China and the Shale Revolution

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China Energy & Sustainability Forum

CGEP, SIPA, Columbia University, New York

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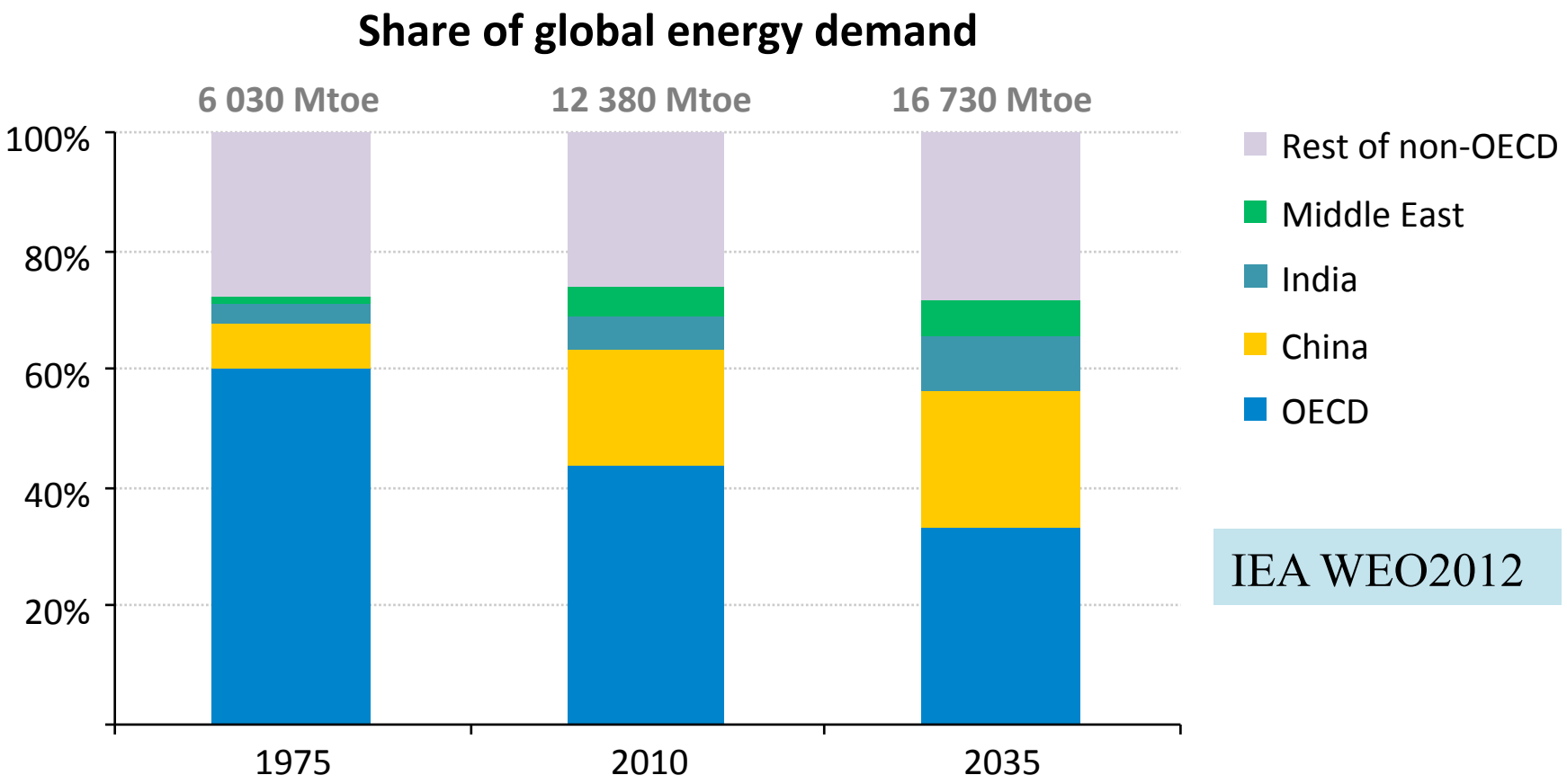
Global Associate of Energy Security and Sustainability, IEEJ

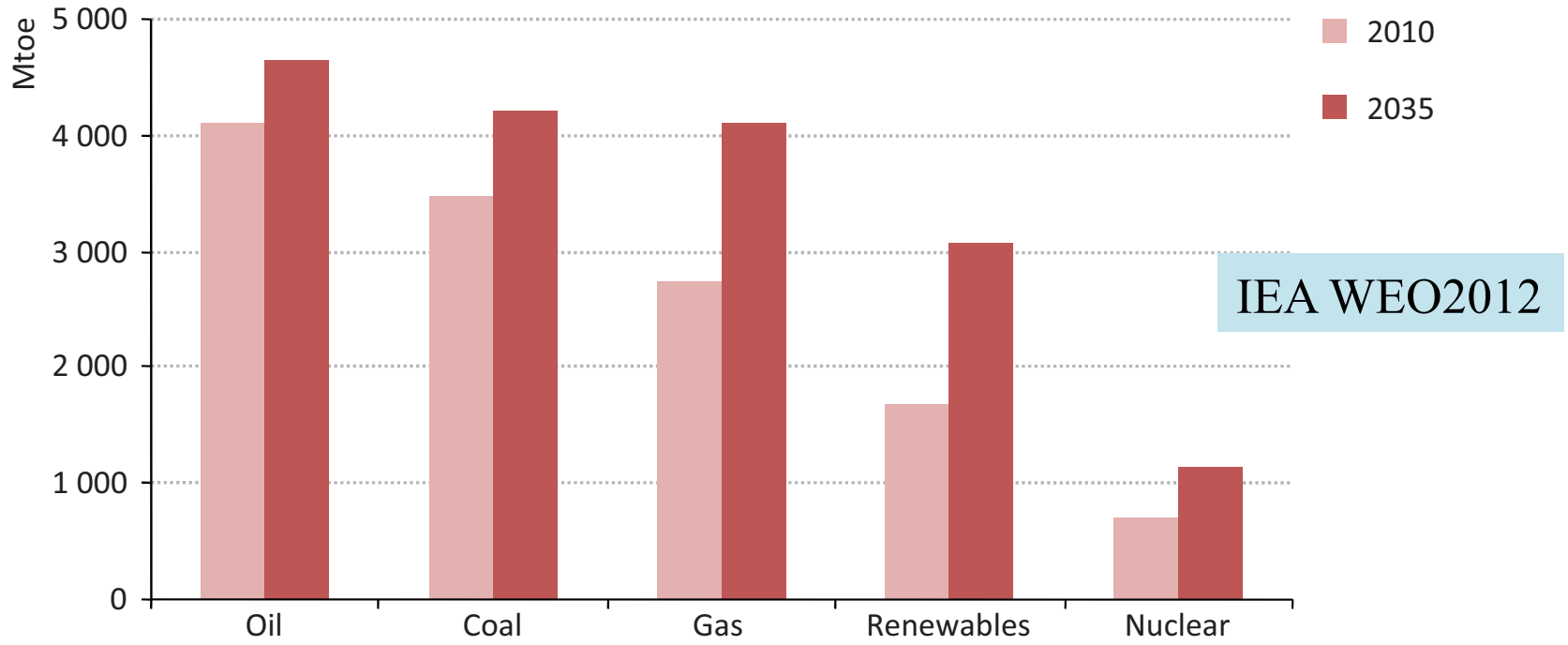
Emerging economies steer energy markets



Global energy demand rises by over one-third in the period to 2035, underpinned by rising living standards in China, India & the Middle East

We will still be in the Fossil Fuel economy.

Figure 2.3 ▷ World primary energy demand by fuel in the New Policies Scenario



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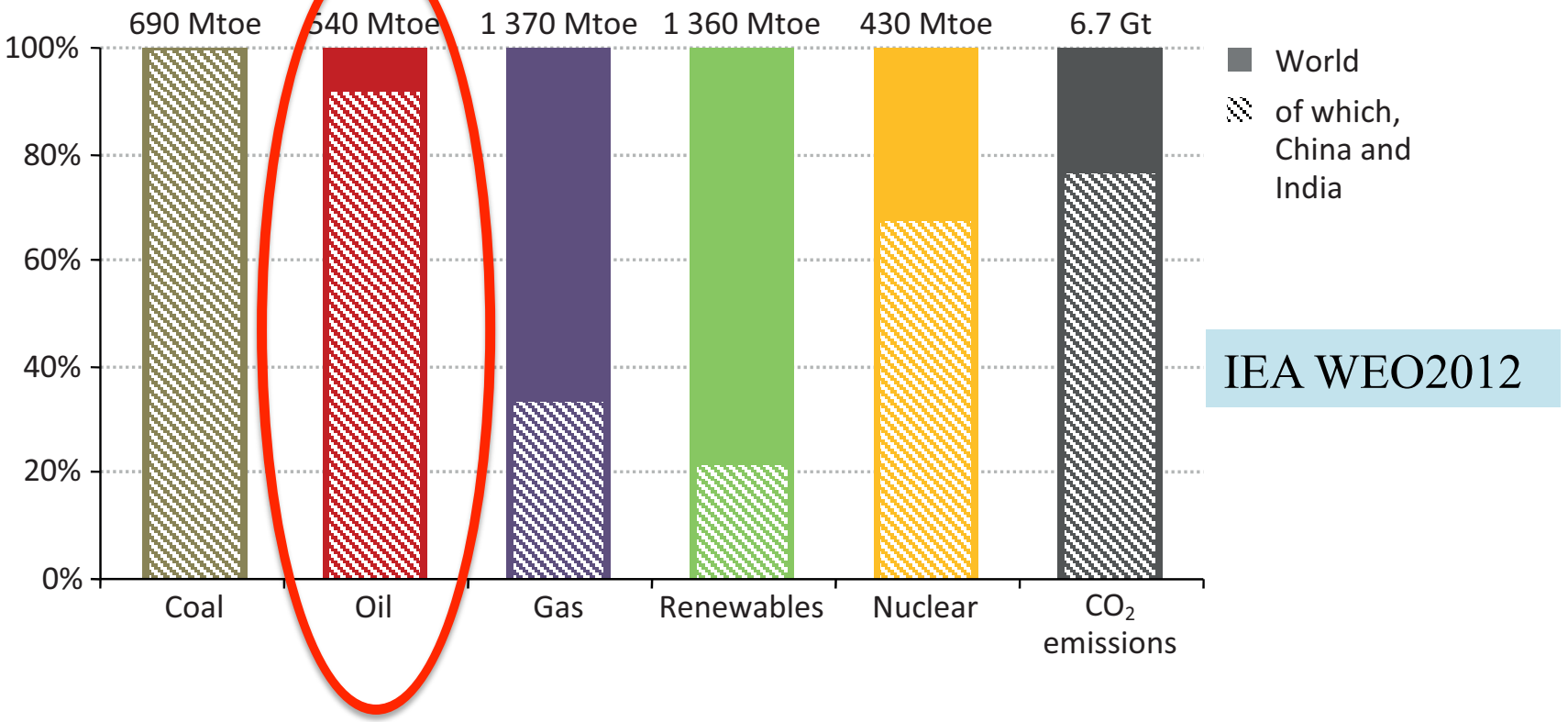
Renewables increases by 80%, Nuclear by 60%. But Fossil Fuels continue to be major sources of energy, though their share drops from 81% to 75% in 2035.

Game Changers : China and India Risk rises at OIL.

Figure 2.6 ▷ **Share of China and India in net increase in global primary energy demand by fuel and CO_2 emissions in the New Policies Scenario, 2010-2035**



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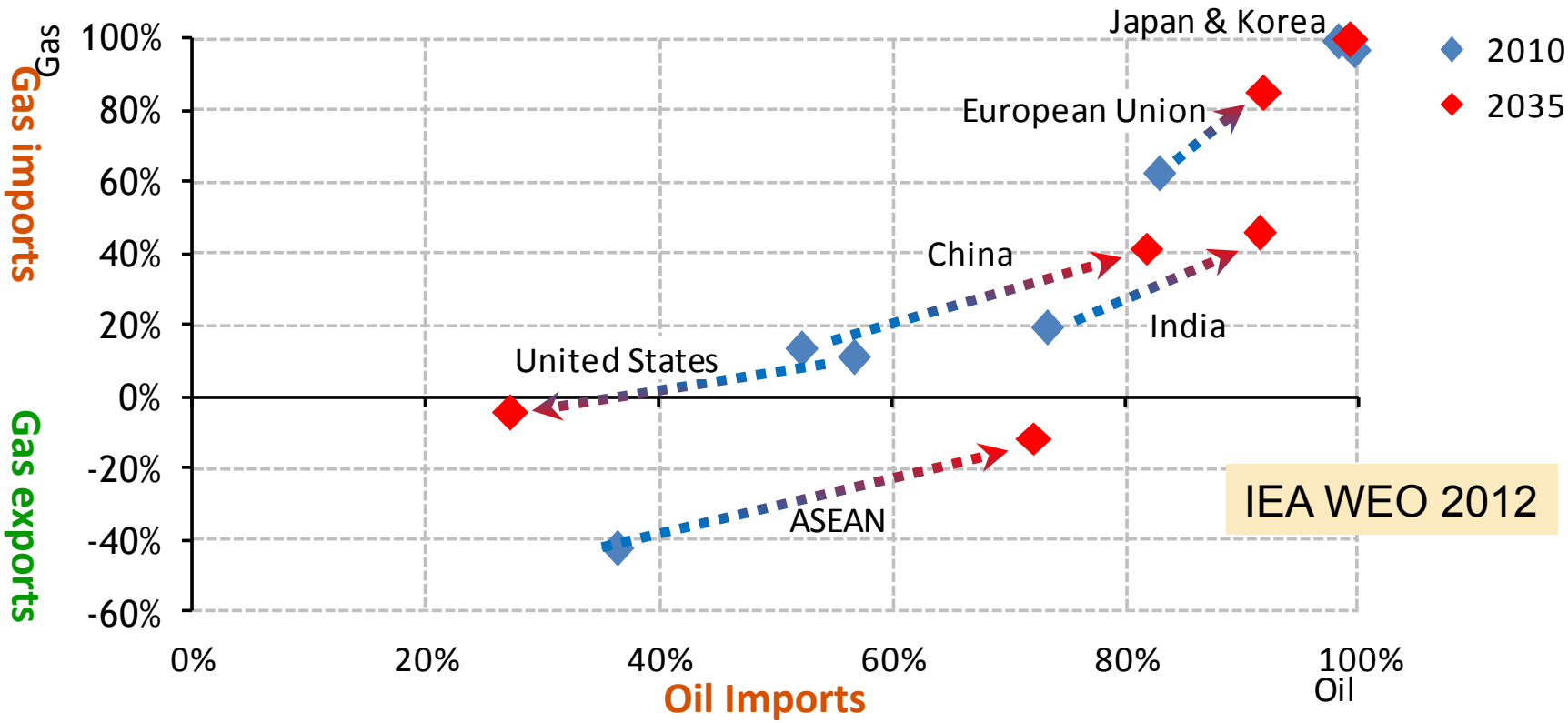
Different trends in oil & gas import ; the US is the sole winner.

Net oil & gas import dependency in selected countries



While dependence on imported oil & gas rises in many countries, the United States swims against the tide

Iraq oil poised for a major expansion

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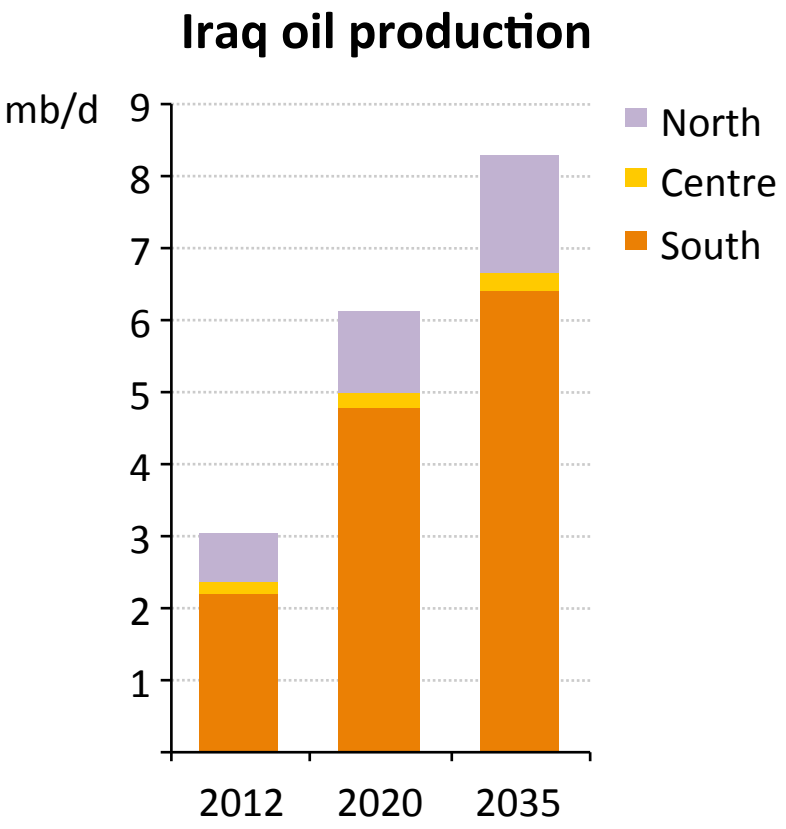
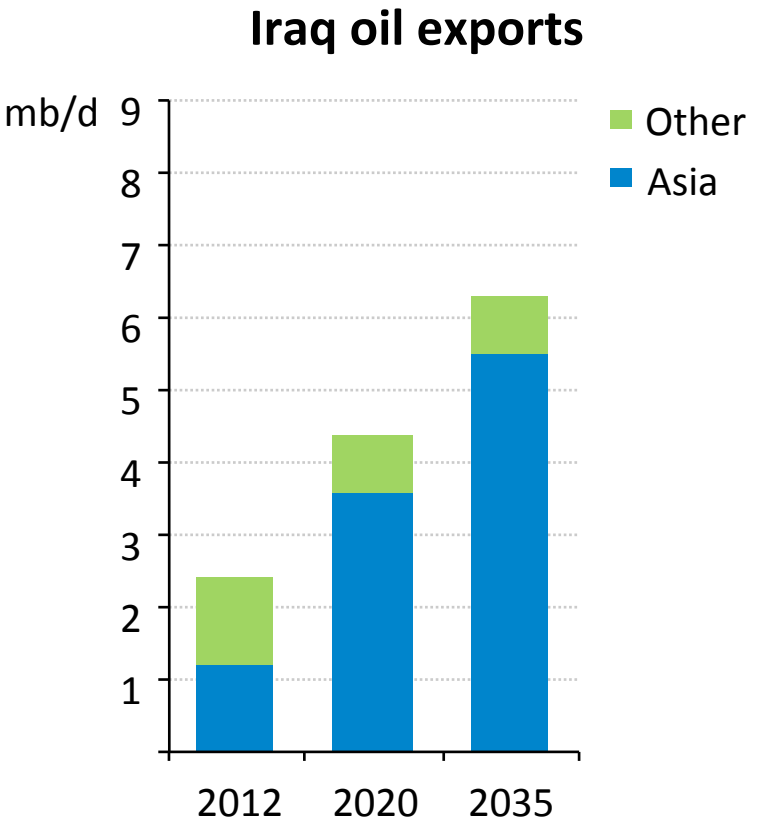
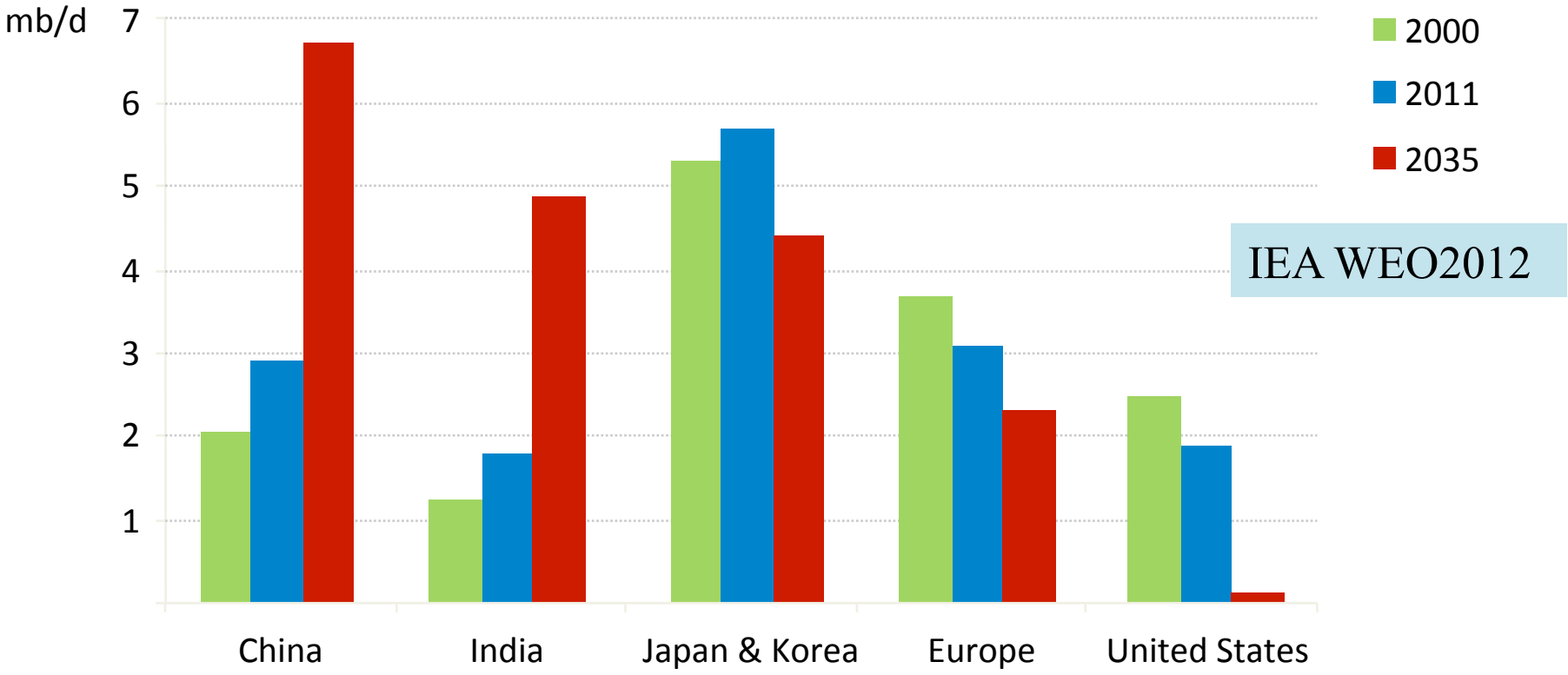




Iraq accounts for 45% of the growth in global production to 2035;
by the 2030s it becomes the second-largest global oil exporter, overtaking Russia

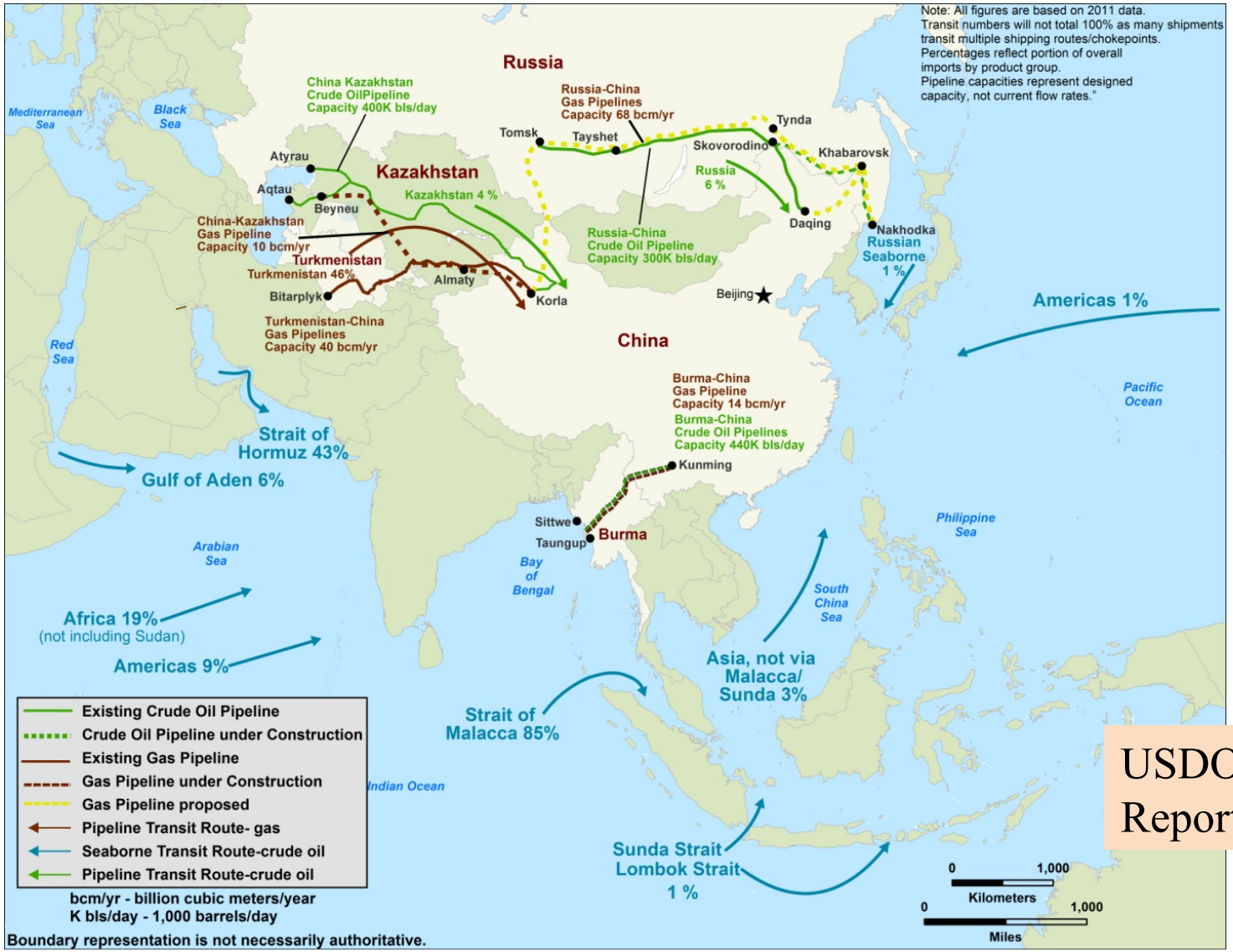
North American Energy Independence and Middle East oil to Asia: a new Energy Silk Road

Middle East oil export by destination



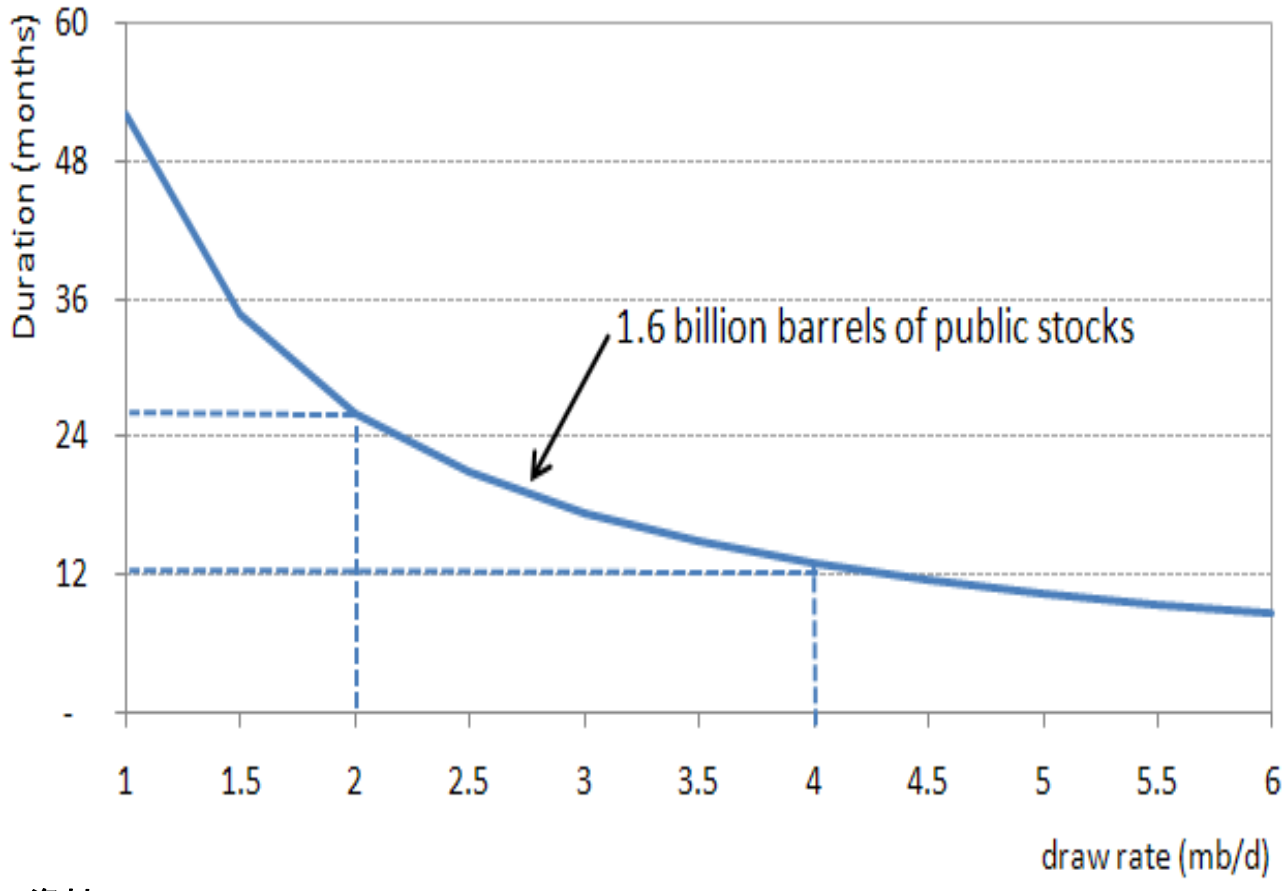
By 2035, almost 90% of Middle Eastern oil exports go to Asia; North America's emergence as a net exporter accelerates the eastward shift in trade

China's Import Transit Routes



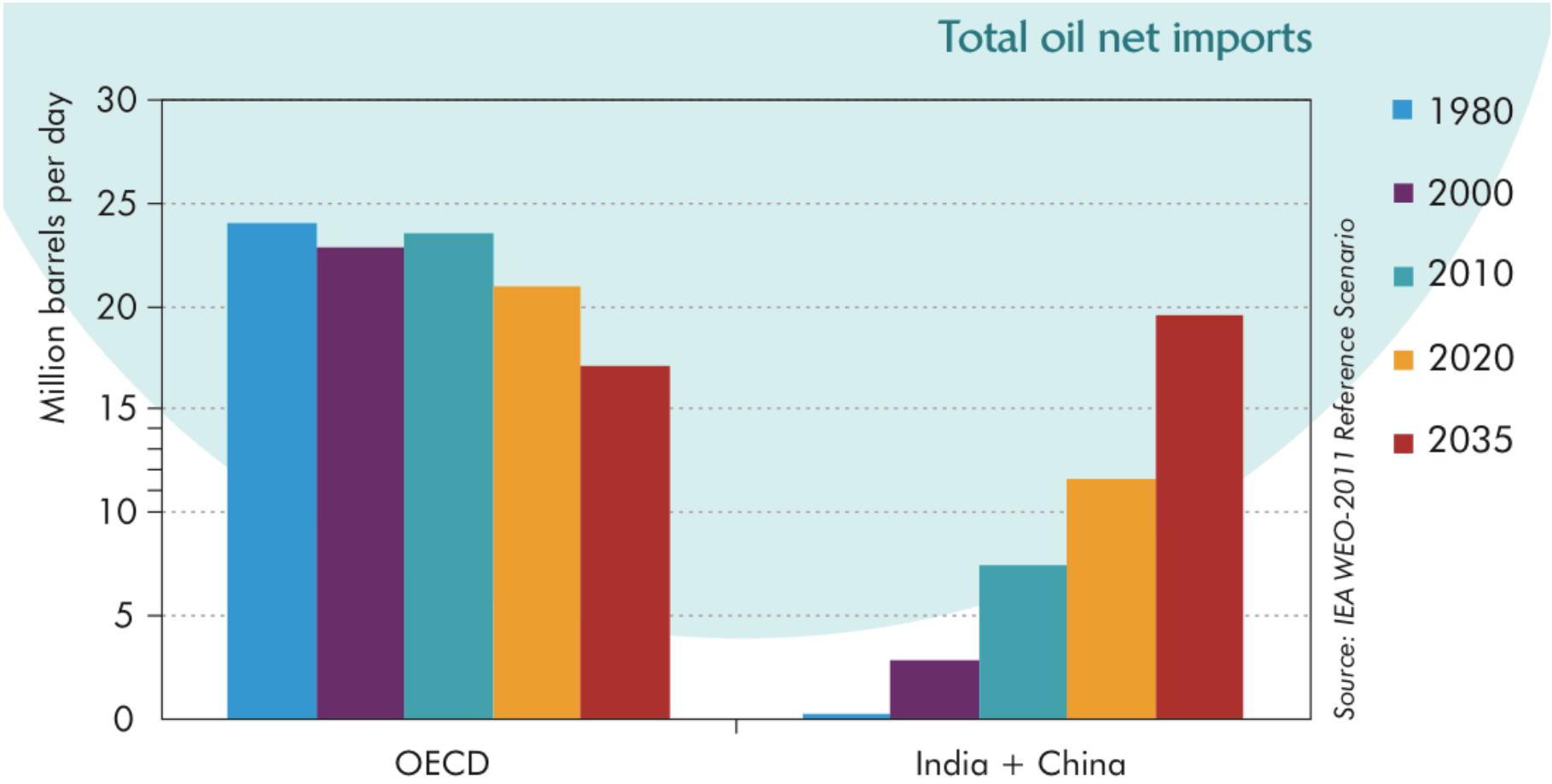
USDOD China Report 2013

IEA Petroleum Strategic Stock can relieve 2mbd disruption for 24 months.



1974 disruption was 4.3mbd. 1979 was 5.6mbd. Hormuz blockage is13 mbd.

Should China and India join the IEA?

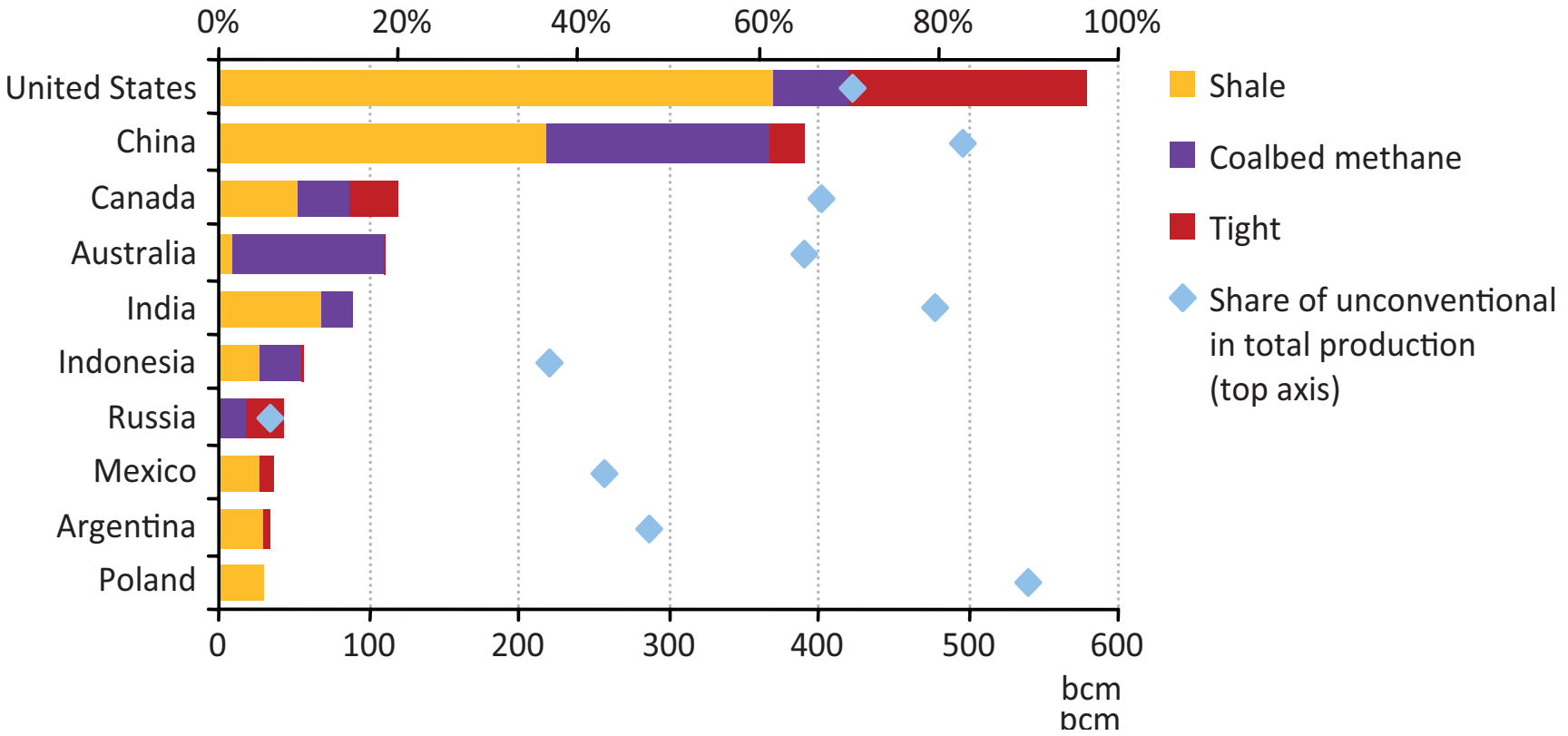


Role of the IEA in a Time of Unprecedented Uncertainties.

- Growing Asian economies will shape the global energy future – where will their policy decisions lead us ?
- It is China and India's interest to join the IEA.

Golden Age for Natural Gas?

Figure 2.5 ▷ Ten largest unconventional gas producers in the Golden Rules Case, 2035



In the Golden Age Scenario, China doubles shale gas production than NPS.

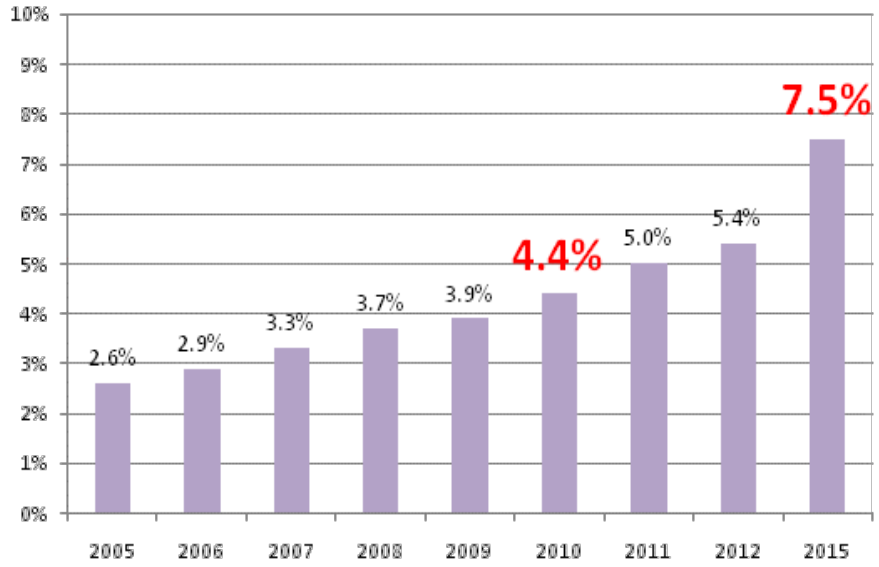
The first Shale Gas in China ; Well Wei 201（威201号井)

Well Wei 201
Is located in Xinchang town , Weiyuan County, Neijiang City, Sichuan Province.
2841m deep.
Drill started in 2009.
Production started in Oct 2010.
Casing pressure is 4.0MPa
Average daily output is 400m3.
Accumulated output is over 700,000m3.

National Targets in 12th Five –Year Plan

- a 16% reduction in energy consumption per unit of GDP;
- a 17% reduction in CO_2 emission per unit of GDP;
- an increase of **natural gas** as a percentage of total primary energy from 4.4% in 2010 to **7.5%** by 2015

Target of NG in primary energy by 2015



Energy Research Institute, NDRC

12th Five-Year Plan for Natural Gas (2011-2015)

Targets by 2015

- **Resource Reserve**
  - Newly added proven reserves of NG: 3.5 TCM
  - Newly added proven reserves of CBM: 1 TCM
  - Proven reserves of shale gas: 600 BCM,
    Proved developed reserves: 200 BCM
- **Domestic production**: 176 BCM(Inter into production peak,
  newly added 80 BCM in 5 years)
  - Conventional gas： about 138.5 BCM
  - Coal-to-gas： about 15～18 BCM
  - CBM (surface development):16 BCM
  - Shale gas： 6.5 BCM

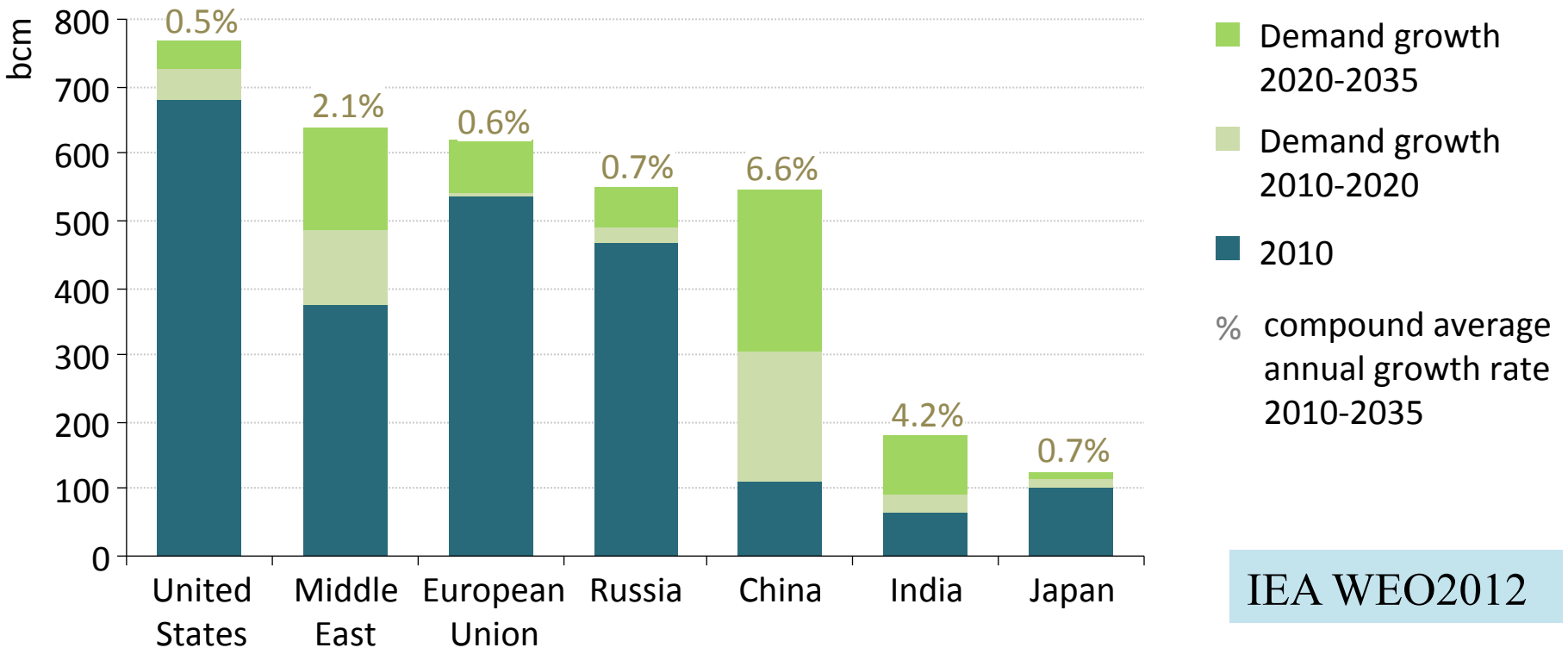
- **Consumption： 230 BCM**

- **Infrastructure capability :**
  - Newly constructed natural gas pipeline is 44,000 KM (including branch line), newly added main line capacity is about 150 billion cubic meters per year
  - Newly working gas of gas storage is about 22 BCM, it accounts for 9% of natural gas consumption in 2015.

- **Gas penetration:**
  City and country population with gas use is about 250 million, it accounts for 18% of total population

Energy Research Institute, NDRC

Natural gas demand in selected regions



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While gas demand expands in every region between 2010-2035, growth is nearly three times faster in non-OECD countries (2.3% per year) than in the OECD (0.8%)

Natural gas: towards a globalised market

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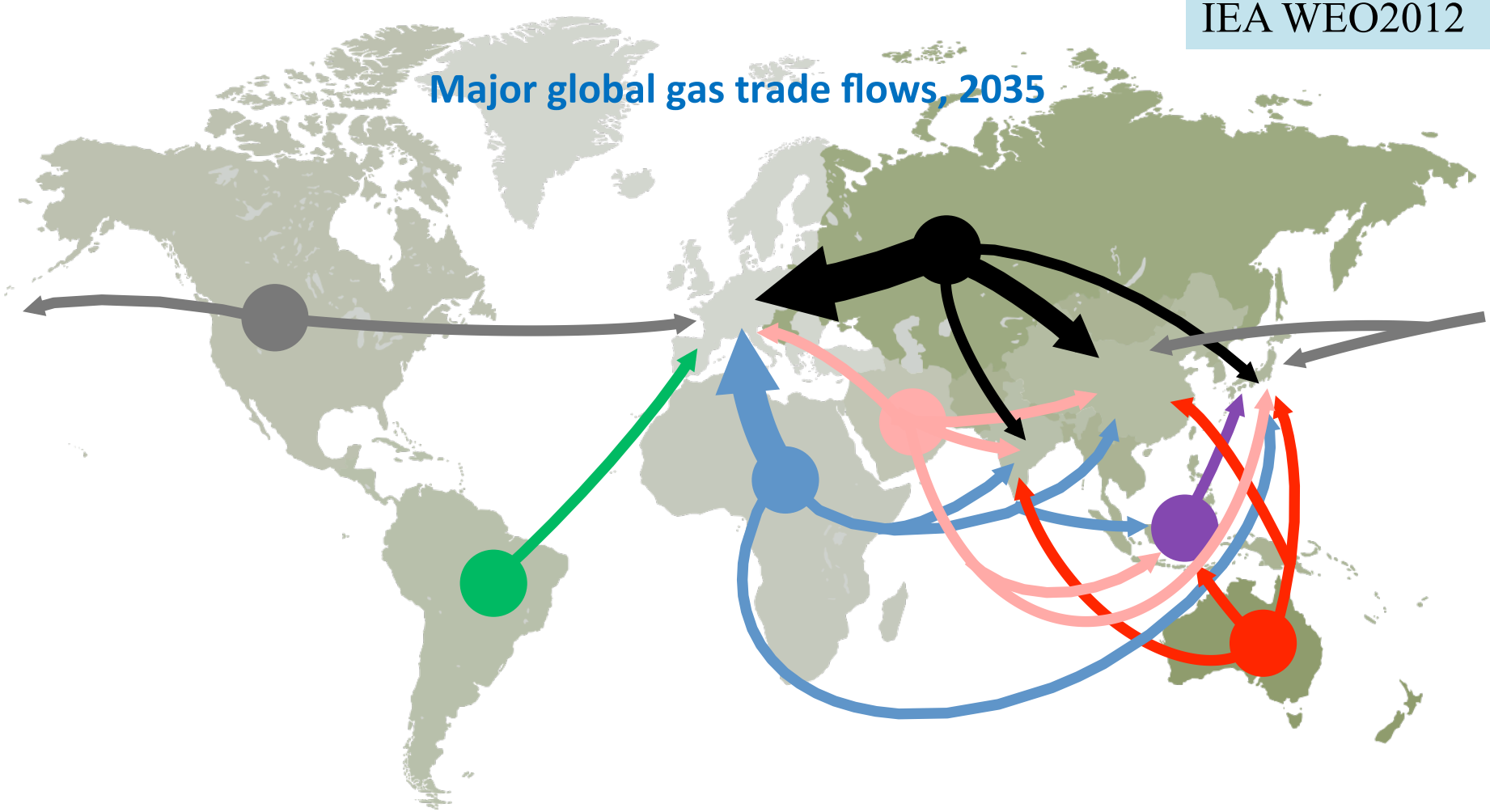


Rising supplies of unconventional gas & LNG help to diversify trade flows, putting pressure on conventional gas suppliers & oil-linked pricing mechanisms

Russian Gas Pipelines

Russian Gas Infrastructure

The boundaries and names shown and the designations used on maps included in this publication do not imply official endorsement or acceptance by the IEA.

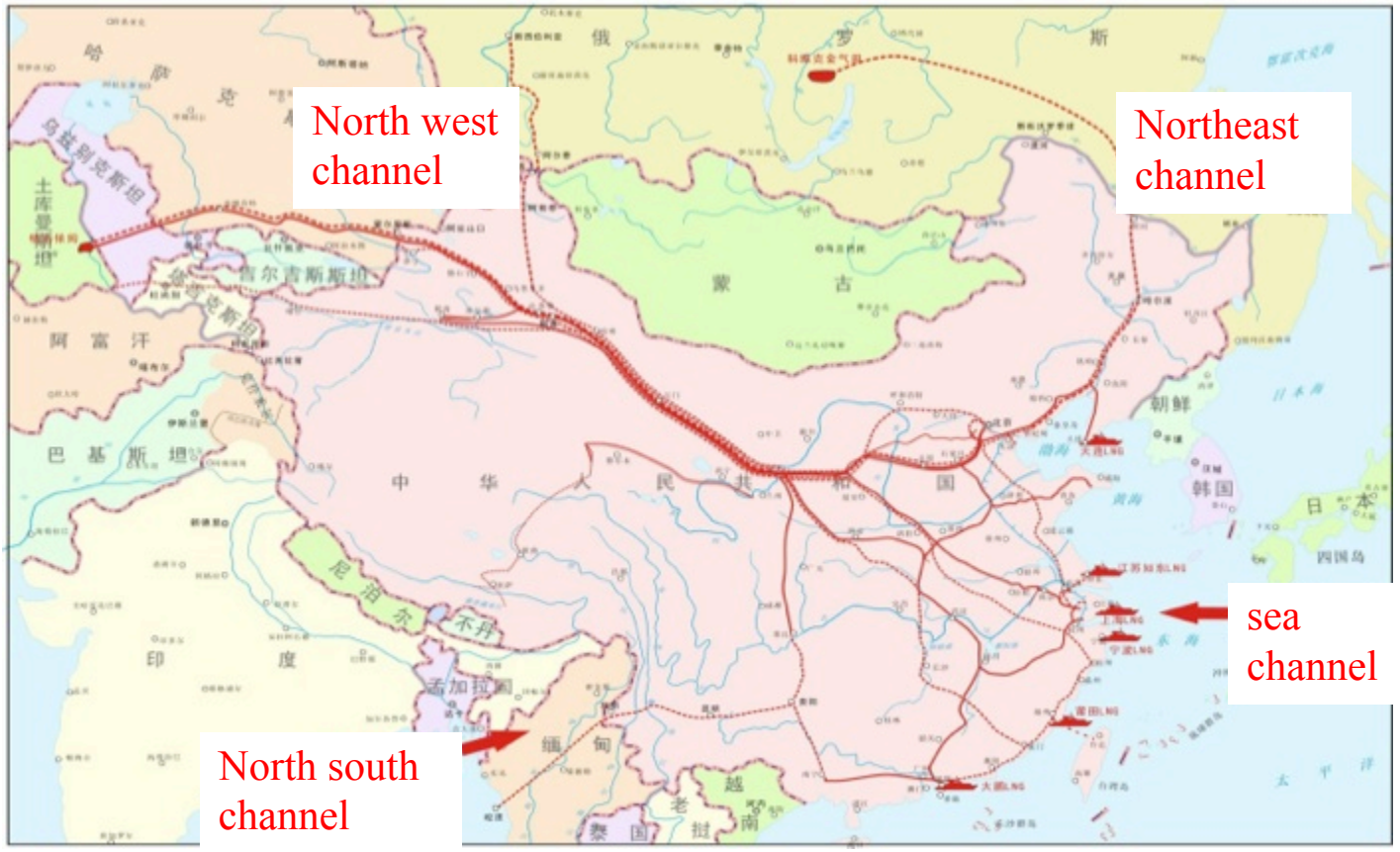
Source: IEA

Mid-Term Oil & Gas Market 2010, IEA

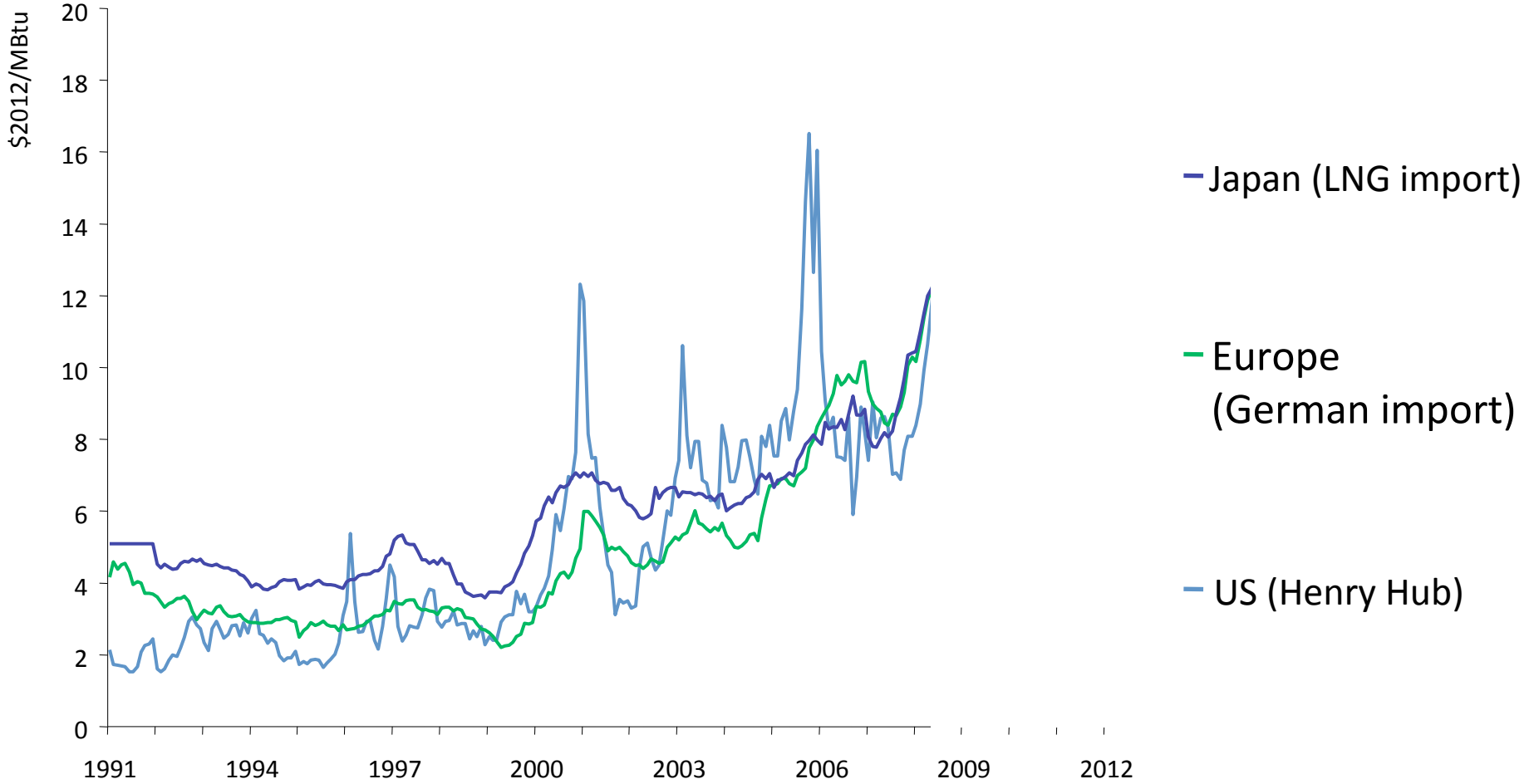
There are 2 kinds of resources strategies from domestic and overseas to build 4 strategic channels for natural gas import

In the next ten years, it will be some different supply ways of natural gas in China, such as domestic conventional natural gas, non-conventional natural gas, coal gas, import LNG, import pipeline natural gas. And it will form two kinds of resources strategies from domestic and overseas. It mainly depend on domestic natural gas and the import is complementary.

There will be four strategic import channels. North west channel for Central Asia natural gas, North south channel for Myanmar natural gas, sea channel for LNG and northeast channel for Russia natural gas and LNG.



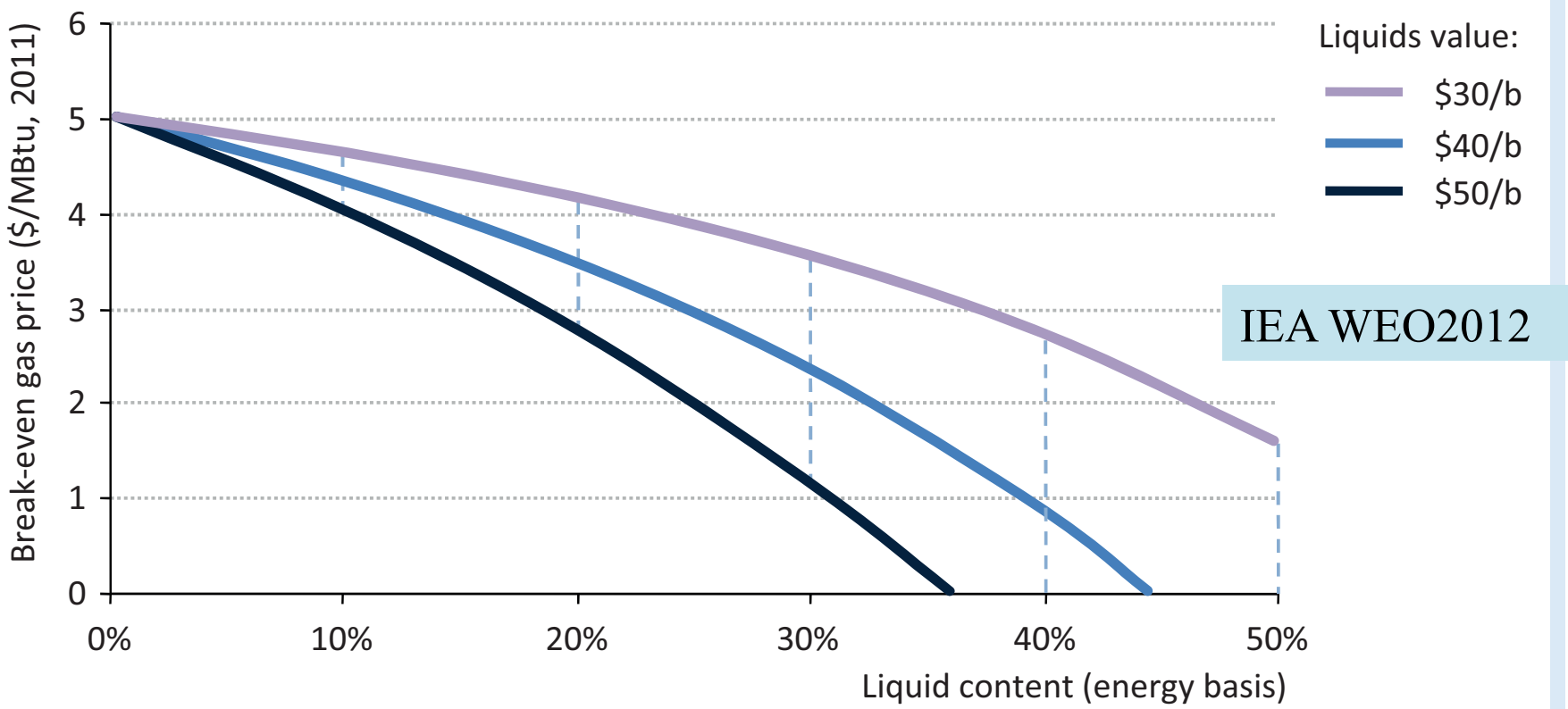
LNG pricing : a competitiveness burden on Asian economies



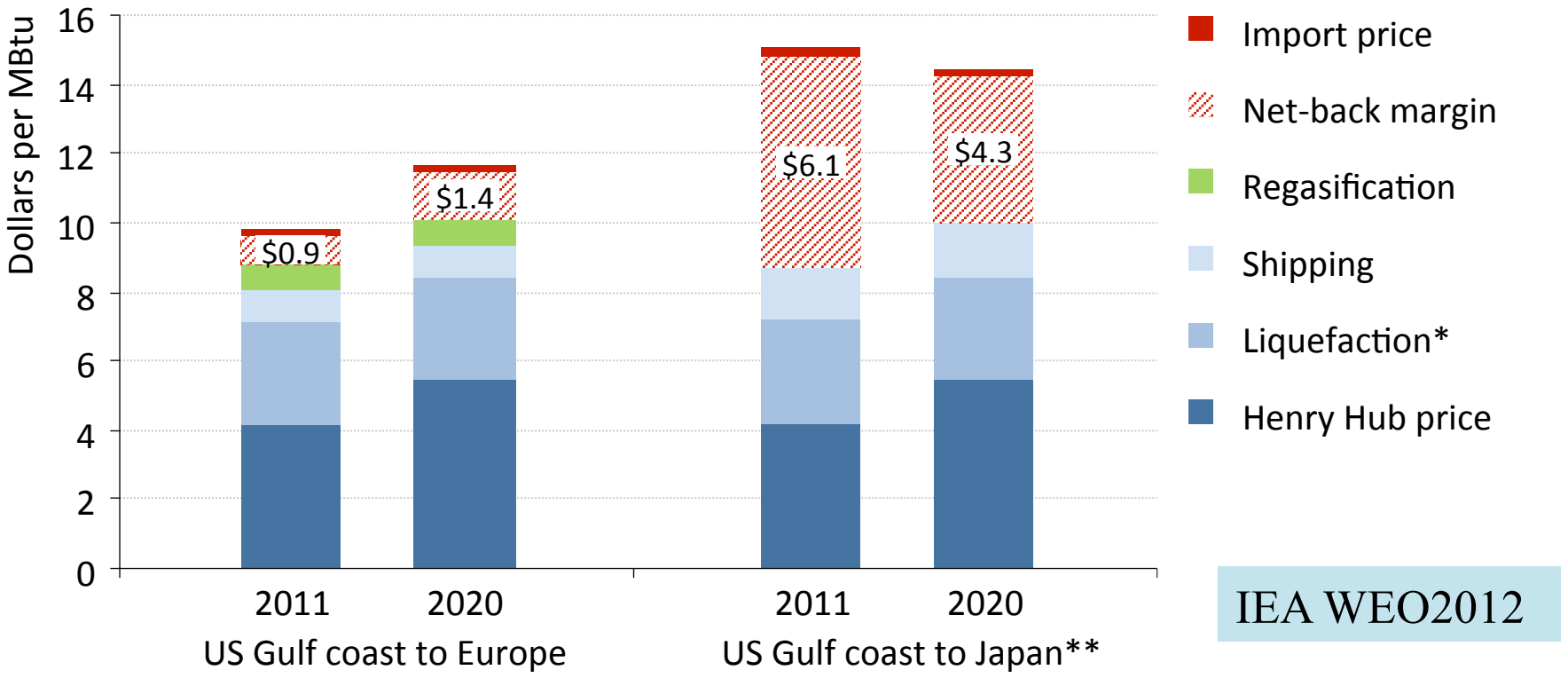
Developing a Natural Gas Trading Hub in Asia (2013 by IEA)

The higher the oil price goes, the lower the gas price becomes.

Figure 4.7 ▻ **Relationship between break-even price (gas price needed to recover well costs) and the liquid content of the gas produced**



Indicative economics of LNG exports from the United States



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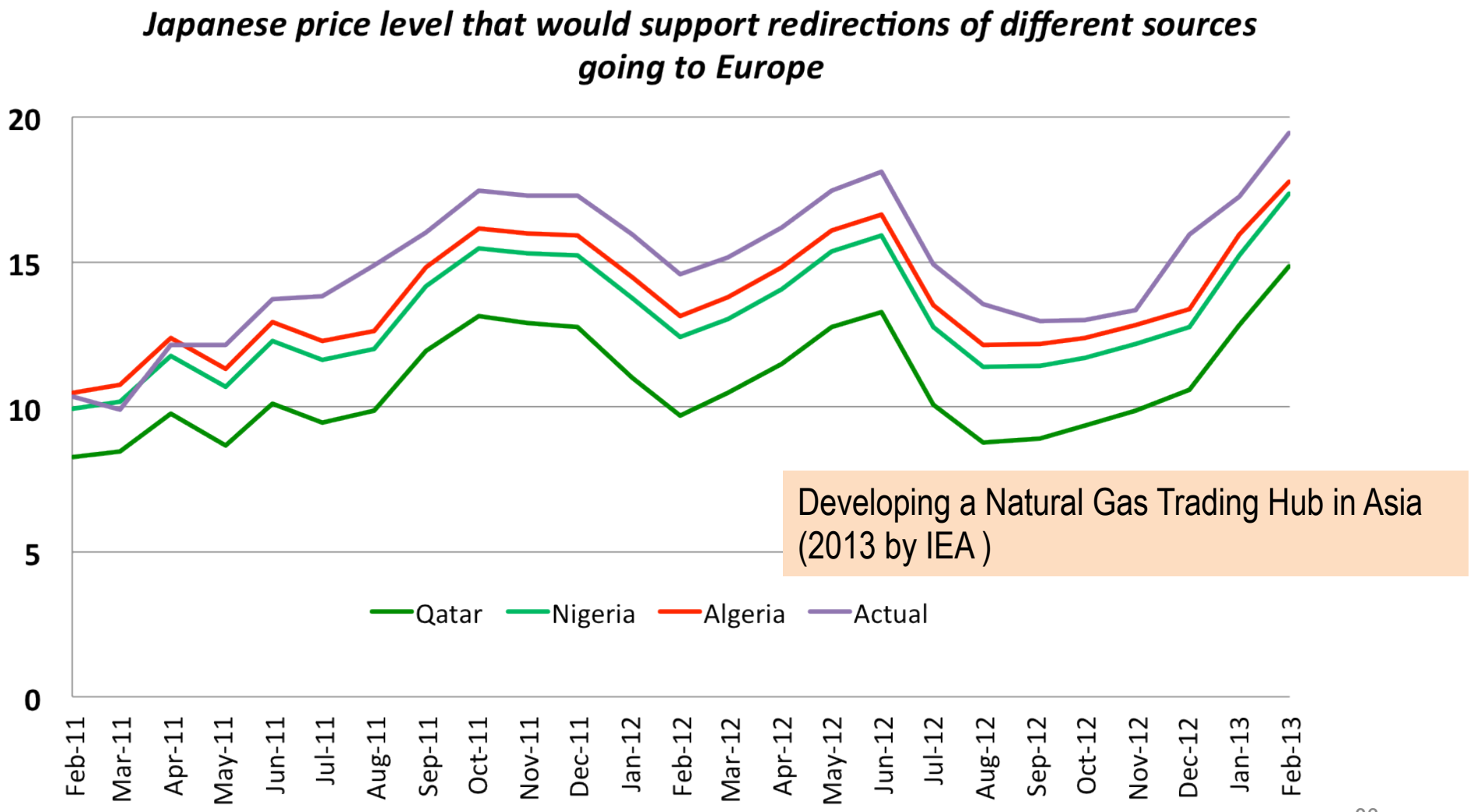
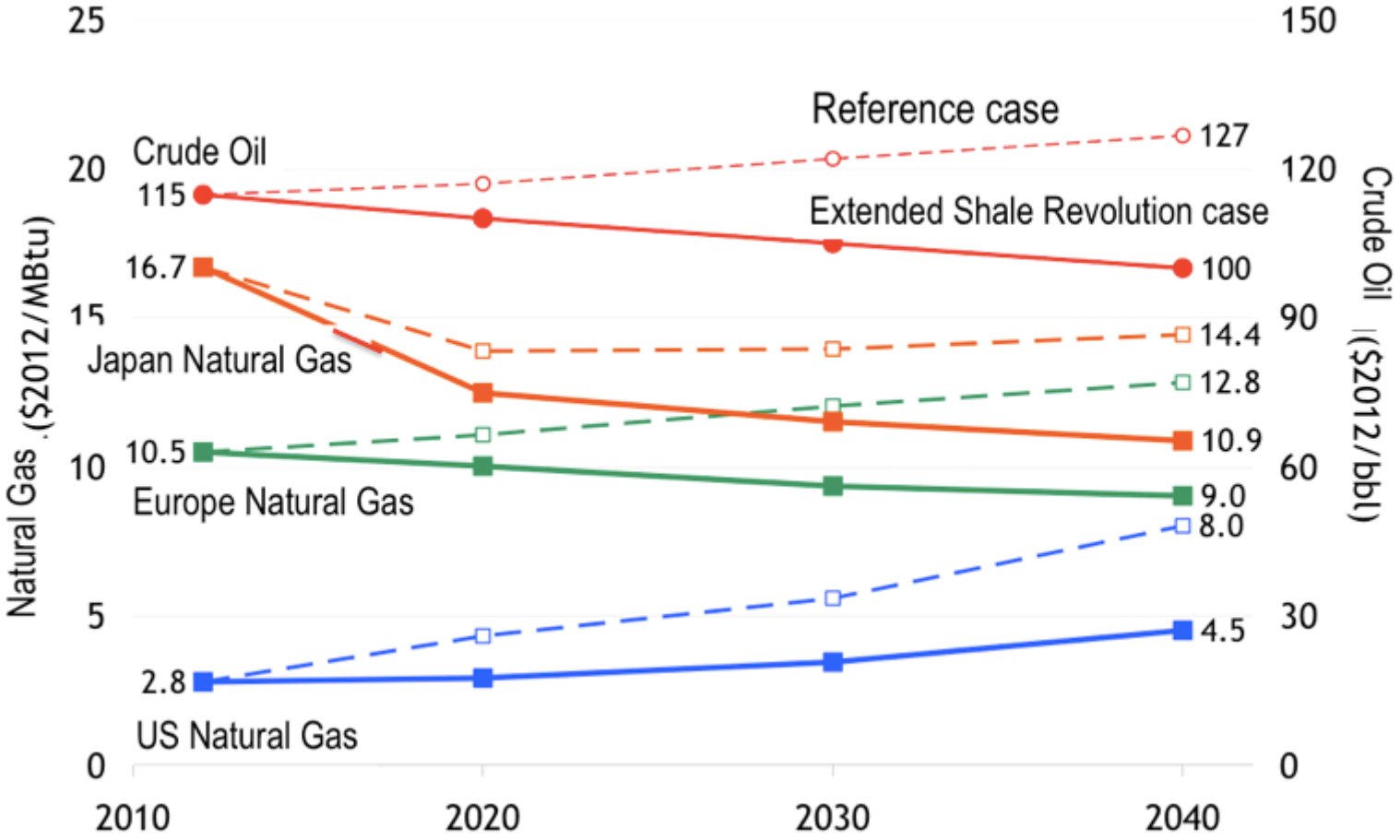
At both current prices and those assumed for 2020, LNG exports from the US would be profitable, especially to Asian markets

Destination clauses and inefficient trade with Europe is a USD 10 billion burden on Japan



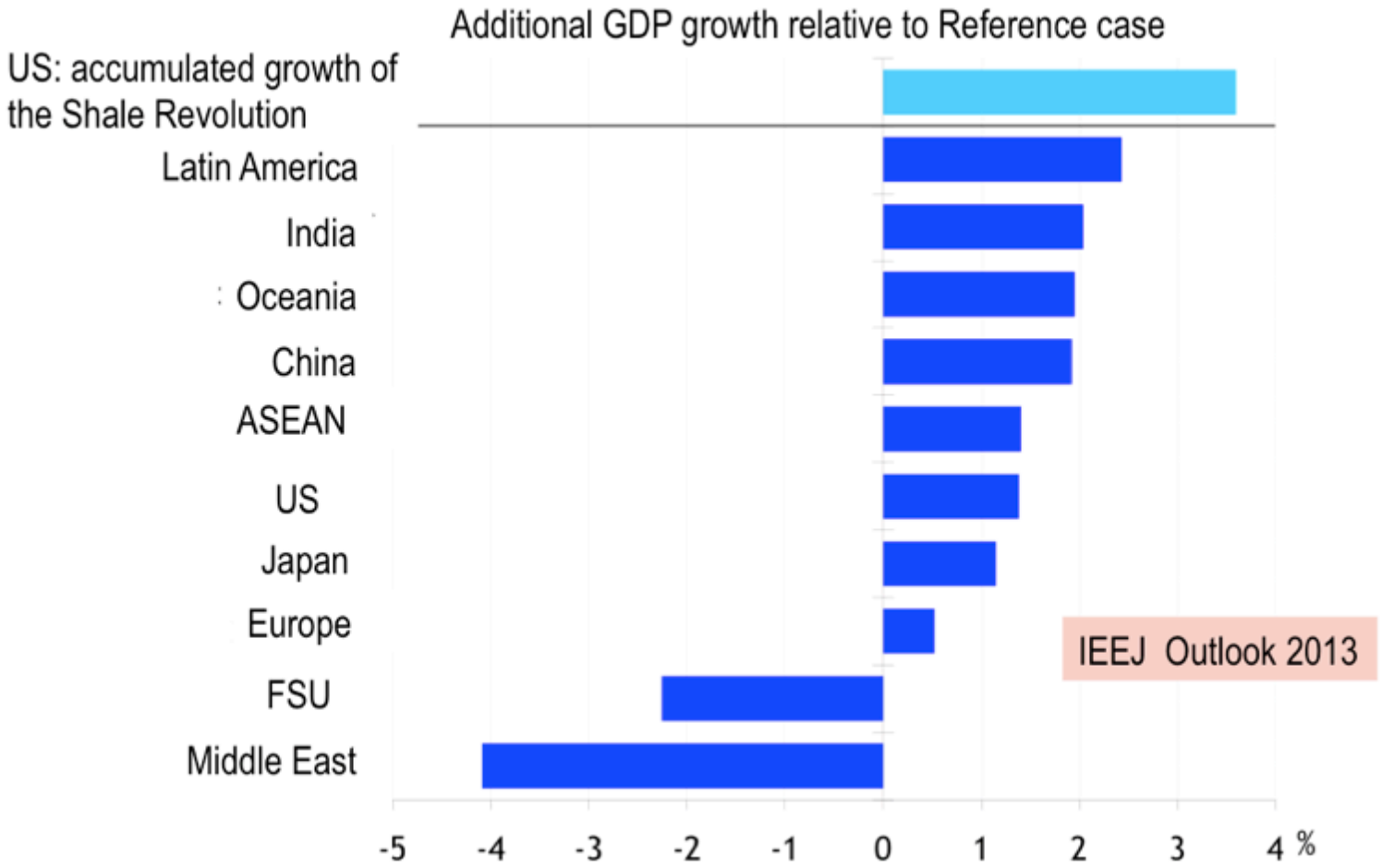
Developing a Natural Gas Trading Hub in Asia (2013 by IEA)

Oil & Gas Price Assumptions for IEEJ Outlook 2013



IEEJ Outlook 2013

Winners and Losers of the Shale Revolution



Golden Rules for a Golden Age of Gas

The “Golden Rules” are principles that can allow governments, industry & other stakeholders to address these environmental & social impacts:

1. Measure, disclose & engage
2. Watch where you drill
3. Isolate well & prevent leaks
4. Treat water responsibly
5. Eliminate venting, minimise flaring & other emissions
6. Be ready to think big
7. Ensure a consistently high level of environmental performance

They are “Golden Rules” because their application can ensure operators have a “social license to operate”, paving the way for a golden age of gas.
But Cost of gas production will increase by 7%.

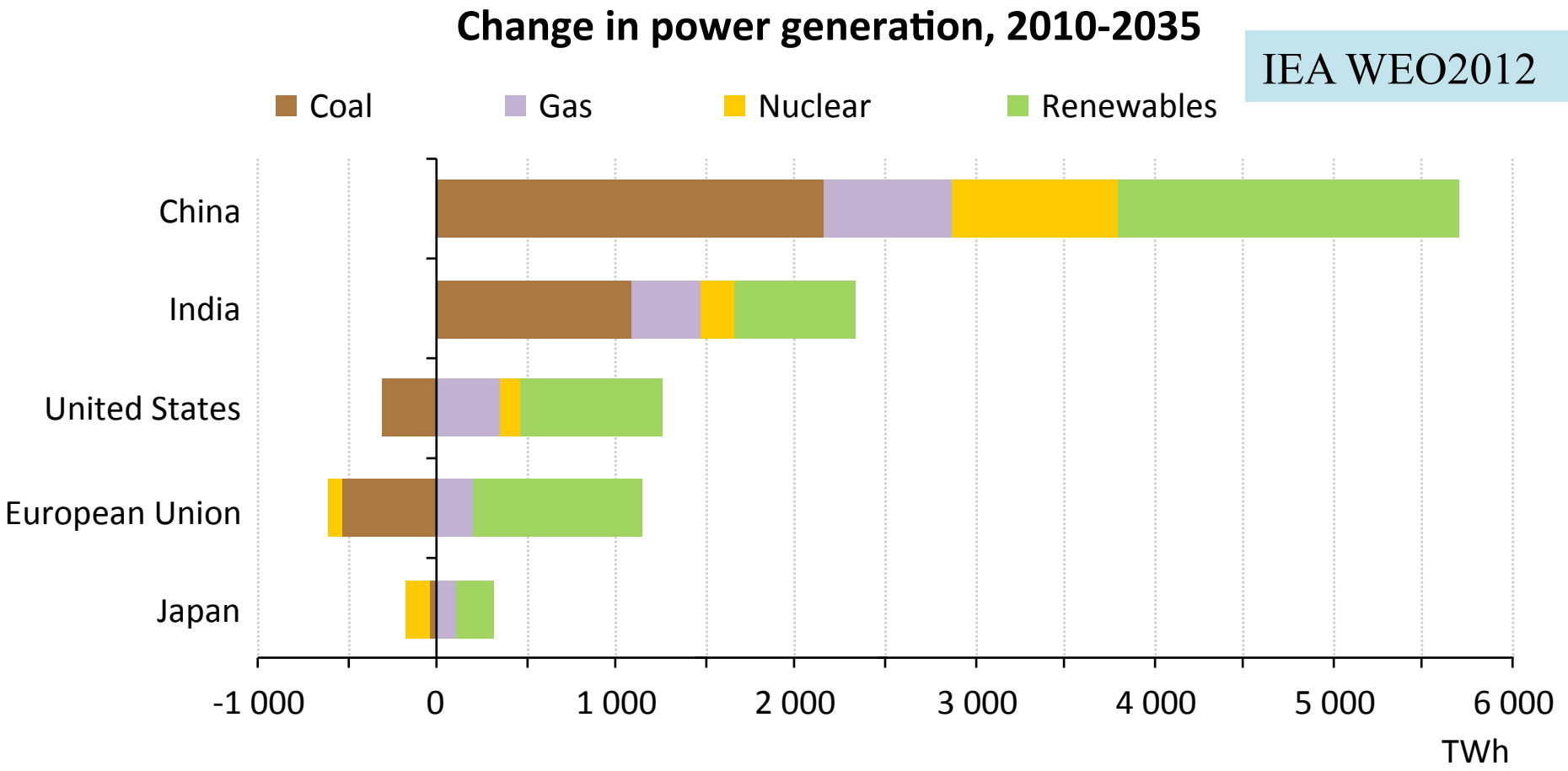
Methane Hydrate, Next unconventional ?

An Energy Coup for Japan: 'Flammable Ice'

Photo by JOGMEC

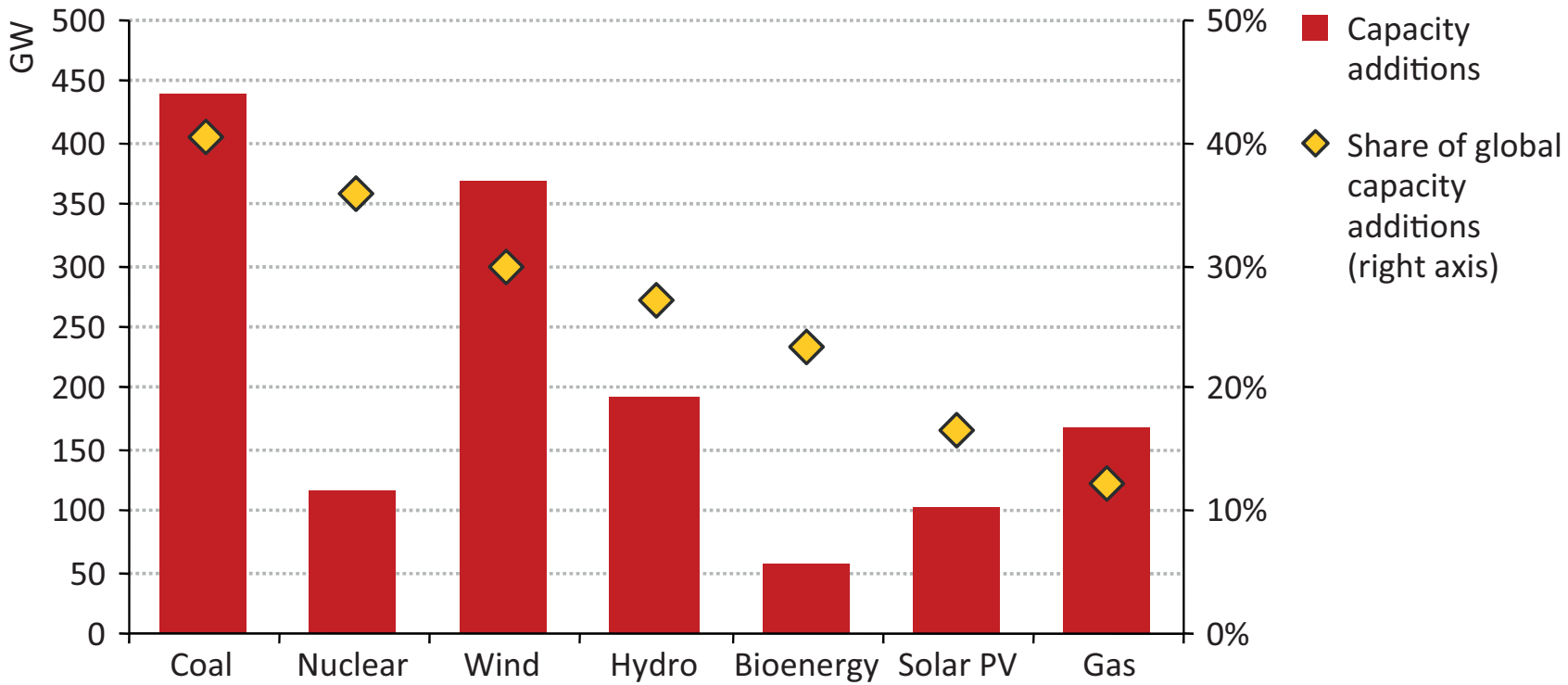
Resource estimates vary by several orders of magnitudes, with many falling between 1000 and 5000 tcm, or between 300 and 1500 years of production at current rates. The USGS estimates that gas hydrates worldwide are more than 10 to 100 times as plentiful as US shale gas reserves. (IEA)

Electrification: A power shift to emerging economies



The need for electricity in emerging economies drives a 70% increase in worldwide demand, with renewables accounting for half of new global capacity

Figure 6.15 ▷ Power generating capacity additions by source in China and share of global additions in New Policies Scenario, 2012-2035



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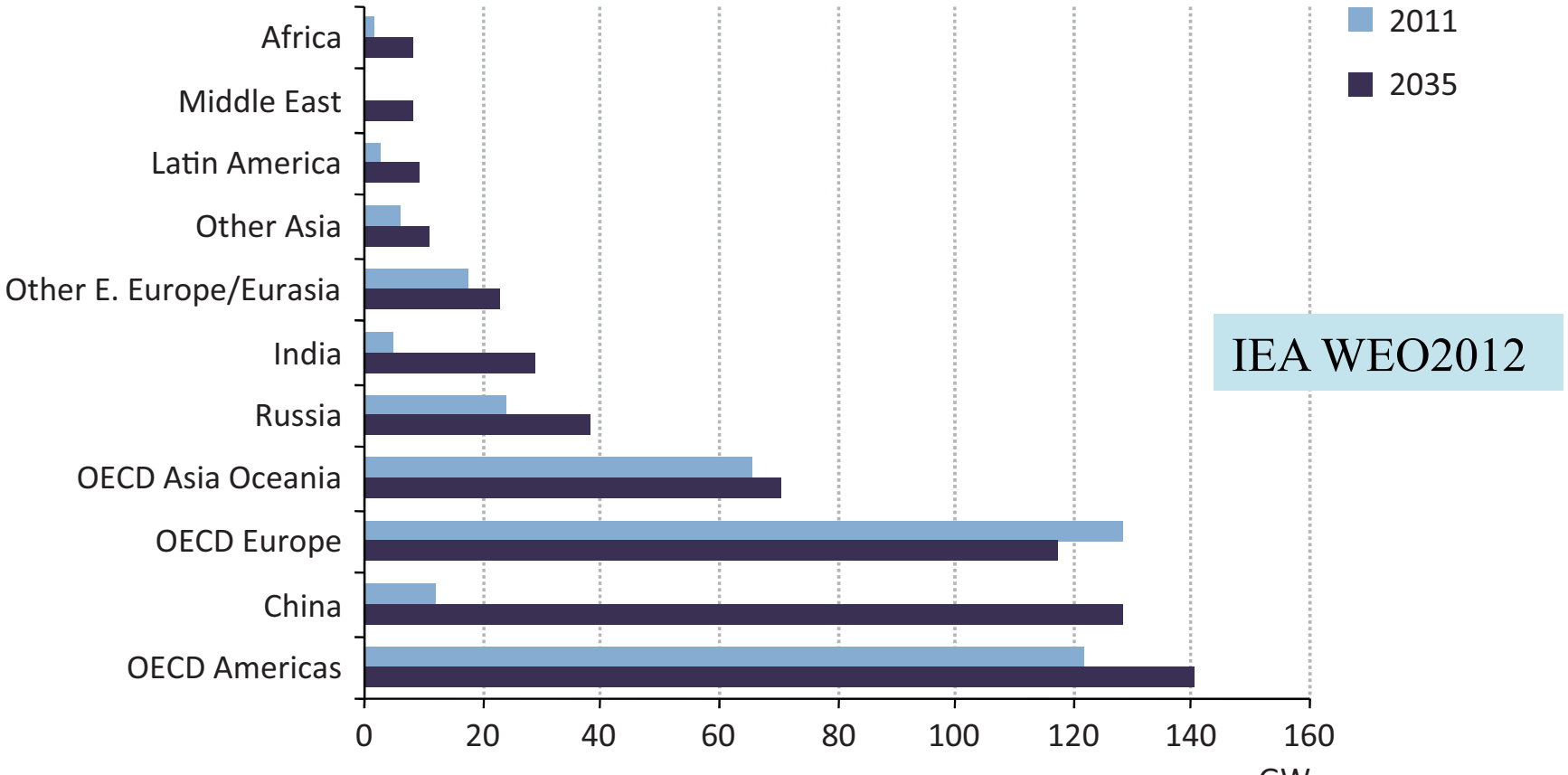
Nuclear Power will expand even after the Fukushima. Safety is the issue.

Figure 6.7 ▷ Nuclear power capacity by region in the New Policies Scenario



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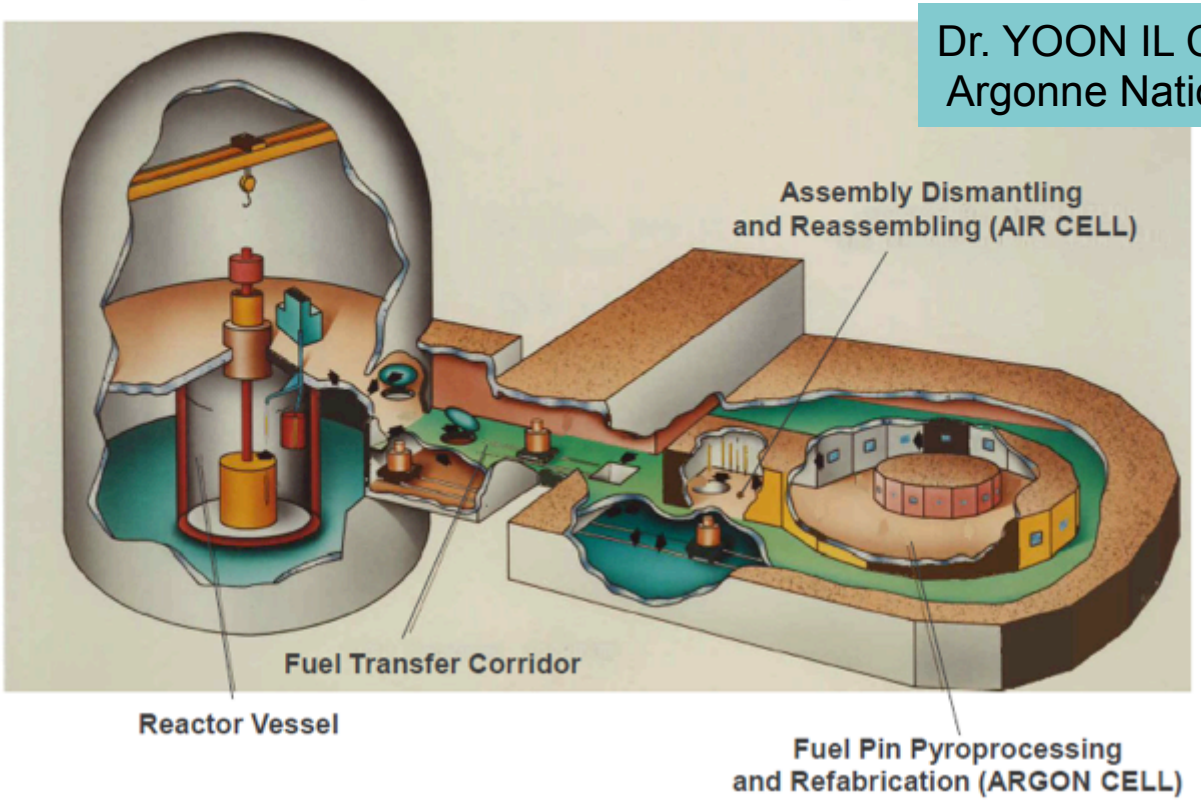
In aggregate, world nuclear capacity reaches 580GW in 2035, 50GW lower from 2011 WEO. Production rises from 2756TWh to 4370TWh, almost 60% increase, though the share in total generation falls from 13% to 12%.

Time for G4 Reactors: Integral Fast Reactor and Pyroprocessing

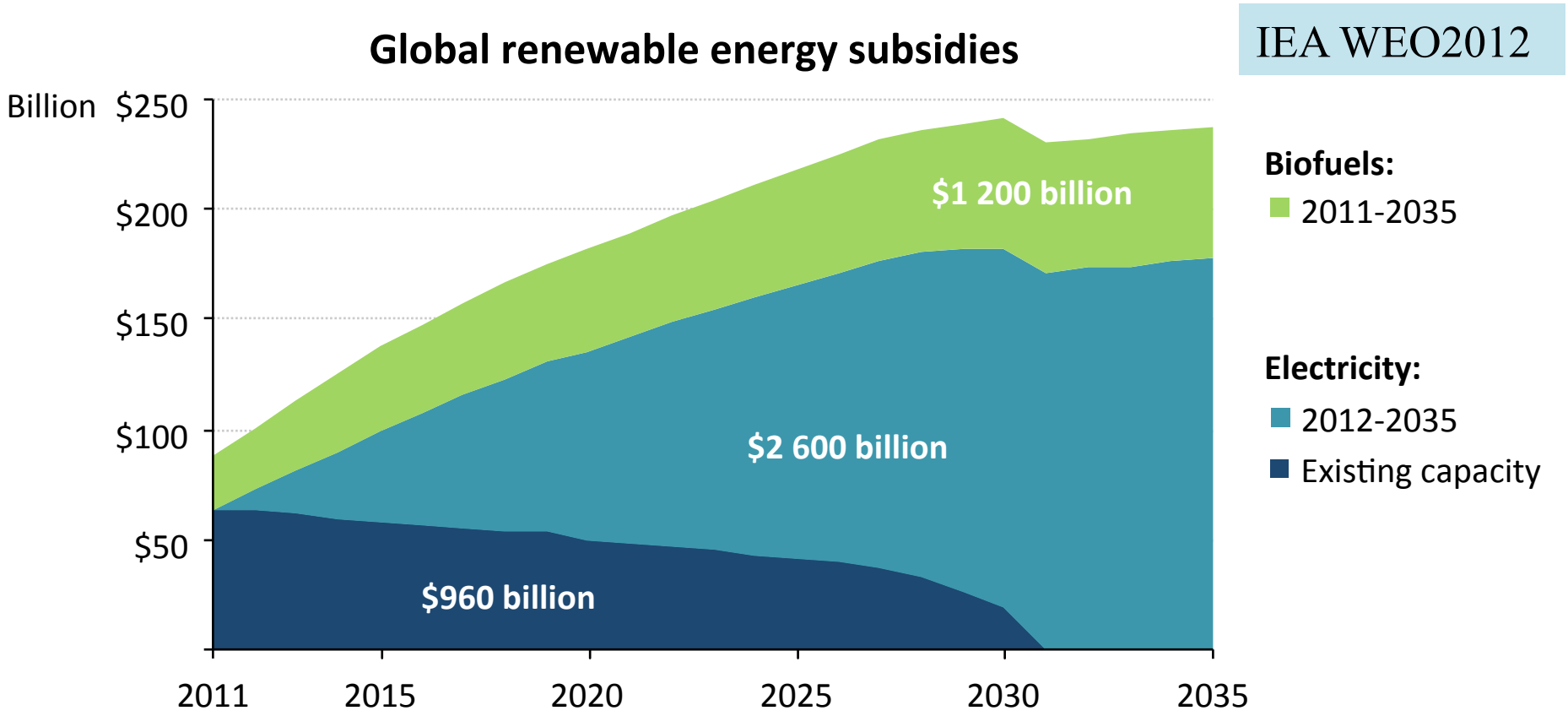
Pyroprocessing was used to demonstrate the EBR-II fuel cycle closure during 1964-69

Dr. YOON IL CHANG
Argonne National Laboratory



IFR has features as Inexhaustible Energy Supply ,Inherent Passive Safety ,Long-term Waste Management Solution , Proliferation-Resistance , Economic Fuel Cycle Closure.
High level waste reduces radioactivity in 300 years while LWR spent fuel takes 100,000 years.

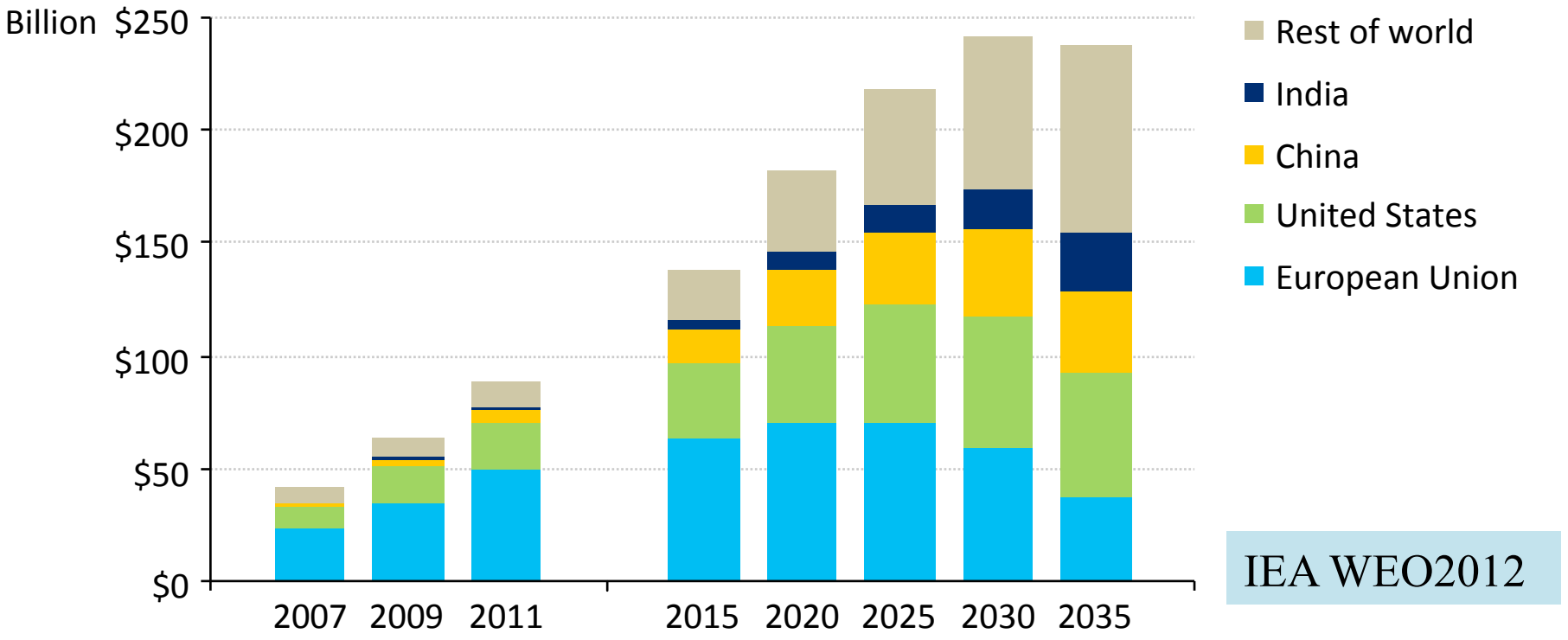
The multiple benefits of renewables come at a cost: Subsidy Lock-In



Renewable subsidies were $88 billion in 2011; over half the $4.8 trillion required to 2035 has been committed to existing projects or is needed to meet 2020 targets

Increasing subsidies for increasing renewables

Global renewable subsidies by region



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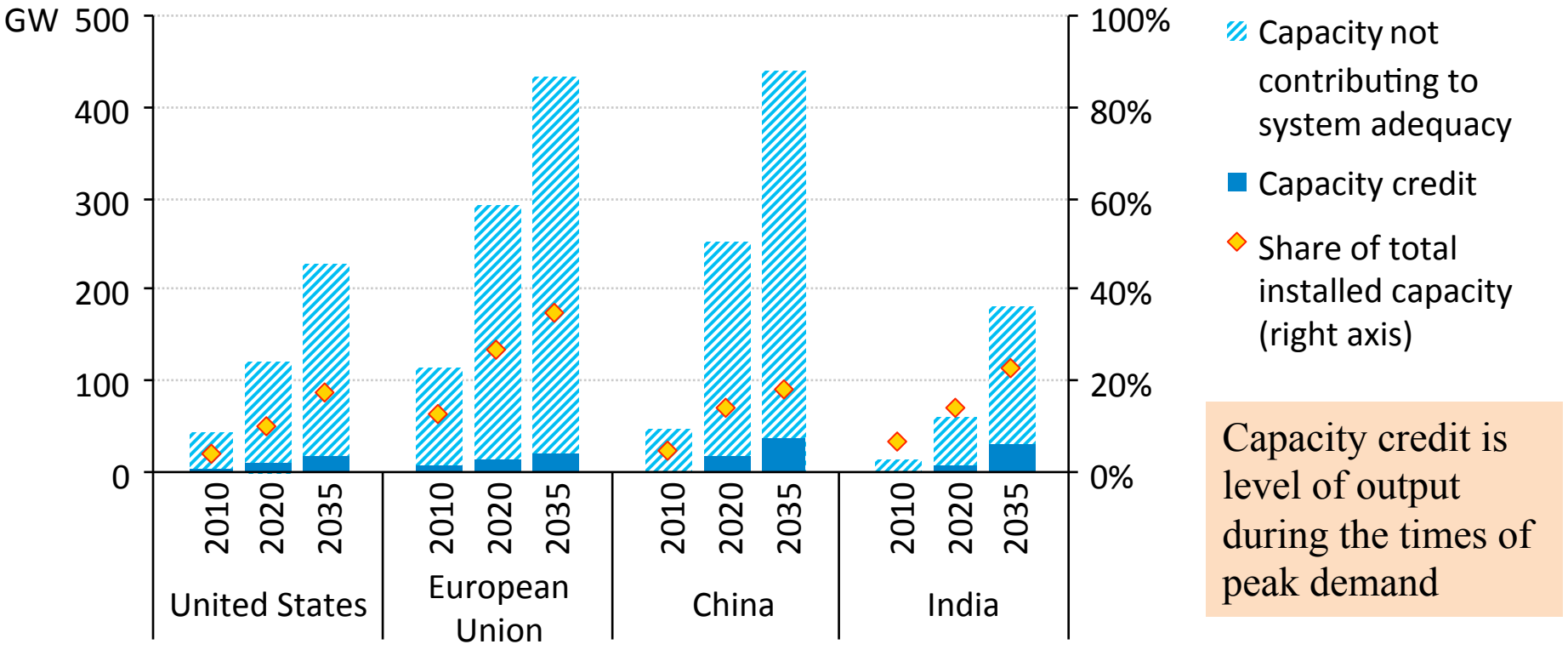
Despite falling unit costs, in 2011 renewables subsidies amounted to $88 billion, 24% higher than in 2010 & 6 times less than the $523 billion subsidies in fossil fuels

Increasing shares of renewables pose new challenges

Installed wind & solar PV capacity and their contribution to system adequacy



Capacity credit is level of output during the times of peak demand

Wind & solar are set to increase strongly, reaching almost one-fifth of global installed capacity in 2035, but their contribution to security of supply is limited

Wide variations in the price of power

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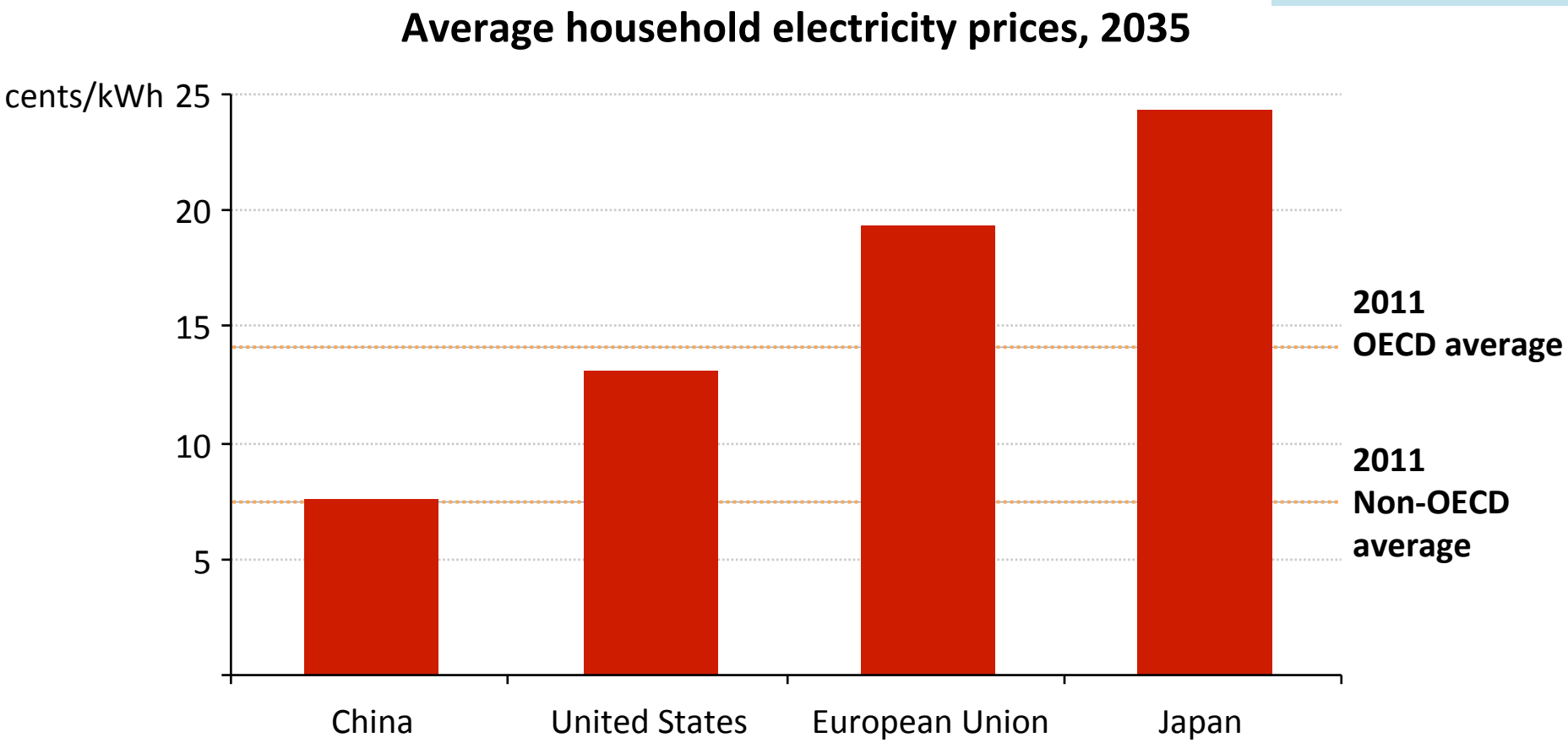
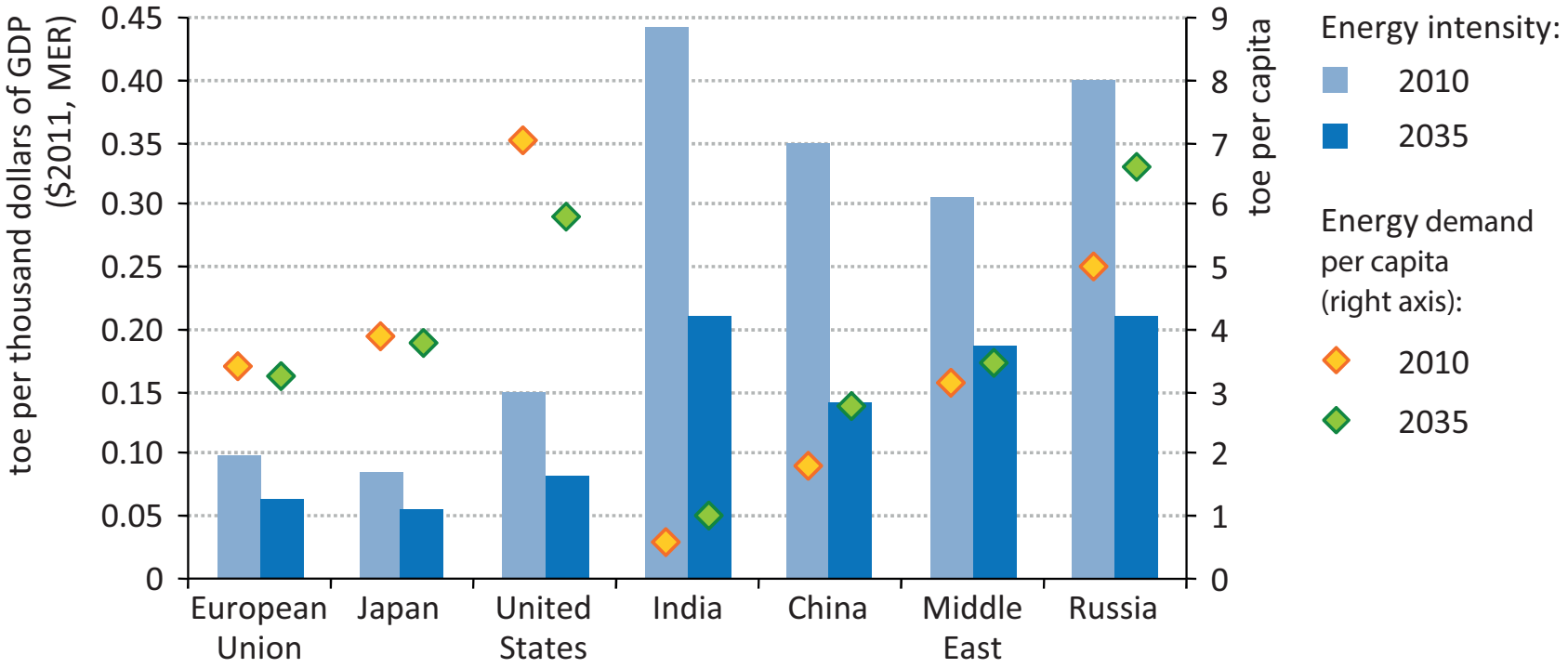


Electricity prices are set to increase with the highest prices persisting in the European Union & Japan, well above those in China & the United States

Growth Needs More Energy but Efficiently.

Figure 2.4 ▷ World primary energy demand per unit of GDP and per capita in the New Policies Scenario in selected regions and countries



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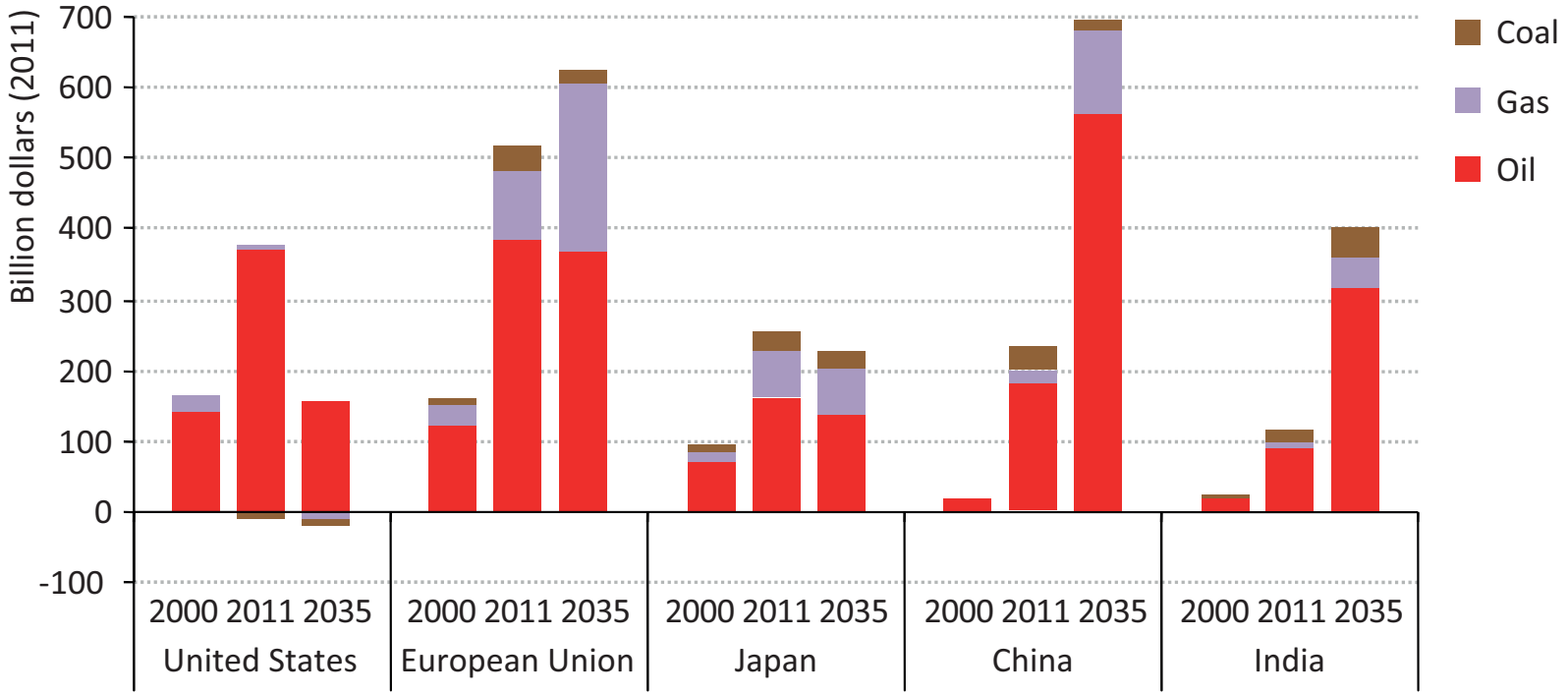
Fossil Fuel Import Burden

Figure 2.14 ▷ Spending on net imports of fossil fuels in the New Policies Scenario



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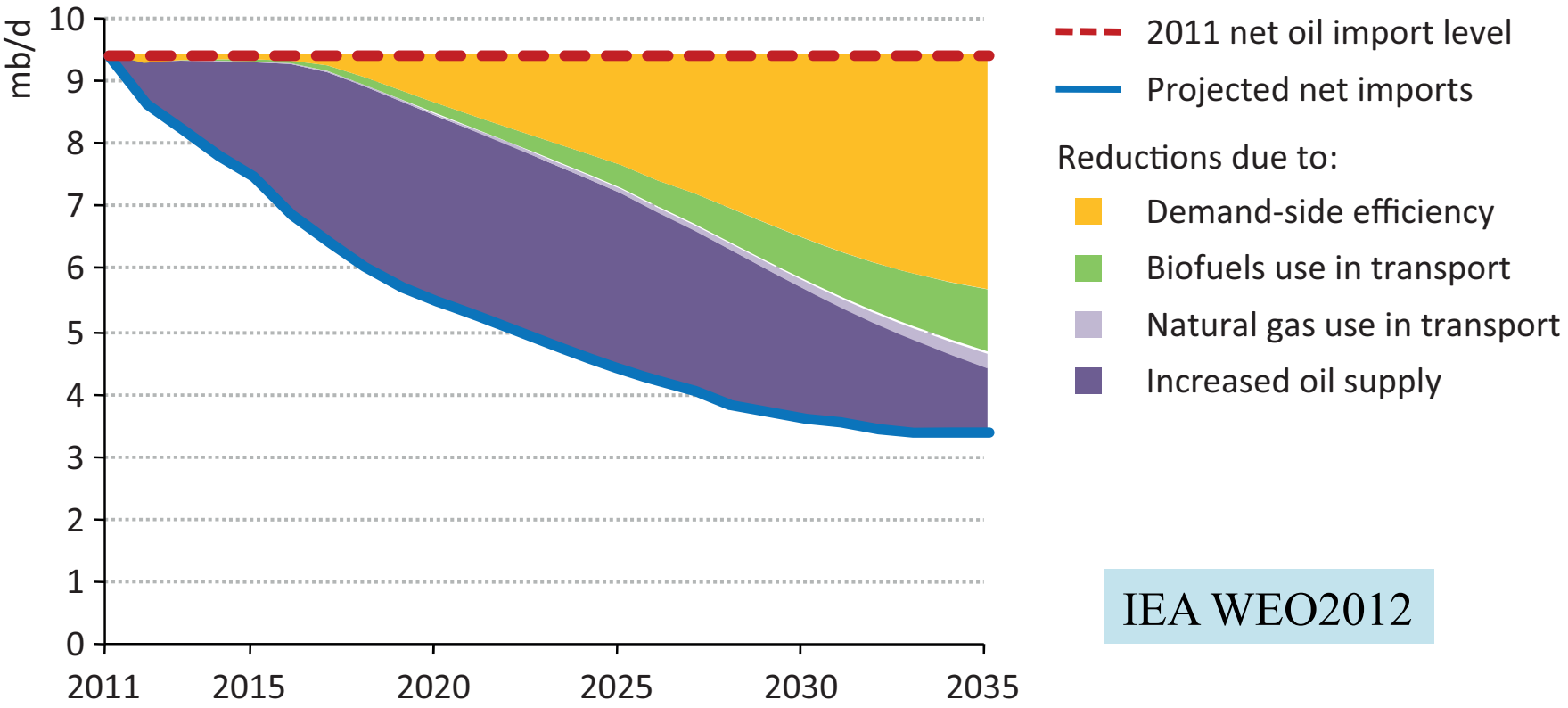
Energy Efficiency Makes the Difference. The Efficient World Scenario

Figure 2.17 ▷ Reductions in net oil imports in the United States by source in the New Policies Scenario



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A half of the US Energy Independence comes from Energy Efficiency

Cars Everywhere, but where will they go ?

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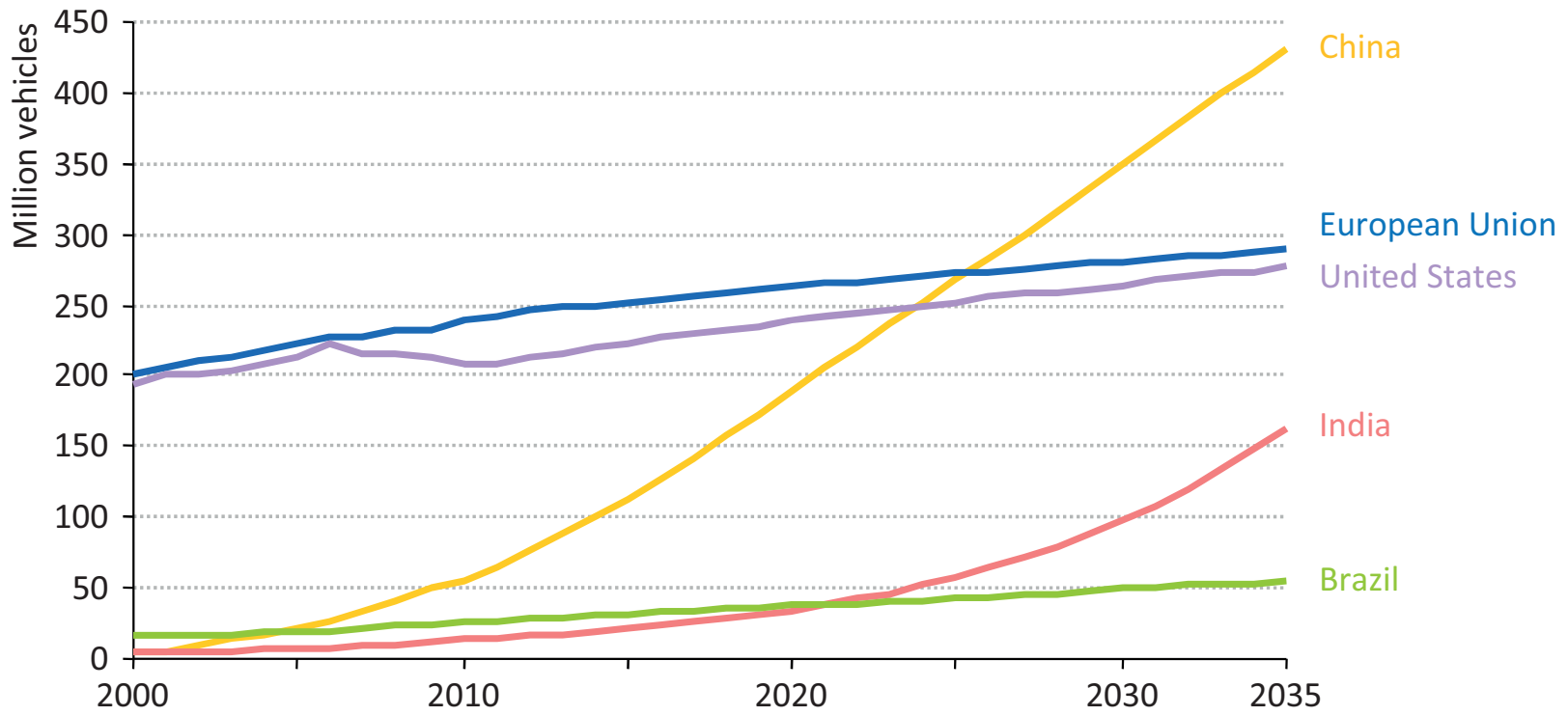
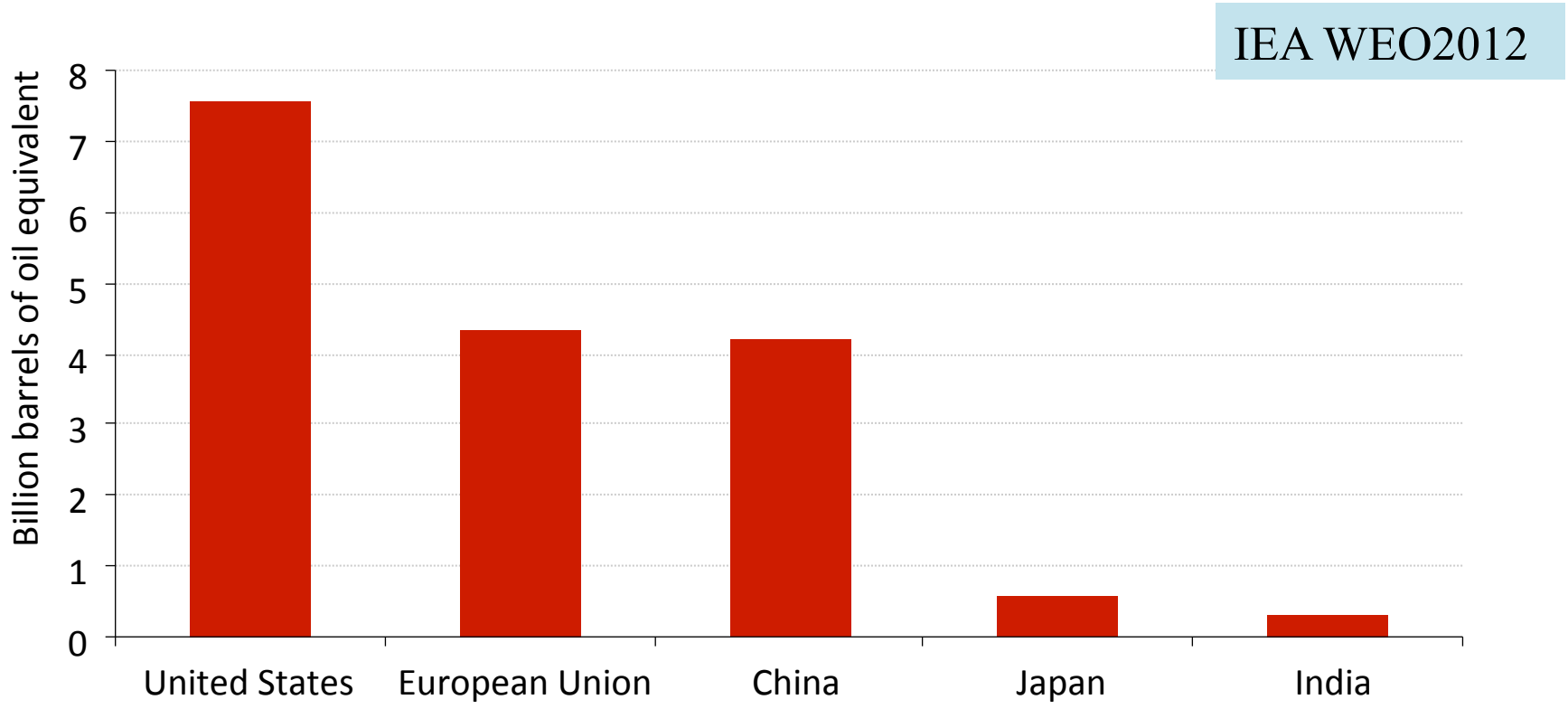
Figure 3.6 ▷ PLDV fleet in selected regions in the New Policies Scenario



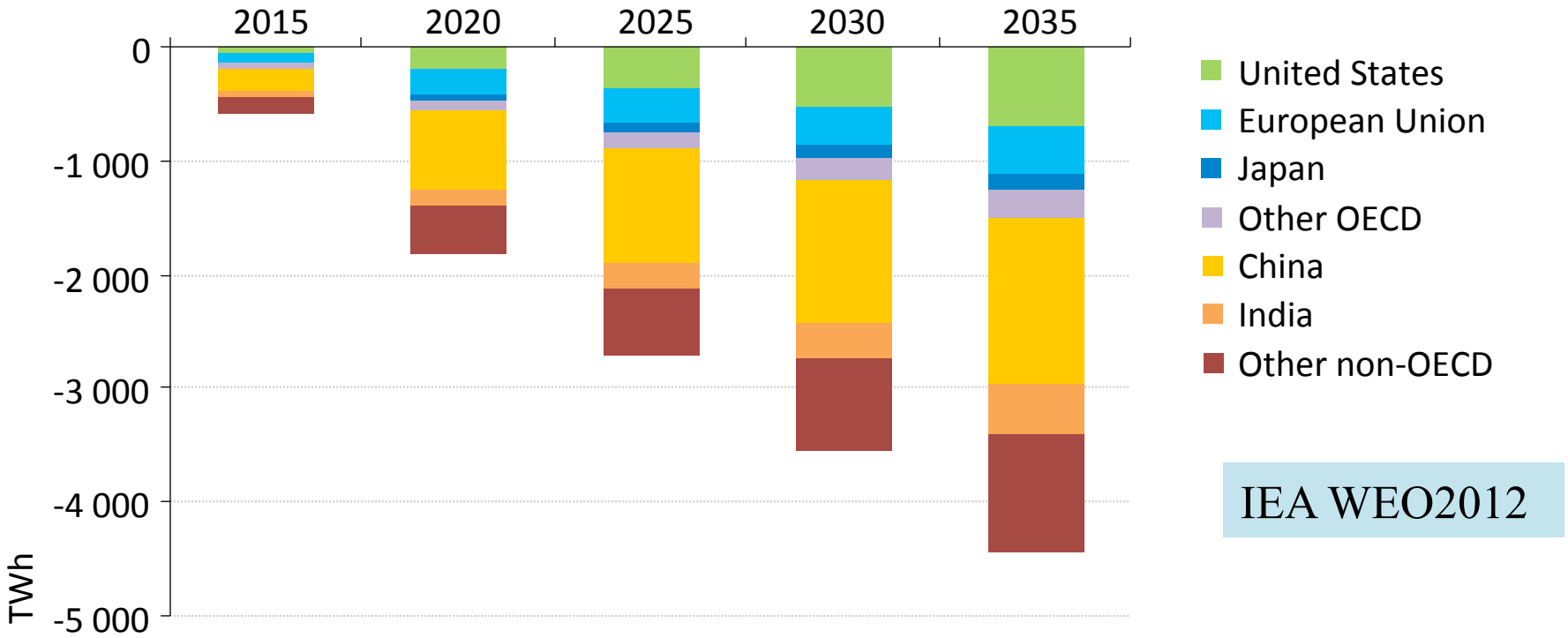
Cumulative oil savings from selected vehicle fuel-economy standards, 2010-2035



Already adopted & planned fuel-economy standards for passenger vehicles in the US, Japan, EU, China & India alone are set to save cumulatively 17 billion barrels of oil

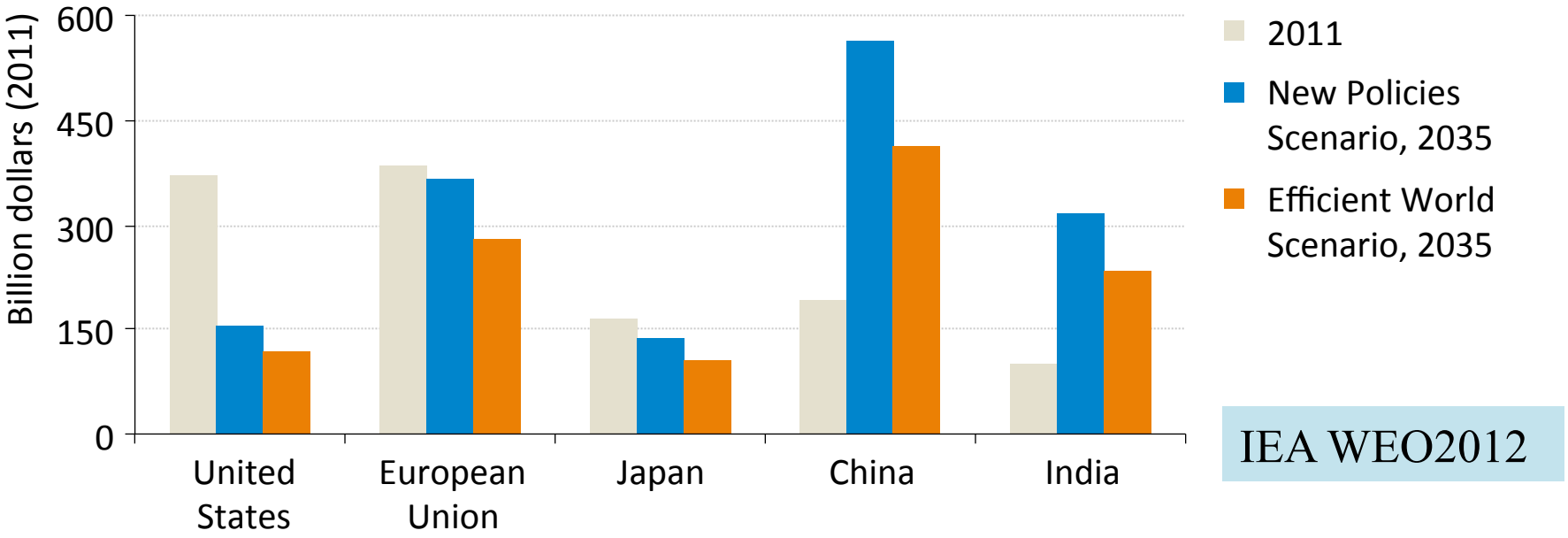
Reduction in electricity demand

The Efficient World Scenario relative to the New Policies Scenario



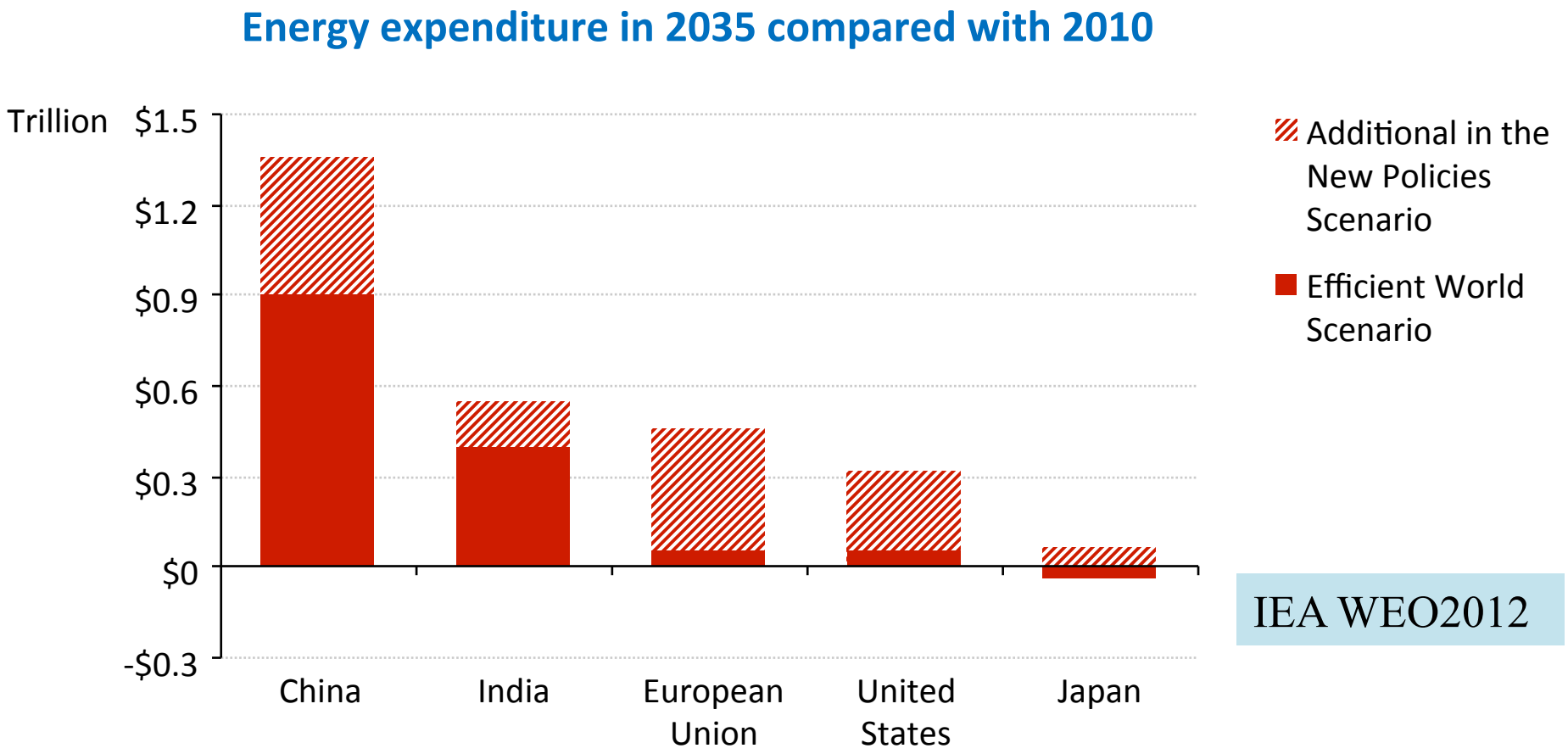
Electricity demand growth slows due to more efficient lighting, appliances, air-conditioning & motor systems & the more intelligent use through automation

Oil import bills in selected countries by scenario



Energy efficiency cuts fossil fuel import bills by $570 billion in the Efficient World Scenario. Almost 70% of these savings accrue from lower oil import bills.

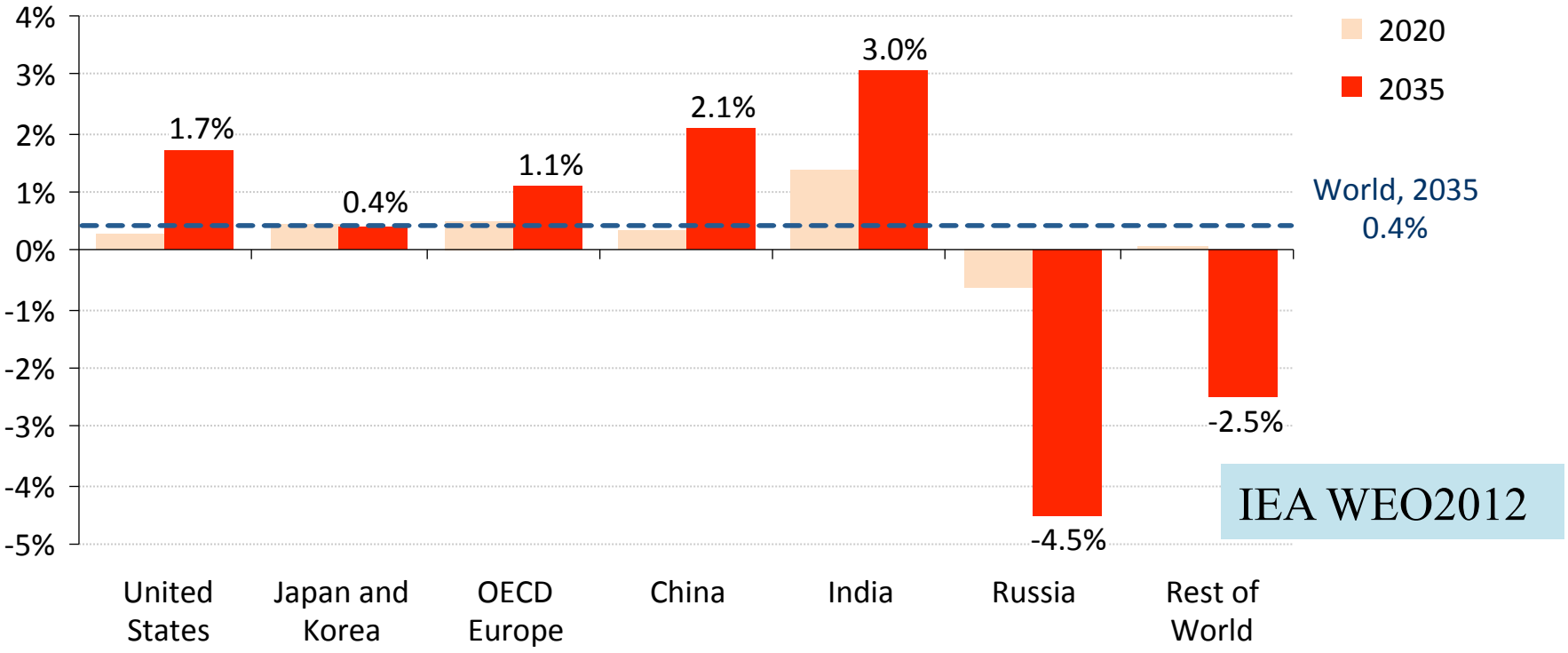
Energy efficiency brings economic gains



In addition to cutting energy expenditures by an average of 20%, improved efficiency brings wider economic gains, particularly for India, China, the United States & Europe

Change in real GDP

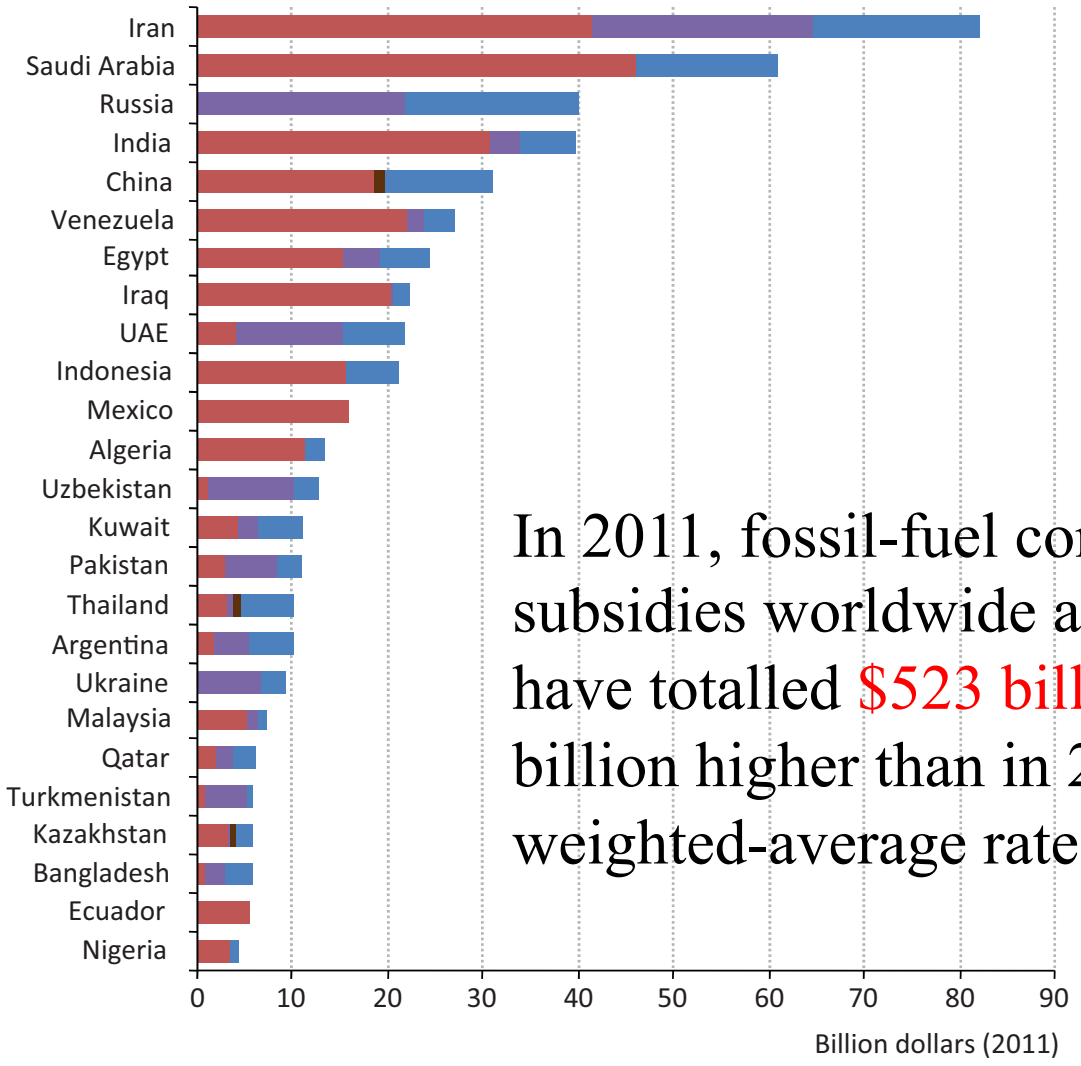
The Efficient World Scenario compared with the New Policies Scenario



Achieving the Efficient World Scenario would give a boost to the global economy of $18 trillion over the Outlook period. The impact differs across countries.

Fossil Fuel Consumption Subsidies

Figure 2.13 ▷ **Economic value of fossil-fuel consumption subsidies by fuel for top 25 countries, 2011**



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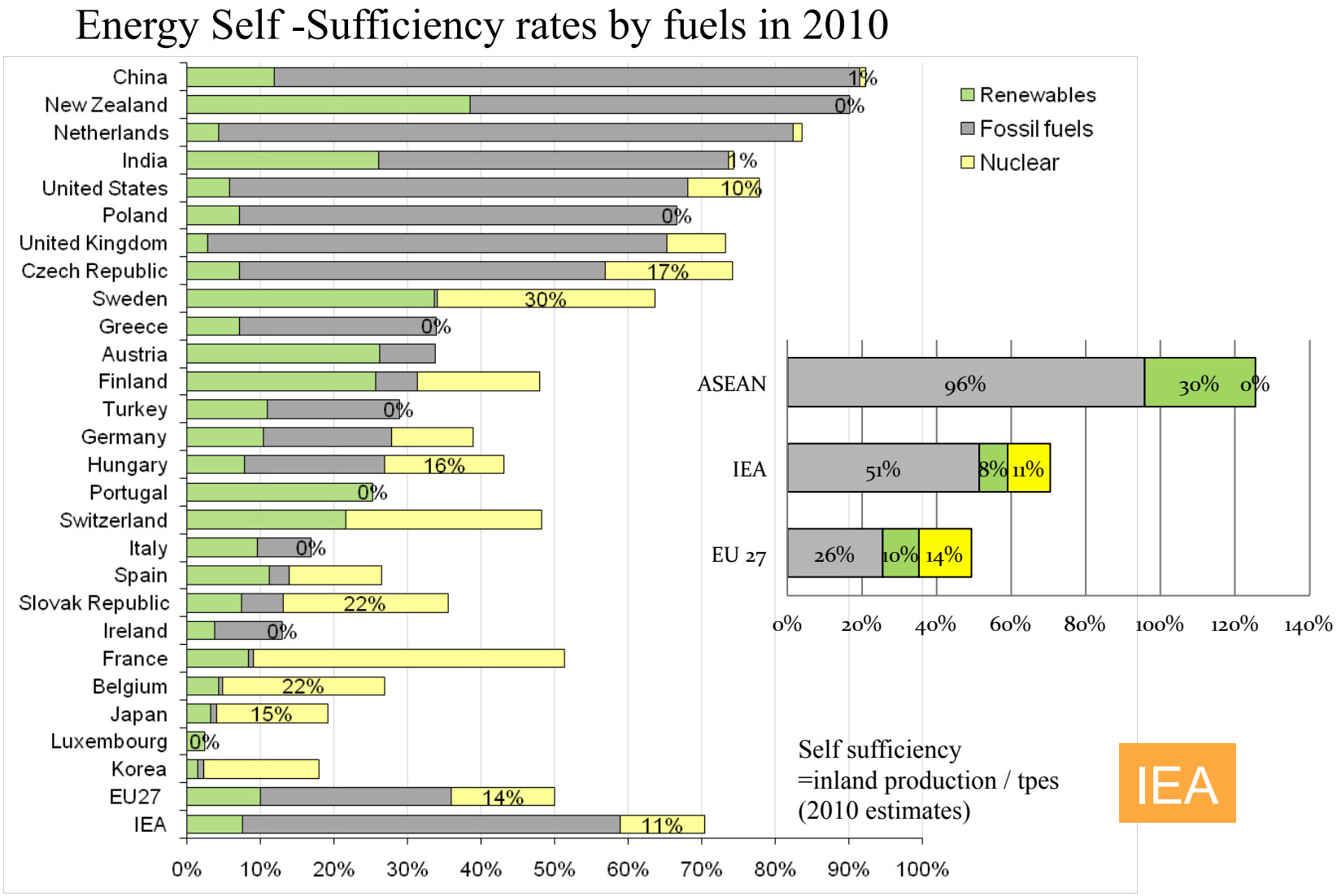
In 2011, fossil-fuel consumption subsidies worldwide are estimated to have totalled $523 billion, $111 billion higher than in 2010, at a weighted-average rate of 24%

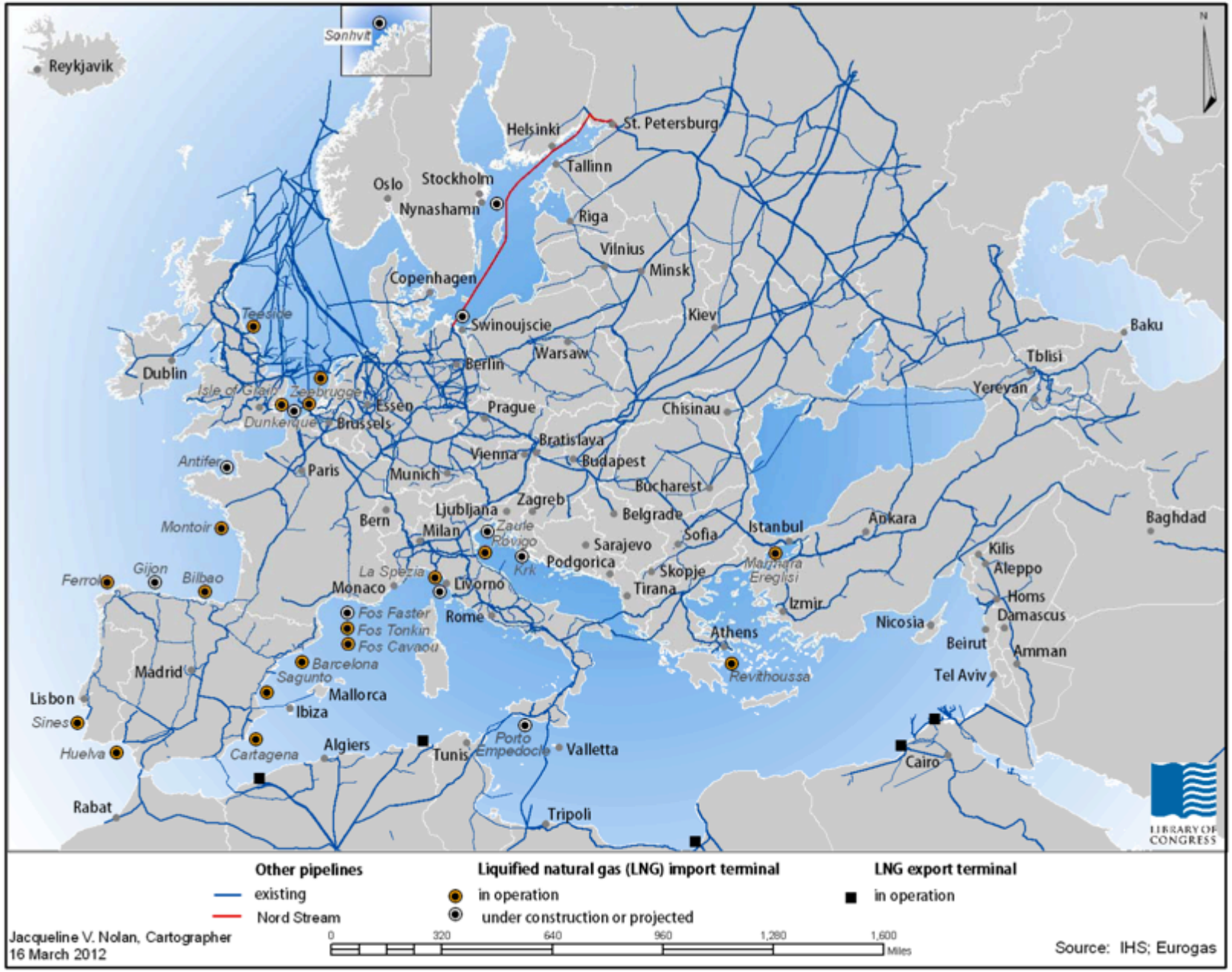
Diversity and Connectivity for Energy Security



Nuclear is an important option for countries with limited indigenous energy resources .

EU is aiming at Collective Energy Security by power grid and pipeline connections.

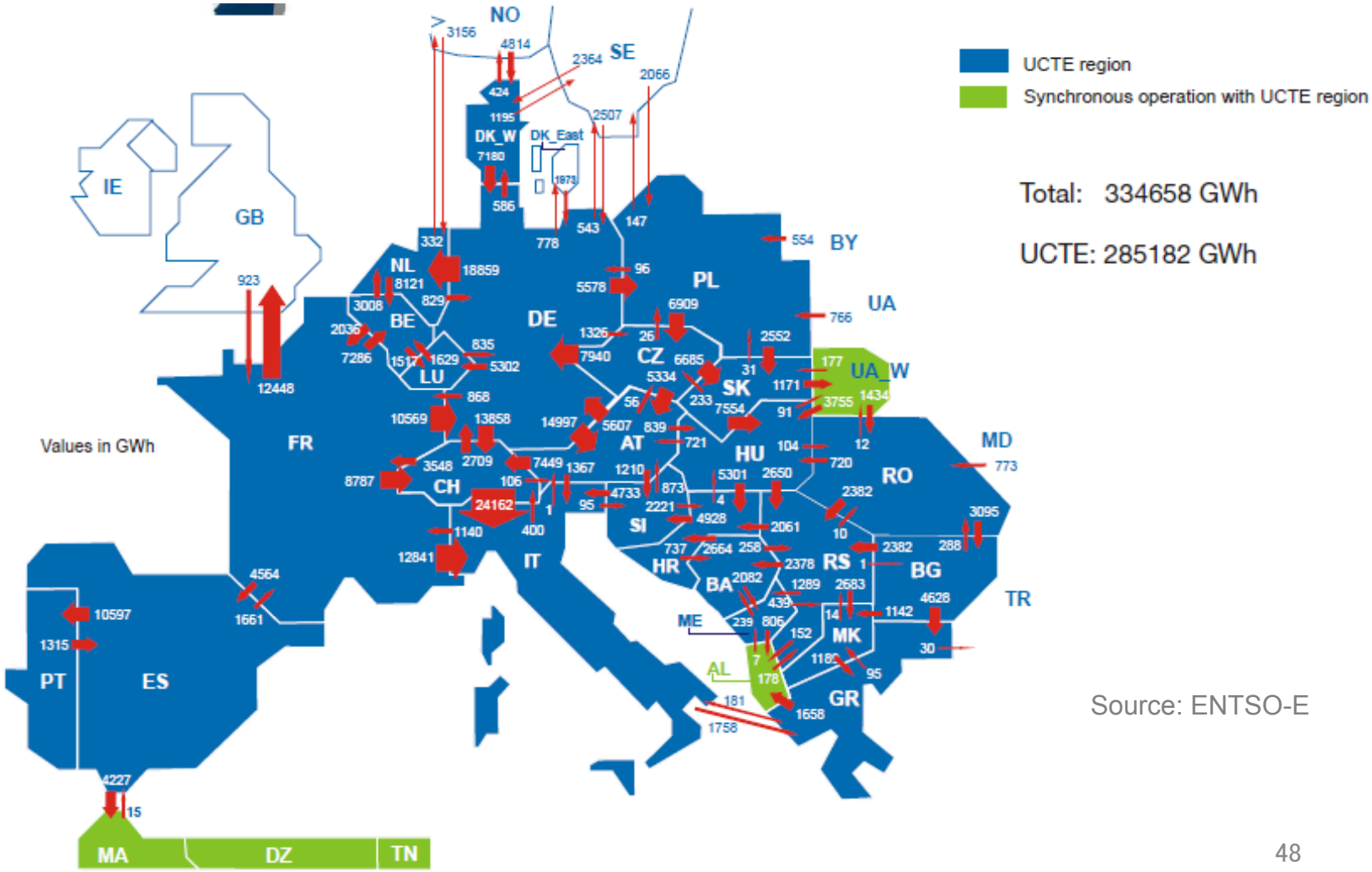
Select European Natural Gas Infrastructure



Source : US Congressional Research ▪July 11,2013

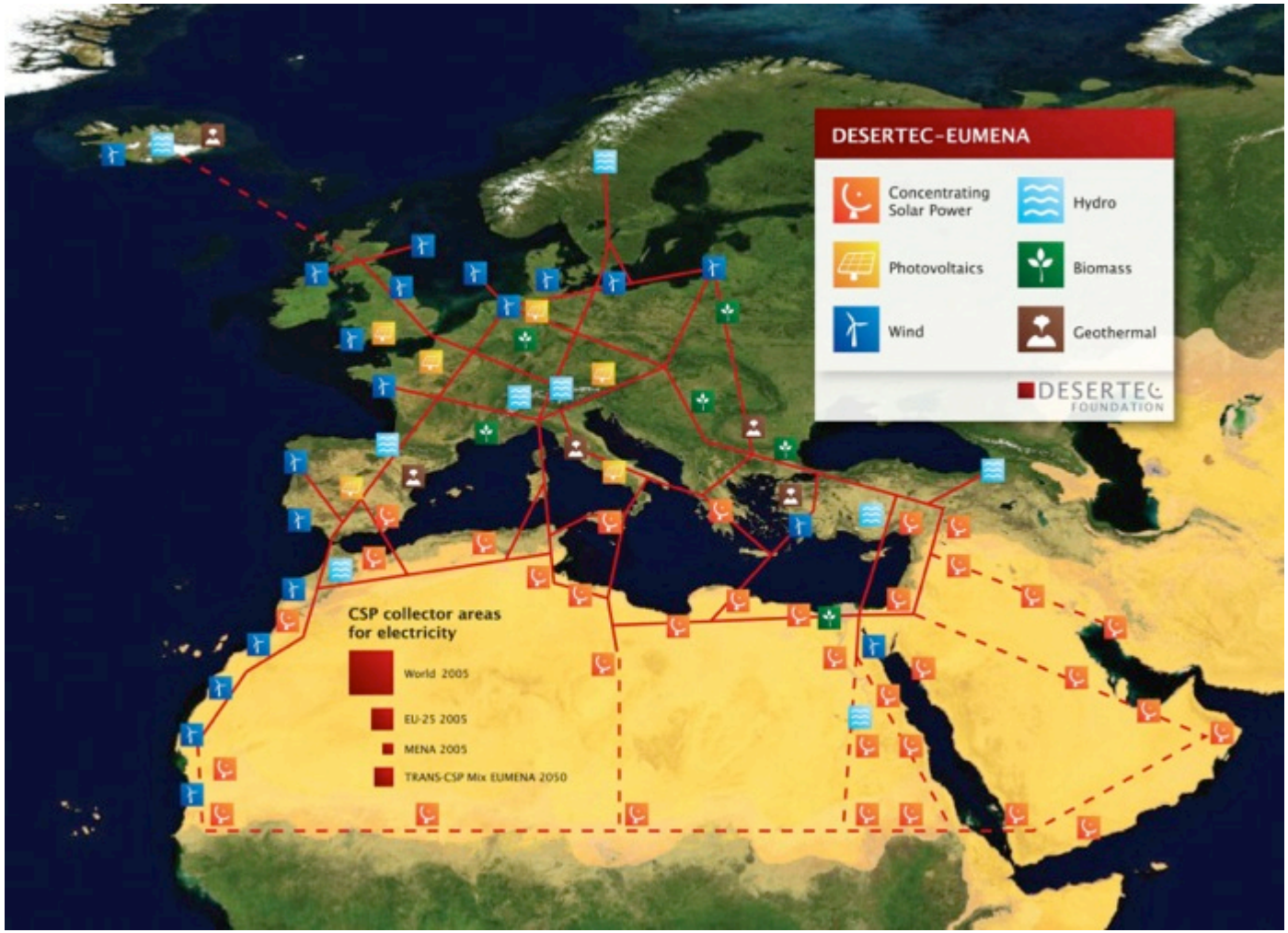
Power Grid Connection in Europe

Physical energy flows between European countries, 2008 (GWh)



Source: ENTSO-E

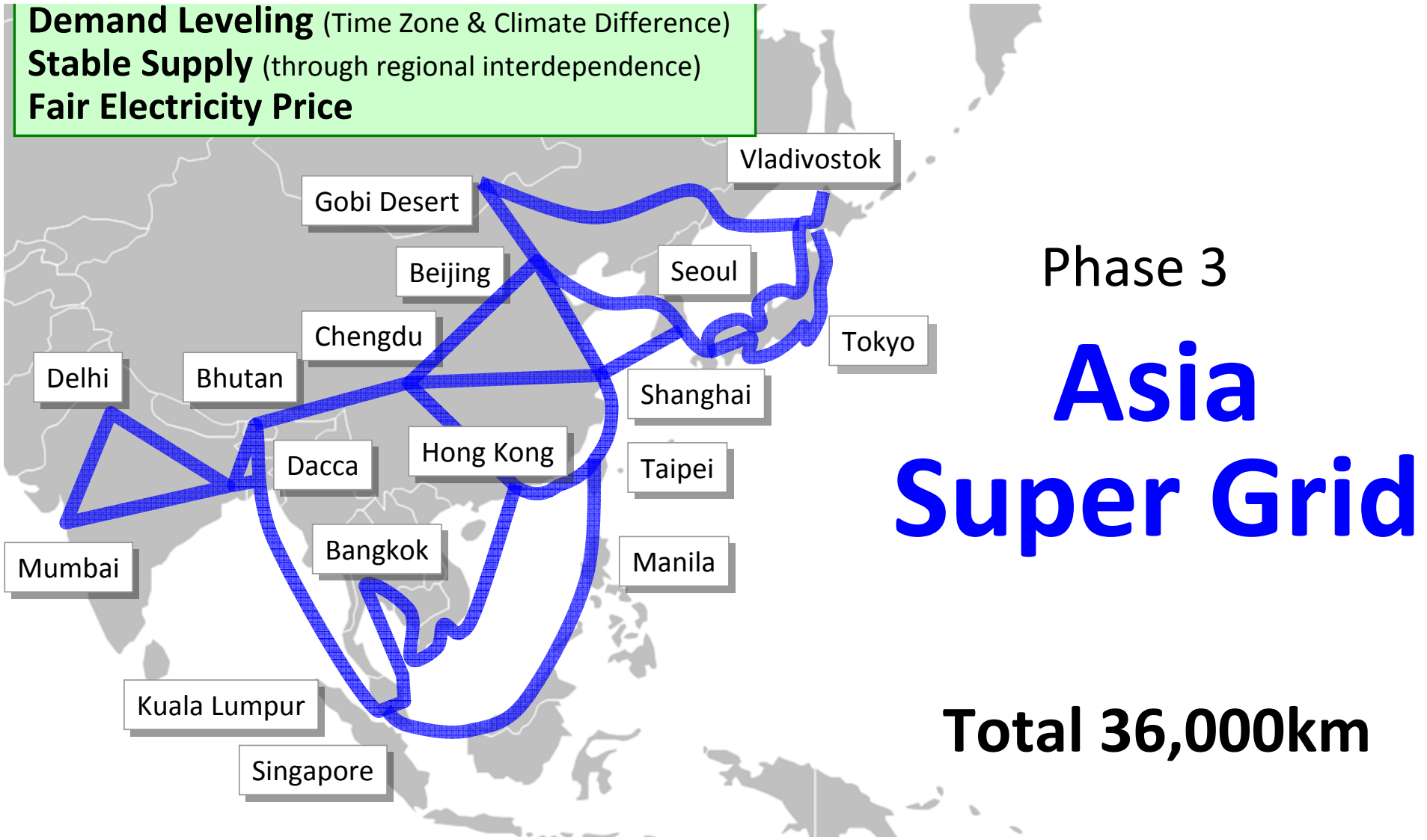
Connecting MENA and Europe: " Desertec" as visionary “Energy for Peace"



Source: DESRETEC Foundation

Blue Print for North East Asia Gas & Pipeline Infrastructure

Energy for Peace in Asia. A New Asian Vision?



Presentation by Mr. Masayoshi SON

Conclusions

Comprehensive Energy Security Policies for Asia

- The Shale Gas Revolution changes the global energy market. Golden Age of Natural Gas will come with golden rules including sustainability requirements and a new pricing formula. Russia remains as a key player with pipelines. LNG exports from North America including Alaska may be a game-changer.
- Energy Security for the 21st Century must be Collective and Comprehensive Electricity Supply Security under sustainability constraints. EU`s connectivity approach can be a model especially for Asia. Contingency Plan is needed for imminent Iranian Crisis. China and India should join the IEA. Need for the North East Asian Energy Security Forum
- Energy Efficiency and Demand side measures are key for China and India. Fossil fuel subsidies be eliminated gradually.
- Nuclear Power will continue to play a major role in the world. Japan's role after Fukushima is to share the lessons learned for safer Nuclear Power deployment in Asia and elsewhere.
- For Coal and to a lesser extent for Gas to remain the backbone of power supply, CCS readiness & highly efficient power plants are needed.
- New technologies help; Hydrogen economy, Methane-hydrate , Super-conductivity grid., EVs, Smart Grids, Storage, 4G Reactors like Integral Fast Reactor, etc.