Asia / World Energy Outlook

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

October 18, 2011
Seoul

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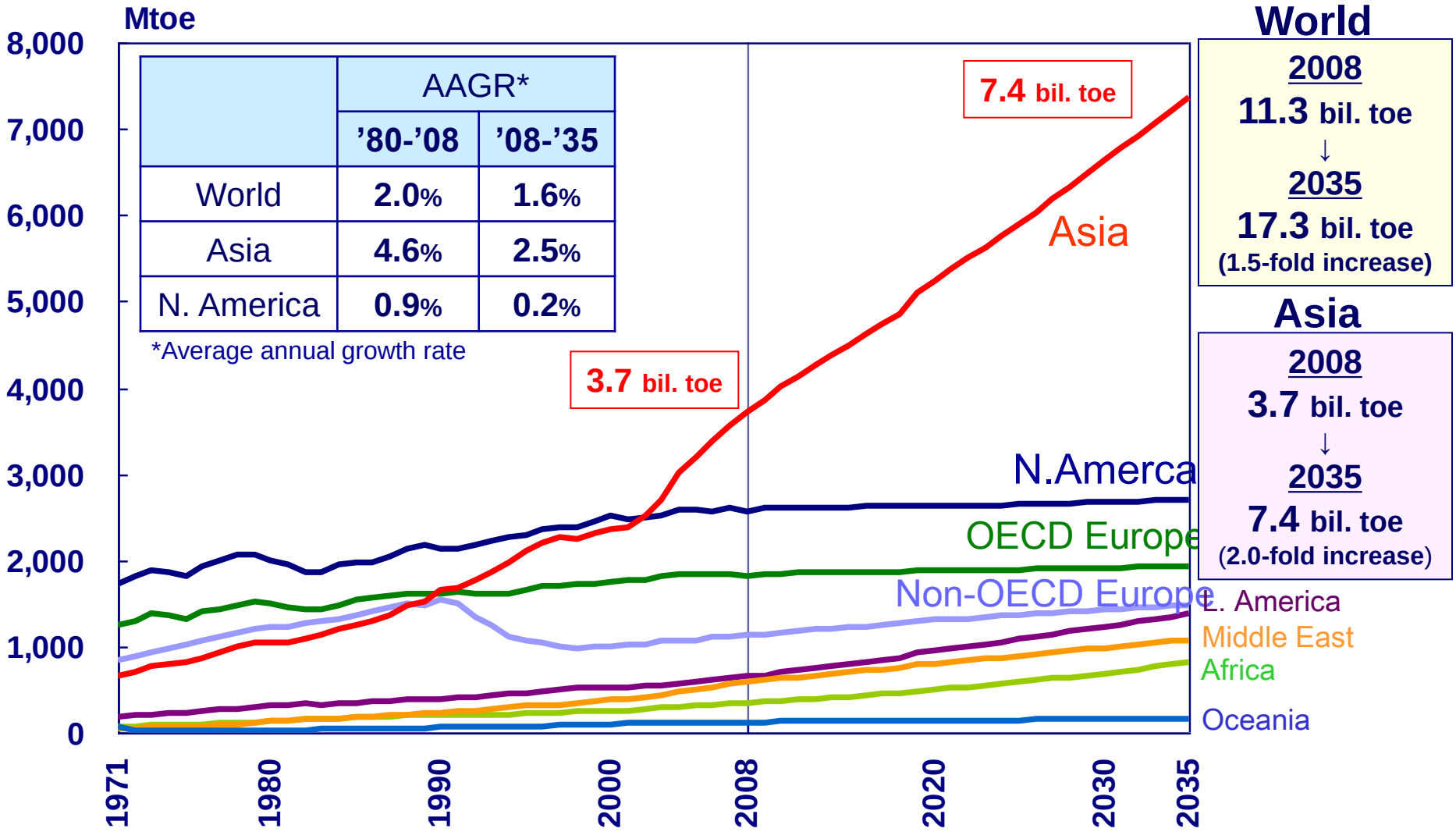
The Institute of Energy Economics, JAPAN (IEEJ)

Primary Energy Demand by Region (World)

Reference

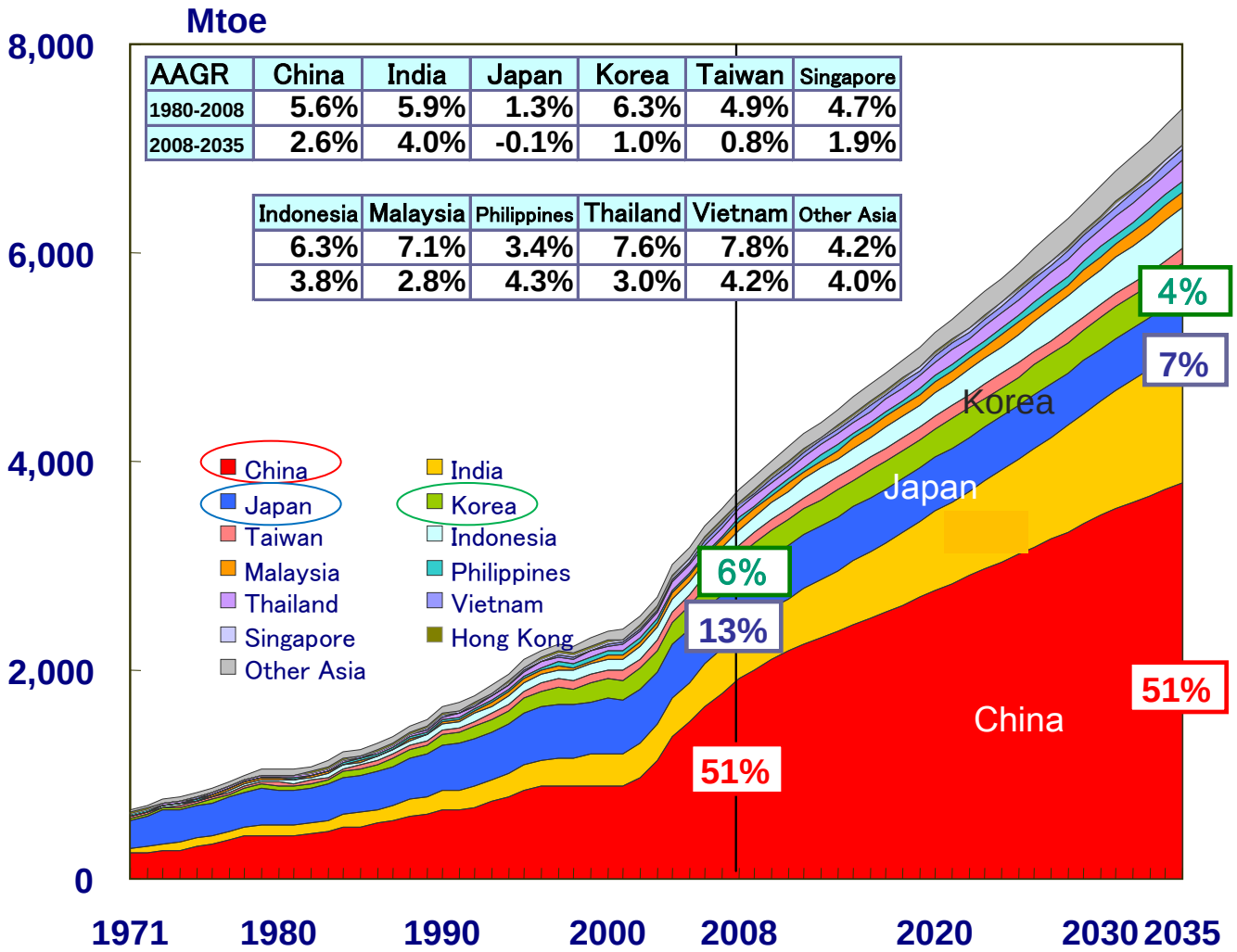


■ By 2035, primary energy demand of Asia will double from the current level, reflecting high economic growth; 3.7 billion toe(2008) → 7.4 billion toe(2035).

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

Primary Energy Demand (Asia)

Reference



AAGR	China	India	Japan	Korea	Taiwan	Singapore
1980-2008	5.6%	5.9%	1.3%	6.3%	4.9%	4.7%
2008-2035	2.6%	4.0%	-0.1%	1.0%	0.8%	1.9%

Indonesia	Malaysia	Philippines	Thailand	Vietnam	Other Asia
6.3%	7.1%	3.4%	7.6%	7.8%	4.2%
3.8%	2.8%	4.3%	3.0%	4.2%	4.0%

Asia

2008

3.7 bil. toe

↓

2035

7.4 bil. toe

(2.0-fold increase)

China / Korea

2008

1.9 bil. toe / 0.23 bil. toe

↓

2035

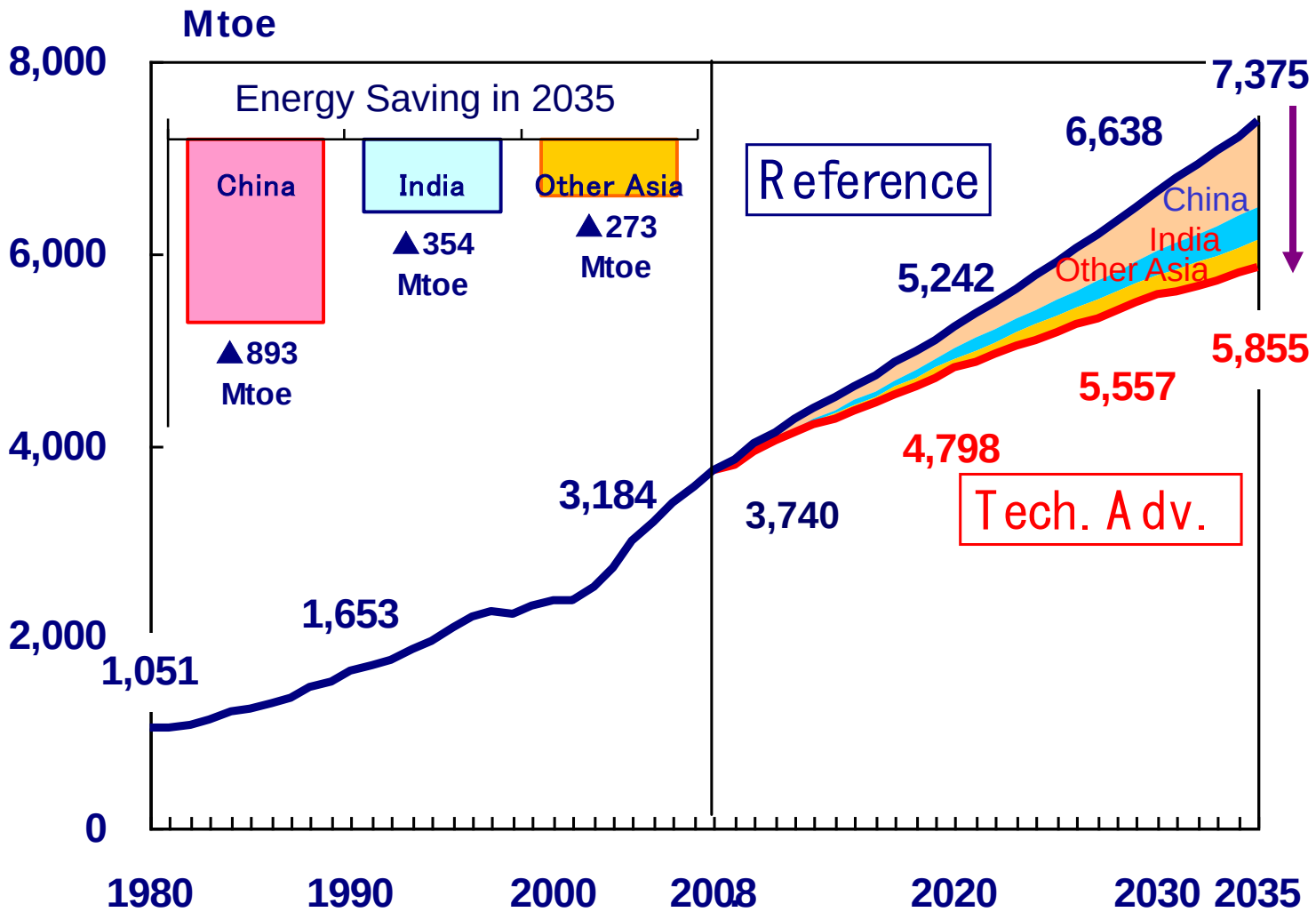
3.8 bil. toe / 0.3 bil. Toe

(2.0-fold inc. / 1.3-fold inc.)

- At the back of steady economic growth, the share of China and India together in Asian primary energy demand will significantly increase to 69% by 2035.
- Japan's energy share in Asia will decline from 13% in 2008 to 7% in 2035 resulting from slow growth in energy demand.

Primary Energy Demand (Asia)

Reference
Tech. Adv.



▲1,520 Mtoe (▲21%)

China
▲893 Mtoe
(59% of saving in Asia)

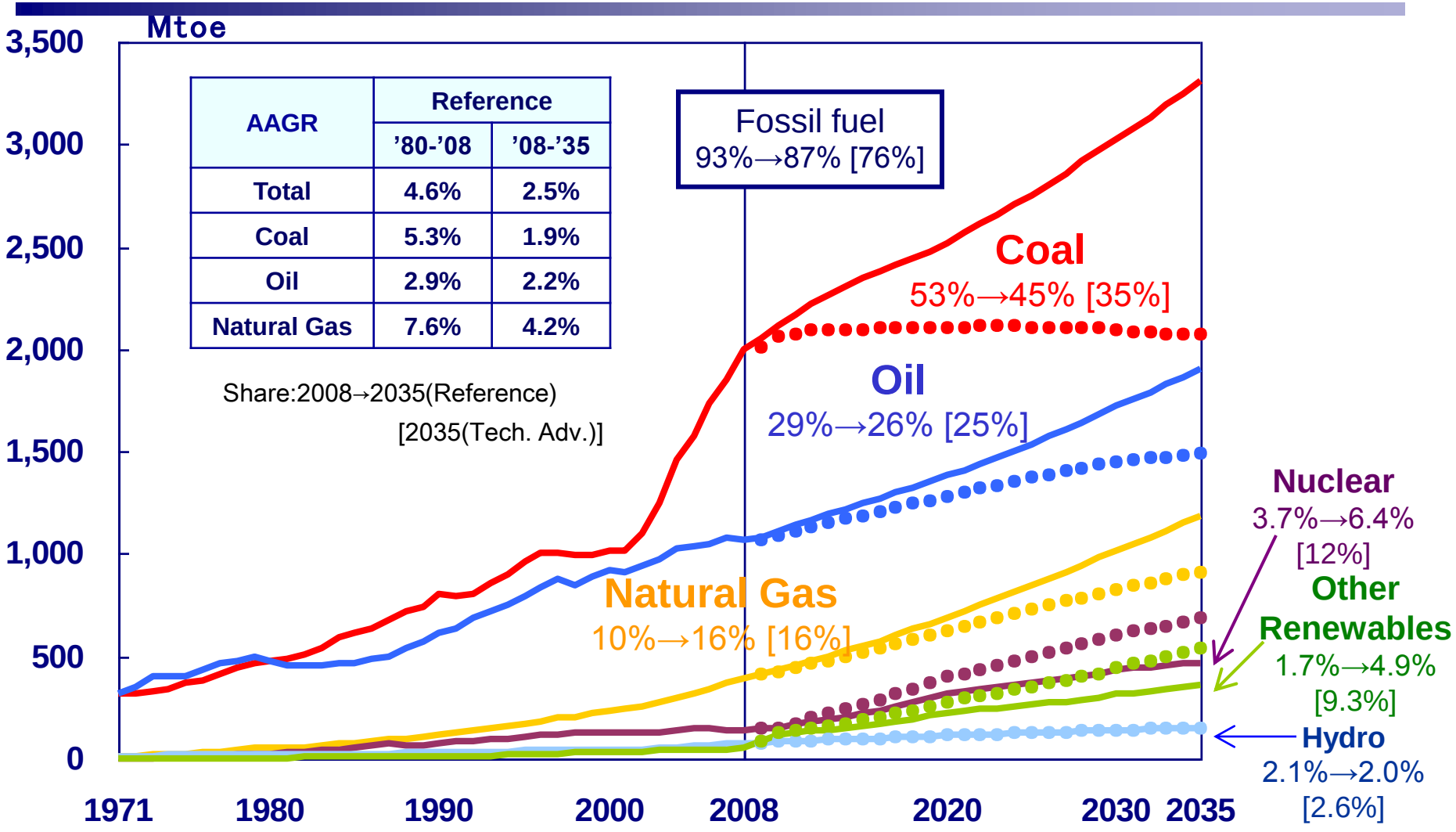
India
▲354 Mtoe
(23% of saving in Asia)

Korea
▲160 Mtoe
(1.1% of saving in Asia)

■ In 2035, TPED of Asia in the Tech. Adv. Scenario will be 1,520 Mtoe lower than the Reference Scenario. This saving (at 1,520 Mtoe) is approximately three times as much as TPED of Japan in 2008. China and India will have 82% of the saving potential.

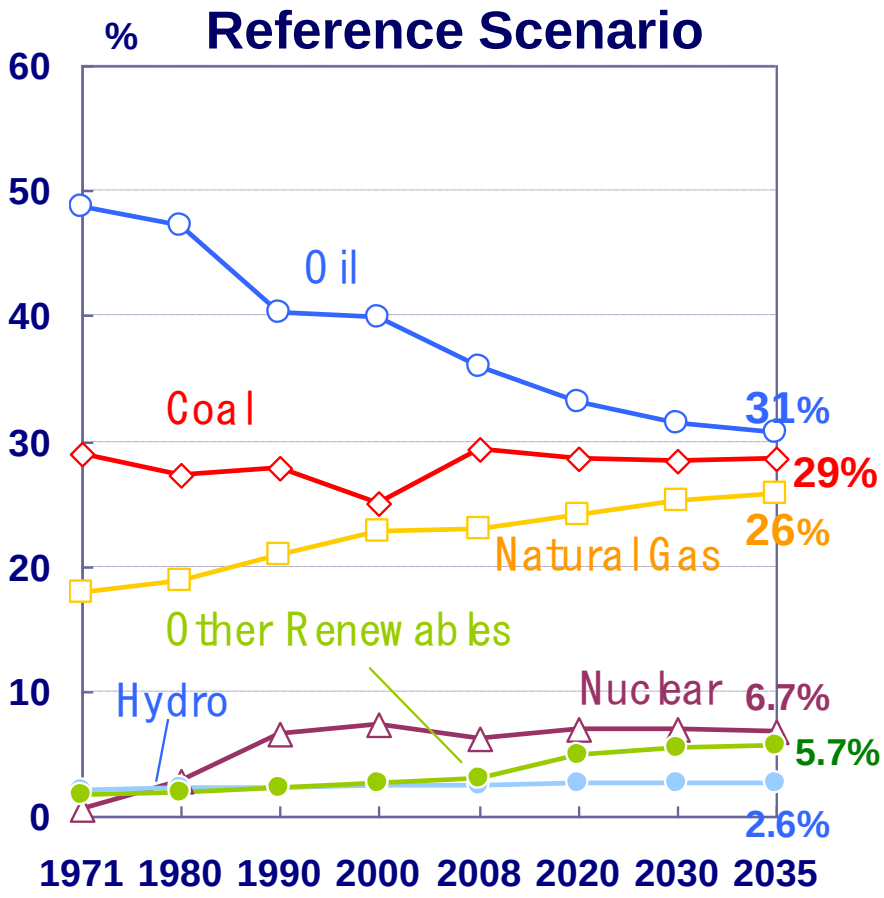
Primary Energy Demand by Type (Asia)

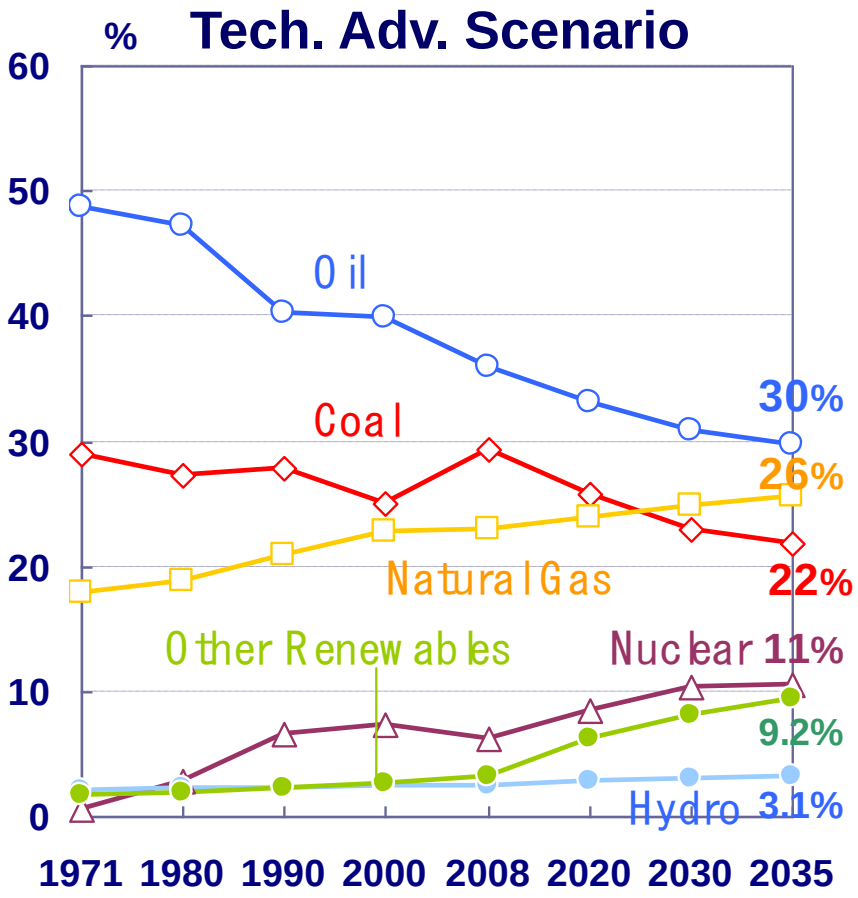
Solid line: Reference
Dotted line: Tech. Adv.



- Coal and oil will continue to maintain the dominant share in Asian energy demand through 2035. The share of natural gas will increase substantially reaching 16% by 2035, driven mainly by power generation.
- Coal share in the Tech. Adv. Scenario will significantly decrease, but will maintain the largest share (35% of total) in primary energy mix by 2035.

Primary Energy Mix (World)



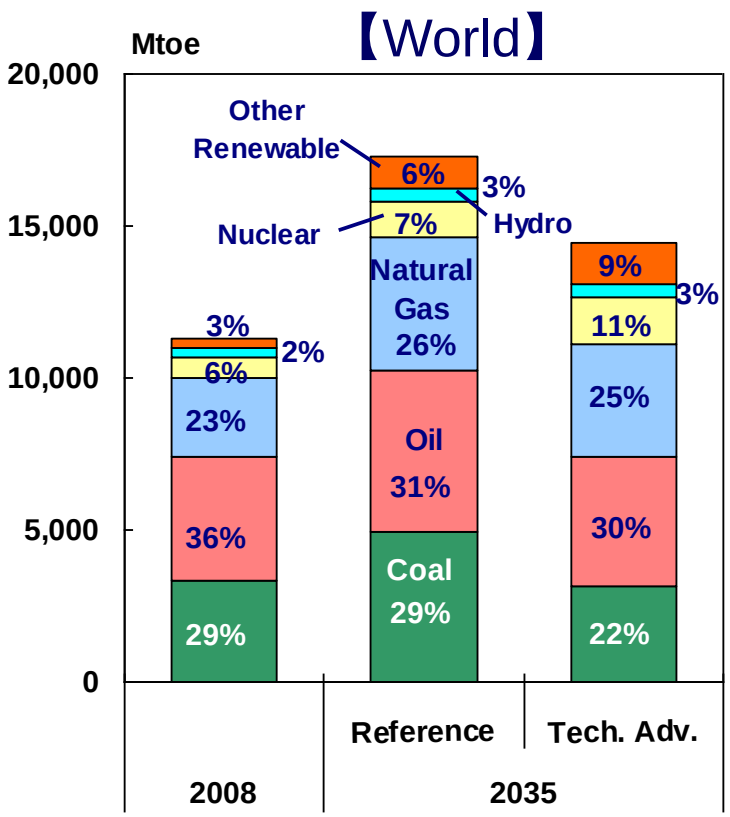


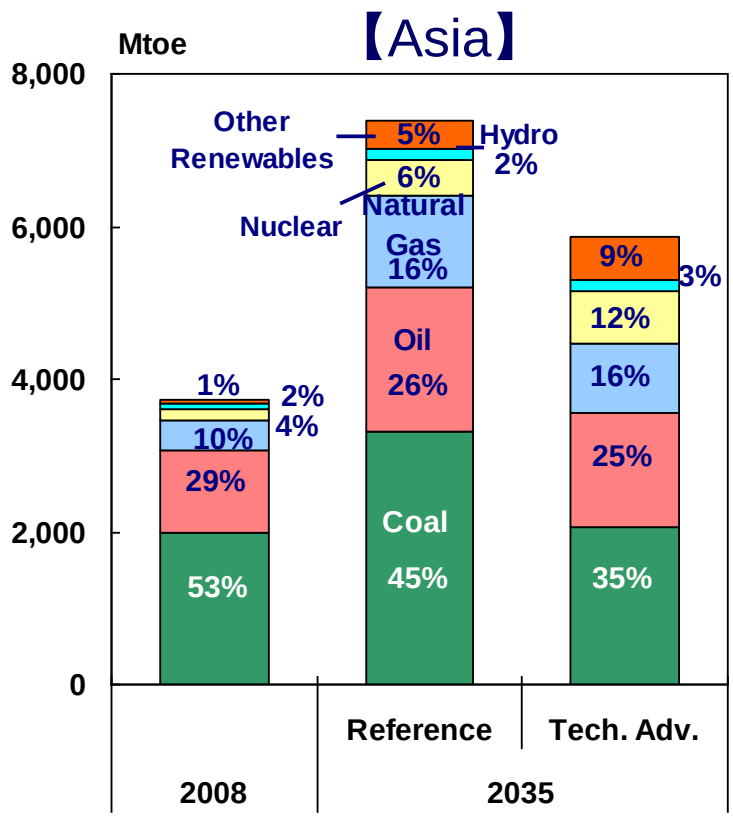
■ In the Reference Scenario, the oil's share will significantly decrease, while the share of natural gas and renewables will expand substantially.

■ In the Tech. Adv. Scenario, coal will significantly decrease mainly in Non-OECD. The share of nuclear and renewables will gradually expand. Fossil fuel will remain the most important fuel in primary energy mix in 2035, maintaining the 76% share.

Primary Energy Mix (World, Asia)

Reference
Tech. Adv.





Share of Non Fossil Fuel (World)

2008
12 %
↓
2035

Reference	Tech. Adv.
15 %	**23** %
(3%up)	**(11%up)**

Share of Non Fossil Fuel (Asia)

2008
7 %
↓
2035

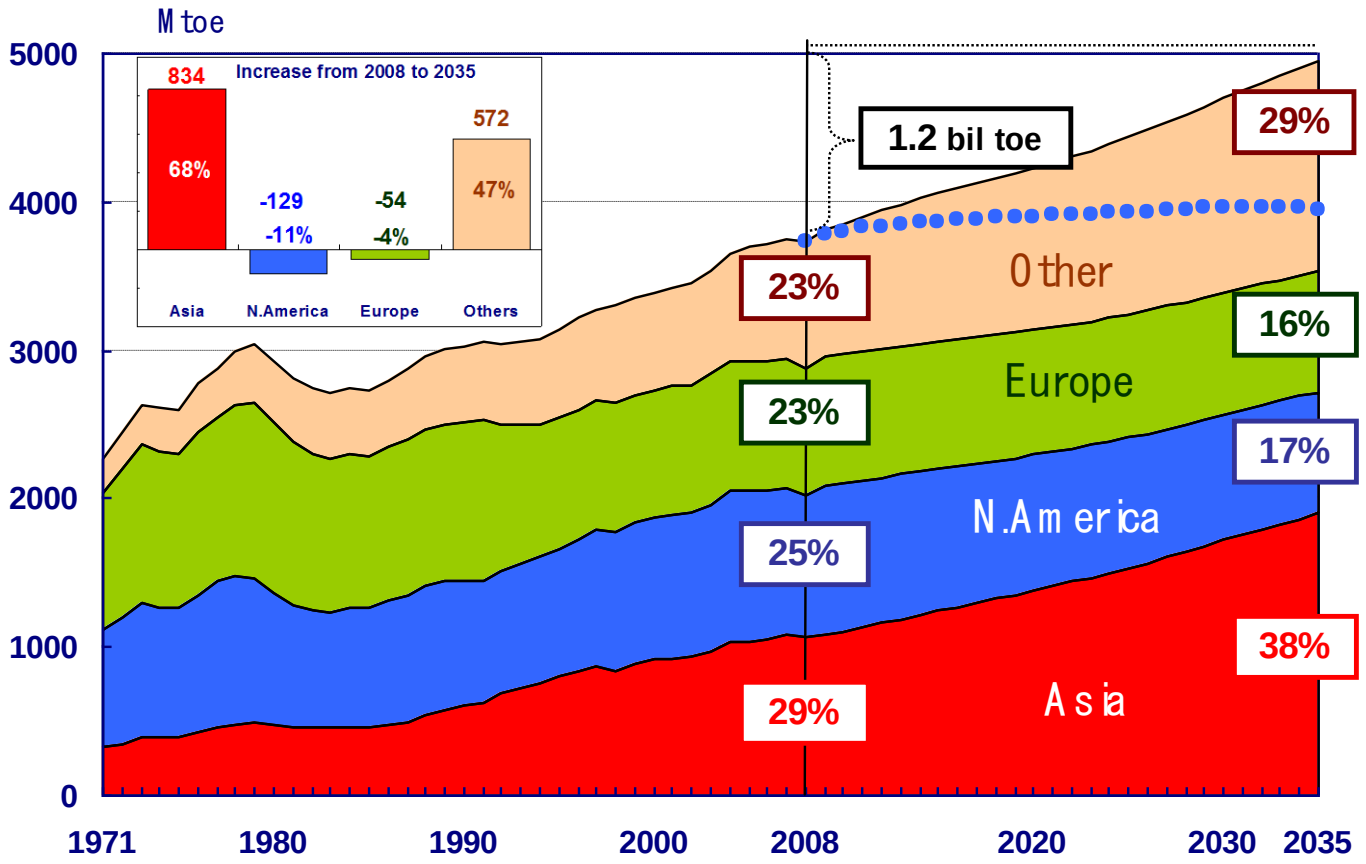
Reference	Tech. Adv.
13 %	**24** %
(6%up)	**(16%up)**

■ In the Tech. Adv. Scenario, the share of non fossil fuel in the world energy demand will increase to 23% in 2035. Similarly, the share of non-fossil fuel in Asia will increase to 24%.

■ In the Tech. Adv. Scenario, fossil fuel will continue to be the most important fuel in the world and Asia by 2035.

Oil Demand by Region (World)

Reference
Tech. Adv.



0.99 bil
(19%)
Saving

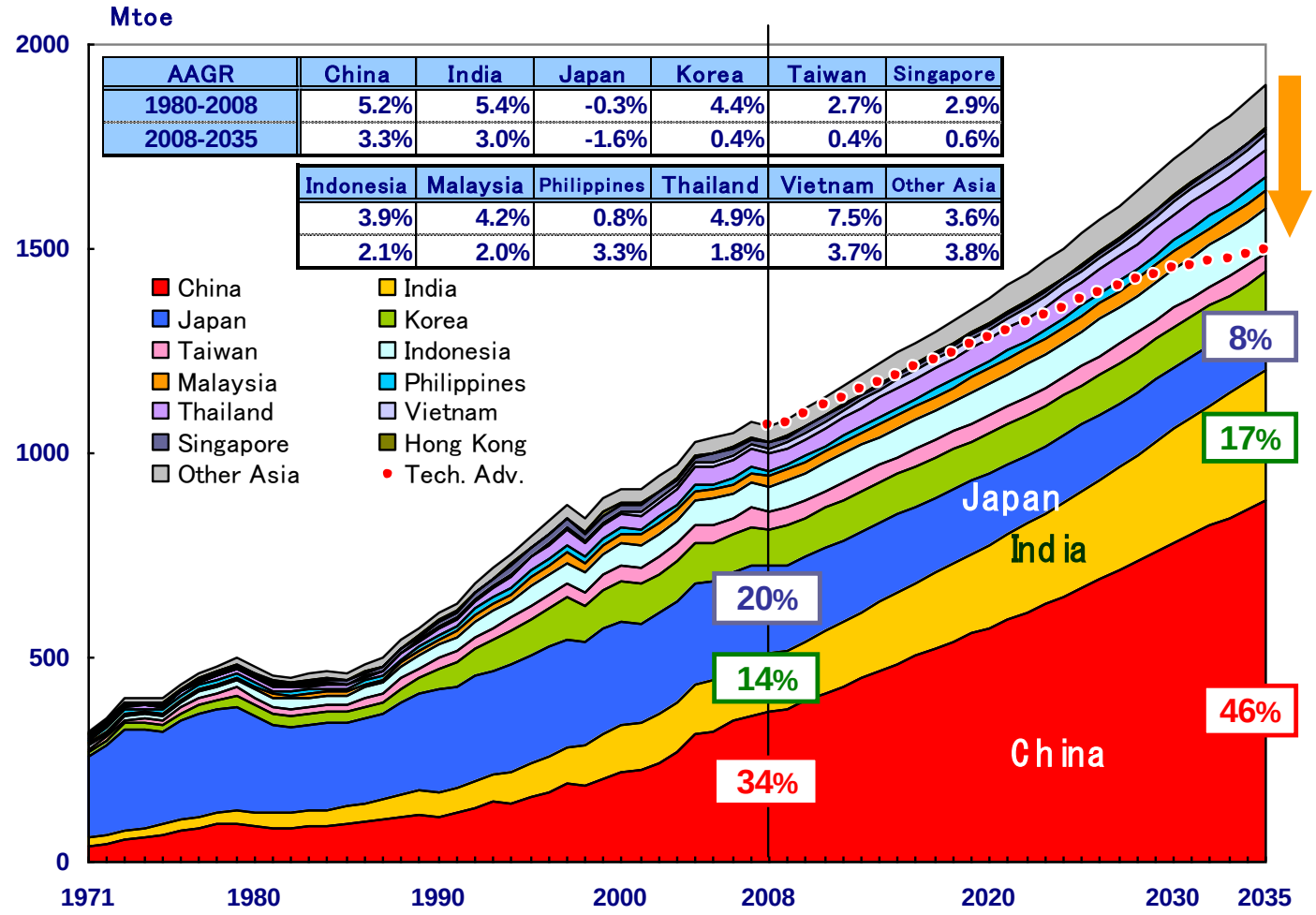
2008
4.1 bil
(82 mbd**)**
↓
2035
Reference
5.3 bil **(107** mbd**)**

Tech. Adv.
4.3 bil **(87** mbd**)**

- More than 70% of global oil growth will take place in Asia, and the share of Asia in the world oil demand will increase from 29% (2008) to 38% (2035). Asia will continue to lead the world oil demand growth by 2035.
- Oil demand in OECD started to decrease since 2005 and this trend will continue through 2035. The share of OECD will decrease from 50% in 2008 to 33% in 2035, while that of Non-OECD will increase to 67% in 2035.
- In the Tech. Adv. the world oil demand will peak in 2030 as a result of vehicle fuel efficiency improvement and shift to the other energy types in the power and industry sectors. Oil demand will be 0.99 billion ton (equal to 20% of reference) lower in 2035 compared with the Reference Scenario.

Oil Demand by Region (Asia)

Reference
Tech. Adv.



AAGR	China	India	Japan	Korea	Taiwan	Singapore
1980-2008	5.2%	5.4%	-0.3%	4.4%	2.7%	2.9%
2008-2035	3.3%	3.0%	-1.6%	0.4%	0.4%	0.6%

Indonesia	Malaysia	Philippines	Thailand	Vietnam	Other Asia
3.9%	4.2%	0.8%	4.9%	7.5%	3.6%
2.1%	2.0%	3.3%	1.8%	3.7%	3.8%

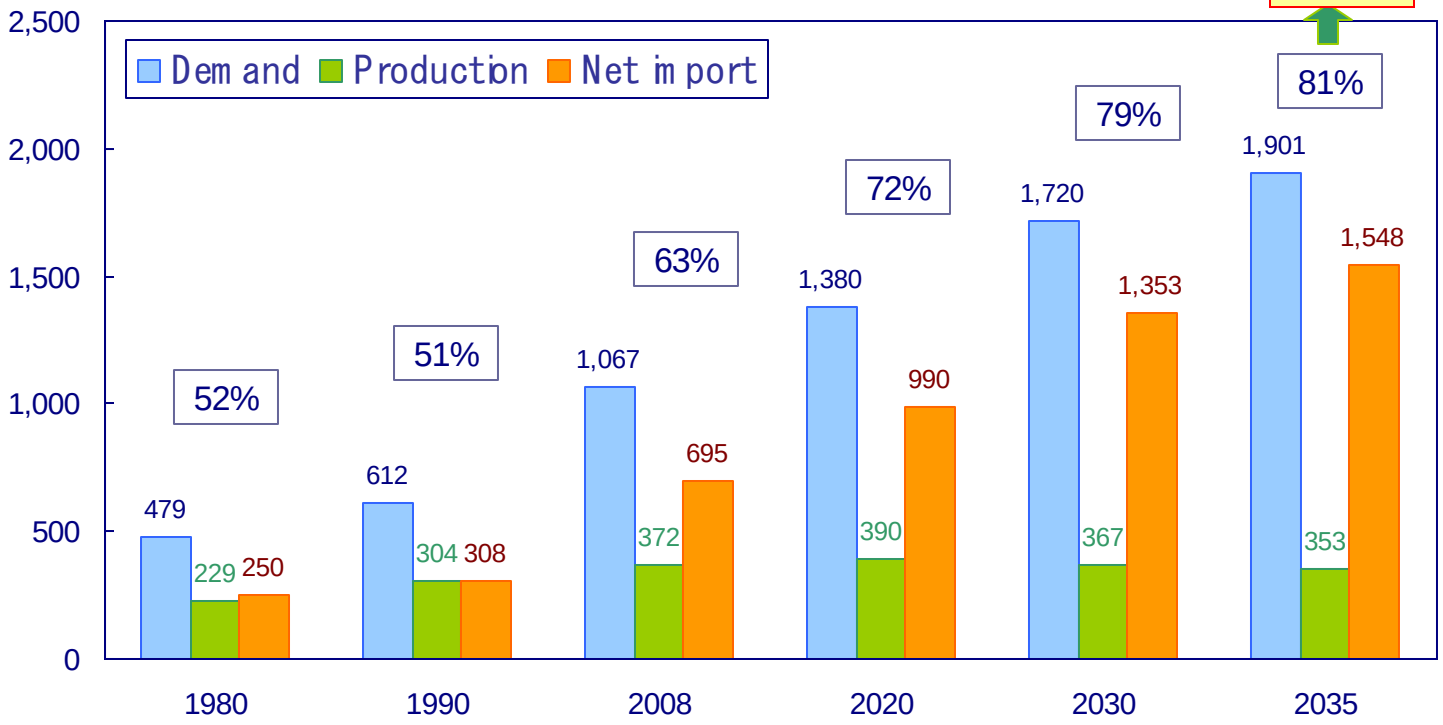
4.1 bil
(21%)
Reduction

2008
1.07 bil
(216 mbd**)**
↓
2035
Reference
1.91 bil **(386** mbd**)**
Tech. Adv.
1.49 bil **(301** mbd**)**

■ Though the vehicles' fuel efficiency may be improved, and clean energy vehicles may expand, oil demand in China will expand from 7.4 million B/D in 2008 to 19.0 million B/D in 2035, due mainly to its escalating vehicle ownership. The share of China and India together in Asian oil demand will grow from 46% in 2008 to 61% in 2035.

■ Even in the Tech. Adv. Scenario, oil demand will not peak out and grow continuously. Projected oil demand saving will be equal to 21% of the Reference Scenario in 2035.

Oil Supply and Demand in Asia



Net Oil Import

2008

14 mbd

↓

2035

Reference

31 mbd

(**2.2**-fold inc.)

Tech. adv.

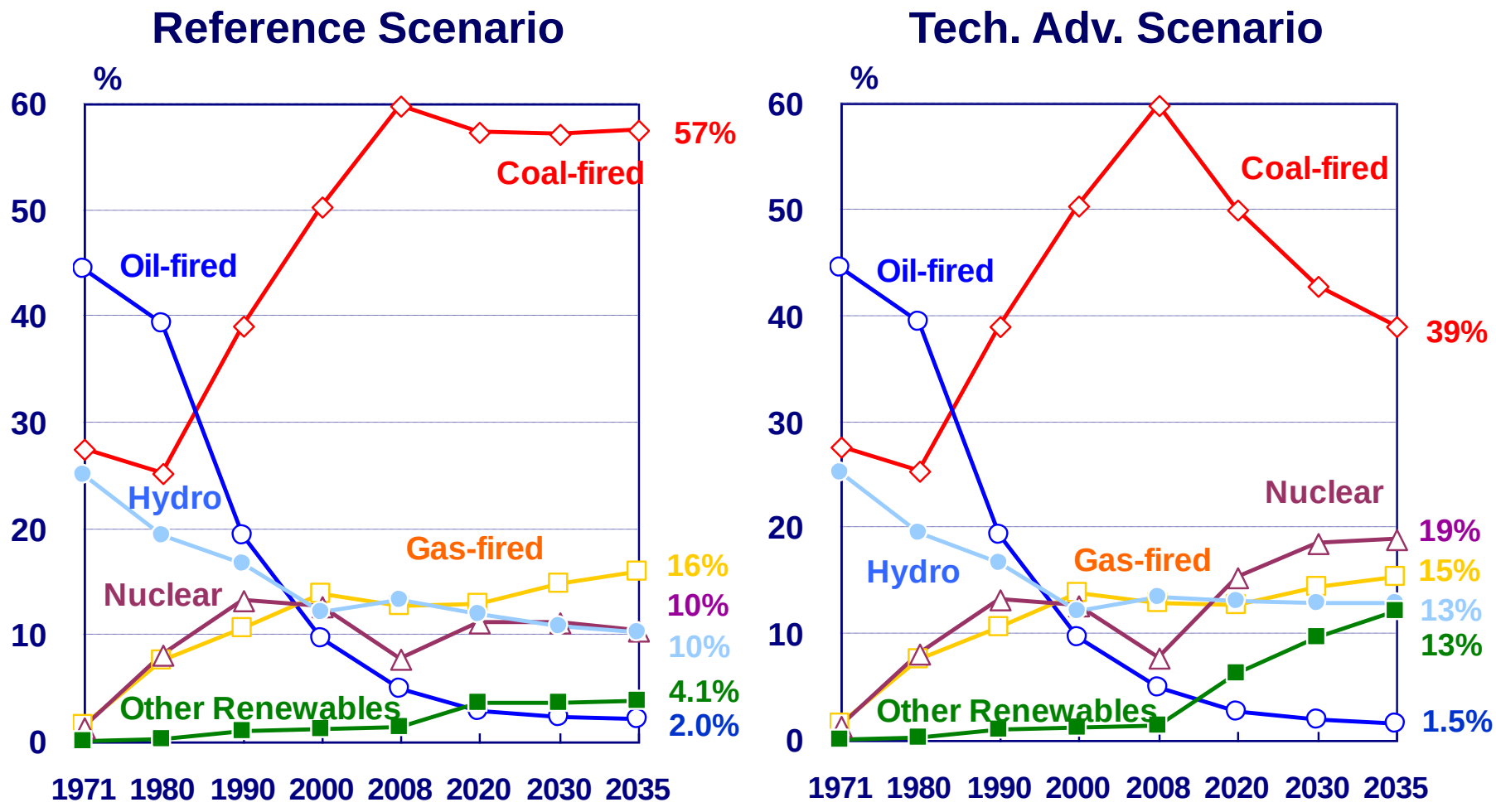
23 mbd

(**1.7**-fold inc.)

■ Net oil import in Asia will expand from 14 mb/d (695 Mtoe) in 2008 to 31 mb/d (1,548 Mtoe) in 2035.

■ Oil production in Asia (such as China, India, Indonesia and Malaysia) will marginally increase, while oil demand will steadily increase. Therefore, net oil import ratio will reach 81% in the Reference Scenario, and 76% in the Tech. Adv. Scenario by 2035 (compared with 63% in 2008).

Power Generation Mix by Fuel (Asia)

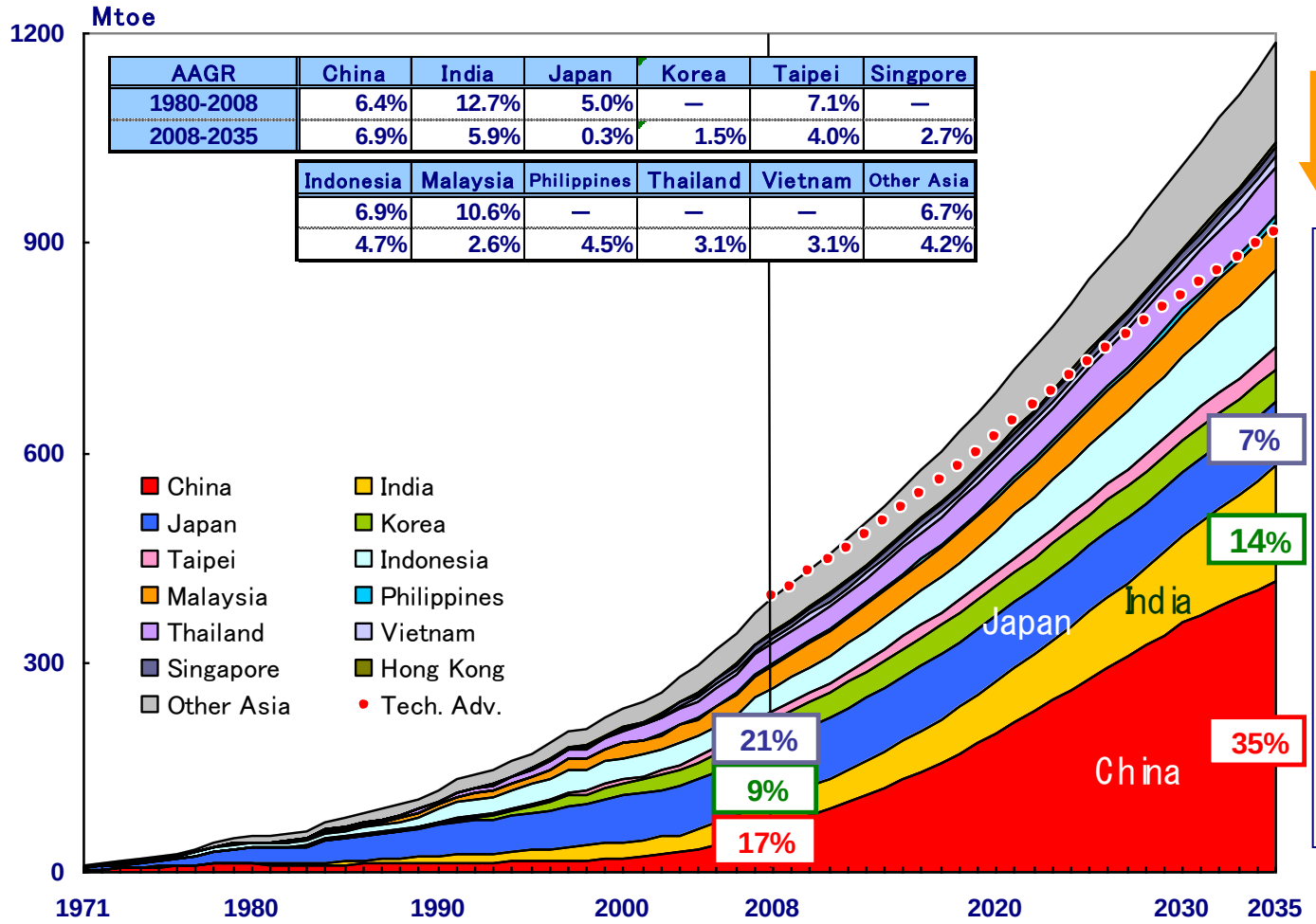


■In Asia, the share of coal-fired generation will increase to meet growing electricity demand.

■In the Tech. Adv. Scenario, the share of coal-fired generation will decrease substantially, which will be substituted by the increases in renewable energy and nuclear share.

Natural Gas Demand by Country (Asia)

Reference
Tech. Adv.



AAGR	China	India	Japan	Korea	Taipei	Singpore
1980-2008	6.4%	12.7%	5.0%	—	7.1%	—
2008-2035	6.9%	5.9%	0.3%	1.5%	4.0%	2.7%

Indonesia	Malaysia	Philippines	Thailand	Vietnam	Other Asia
6.9%	10.6%	—	—	—	6.7%
4.7%	2.6%	4.5%	3.1%	3.1%	4.2%

270 mil.
(23%)
Reduction

2008
0.39 billion toe
(440 billion m^3**)**
(0.32 bil.tonnes LNG**)**

↓

2035

Reference
1.19 billion toe
(1.3 trillion m^3**)**
(0.97 bil.tonnes LNG**)**

Tech.Adv.
0.91 billion toe
(1 trillion m^3**)**
(0.74 bil.tonnes LNG**)**

■ Natural gas demand in China will considerably increase due mainly to the increasing demand for power generation, and gas use in urban areas. India's natural gas demand will also expand, representing a five-fold increase from 2008 to 2035.

■ In the Tech. Adv. Scenario, the world natural gas demand will be 270 bcm (or 23%) lower than the Reference Scenario by 2035. Although substantial saving is projected in the Tech. Adv. Scenario, natural gas demand will increase at a relatively fast pace of 4.2% per year through 2035.

Energy Issues after the Quake

- Domestic Issues
  - Top Priority:
    Stabilization of the situation at Fukushima #1 Nuclear Power Station
  - Restoration of damaged energy supply facilities and infrastructures
  - Next Priority: Electricity Supply-Demand
    - Restoration of Power Supply and Expansion
    - Deeper Energy Saving and Power Saving Measures
    - Securing Fuel Supply for Power Generation
  - Mid, Long-term Energy Policy and Measures by the Public
  - Importance of Crisis Control
    - Chain of Command Structure, Information Disclosure

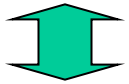
- Influence to the World
  - Nuclear Power Policy
    - Circumstances surrounding nuclear power development, safety standards, etc.
  - Energy Supply & Demand
    - Natural Gas, Renewable Energy, Energy Efficiency Improvement
    - Global warming issues
    - Kyoto Protocol 1st Commitment Period, Post Kyoto negotiations…
  - Japan's role as a member of the International Society

Oil supported People's Life

- Oil was re-discovered and re-appreciated as useful & convenient energy source which can be used for many different end-use.
  - Good for "**transport**", "**delivery**". Also good for "**cooking**", "**lighting**", "**heating**", etc.
  - Oil is not only useful for **emergency** situation but also in **peacetime** to meet variety of demands.
- What if…. There was no oil (Gasoline, Diesel, Kerosene, LPG, etc.) immediately after the quake?
  - How to commute? How to deliver? How to warm?
  - How to cook? How to light-up?
  - How to keep clean? (toilet, washing, hot bath….)
- Oil is important after Food
  - Shortage of oil in many places was a big problem after the quake.
  - Total oil availability was enough but the products did not reach where it was needed.
    - ➔ Importance of Oil was re-discovered everywhere
    - ➔ Stock piling scheme for oil products , emergency plans, etc. to be in place

Japan's Demand for Oil & Gas after the Quake

- **Factor fo r Oil Demand Decrease**
  - **Economic slow down and overall lower activities of industry and demand decrease**



- **Factors for Oil Demand Increase (bigger influence)**
  - **Increased usage of oil & gas fired power plants by TEPCO & Tohoku**
  - **Added demand from other power utilities**
    - **Additional Demand caused by shtdown of Hamaoka nuclear station for Chubu Electric**
    - **Possible re-start of other Nuclear Power Station after stress check, etc.**
    - **Increased usage of auto power generation, etc.**
  - **Increase in FY2011, Oil:50-210 KB/D, LNG:11.4 ~ 15.3 ton**

- **Overall supply can be secured for both Oil and LNG**
  - **Extra supply capacity in International Markets**
  - **Utilization of variety of supply measures**
  - **Can influence for market crunch (especially in LNG)**

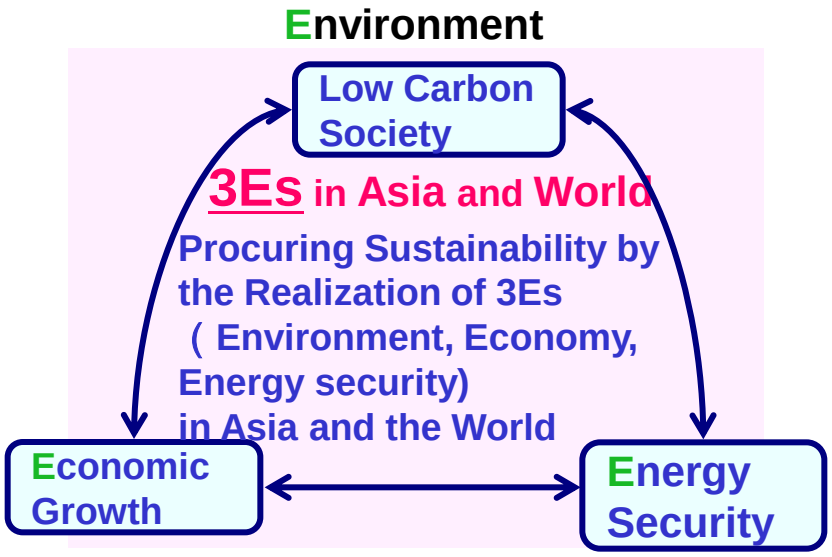
Analysis by Ken Koyama IEEJ, 2011 July

Best Energy Mix : 3E + S

- **Importance of a comprehensive perspective**
  - a. Standpoint of energy security → (Energy Security)
  - b. Standpoint of global warming → (Environment /Low Carbon Society)
  - c. Standpoint of costs → (Economic Growth)
  - d. Standpoint of available potential reserves/energy density → (Energy Security II)

+

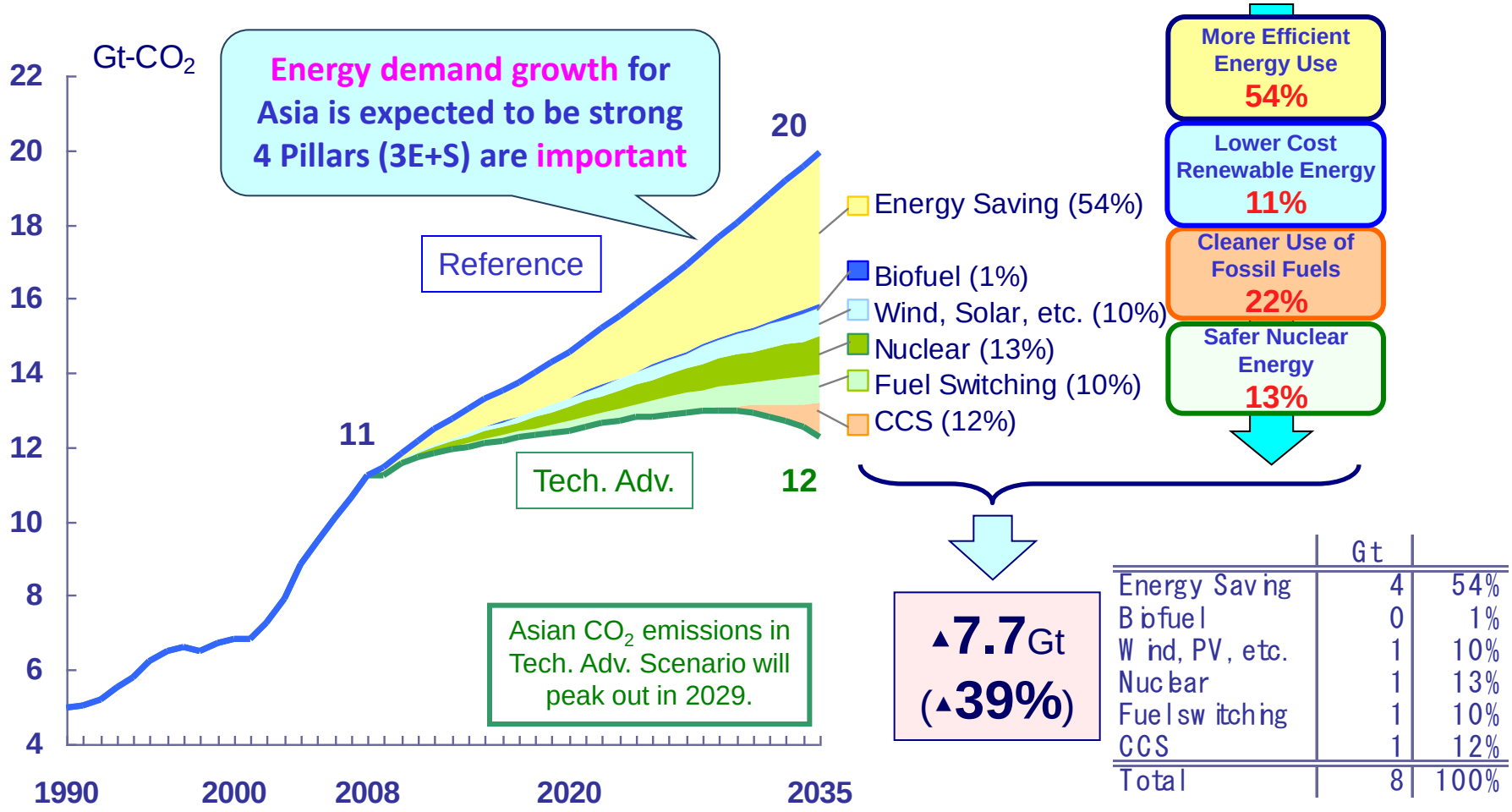
e. Standpoint of safe Nuclear → (Safety)



+ S (Safety)

CO_2 Emissions Reduction by Technology (Asia)

Reference
Tech. Adv.



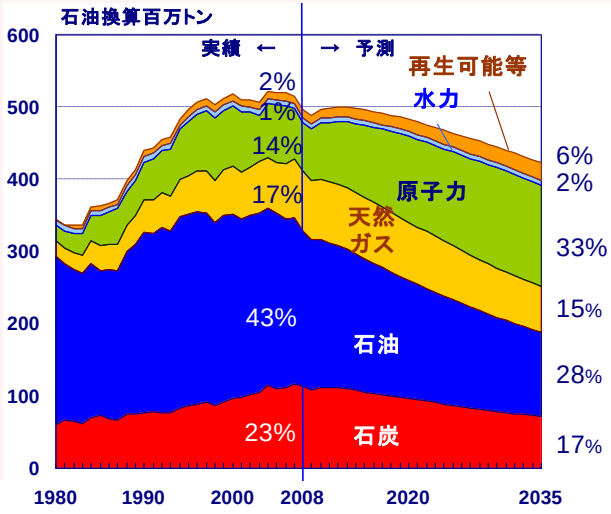
	Gt	
Energy Saving	4	54%
Biofuel	0	1%
Wind, PV, etc.	1	10%
Nuclear	1	13%
Fuel switching	1	10%
CCS	1	12%
Total	8	100%

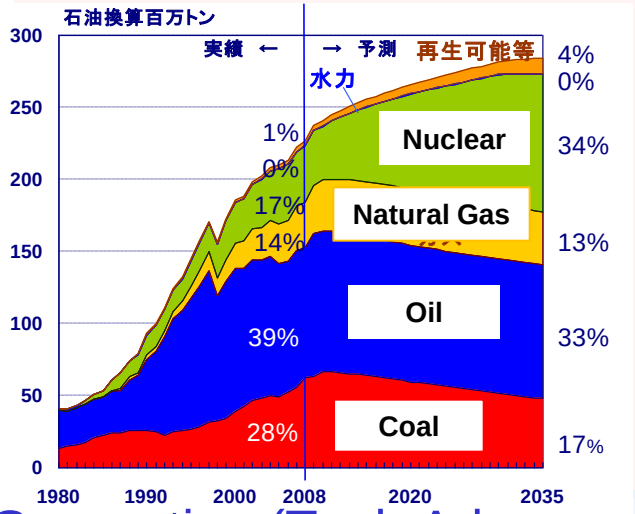
■ Aggressive development and deployment of advanced technologies in Asia enables to considerably reduce CO_2 emissions and realize its peak-out by 2030.

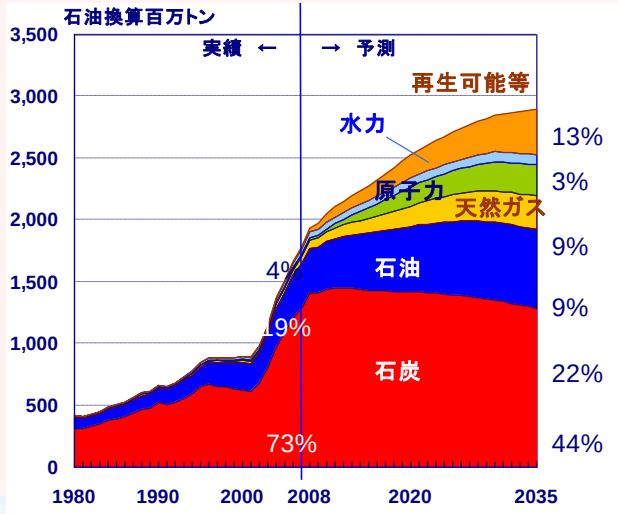
Primary Energy Consumption & Power Generation

Japan **Korea** **China**

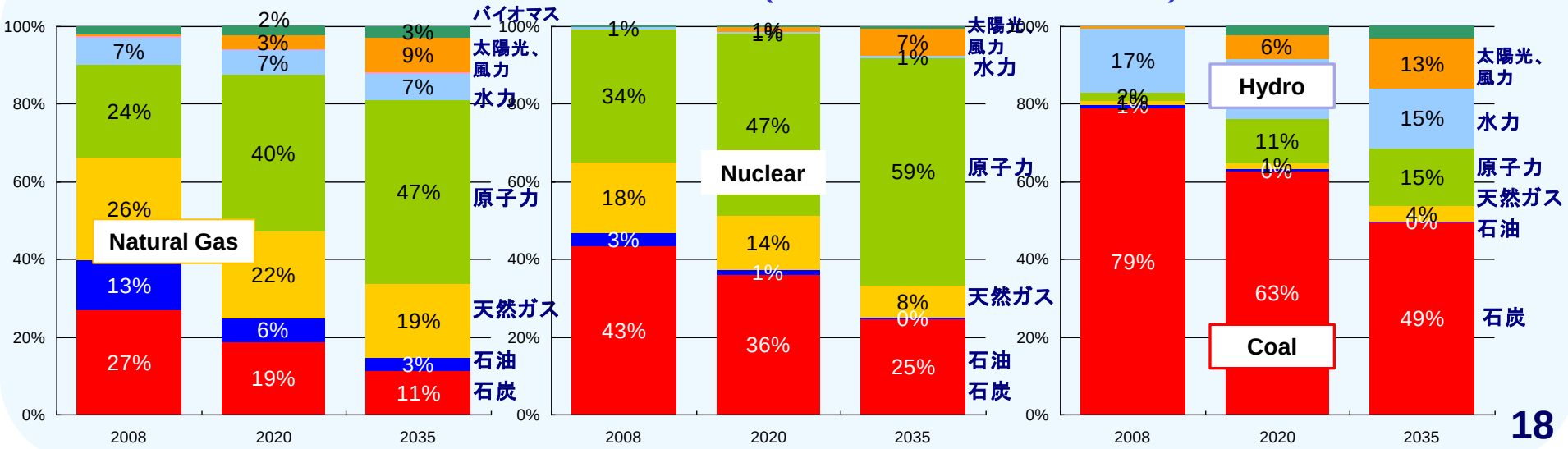
Primary Energy Supply (Tech Advance Case)





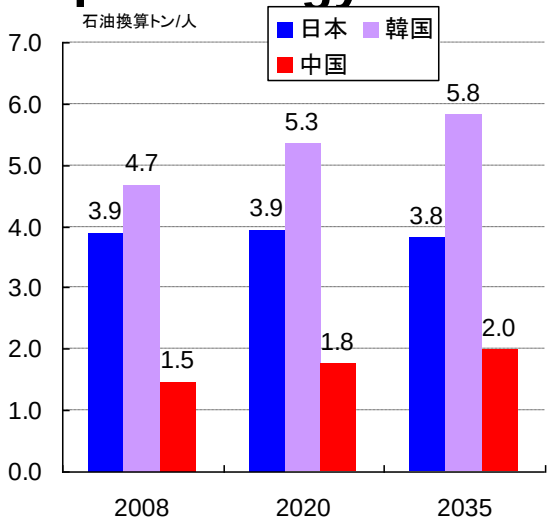


Power Generation (Tech Advance Case)

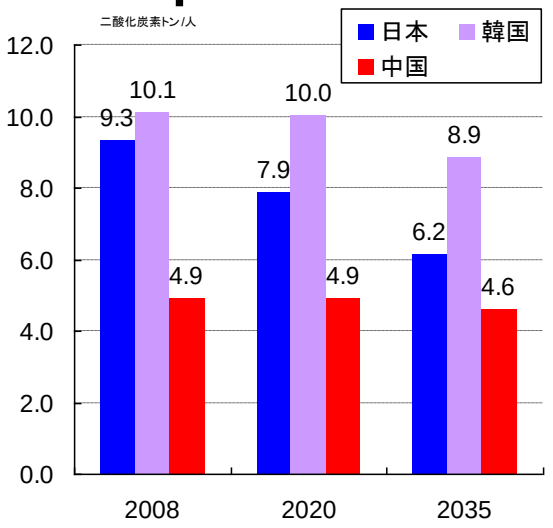


Energy Indicators Comparison (Tech Adv. Case)

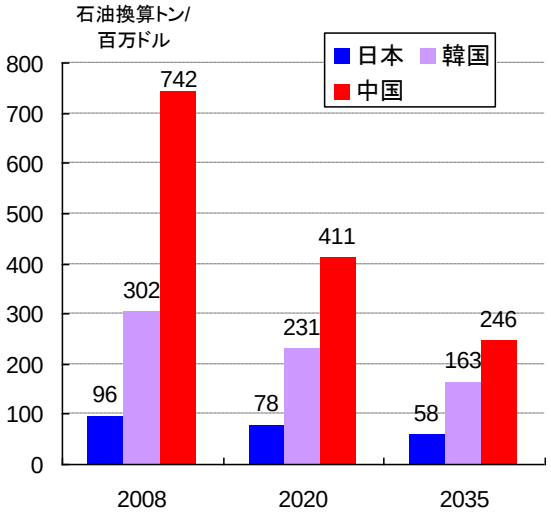
Per Capita Energy Consumption



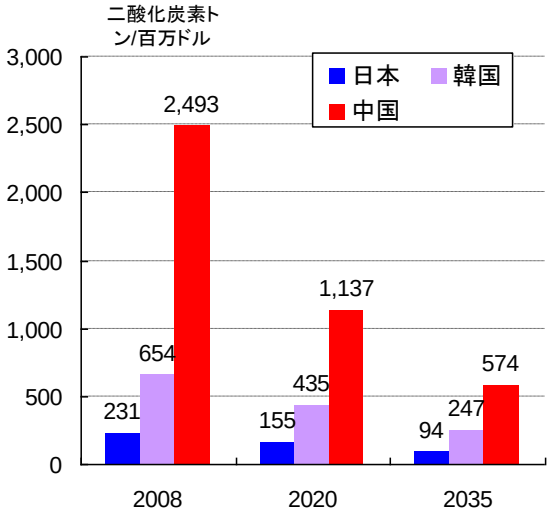
Per Capita CO2 Emissions



Energy Intensity per GDP

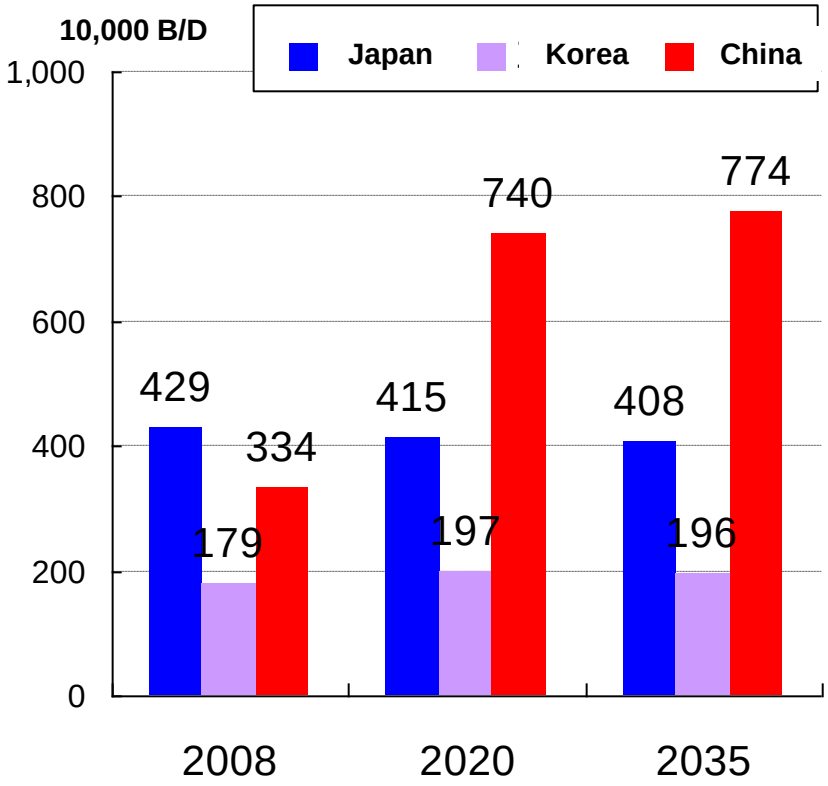


CO2 Intensity per GDP



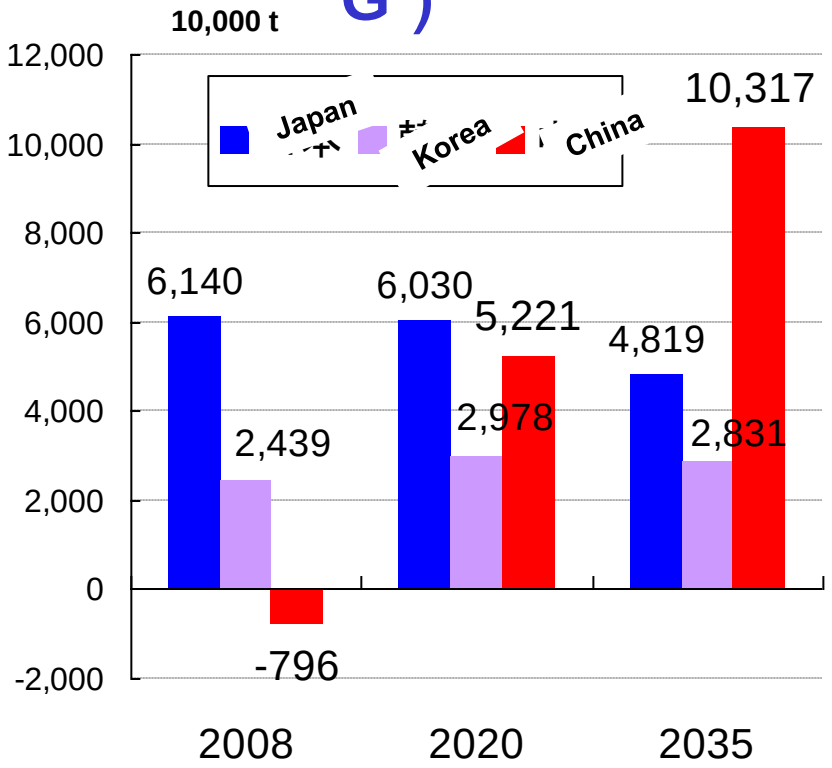
Fossil Fuel Import (Tech Adv Case)

Oil



World crude oil import in 2009 is about 53 Mb/d (BP Statistics). Share of Japan, Korea and China reaches about 18%.

Natural Gas (LNG)



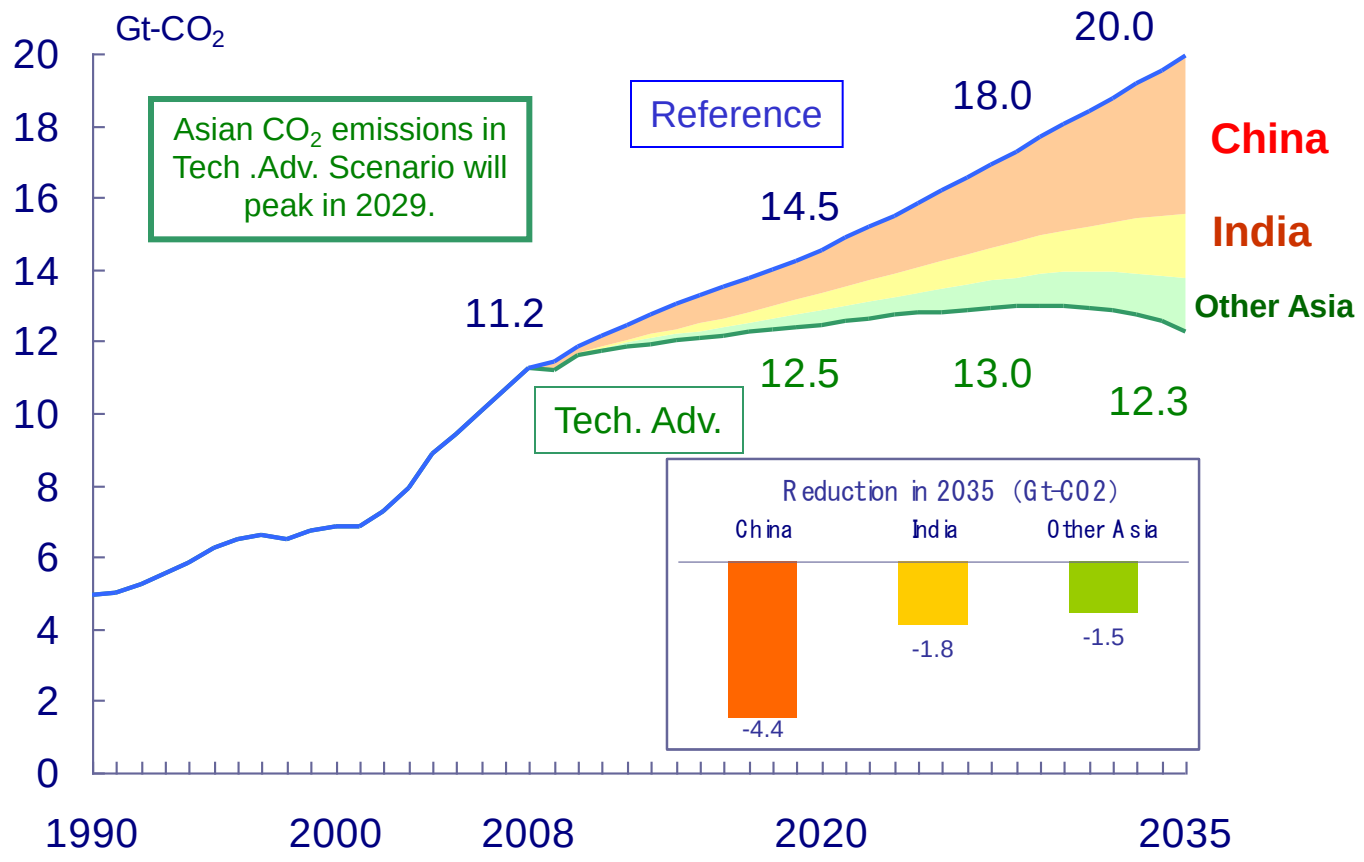
World LNG import in 2009 is about 180 Million tons. Share of Japan, Korea and China reaches over 40%.

Importance of Energy Cooperation in Asia (Pacific)

- Certain merit in pursuing and implementing policies and measures individually in each country
- Importance of Energy Cooperation to compliment individual Policies and Measures.
- Background to consider cooperation.
  - Necessity of smooth and timely large-scale investment
  - Efficient utilization of advanced technologies & best practices
  - Optimum utilization of existing resources/assets, capital/stock, know-how, infrastructure, etc.
  - Market stability and negotiation power through cooperation,
  - Creation of new business opportunities and market efficiency improvement
  - Strengthening political/economic relation through energy cooperation.

➔ Combination of **bi-lateral**, **regional** and **multi-lateral cooperation** among **East Asia countries**.

CO_2 Reduction Potential in Asia with Technologies



Total **7.7** Gt
(39% reduction)

China
4.4 Gt
(57% of total)

India
1.8 Gt
(24% of total)

Other Asia
1.5 Gt
(19% of total)

■ In the Tech. Adv. Scenario, CO_2 emissions in Asia will reach its peak in 2029, although it will increase by 3.3 Gt-CO_2 (35%) from 2005 to 2025.

■ China and India have great potential to reduce CO_2 emissions. China's CO_2 emissions reduction (calculated as difference between CO_2 emissions in the Reference Scenario and the Tech. Adv. Scenario) will account for 60% of Asia's reduction in 2035. India and other Asian countries will account for the remaining 40%.

Importance of Regional Cooperation in Asia : Construct & Deepen Energy Dialogue to address risks

1) To address "Unbalance Supply-Demand" risk
   a. Cooperative initiative to prevent miss-match via supplier-consumer dialogue
   b. Collaboration in energy development, joint purchase, supply cooperation utilizing pipeline, etc.
2) To address "Global Warming" risk
   a. Collaboration towards early agreement on Post Kyoto framework.
   b. Promotion of "clean energy & energy efficiency" to support Asia.
3) To address "Geopolitical" risk
   a. Development of national energy resource (nuclear, renewables) and promotion of technology exchange
   b. Diversification of energy resources
   c. Diversification of import routes
   d. Cooperation for expansion of stock piling and establishment of "emergency facilitation scheme"
4) To address "Speculative Financial Investment" risk
   a. Securing "transparency" and international agreement on quota regulation.
5) To address "Nuclear Safety" risk
   a. Sharing of information & best practices and creation of international standards.
   b. Collaborative technology development (cooperation and IPR consideration)

In Summary

- Possibility for “Asia as a Growth Center” to become “Asia as an Instability Center” from energy security perspectives
- Fossil fuels will remain core of energy use and demand increases, while possible supply risks exist in Asia
- New challenges for energy producing countries on “Supply-Demand Unbalance”
- New challenges on “Safety” in addition to 3Es (Economy, Environment and Energy)
- Increasing importance of regional cooperation promotion in the area of **“Energy and Environment” for Asia**

Coming Soon!

Asia/World Energy Outlook 2011

Thank very much for your attention!

Projection Outline

- **Objective**： Attempt to quantitatively simulate realistic energy pictures of energy demand and supply in a fully logical and consistent way, with investigation into current socio-economic situations and energy fundamentals, in both Asia and the world. Particularly, analysis of Asia is carefully implemented through the exchange of information with numerous research institutes and organizations in the region.

- **Projection Period**：
  - **2008 ~ 2035** (detailed energy supply and demand analysis for each country)
  - **2035 ~ 2050** (rough sketch for Asia and the World)

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

- **Scenarios**：

  ■ **Reference**

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

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

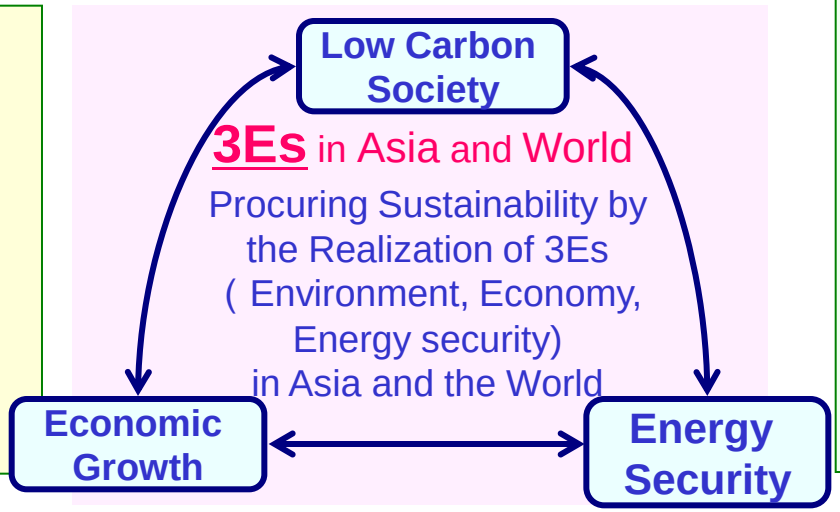
  This scenario develops future picture which assumes;
  - Accelerated R&D encourages global deployment of advanced technology.
  - Global technological cooperation and technology transfer from developed to developing countries are promoted.
  - All the countries of the world take technologically advanced measures in order to secure energy demand and supply.

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

Agenda on Energy-Environmental Policy

Firm resolutions on ensuring energy security, R&D and address climate change issues

- ■Expansion of non-fossil fuel
- ■Best mix (diversification and efficient energy use)
- ■Oil & gas supply security



Technological Strategy of Japan

Japan should focus on its competitive technological edge.

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

Development and deployment of innovative technology and transformation of social system

2020

- Nuclear
- PV, Wind, Bio-fuel etc.
- Environmentally compatible use of fossil fuel
  - Clean Coal Technology(IGCC, CCS)
  - MACC
- Clean Energy Vehicles (Plug-in Hybrid Vehicles、EV etc.)
- Battery technology、Power electronics etc.
- Fuel cell
- Heat-pump
- Smart grid, smart meter etc.

2030

Energy demand expansion in China, India etc.

Risk of extraordinary price escalation of fossil fuel (Peak-out of Easy Oil)

Massive introduction of innovative technologies

Acceleration of development of low carbon technology
⇒Sustainable economic growth

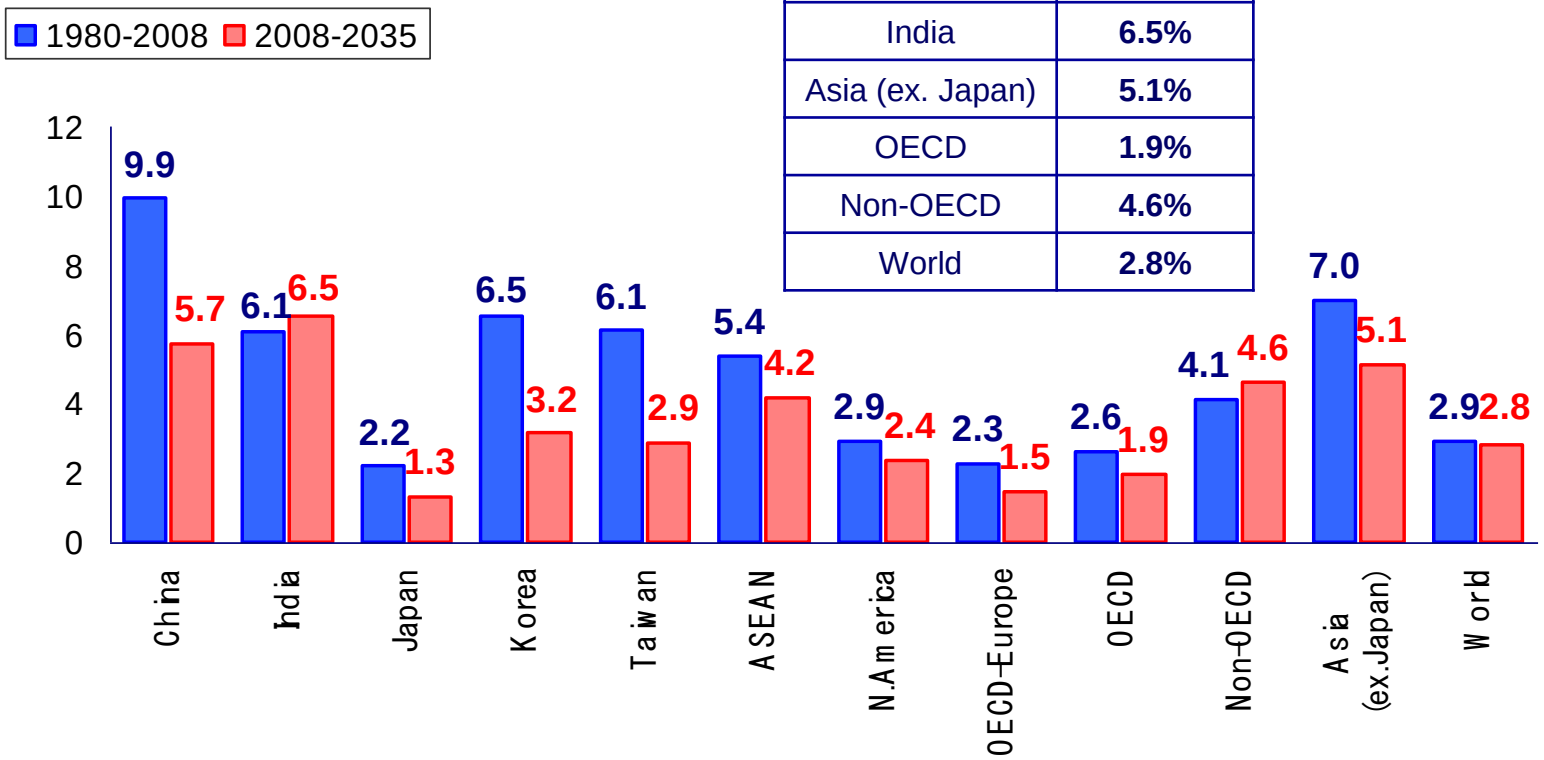
2035

2050

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

Major Assumption : GDP

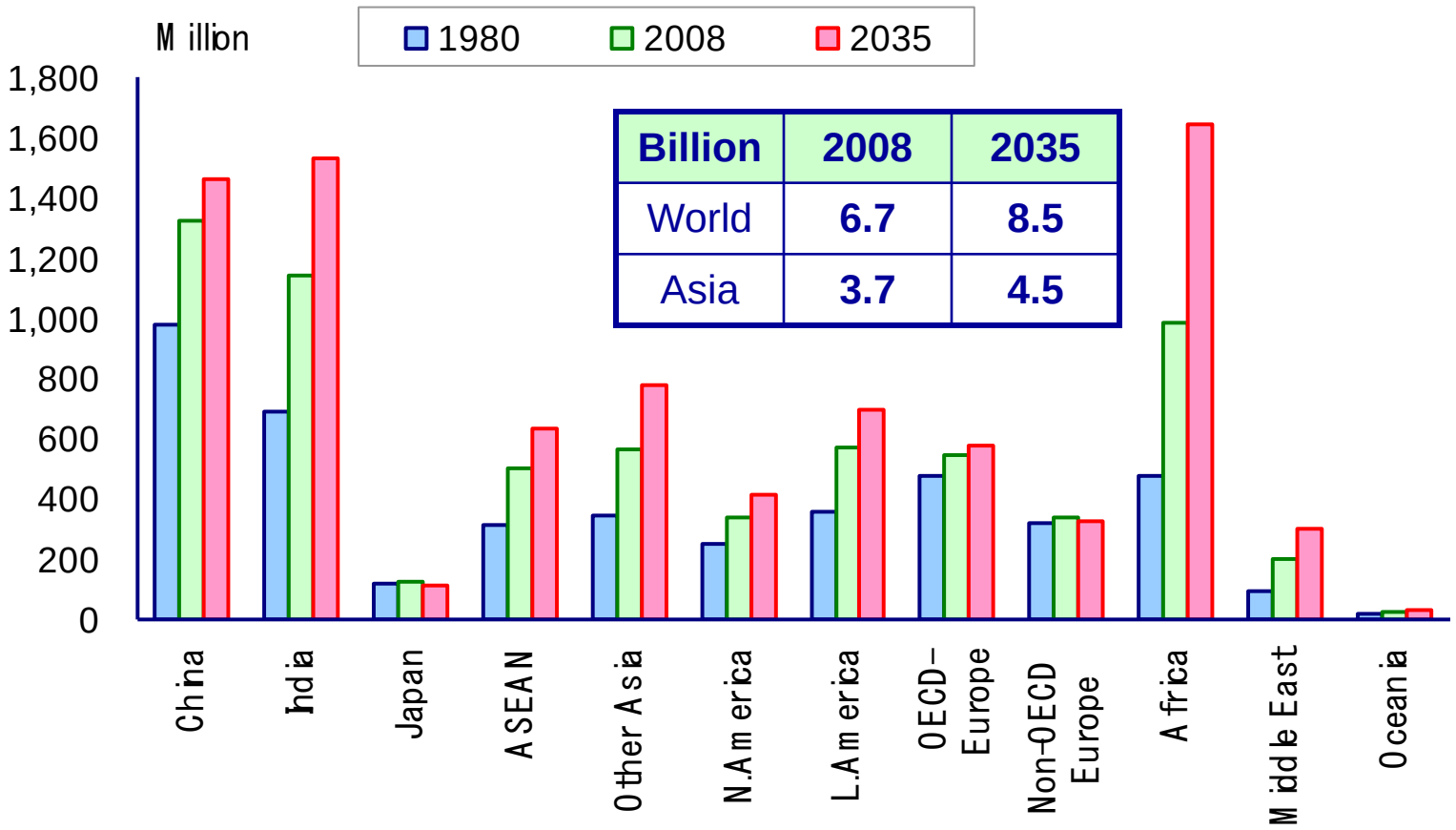
Average Annual Growth Rate (%)



	2008-2035
China	**5.7%**
India	**6.5%**
Asia (ex. Japan)	**5.1%**
OECD	**1.9%**
Non-OECD	**4.6%**
World	**2.8%**

- World economy will continue to grow steadily at 2.8% per annum through 2035. Repercussions from the recent financial crisis were globally felt to slow the economic growth, but with the economic stimulus measures by numerous countries will lead to early recovery.
- GDP in China will continue to achieve an annual growth rate of 5.7% per year shifting from the investment- and export-driven growth to the domestic demand-driven one.
- GDP in India will register a high growth rate at 6.5% per year, reflecting increases in improved labor quality, and liberalization and direct investment from foreign countries.
- ASEAN countries will achieve steady economic growth supported by industrialization and export increases.

Major Assumption : Population



Billion	2008	2035
World	6.7	8.5
Asia	3.7	4.5

China

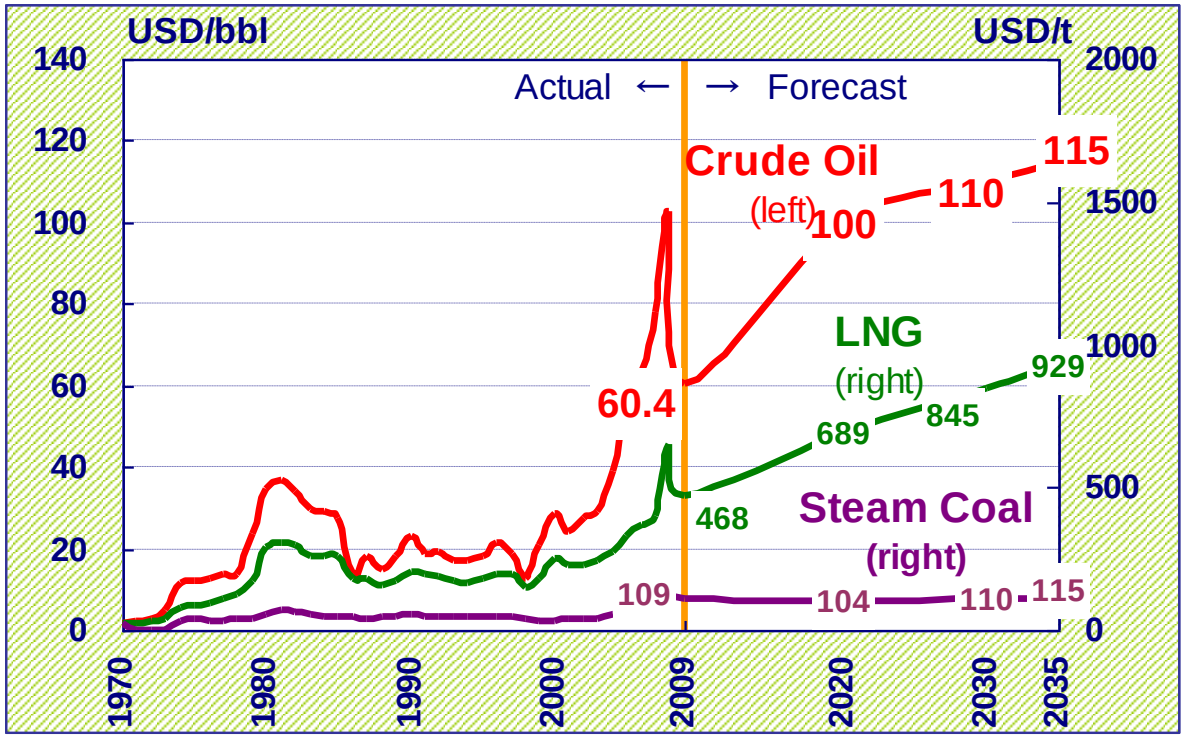
2008
1.32 bil
↓
2035
1.46 bil
(**0.14** bil growth)

India

2008
1.14 bil
↓
2035
1.53 bil
(**0.38** bil growth)

- Of the incremental increase in world population over the period 2008-2035, developing countries account for roughly 90%.
- Population in China and India together will reach about 3 billion and its share will increase to 35% by 2035.
- Chinese population will peak in 2030 as a result of declining birth rate. India's population will represent the biggest in the world by 2035.

Major Assumption： Energy Prices



(*) 2009 real price (**) All the prices are calendar year data; In the graph, energy prices are explained by Japan's import energy price (on a CIF basis).

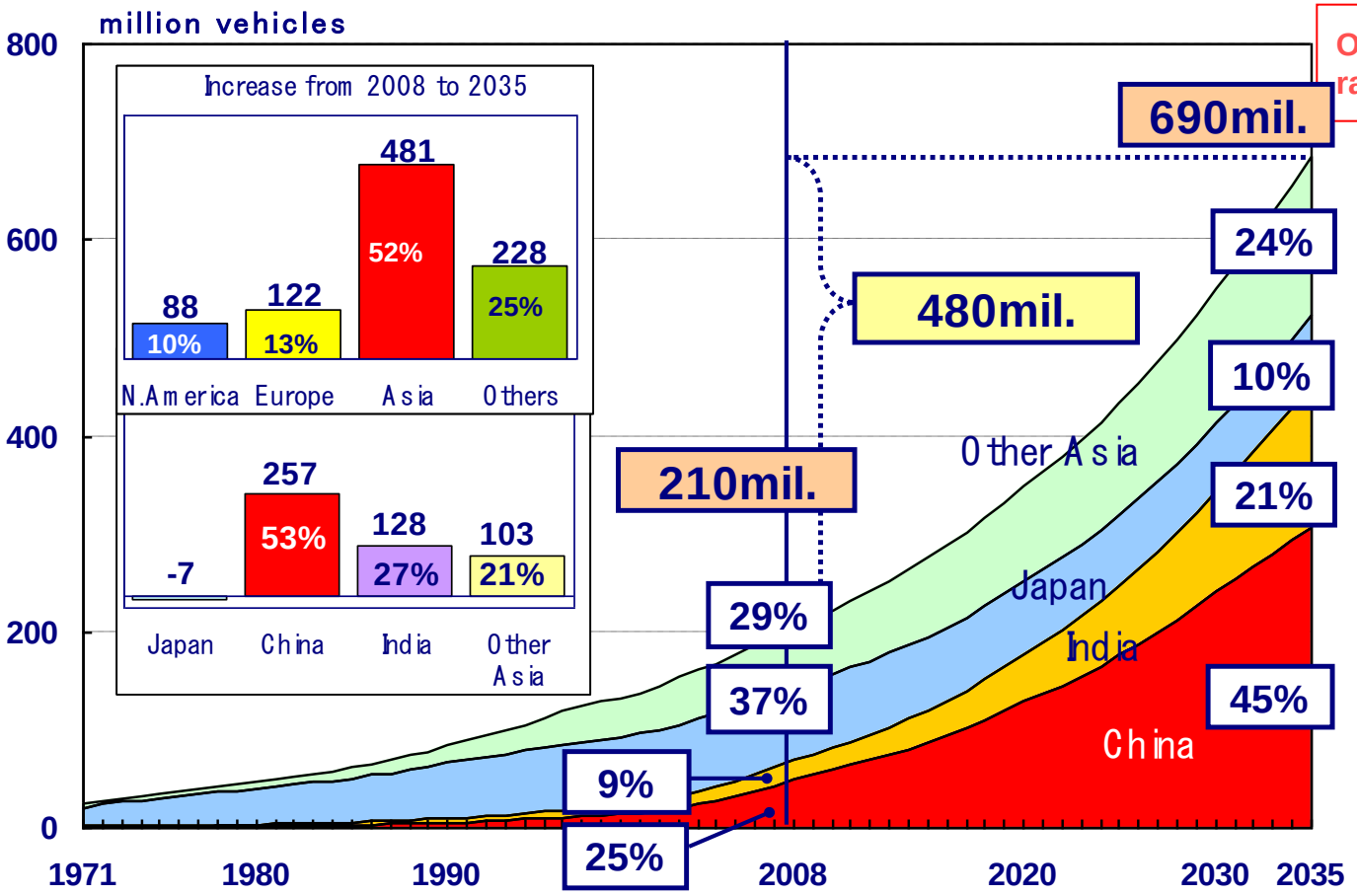
■Despite a decline in crude oil price from the recorded high level in 2008 to 2009, crude oil price will continue to increase in the future resulting from the tight balance between demand and supply. Oil demand is projected to increase driven mainly by Asia, while upstream investment may not progress at a pace meeting the demand growth (The crude oil price is the median of the assumed price ranges of 90 USD/bbl to 110 USD/bbl in 2020 and 110 USD/bbl to 120 USD/bbl in 2035).

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

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

The Number of Vehicles (Asia)

Reference
Tech. Adv.



Ownership rate in 2035

Japan : 62%

India : 9.6%

China : 21%

China

2008
51 mil.
↓
2035
310 mil.
(6.0-fold inc.)

India

2008
19 mil.
↓
2035
150 mil.
(8.0-fold inc.)

- Approximately 36% of the world vehicle stocks concentrates in Asia.
- China and India's vehicle stocks will expand substantially.