



The Shale Revolution and Energy Security: What did we learn from the Oil Shock?

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Columbia University, New York

Nobuo TANAKA

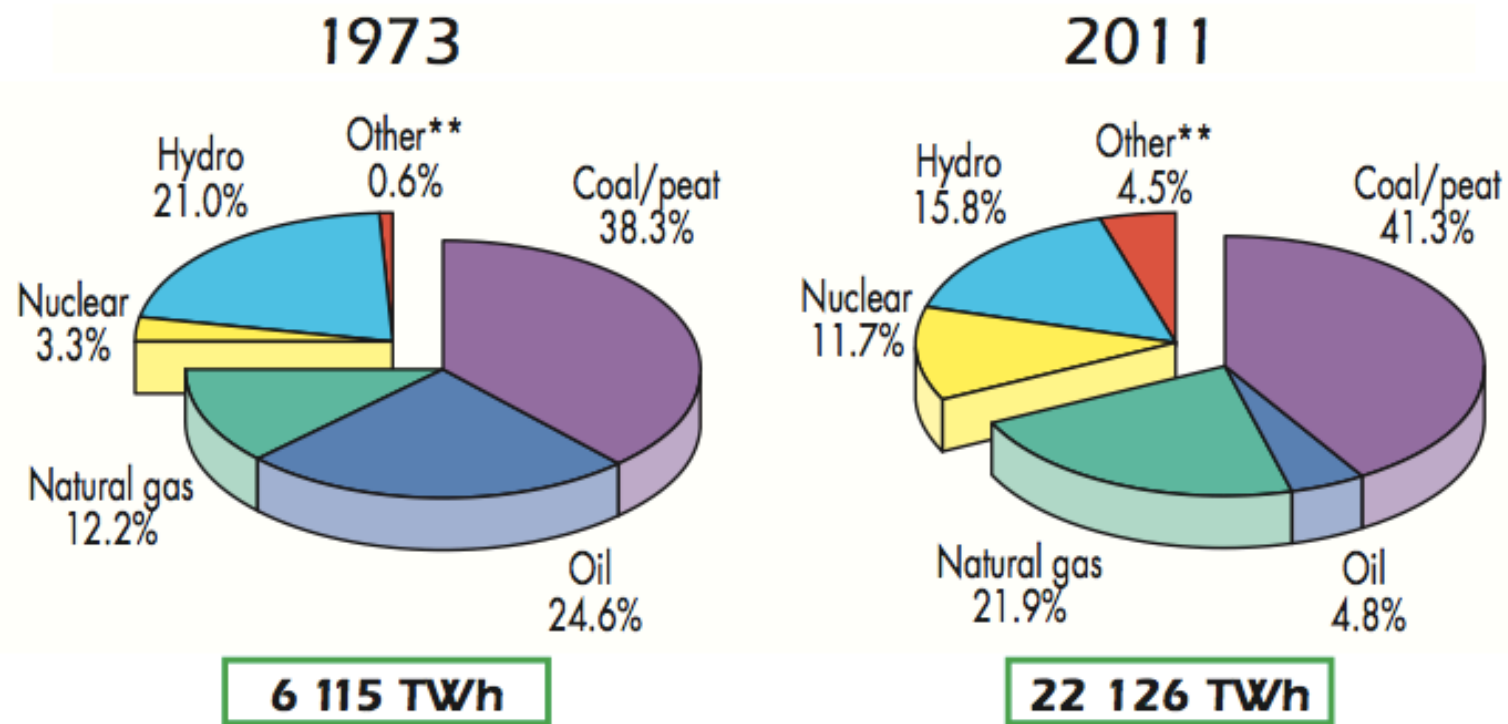
*Distinguished Fellow, Center on Global Energy Policy, SIPA,
Columbia University*

Former Executive Director of the IEA

Global Associate of Energy Security and Sustainability, IEEJ

The World moves away from oil since the oil shock.

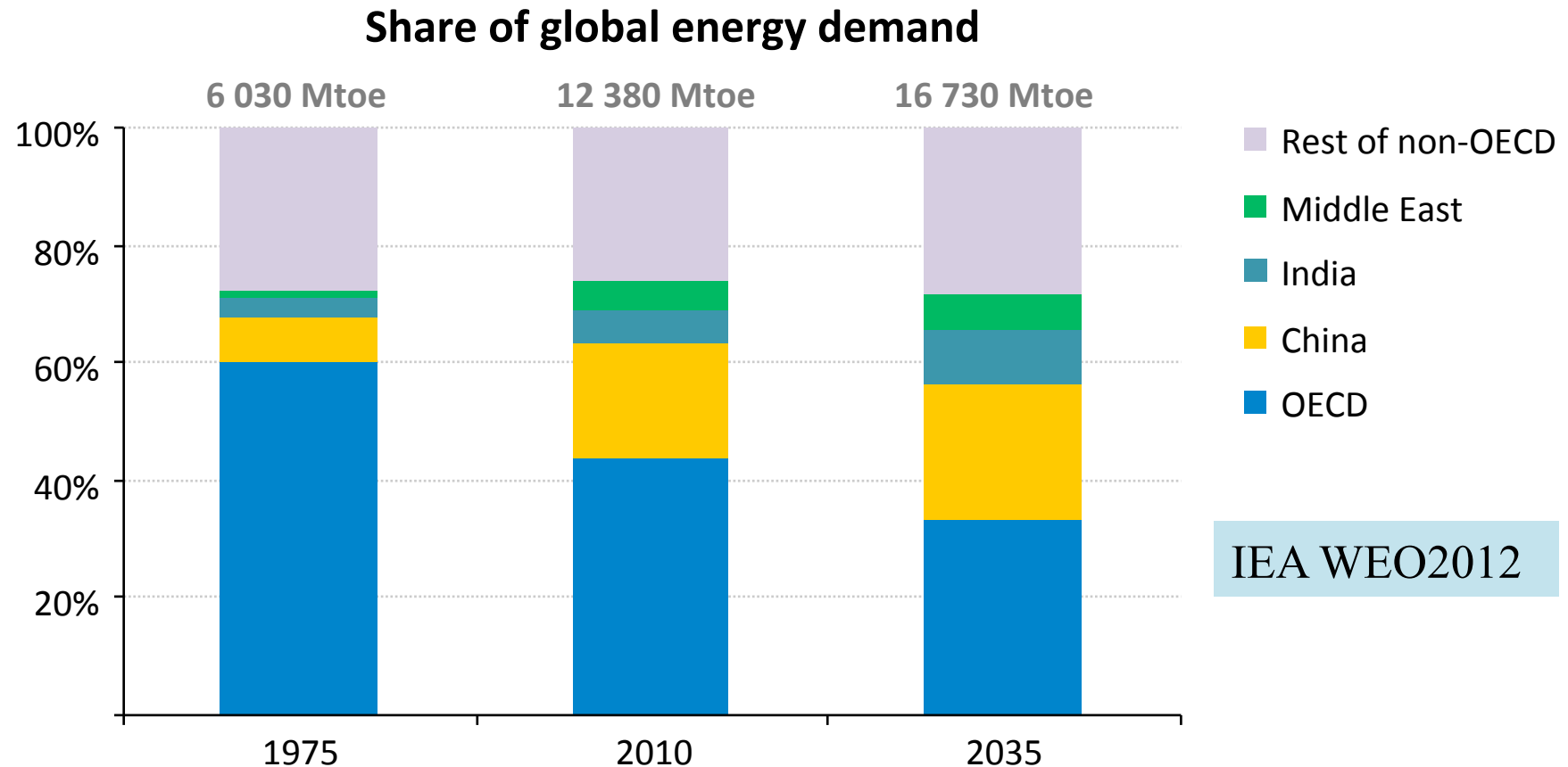
1973 and 2011 fuel shares of electricity generation*



*Excludes pumped storage.

**Other includes geothermal, solar, wind, biofuels and waste, and heat.

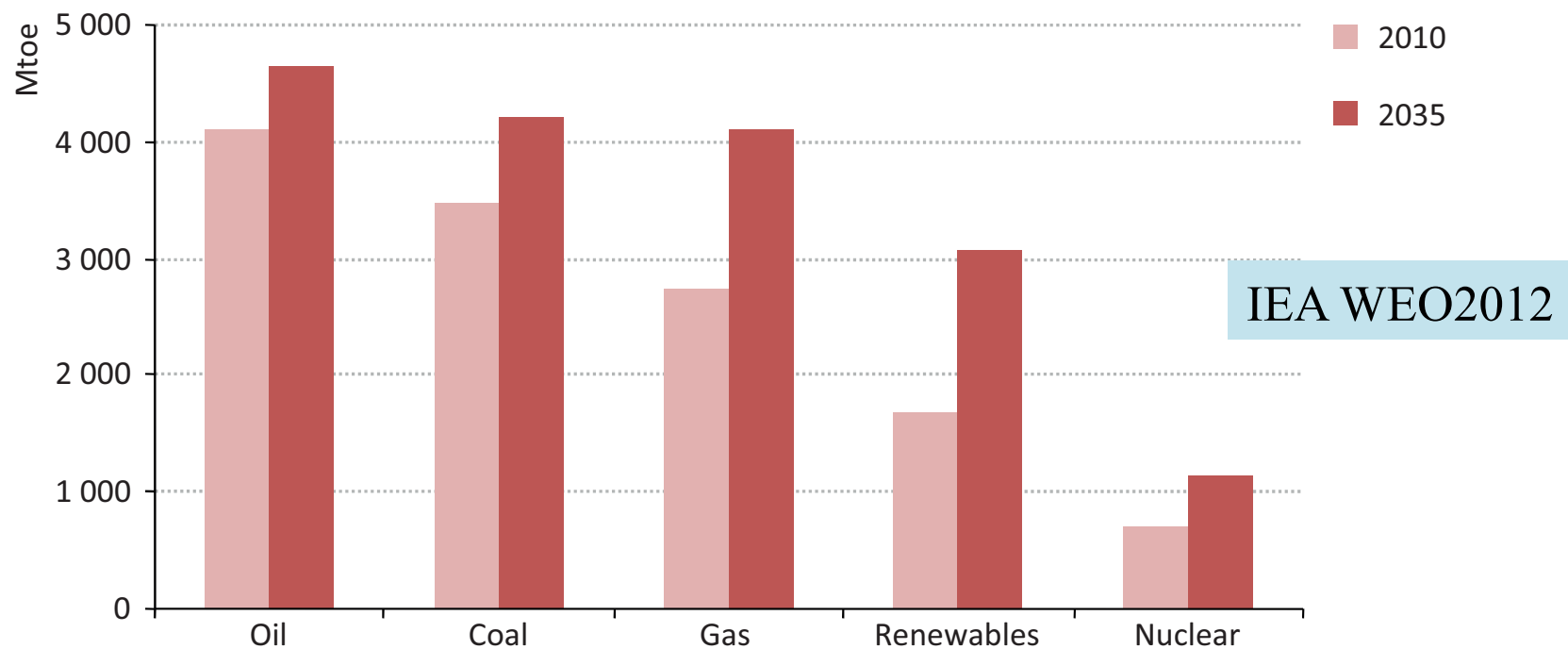
Emerging economies steer energy markets



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.

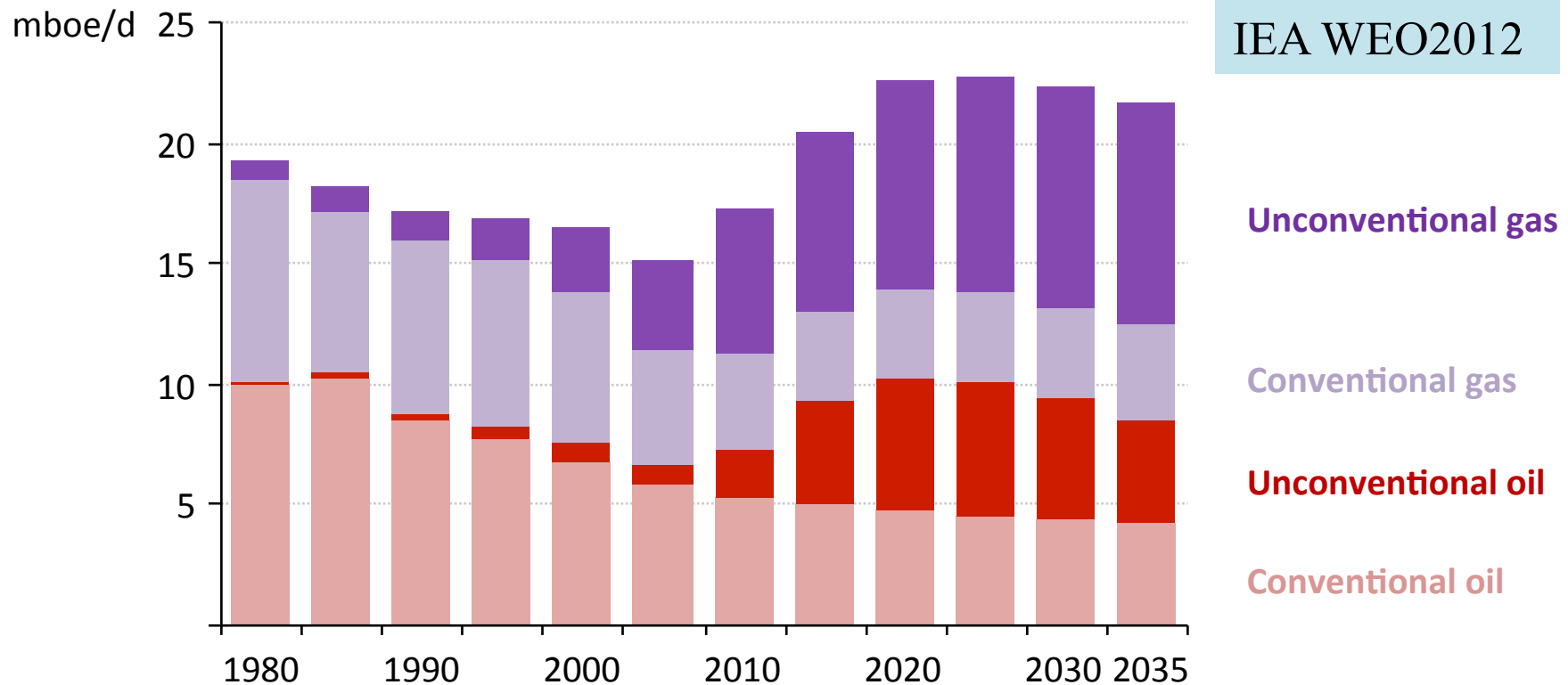
Figure 2.3 ▶ World primary energy demand by fuel in the New Policies Scenario



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.

A United States oil & gas transformation

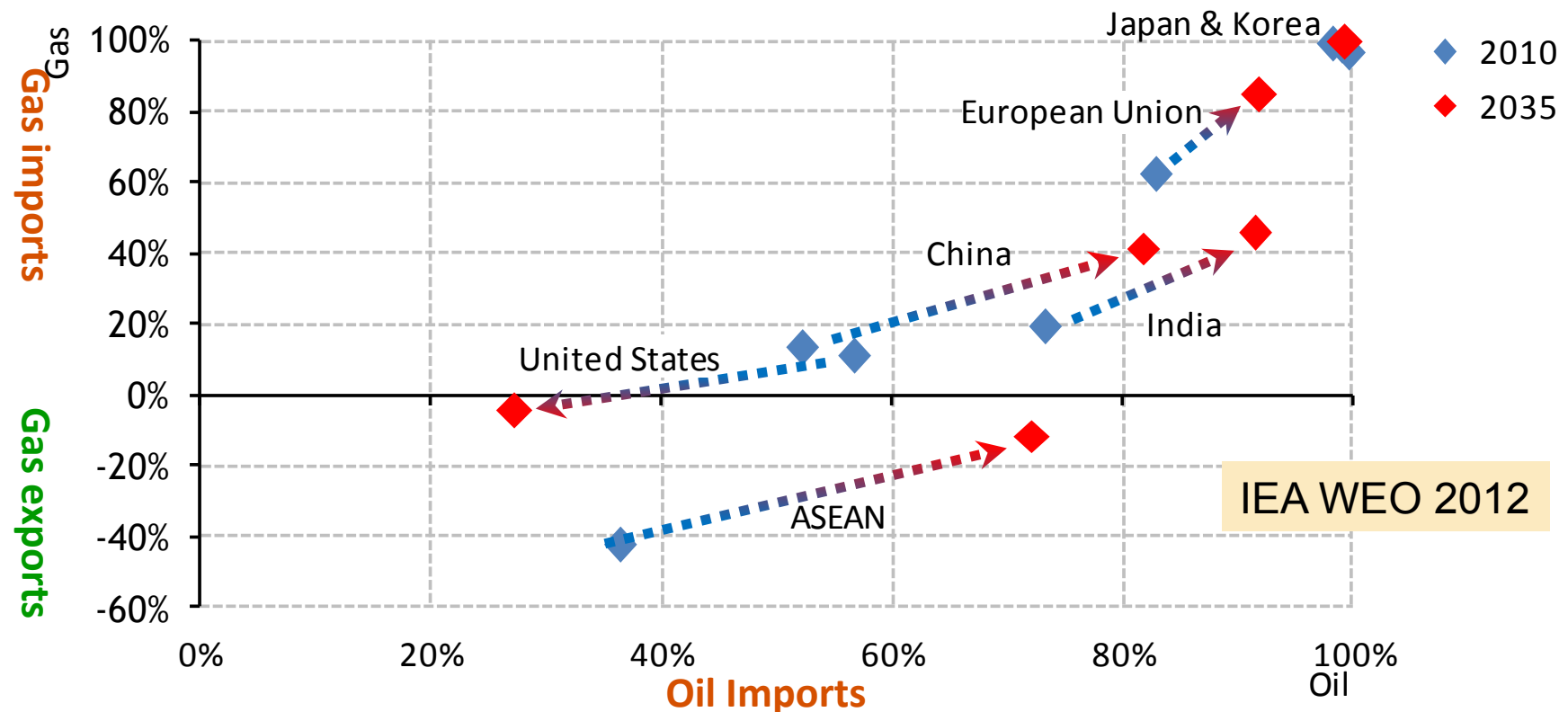
US oil and gas production



The surge in unconventional oil & gas production has implications well beyond the United States

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

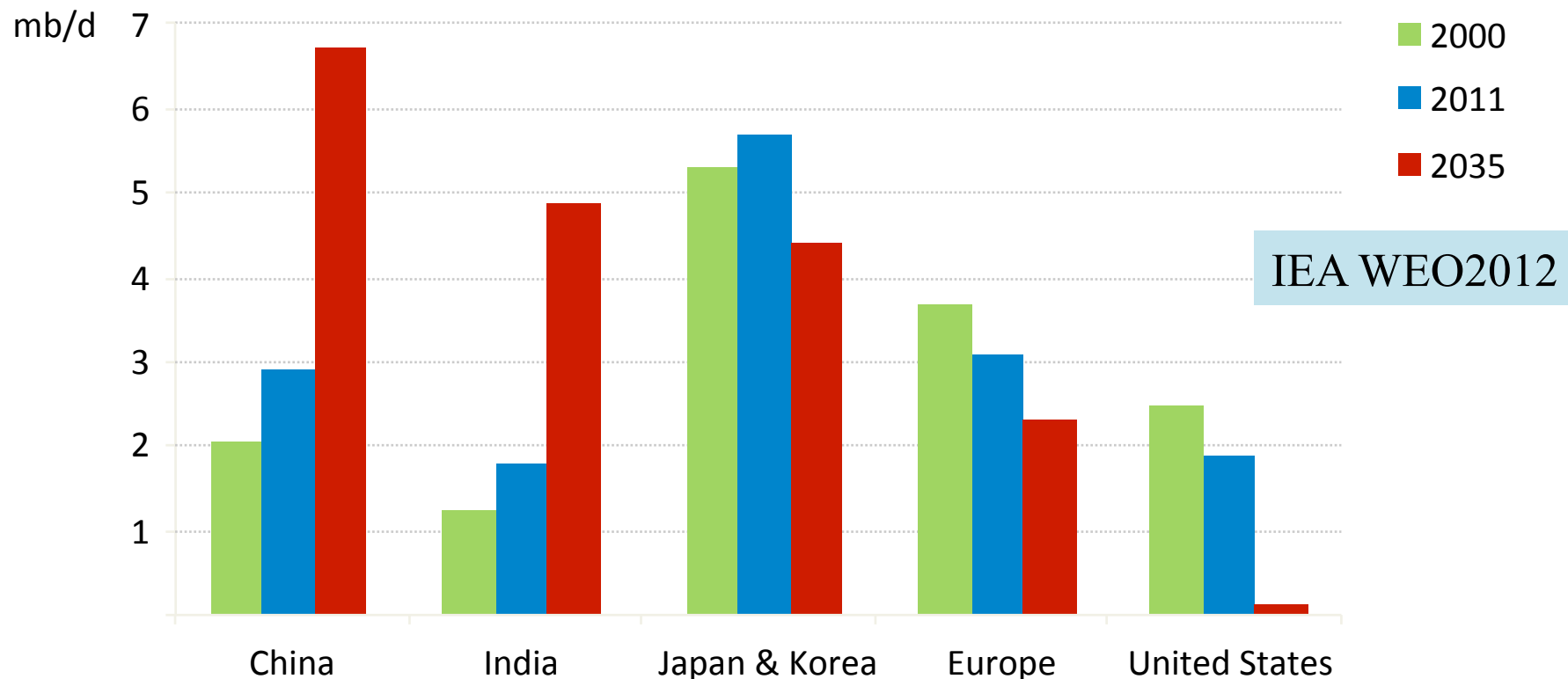
Net oil & gas import dependency in selected countries



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

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

Blockage of the Strait of Hormuz may push Japan into the Economic Death Spiral.



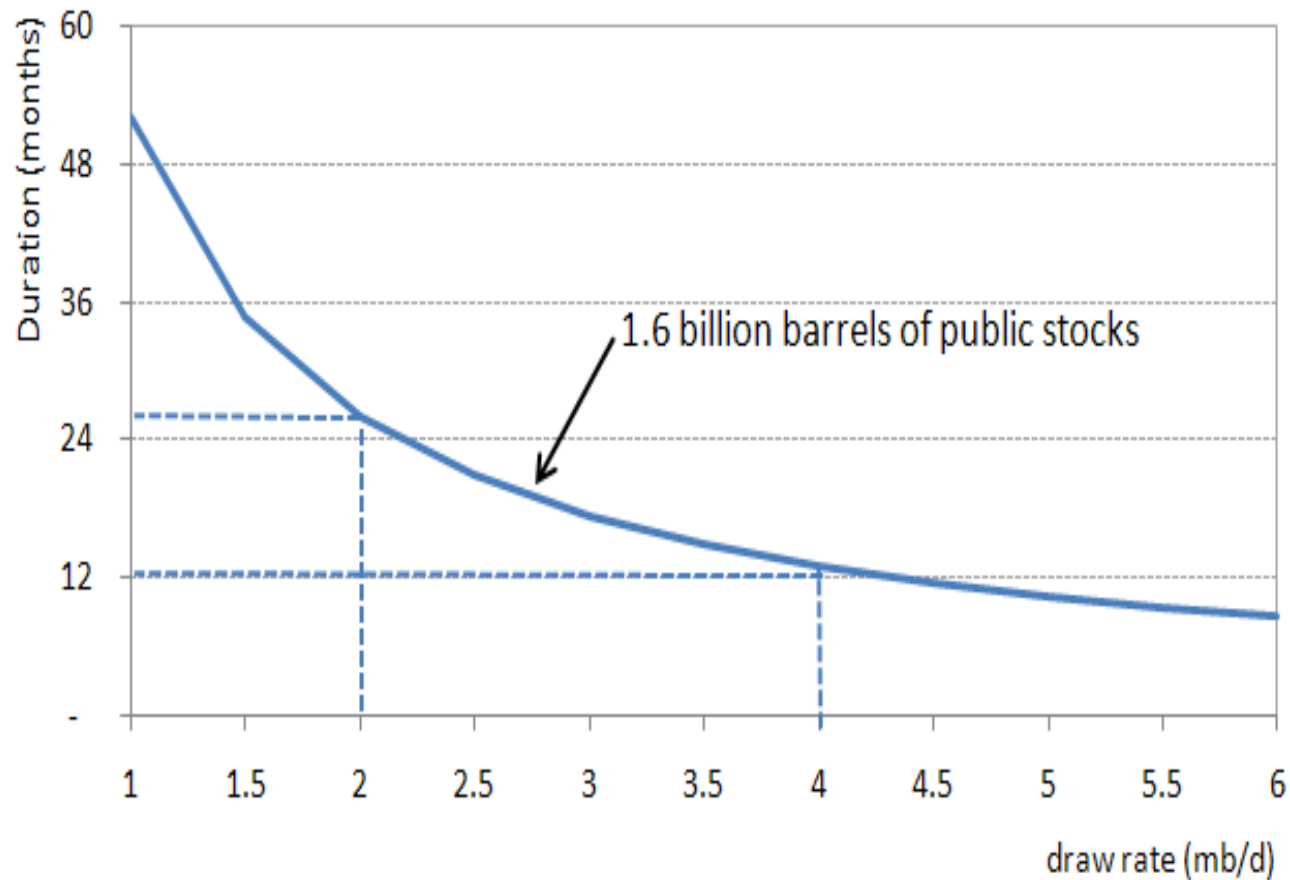
85% of Japanese oil import
20% of Japanese LNG import
But if no nuclear reactors are running,,,,,,?

17 mbd of petroleum
(20% of global demand
& 42% of trade)

82 million tons of LNG pa
(30% of global demand)

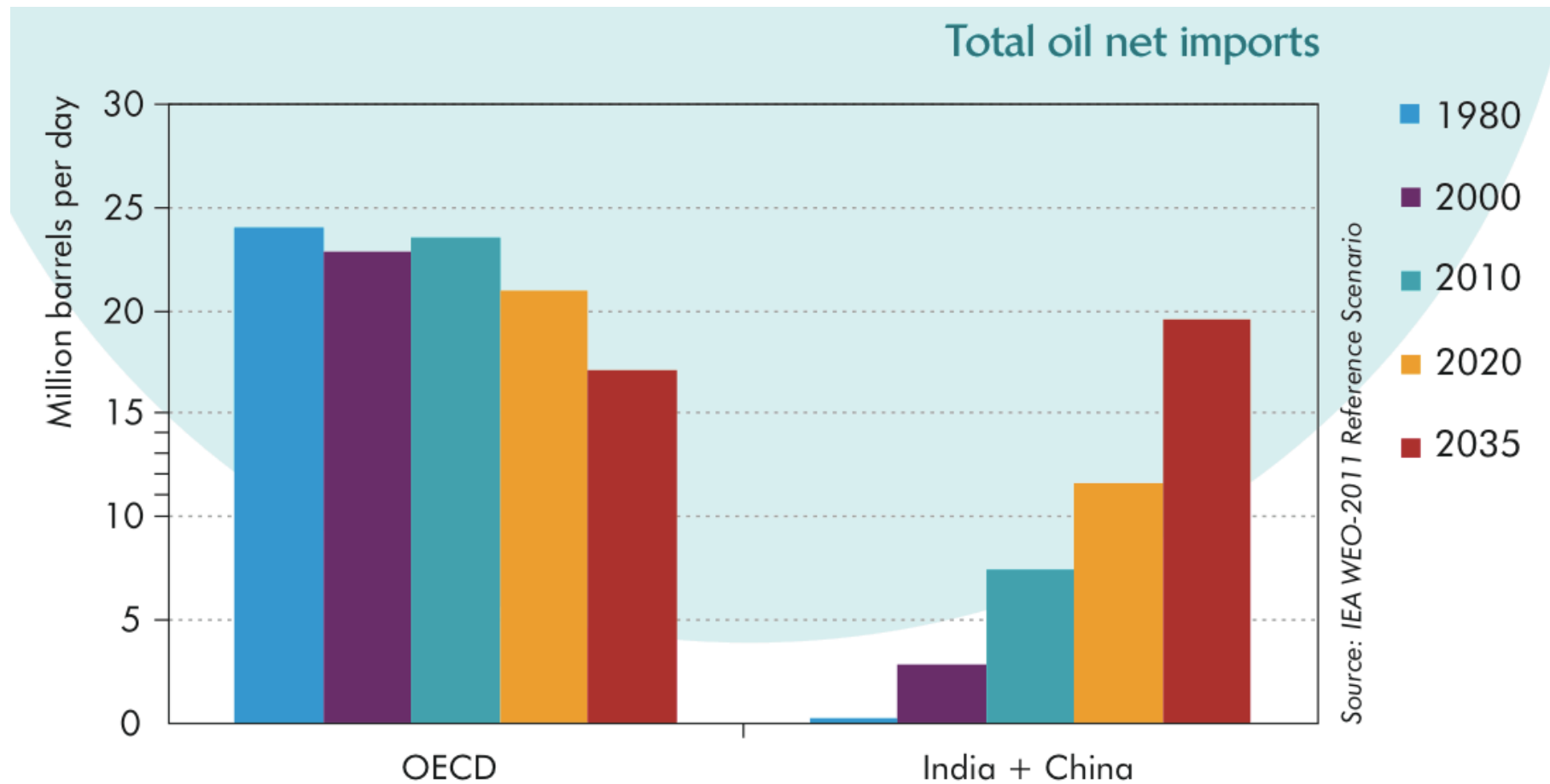


IEA Petroleum Strategic Stock can relieve 2mbd disruption for 24 months.



1974 disruption was 4.3mbd. 1979 was 5.6mbd. Hormuz blockage is 13 mbd.

Should China and India join the IEA?

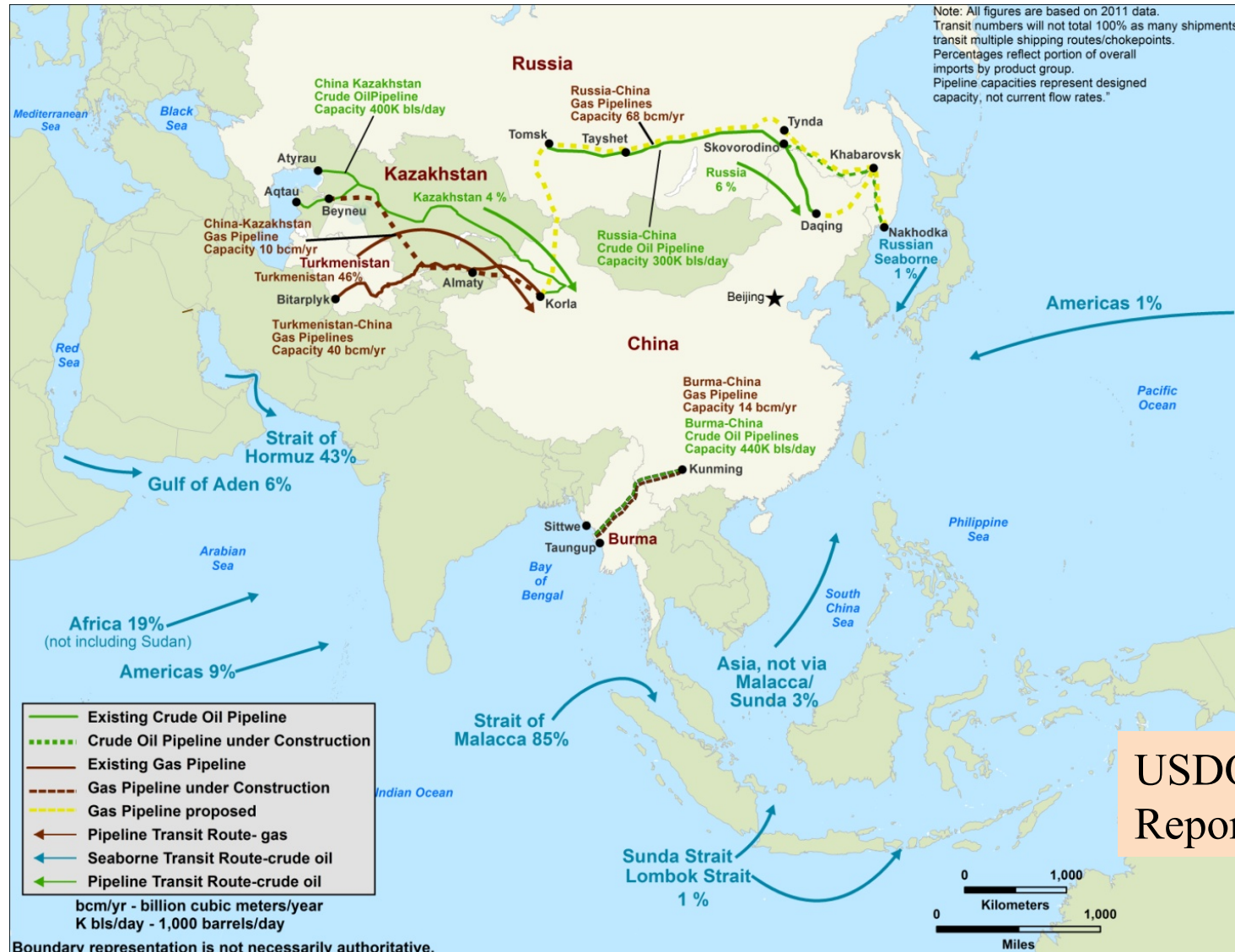


Role of the IEA in a Time of Unprecedented Uncertainties.

- 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.



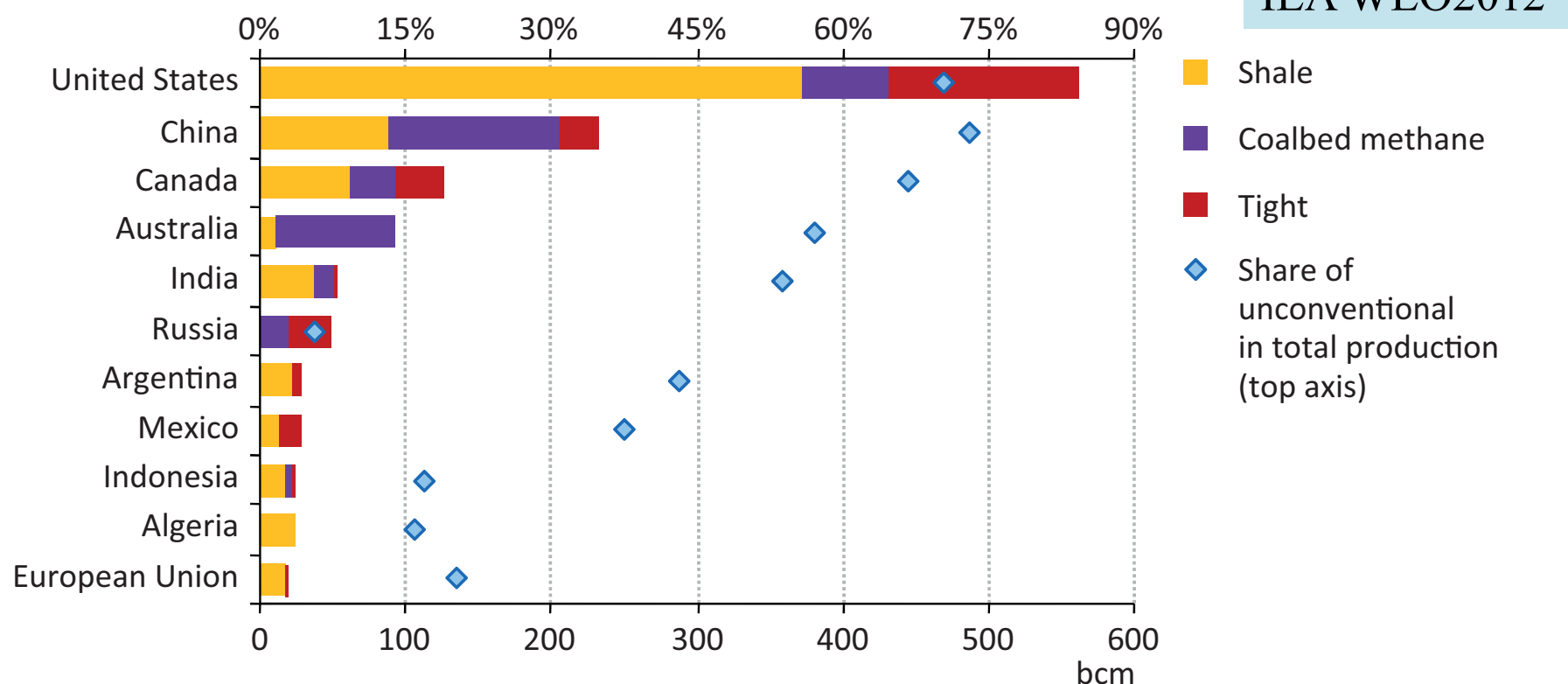
China's Import Transit Routes



USDOD China
Report 2013

Golden Age for Natural Gas?

Figure 4.5 ▶ Unconventional gas production in leading countries in the New Policies Scenario, 2035

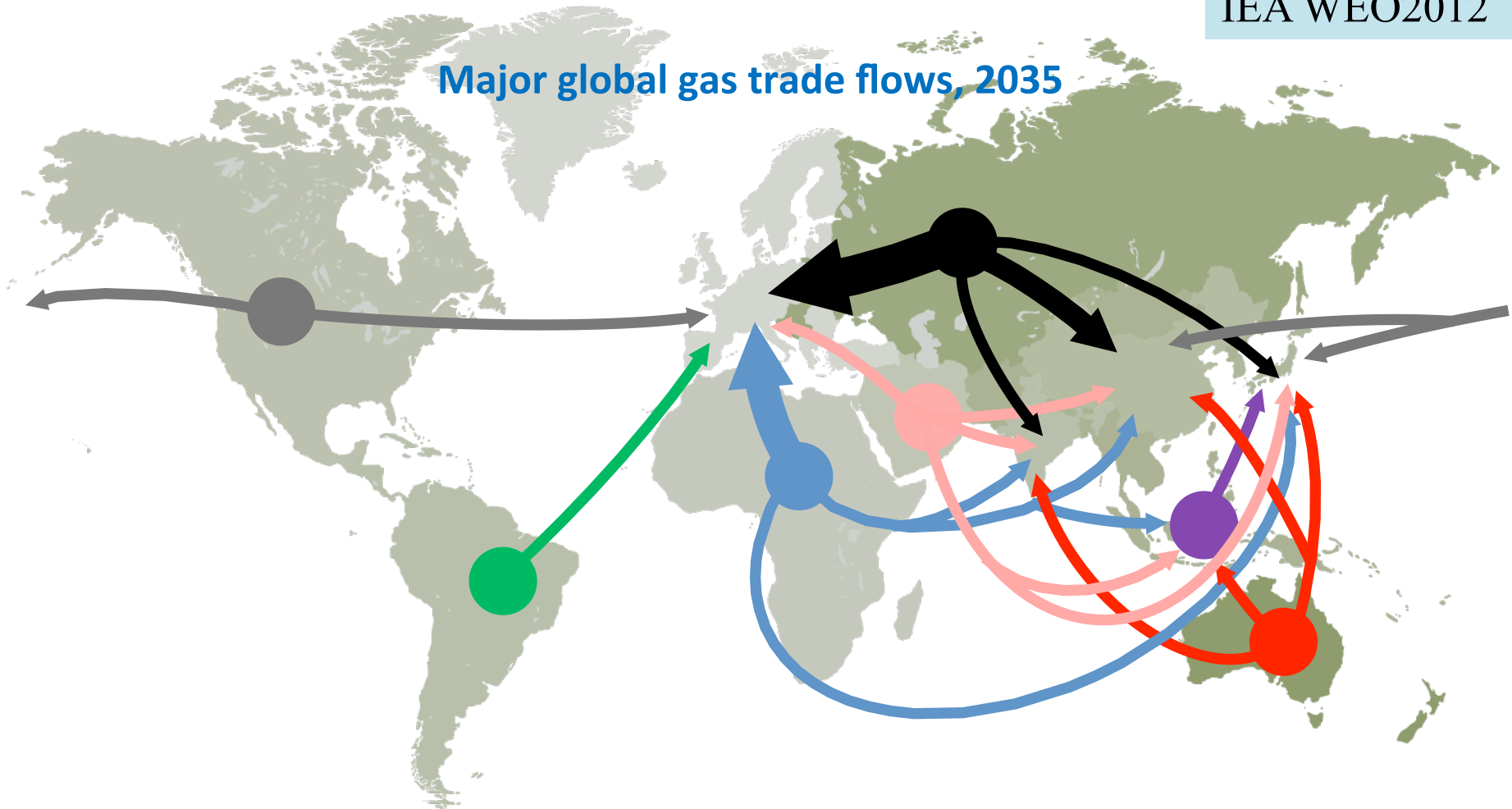


Technically recoverable resources amount to 790tcm or more than 230 years of production at current rates.

Natural gas: towards a globalised market

IEA WEO2012

Major global gas trade flows, 2035



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

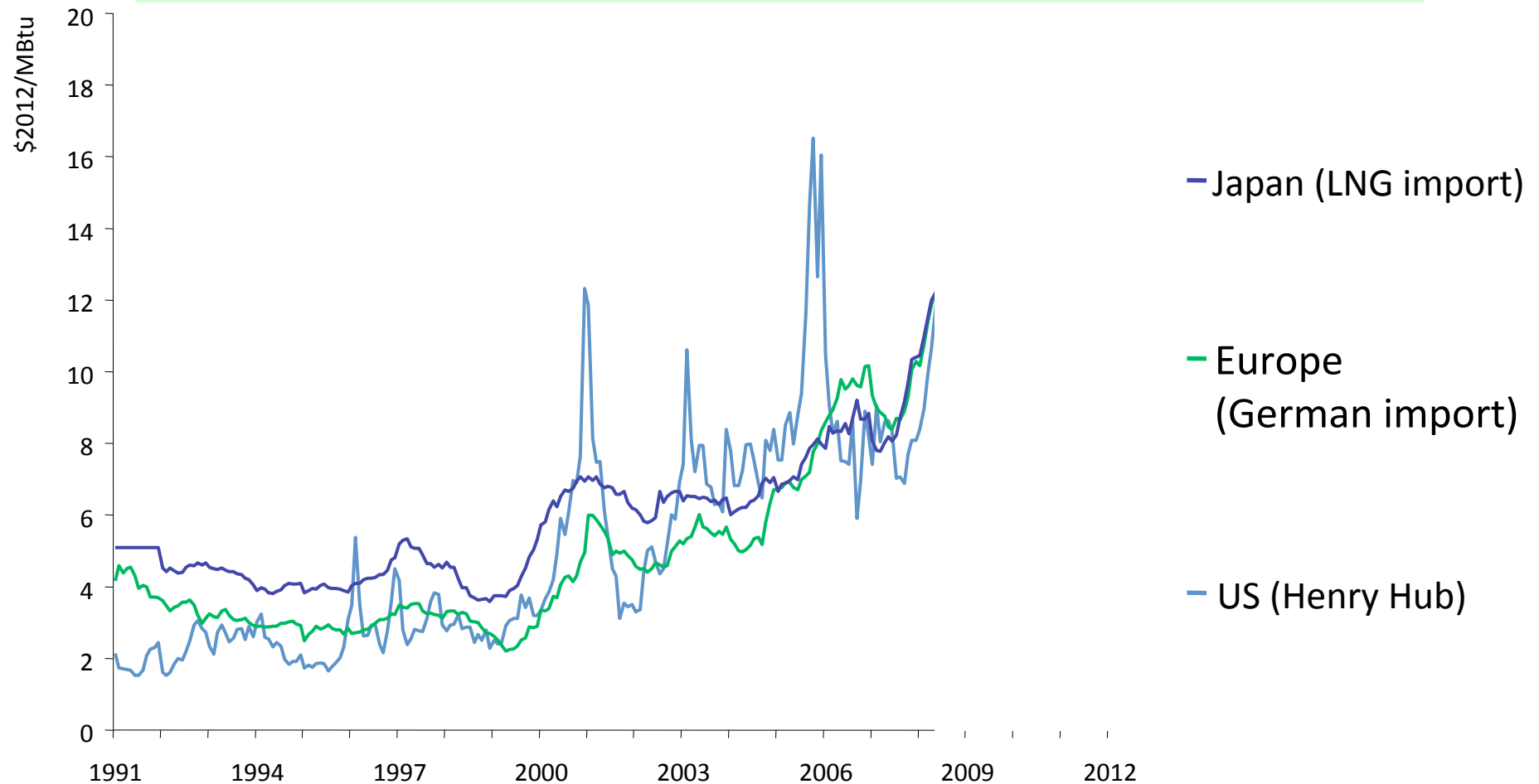


The boundaries and names shown and the designations used on maps included in this publication do not imply official endorsement or acceptance by the IEA.

Source: IEA

Mid-Term Oil & Gas Market 2010, IEA

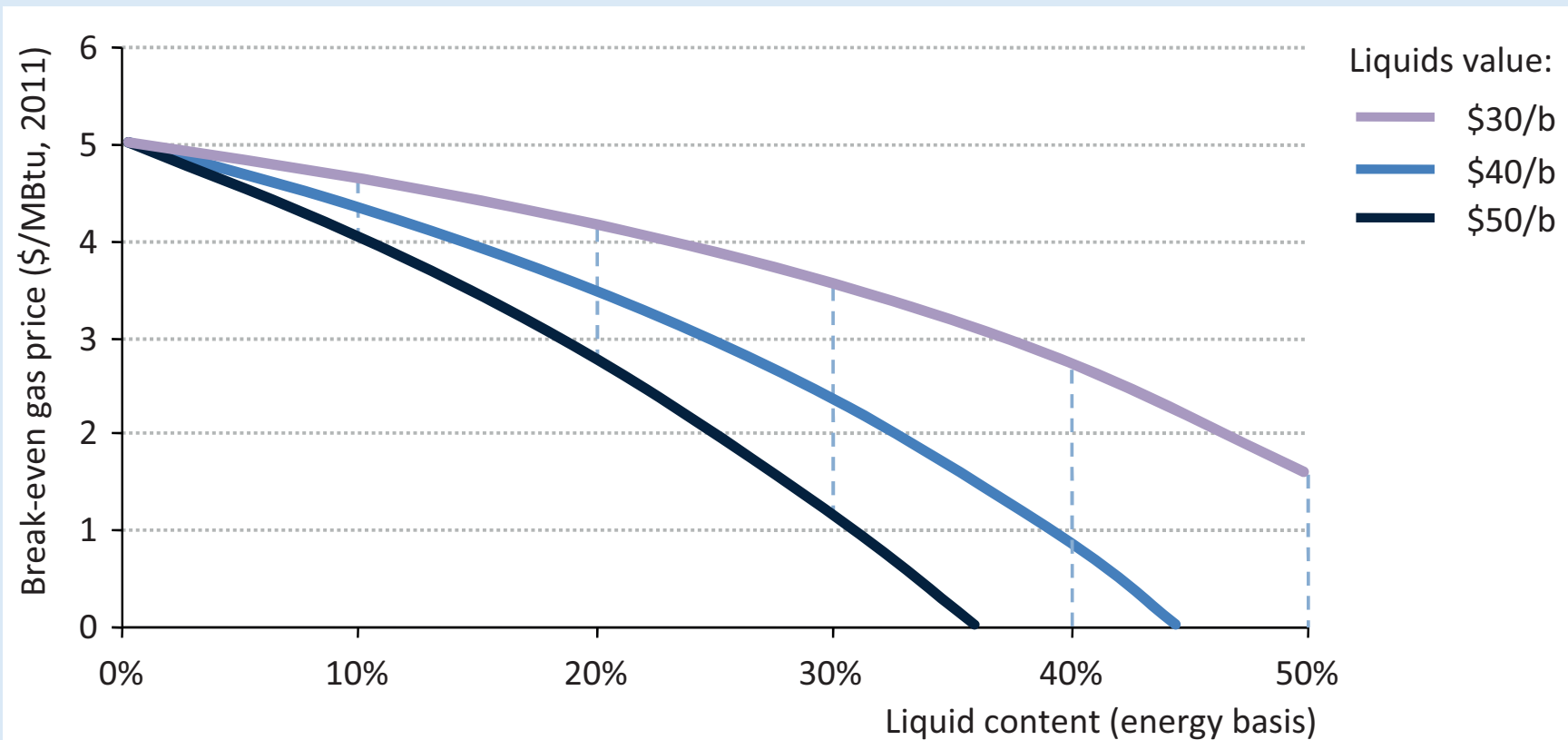
LNG pricing : a competitiveness burden on Asian economies



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

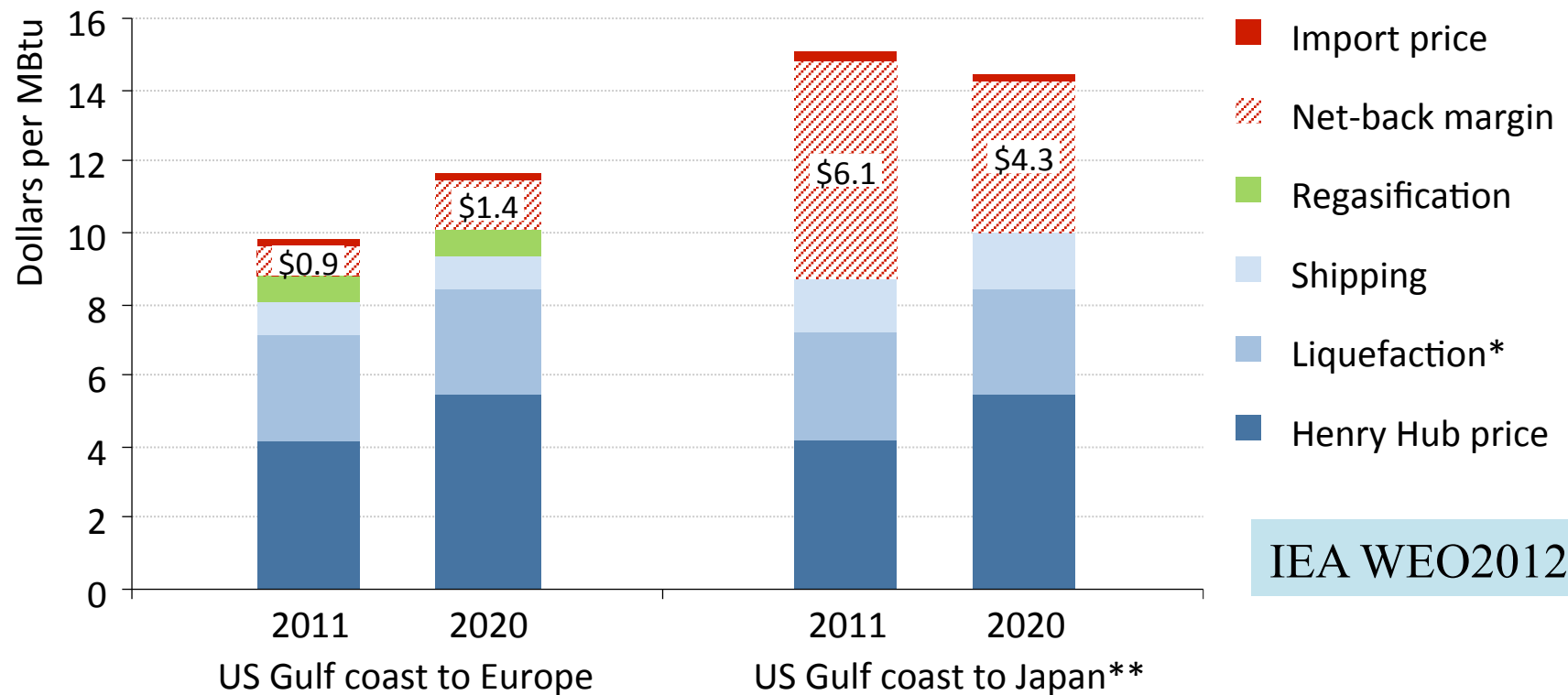
The higher the oil price goes, the lower the gas price becomes.

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



IEA WEO2012

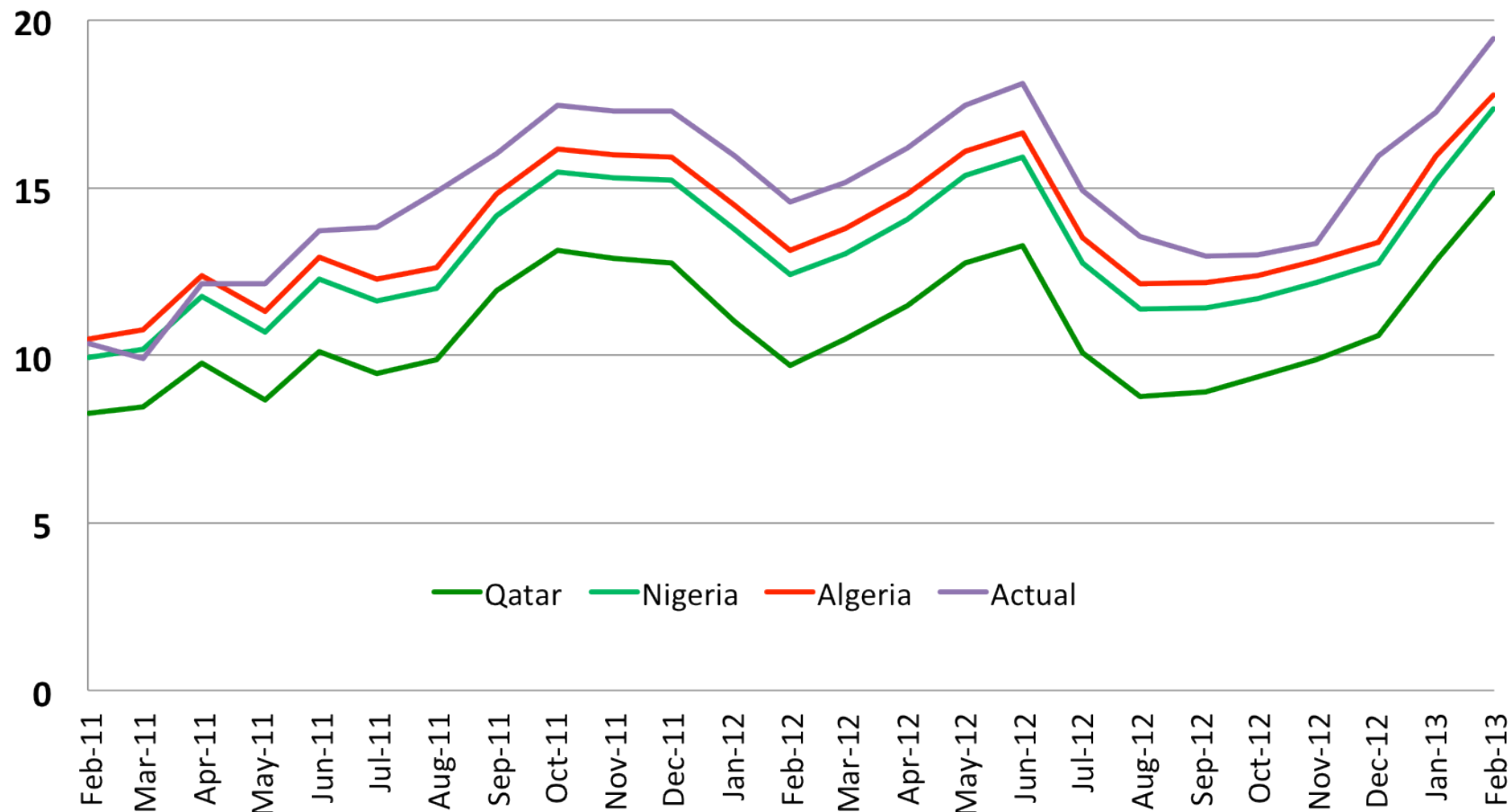
Indicative economics of LNG exports from the United States



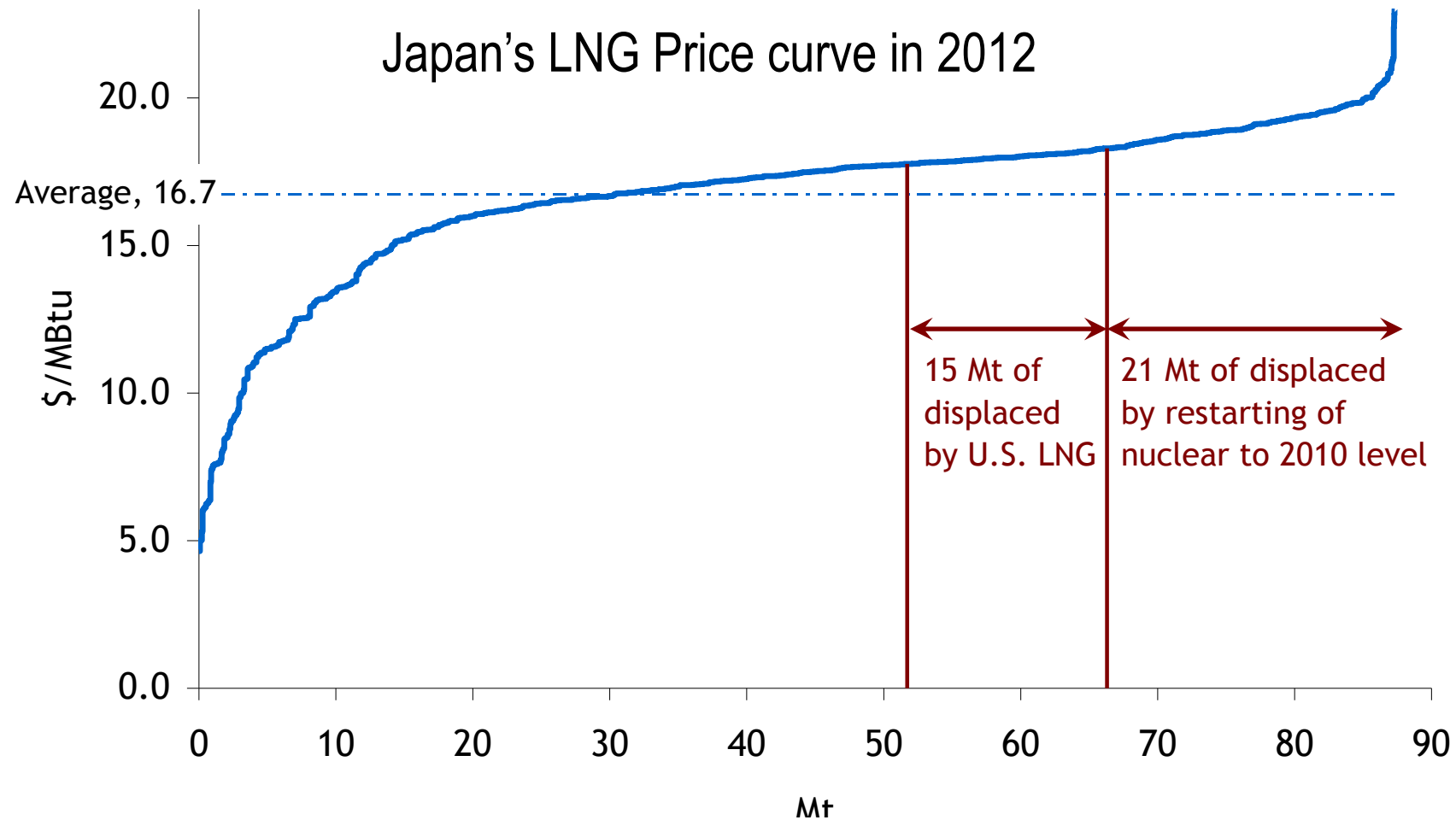
At both current prices and those assumed for 2020, LNG exports from the US would be profitable, especially to Asian markets

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

Japanese price level that would support redirections of different sources going to Europe

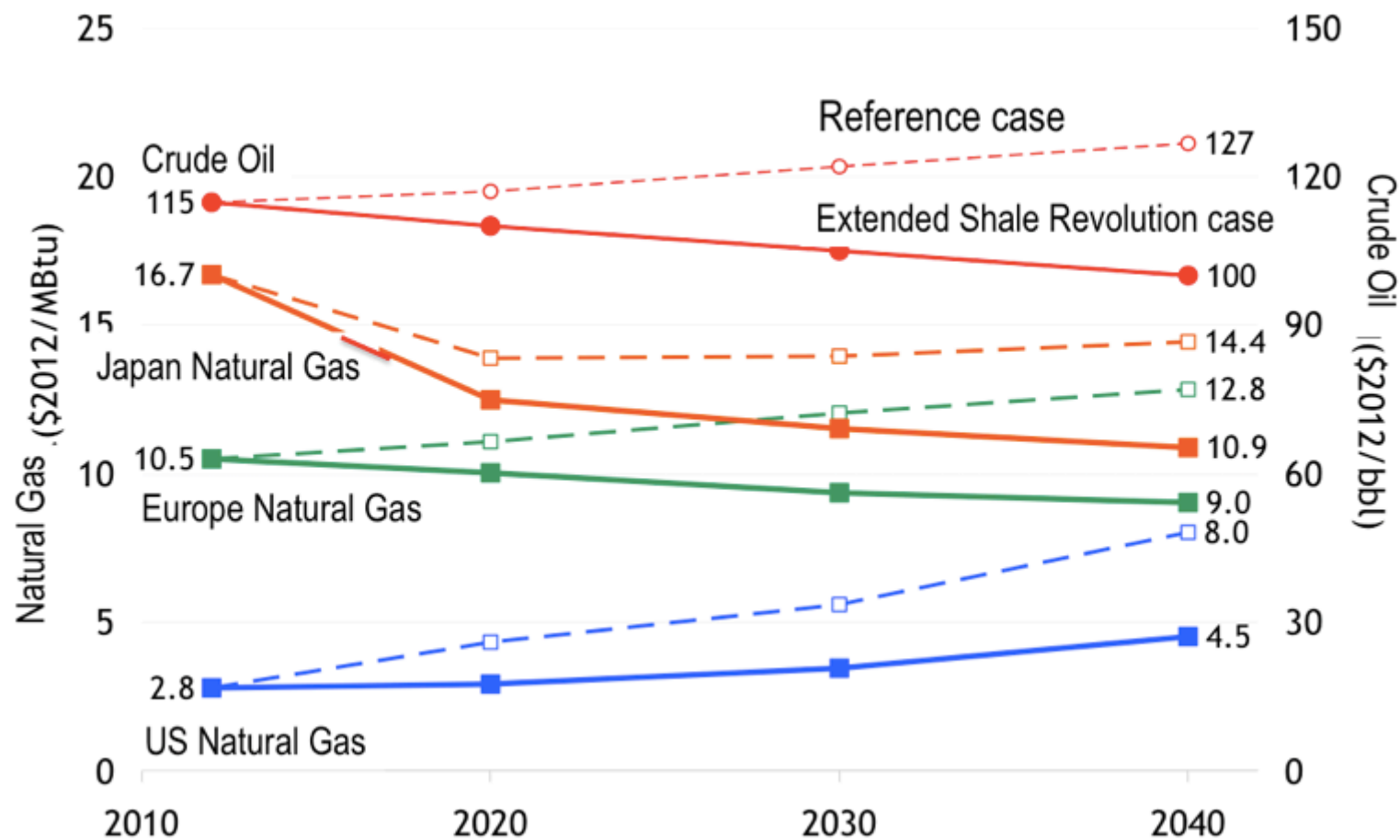


Impact of US LNG and Nuclear restarting

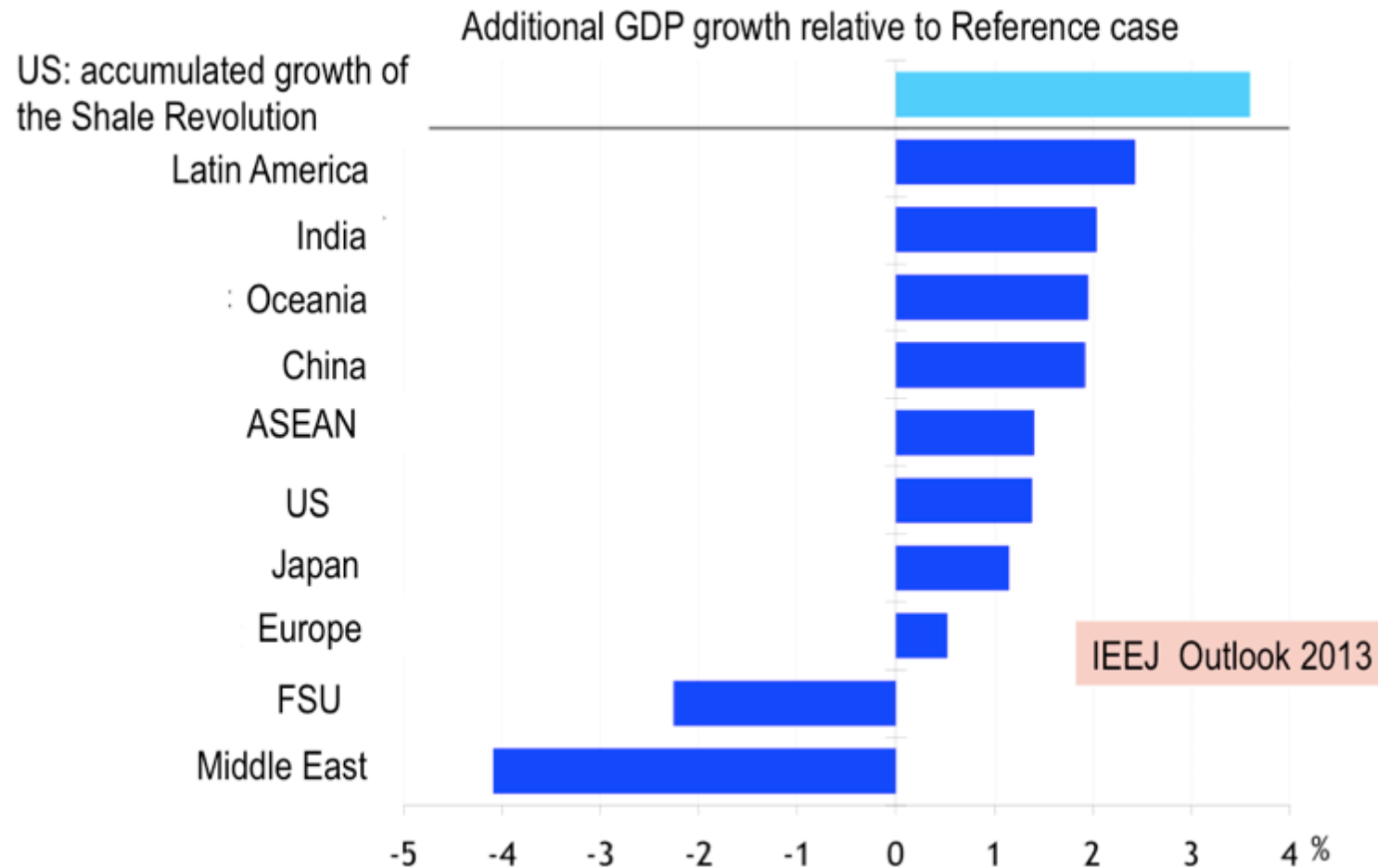


IEEJ

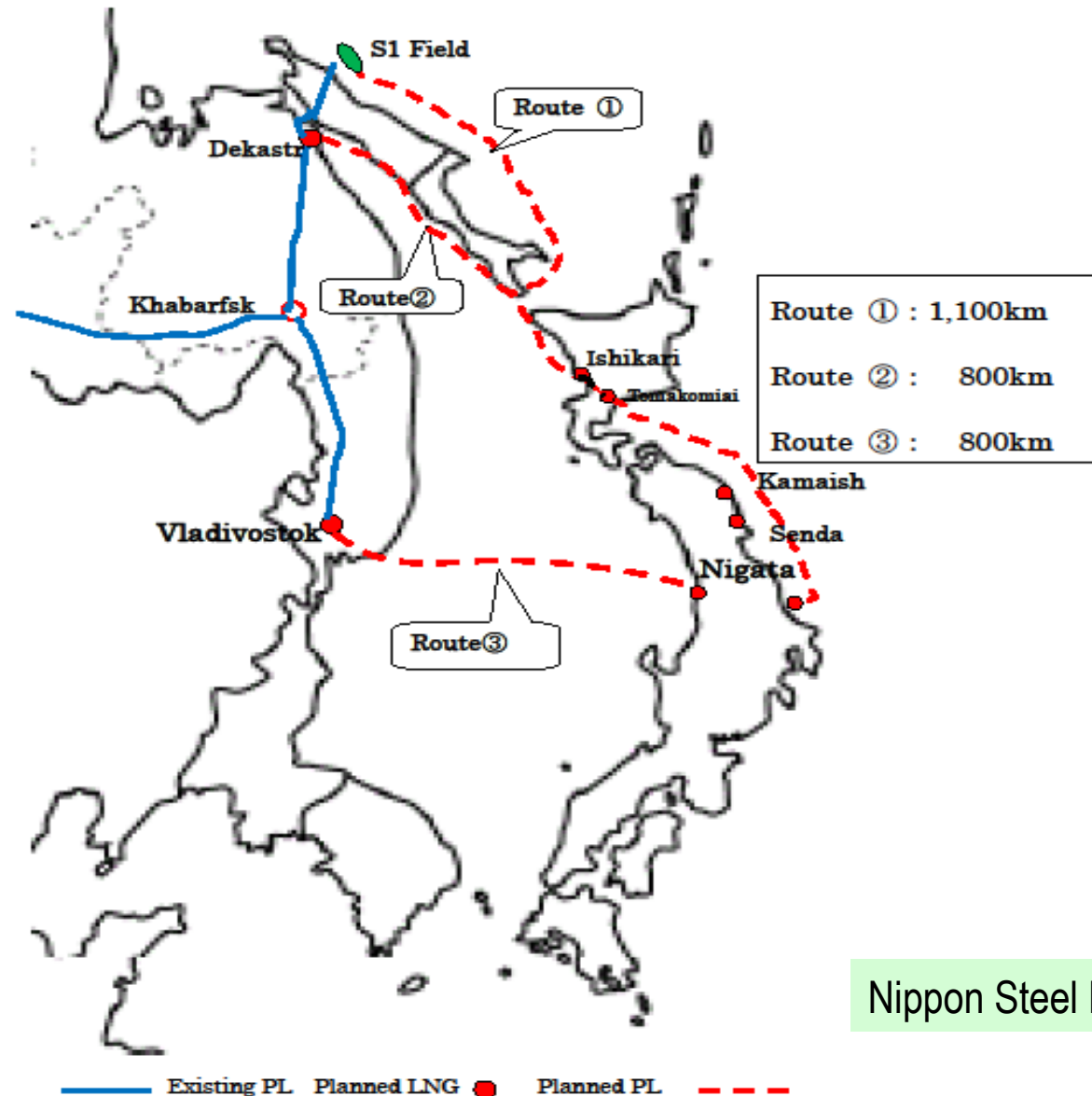
Oil & Gas Price Assumptions for IEEJ Outlook 2013



Winners and Losers of the Shale Revolution



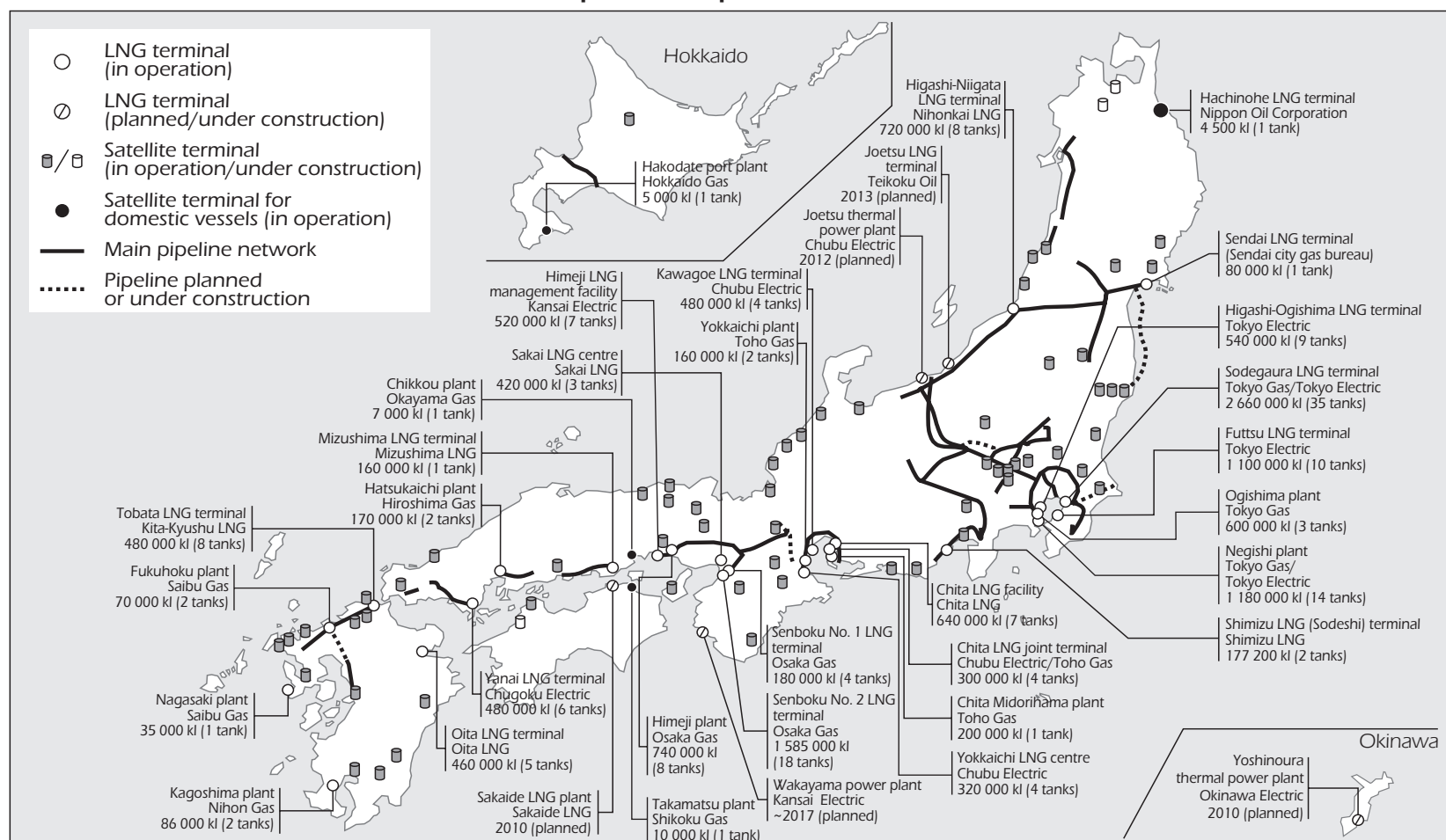
Japan needs Russian Gas. Russia needs Japanese market. Rational for Natural Gas Pipeline from Russia to Japan



Nippon Steel Engineering

Japan's Pipeline system

Map of the Japanese Gas Grid



Note: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the IEA.
Source: Country submission (compiled by ANRE from data provided by relevant companies).

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

Bakken

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)

Japan's Methane Hydrate Development Program (announced in 2001)

Phase 1 (FY 2001 – FY2008)

Basic Research

Onshore Production Tests

- 1st Production Test 2002
- 2nd Production Test in 2008



Resource Assessment in Eastern Nankai Trough

- Seismic Surveys (2D, 3D)
- Exploratory Drillings



Phase 2 (FY 2009 – FY2015)

Technological Research and Production Tests

Offshore Production Tests

- 1st Production Test - FY2012



Technological Studies

- Designing and Manufacturing Systems for Flow Test
- Studying Production Methods
- Assessing Environmental Impacts
- Resource Assessments

Phase 3 (FY2016 – FY2018)

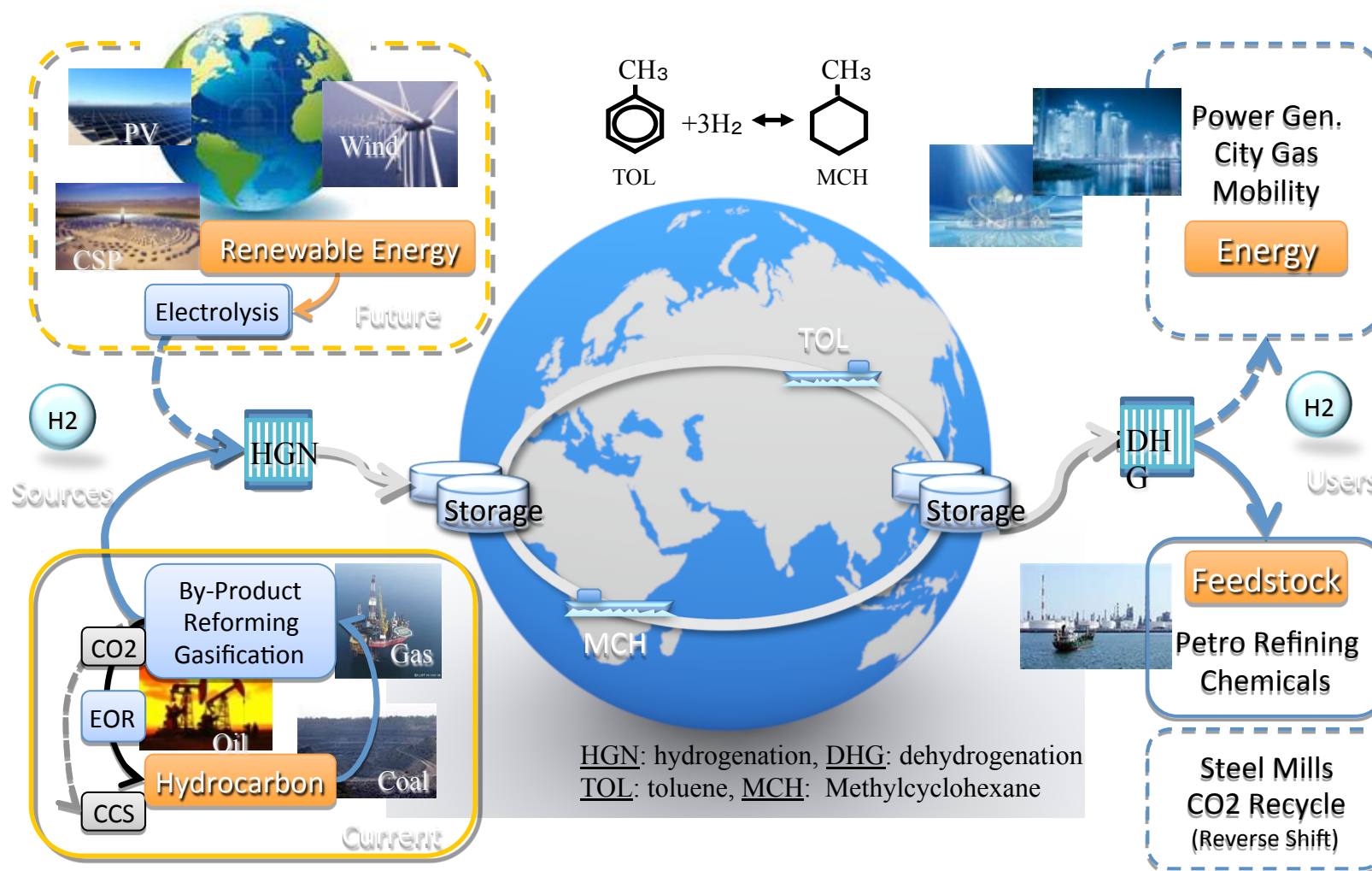
Establishment of Technological Platform

To conduct studies to establish the technological platform for commercialization of methane hydrate

- Preparatory study for commercial production
- Feasibility
- Environmental Impacts
- Overall evaluation of the total Program etc.

Introduction - Chiyoda's Hydrogen Supply Chain Outlook

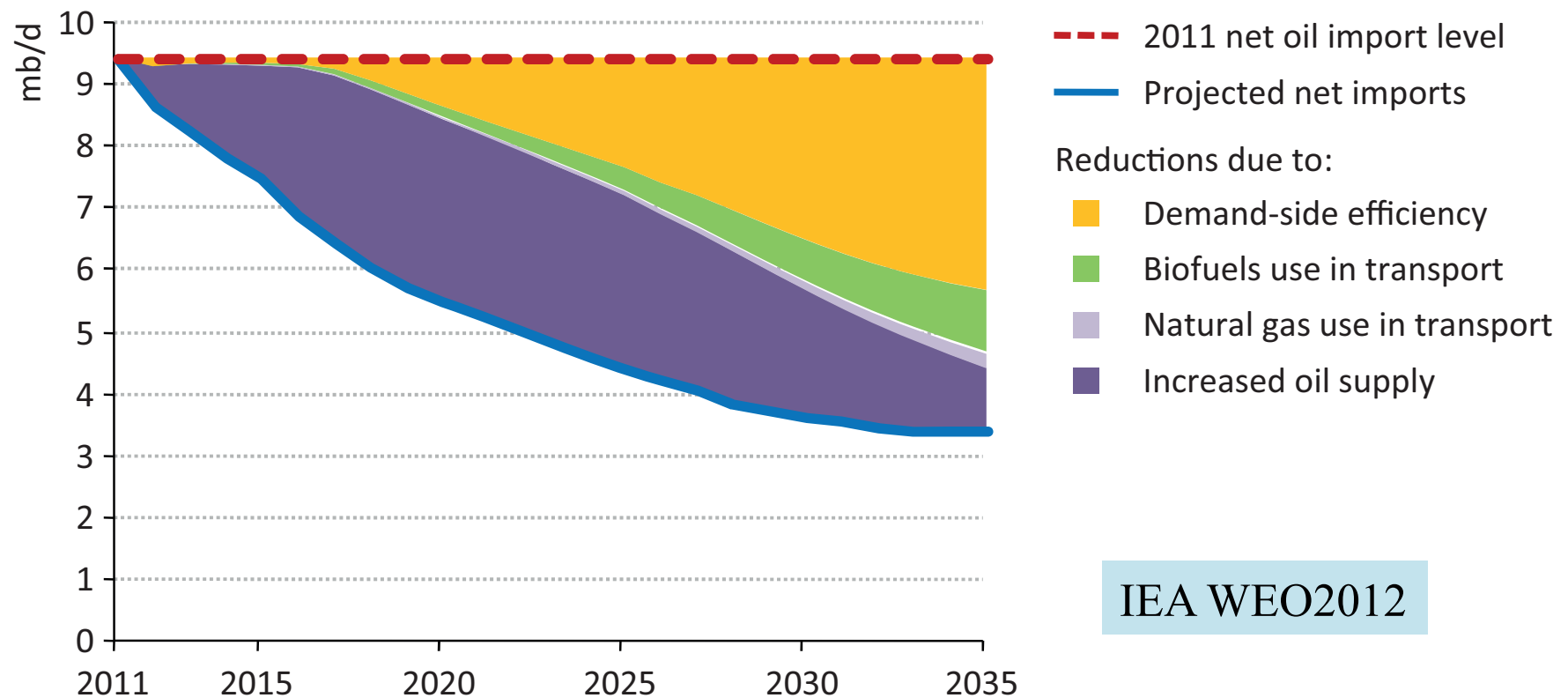
- Chiyoda established a complete system which enables economic H₂ storage and transportation.
- MCH, an H₂ carrier, stays in a **liquid state** under ambient conditions anywhere.



- H₂ Supply of a 0.1-0.2mtpa LNG equivalent scale (M.E. to Japan) could be feasible.

A half of US Energy Independence comes from Energy Efficiency

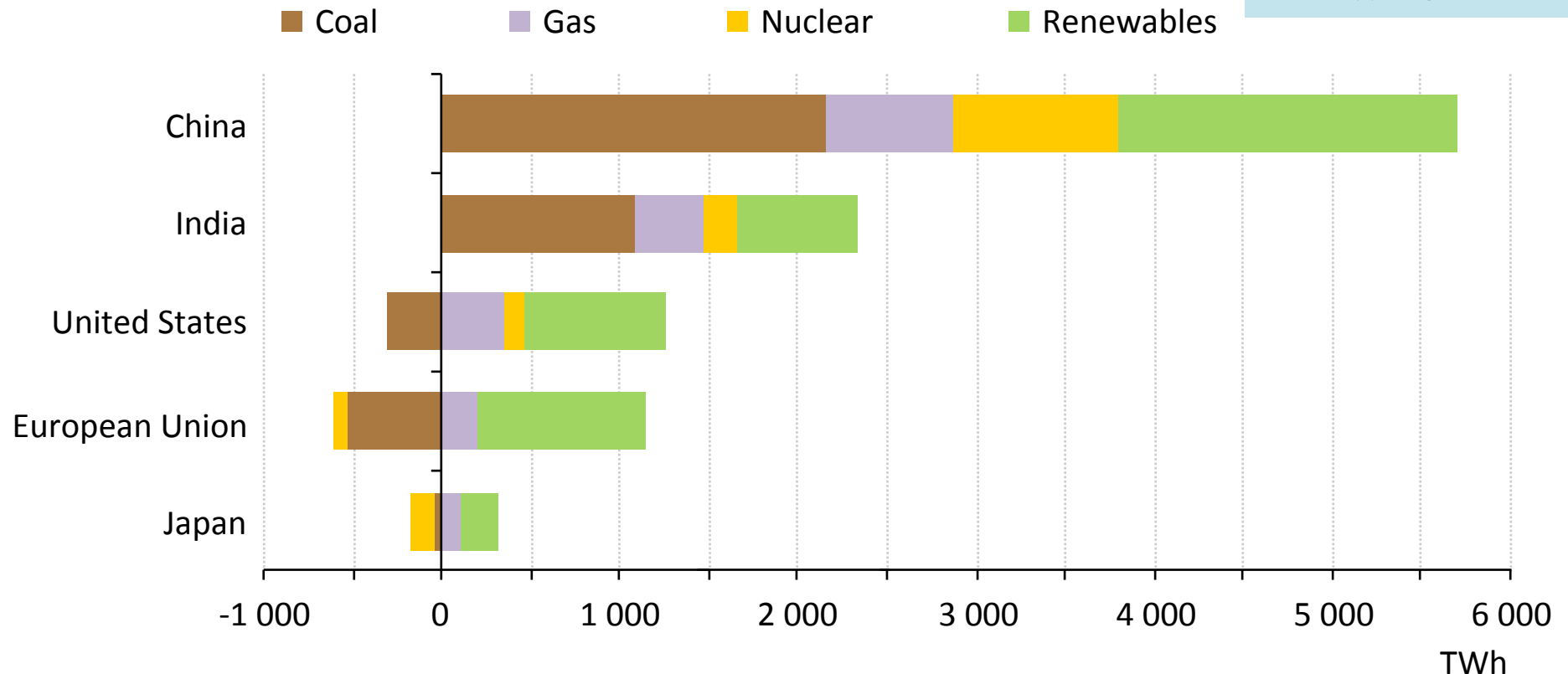
Figure 2.17 ▶ Reductions in net oil imports in the United States by source in the New Policies Scenario



Electrification: A power shift to emerging economies

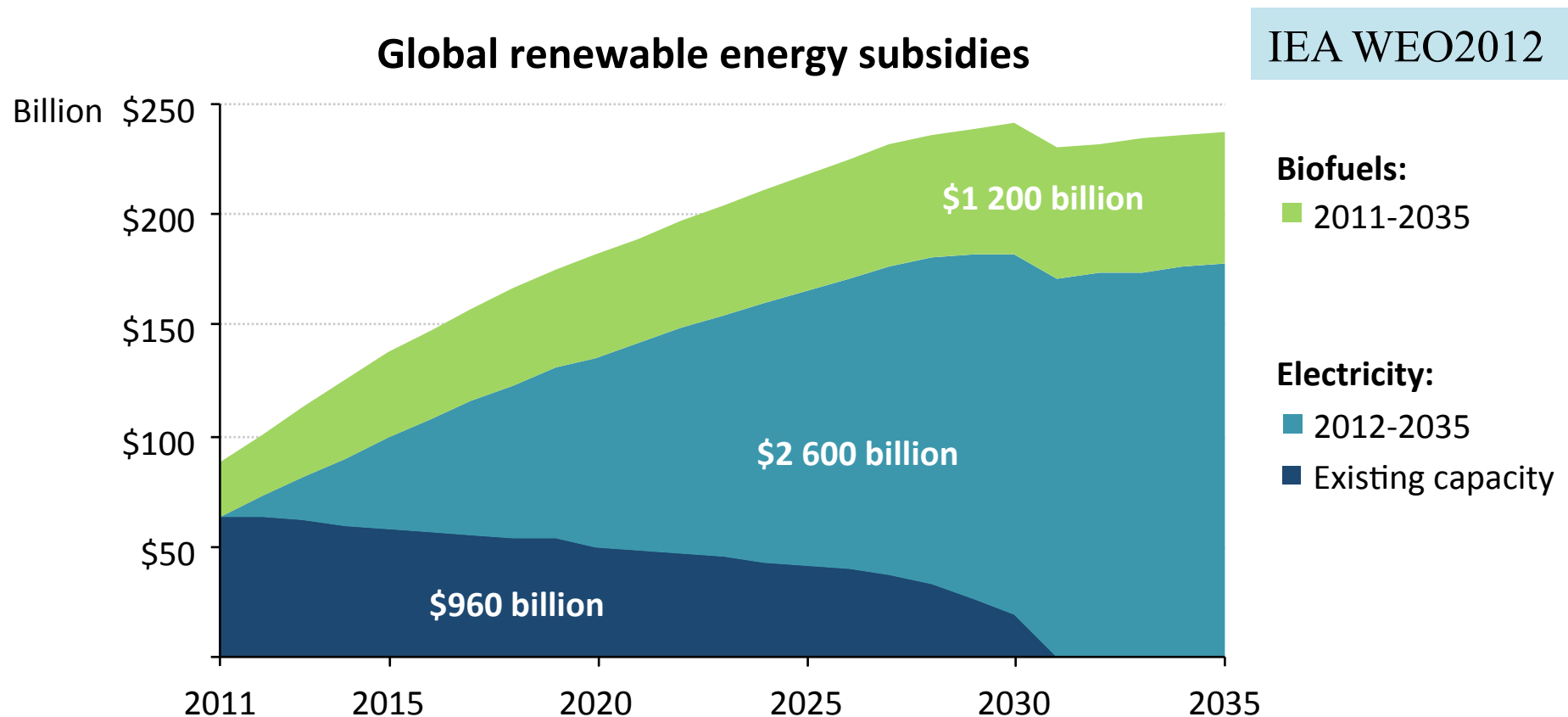
Change in power generation, 2010-2035

IEA WEO2012



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

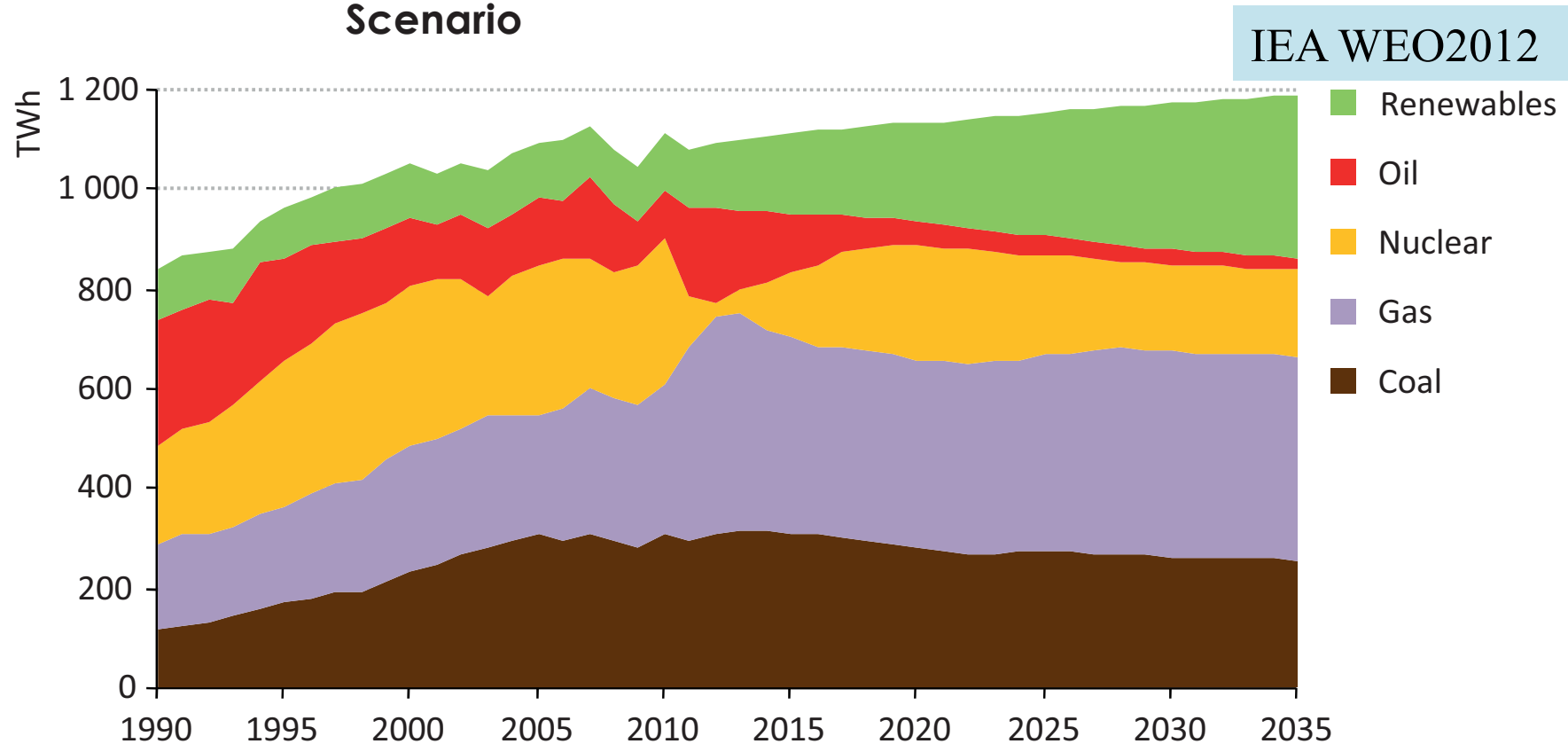
The multiple benefits of renewables come at a cost: Subsidy Lock-In



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

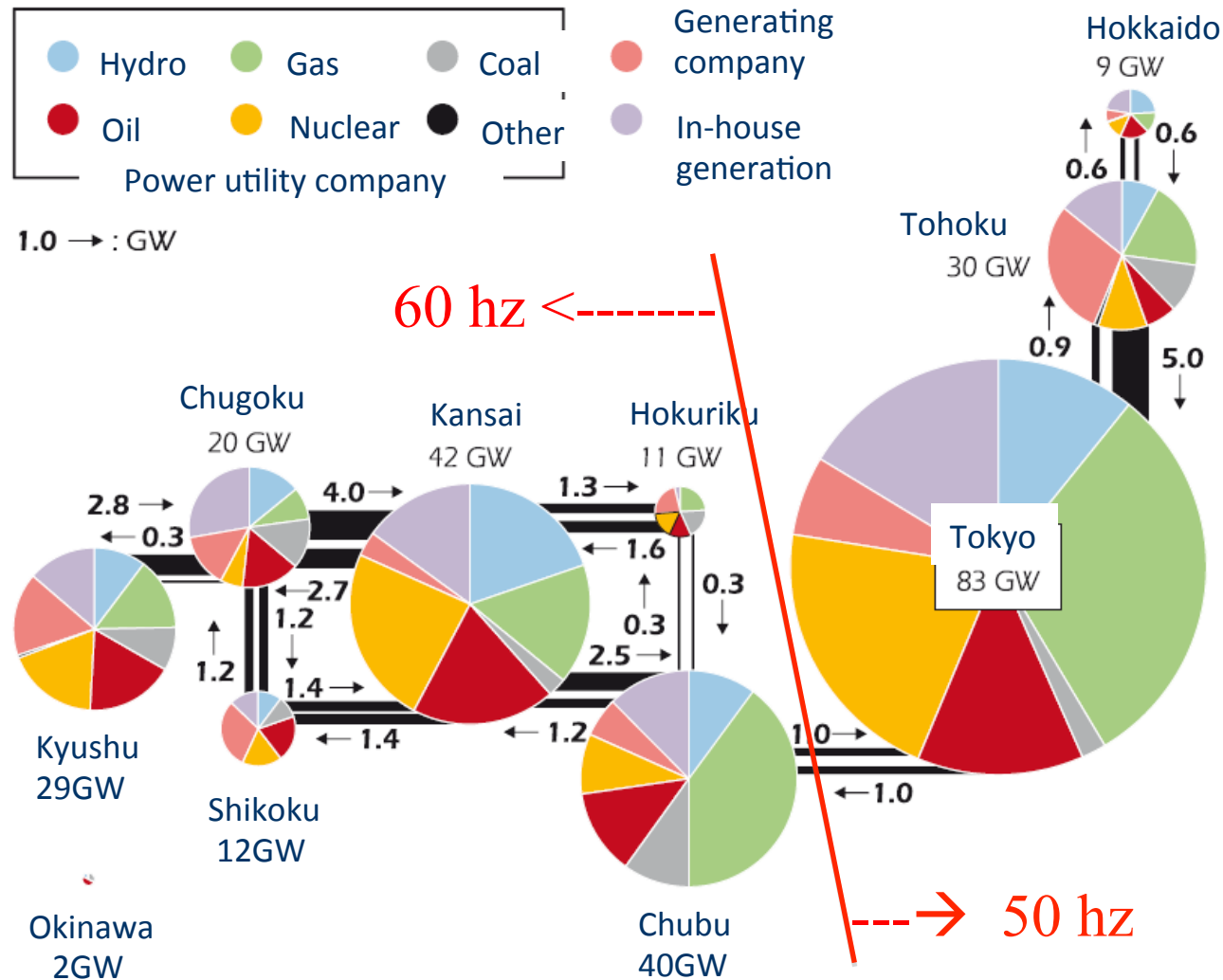
Japan's Power Sector: Renewables, gas and energy efficiency leading the charge

Figure 6.13 ▶ Japan electricity generation by source in the New Policies Scenario



A decline in nuclear is compensated by a 3-fold increase in electricity from renewables, a continued high reliance on LNG imports & improvements in efficiency

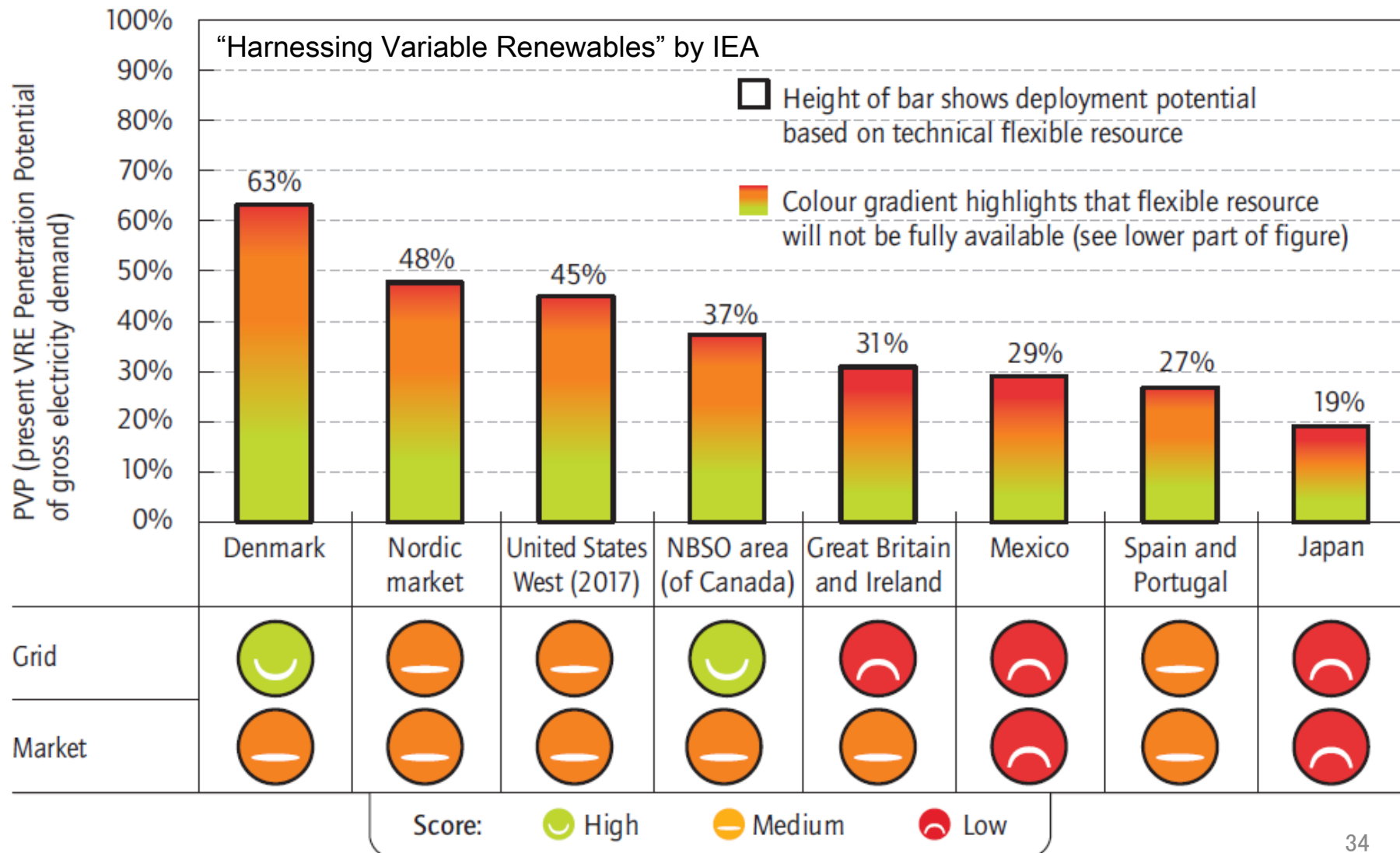
Power grid in Japan



Source: Agency for Natural Resources and Energy, The Federation of Electric Power Companies of Japan, Electric Power System Council of Japan, The International Energy Agency

Not only Feed-in-tariffs but Grid integration !

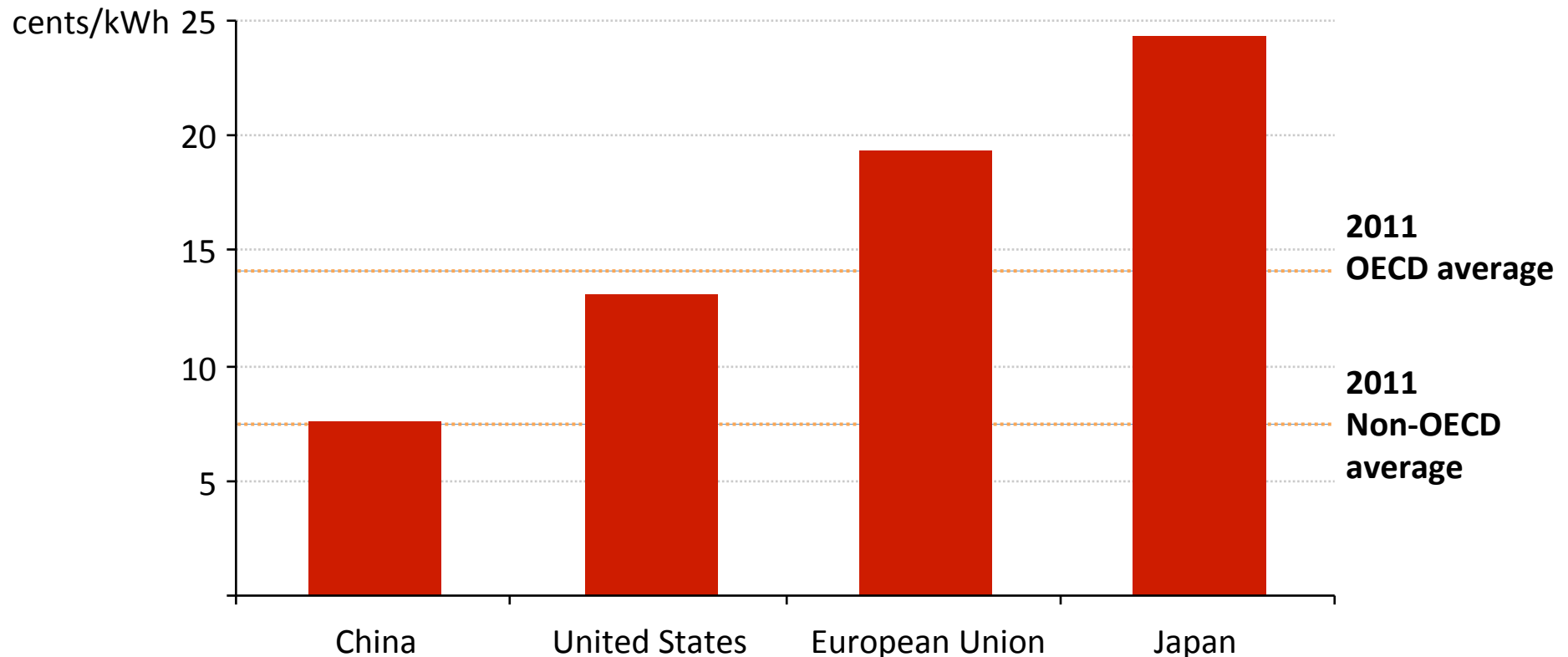
Snapshot of present penetration potentials



Wide variations in the price of power

IEA WEO2012

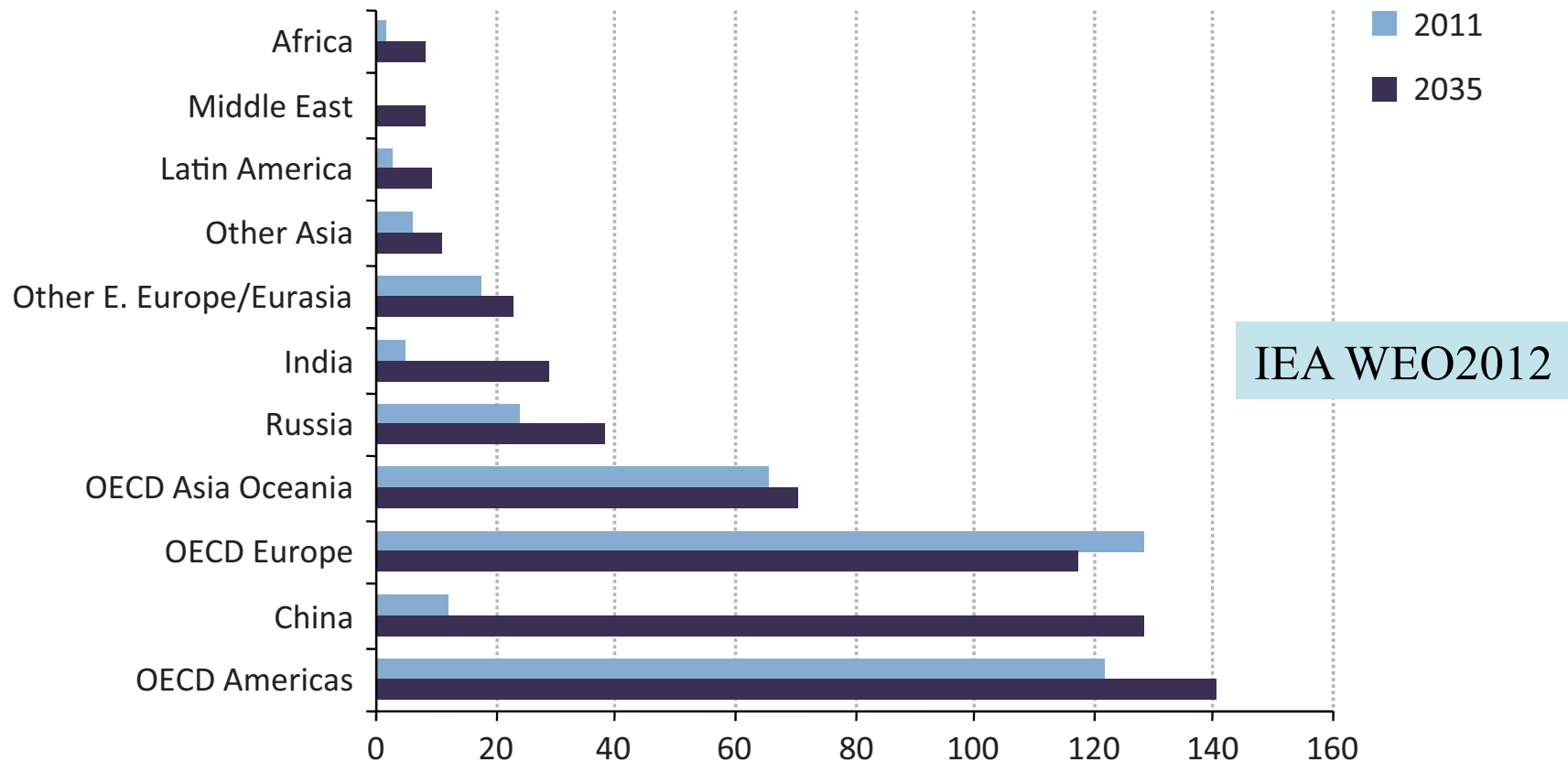
Average household electricity prices, 2035



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

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



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%.

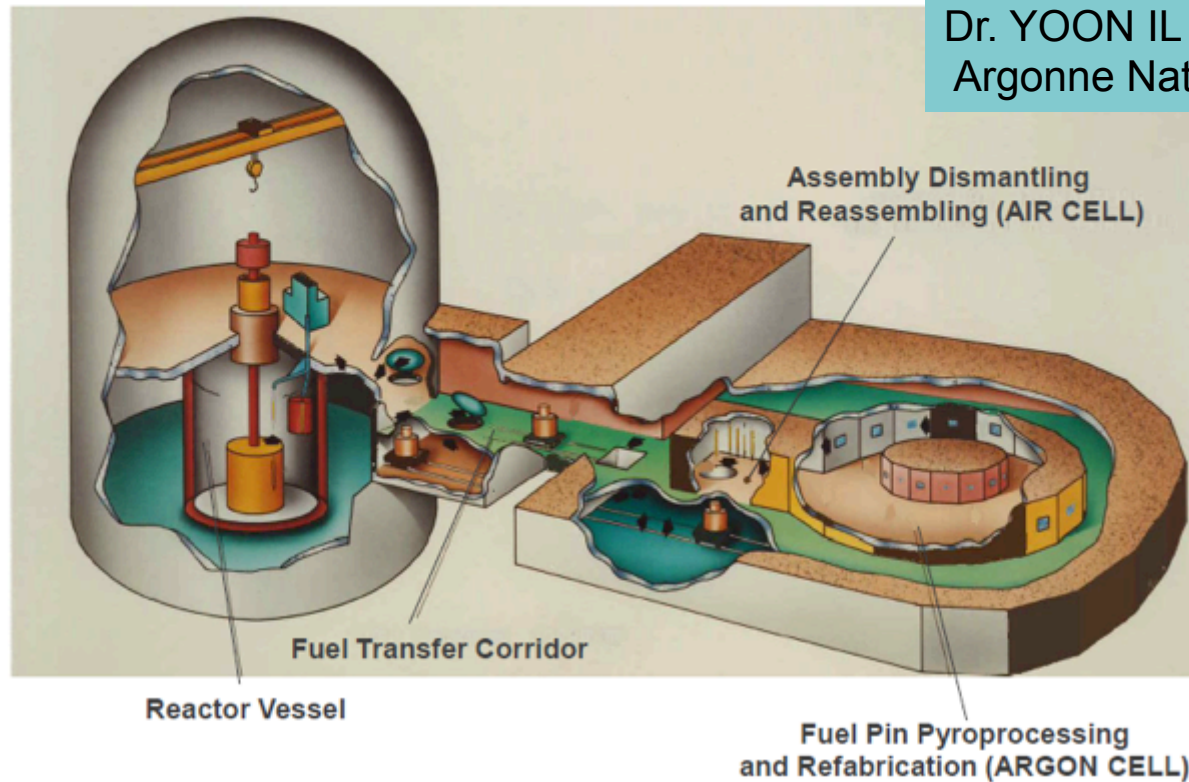
Share the Lessons of the Fukushima

- Lessons to be Shared
 - **Think about the unthinkable**; Tsunami and Station Black Out. Large scale Blackout. Change total mind set for “Safety”.
 - Prepare for the severe accidents by defense in depth, common cause failure & compound disasters.
 - Clarify why it happened only to Fukushima Daiichi and NOT to other sites.
- Safety Principles
 - **Fukushima accident was caused by human error and should have been avoided.** (Parliament Investigation Commission report)
 - International Cooperation : A nuclear accident anywhere is an accident everywhere.
 - Independent Regulatory authority ; Transparency and Trust, “Back Fitting” of regulation
- Secured supply of Electricity
 - Power station location
 - Strengthened interconnection of grid lines
- Once disaster has happened, Recovery from disaster is at least as important as preparing for it.
 - FEMA like organization and training of the nuclear emergency staff including the self defense force ; integration of safety and security.
- New Technology. New type of Reactors such as **Integral Fast Reactor**.

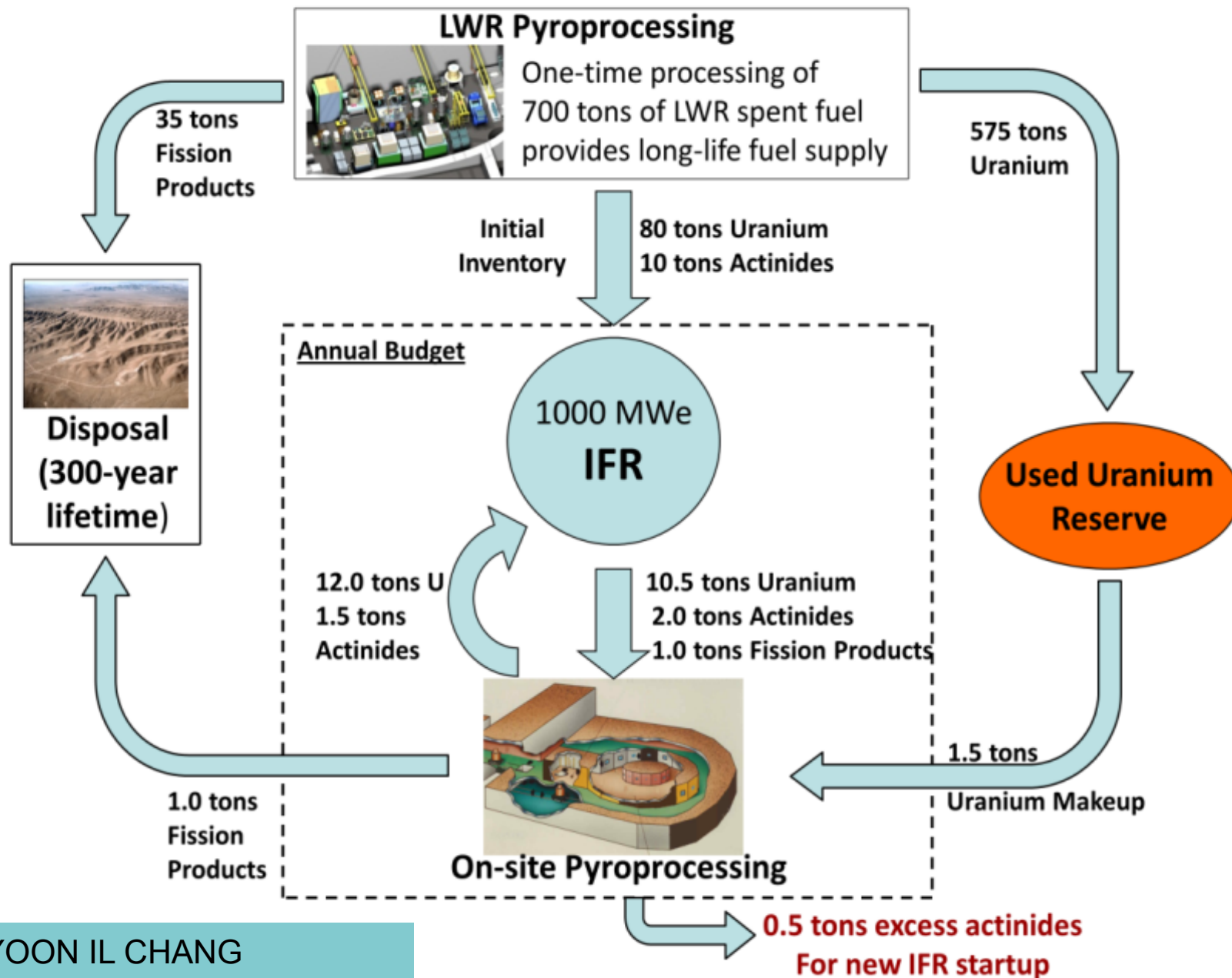
Time for G4 Reactors: Integral Fast Reactor and Pyroprocessing

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

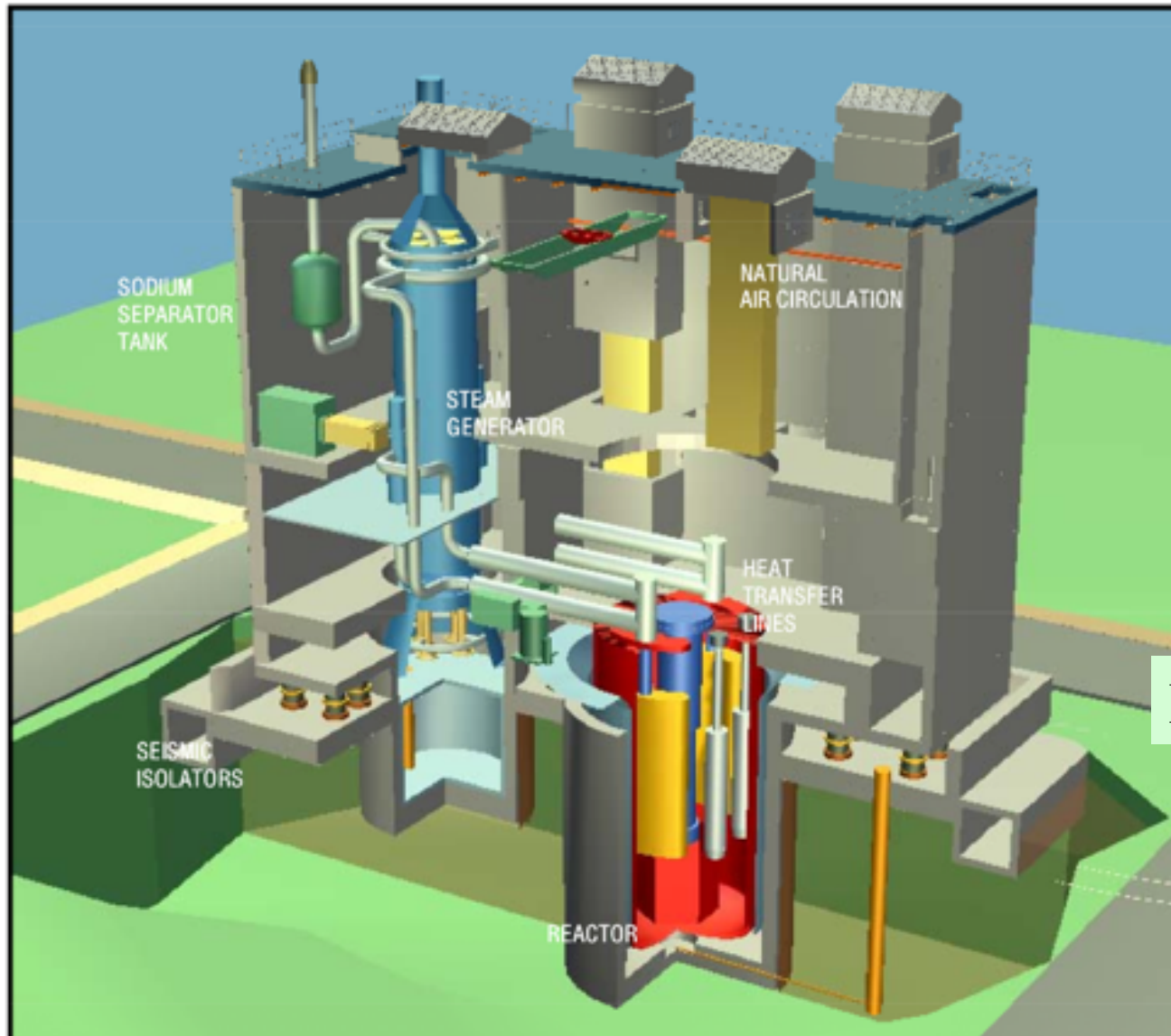
Dr. YOON IL CHANG
Argonne National Laboratory



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.



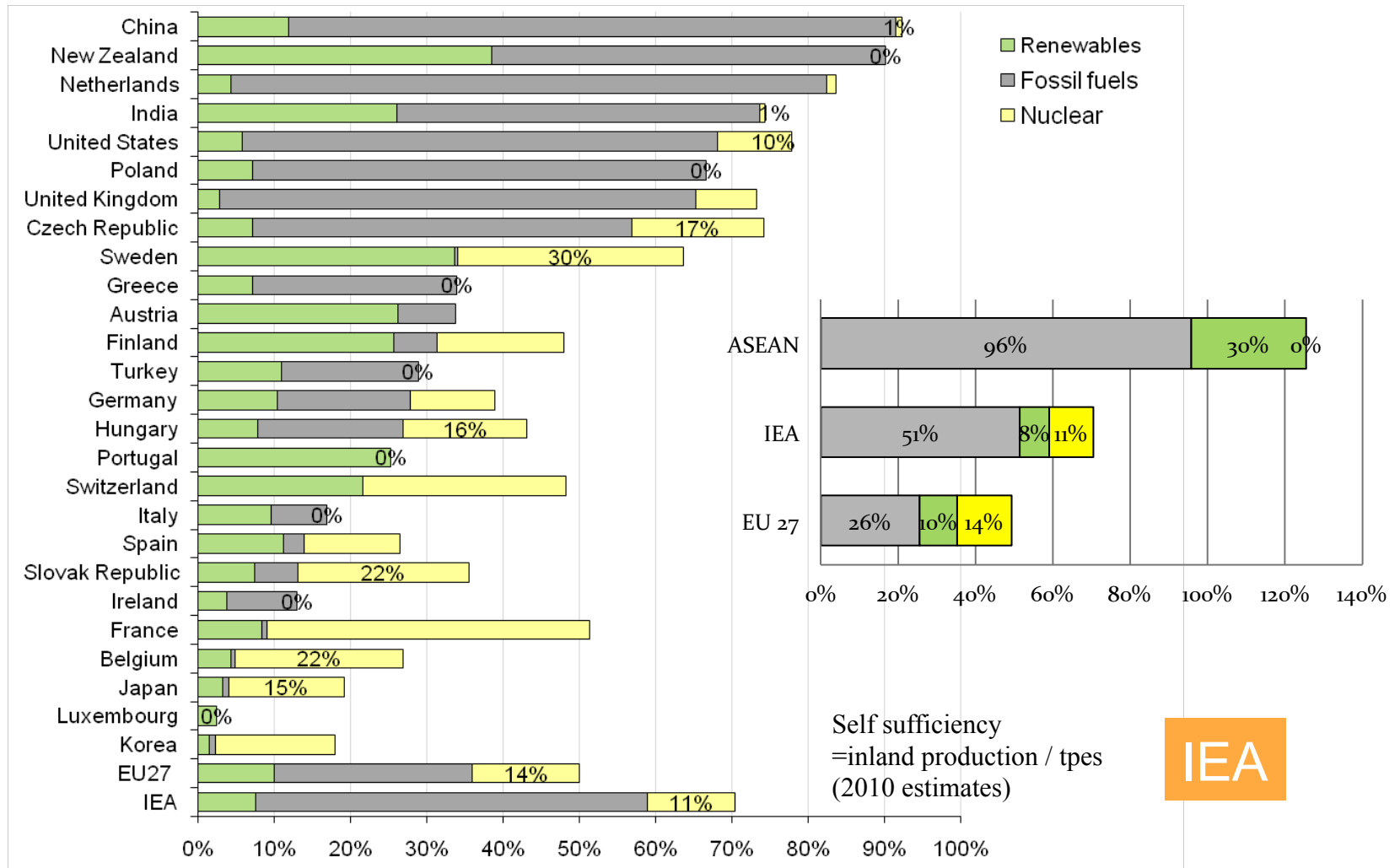
S-PRISM Nuclear Steam Supply System



RC Berglund

Diversity and Connectivity for Energy Security

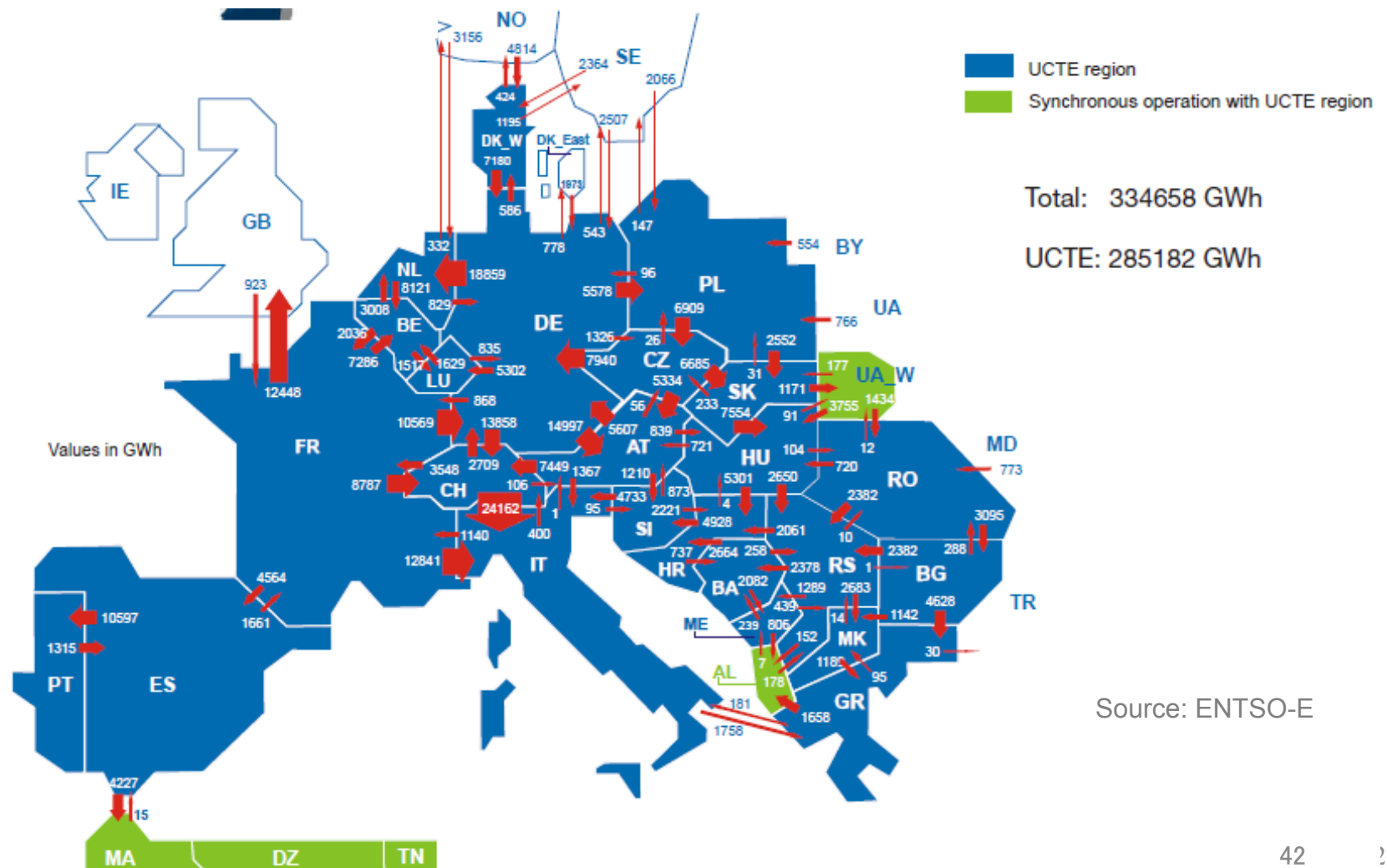
Energy Self-Sufficiency rates by fuels in 2010



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.

Power Grid Connection in Europe

Physical energy flows between European countries, 2008 (GWh)



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



Source: DESRETEC Foundation⁴³

Select European Natural Gas Infrastructure

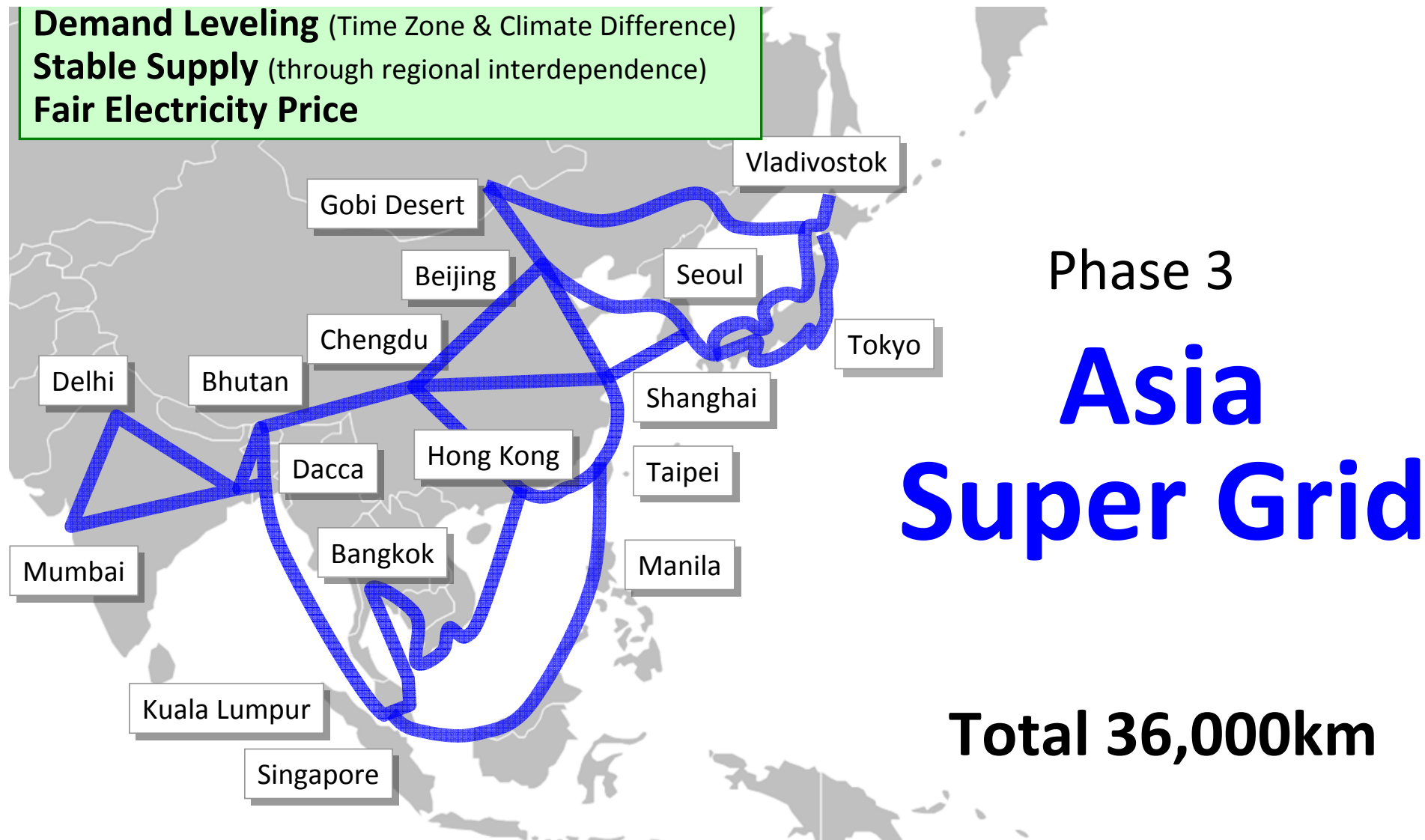


Source : US Congressional Research ▪ July 11,2013

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
- 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.