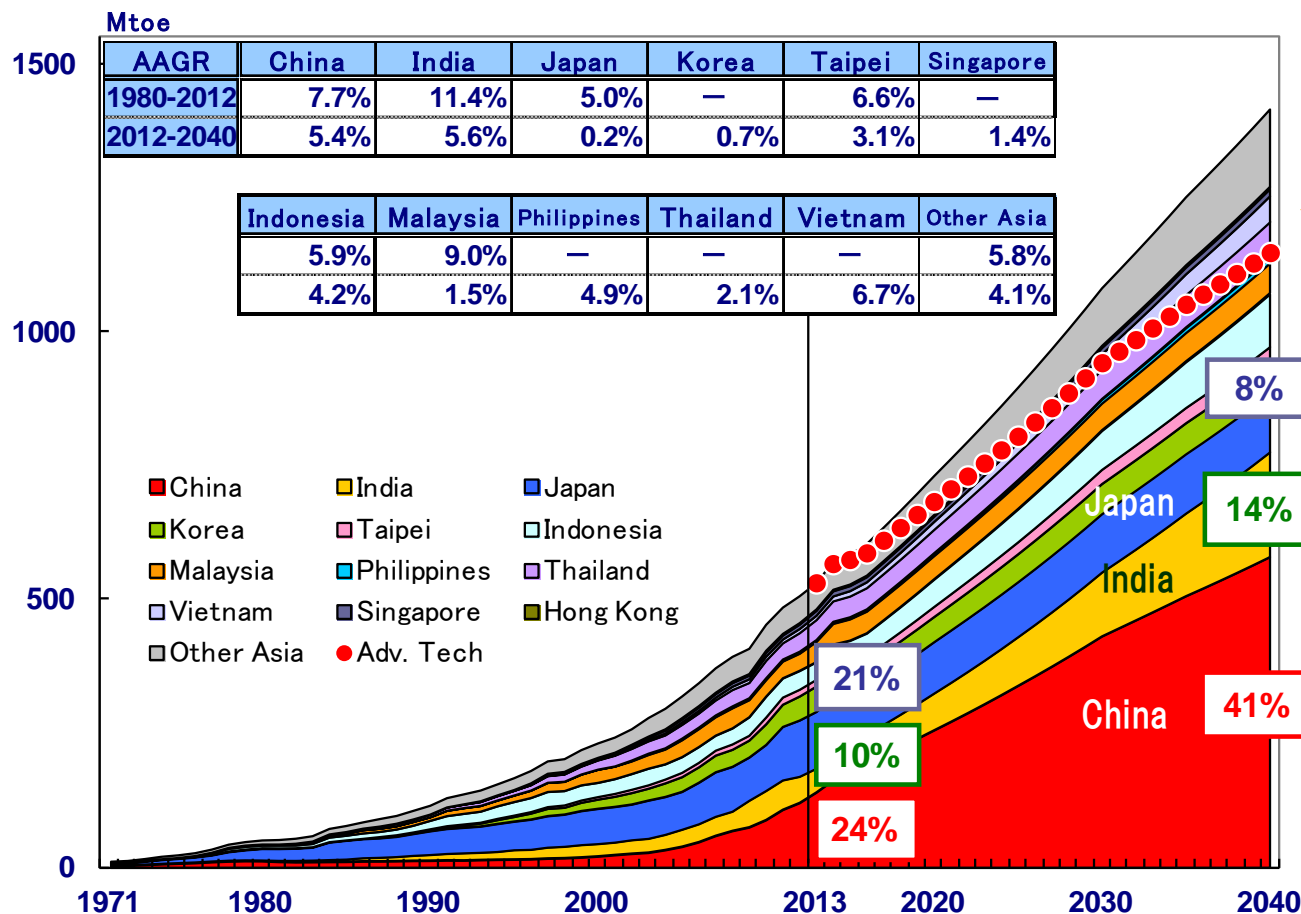
2040

Reference
4.7 billion toe
(5.8 trillion m³)
(3.9 bil. tons LNG)

Adv. Tech.
3.7 billion toe
(4.4 trillion m³)
(3.6 bil. tons LNG)

- The world natural gas consumption is expected to increase from 3.5 trillion cubic meters (tcm) in 2013 to 5.8 tcm in 2040, a 1.6-fold increase.
- In the Advanced Technologies Scenario, natural gas consumption is 1.4 tcm lower than the Reference Scenario. Despite projected savings, natural gas consumption continues to grow in the Advanced Technologies Scenario suggesting further needs of energy resources development.

Natural Gas Consumption by Country (Asia)

Reference
Adv. Tech.

0.27 bil. toe
(19%)
Reduction

2013
0.53 billion toe
(646 billion m³)
(0.43 bil. tons LNG)

↓

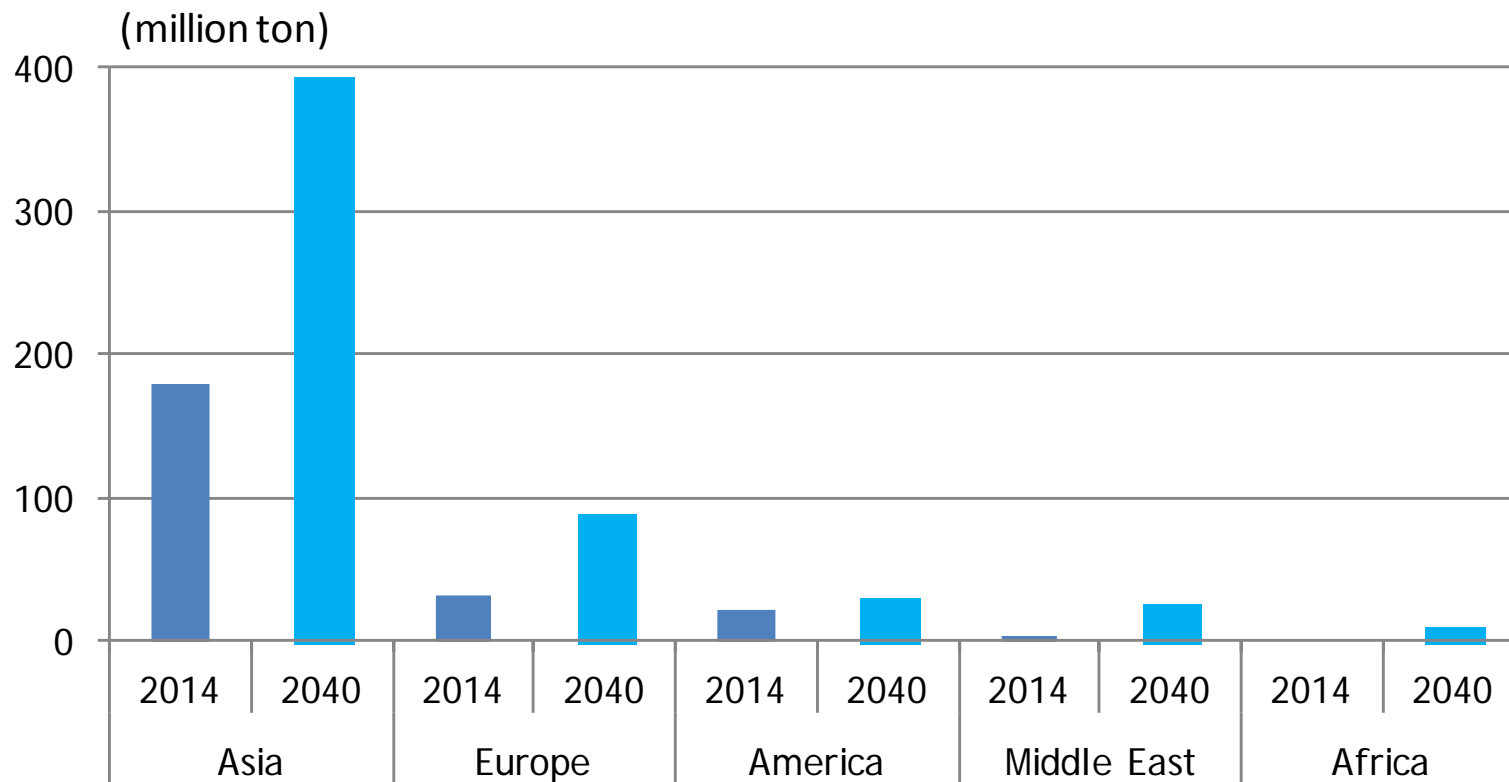
2040
Reference
1.42 billion toe
(1.72 trillion m³)
(1.15 bil. tons LNG)

Adv. Tech.
1.15 billion toe
(1.39 trillion m³)
(0.93 bil. tons LNG)

- Natural gas consumption in China considerably increases (5.4%/y) due mainly to the increasing consumption for power generation and use in urban areas. India's natural gas consumption also expands but at a similar pace (5.6%/y), representing more than a four-fold increase from 2013 to 2040.
- In the Advanced Technologies Scenario, the Asia natural gas consumption is 325 bcm (or 19%) lower than the Reference Scenario by 2040. Even in this scenario, natural gas consumption increases at a relatively fast pace of 3.7% per year through 2040.

LNG imports (world)

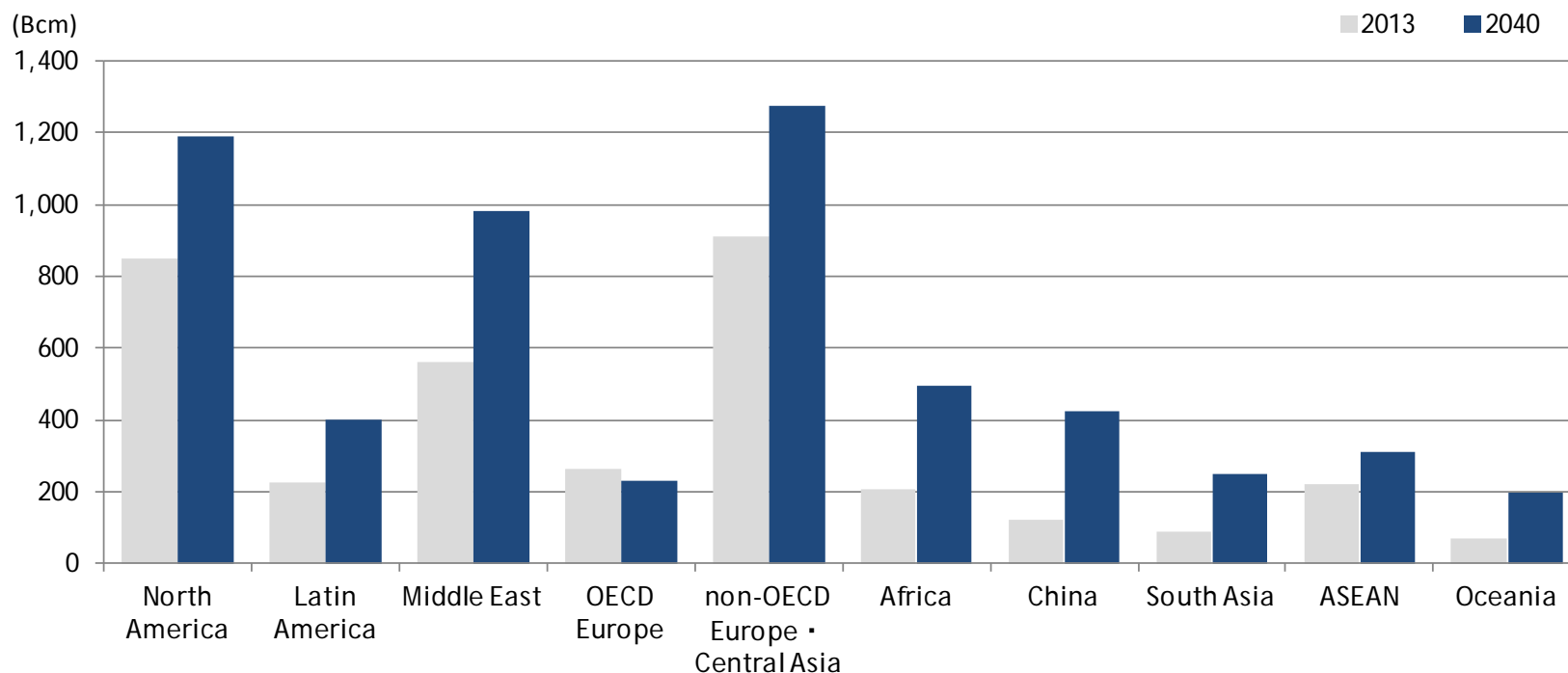
Reference Scenario



- World LNG demand expands from 239 million tons in 2014 to 547 Mt in 2040 (2.3 times).
- Asia's LNG demand increases by 214 Mt, accounting for about 70% of the world's LNG demand growth, whereas the growth in Europe (56 Mt) accounts for around 20%. LNG import from North America to Latin America increases by 6 Mt.
- LNG supply capacity is sufficient to meet demand if new LNG projects starts on schedule in the future.

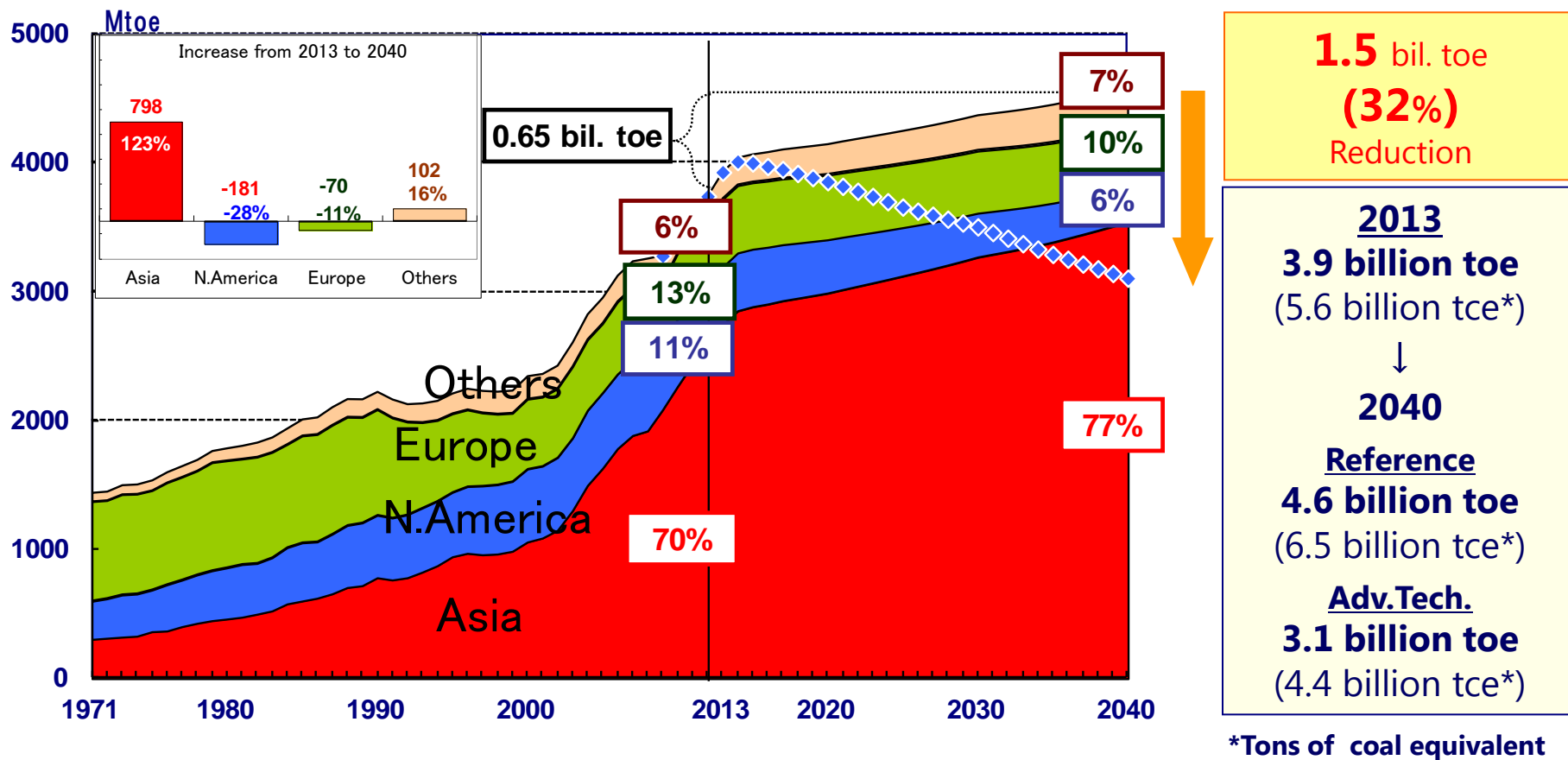
Natural Gas Production (World)

Reference



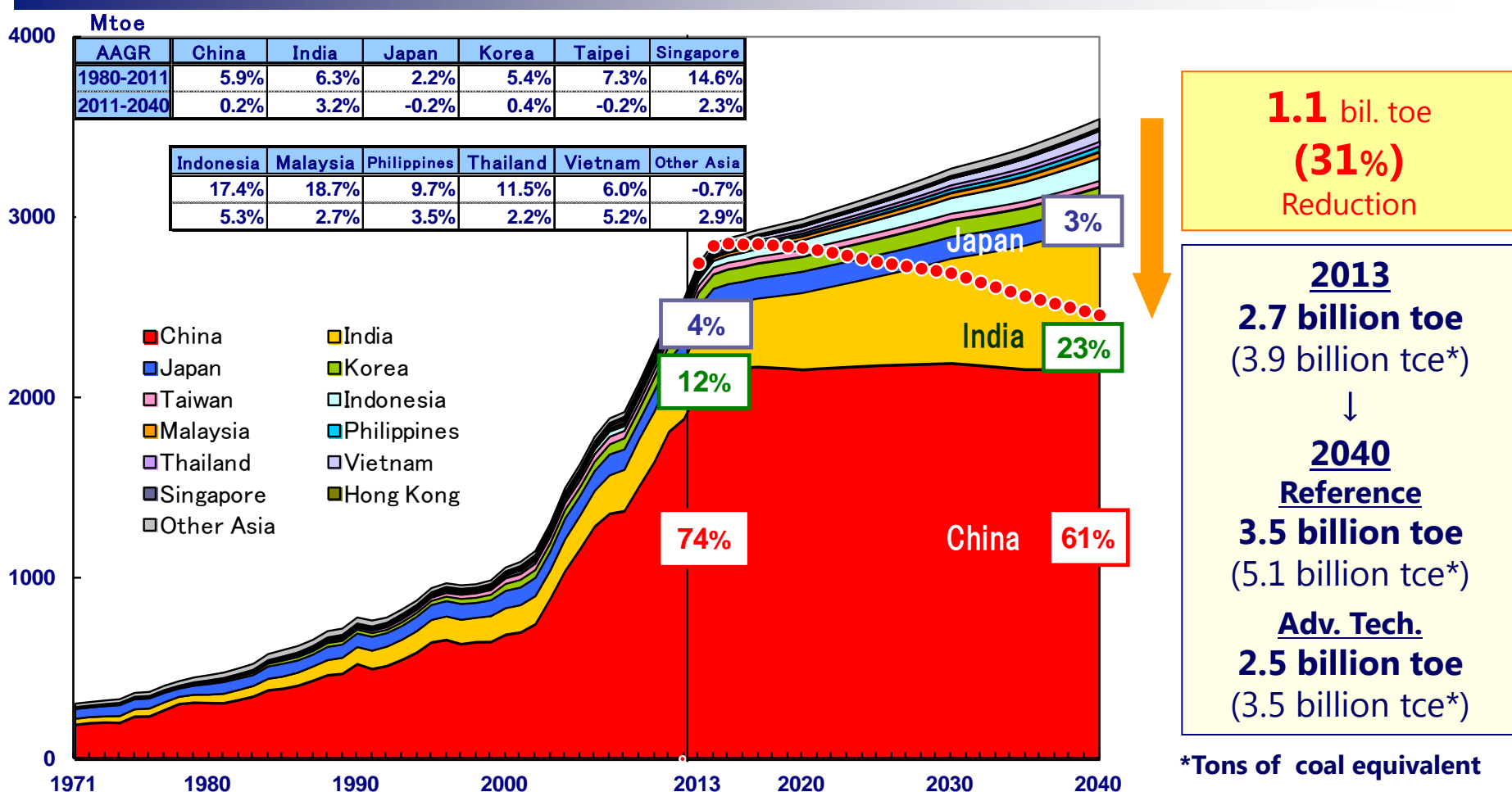
- Natural gas production expands to meet the increasing demand around the world especially in North America, the Middle East, Russia, Africa, China, India and Australia.
- Unconventional gas is to be commercialized gradually in Latin America, the Middle East, non-OECD Europe/Central Asia, and OECD-Europe in addition to North America and China.

Coal Consumption by Region (World)



- Asia accounts for about 80% of the world coal consumption growth through 2040. The share of Asia in total coal consumption expands to 77% in 2040 from 70% in 2013.
- In the Advanced Technologies Scenario, the world coal consumption in 2040 is 1.5 billion toe (or 32%) lower compared with the Reference Scenario.

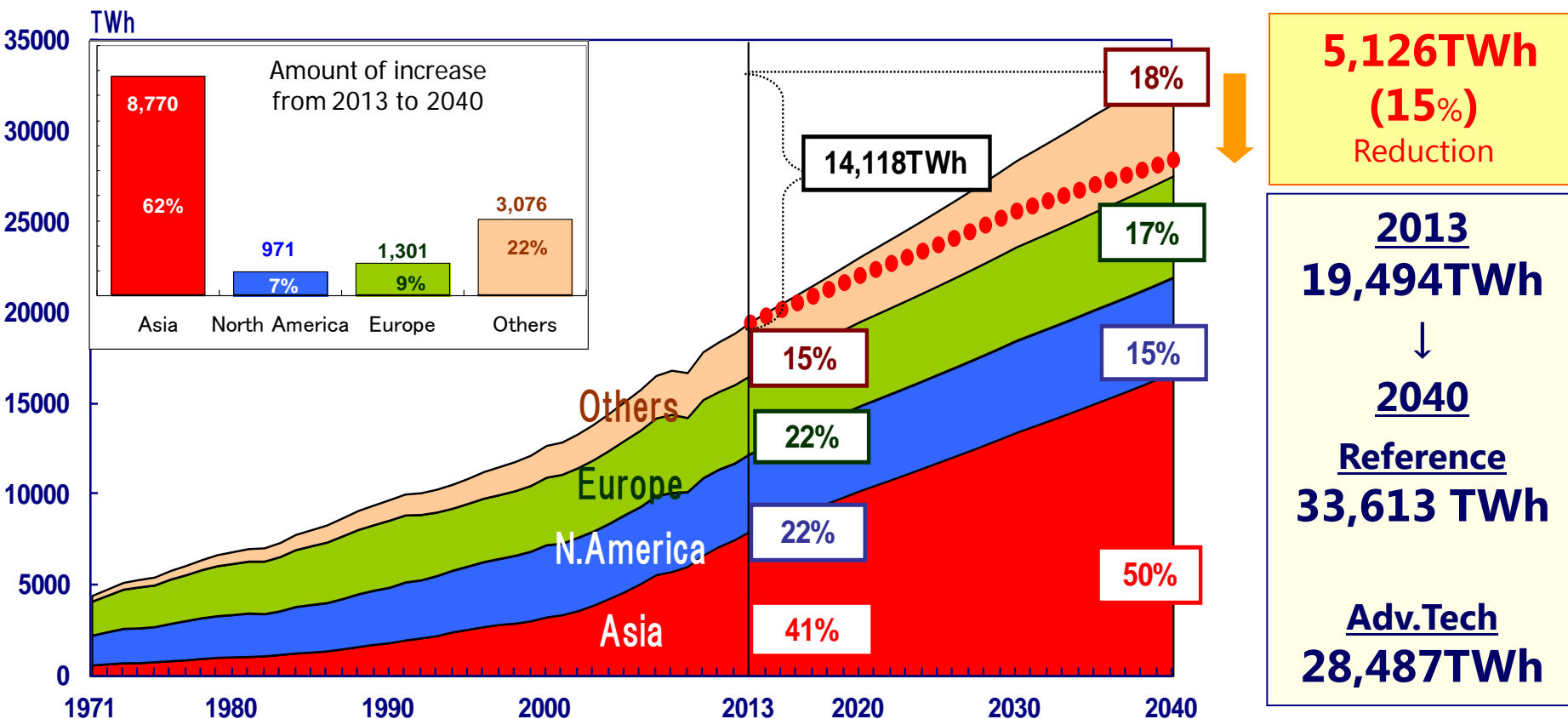
Coal Consumption by Country (Asia)



- The power sector, mainly in China and India, drives coal consumption. Both those countries have abundant domestic coal reserves.
- In the Advanced Technologies Scenario, coal consumption in Asia by 2040 is 1.1 billion toe (or 31%) lower due to a shift to natural gas and the enhancement of power generation efficiency compared to the Reference Scenario.

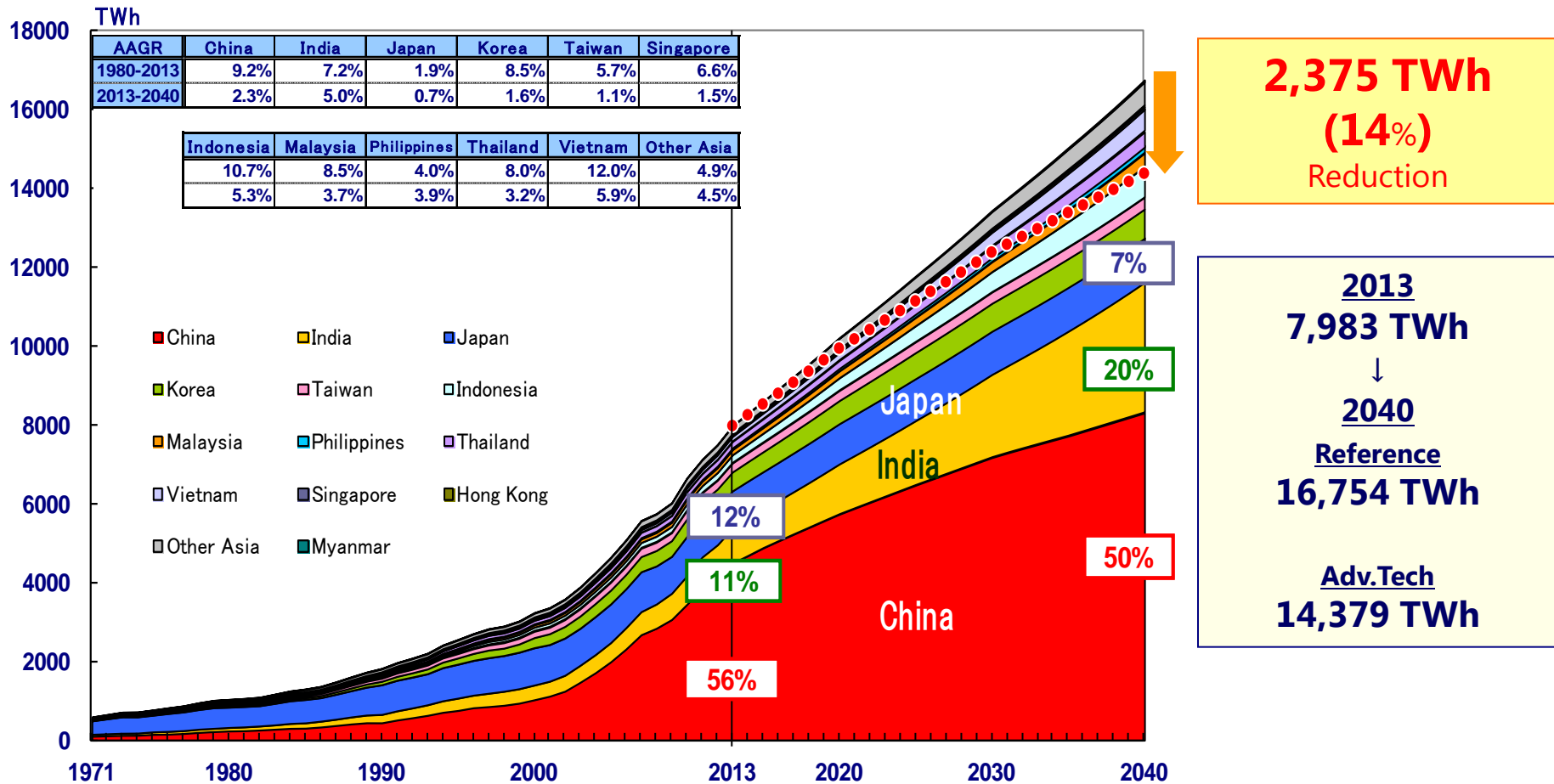
Electricity Consumption by Region (World)

Reference
Adv. Tech.



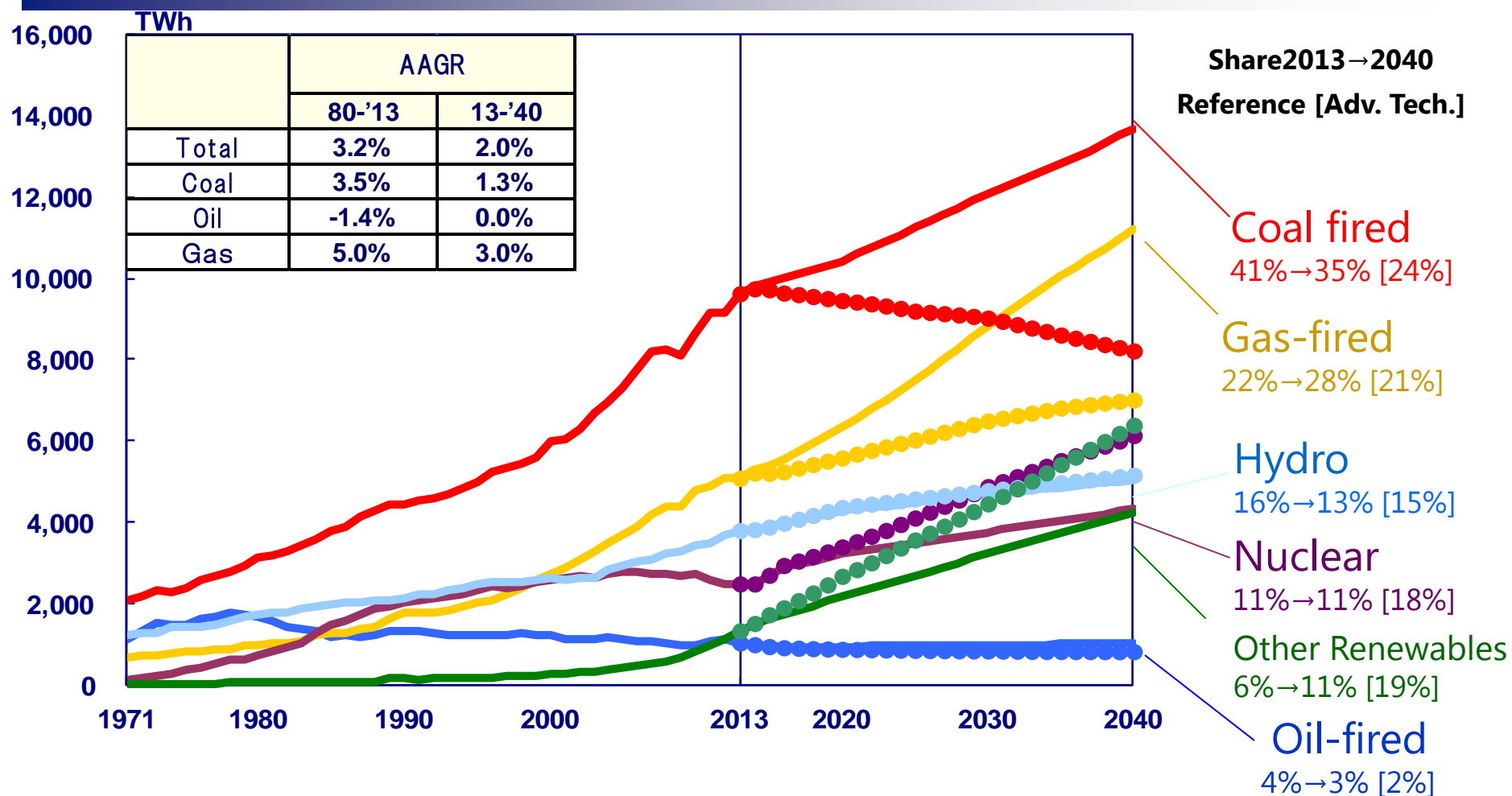
- Asia accounts for 60% of the world electricity consumption growth through 2040, and the share of Asia in total electricity consumption expands to almost 50%.
- In the Advanced Technologies Scenario, the world electricity consumption in 2040 is 5,126TWh (or 15%) lower compared to the Reference Scenario.

Electricity Consumption by Country (Asia)



- Electricity consumption in Asia increases rapidly driven by the improvement of living standards. Electricity consumption in China expands 185% by 2040, and India expands 368% during the same period.
- Through 2040, electricity consumption increases at a faster rate than final energy consumption (Reference Scenario at 2.8%, and Advanced Technologies Scenario at 2.2% per year).

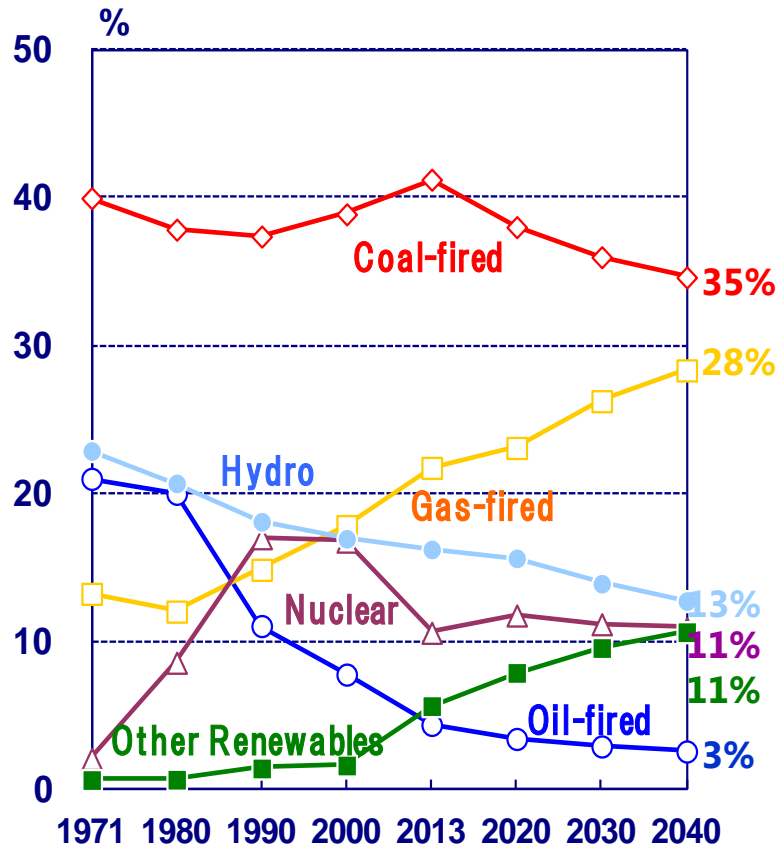
Power Generation Mix by Source (World)



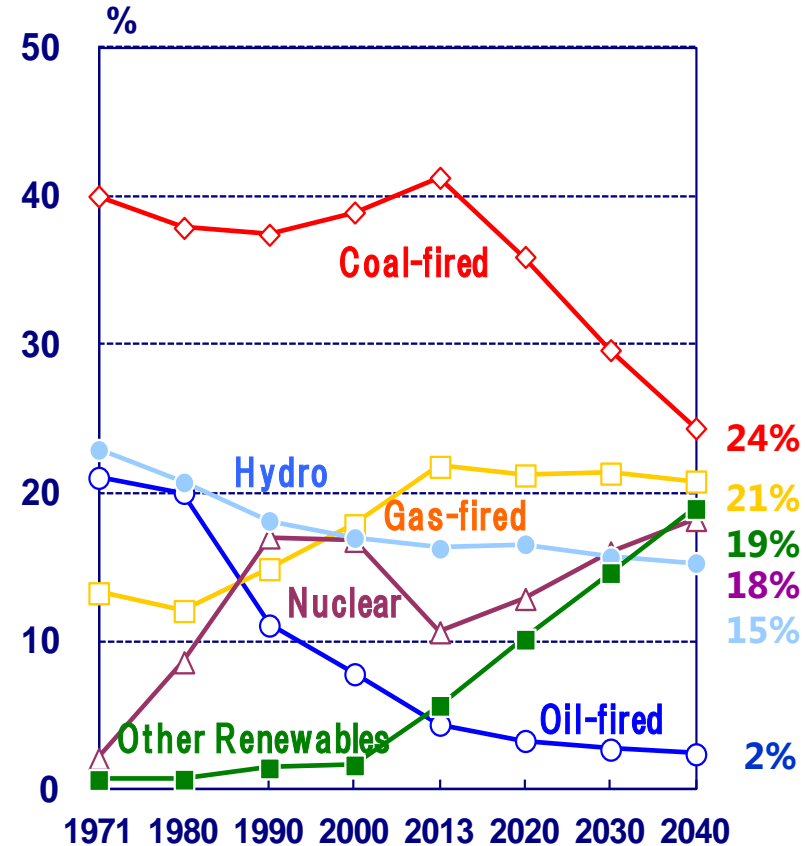
- Coal-fired generation maintains the biggest share in the power generation mix by 2040.
- Gas fired generation increases due to technology import of Integrated Gasification Combined Cycle.
- In the Advanced Technologies Scenario, the share of coal-fired generation decreases substantially to 24%, while that of renewable energy and nuclear increases.

Power Generation Mix by Source (World)

Reference Scenario



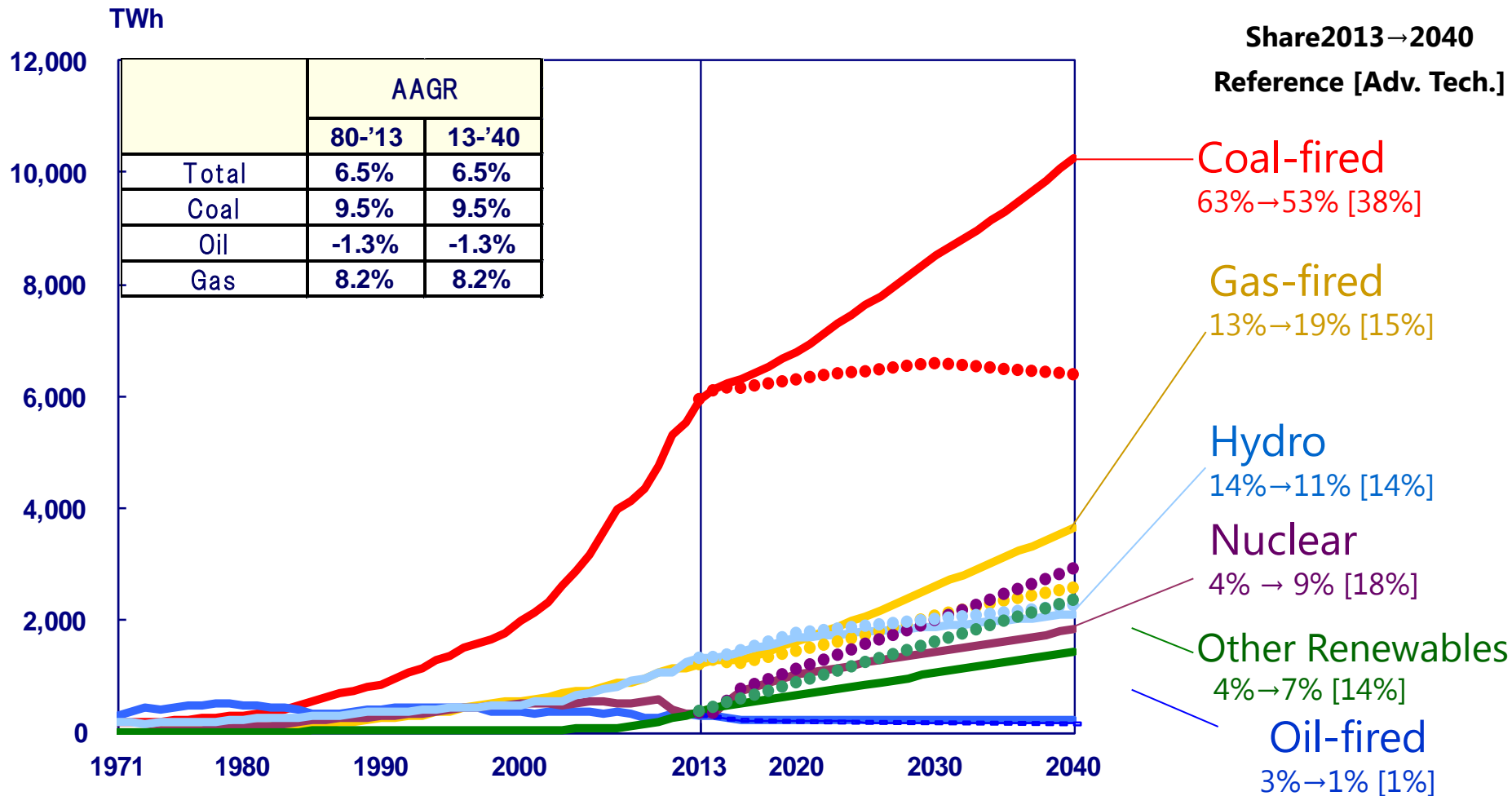
Adv.Tech Scenario



- In the Ref. Scenario, Coal-fired generation maintains the biggest share in the power generation mix by 2040.
- In the Advanced Technologies Scenario, the share of coal-fired generation decreases substantially, while that of renewable energy and nuclear increases.

Power Generation Mix by Source (Asia)

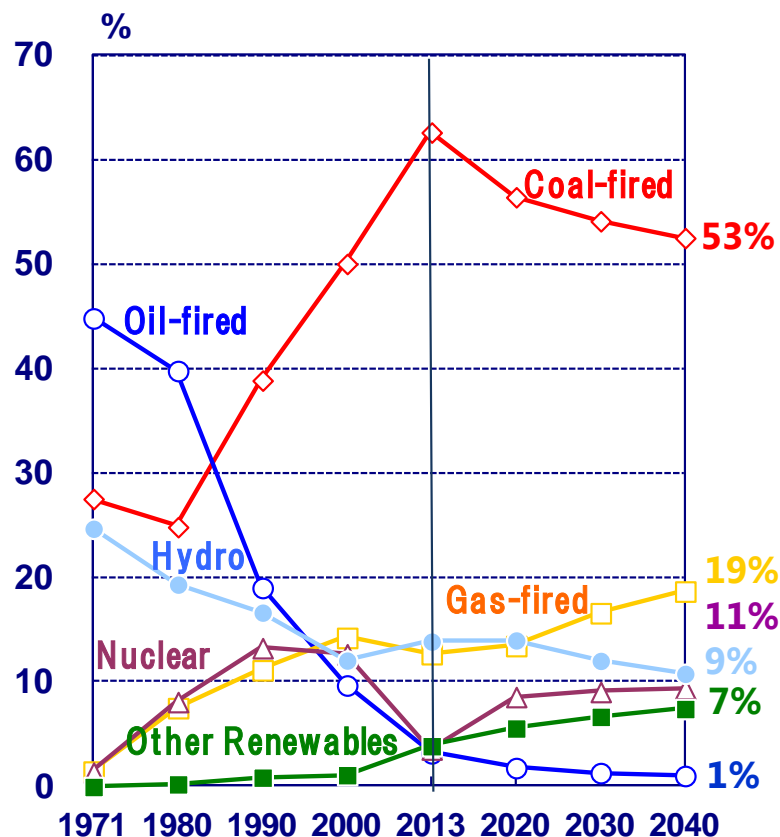
Solid line: Reference
Dotted line: Adv. Tech.



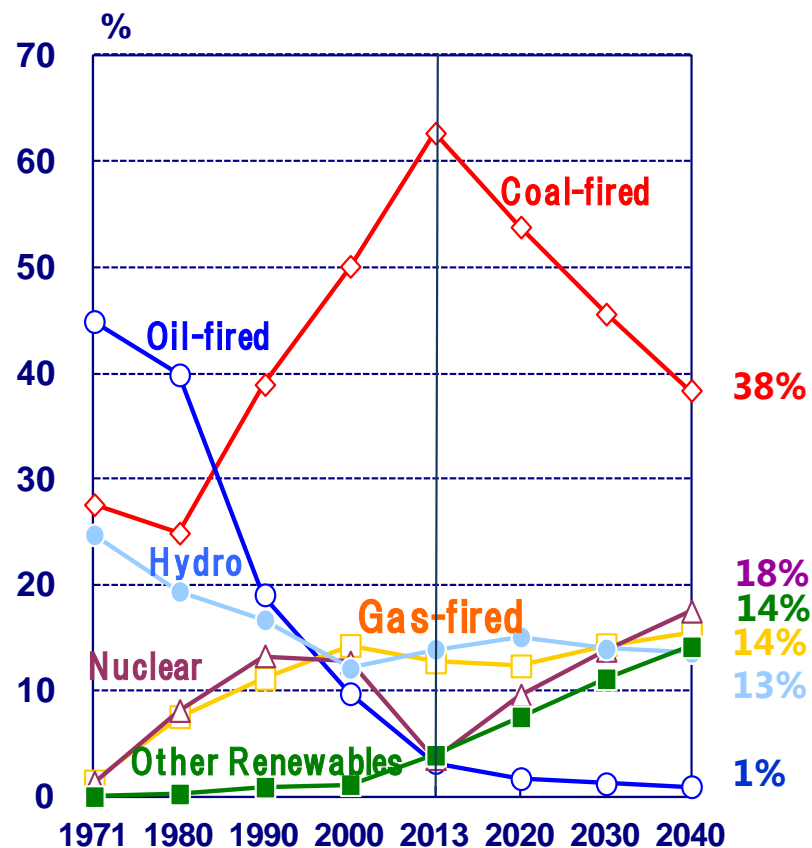
- The Asia's share of coal in the generation mix remains higher than 50%, reflecting resources availability.
- The share of natural gas increases from 13% in 2013 to 19% in 2040. The share of nuclear power generation remains 9% in 2040.
- In the Advanced Technologies Scenario, the share of coal declines from 63% in 2013 to 38% in 2040. Clean coal technology (CCT) is expected to play an important role in addressing global warming issues.

Power Generation Mix by Source (Asia)

Reference Scenario



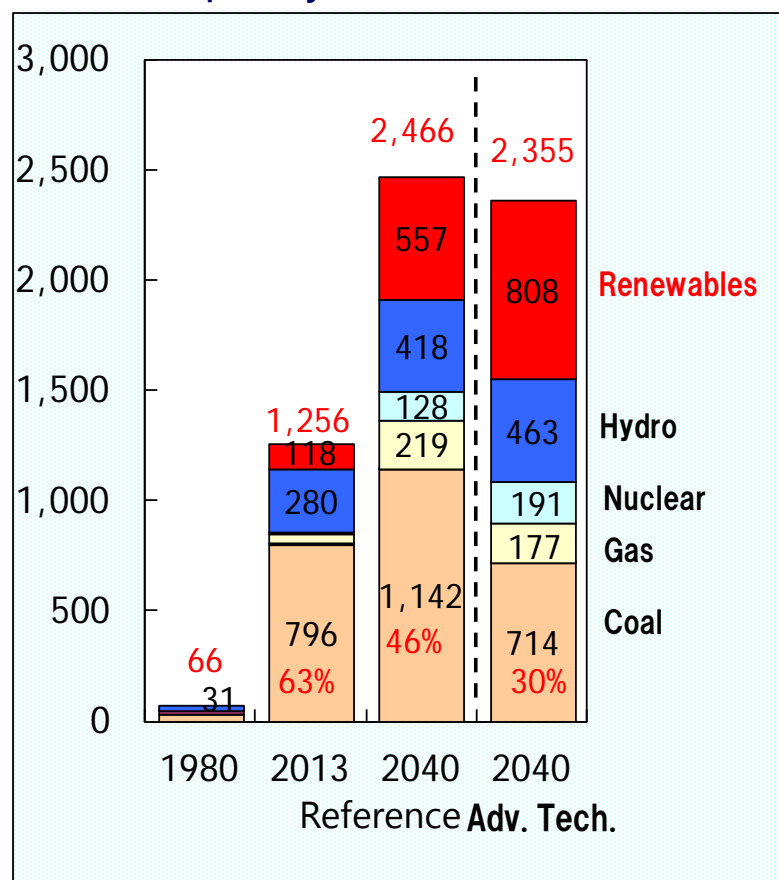
Adv.Tech Scenario



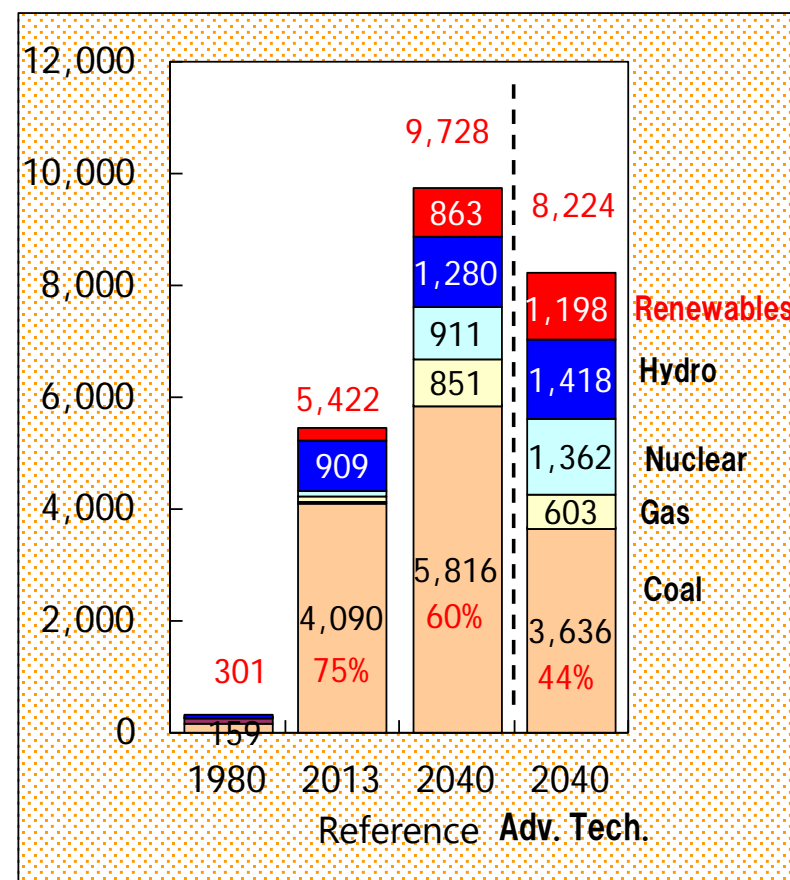
- In Asia, the share of coal-fired generation remains the highest in order to meet a growing electricity consumption.
- In the Advanced Technologies Scenario, the share of coal-fired generation decreases substantially, substituted by increases in renewable energy, hydro and nuclear shares.

Power Generation mix in China

Capacity (GW)



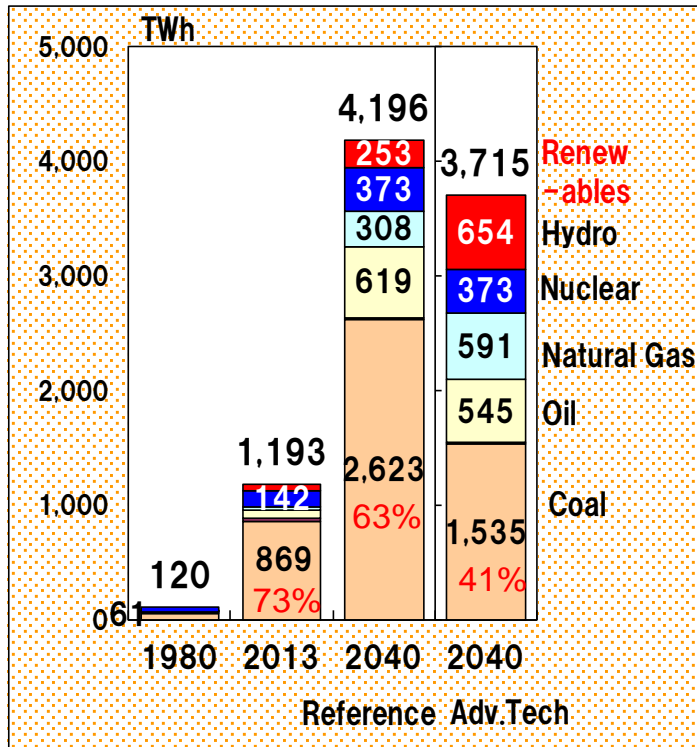
Power Generation (TWh)



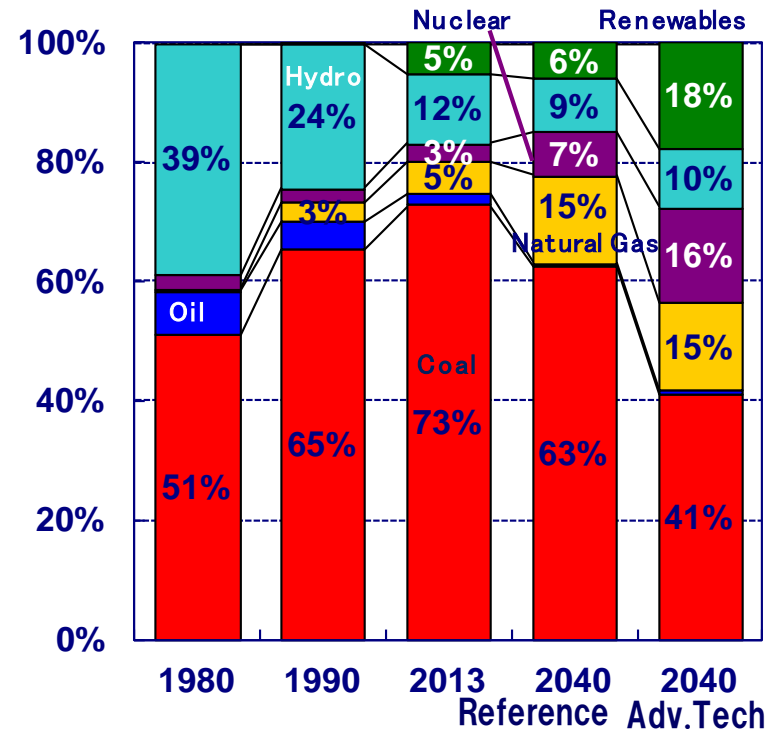
- Total power generation capacity increases on average by 45 GW per year, from 1,256GW in 2013 to 2,466 GW in 2040. The share of coal-fired power plant gradually declines to 46% in 2040.
- Total power generation increases 80%, from 5,422 TWh in 2013 to 9,728 TWh in 2040. The share of coal-fired generation declines from 75% in 2013 to 60% in 2040.
- Power generation from gas-fired, nuclear and renewables substantially increase.
- In the Advanced Technologies Scenario, generation from nuclear, hydro and renewable energy sharply expand to substitute a further decline in coal-fired generation.

Power Generation Mix in India

Power Generation

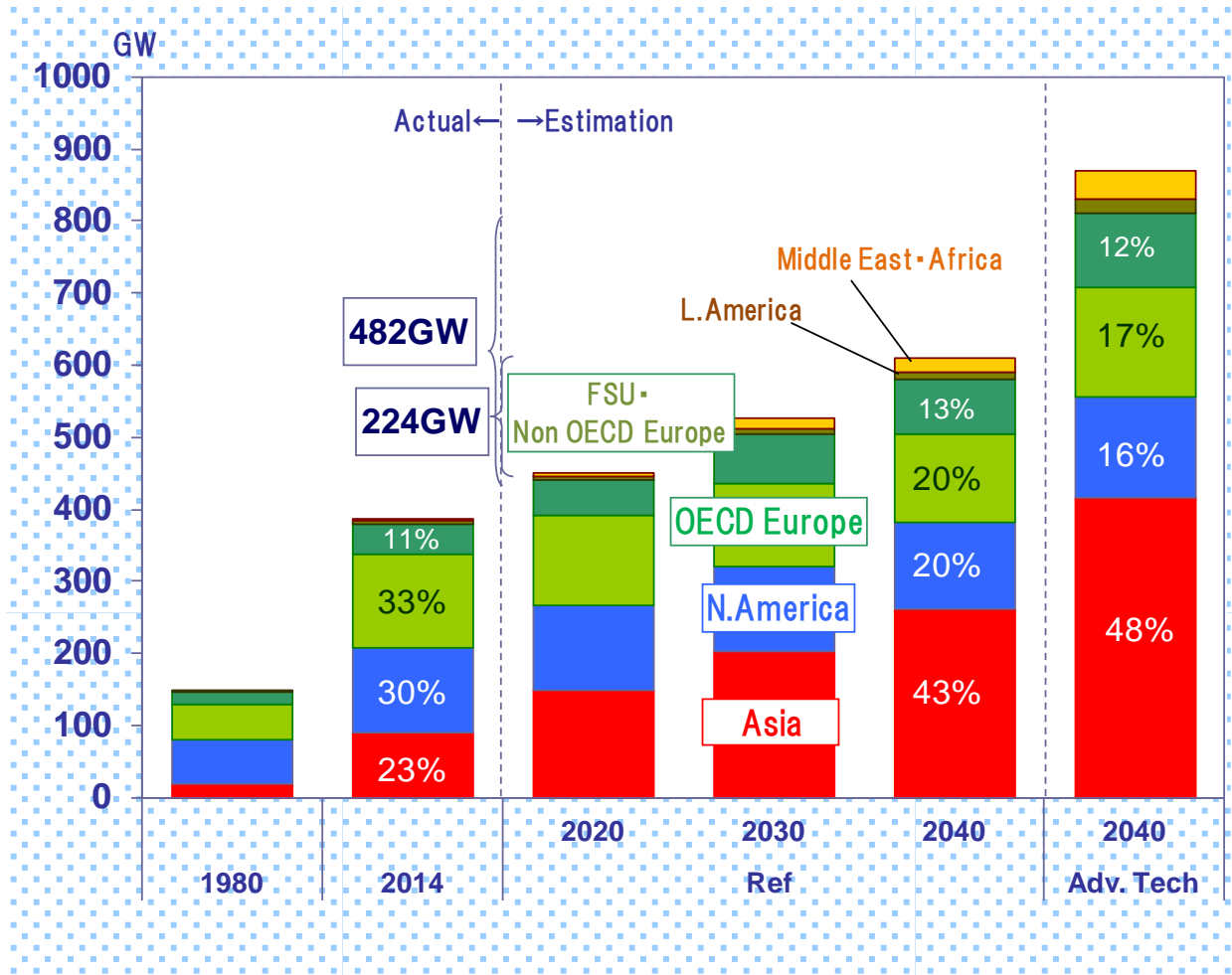


Power Generation Mix



- Coal-fired power continues to account for the largest share. The generation efficiency improves led by the government's Ultra Mega Power Project to introduce several 4GW-class super critical coal-fired power plants.
- On the other hand, the share of natural gas and nuclear gradually expands and power generation mix becomes more diversified.
- Nuclear capacity increases from 5.8 GW in 2015 to 47GW in 2040 (a 8.1-fold increase) in reference scenario, 90GW in 2040(a 15.6-fold increase) in Advanced Technologies Scenario.

Nuclear Power Generation Capacity



World

2014
386 GW

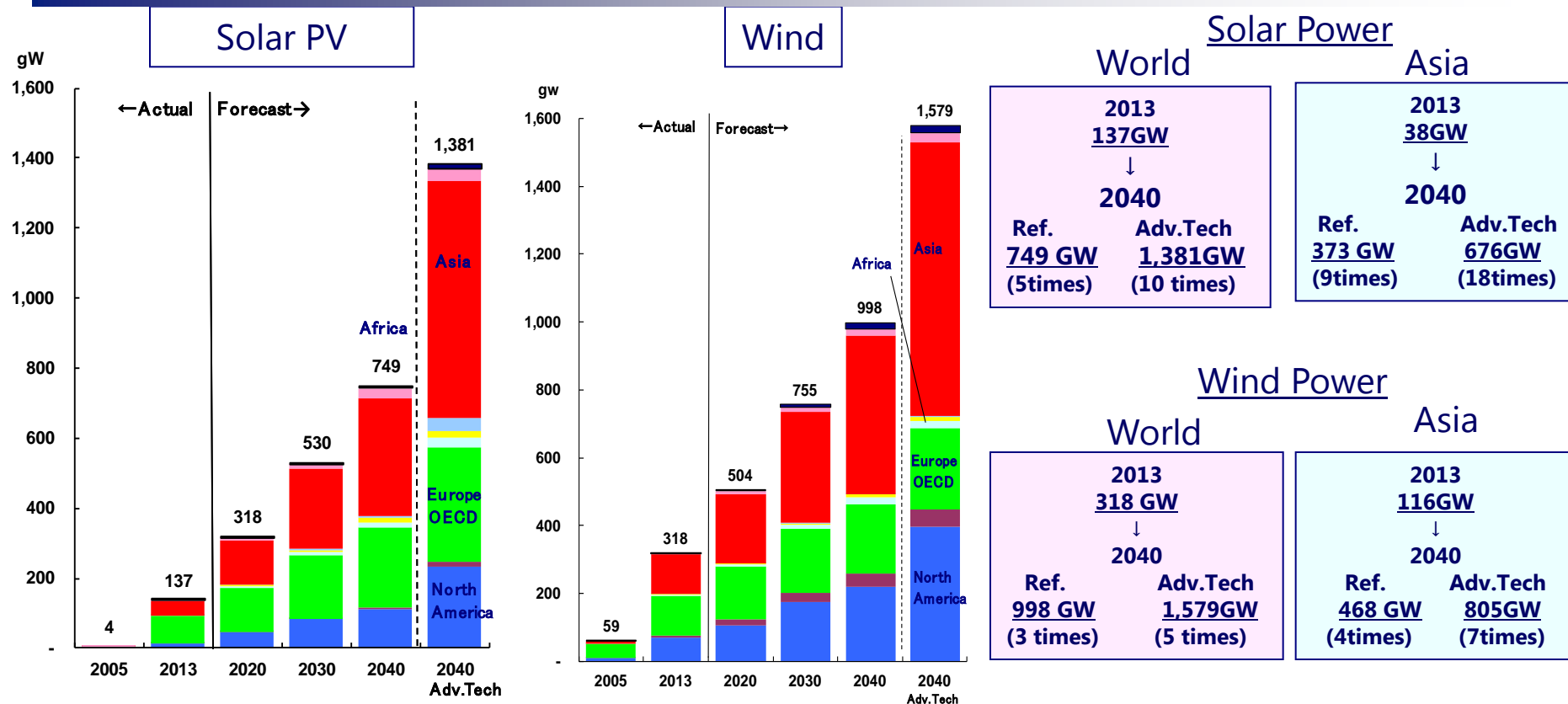
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2040
Reference
610 GW
(+224 GW)

Adv. Tech
868GW
(+482GW)

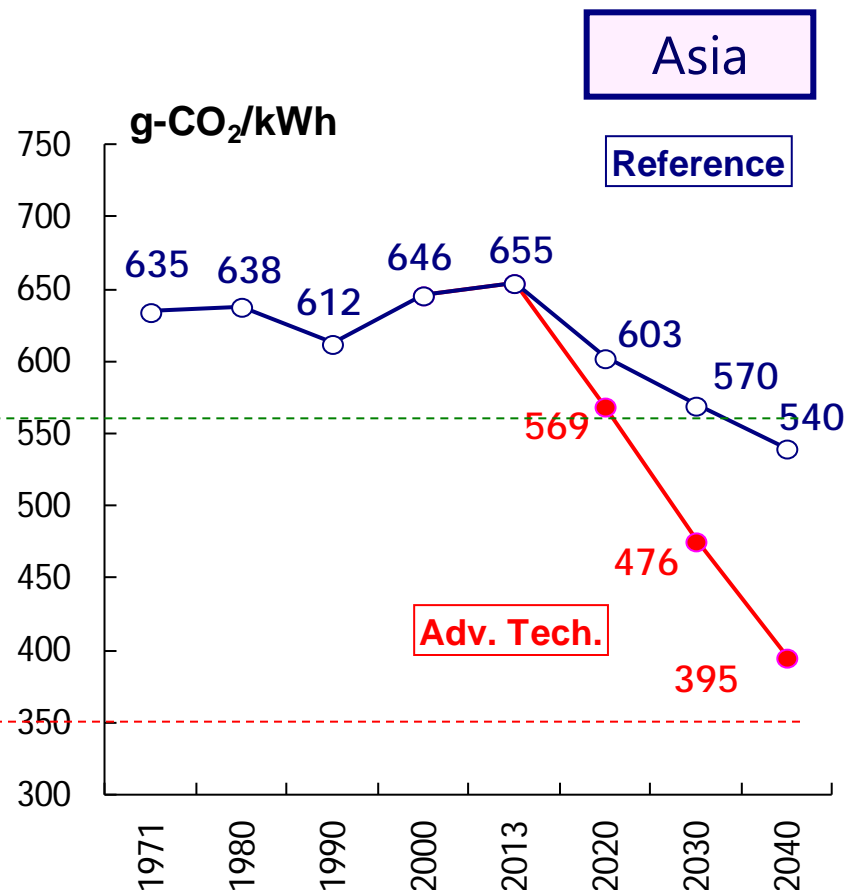
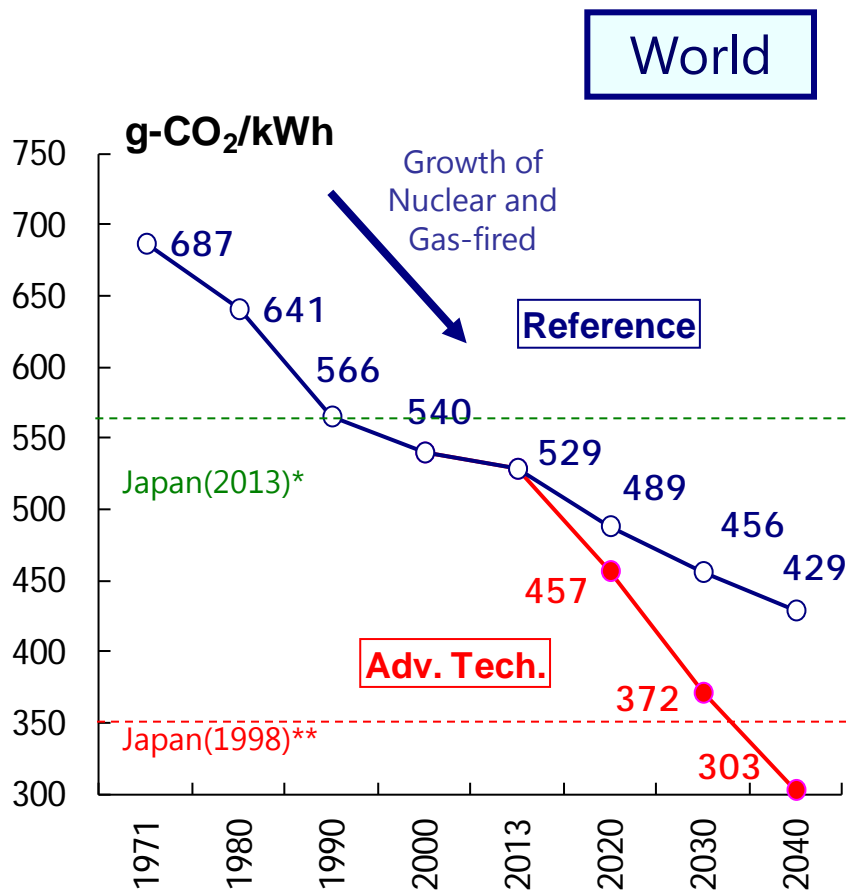
- Nuclear power generation capacity increases 224 GW in the Reference Scenario, and 482 GW in the Advanced Technologies Scenario up to 2040 with most of the increase concentrated in Asia. In the Advanced Technologies Scenario, nearly half of generation capacity is in Asia in 2040.

Solar PV and Wind Power Generation Capacity (World)



- Renewable energy will increase by support measures such as, technological developments, Feed-in Tariff(FIT) and subsidy.
- In the Ref Scenario, Solar Power Plant Capacity increases to 749GW and Wind Power Plant Capacity increases to 998GW by 2040.
- The component ratio of solar and wind energy increases from 2.0% in 2013 to 4.4% in 2040.
- In the Advanced Technologies Scenario, Solar Power Plant Capacity increases to 1,381GW by 2040, and wind capacity increases to 1,579GW.

Carbon Intensity of Electricity (CO₂ Emissions per kWh)



*560g-CO₂/kWh **350g-CO₂/kWh

- The average CO₂ emissions per kWh is reduced substantially reflecting the expansion in nuclear and renewable energy as well as efficiency improvements in fossil-fired power generation.
- In the Advanced Technologies Scenario, the average CO₂ emissions per kWh in the world in 2040 are 43% less than the 2013 level. In Asia, the reduction reaches 40%.

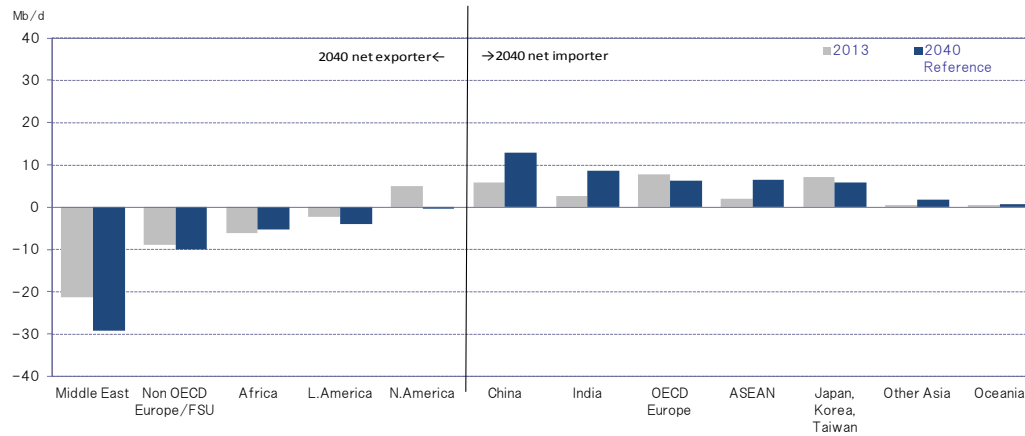
Fossil fuel international trade

Oil and natural gas net import

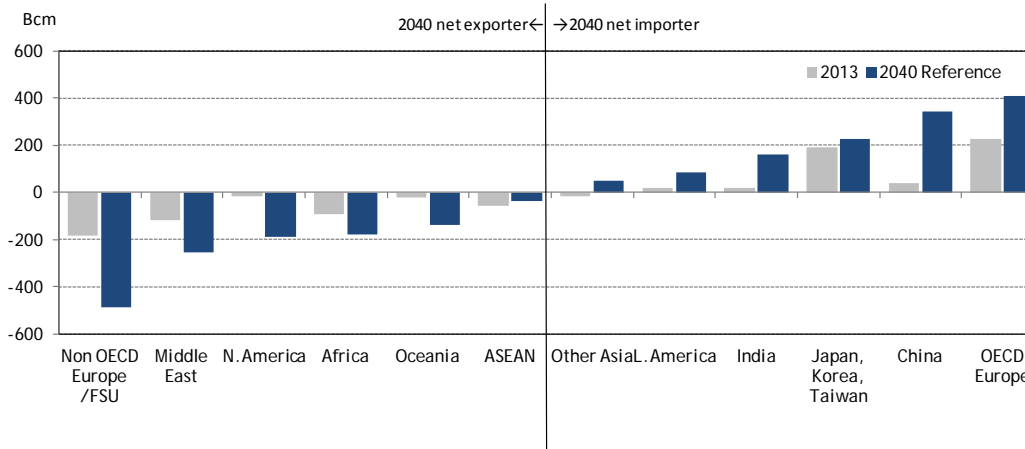
Reference Scenario



Oil

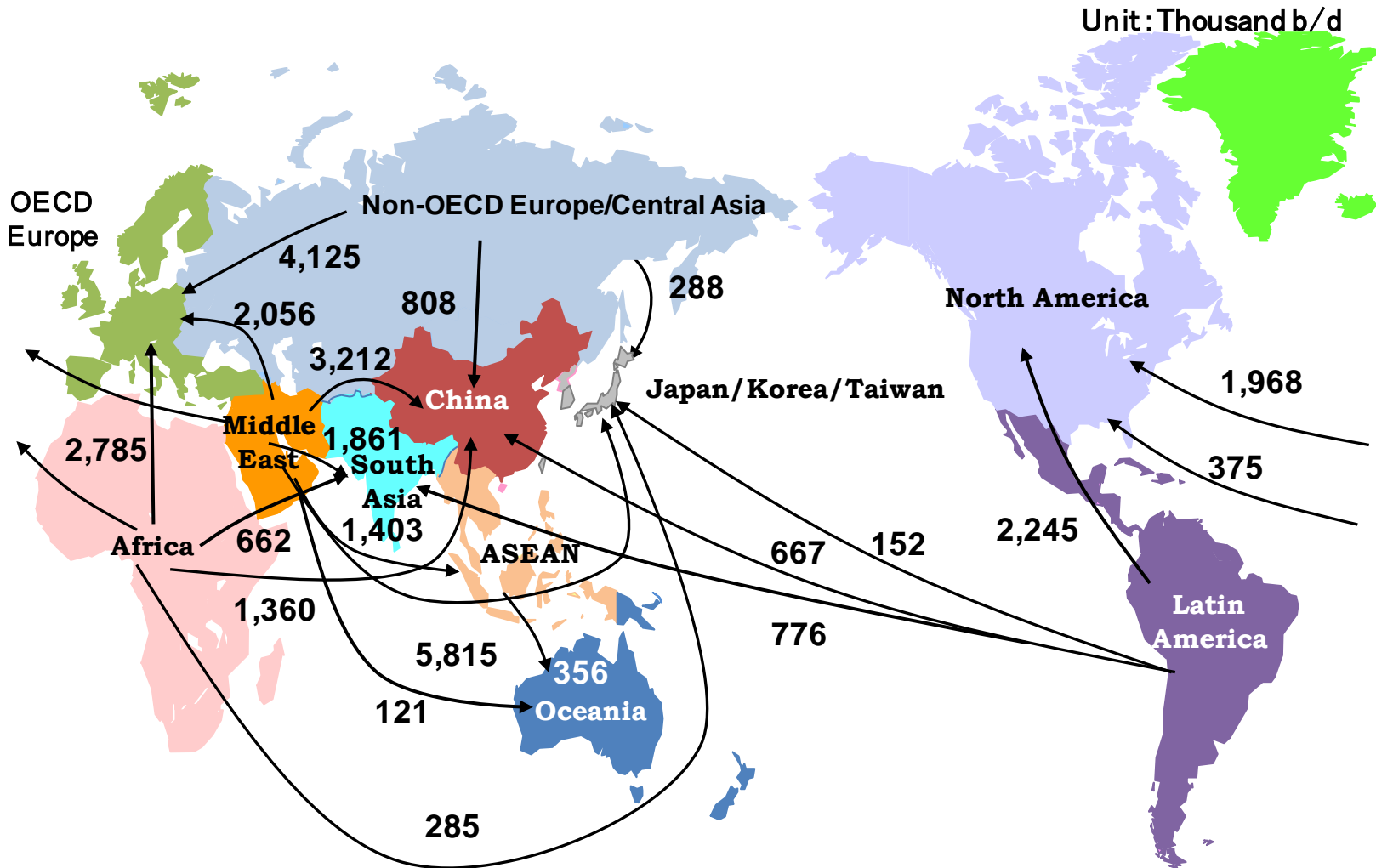


Natural Gas



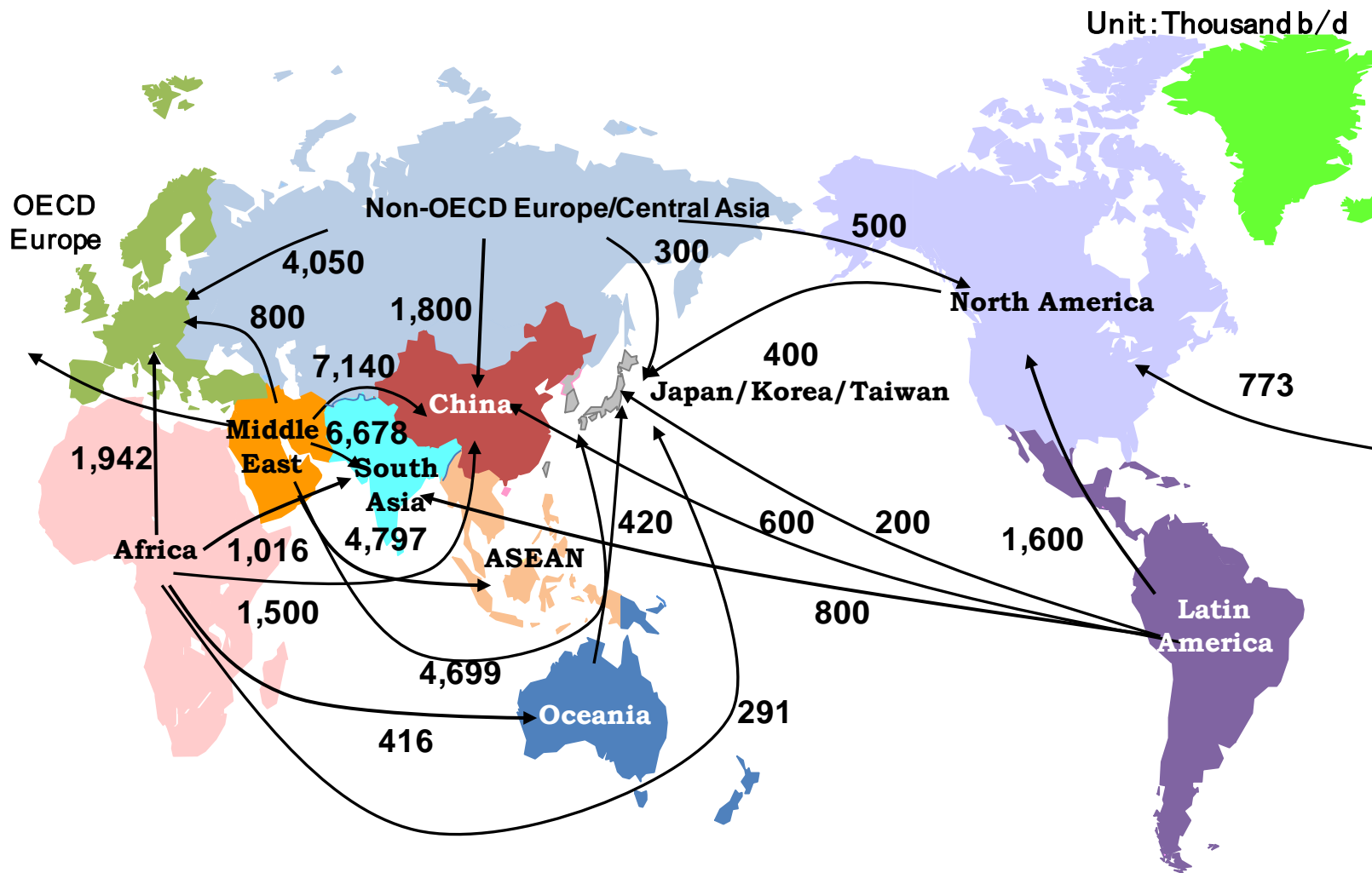
- While oil consumption expands in Asia up to 2040, North America turns into an exporting region.
- Oil production increase in the Middle East is imperative in correspondence with Asian consumption increase.
- Asia also increases natural gas imports. Exports from North America increase largely.

Major crude oil trade flows (2014)



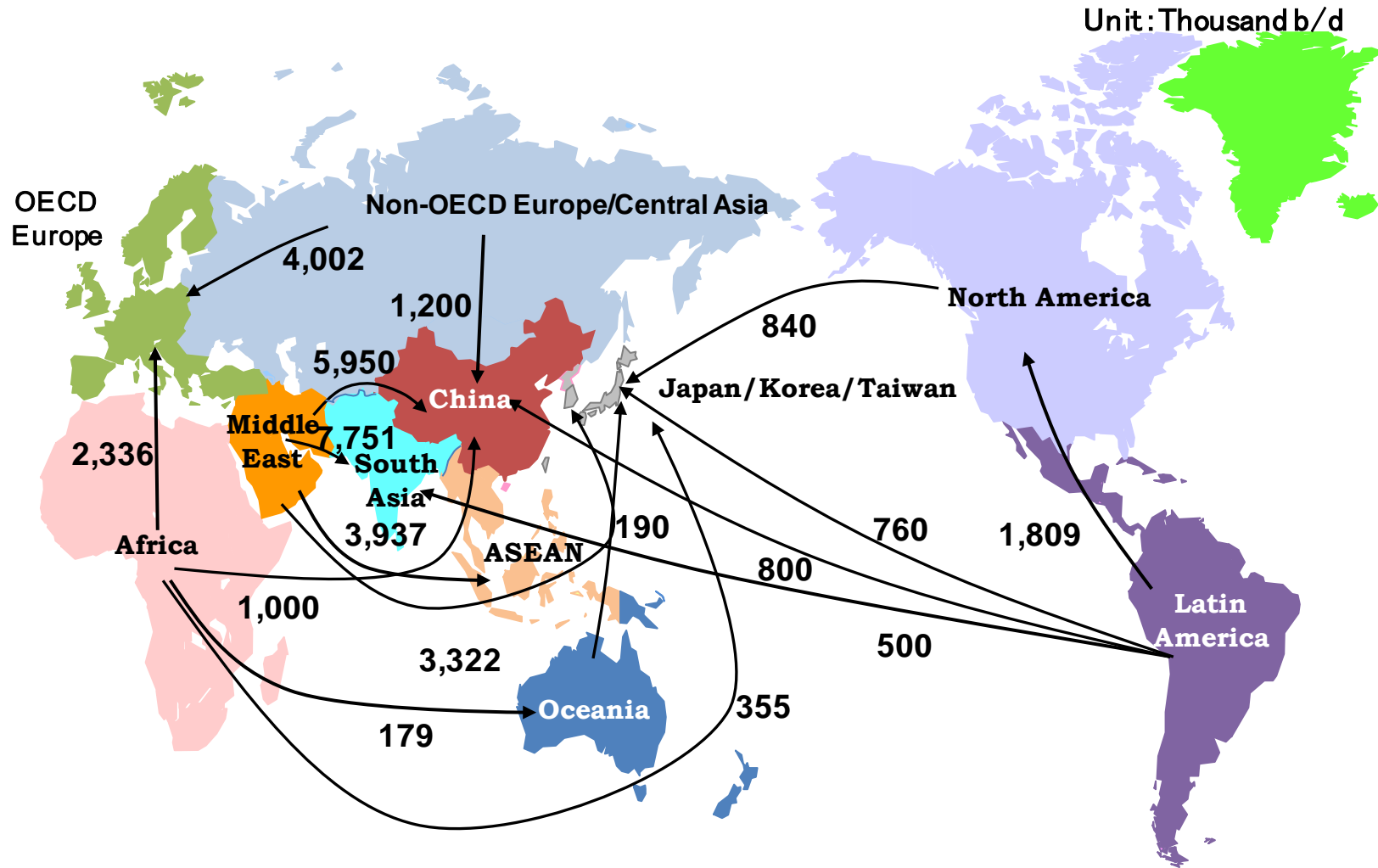
- This chart shows the crude oil flows for 2014, from production region such as the Middle East, Africa, Non-OECD/Central Asia, and Latin America, to consumption region such as North America, Asia, and Europe in the world.

Major crude oil trade flows (Reference Scenario, 2030)



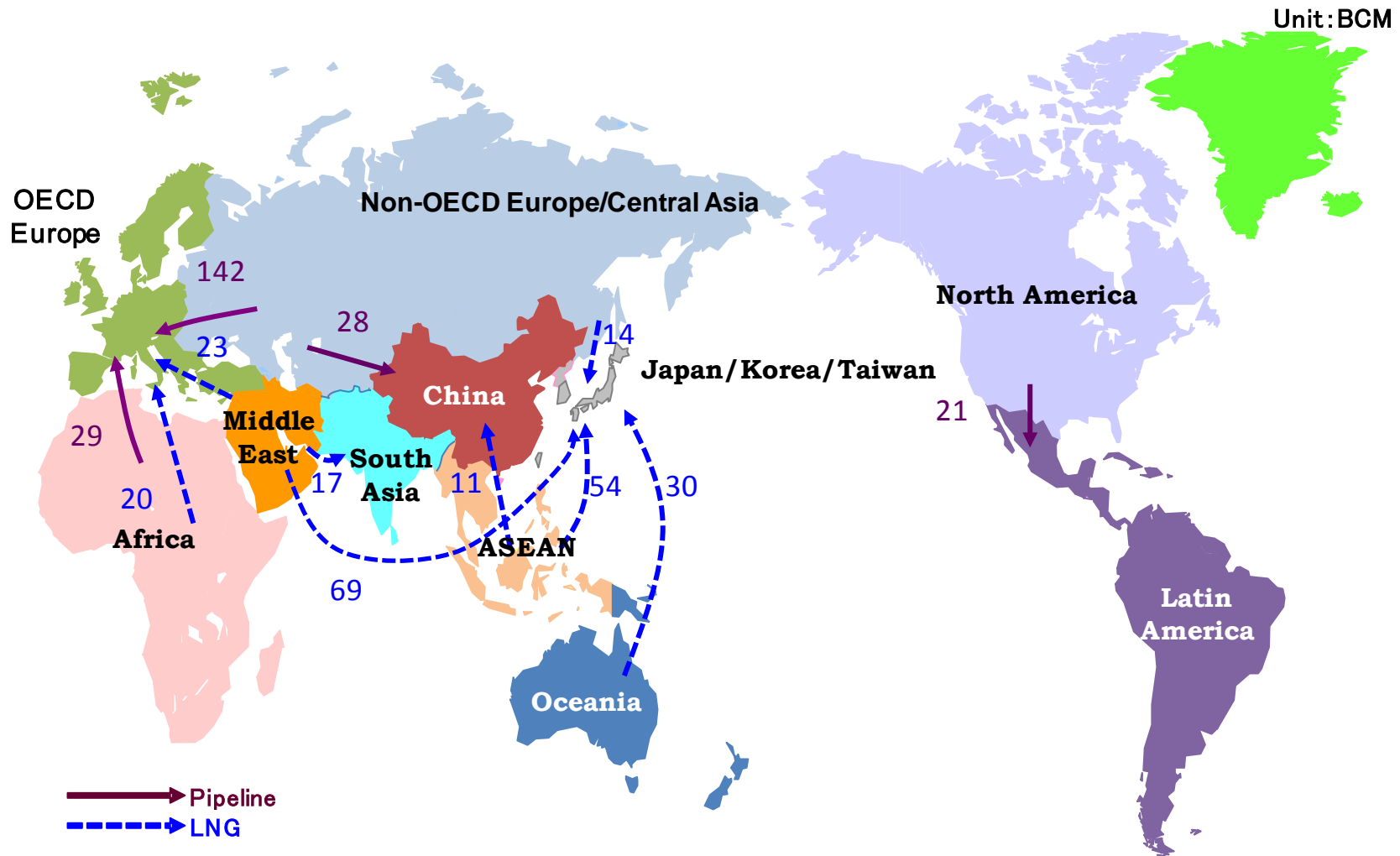
- North America exports to Asia.

Major crude oil trade flows (Lower Price Scenario, 2030)



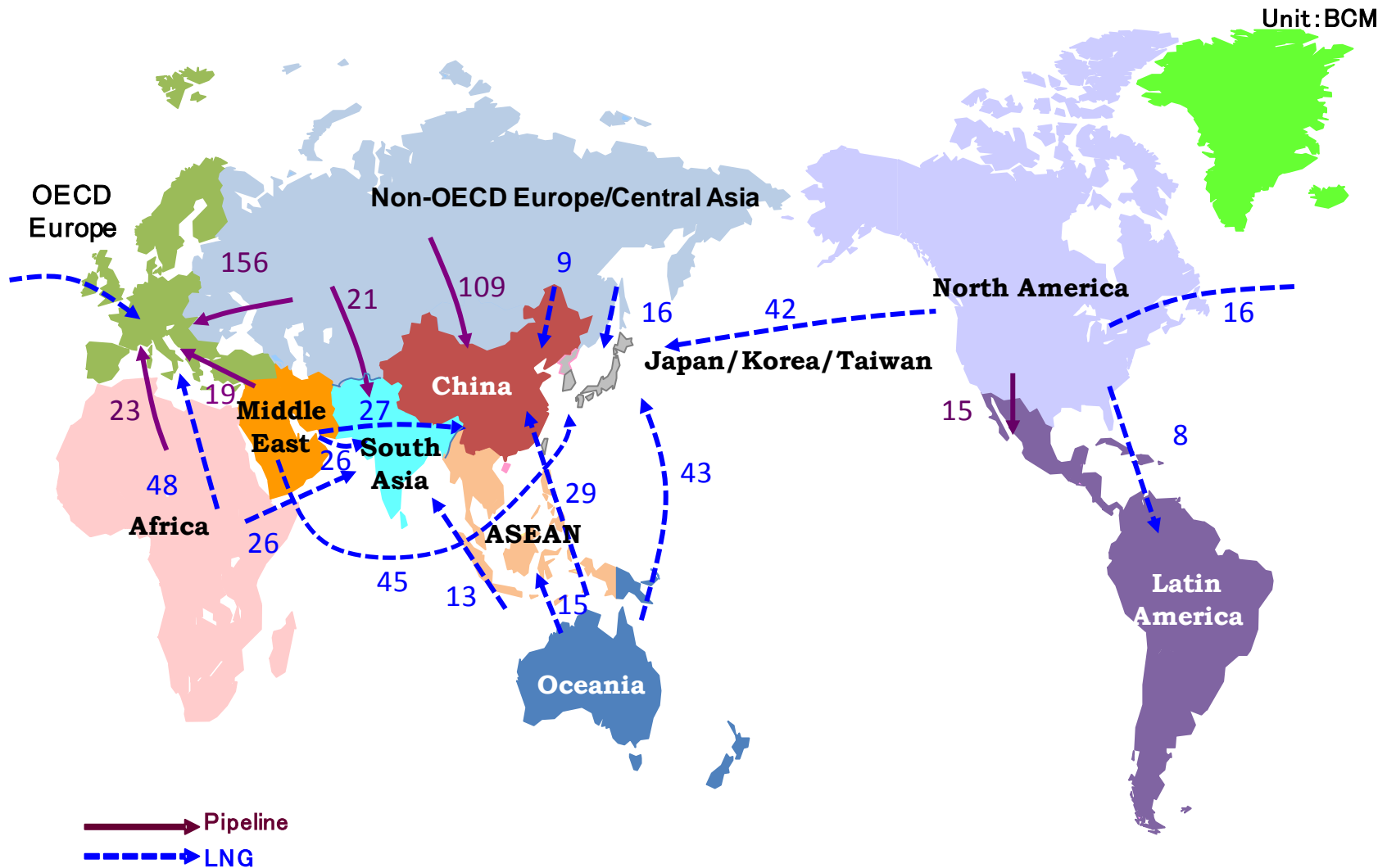
- In the Lower Price Scenario, crude oil exports from the Middle East to North America and Europe become zero and most exports flow in Asia in 2030.

Major natural gas trade flows (2014)



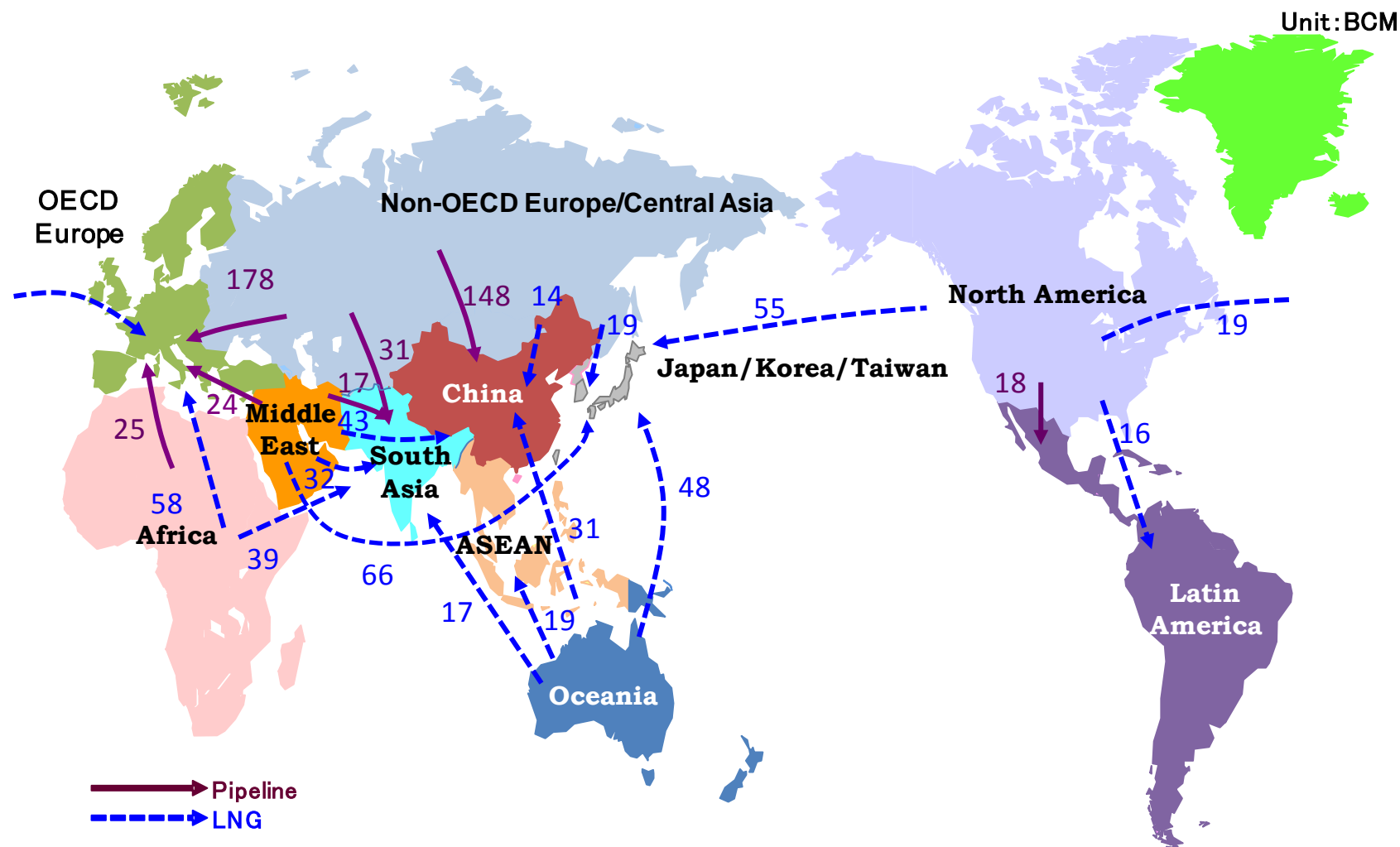
- In 2014, pipelines are used mainly to transport natural gas from Non-OECD Europe/Central Asia to OECD Europe while LNG is transported from ASEAN, Oceania, the Middle East to Japan/Korea/Taiwan.

Major natural gas trade flows (Reference Scenario, 2030)



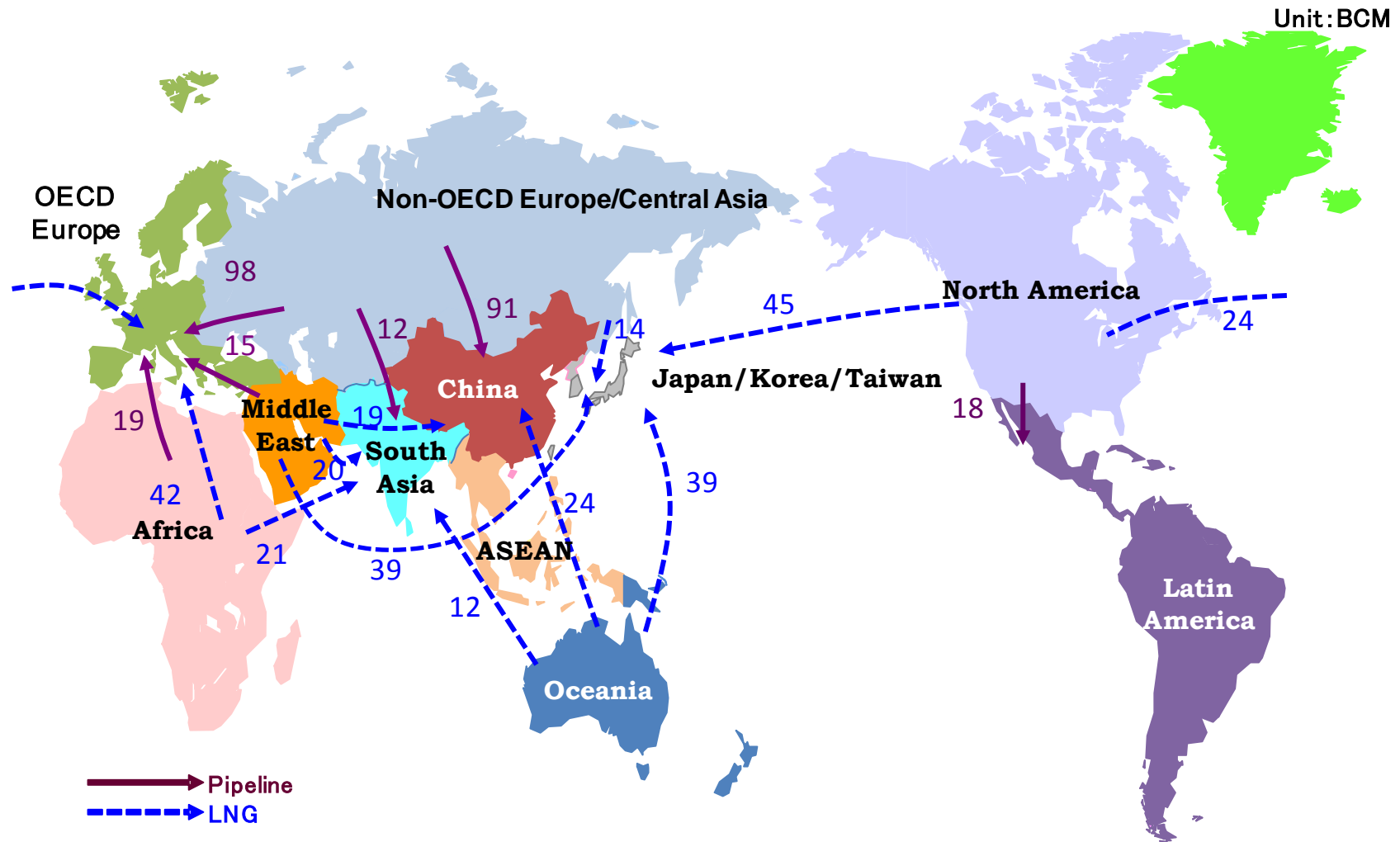
- North America starts to supply Asia and OECD Europe.
- Owing to a geographical reason, China and South Asia increase imports from traditional producers such as Non-OECD Europe/Central Asia and the Middle East.

Major natural gas trade flows (Reference Scenario, 2040)



- North America becomes one of the main LNG suppliers to Asia and OECD Europe.
- China and South Asia moreover increase imports from traditional producers such as Non-OECD Europe/Central Asia and the Middle East.

Major natural gas trade flows (Lower Price Scenario, 2030)



- Increases of natural gas production in Asia and decline of the slowing down of the production in OECD Europe lead regional trade decline.
- While exports of Non-OECD Europe/Central Asia and the Middle East slow down, North America becomes the main LNG suppliers to Asia.

Advanced Technologies Scenario assumptions

Advanced Technologies Scenario assumptions

In this scenario, each country further enhances policies on energy security and address climate change. Technology developments and international technology transfers are promoted to further expand the penetration of innovative technologies.

Introducing and enhancing environmental regulations and national targets

Environment tax, emissions trading, RPS, subsidy, FIT, efficiency standards, automobile fuel efficiency standard, low carbon fuel standard, energy efficiency labeling, national targets, etc.

Promoting technology development and international technology cooperation

R&D investment expansion, international cooperation on energy efficient technology (steelmaking, cement and other areas), support for establishing energy efficiency standards, etc.

【Demand side technology】

Industry

Under sectoral and other approaches, best available technologies on industrial processes (for steelmaking, cement, paper-pulp and oil refining) will be deployed globally

Transport

Clean energy vehicles (highly fuel efficient vehicles, hybrid vehicles, plug-in hybrid vehicles, electric vehicles, fuel cell vehicles) will diffuse further.

Buildings

Efficient electric appliances (refrigerators, TVs, etc.), highly efficient water-heating systems (heat pumps, etc.), efficient air conditioning systems and efficient lighting will diffuse further, with heat insulation enhanced.

【Supply side technology】

Renewable energy

Wind power generation, photovoltaic power generation, CSP (concentrated solar power) generation, biomass-fired power generation and biofuel will penetrate further.

Nuclear

Nuclear power plant construction will be accelerated with operating rates improved.

Highly efficient fossil fuel-fired power generation technology

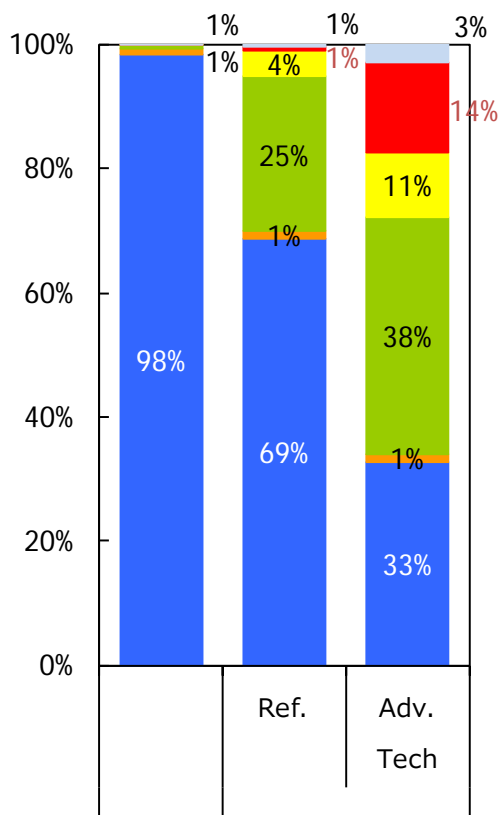
Coal-fired power plants (USC, IGCC, IGFC) and natural gas-fired more advanced combined cycle (MACC) plants will penetrate further.

CCS

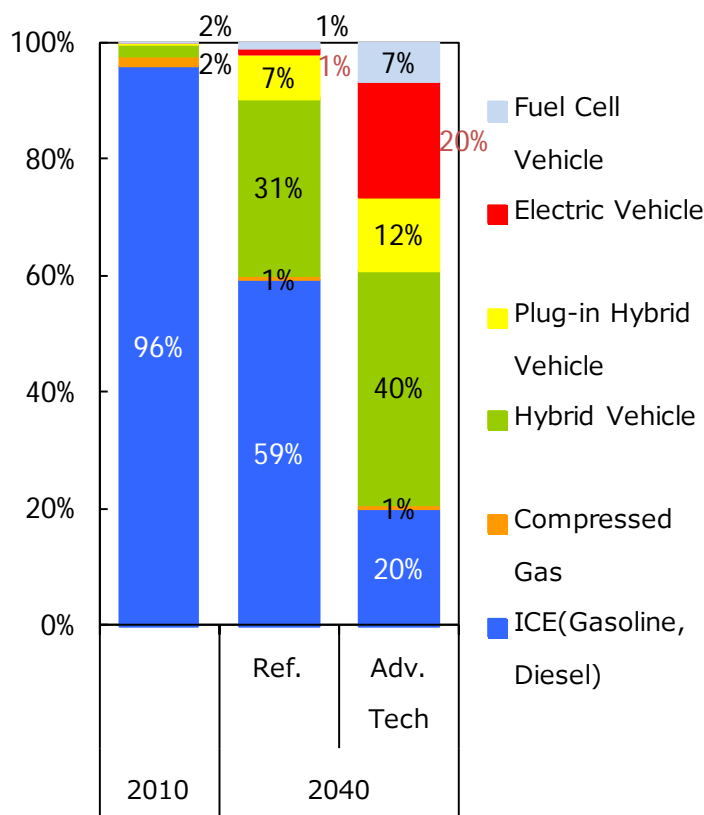
CCS deployment will expand in power generation (new and existing coal-fired and natural gas-fired plants) and industry (steelmaking, cement and other plants that emit massive GHGs).

Vehicle Stock and Sales by Type (World)

The Share of Vehicle Stocks by Type (World)



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



Share of clean energy vehicles in total stocks (2040)

Reference

31 %

Adv. Tech

67 %

Share of clean energy vehicles in annual sales (2040)

Reference

41 %

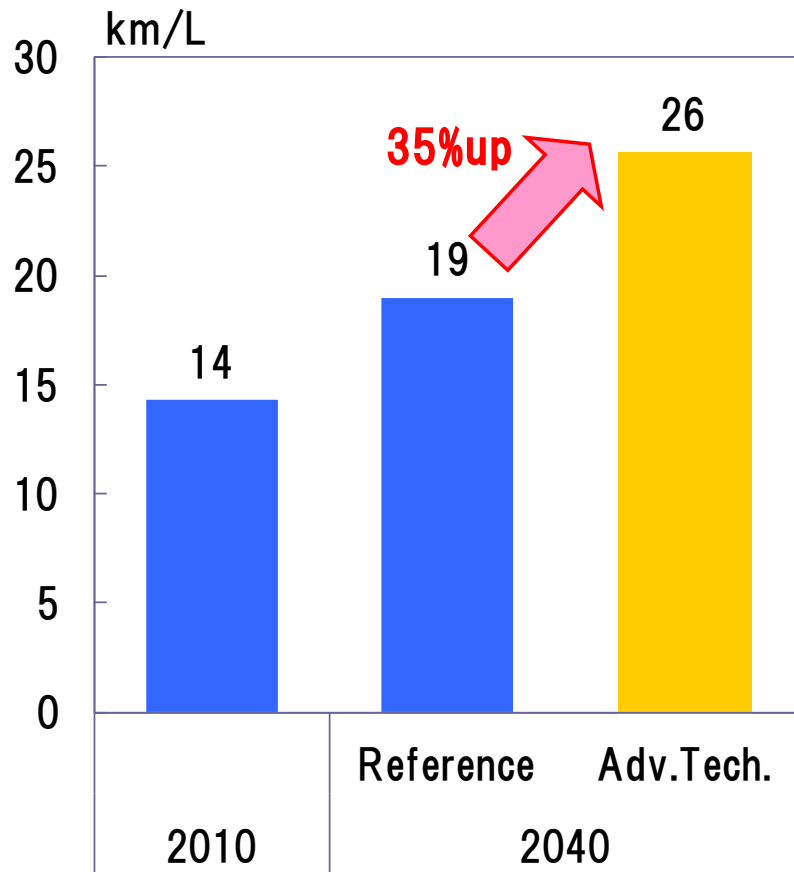
Adv. Tech

80 %

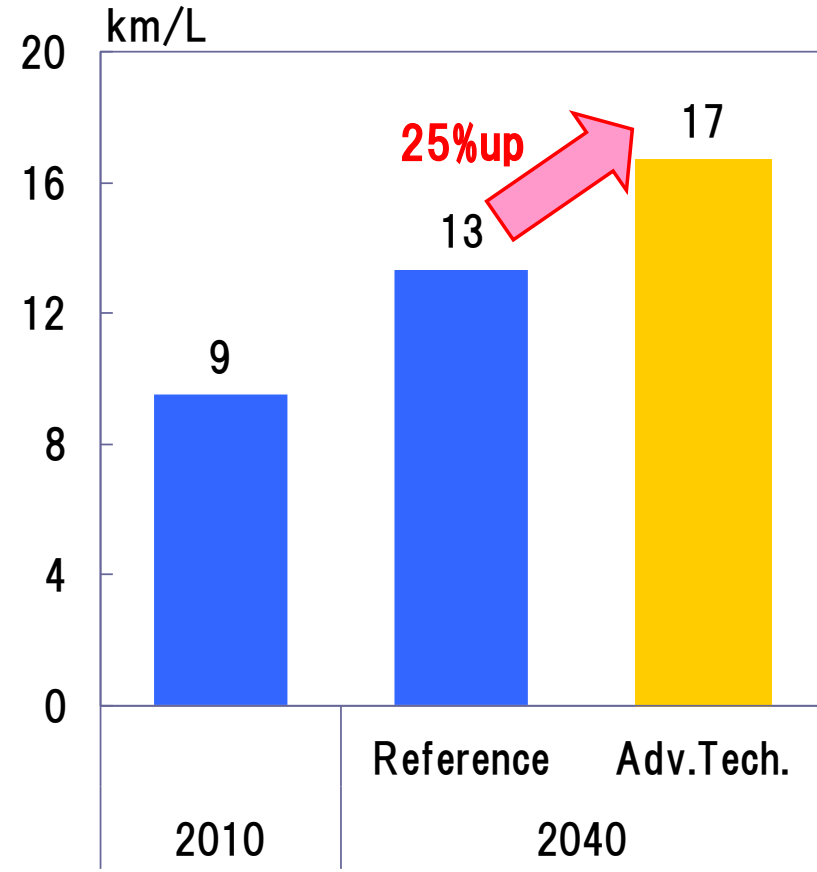
- In the Reference Scenario, in 2040, ICE accounts for 69% of the total stocks and 59% of the annual sales. Clean energy vehicles increase mainly by hybrid vehicles.
- In the Advanced Technologies Scenario, ICE drops to 33% of the total stocks and 20% of the annual sales. Within clean energy vehicles, in 2040, hybrid (38%), plug-in hybrid (11%), and electric vehicles (14%) are the main stream of the total stocks. Similarly, hybrid (40%), plug-in hybrid (12%), and electric vehicles (20%) are the main stream of the total sales, and fuel cell vehicles are also introduced (7%).

Fuel Efficiency of Passenger Vehicles (World)

Fuel Efficiency (New sales basis)



Fuel Efficiency (Stock basis)



In 2040, stock-based fuel efficiency of passenger vehicles in the Advanced Technologies Scenario achieves a 25% improvement in comparison with the Reference Scenario due to an increase of next generation vehicles such as plug-in hybrid and electric vehicles.

Energy outlook in Asia and the world through 2050 and actions against climate change

GDP, population and energy price

	2013	2040	2050
GDP (\$2010 trillion)	71 (AAGR in 1990-2013: 2.8%)	152 (AAGR in 2013-2040: 2.9%)	192 (AAGR in 2040-2050: 2.4%) (AAGR in 2013-2050: 2.7%)
Population (billion)	7.1	9.1 (+2.0 from 2013)	9.6 (+2.5 from 2013)
GDP per capita (\$2010 thousand)	10	17	20
Real oil price (\$2014/bbl)	105 (2014)	125	130
Nominal oil price (\$/bbl)	105 (2014)	209	265

- Global GDP grows annually at 2.7% from 2013 to 2050.
- World total population expands from 7.1 billions in 2013 to 9.6 billions in 2050.
- Crude oil price (\$2014 real price) is assumed to increase from \$105/bbl in 2013 to \$130/bbl in 2050.

Energy and environmental technologies

	2013	2040		2050	
	Historical	Reference	Advanced Technologies	Reference	Advanced Technologies
Nuclear (GW)	386 (2014)	610	868	695	1,044
Thermal efficiency					
Coal	36%	39%	40%	41%	44%
Natural gas	41%	52%	53%	55%	57%
Solar photovoltaic (GW)	137	749	1,381	1,001	2,029
CSP (GW)	3.8	84	221	153	409
Wind (GW)	318	998	1,579	1,311	2,034
Biomass power generation (GW)	70	190	204	228	235
Biofuel (Mtoe)	68	128	213	138	242
Share in annual vehicle sales					
PHEV	-	7%	12%	10%	12%
EV/FCV	-	2%	27%	6%	31%
Average fuel efficiency of new vehicle sales (km/L)	14 (2010)	19	26	20	27

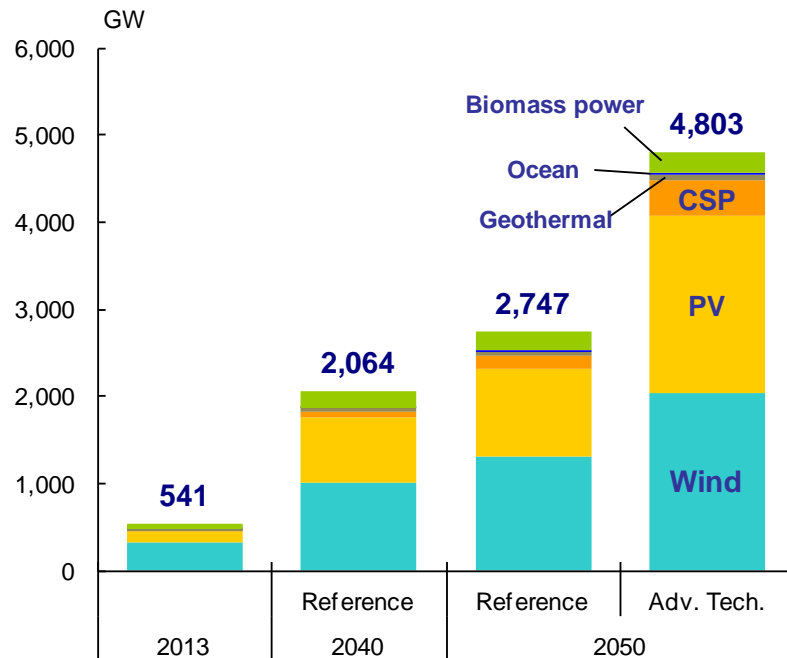
CSP: Concentrated solar power, PHEV: Plug-in hybrid electric vehicle, EV: Electric vehicle, and FCV: Fuel cell vehicle

Renewable power generation (world)

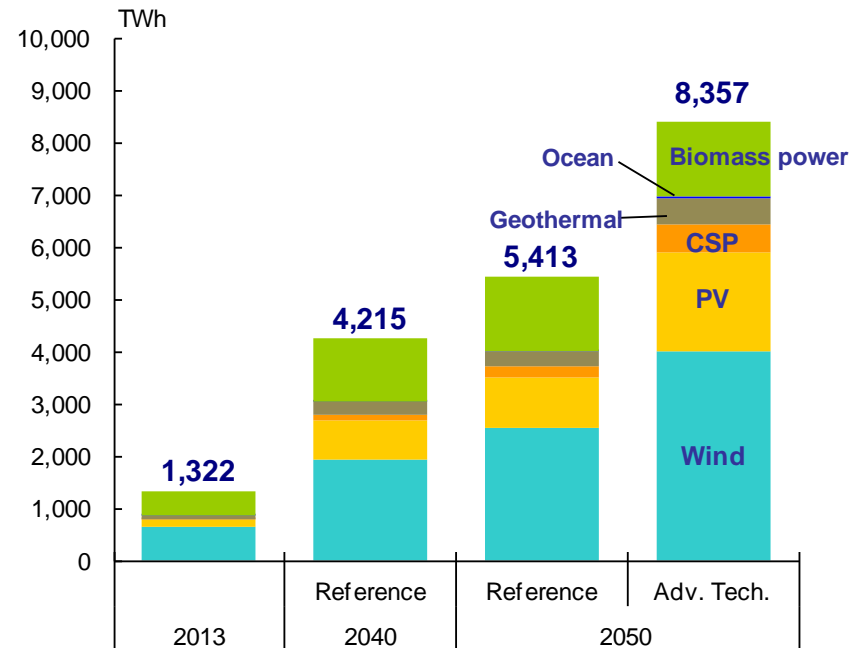
Reference Scenario
Advanced Technologies Scenario



Power generation capacity



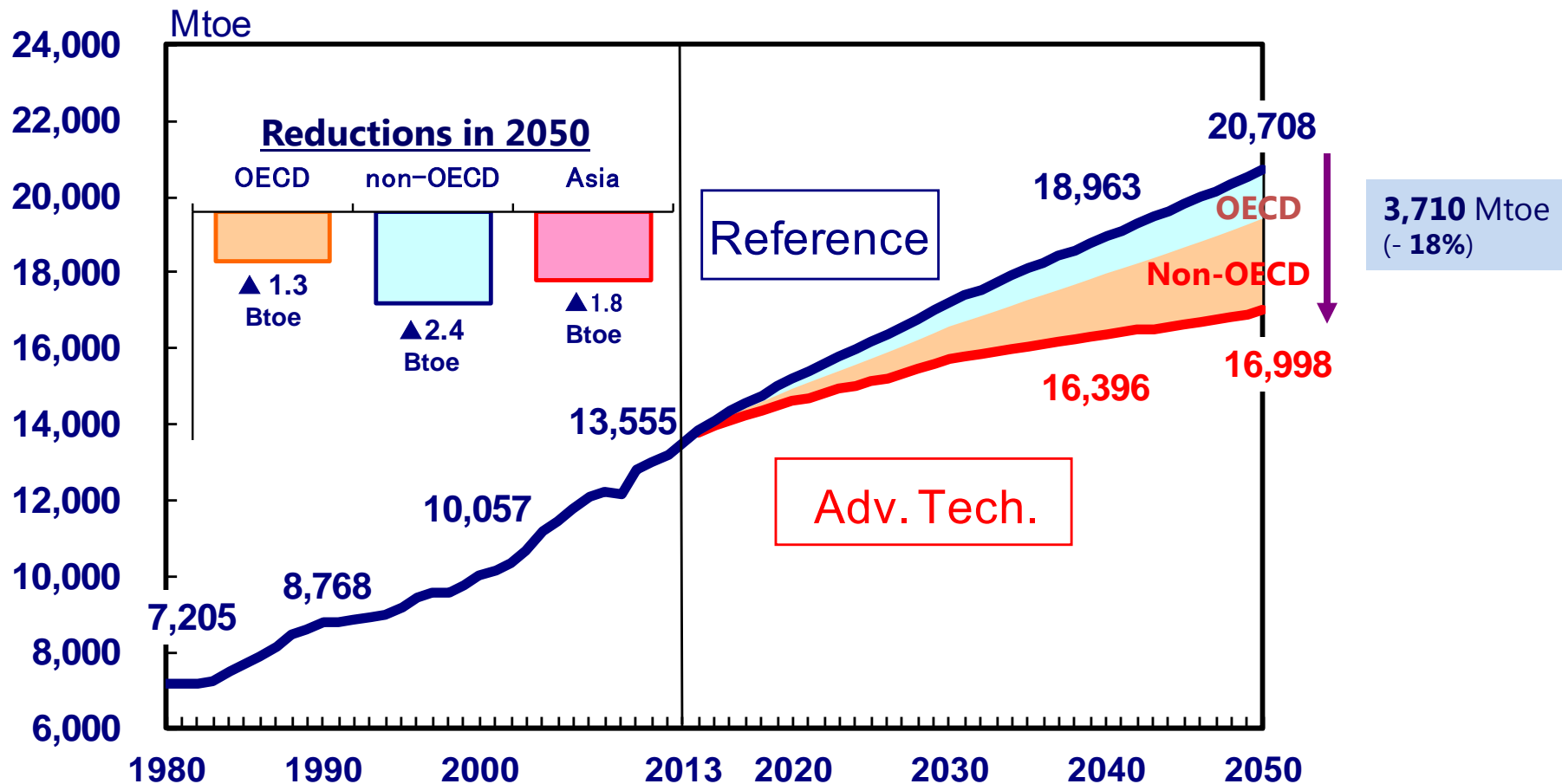
Electricity generated



- In the Advanced Technologies Scenario, renewable power generation capacity, excluding hydro, expands 6 times as much as that of 2013 by 2050.
- Wind power generation capacity in 2050 exhibits a 6-fold increase compared with that in 2013; 15-fold increase for solar PV, 107-fold increase for CSP, 34-fold for ocean energy, and 3-fold for biomass-fired.

Primary energy consumption (world)

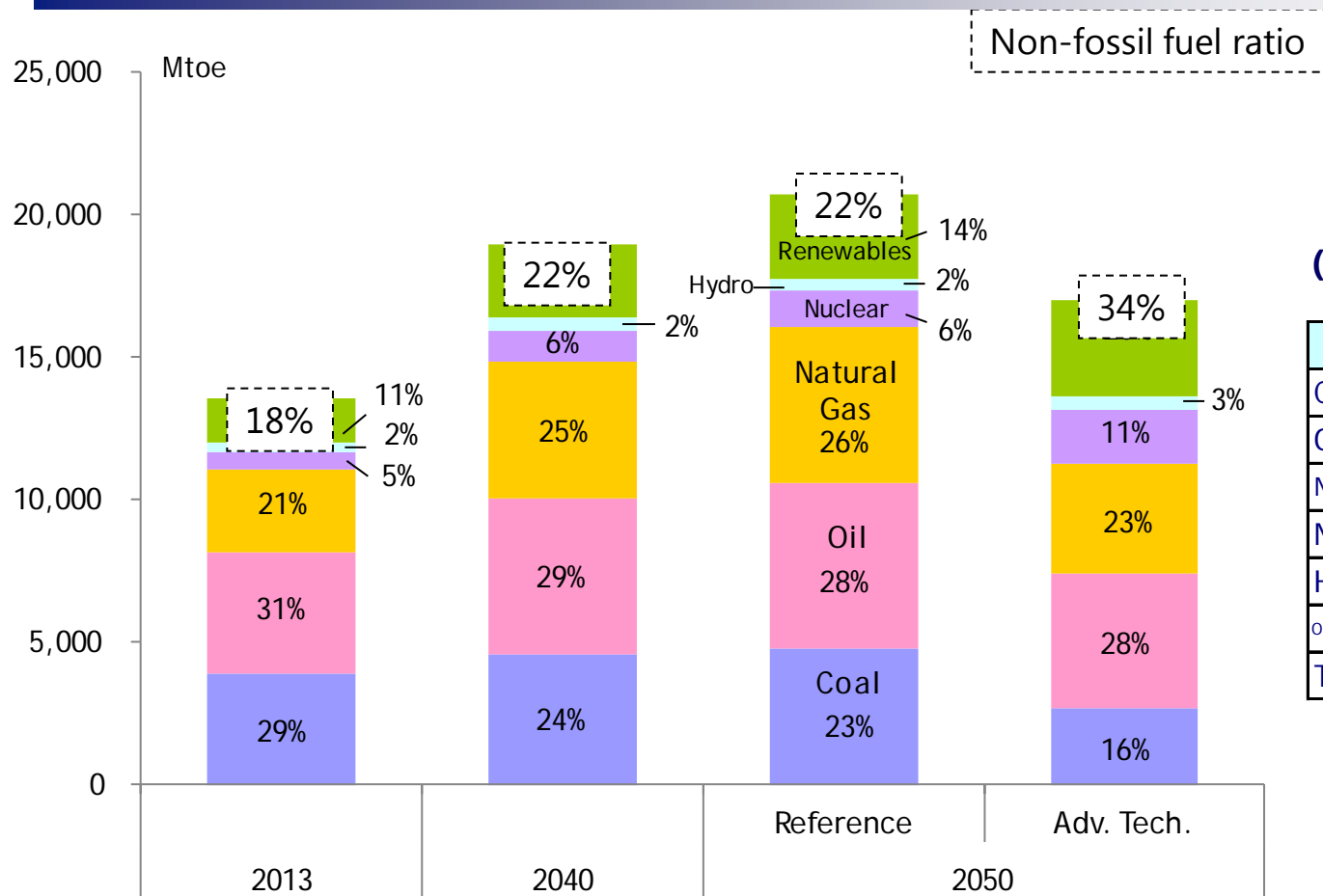
Reference Scenario
Advanced Technologies Scenario



- World primary energy consumption in 2050 can decrease by 3,710 Mtoe in the Advanced Technologies Scenario compared with that in the Reference Scenario. The consumption by OECD and by non-OECD decrease by 1,300 Mtoe and 2,700 Mtoe, respectively.
- The progress of the reliable measures of energy consumption reduction is highly important to suppress the primary energy consumption especially in Asia, where the potential of the reduction is very high at 1,800 Mtoe.

Primary Energy Consumption by Source (World)

Reference
Adv. Tech.

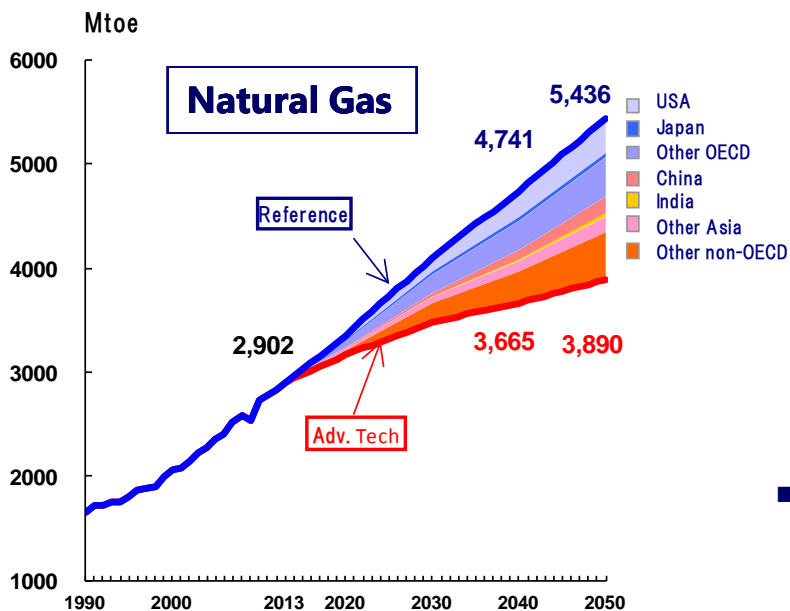
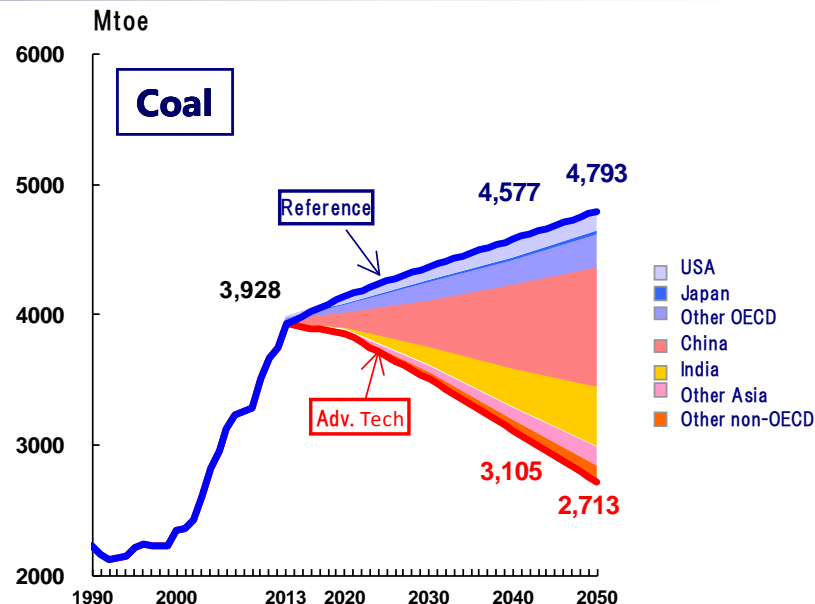
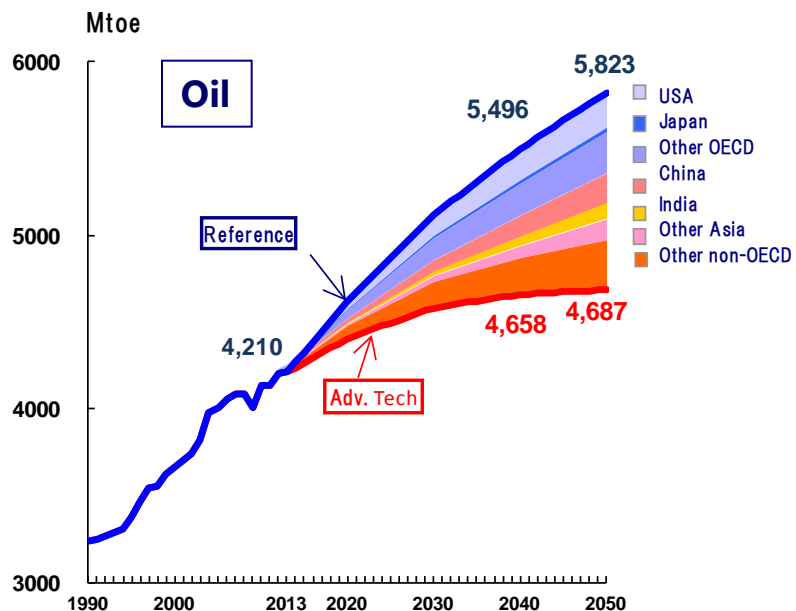


Growth rates in 2050 (in comparison with 2013)

	Reference	Adv. Tech.
Coal	22%	▲ 31%
Oil	38%	11%
Natural Gas	87%	34%
Nuclear	95%	193%
Hydro	43%	46%
Other Renewables	90%	116%
Total	53%	25%

- Non-fossil fuel ratio is 22% in the Reference Scenario and 34% in the Advanced Technologies Scenario in 2050.
- Even in 2050 in the Advanced Technologies Scenario, fossil fuel ratio is in the vast majority(67%) of the primary energy consumption of the world.
- In both of the Reference and the Advanced Technologies Scenarios, the efficient use of Natural Gas becomes further important in terms of suppression of the primary energy consumption, because its amount and share expand.

Fossil Fuel Consumption



Reduction in 2050 (Regional Breakdown)

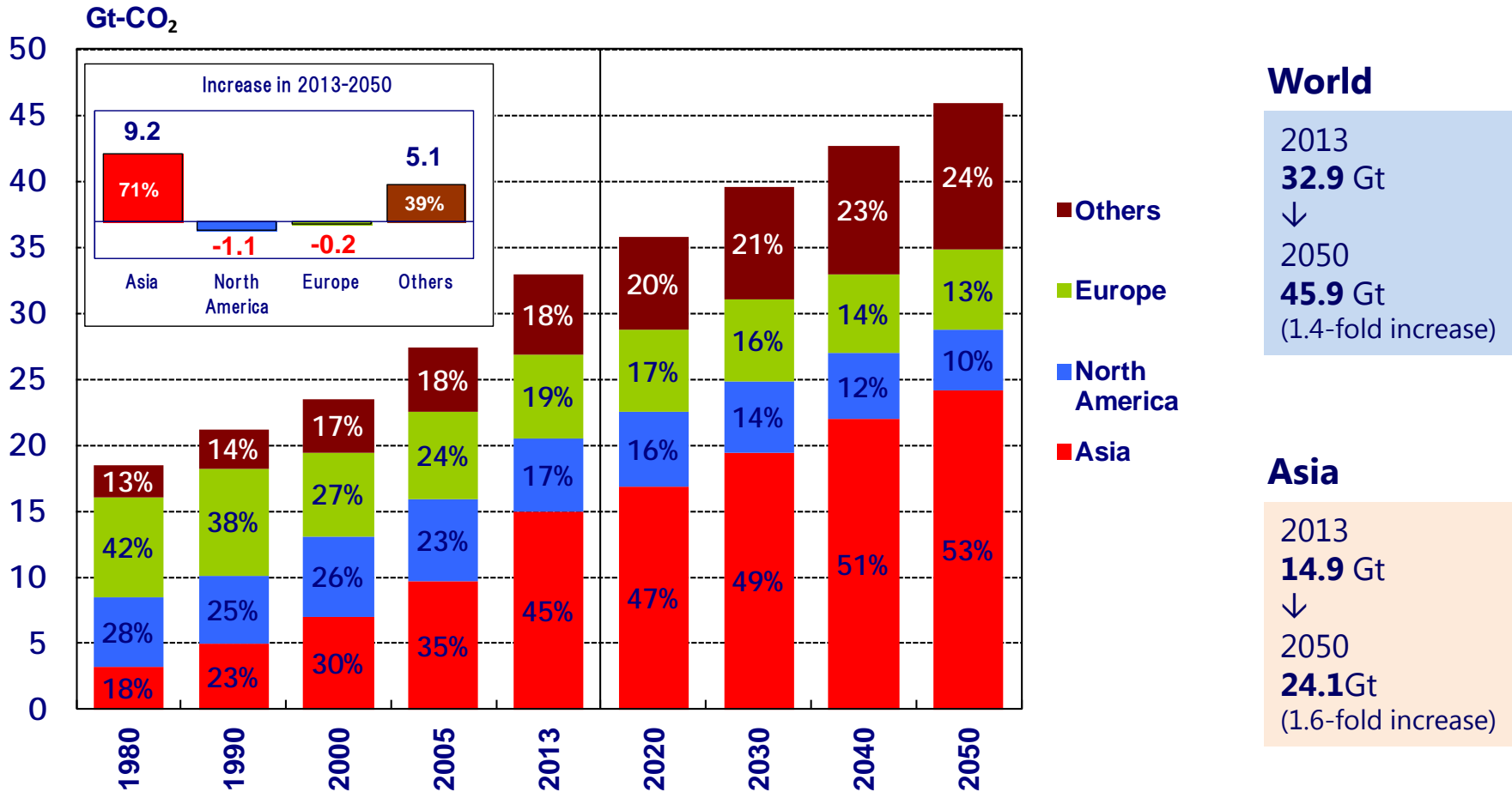
(Oil) (Coal) (Natural Gas)

	Mtoe	Share		Mtoe	Share		Mtoe	Share
USA	202	18%	USA	144	7%	USA	332	21%
Japan	28	2%	Japan	28	1%	Japan	44	3%
Other OECD	235	21%	Other OECD	256	12%	Other OECD	373	24%
China	171	15%	China	919	44%	China	155	10%
India	93	8%	India	456	22%	India	44	3%
Other Asia	121	11%	Other Asia	145	7%	Other Asia	146	9%
Other non-OECD	286	25%	Other non-OECD	133	6%	Other non-OECD	453	29%
OECD	465	41%	OECD	428	21%	OECD	749	48%
non-OECD	672	59%	non-OECD	1,653	79%	non-OECD	797	52%
Developing Asia	386	34%	Developing Asia	1,520	73%	Developing Asia	344	22%
World	1,136	100%	World	2,080	100%	World	1,547	100%

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

CO₂ emissions by region (world)

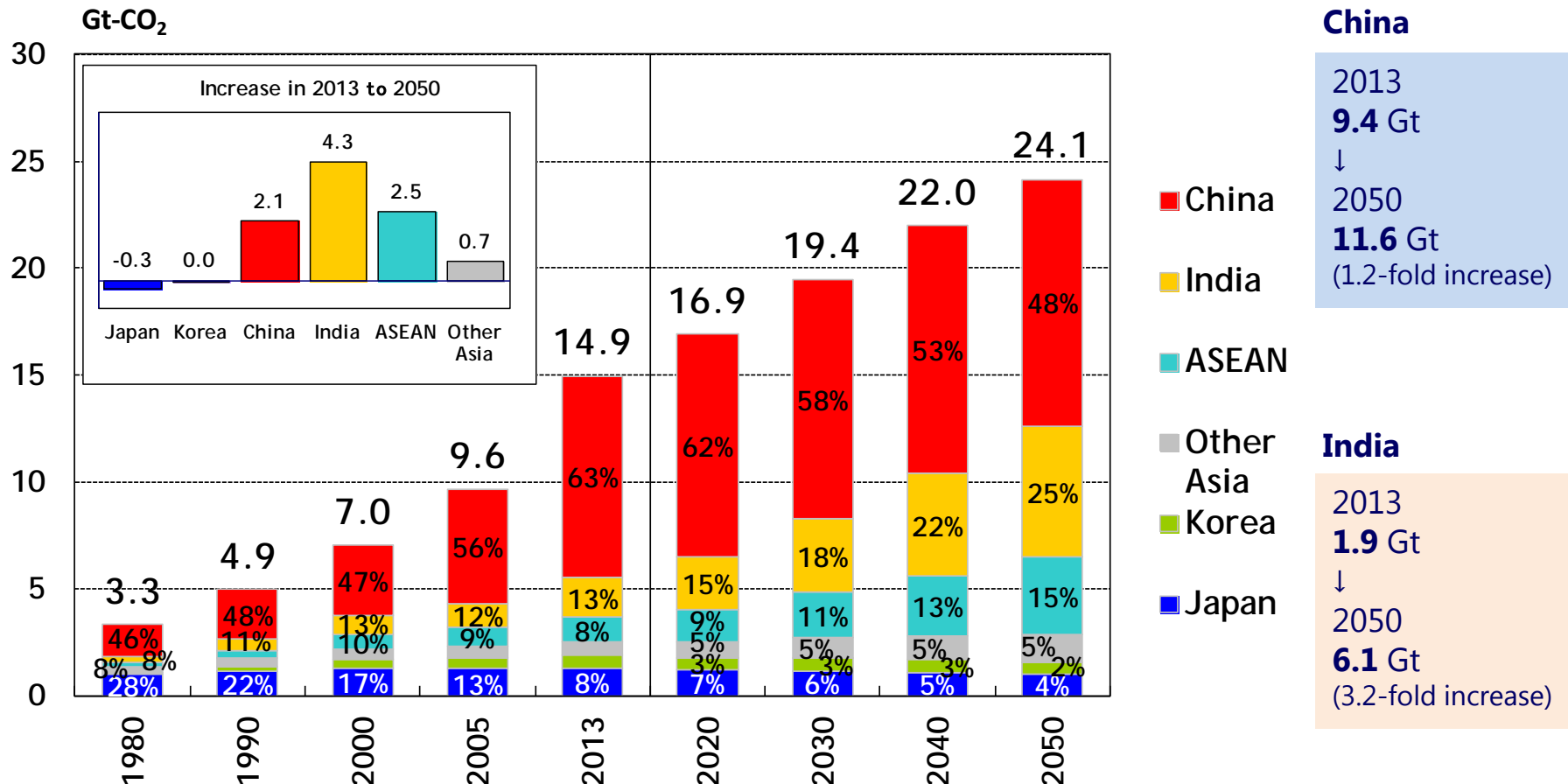
Reference Scenario



- CO₂ emissions in the world reach 45.9 Gt in 2050 from 32.9 Gt in 2013.
- Asia alone accounts for about 70% of the increase in global CO₂ emissions through 2050. The share of North America and Europe combined decreases from 36% in 2013 to 23% in 2050.

CO₂ emissions by region (Asia)

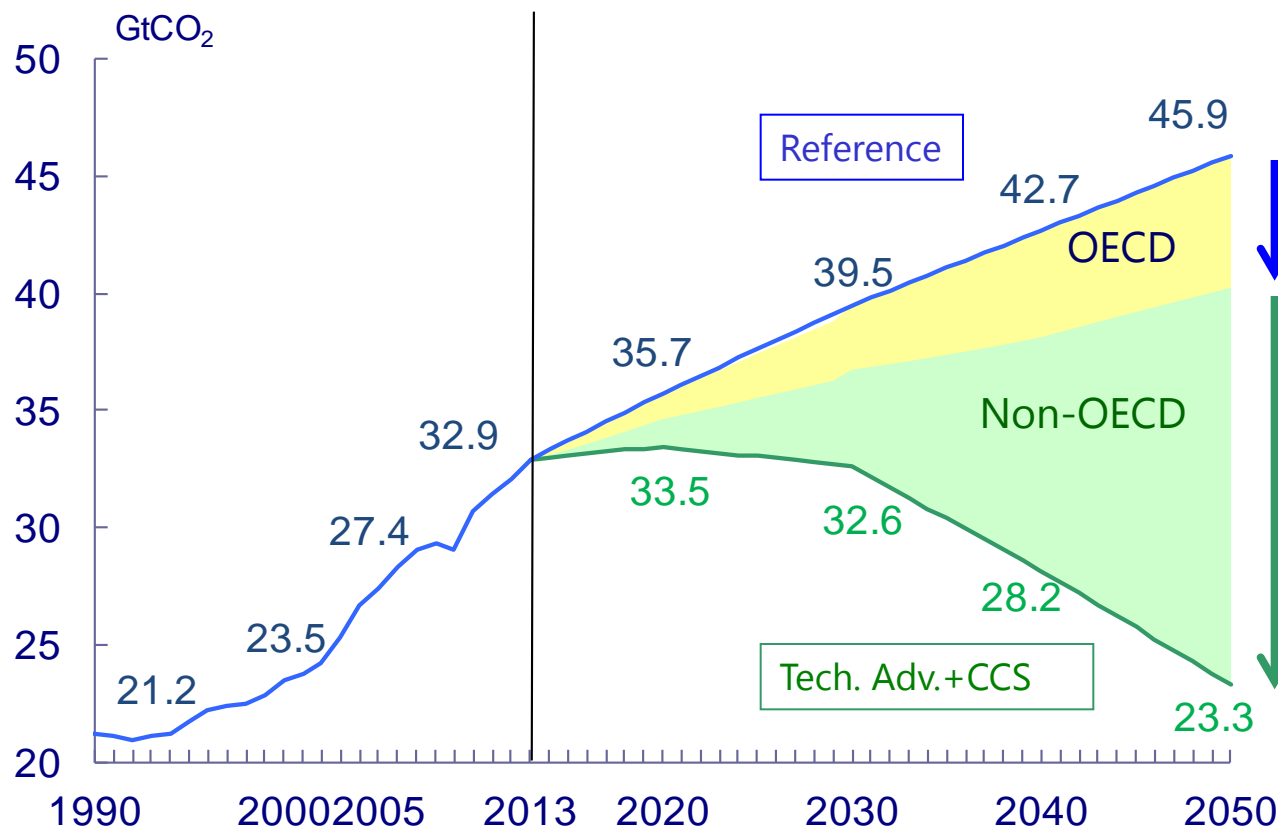
Reference Scenario



- CO₂ emissions in Asia steadily increase driven by coal consumption. The combined share of China and India in the Asian total remains constant throughout the projection period at almost 75%.
- The increases in Asia account for about 70% of the world CO₂ emission growth through 2050. The development of clean coal technology plays a large role to reduce CO₂ emissions in Asia.

CO₂ Emission Reduction by Region (World)

Reference
Adv. Tech.



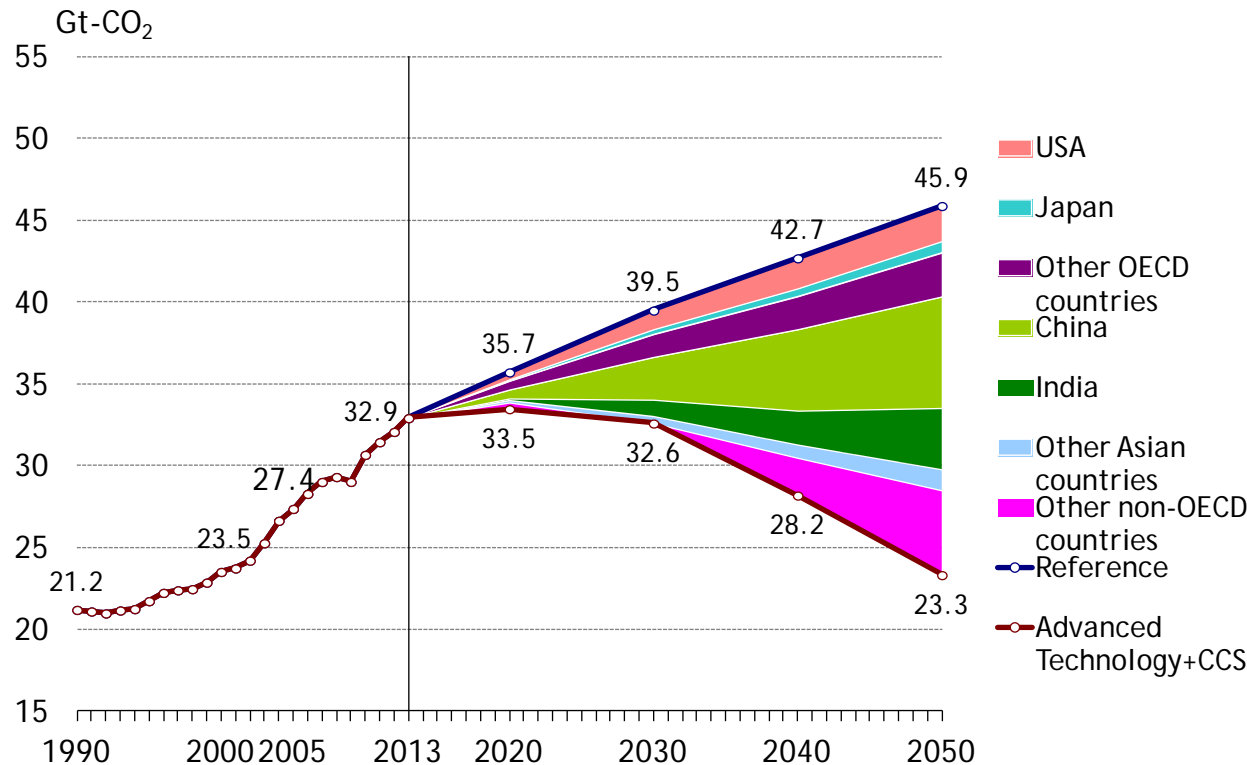
Total **22.6** Gt
(49% reduce)

5.6 Gt
(25% of total)

16.9 Gt
(75% of total)

- In 2050, Non-OECD's CO₂ emission reduction (between the Reference Scenario and the Advanced Technologies Scenario) reaches 16.9 Gt, more than three times that of OECD at 5.6 Gt.
- Technology transfer and swift deployment of advanced technology in Asia is indispensable in order to address climate change issues.

CO₂ Emission Reduction by Region (World)

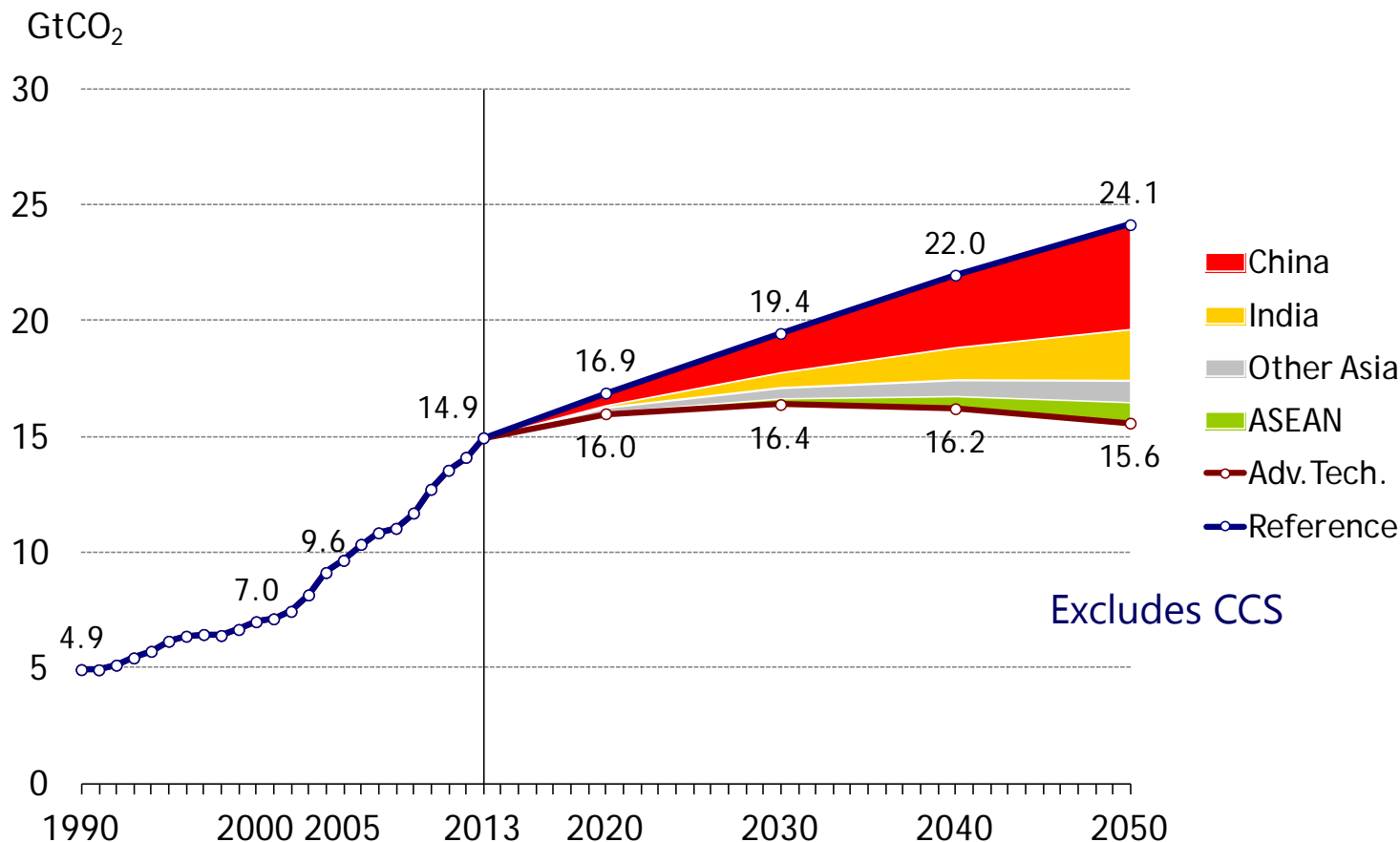


CO₂ Reduction in 2050

	Gt-CO ₂	Share
USA	2.1	10%
Japan	0.7	3%
Other OECD	2.7	12%
China	6.8	30%
India	3.7	17%
Other Asian countries	1.3	6%
Other non-OECD	5.2	23%
OECD	5.5	25%
Non-OECD	17.0	75%
Non-OECD Asia	11.8	53%
World total	22.6	100%

- Asia has a huge CO₂ reduction potential; CO₂ emission reduction reaches 11.8 Gt in Non-OECD Asia and 6.8 Gt in China.

CO₂ Emission Reduction by Region (Asia)



Total **8.6**Gt
(36% reduction)

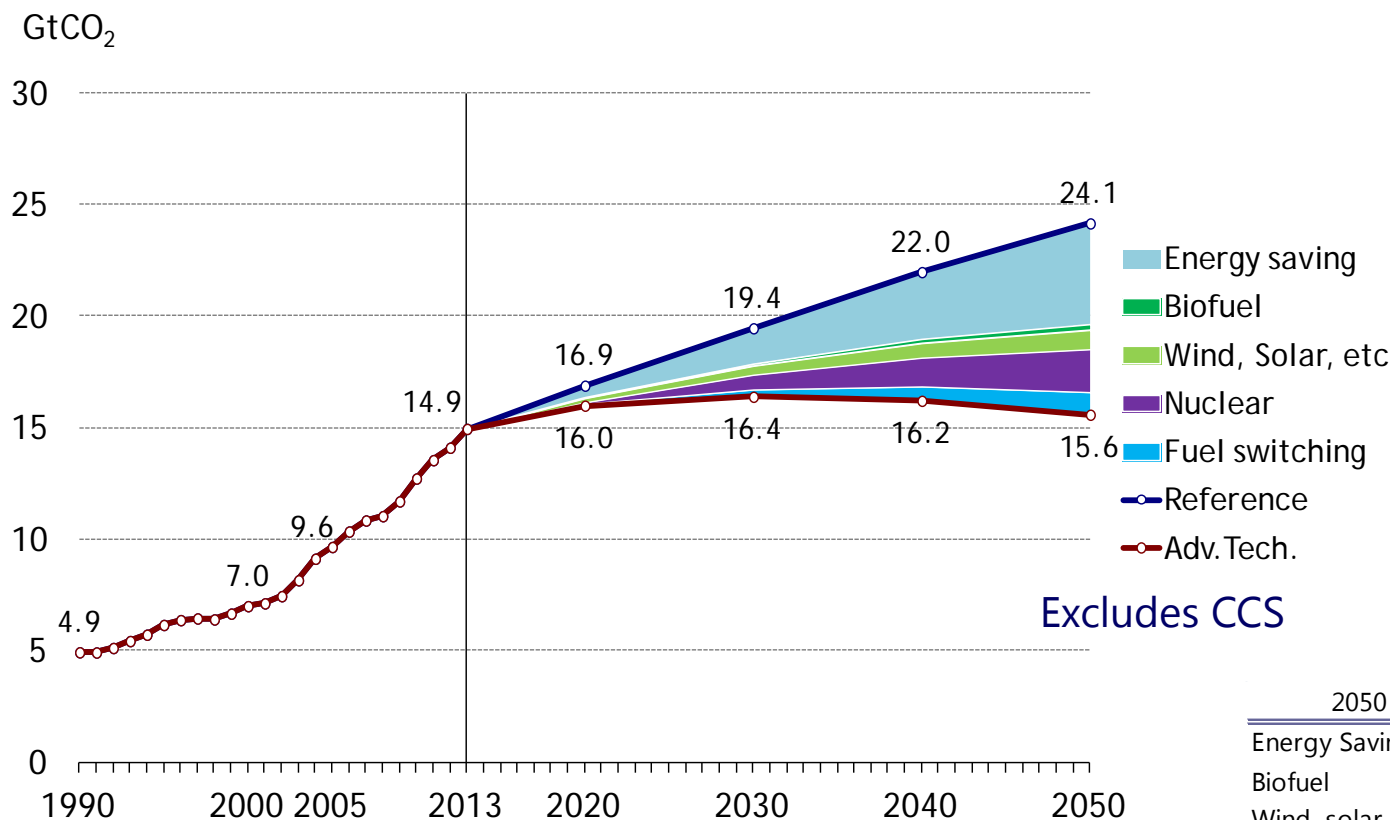
China
4.5 Gt
(**53% of total**)

India
2.2 Gt
(**26% of total**)

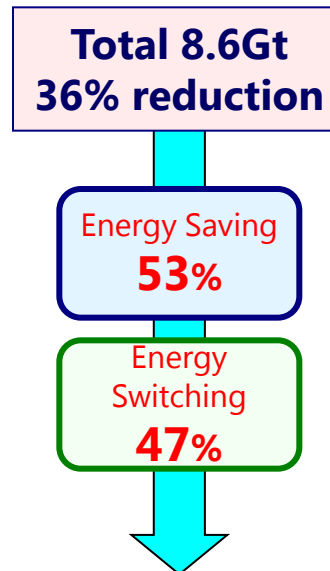
ASEAN
0.9 Gt
(**11% of total**)

- In the Advanced Technologies Scenario, CO₂ emissions in Asia is reduced by 8.6 Gt in 2050.
- China and India have great potential to reduce CO₂ emissions. China's CO₂ emission reduction accounts for 53% of Asia's reduction in 2050. India and ASEAN combined account for around 40% of Asia's reduction in 2050.

CO₂ Emission Reduction by Technology (Asia)



Excludes CCS

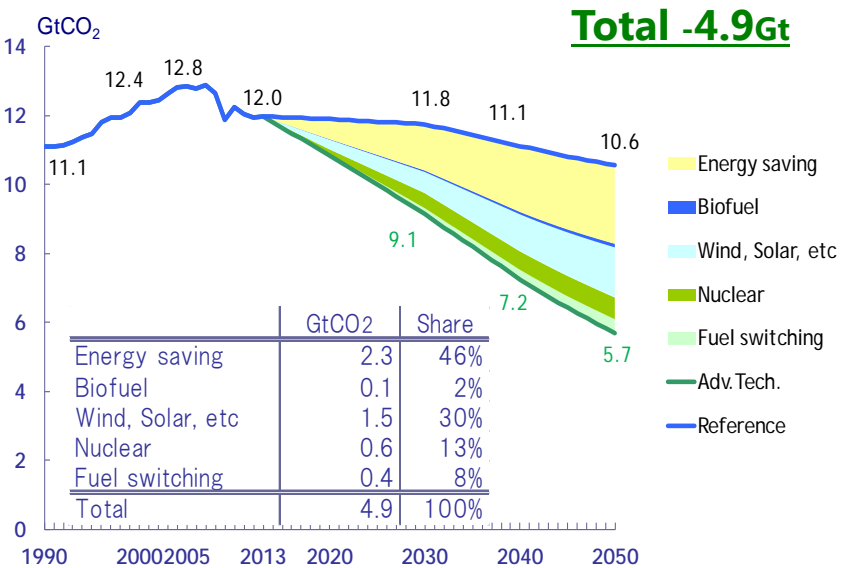


2050	GtCO ₂	Share
Energy Saving	4.5	53%
Biofuel	0.2	3%
Wind, solar etc.	0.9	10%
Nuclear	1.9	23%
Fuel Switching	1.0	12%
計	8.6	100%

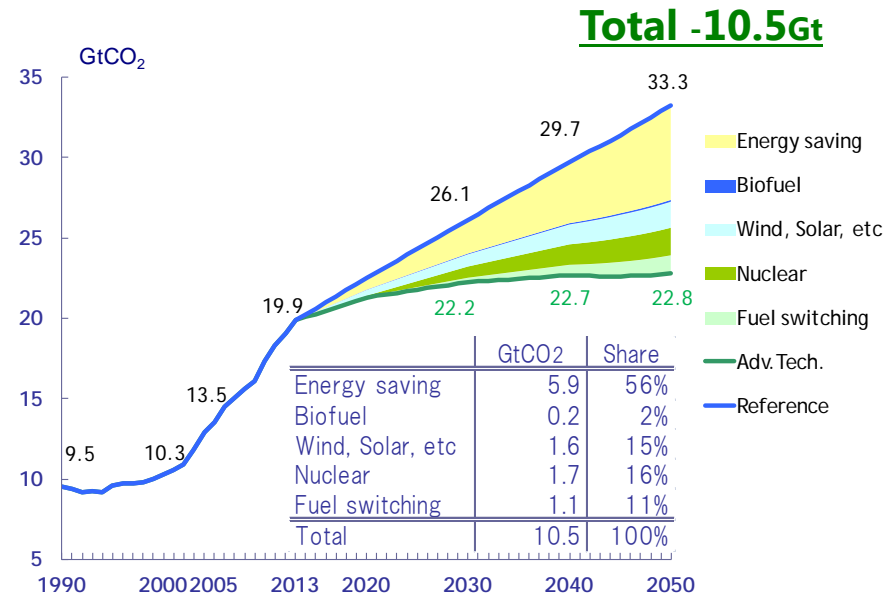
- Aggressive development and deployment of advanced technologies in Asia considerably reduce CO₂ emissions. Energy saving accounts for 53% of Asia's CO₂ reduction in 2050.

CO₂ Emission Reduction by Technology (OECD and Non-OECD)

OECD



Non-OECD

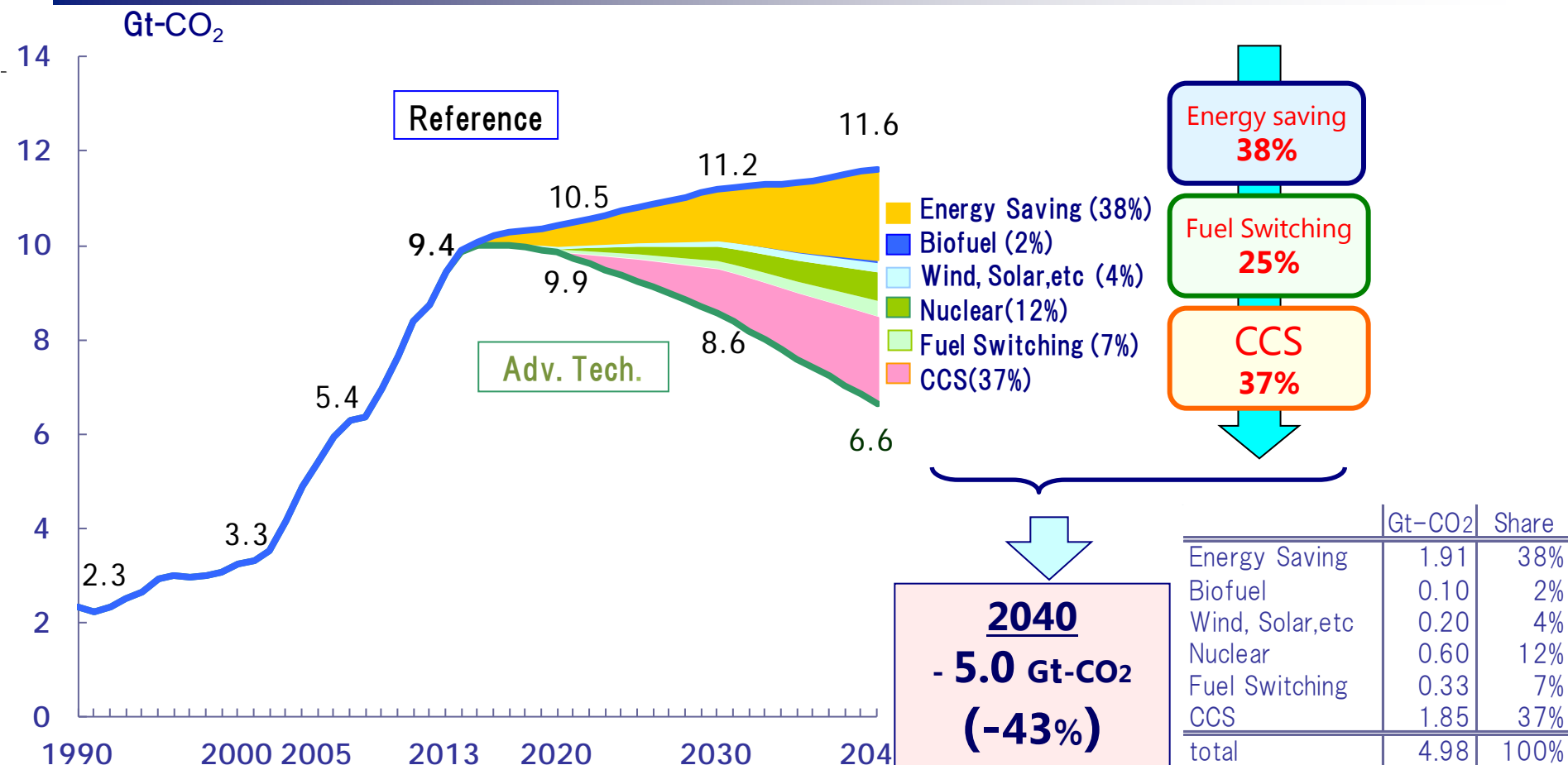


Excludes CCS

- Various technologies are required to reduce CO₂ emissions. In OECD, energy saving is responsible for the largest share at 46% (or 2.3 Gt). It is followed by renewable energy at 30% (or 1.5 Gt), nuclear at 13% (or 0.6 Gt), and fuel switching at 8% (or 0.4 Gt).
- In Non-OECD countries, energy saving is responsible for more than half of the 5.9 Gt reduction. Supportive measures concerning technology transfer and the establishment of efficiency standards are important to realize those CO₂ emission reduction while further enhancing energy security.

CO₂ Emissions in China

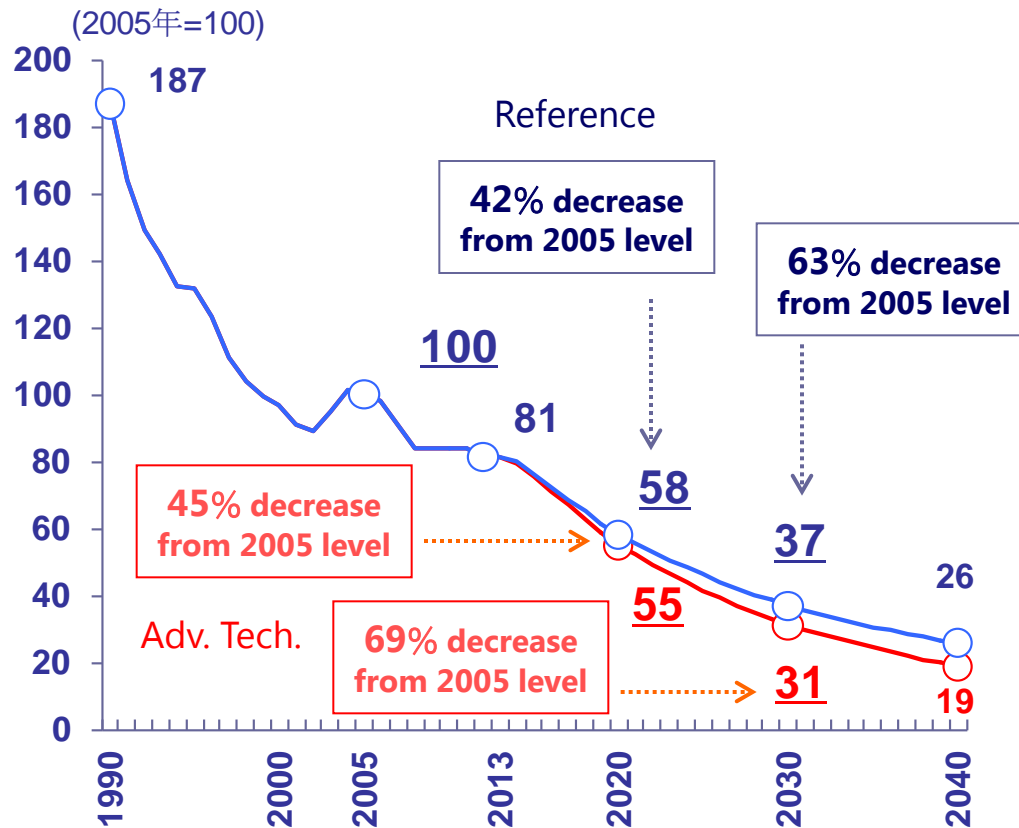
Reference
Adv. Tech.



- In the Reference Scenario, CO₂ emissions increase by 2.2Gt (up 23%) between 2013 to 2040.
- In the Advanced Technologies Scenario, CO₂ emissions are 5.0 Gt (down 43%) lower than the Reference Scenario in 2040.
- CO₂ emissions peak before 2020 due to energy saving and fuel switching to non-fossil fuels.

CO₂ Emissions per GDP in China

National Target : 40 to 45% reduction by 2020
60to 65% reduction by 2030



Decomposition Analysis of CO₂ Emissions

		CO ₂ Emission ΔC			Economy Growth ΔY
		Carbon Intensity Δ(C/E)	Energy Saving Δ(E/Y)		
1990-2005		5.7%	0.8%	-4.8%	10.2%
2005-2020	Reference	4.5%	-0.1%	-3.5%	8.4%
	Adv. Tech.	4.1%	-0.2%	-3.7%	
2020-2030	Reference	0.7%	-0.4%	-4.1%	5.4%
	Adv. Tech.	-0.4%	-0.9%	-4.7%	

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

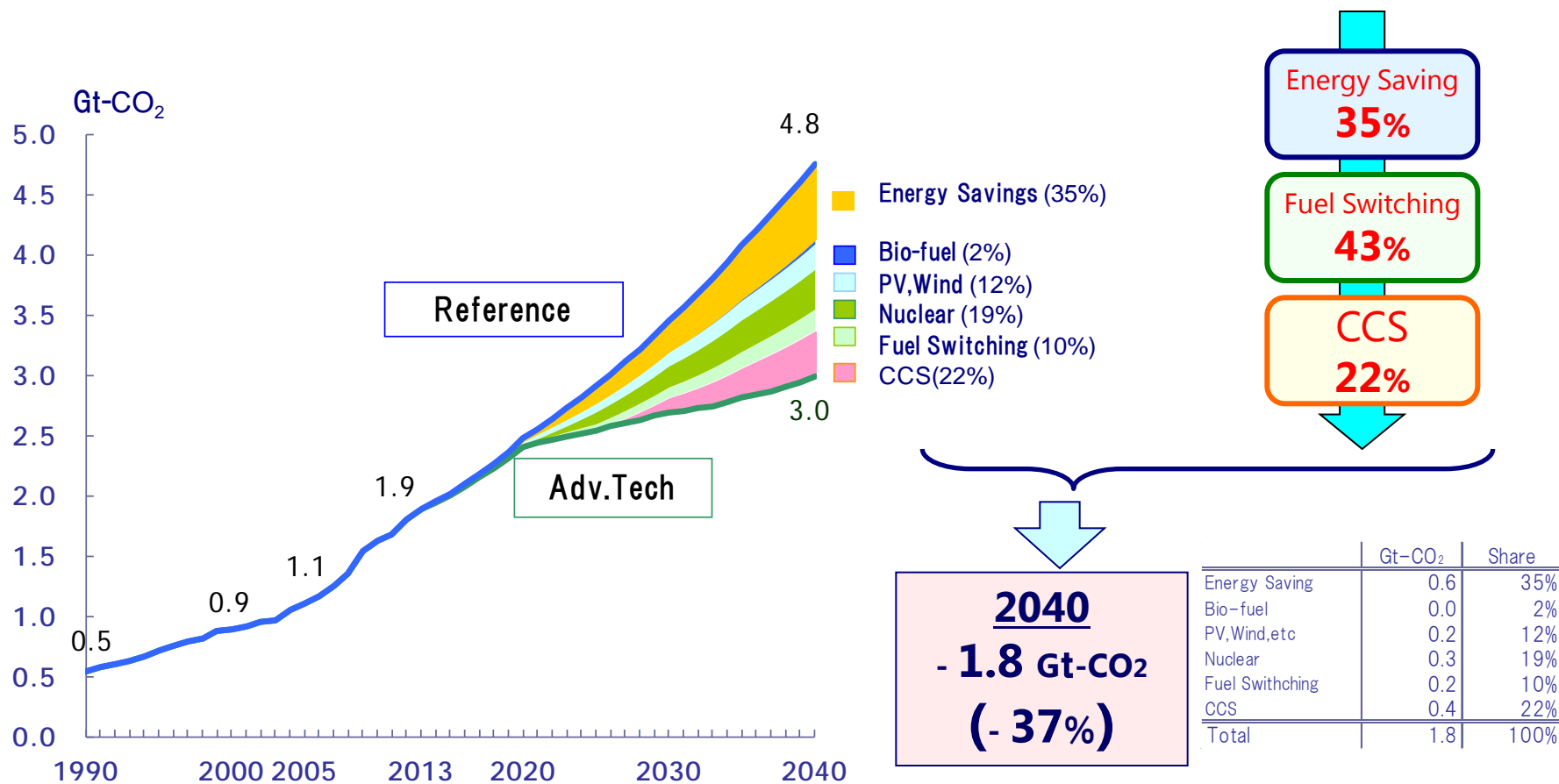
$$\Delta C = \Delta(C/E) + \Delta(E/Y) + \Delta Y$$

Decarbonization / Energy-Saving / Economic-Growth

- Chinese government decided to improve CO₂ intensity (calculated as CO₂ emissions per GDP) by 40%-45% by 2020, by 60%-65% by 2030 from the 2005 level.
- In the Reference Scenario, the projected CO₂ emissions intensity (per GDP) is 42% lower in 2020, 63% lower in 2030 than the 2005 level. And the reduction is 45% in 2020 and 69% in 2030 in the Advanced Technologies Scenario. The official target will be achieved, when the changes of the industry structure and the introduction of advanced technologies on energy and environment are steadily implemented.

CO₂ Emission Reduction in India

Reference
Adv. Tech.

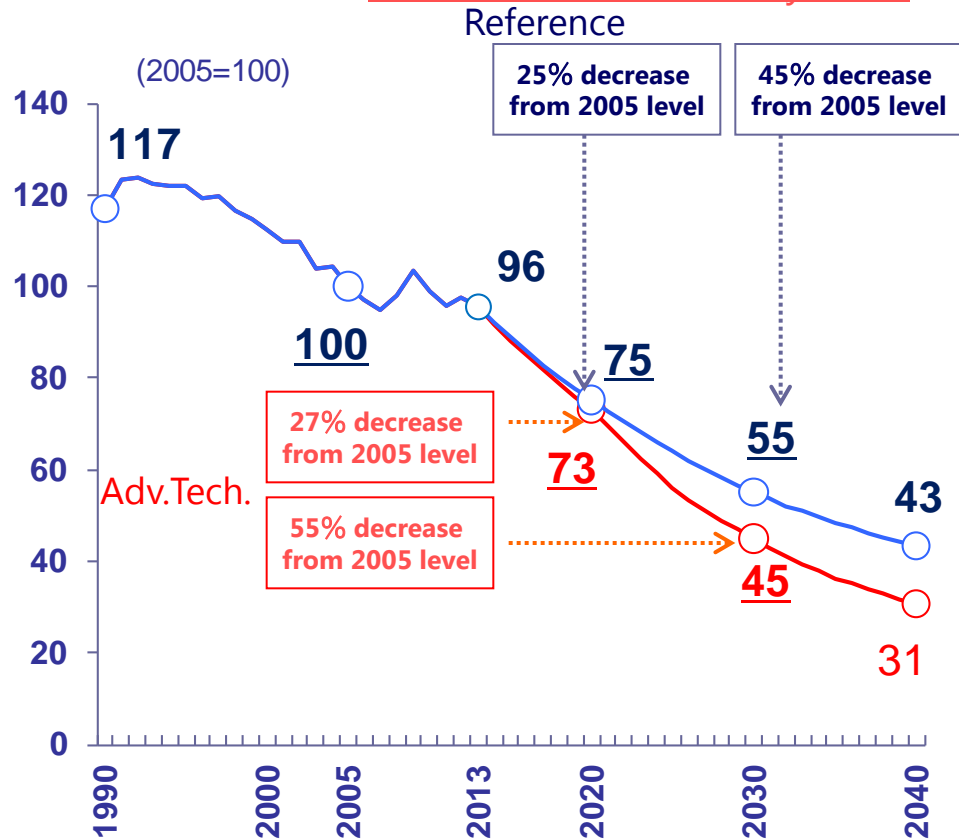


- In the Reference Scenario, CO₂ emissions increase by 2.9 Gt (a 2.5 fold-increase) in 2040 from 2013.
- In the Advanced Technologies Scenario, CO₂ emissions are 1.8 (37%) lower from the Reference Scenario.

CO₂ Emissions per GDP in India

National Target : 20 to 25% reduction by 2020

33 to 35% reduction by 2030



Decomposition Analysis of CO₂ Emissions

	1990-2005	2005-2020	
		Reference	Adv. Tech
CO ₂ Emissions ΔC	4.8%	5.5%	5.3%
Carbon intensity Δ(C/E)	1.3%	1.0%	0.9%
Energy saving Δ(E/Y)	-2.3%	-2.9%	-2.9%
Economic growth ΔY	6.0%	7.5%	

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

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

Decarbonization / Energy-Saving/ Economic-Growth

- India announced to improve its CO₂ intensity (calculated as CO₂ emissions per GDP) by 33 to 35% from 2005 level by 2030.
- The improvement in CO₂ emissions per GDP in 2030 exceeds those targets reaching 45% in the Reference Scenario and 55% in the Advanced Technologies Scenario.