Asia/World Energy Outlook 2016

9 November 2016

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Outline

Long-term energy outlook for Asia and world

Reference Scenario

This scenario reflects past trends as well as energy and environment policies that have been introduced so far. This scenario does not reflect any aggressive policies for energy conservation or low-carbon measures.

Advanced Technologies Scenario

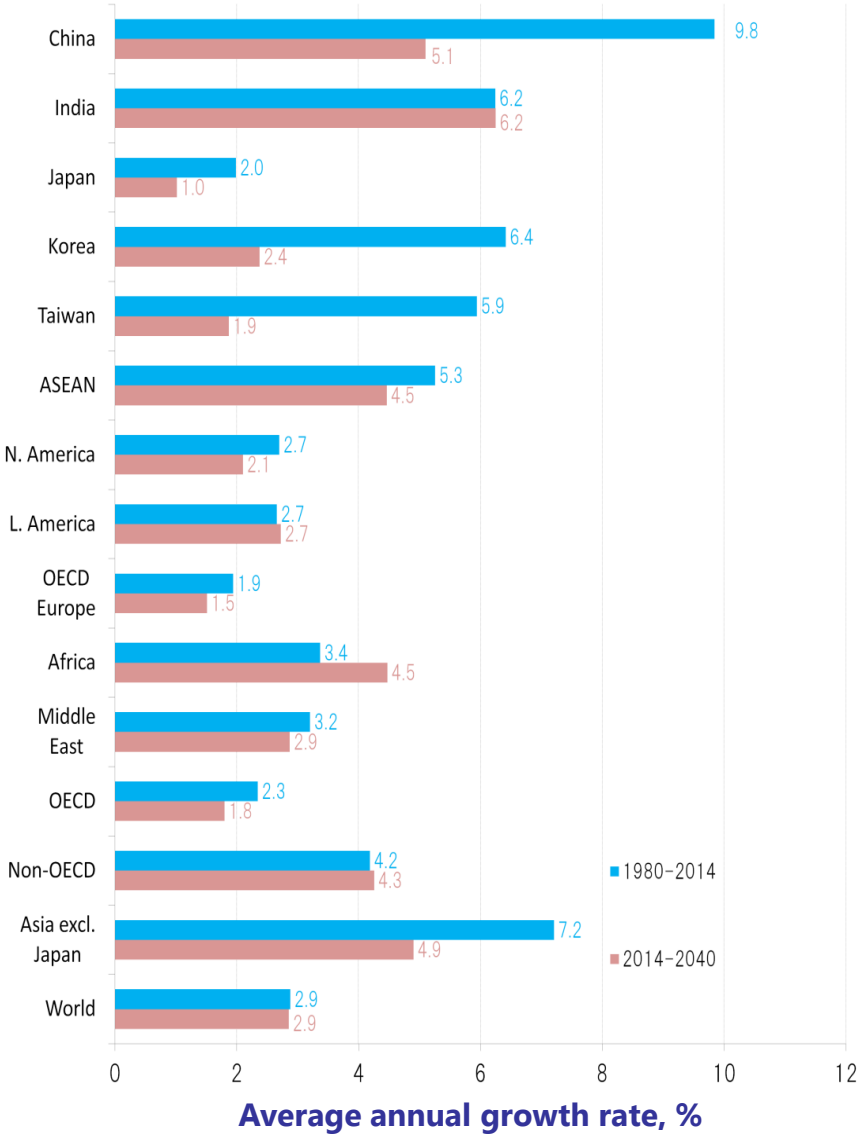
In this scenario, energy conservation and low-carbon technologies are promoted for maximum impacts, as each country is assumed to implement powerful policies to enhance energy security and address climate change issues.

Supply disruption of oil

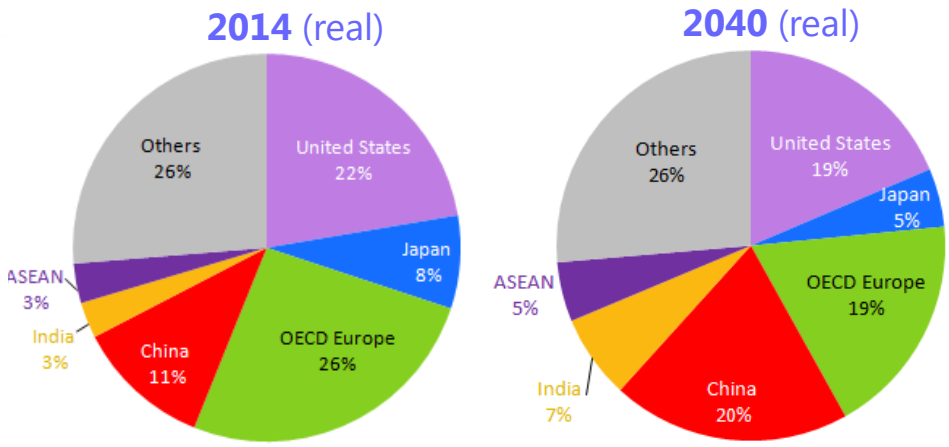
Estimate the economic impact of supply disruption of oil in the Middle East

Major assumptions

Economic growth

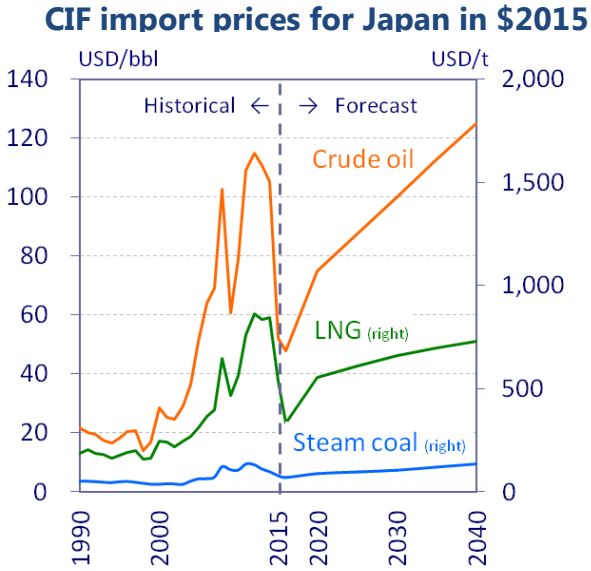


GDP share in the world



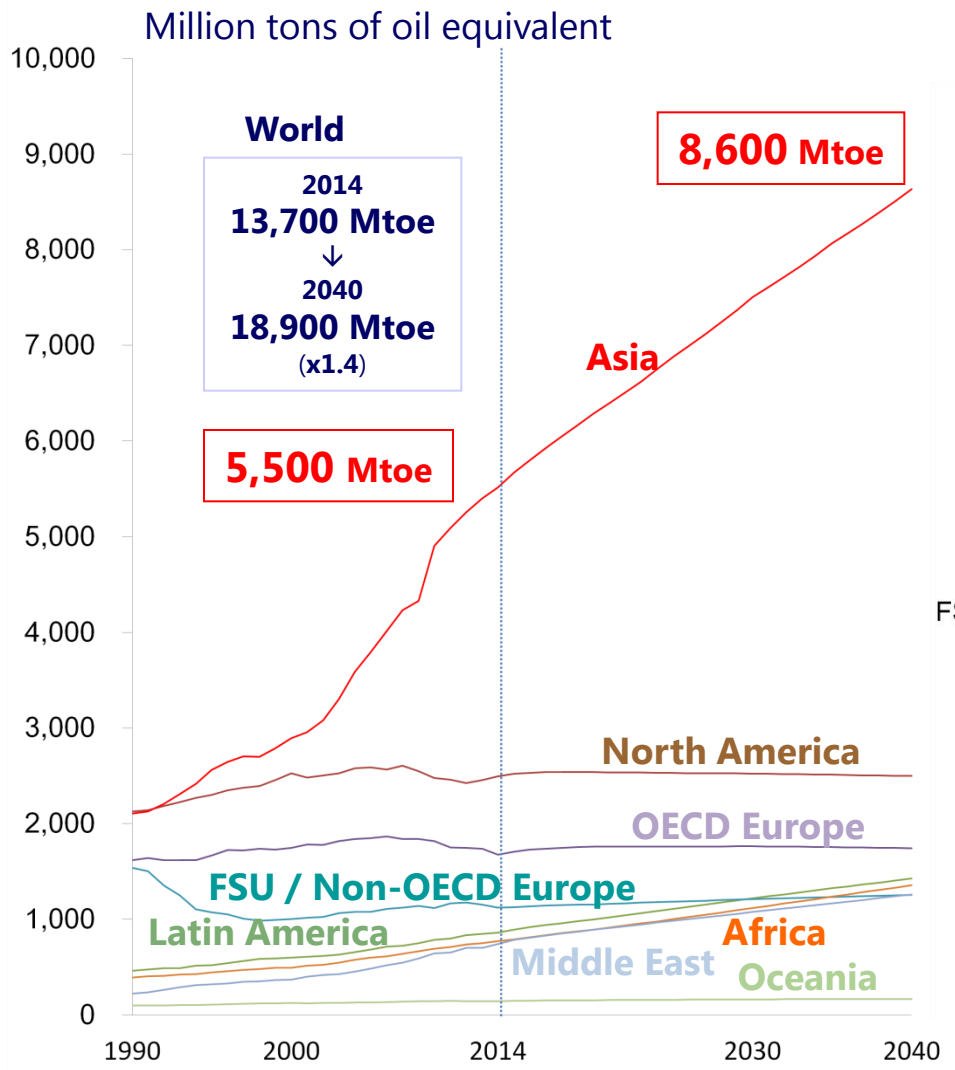
Note: Real values are in $2010

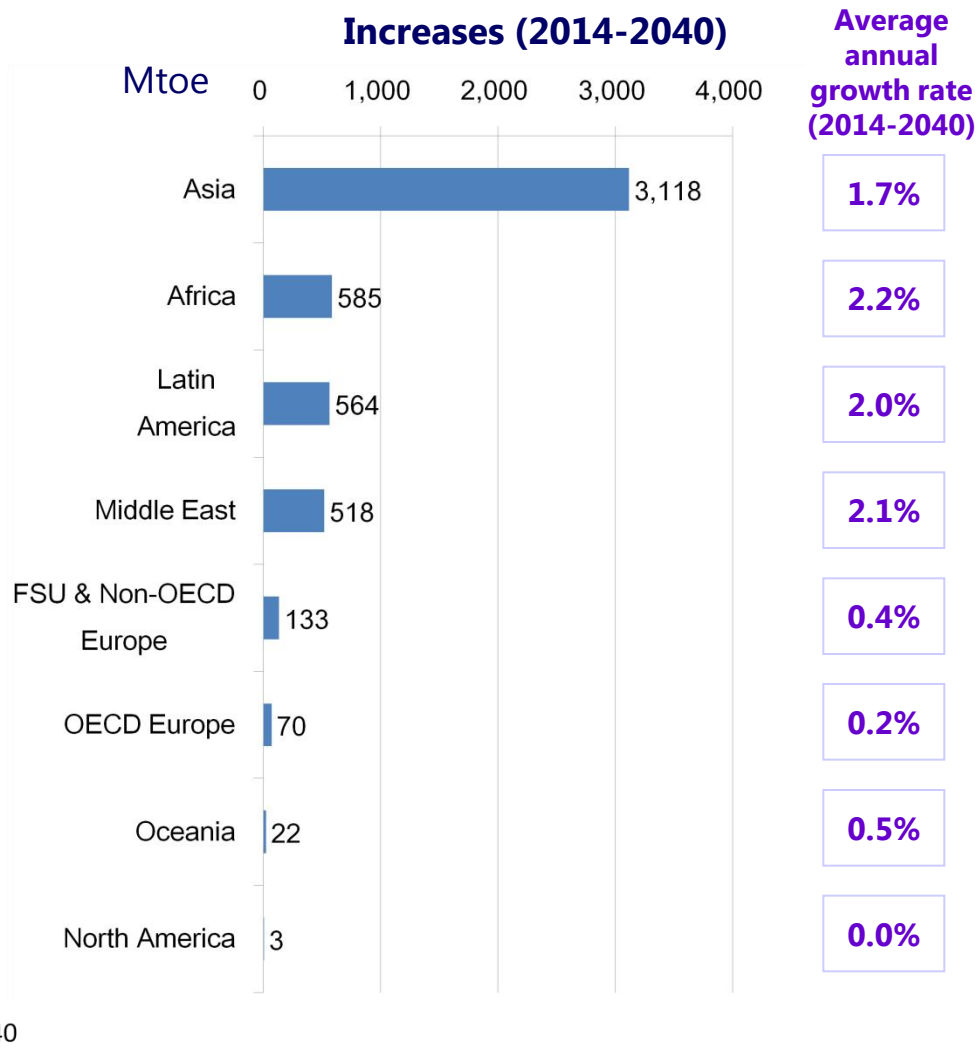
Primary energy prices



Primary energy consumption by region

Reference Scenario

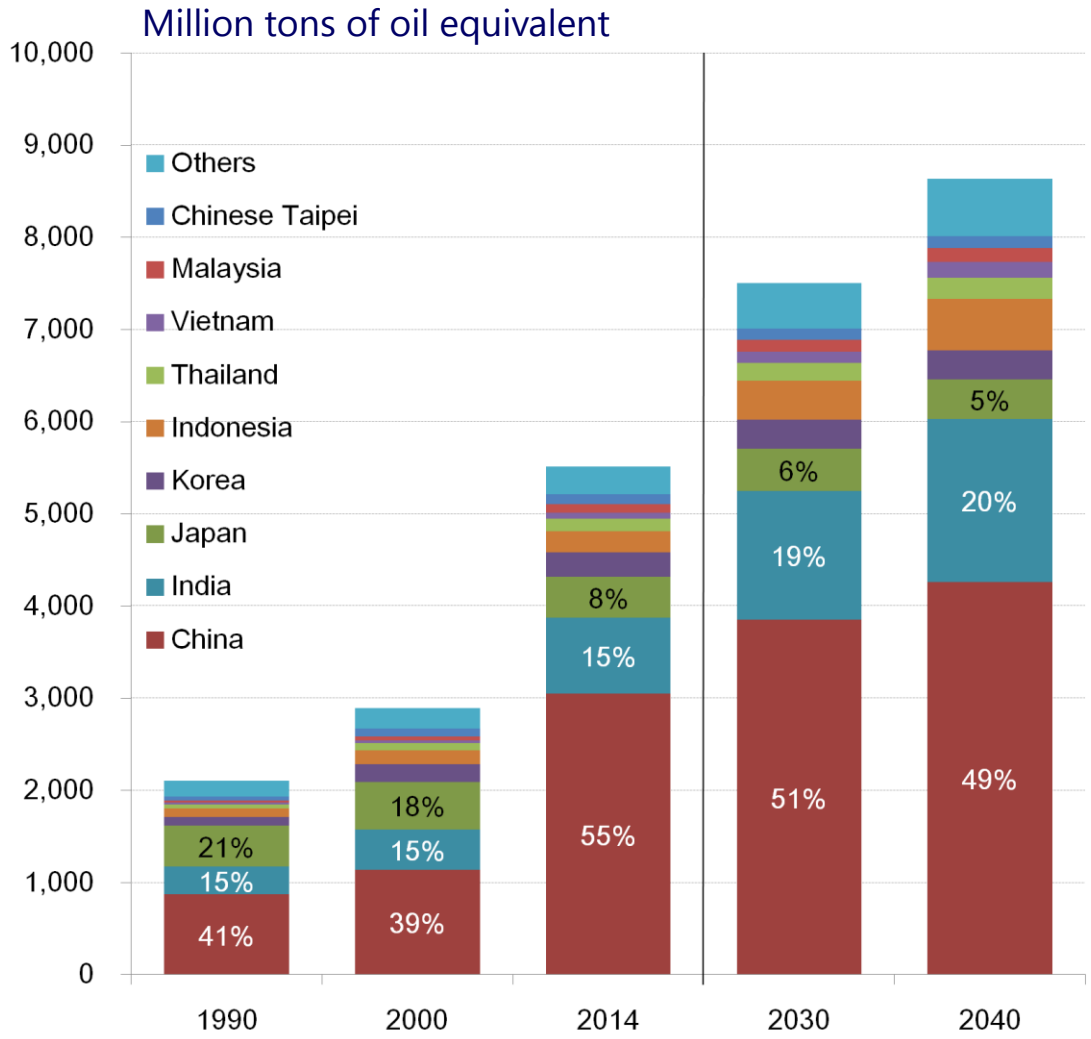




- Under the steady economic growth assumption, Asian energy consumption in 2040 increases 1.4-fold from the present level (from 5.5 Gtoe in 2014 to 8.6 Gtoe in 2040).
- Non-OECD countries account for about 90% of global energy consumption increase between 2014 and 2040.

Primary energy consumption (Asia)

Reference Scenario



Asia

2014
5,500 Mtoe
↓
2040
8,600 Mtoe
(x1.6)

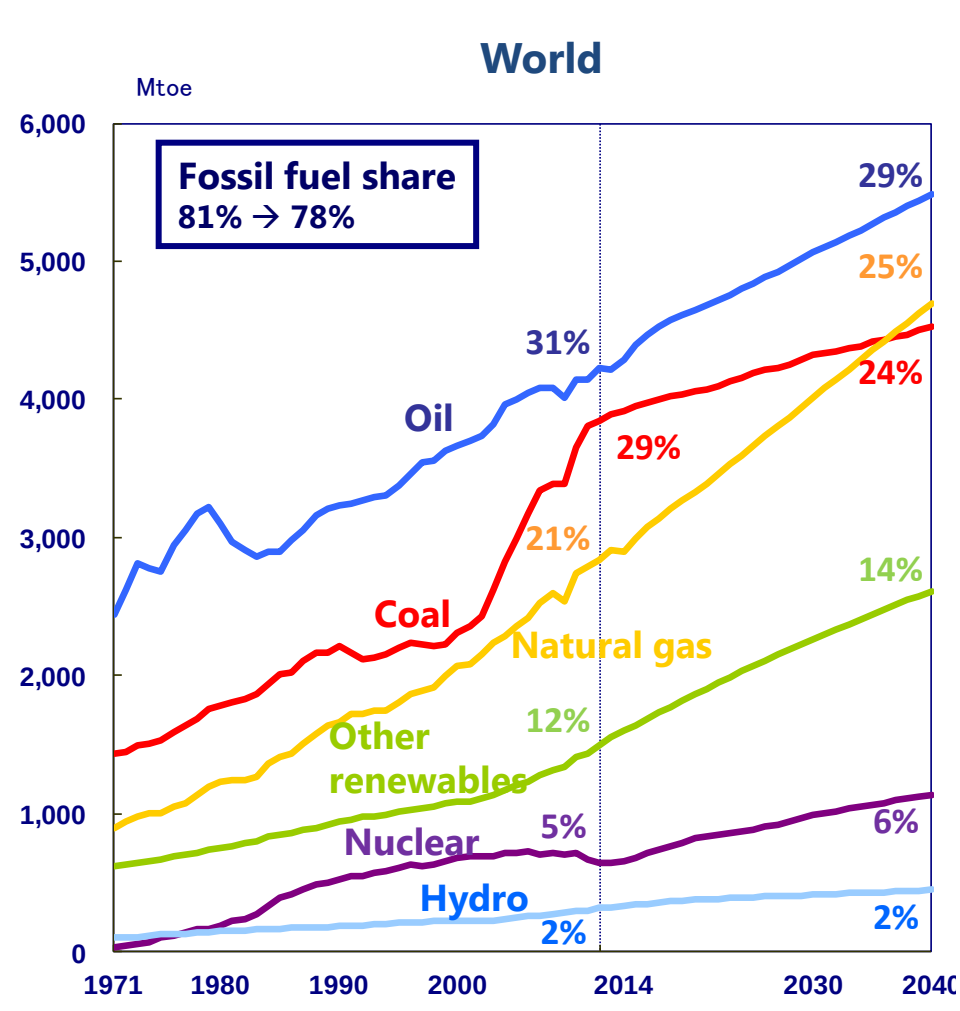
China **India**

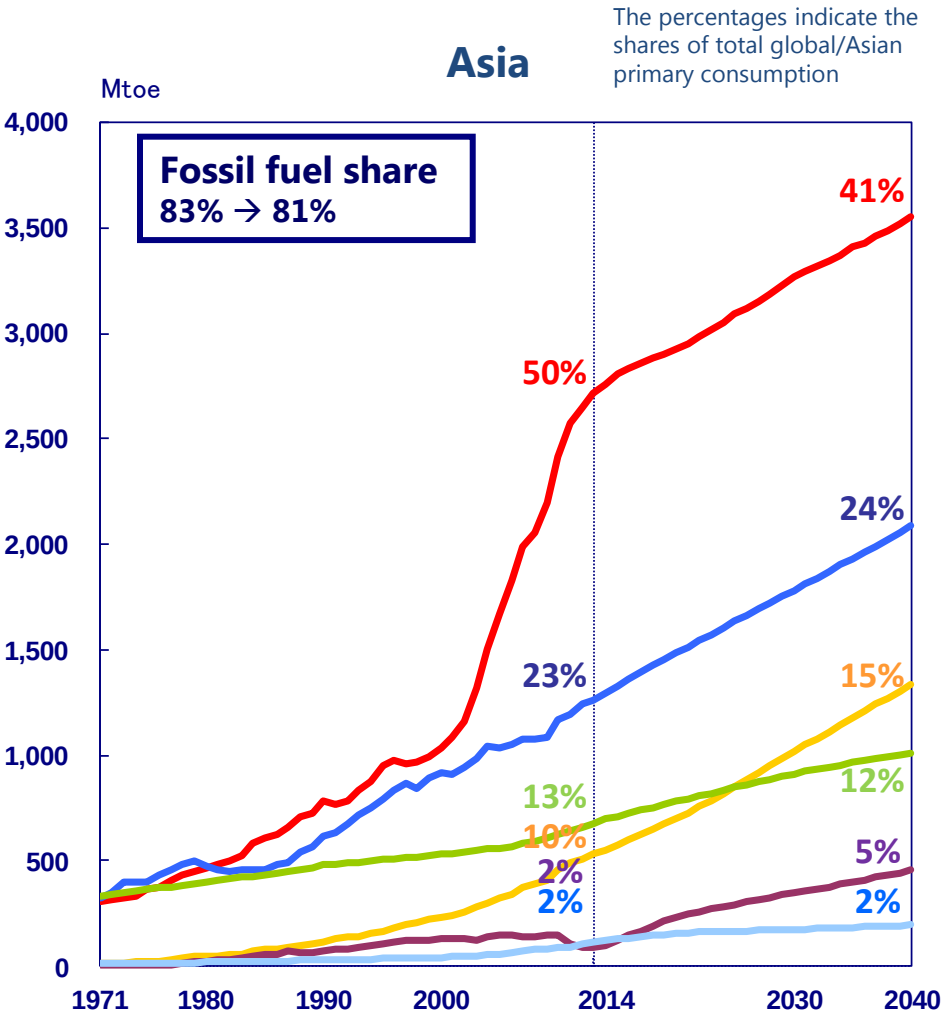
2014
3,100 Mtoe **820 Mtoe**
↓
2040
4,300 Mtoe **1,800 Mtoe**
(x1.4) **(x2.1)**

- Energy demand in China and India increase rapidly in line with economic growth. Their share of Asian energy demand will expand to 70% in 2040.
- Japan's energy consumption declines as a result of progress in energy efficiency combined with maturity of its economy and decrease of its population. Its share of Asian energy consumption will shrink from 8% to 5%.

Primary energy consumption by source

Reference Scenario



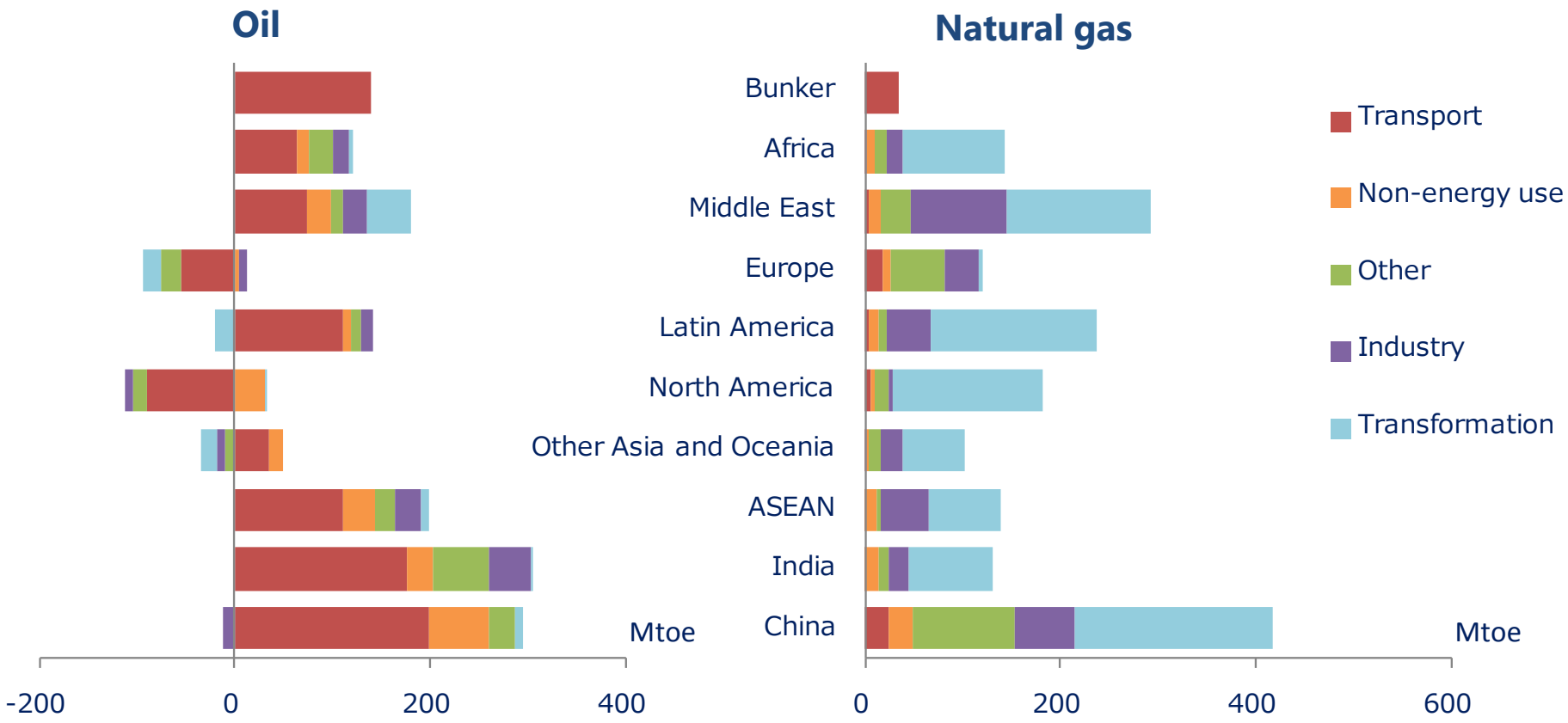


The percentages indicate the shares of total global/Asian primary consumption

- Oil continues to be the largest share of primary energy consumption and remains a major energy source up to 2040.
- In Asia, coal remains the largest share among energy sources.
- The share of fossil fuel in both Asia and the world will decline until 2040 while maintaining around 80%.

Changes of world oil and natural gas consumption (2014-2040)

Reference Scenario

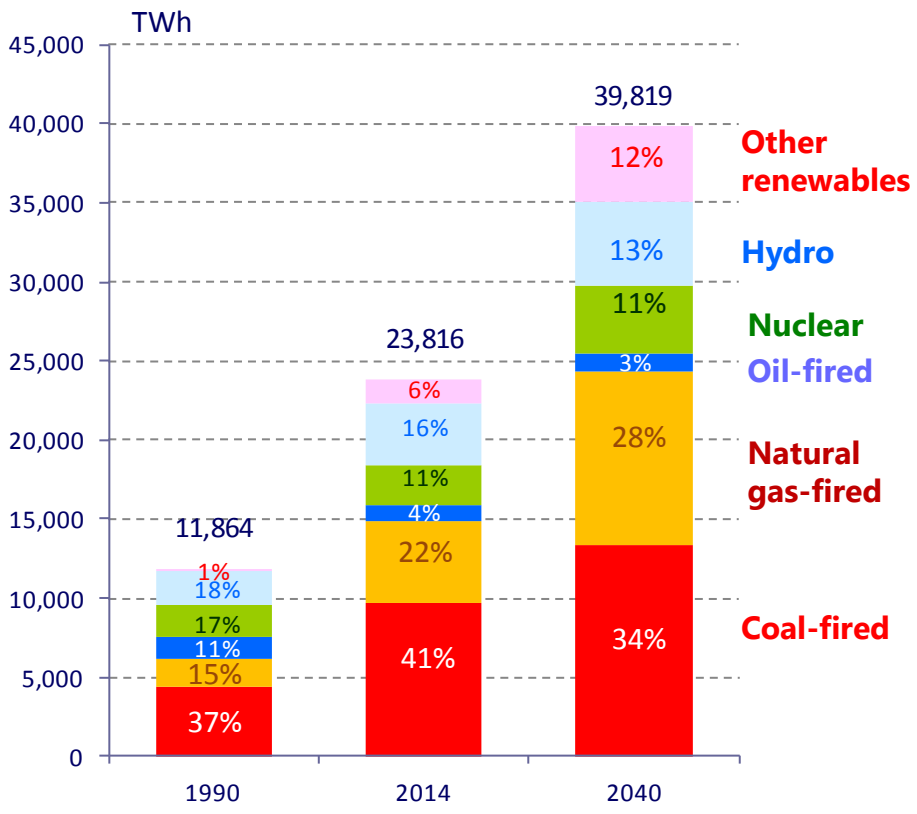


- Oil demand increases 1,203 Mtoe. More than 60% of the increase is attributed to Transport, more than 10% to Bunker, and nearly 20% to Non-energy use.
- India accounts for a quarter; Asia and Oceania for two thirds of the world oil demand increase.
- On the other hand, oil demand decrease in North America, Europe, and Japan.
- Natural gas demand increases 1,794 Mtoe. More than 40% of the increase is attributed to Power generation sector, 20% to Industry, and 15% to Other.
- Nearly 20% of the increment is by OECD, Non-OECD accounts most of the increment.

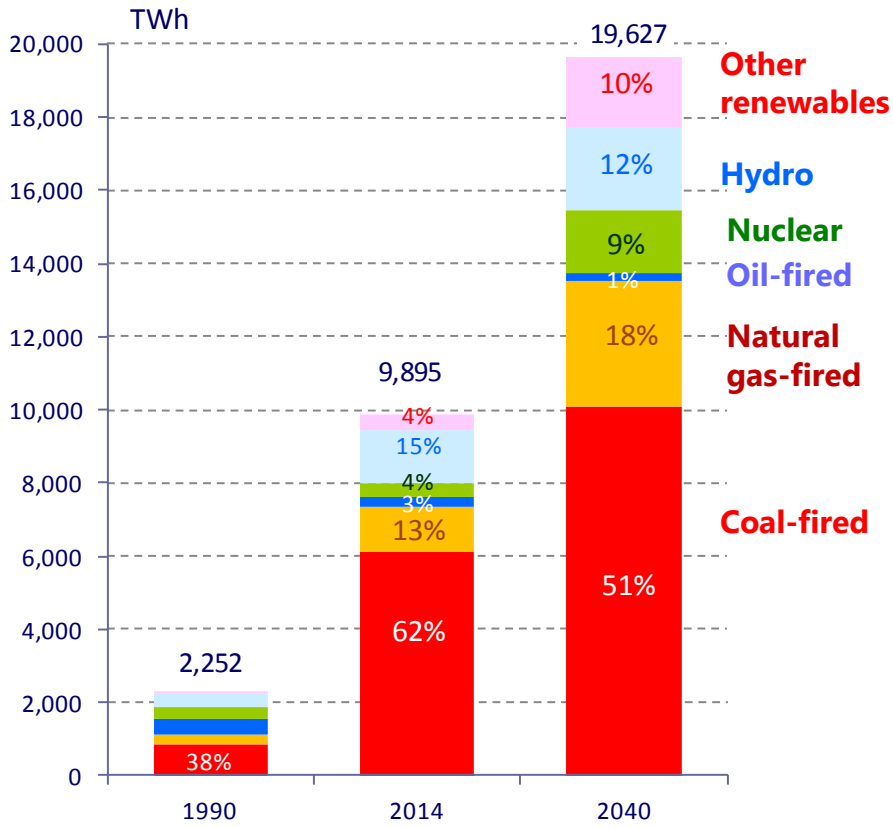
Power generation mix in 2040

Reference Scenario

World



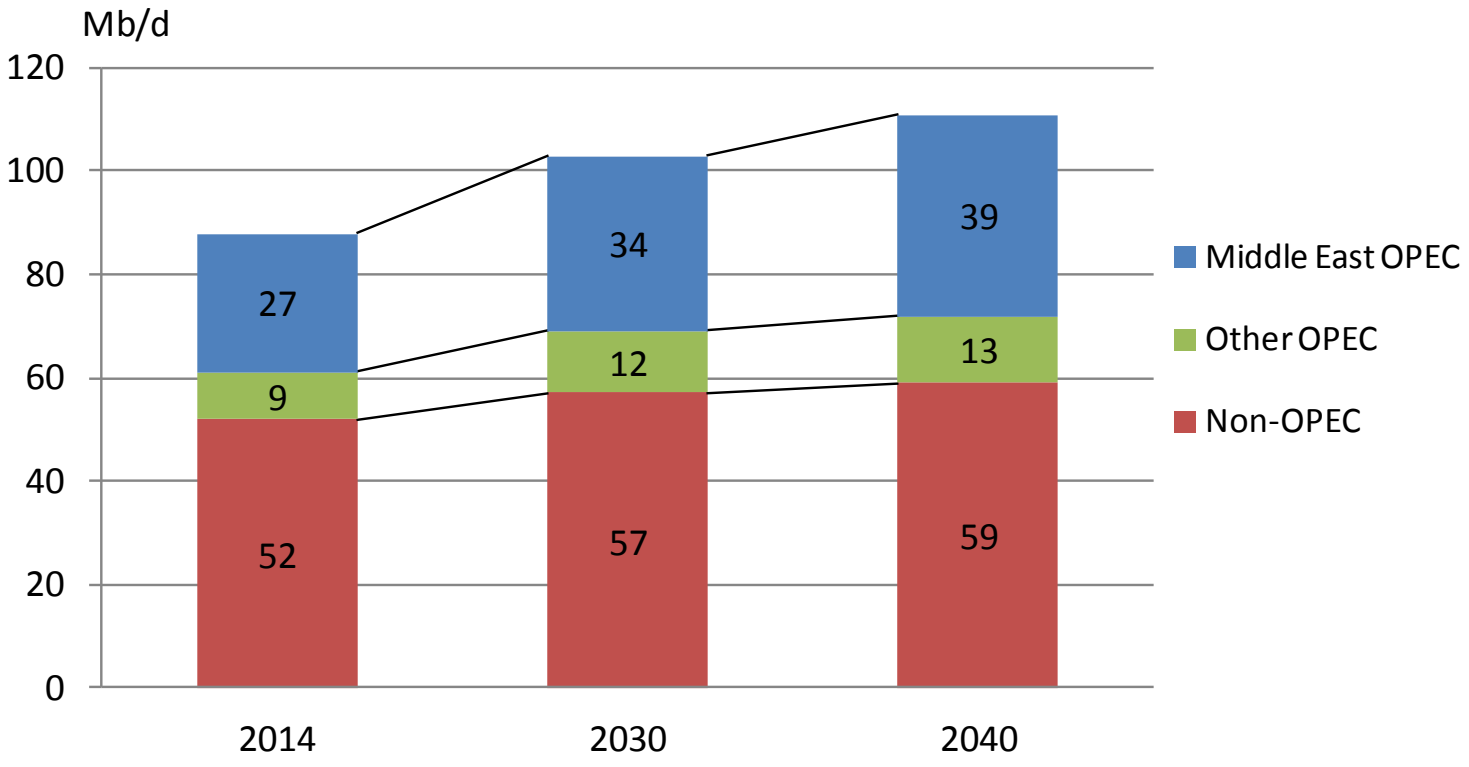
Asia



- In 2040, coal still accounts for the largest share of power generation.
- Natural gas-fired power plants globally increase on the introduction of natural gas combined cycle plants.
- Renewable energy sources including wind and solar energy also expand their share of power generation.
- The share of nuclear will stay at the same level in the world, and increase significantly in Asia.

Oil production

Reference Scenario



OPEC

2014
37 Mb/d
↓
2040
52 Mb/d
(**+15** Mb/d)

Non-OPEC

2014
52 Mb/d
↓
2040
59 Mb/d
(**+7** Mb/d)

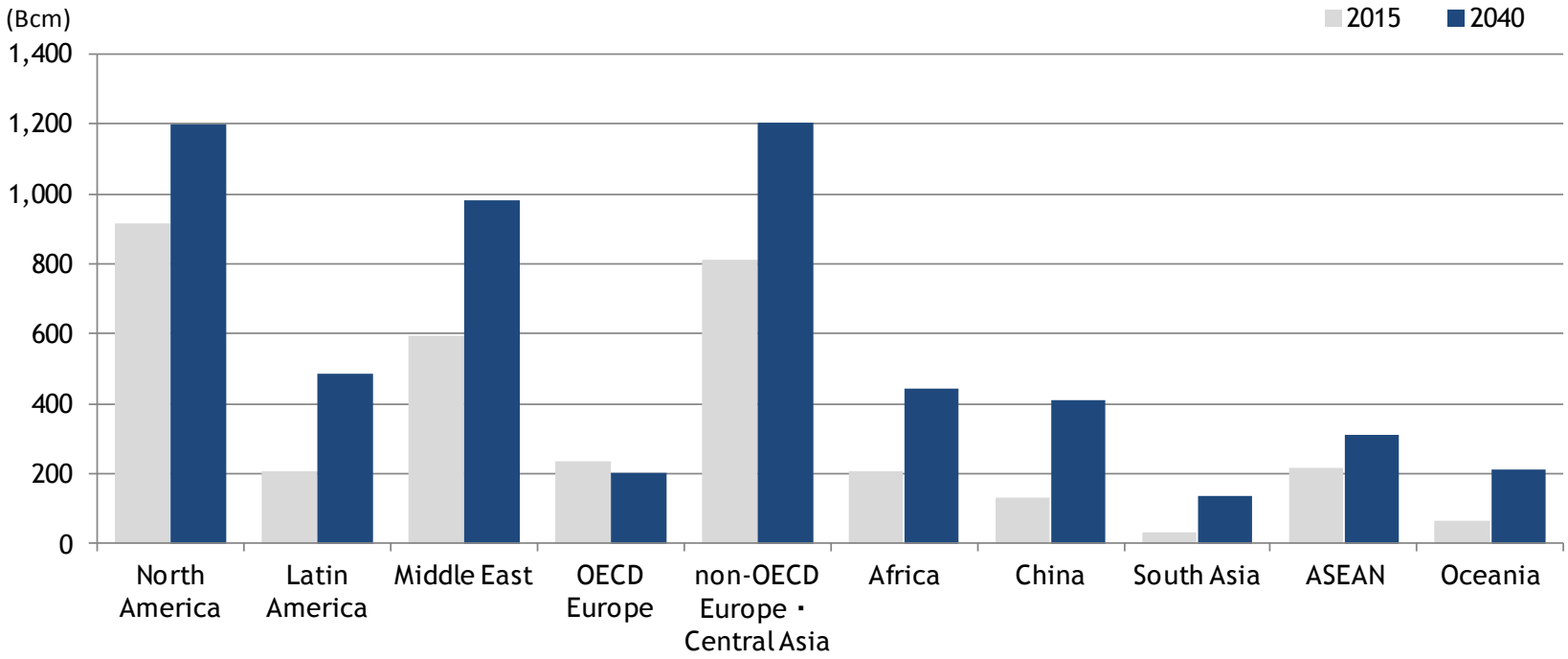
- 67% of the increases in world oil consumption is met by OPEC. OPEC's share of world oil production in 2040 increases to 46%.
- However, the domestic oil consumption in the Middle East OPEC is also projected to increase significantly. Enhancement of production capacity and improvement of energy efficiency in the Middle East OPEC is necessary to ensure availability of oil supply to the world market.

Natural gas production

Reference Scenario

Production in 2040
5,700 Bcm
+2,202 Bcm from 2015

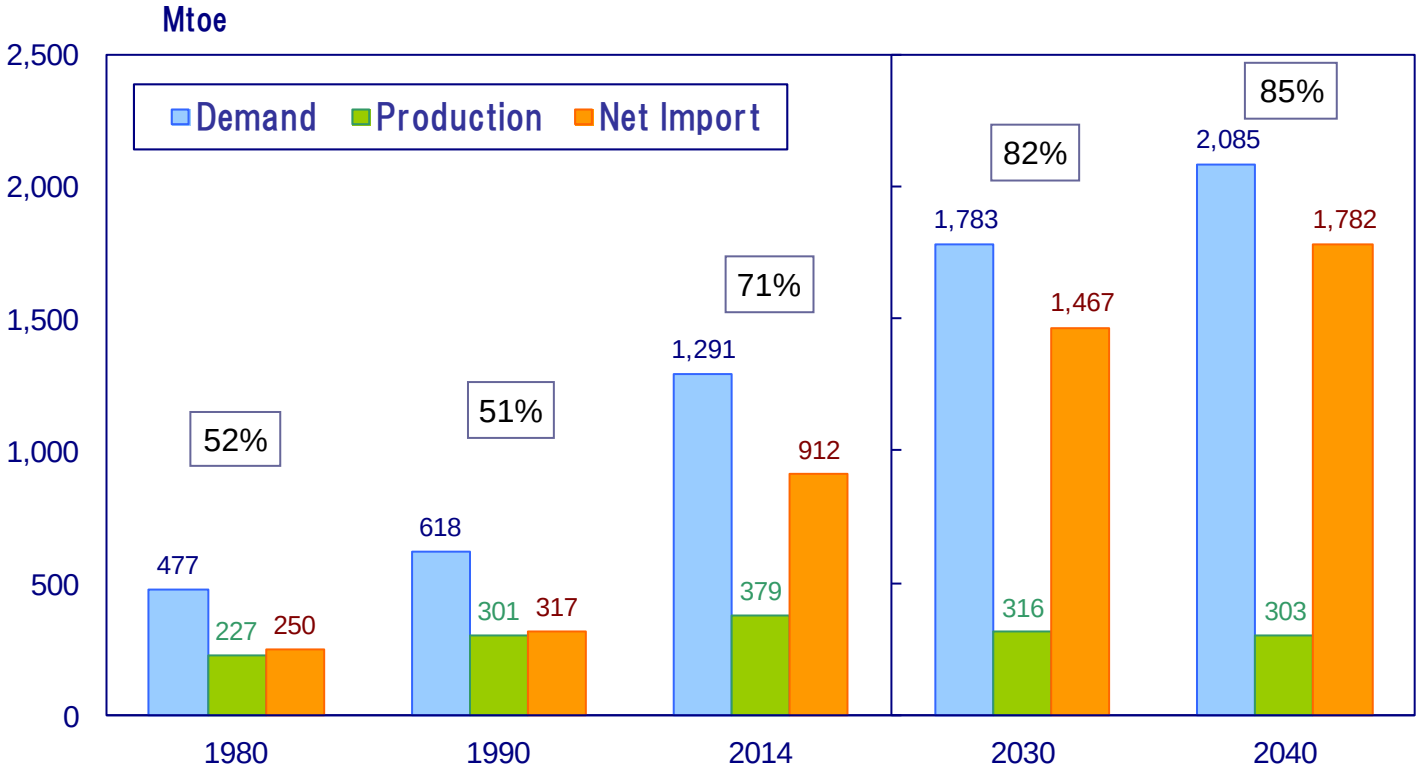
Shares of the increase
North & Latin Americas 26%
Middle East 18%
Africa 11%



- 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.

Oil supply and demand in Asia

Reference Scenario

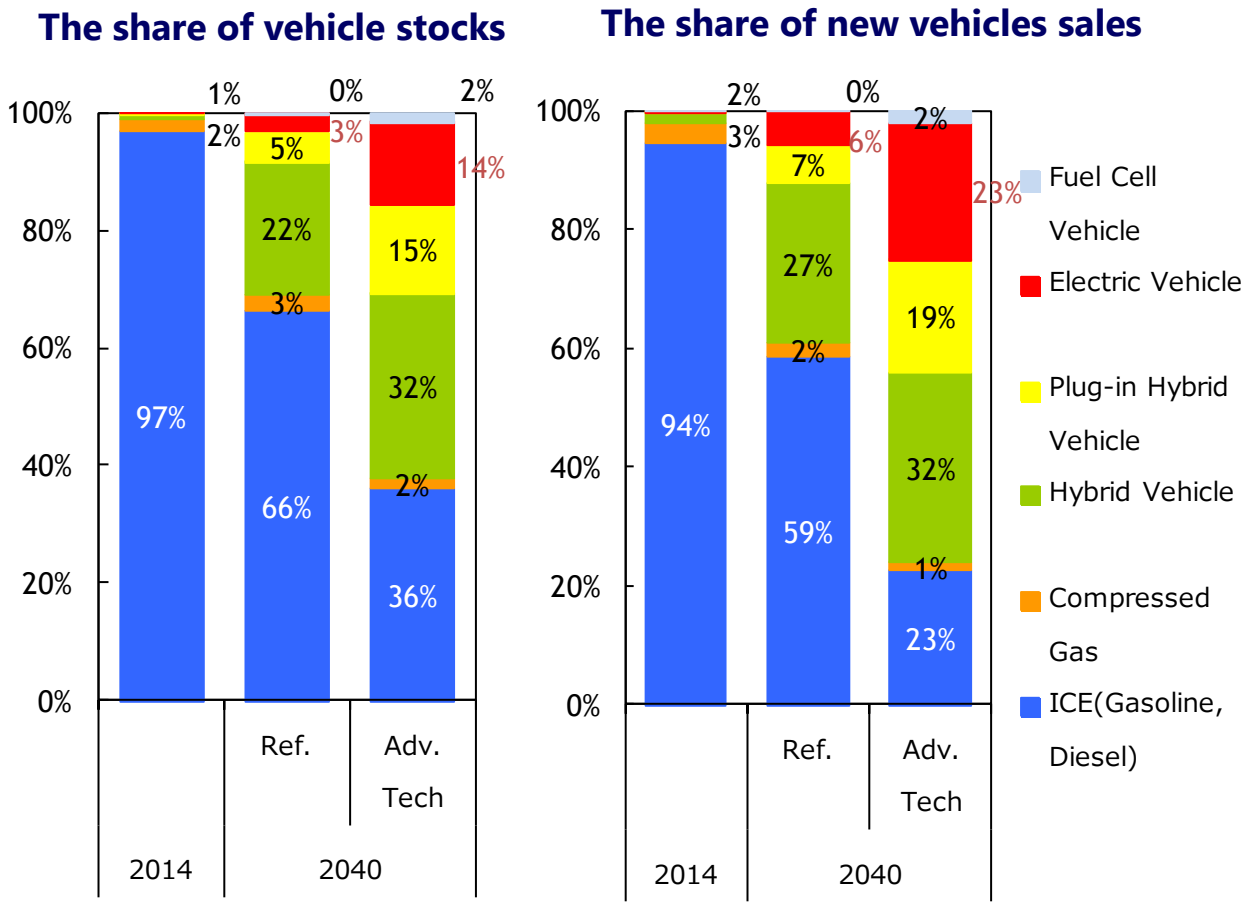


Net oil imports

2014
18.92 Mb/d
↓
2040
36.98 Mb/d
(x2.0)

- Net oil imports are projected to expand to 1,782 million ton (36.98 Mb/d) in 2040 from 912 million ton (18.92 Mb/d) in 2014.
- With the sluggish oil production of in Asia (China, India, Indonesia), net oil import ratio reaches 85% in 2040.

Assumption in Advanced Technologies Scenario (Example：Vehicle in the world)



Share of clean energy vehicles in total stocks (2040)

Reference **34%**
Adv. Tech. **64%**

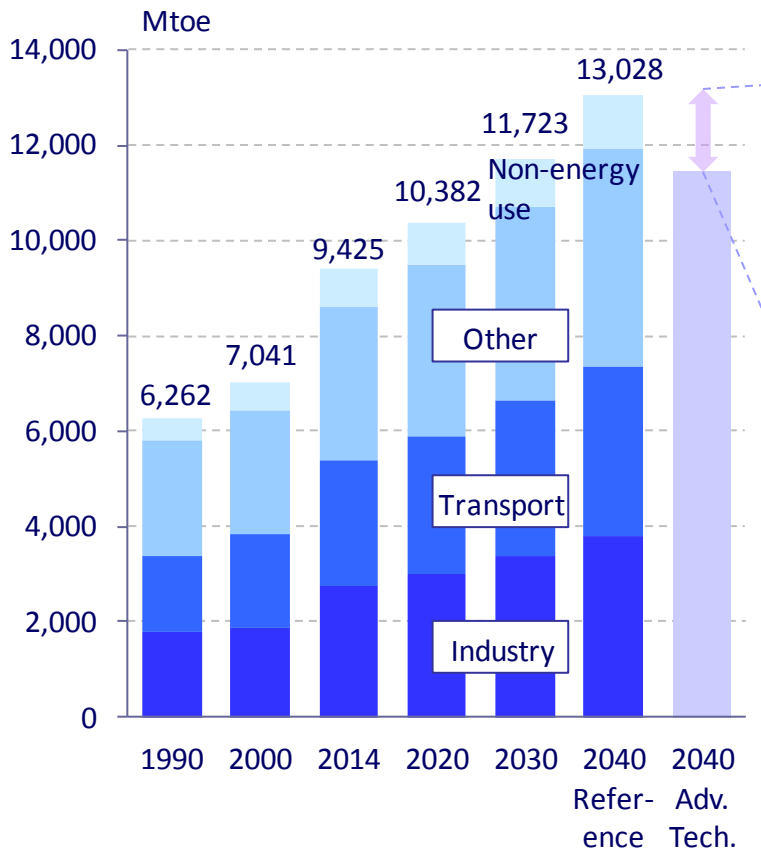
Share of clean energy vehicles in annual sales (2040)

Reference **41%**
Adv. Tech. **77%**

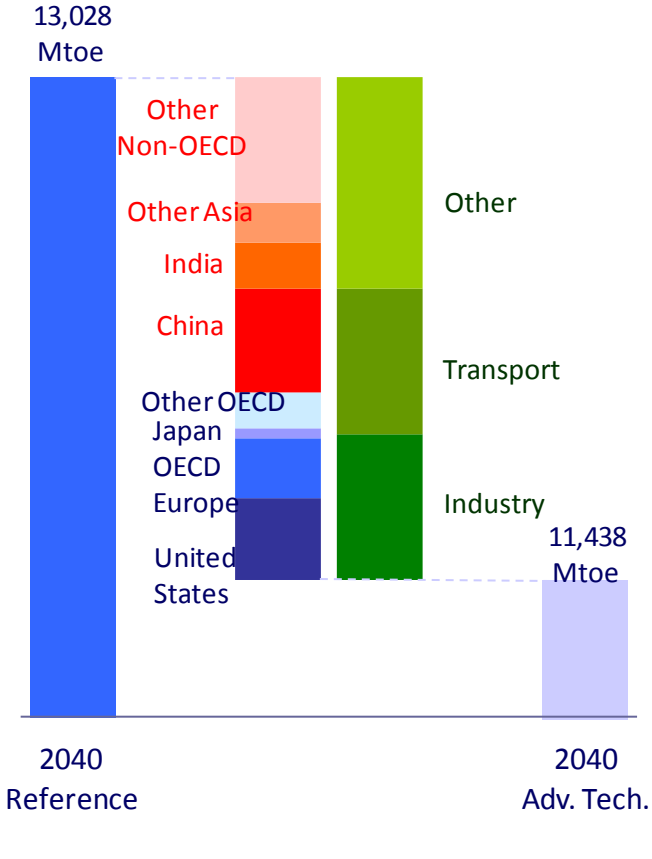
- In the Reference Scenario, in 2040, ICE accounts for 66% of the total stocks and 59% of the annual sales. Clean energy vehicles increase mainly by hybrid vehicles.
- In the Advanced Technologies Scenario, ICE drops to 36% of the total stocks and 23% of the annual sales. Within clean energy vehicles, in 2040, hybrid (32%), plug-in hybrid (15%), and electric vehicles (14%) are the main stream of the total stocks. Similarly, hybrid (32%), plug-in hybrid (19%), and electric vehicles (23%) are the main stream of the total sales, and fuel cell vehicles are also introduced (2%).

Energy saving in 2040 by region and by sector

Global final energy demand



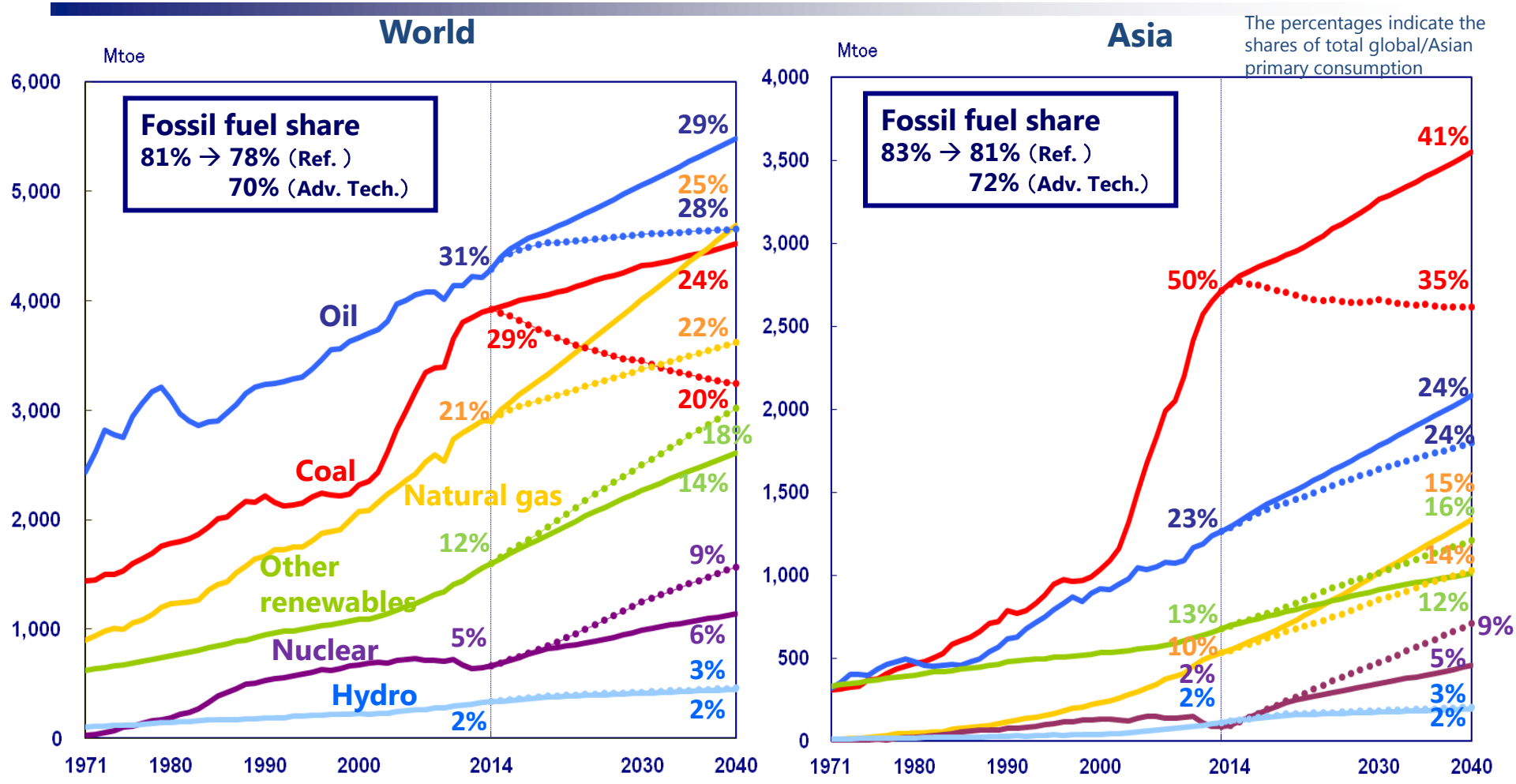
Energy saving by region and by sector



- Global final energy demand expands 1.4-fold from 9,425 Mtoe in 2014 to 13,028 Mtoe in 2040 in the Reference Scenario.
- In the Advanced Technologies (Adv. Tech.) Scenario, final energy demand in 2040 is reduced by 12% to 11,438 Mtoe. 60% of the energy saving is attributable to non-OECD countries. By sector, "other" sector including residential and commercial sectors accounts for 42% of total energy saving.

Primary energy consumption by source

Reference Scenario (solid)
Advanced Technologies Scenario (dotted)

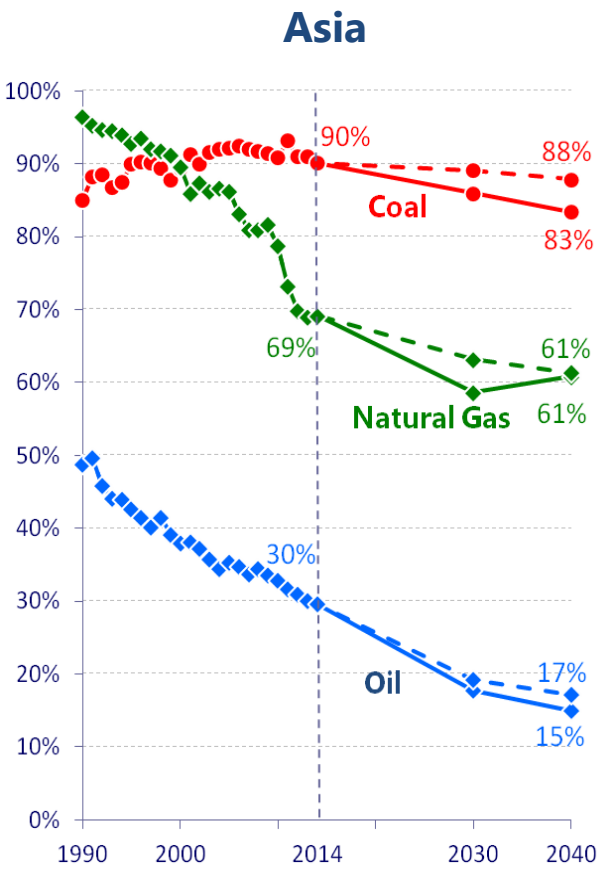


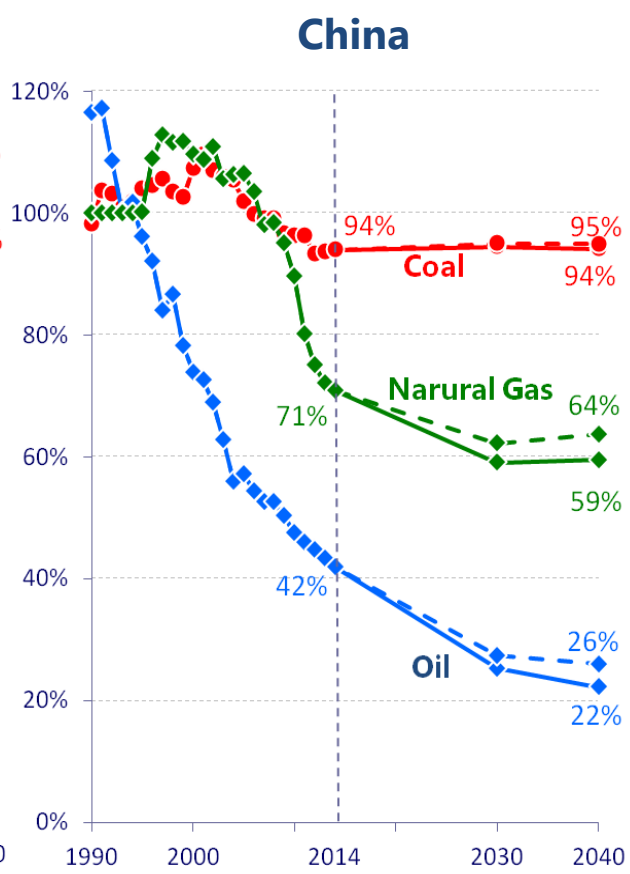
The percentages indicate the shares of total global/Asian primary consumption

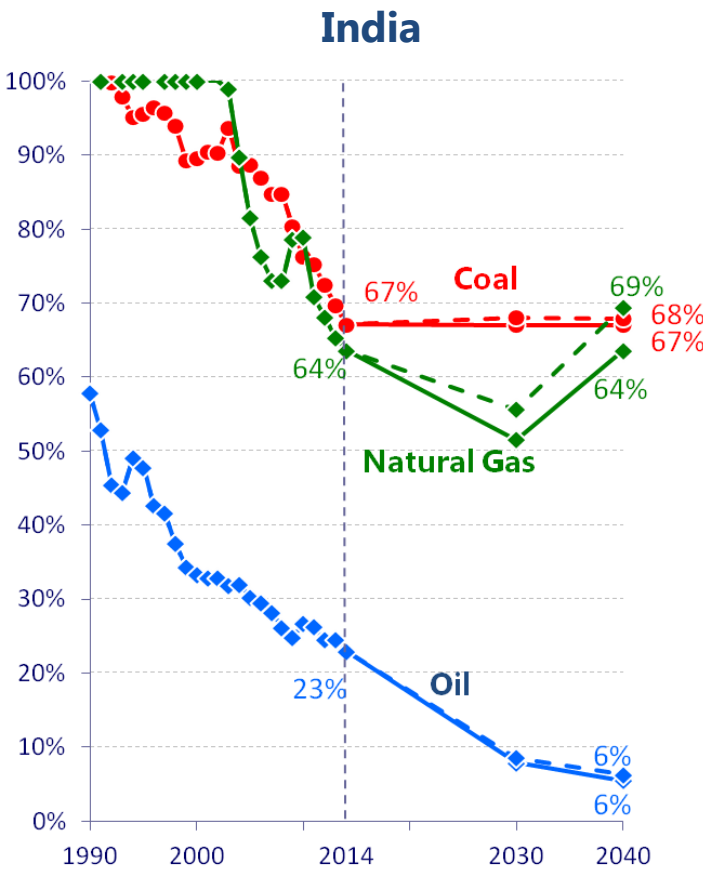
- In Adv. Tech. Scenarios, oil continues to be the largest share of primary energy consumption up to 2040. And the consumption of oil will hit a peak during 2030s.
- In the Adv. Tech. Scenario, coal consumption declines substantially while retaining the largest share among energy sources in Asia.
- In Adv. Tech. Scenario, renewables expand more rapidly. More nuclear plants are built around the world, most of the additional new plants locates in Asia.
- The share of fossil fuel declines until 2040 while maintaining 70% of its share in the Adv. Tech. Scenario.

Energy self-sufficiency in Asia

Reference Scenario (solid)
Advanced Technologies Scenario (dotted)



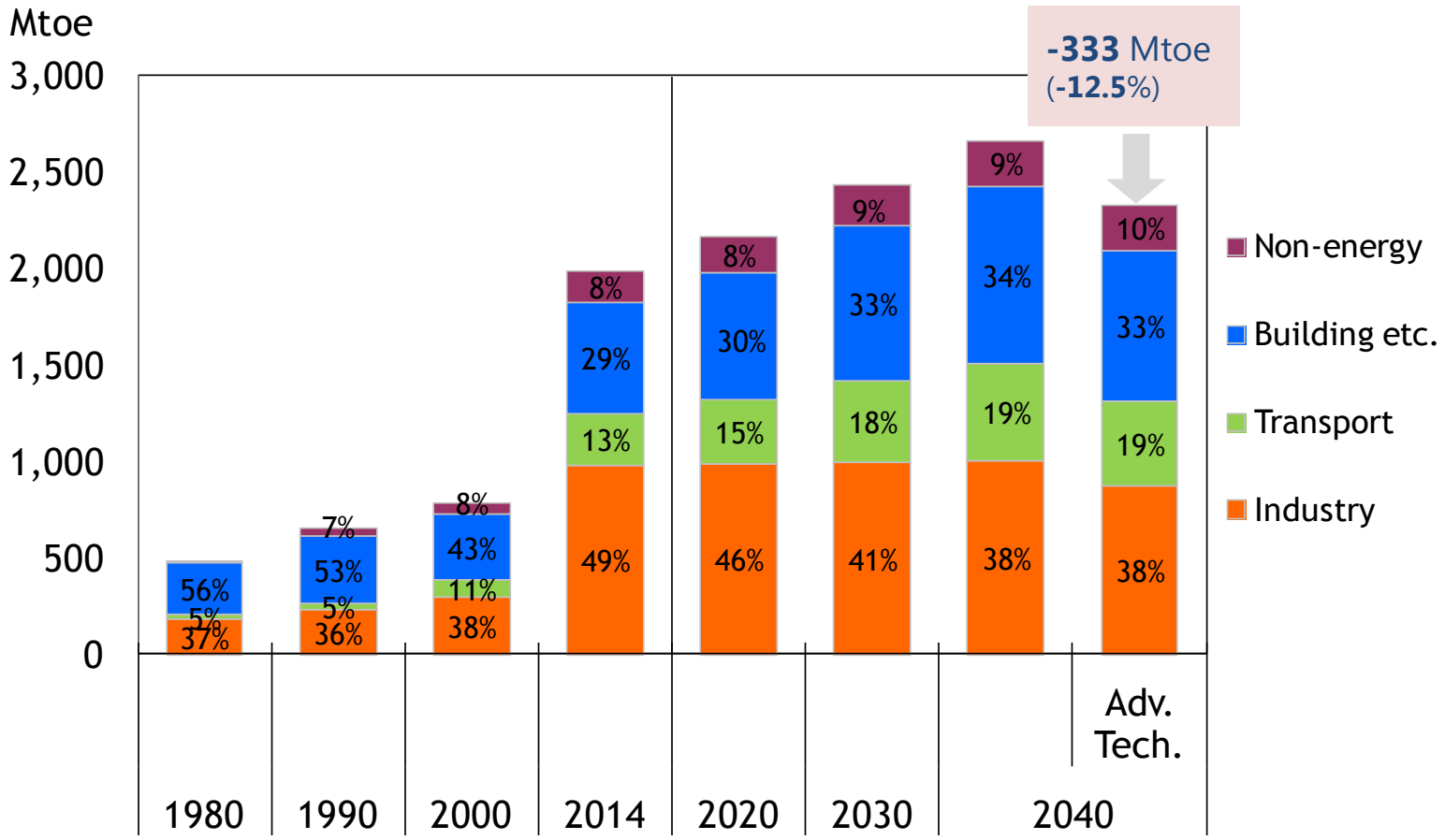




- While Asia including China and India is poor in oil and natural gas resources, coal resources are abundant. so coal contributes to stabilize energy self-sufficiency in Asia.
- Asian fossil fuel self-sufficiency rate has been decreasing and it keeps decreasing not only in the Reference Scenario where demand rapidly increases, but also in the Advanced Technologies Scenario where energy saving technologies are heavily implemented.

Final energy consumption in China

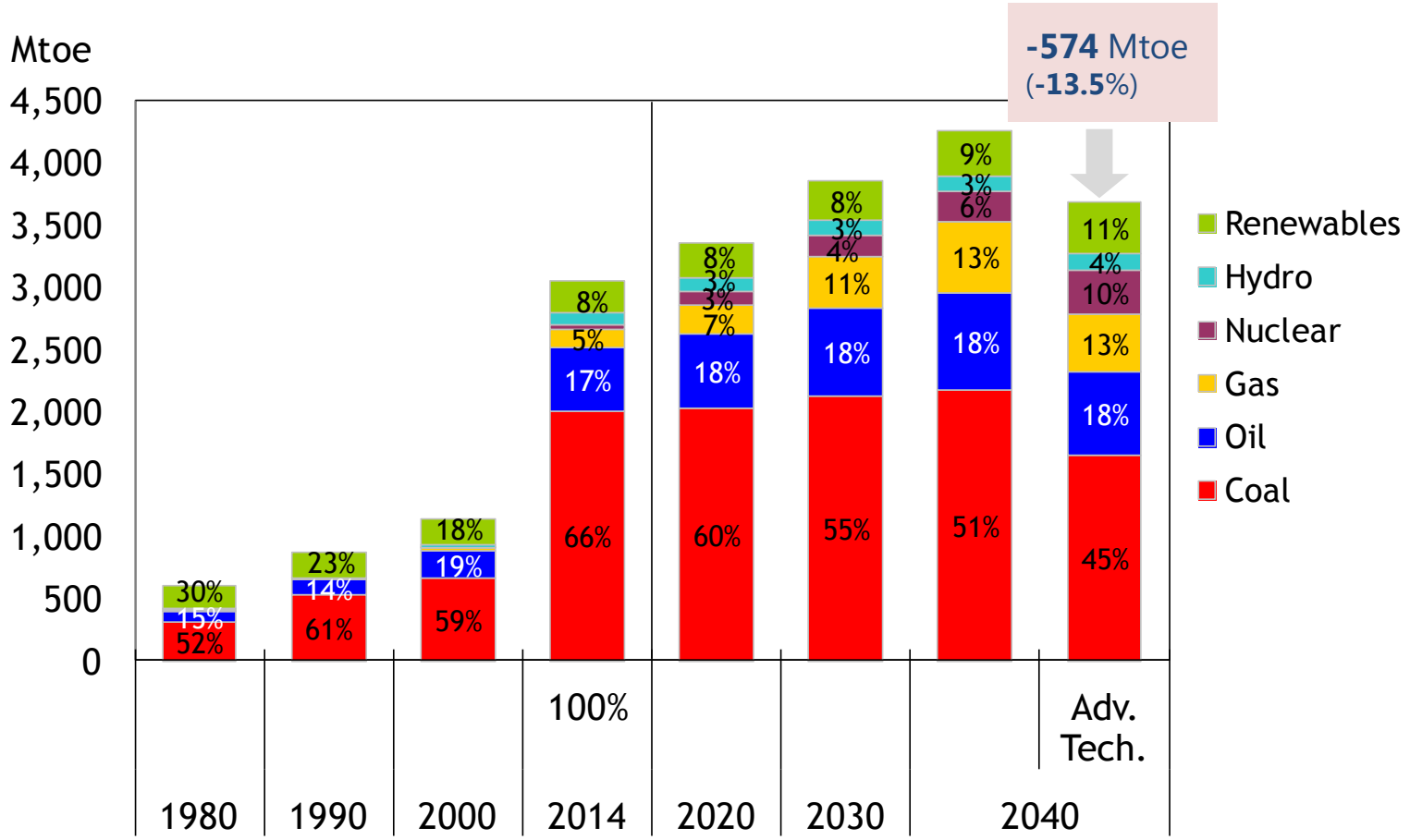
Reference Scenario
Advanced Technologies Scenario



- Final energy consumption increases strongly, reaching 2,667 Mtoe in 2040, from 1,988 Mtoe in 2014.
- 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 29% in 2014.
- 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 333 Mtoe, or 12.5% lower than the Reference Scenario.

Primary energy consumption in China

Reference Scenario
Advanced Technologies Scenario

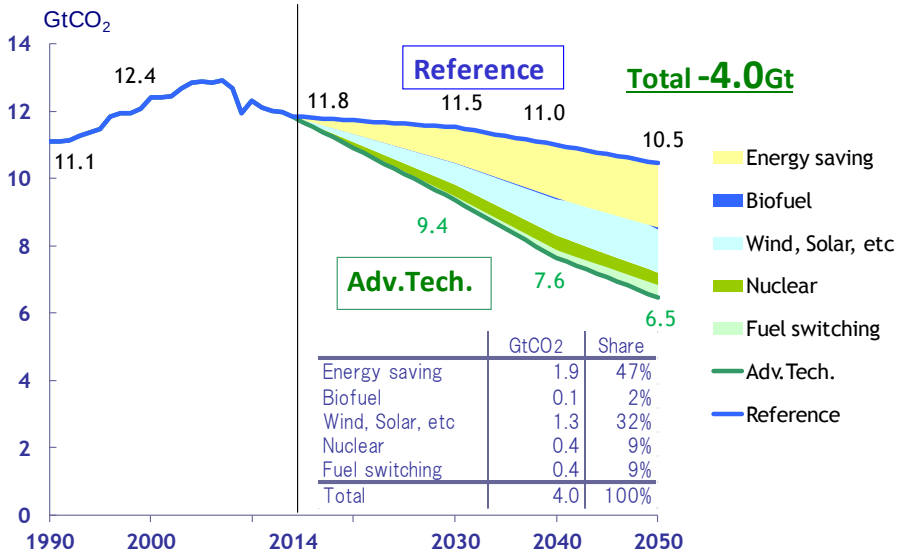


- TPED increases at an annual rate of 1.3% in the Reference Scenario at the back of economic growth. Oil expands reflecting rapid motorization.
- Natural gas increases sharply for residential and commercial use, especially in urban areas.
- In the Advanced Technologies Scenario, coal consumption decreases, especially in power generation, TPED is 574 Mtoe, or 13.5% lower than that in the Reference Scenario in 2040.

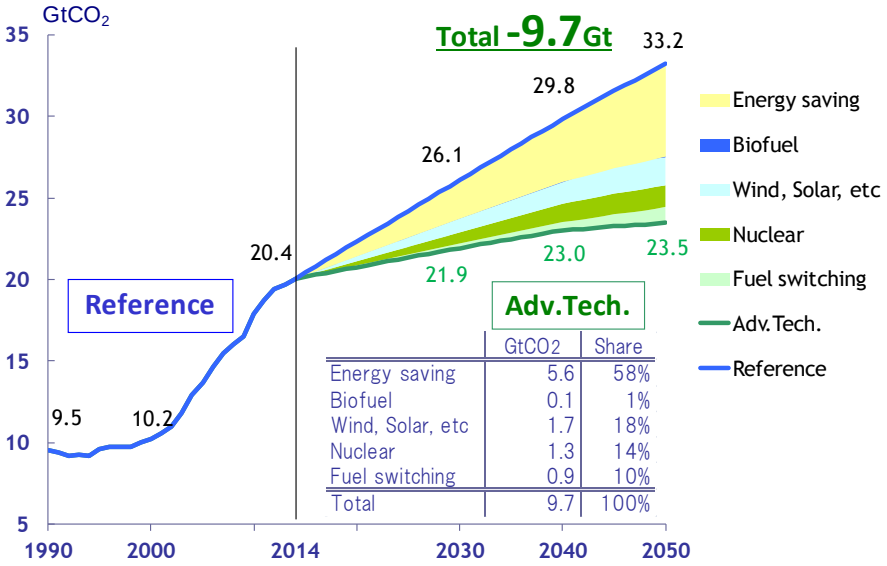
CO_2 emission reduction by technology (OECD and non-OECD)

Reference Scenario
Advanced Technologies Scenario

OECD



Non-OECD



Excludes CCS

- Various technologies are required to reduce CO_2 emissions. In OECD, energy saving is responsible for the largest share at 47% (or 1.9 Gt). It is followed by renewable energy at 34% (or 1.4 Gt), nuclear at 9% (or 0.4 Gt), and fuel switching at 9% (or 0.4 Gt).
- In Non-OECD countries, energy saving is responsible for more than half of the 9.7 Gt reduction. It is followed by renewable energy at 19% (or 1.8 Gt), nuclear at 14% (or 1.3Gt), and fuel switching at 10% (or 0.9Gt).
- Supportive measures concerning technology transfer and the establishment of efficiency standards are important to realize those CO_2 emission reduction while further enhancing energy security.

Supply disruption of oil

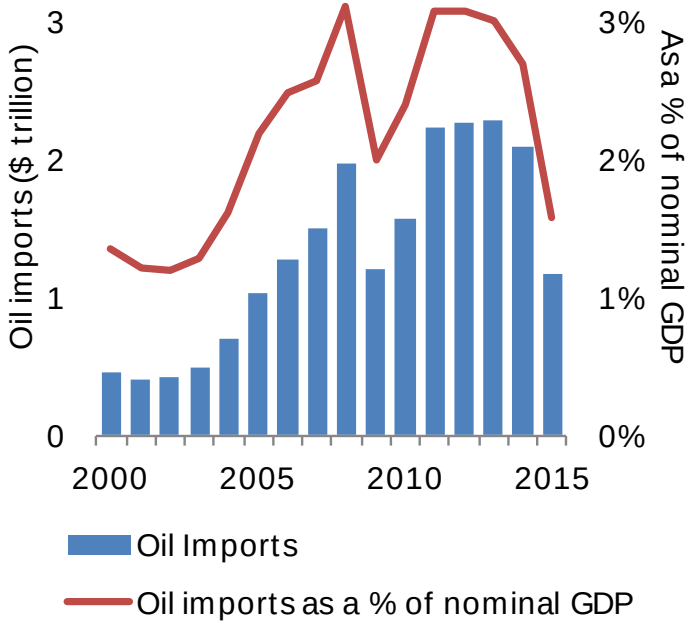
In prosperity prepare for adversity

Energy Security | The uninterrupted availability of energy sources at an affordable price

— IEA

Economic issue 》Relaxed by lower oil price

❖ World oil import value



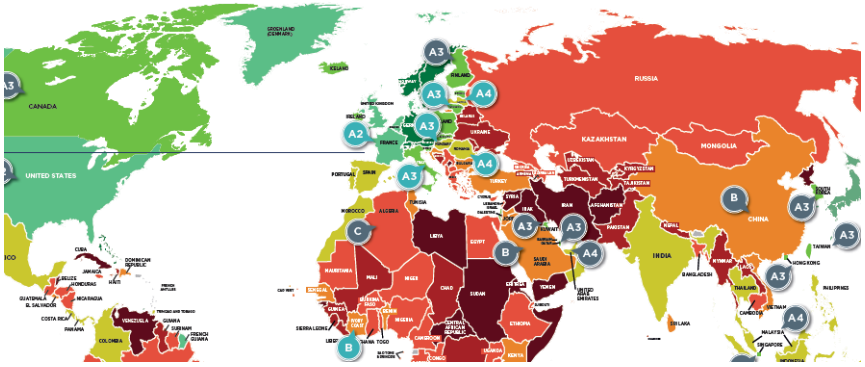
Source: estimated from BP, IMF

Note that there are some Mid-term concern:

- Investment shortage from price volatility and lower energy price,
- Investment shortage with concerns for turning into “stranded” assets, ...

Physical supply disruption 》Risk will remain

❖ Country risks



Source: Coface “Country Risk Assessment Map” 2Q2016

Despite the current over-supply, geopolitical risk factors have not been resolved. While there are few issues such as Iranian nuclear issue, there are others which became more complex and aggravated.

- Saudi Arabia – Iran Relationships,
- ISIS issues, Syrian situation,
- Ukrainian issues, Western Countries – Russia relationships,
- Domestic situations of MENA countries, …

Analytical flow of economic impact analysis of physical supply disruption

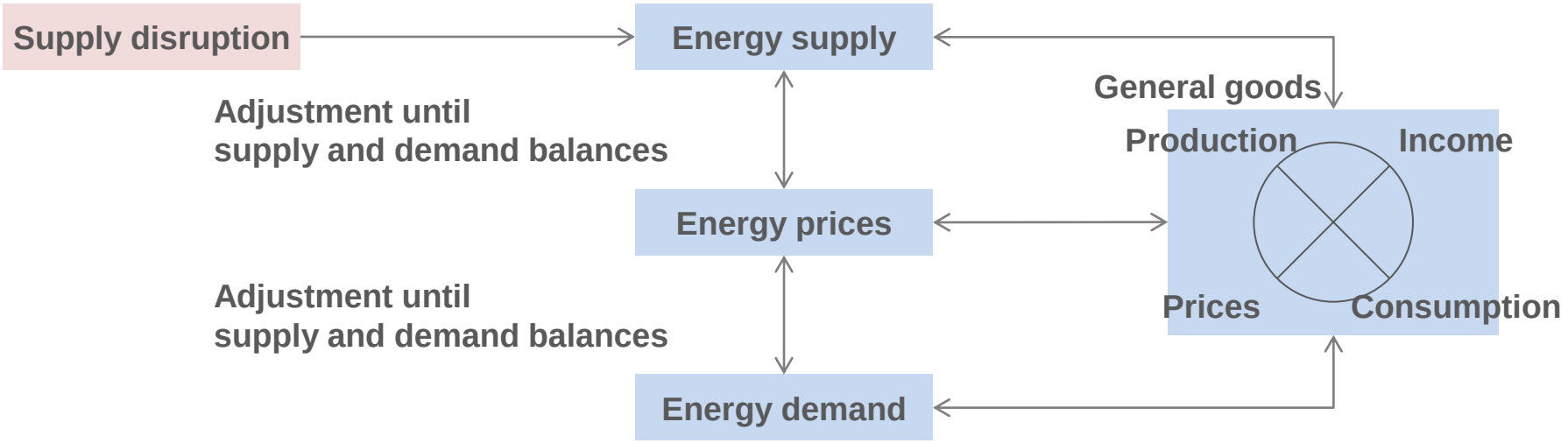
Hypothetical case setting utilising computable general equilibrium model

Description of the assumptions and situation

Immediate panic after the supply disruption has subsided while effects are yet to be seen from supply increase from other countries/regions or from energy saving.

This is a comparative statics analysis with no assumption on concrete number for the duration of supply disruption. It is not expected to last for only a few days nor for as long as several decades.
Price volatility caused by speculative factors are not included.
Effects of stock pile release is omitted for simplification.

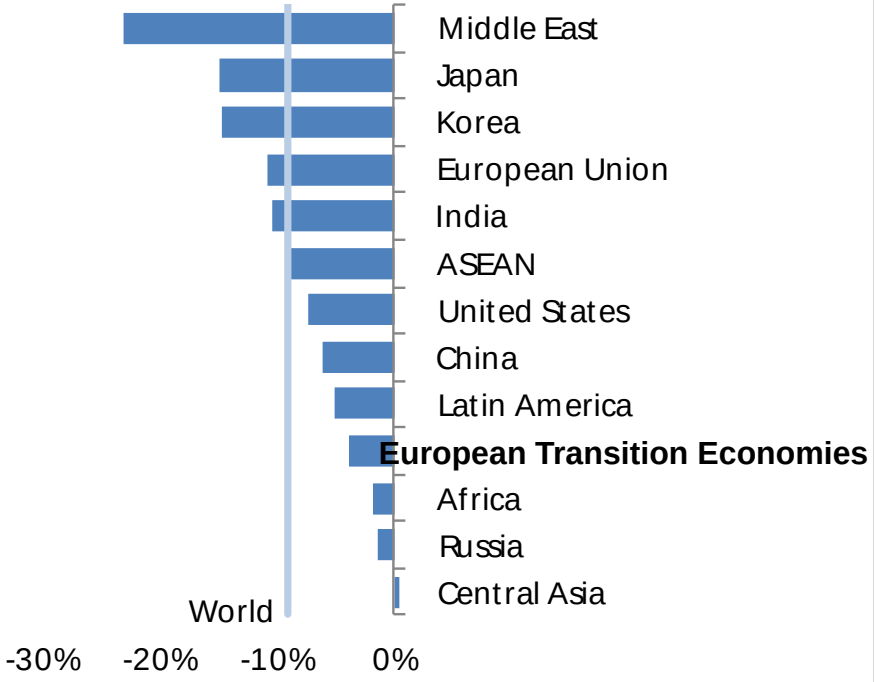
❖ Model flow



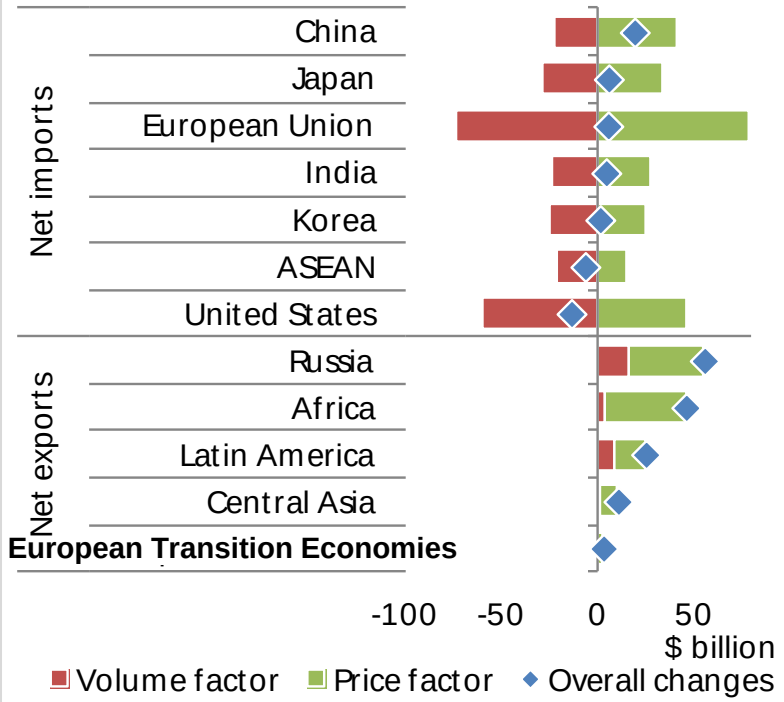
This is the IEEJ's first attempt to analyze the effect of supply disruption on economy. Such analysis is relatively rare in comparison to those of the effect of change in energy prices.

Supply disruption of 10 Mb/d incurs serious damage to the world economy

Real GDP



Crude oil net export value



Note: Crude oil exports from the Middle East diminishes by $139 billion.

In the situation where crude oil production in the Middle East drops unexpectedly and by large amount while other countries/regions are unable to increase the production to replace the lost volume, the world economy will shrink by 9%. It hits countries such as Japan and Korea which are dependent on imported oil the most.

Despite the increase in export value, the economy of the non-Middle East exporting regions will not manage to avoid being hit by the depression pressure.

Conclusions

- **Global and Asian primary energy consumption increase 1.4-fold and 1.6-fold through 2040. As energy demand expands rapidly, Asia's energy self-sufficiency rate continues to fall and that change may destabilize the world energy markets.**

- **The share of fossil fuel in the primary energy consumption will decline until 2040, but still is around 70% even in the Advanced Technologies Scenario. It also results in increasing global CO_2 emissions, causing severe damages to the environment.**

- **Asian emerging countries, including China and India, hold the key to reducing CO_2 and GHG emissions. Without their cooperation, the international community is not able to address the climate change problem. All countries or regions have to adopt maximum measures of efficiency, while maintaining a sustainable economic growth.**

- **Energy supply disruption in the Middle East, will bring great economic damage worldwide. In order to mitigate such adverse effects, there are no better choices than the classic and steady measures, such as reducing energy consumption through energy conservation, reducing dependence on fossil fuel by expanding the use of renewable energy and nuclear, diversifying energy use and energy imports, strengthening the stockpile. And, not only cooperation between the consuming countries, strengthening of dialogue with energy exporting countries will also contribute to the stabilization of the energy market. In the long term, economic assistance to developing countries is also important measures to improve the social and political stabilization of the energy exporter, by alleviating the economic disparities and poverty problem.**

Thank you very much for your attention!

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