

Navigating a stormy energy future for Japan

「嵐のなかの日本のエネルギー戦略」

(Messages from the IEA World Energy
Outlook 2014)

2015-3-10 IFRI-PARI Joint WS

Tokyo University

Nobuo TANAKA

Former Executive Director, IEA

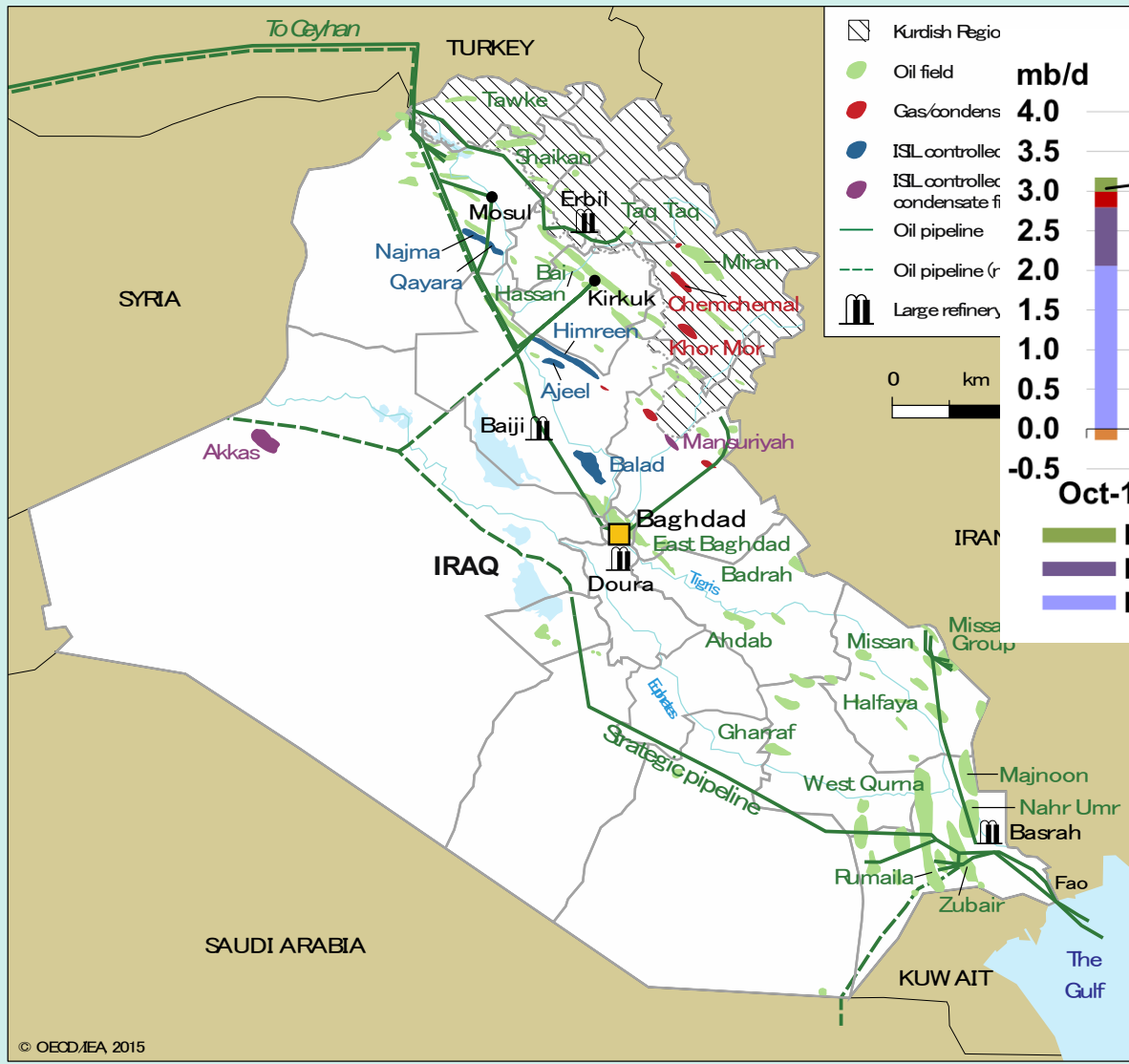
Signs of stress in the global energy system

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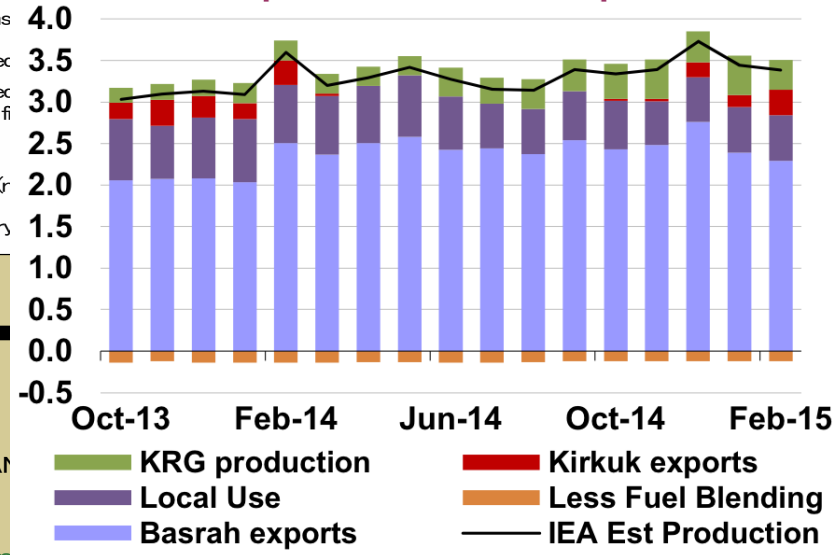
- Current calm in markets should not disguise difficult road ahead
 - Turmoil in the Middle East raises doubts over future oil balance
 - Resurgent debate over the security of gas supply to Europe
- Mixed signals in run-up to crucial climate summit in Paris in 2015
 - Global CO₂ emissions still rising, with most emitters on an upward path
 - At \$550 billion, fossil fuel subsidies over four-times those to renewables
 - Increasing emphasis on energy efficiency starting to bring results
- Will change in global energy be led by policies, or driven by events?

No.1 Risk Iraq: Production of Oil continues but Investment.

Map 2.1 Iraq's oil infrastructure



Iraq Production and Exports

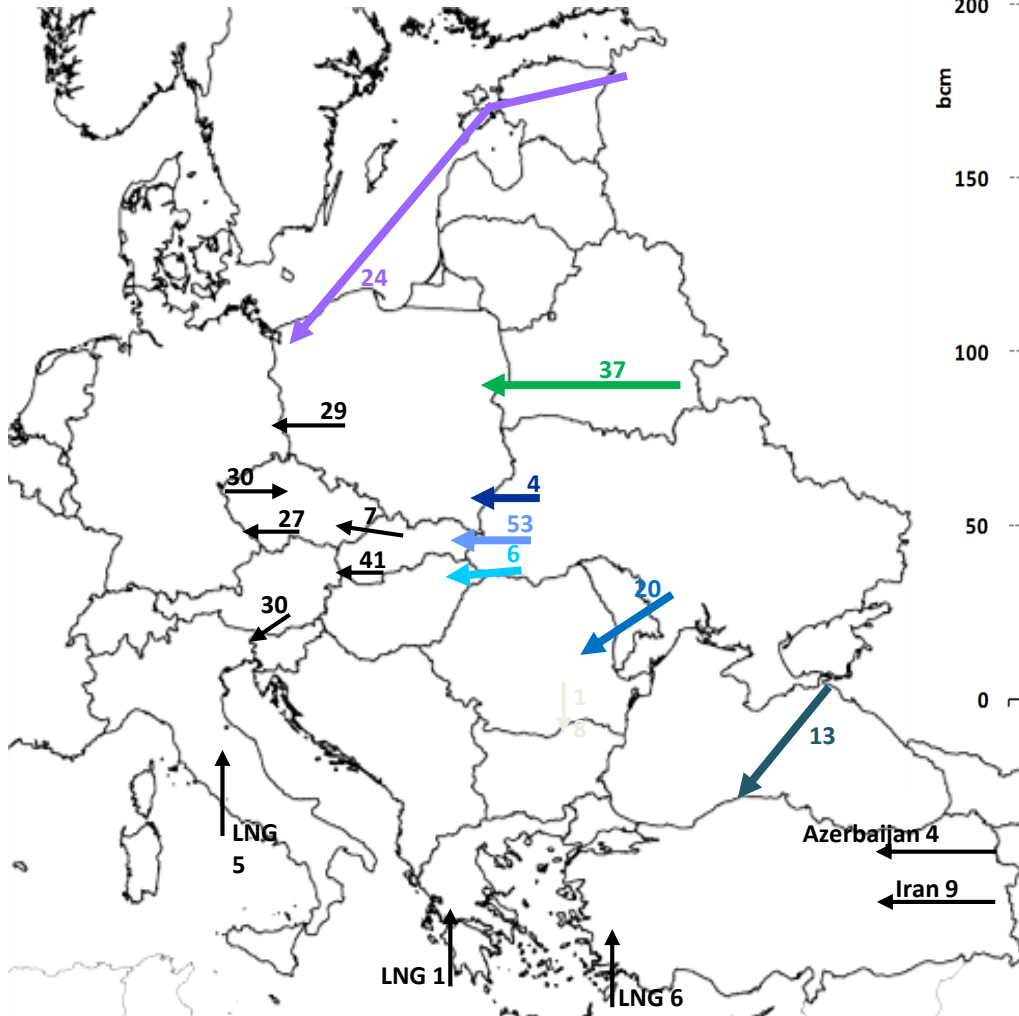


Iraq production climbed 290 kb/d to a 35-year high of 3.7 mb/d in December. (IEA Oil Market Report March 2015)

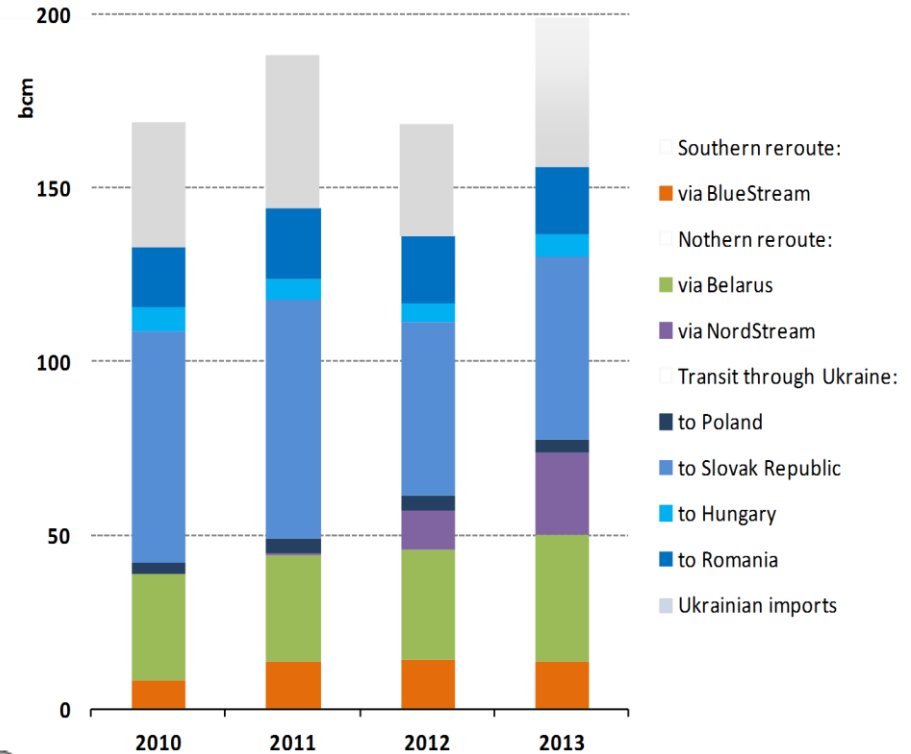
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 This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

No2 Risk : Ukraine and Russia

Major physical flows in 2013 in bcm



Russian gas exports to Europe



Data from IEA 2014

IEA's view on the current oil market: **"We have begun a new chapter in the history of the oil markets."** (OMR 2014 Nov)

Oil Market Report Jan16

"Oil's place in the global energy mix is also transforming. While there might be light at the end of the tunnel for producers as far as prices are concerned, the next few years could nevertheless prove a period of reckoning for a market and an industry that, through the course of their 150-year history, have had to periodically reinvent themselves."

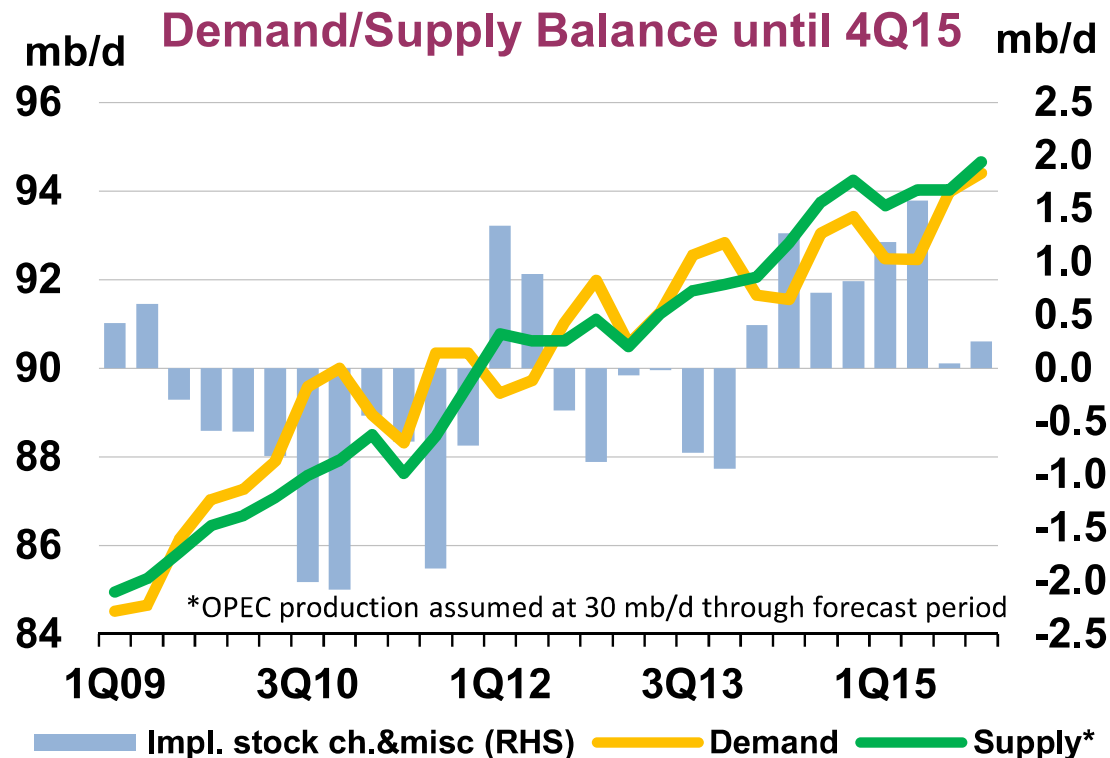
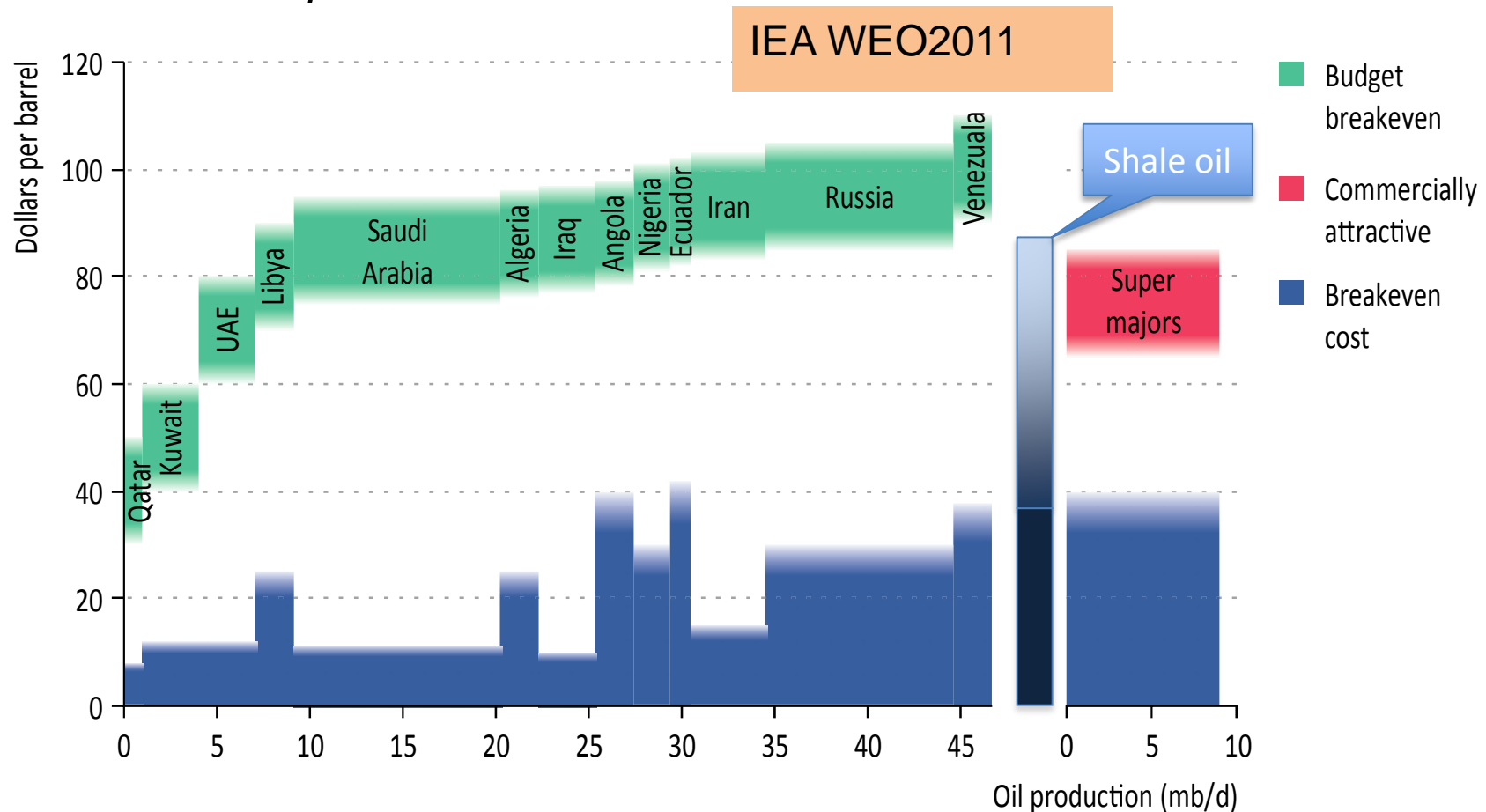


Figure 3.21 • Breakeven costs, budget breakeven and commercially attractive prices for current oil production for selected producers, mid-2011

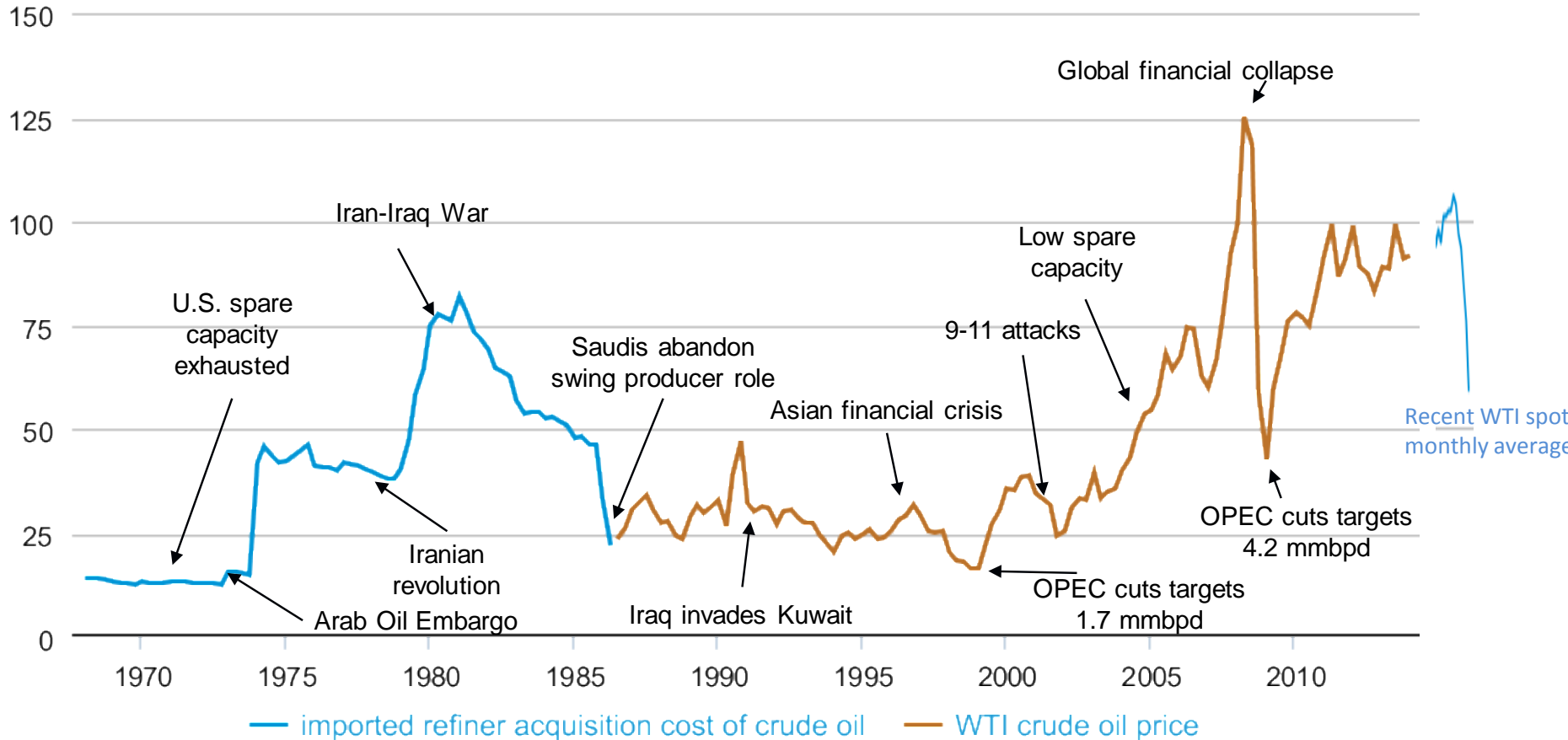


Notes: Only OPEC countries, Russia and the aggregation of the five super-majors (BP, Chevron, ExxonMobil, Shell and Total) are included. The breakeven cost is the realised oil price at which all operating expenses (excluding taxes) and capital costs (including a 10% capital discount rate), are fully recovered.

Sources: IEA databases and analysis based on industry sources: APICORP (2011), Deutsche Bank (2011), Credit Suisse (2011), IMF (2011), PFC (2011) and CGES (2011).

Historical Trend of Oil Price : Ups and Downs.

price per barrel (real 2010 dollars)

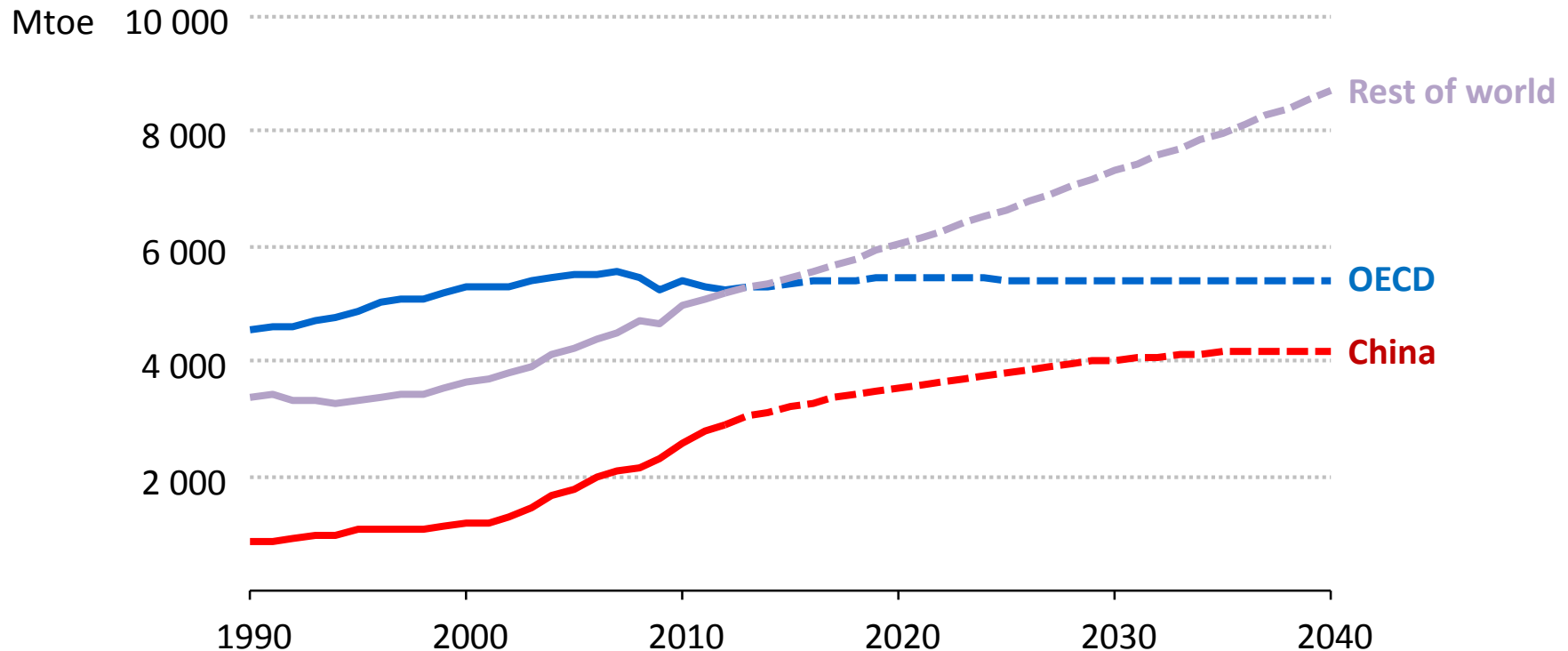


Sources: U.S. Energy Information Administration, Thomson Reuters

Changing dynamics of global demand

Energy demand by region

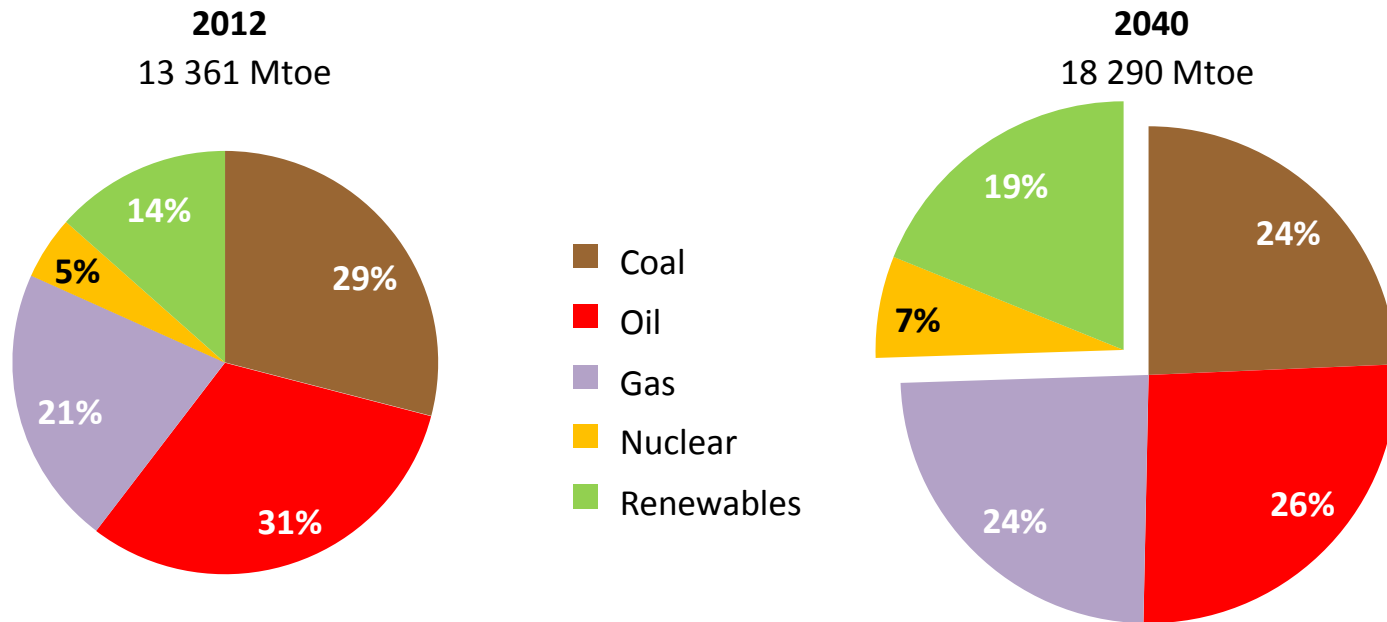
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As China slows, then India, Southeast Asia, the Middle East and parts of Africa & Latin America take over as the engines of global energy demand growth.

A changing energy mix

Fuel shares in world primary energy demand in the New Policies Scenario



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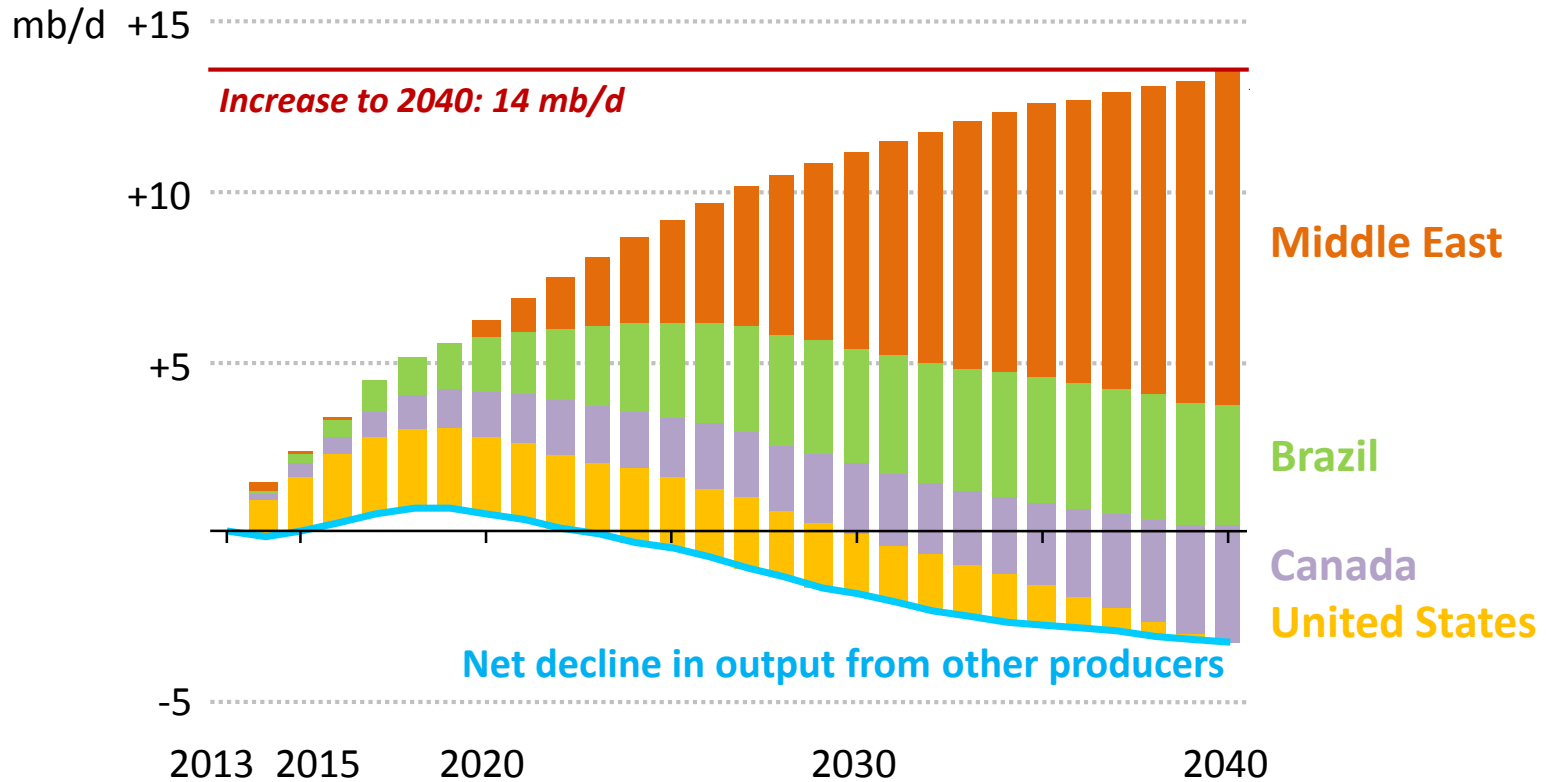
The share of fossil fuels falls gradually through the Outlook period, though they remain dominant in 2040, each accounting for roughly one-quarter of demand

Instability in the Middle East a major risk to oil markets

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Oil production growth

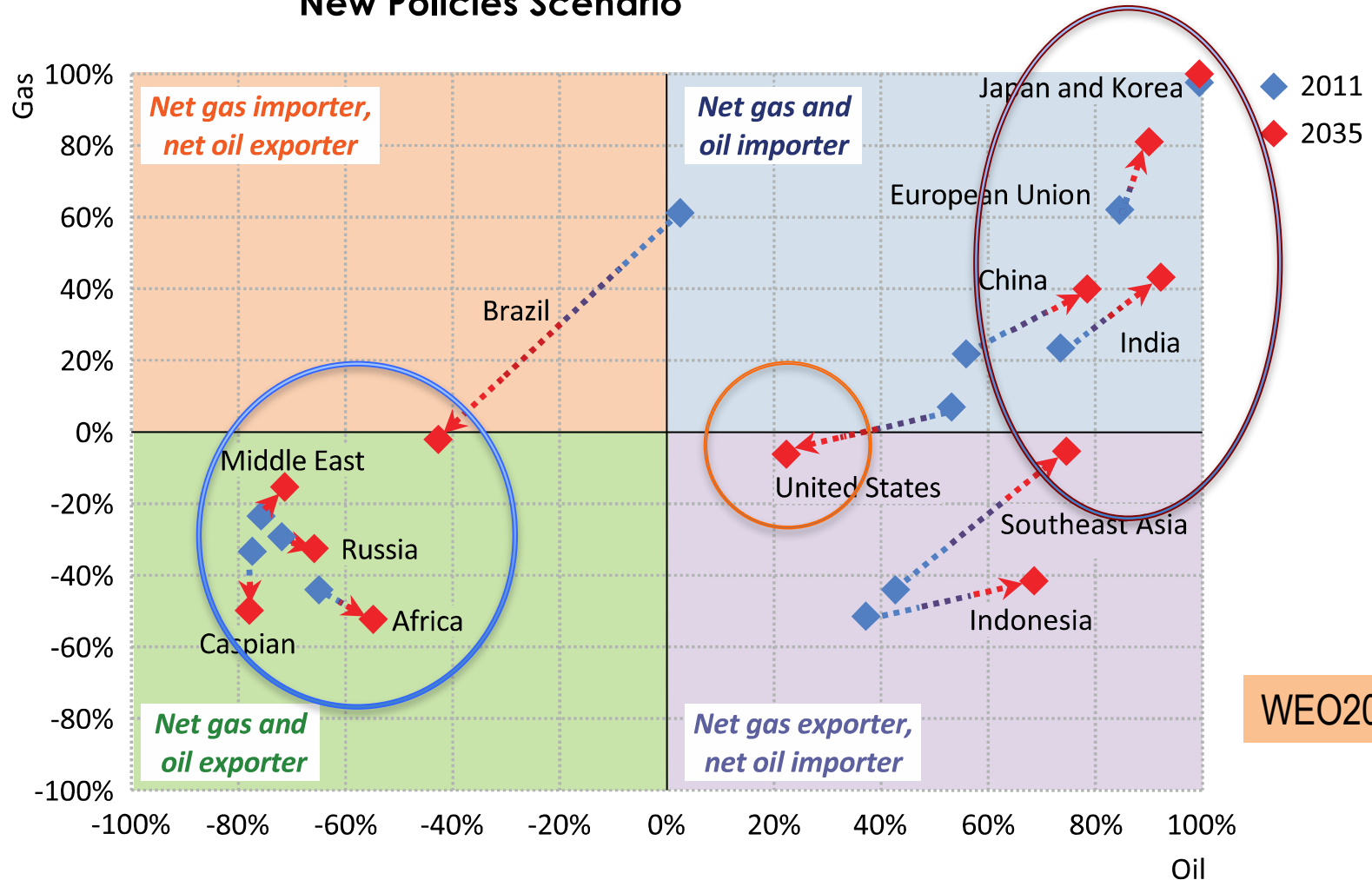
in United States, Canada, Brazil & the Middle East



The short-term picture of a well-supplied market should not obscure future risks as demand rises to 104 mb/d & reliance grows on Iraq & the rest of the Middle East

Geopolitics of the Shale Revolution: Dichotomy between Oil / Gas exporters and importers.

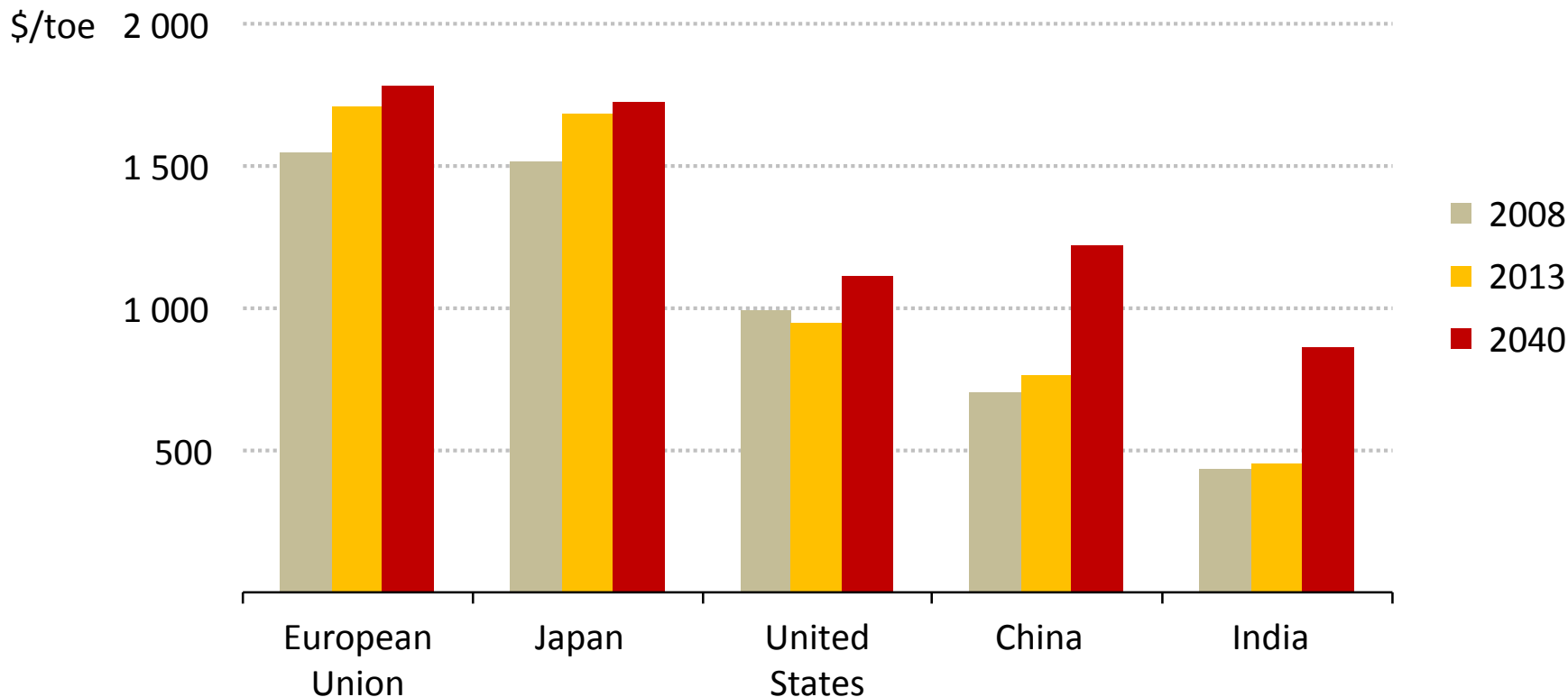
Figure 2.12 ▶ Net oil and gas import/export shares in selected regions in the New Policies Scenario



United States holds a strong position on energy costs

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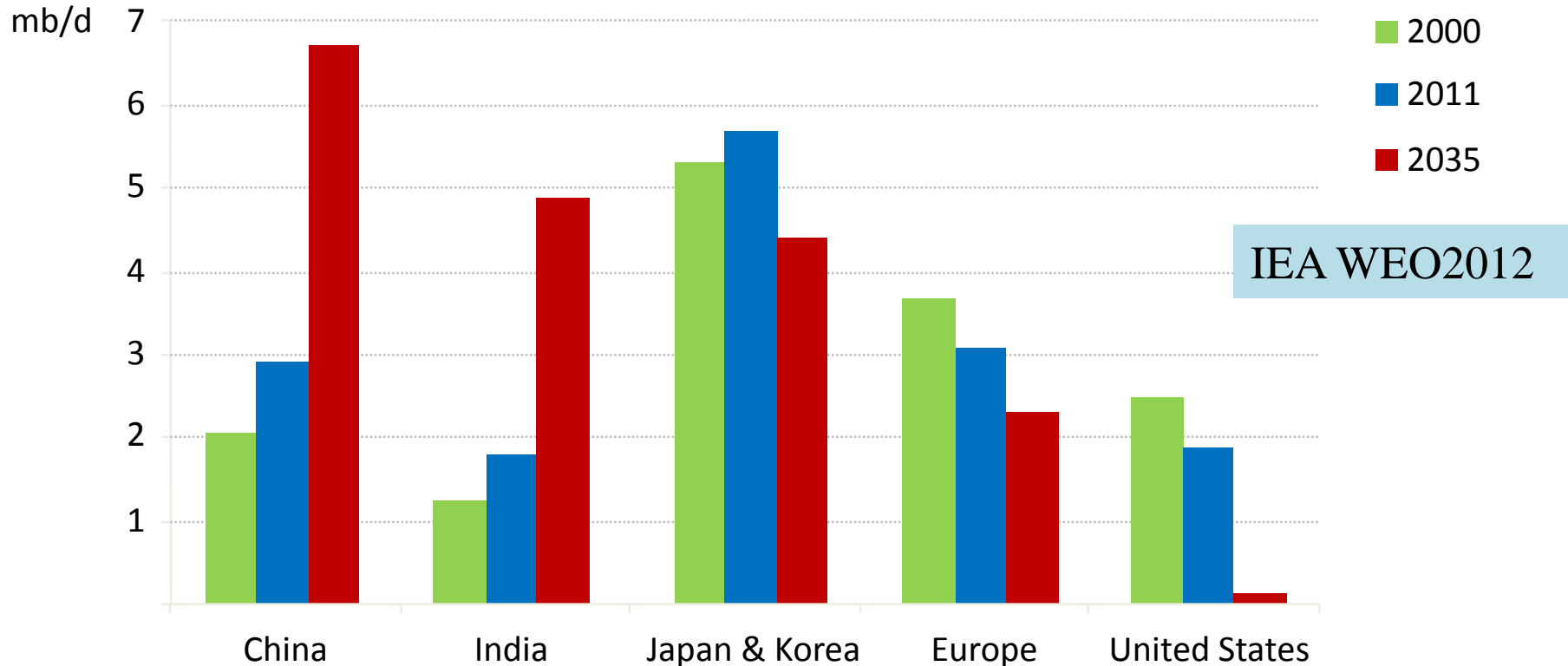
Weighted average cost of energy paid by consumers



Economies face higher costs, but the pace of change varies: China overtakes the US, costs double in India & remain high in the European Union & Japan

North American Energy Independence and Middle East Oil to Asia: a new Energy Geopolitics

Middle East oil export by destination

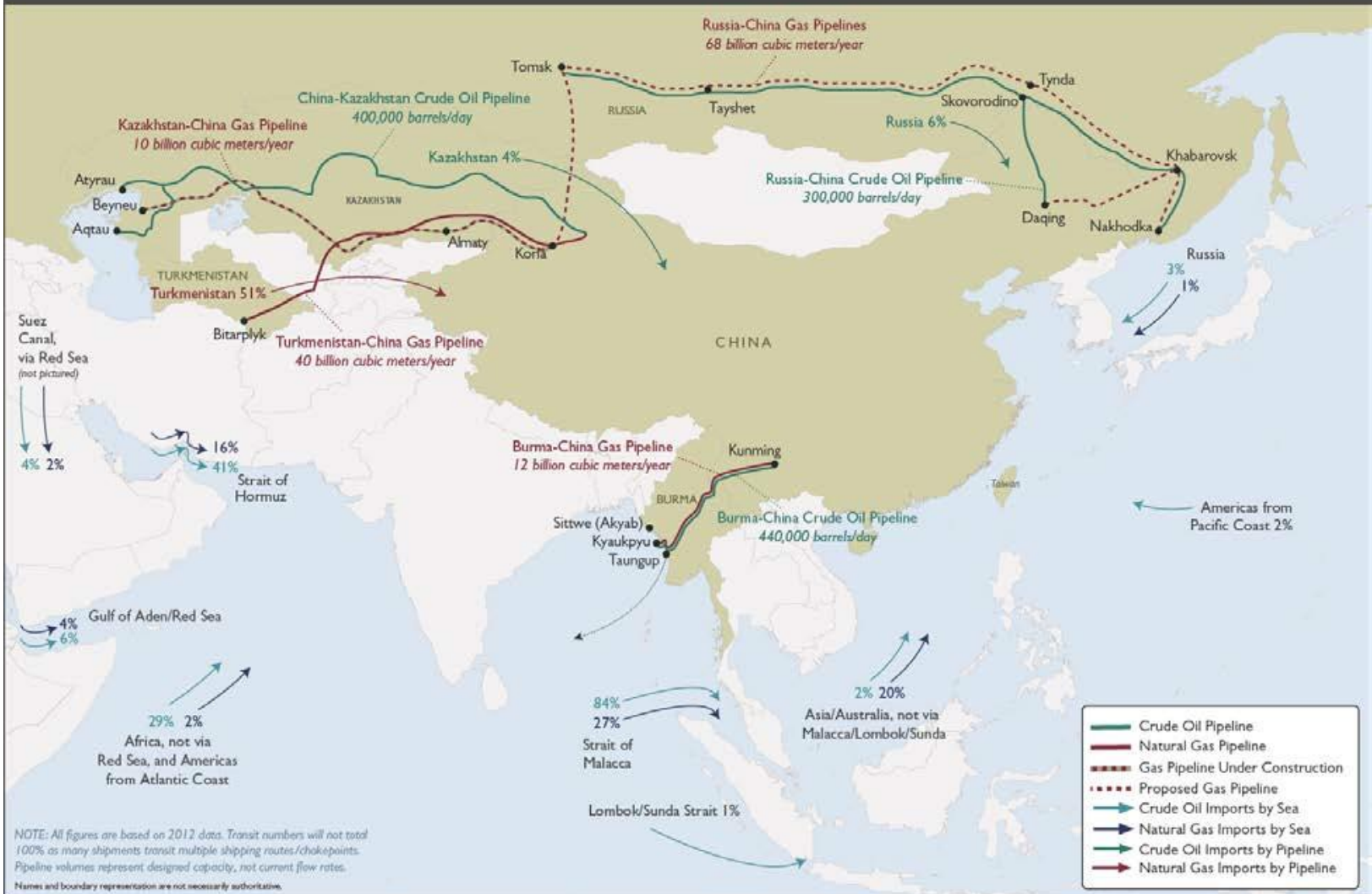


By 2035, almost 90% of Middle Eastern oil exports go to Asia; North America's emergence as a net exporter accelerates the eastward shift in trade

China's Oil and Gas Import Transit Routes

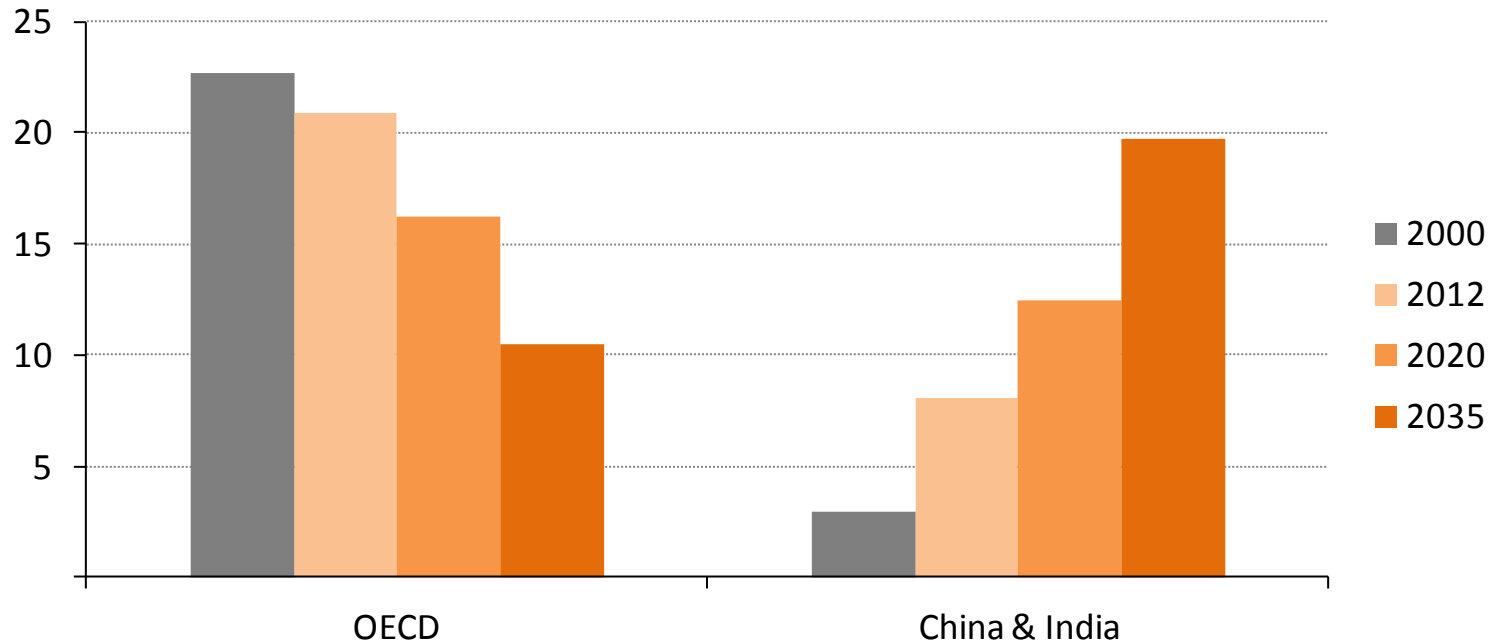
UNCLASSIFIED

(U) China's Import Transit Routes/Critical Chokepoints and Proposed/Under Construction SLOC Bypass Routes



Should China and India join the IEA ?

Net oil imports of selected countries in the New Policies Scenario (mb/d)



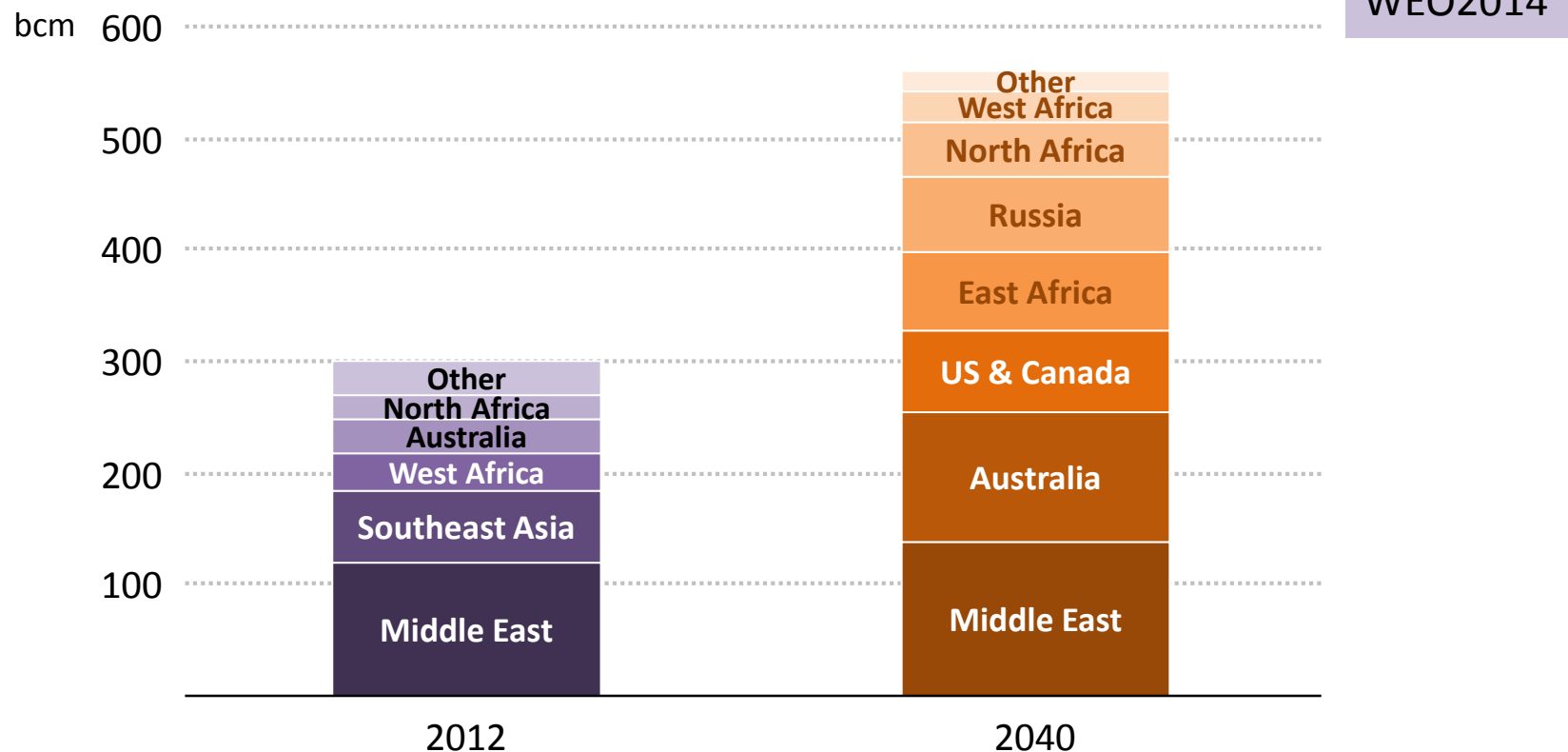
Asia becomes the unrivalled centre of the global oil trade as the region draws in a rising share of the available crude

Henry Kissinger said, “Yes.”



Gas on the way to become first fuel, with role of LNG on the rise

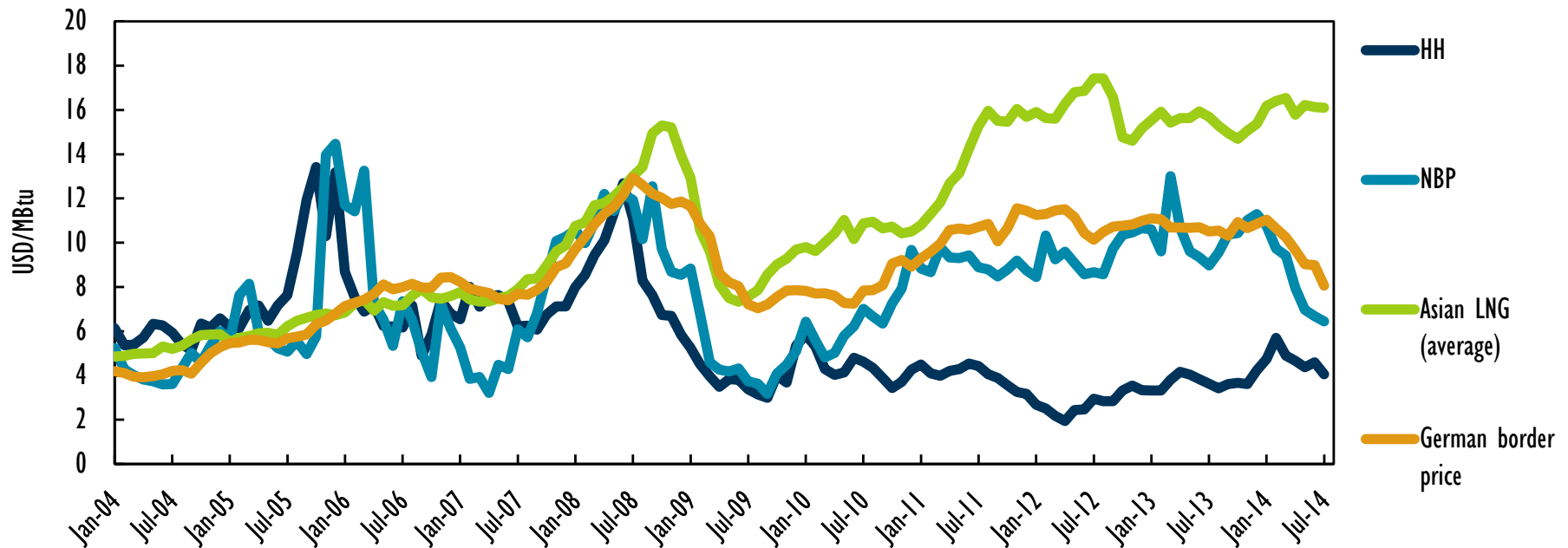
Main sources of regional LNG supply



***Share of LNG rises in global gas trade, pushed by a near-tripling in liquefaction sites:
LNG brings more integrated & secure gas markets, but only limited relief on prices***

What is making Asian gas price so high?

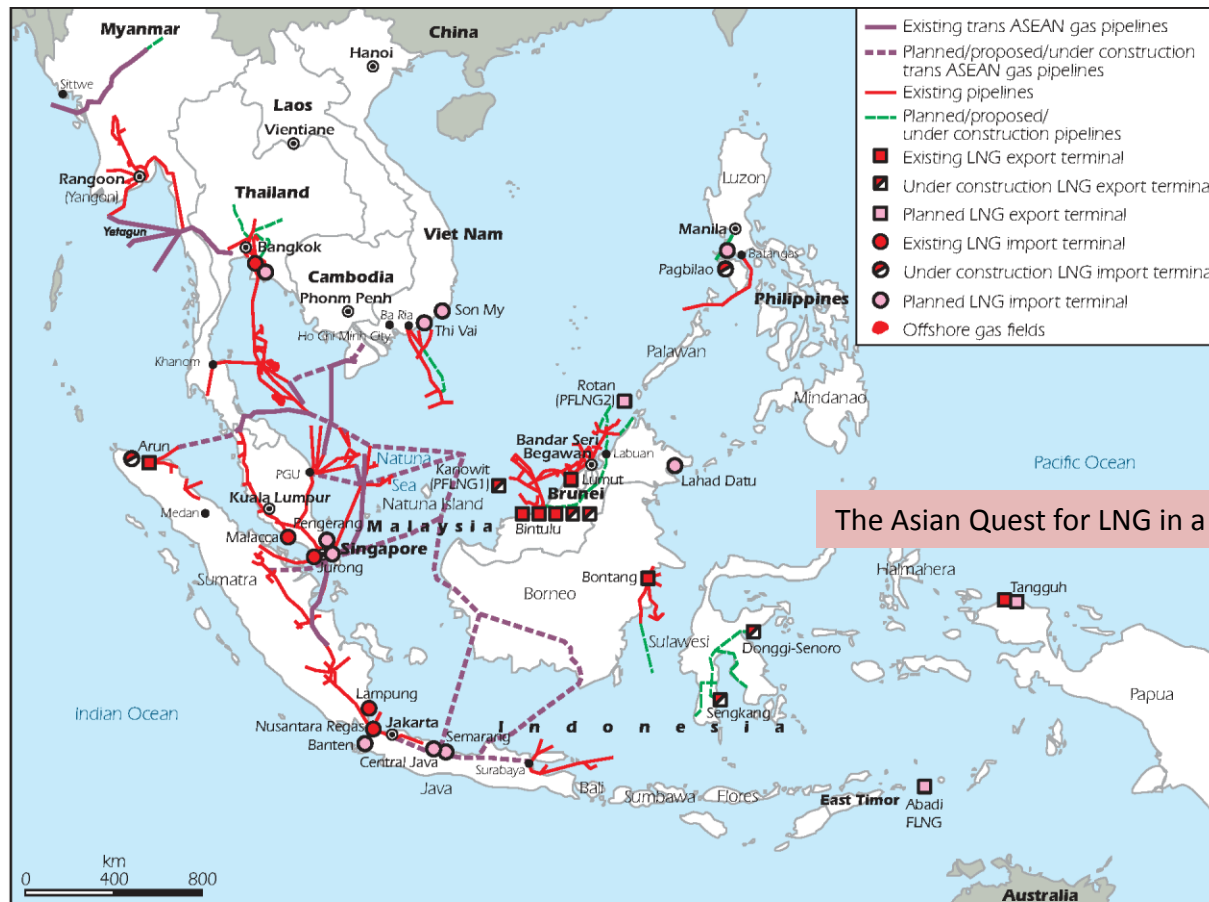
Evolution of regional gas prices



- Wide price gap has been seen for several years among major regional gas markets with no convergence.
- Not only as being the fastest-growing gas market, Asia is even more attractive for producers as Asian buyers pay the highest prices.

Trading hub – Asian-tailored solution?

TAGP and LNG terminals in Southeast Asia



This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

- Southeast Asian countries are already interlinked by pipeline and plan to increase these linkages through Trans ASEAN Gas Pipeline (TAGP) and LNG.

Russian Gas Pipelines Will Extend to the East: Recent China Deal

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

Possible Pipeline Project from Russia to Japan

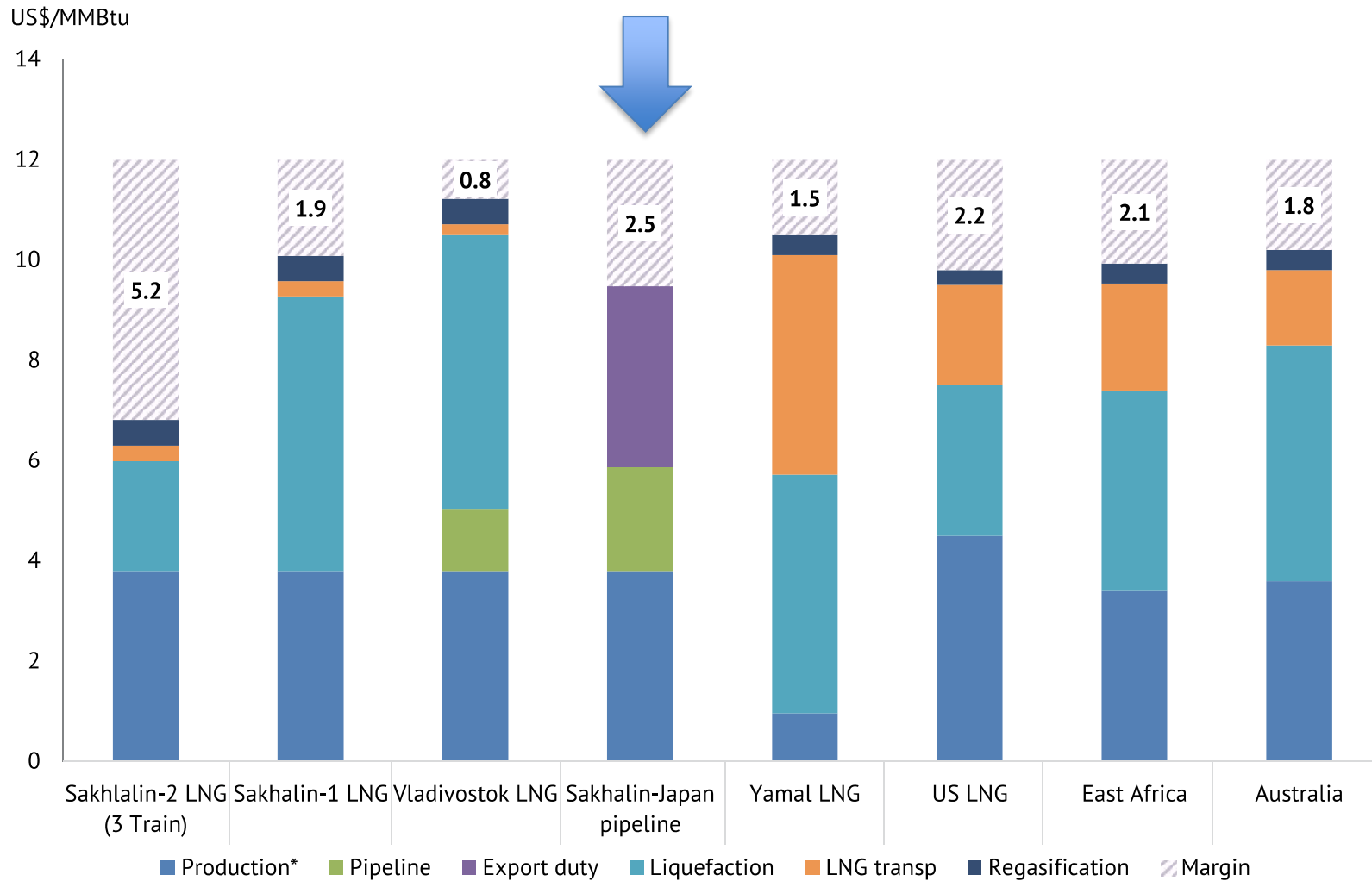
Figure 1. Proposed Subsea Pipeline Route*



* Only the Ishikari-Tomakomai section has onshore PL.

Estimated volume of 8bcm pa

Pipeline is much cheaper than other LNG projects

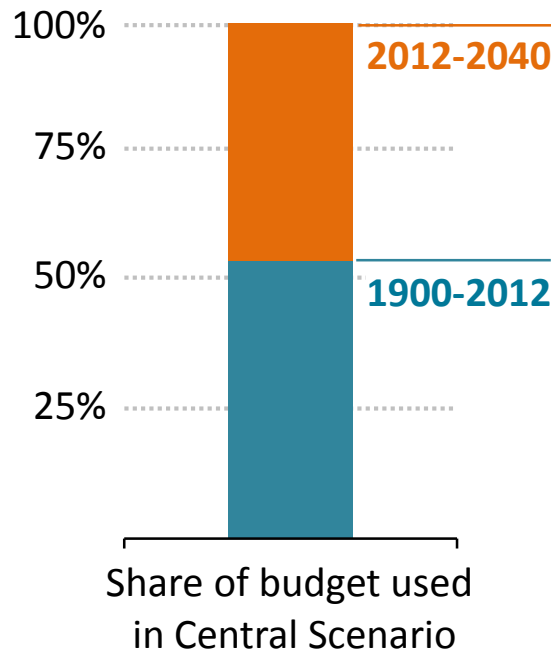


*Production tax included, except for the Yamal project.

Source: Compiled by ERI and IEEJ, based on various sources.

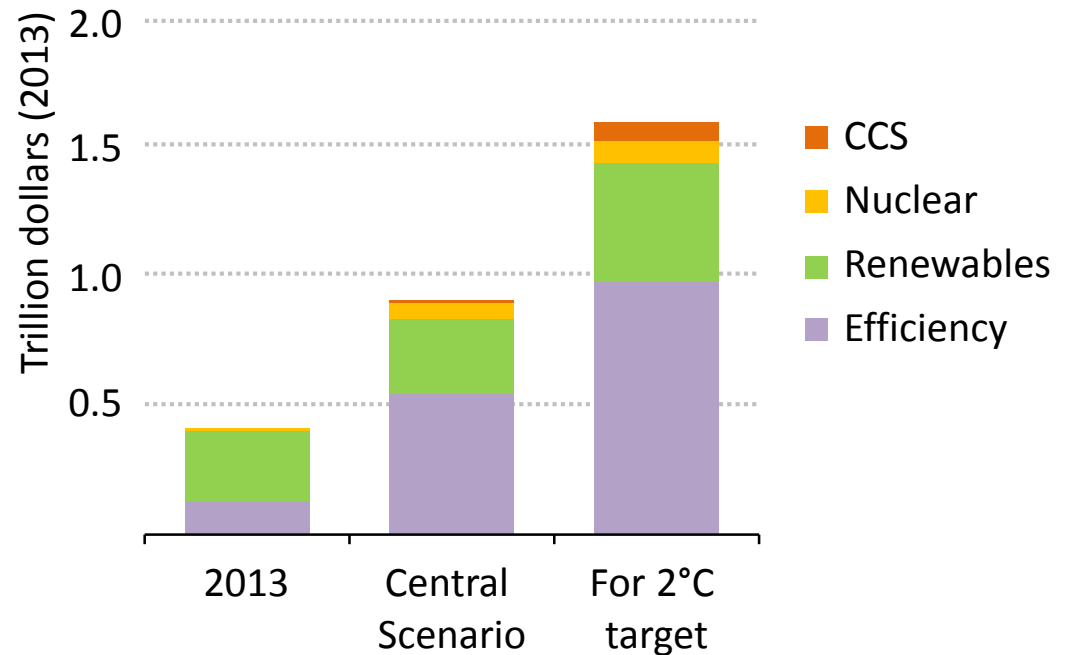
The 2 °C goal – last chance in Paris?

World CO₂ budget for 2 °C
~2300 Gt



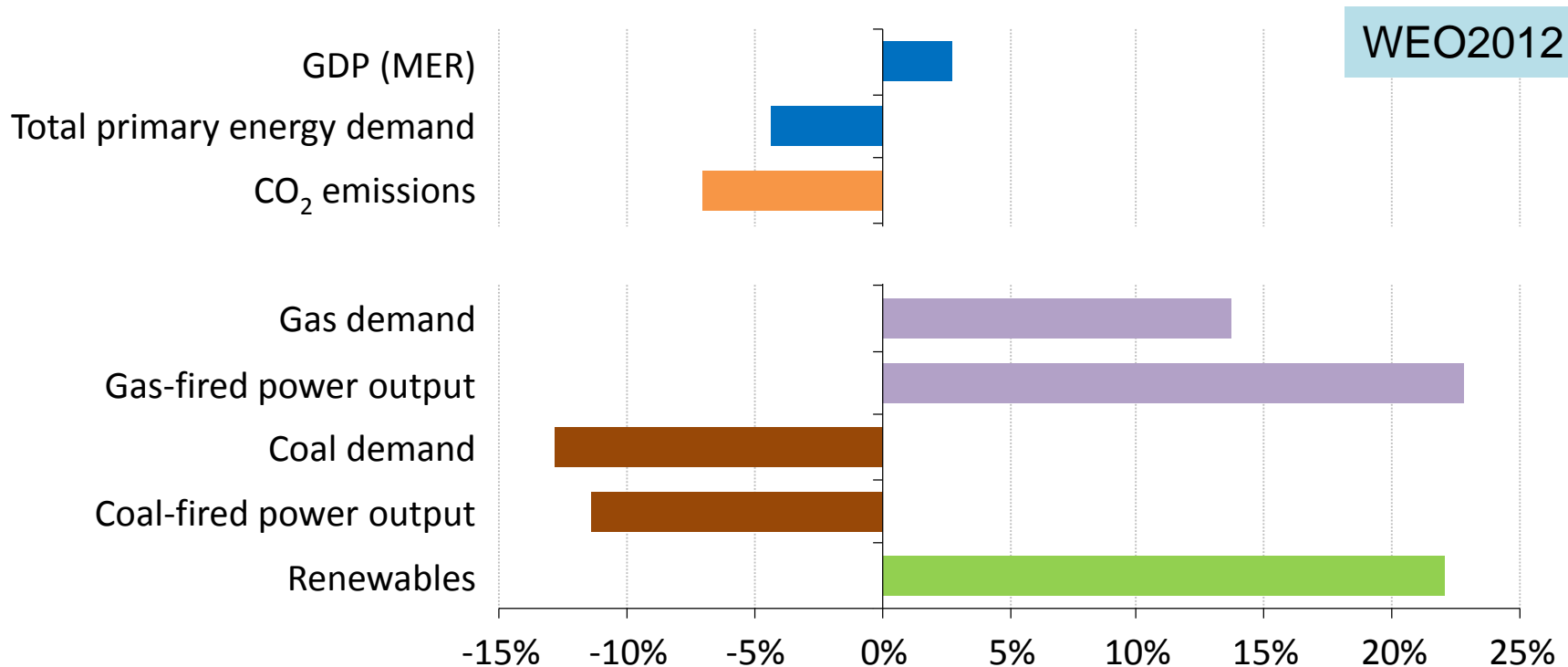
Average annual low-carbon investment, 2014-2040

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The entire global CO₂ budget to 2100 is used up by 2040 – Paris must send a strong signal for increasing low-carbon investment four times beyond current levels

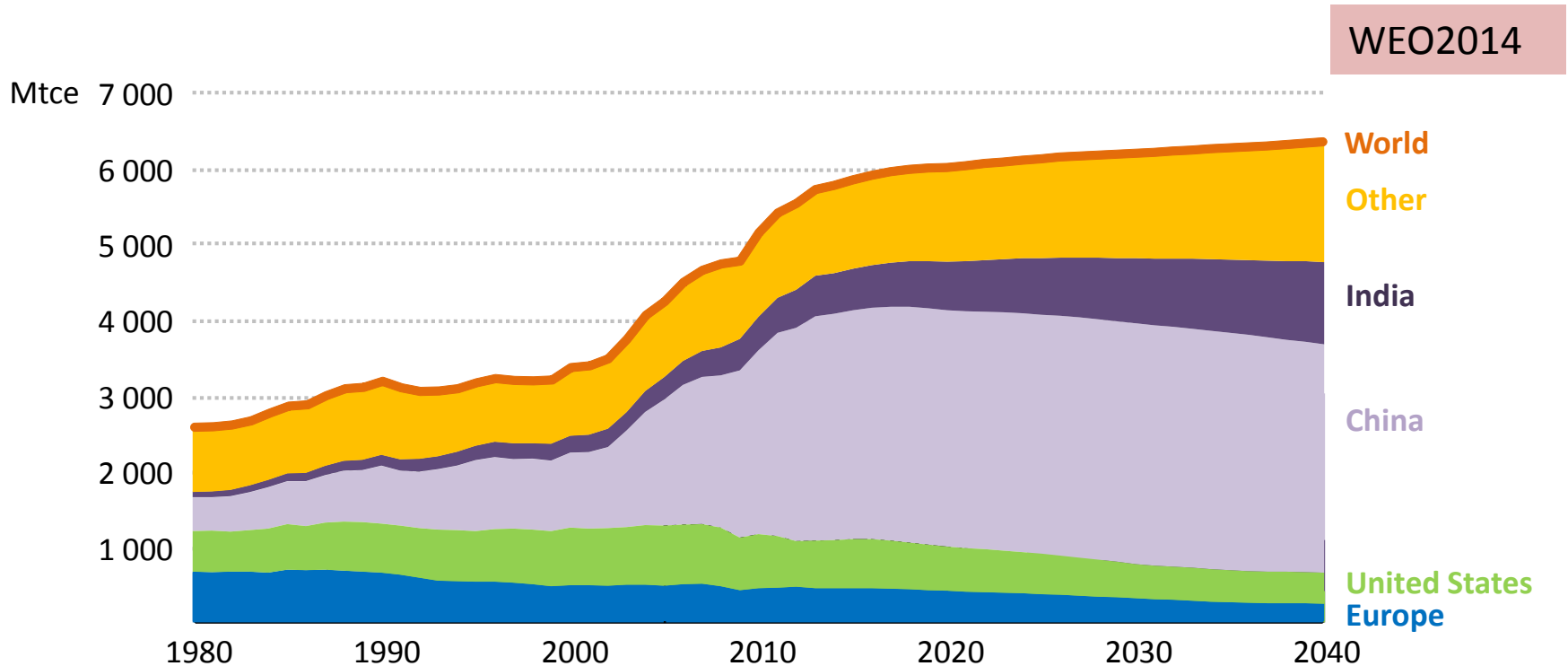
What has happened in the Shale revolution of the US: US aims to reduce CO₂ by 30% towards 2030 in the Power sector.



From 2006-2011, United States CO₂ emissions went down by 7% due to coal-to-gas fuel switching, power generation efficiency gains & increased renewables output

Global coal demand leveling off

Global coal demand by key region

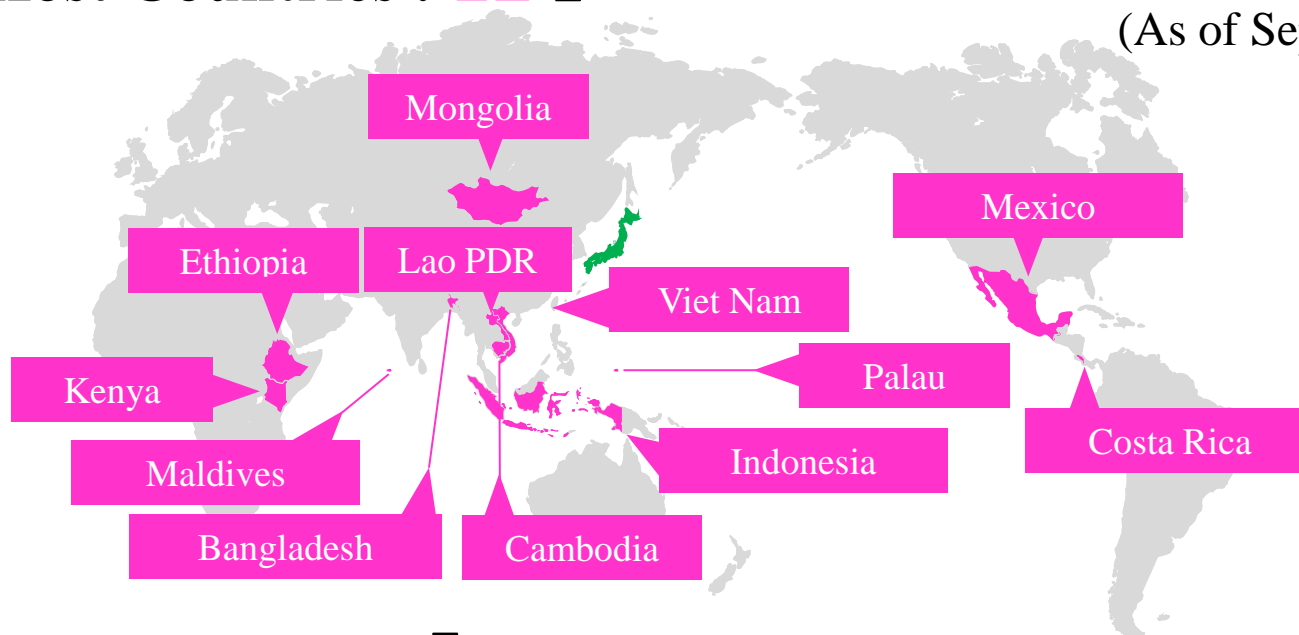


Global coal demand growth slows rapidly due to more stringent environmental policies, underlining the importance of high-efficiency plant & CCS to coal's future

JCM Host Countries and Future Projects

□ JCM Host Countries : 12 □

(As of September, 2014)



□ Future JCM projects □

□ Renewable Energy

- Solar Power Plant
- Micro Hydro Power Plant
- Biomass Power Generation

□ Energy-Saving

- Integrated Steel Works
- Building Energy Management System
- Energy Efficient Air Conditioner

□ High Efficient Thermal Power Plant

- CCGT(Combined Cycle Gas Turbine) : Natural Gas

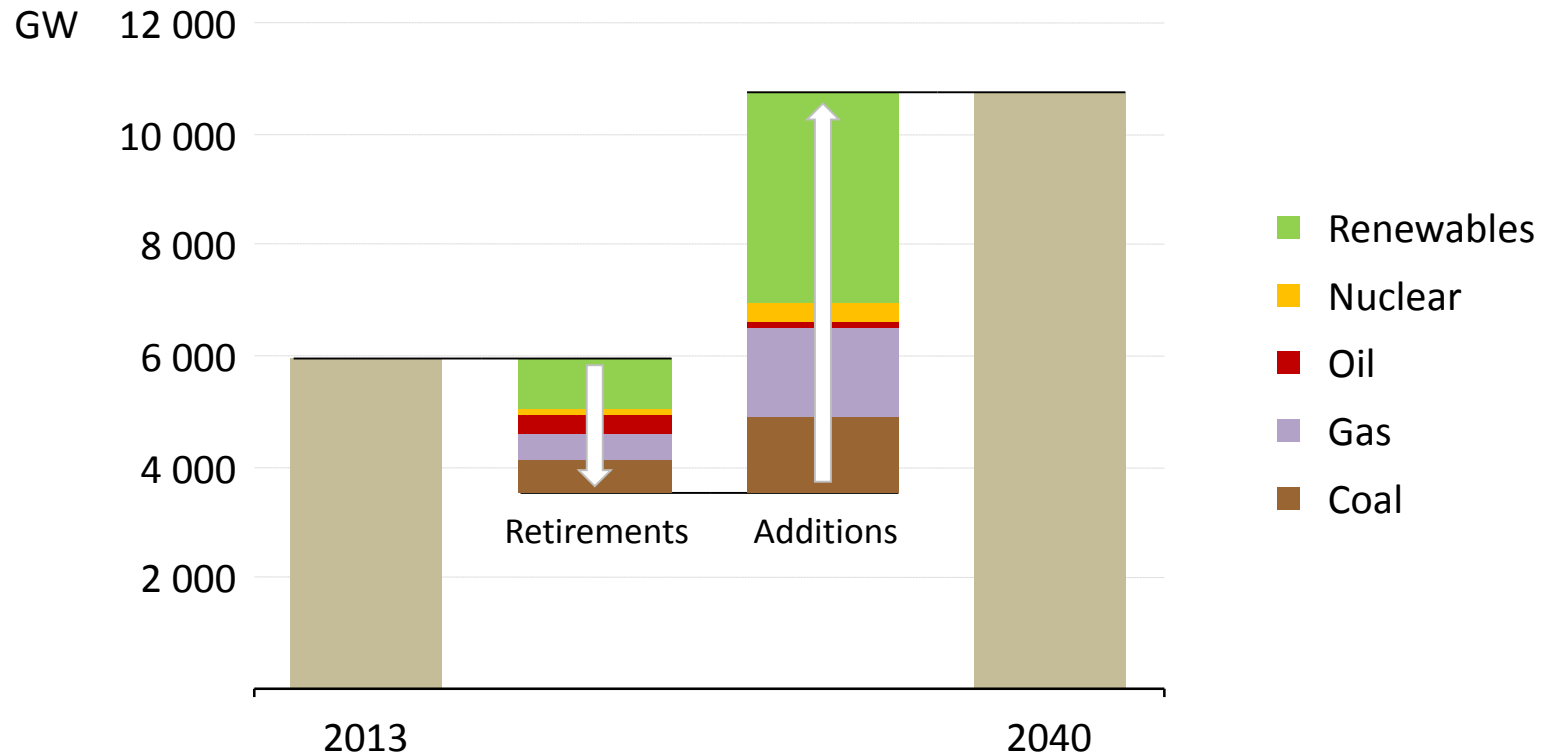
□ CCS (Carbon dioxide Capture and Storage)

- CO₂-EOR (Enhanced Oil Recovery)

Retirements add to the investment challenge in the power sector

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Power capacity by source, 2013-2040

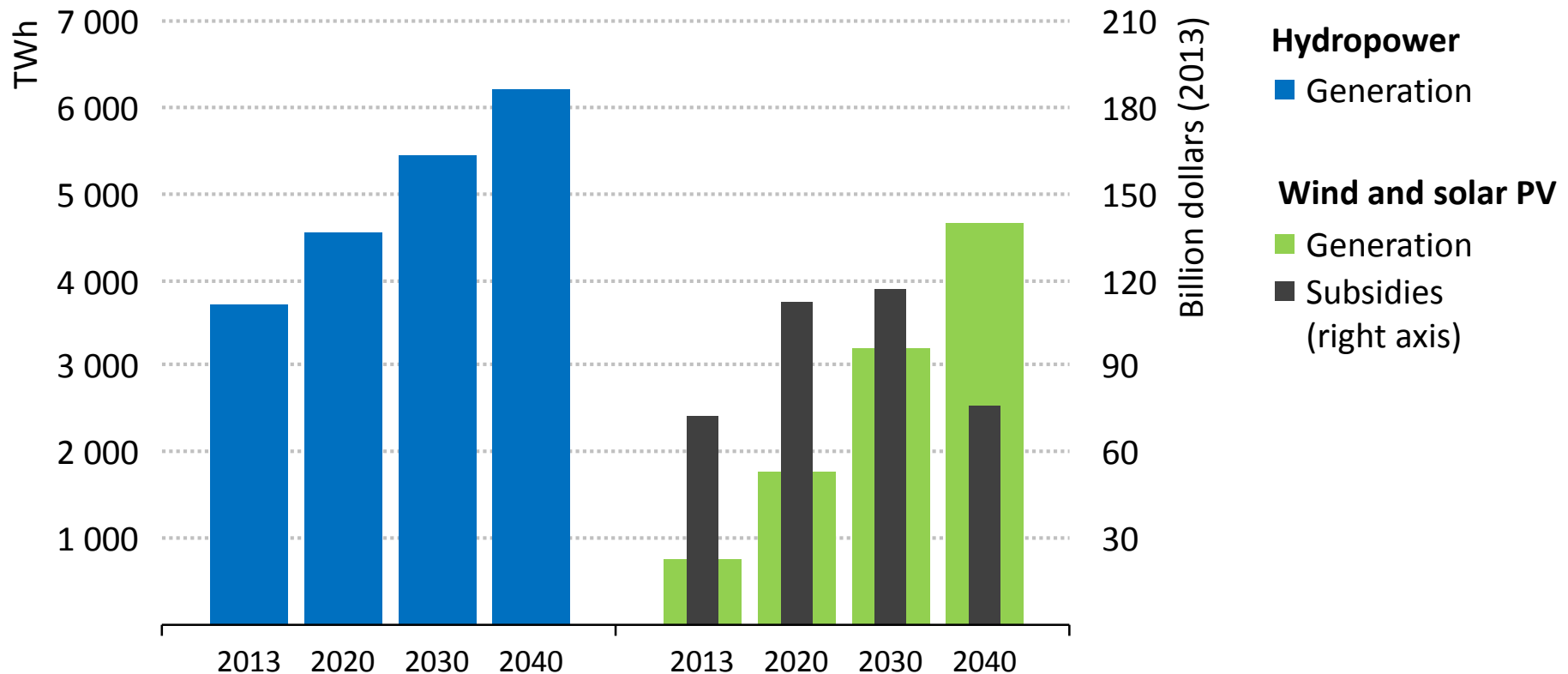


Despite limited demand growth, OECD countries account for one-third of capacity additions – to compensate for retirements & to decarbonise

Renewables overtake coal to become the leading source of power

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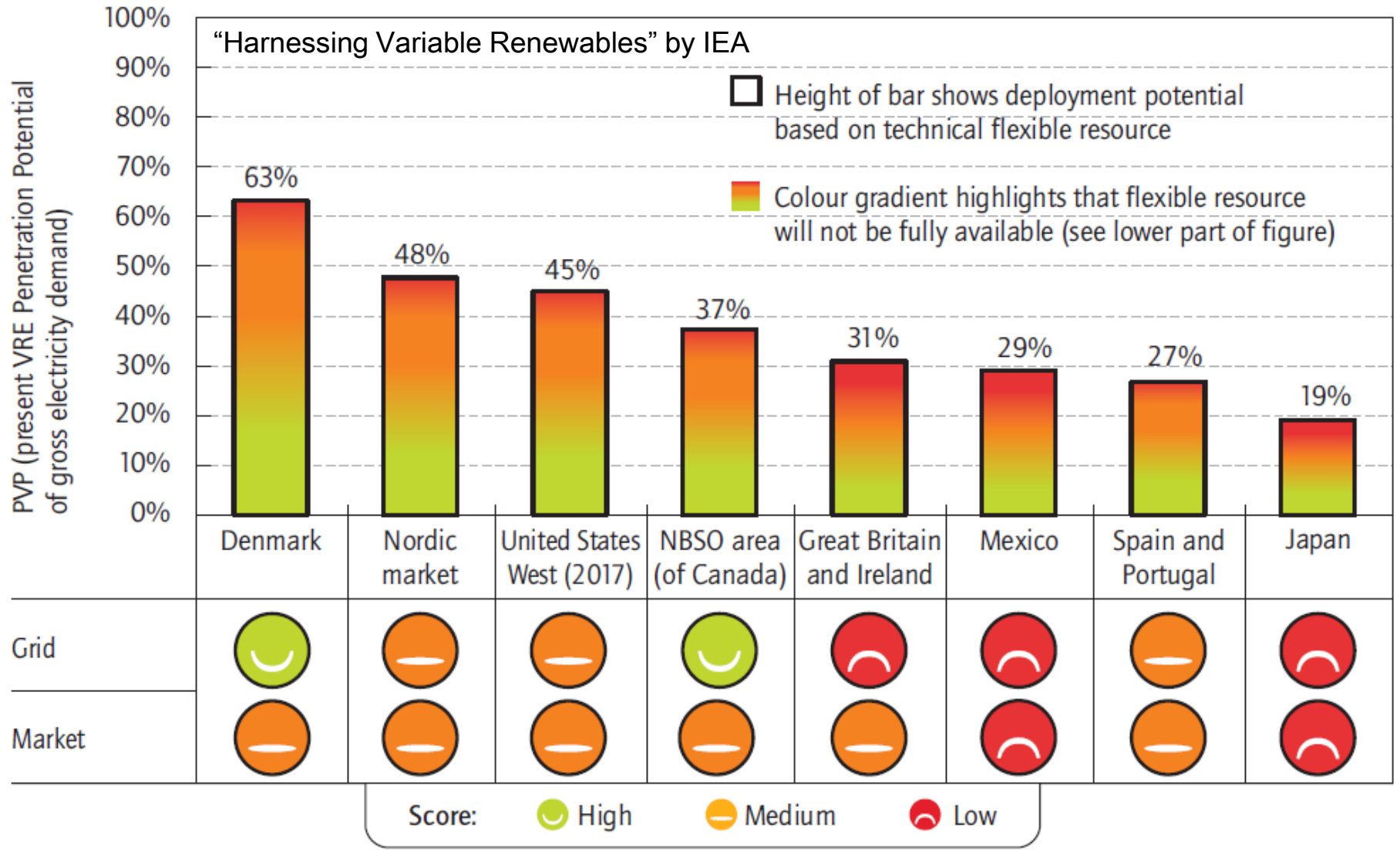
Renewables-based power generation and subsidies



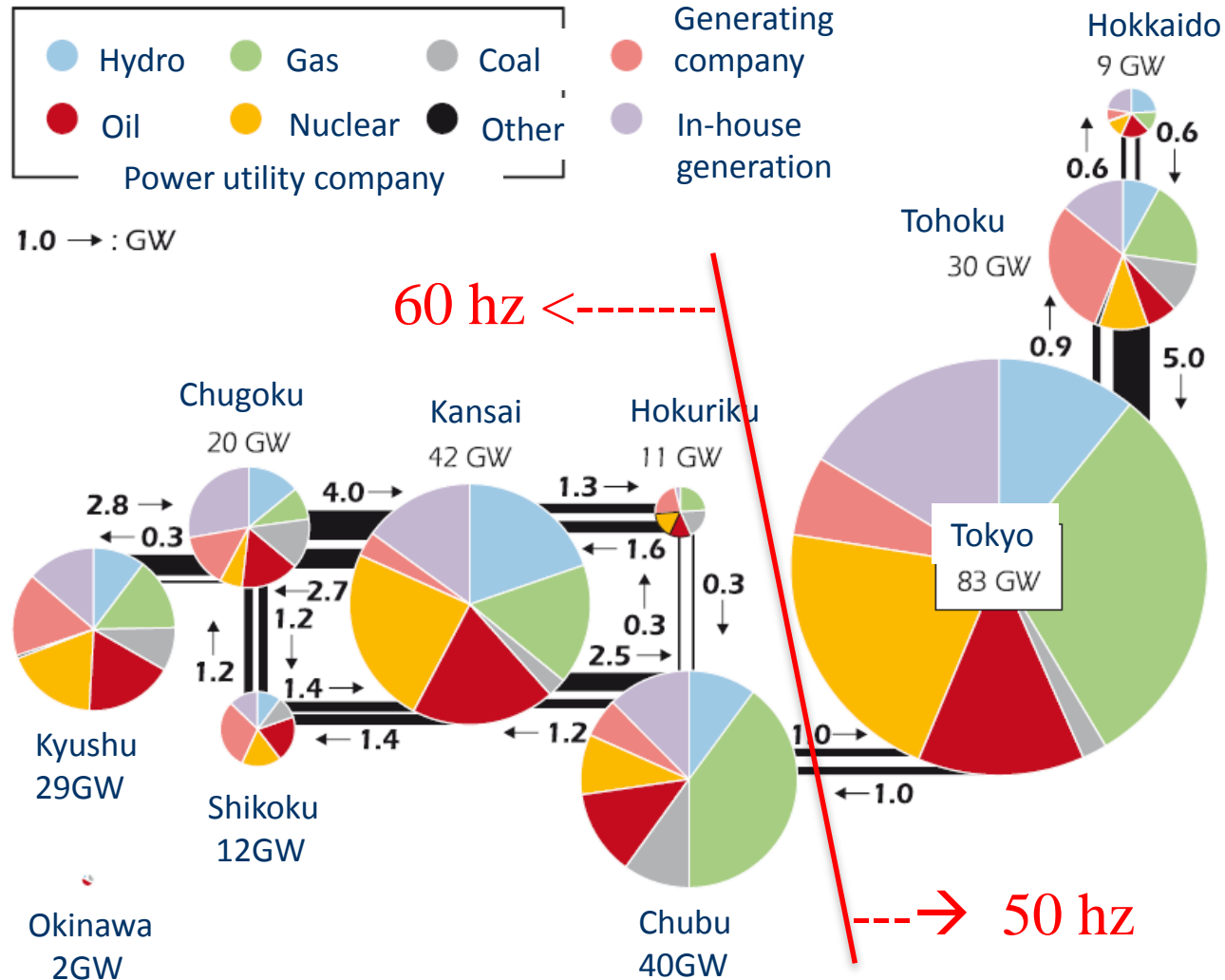
Renewables supply half of the growth in global power demand; wind & solar PV subsidies decline from 2030 as costs fall & recent higher-cost commitments expire

Not only Feed-in-tariffs but Grid integration !

Snapshot of present penetration potentials



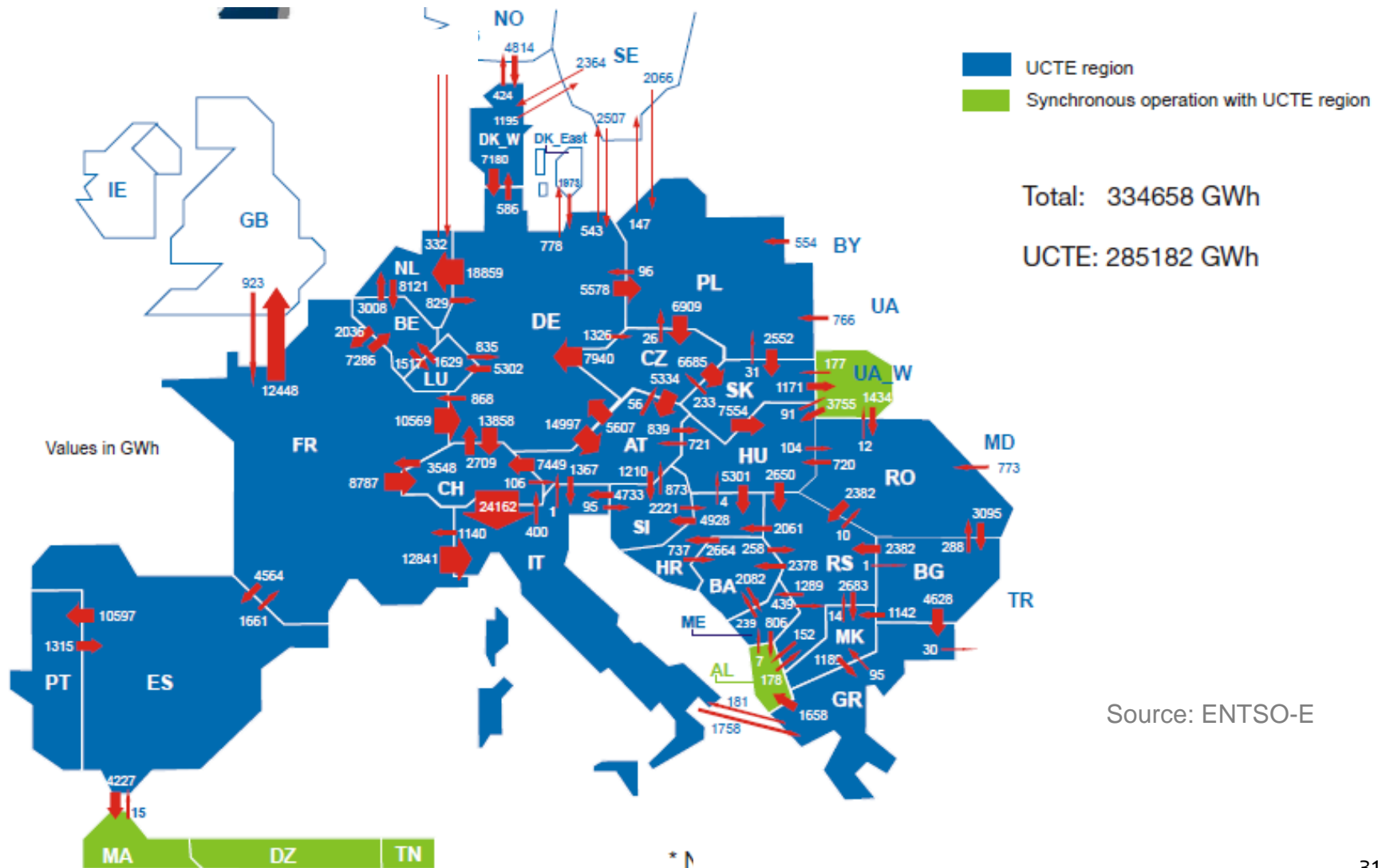
Problem is in Power grid connectivity



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

Power Grid Connection in Europe

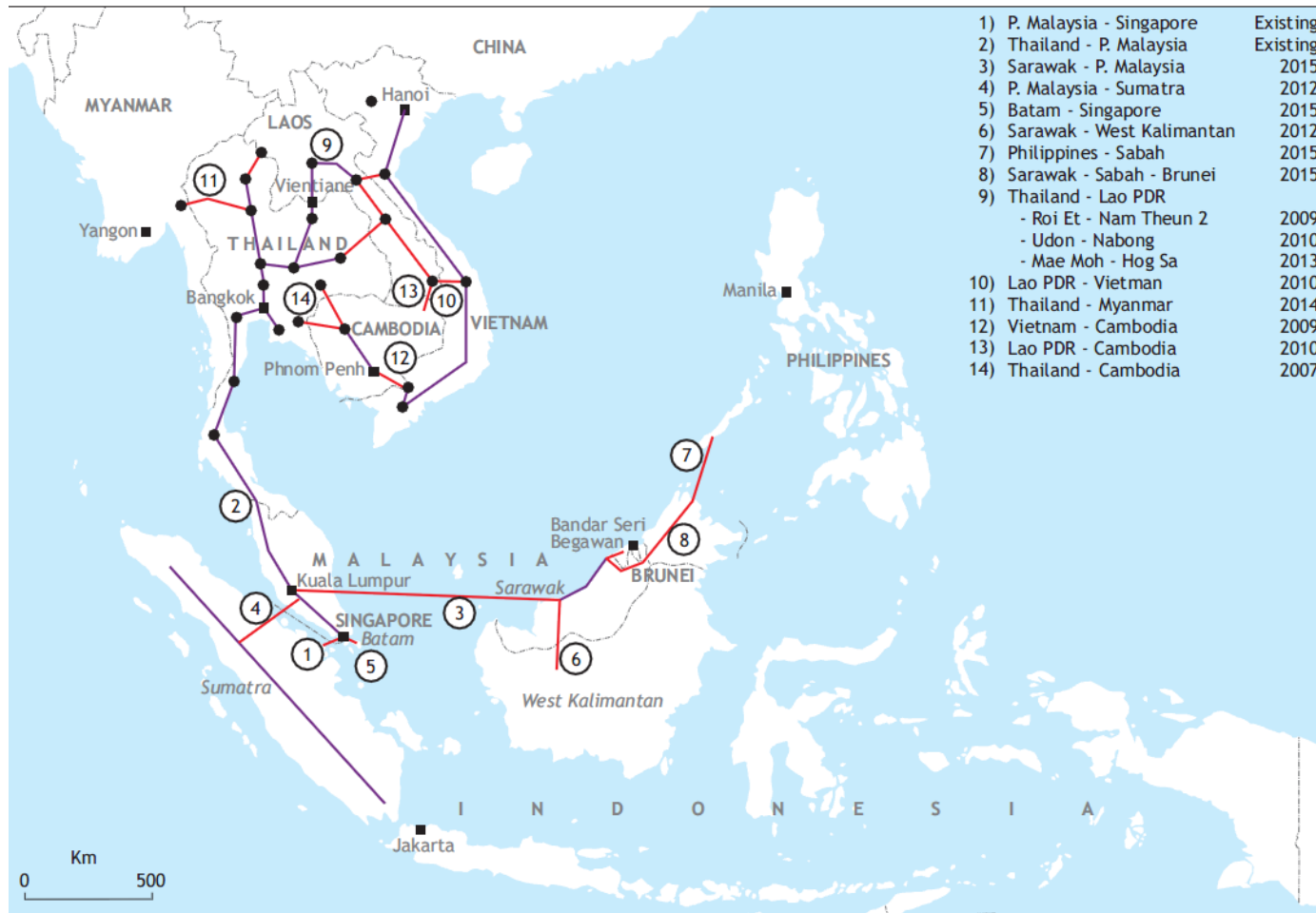
Physical energy flows between European countries, 2008 (GWh)



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



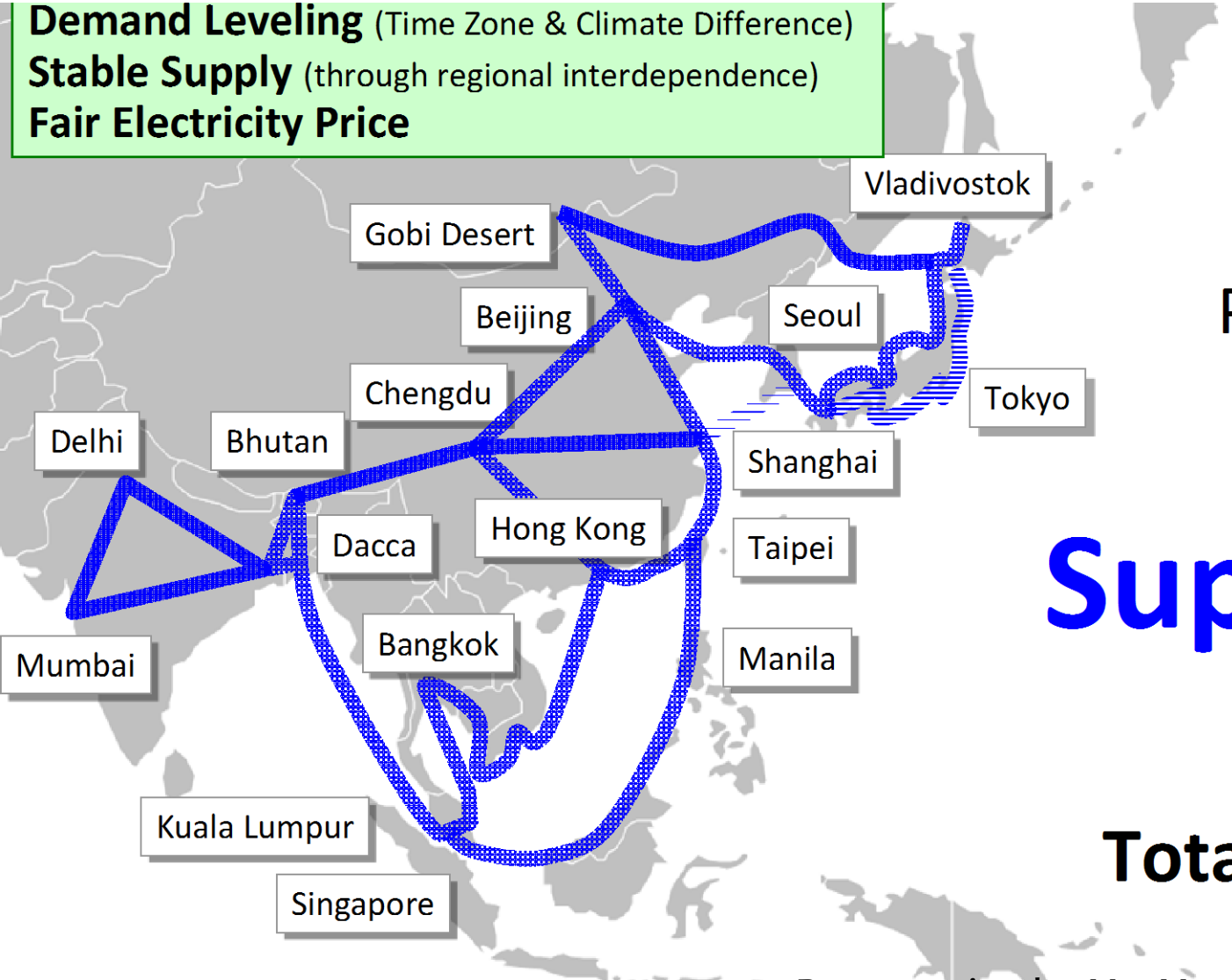
ASEAN power grid connection



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“Energy for Peace in Asia” New Vision?

Demand Leveling (Time Zone & Climate Difference)
Stable Supply (through regional interdependence)
Fair Electricity Price

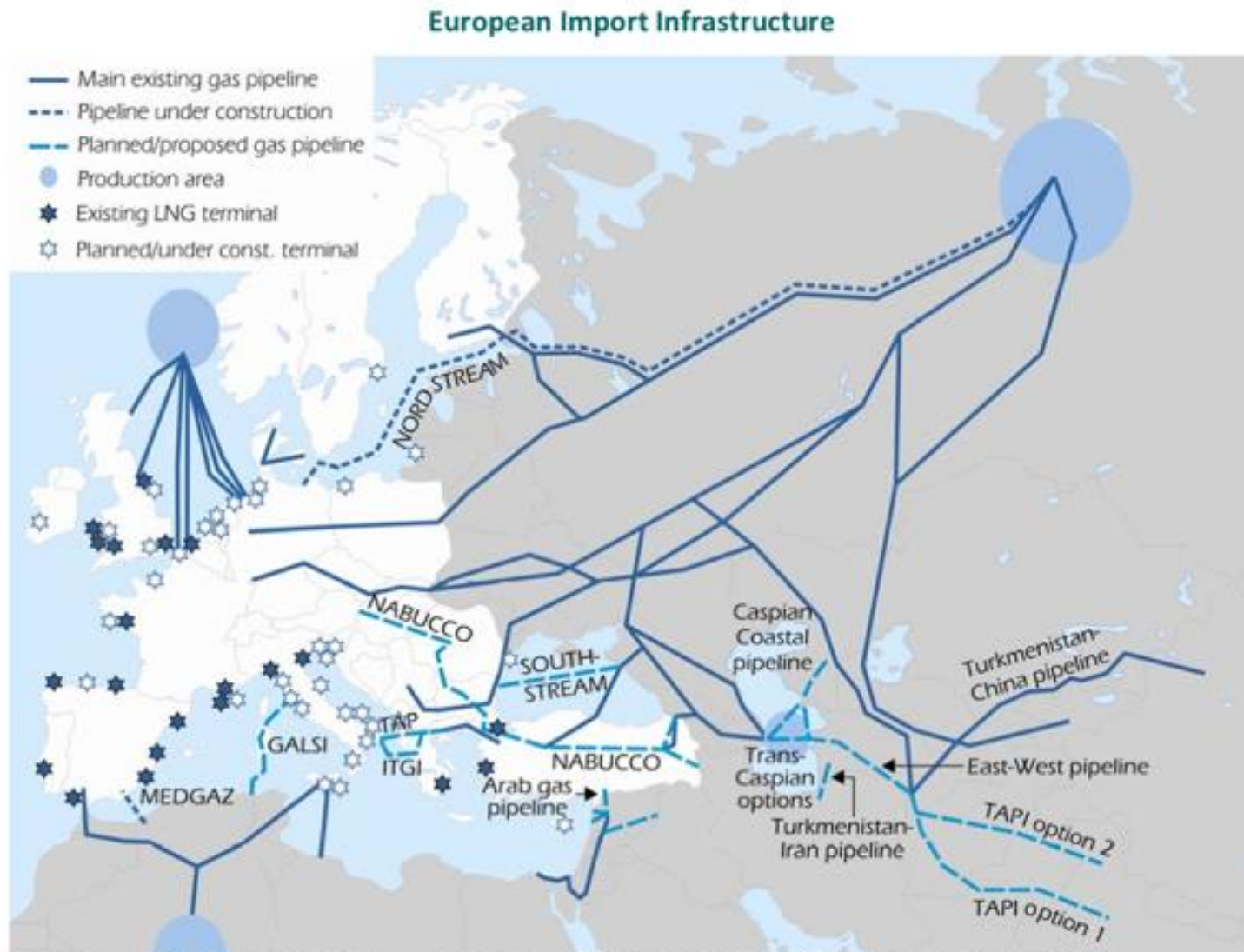


Phase 3 **Asia Super Grid**

Total 36,000km

Presentation by Mr. Masayoshi SON

Natural Gas Import Infrastructure in Europe

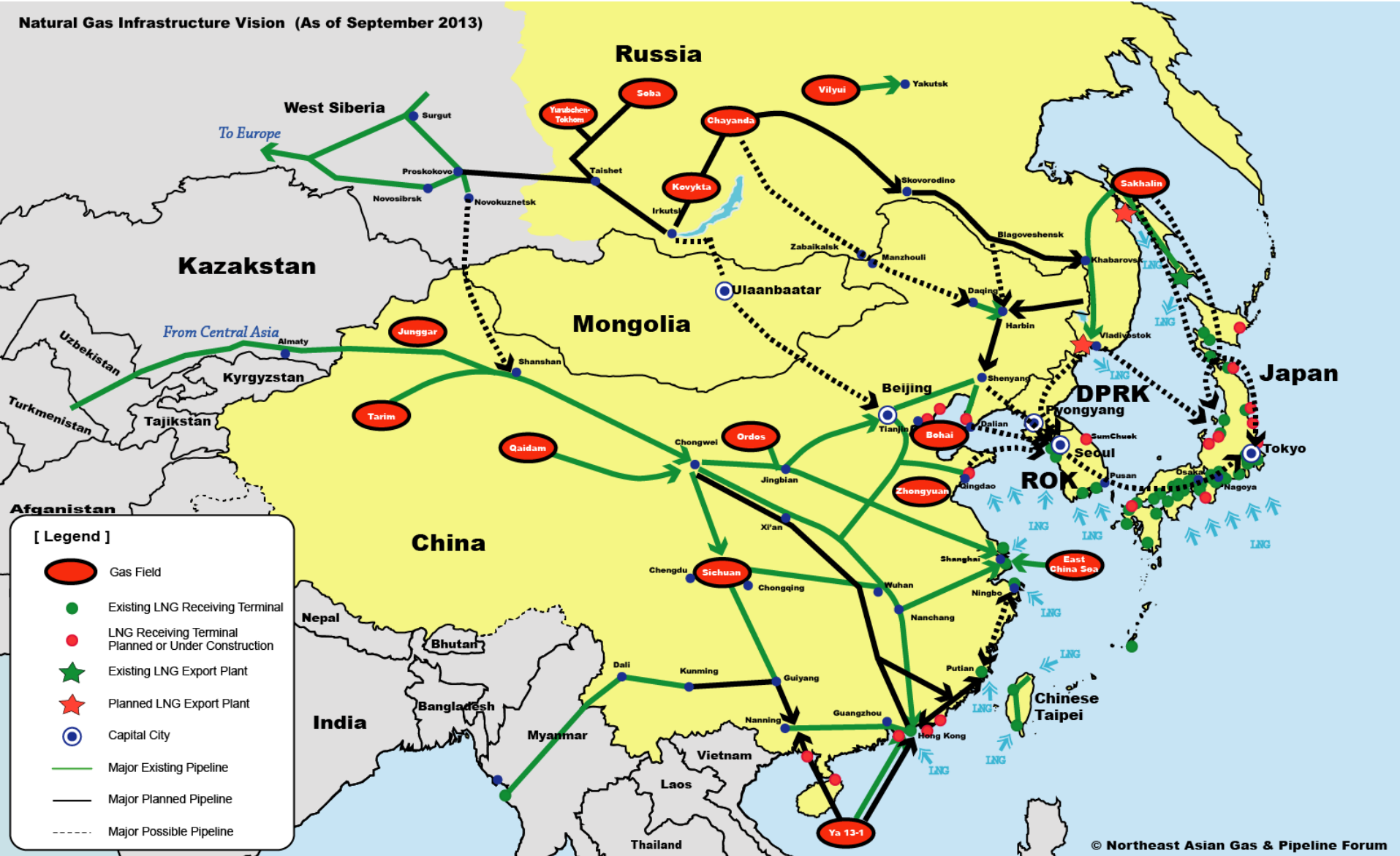


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Source: IEA.

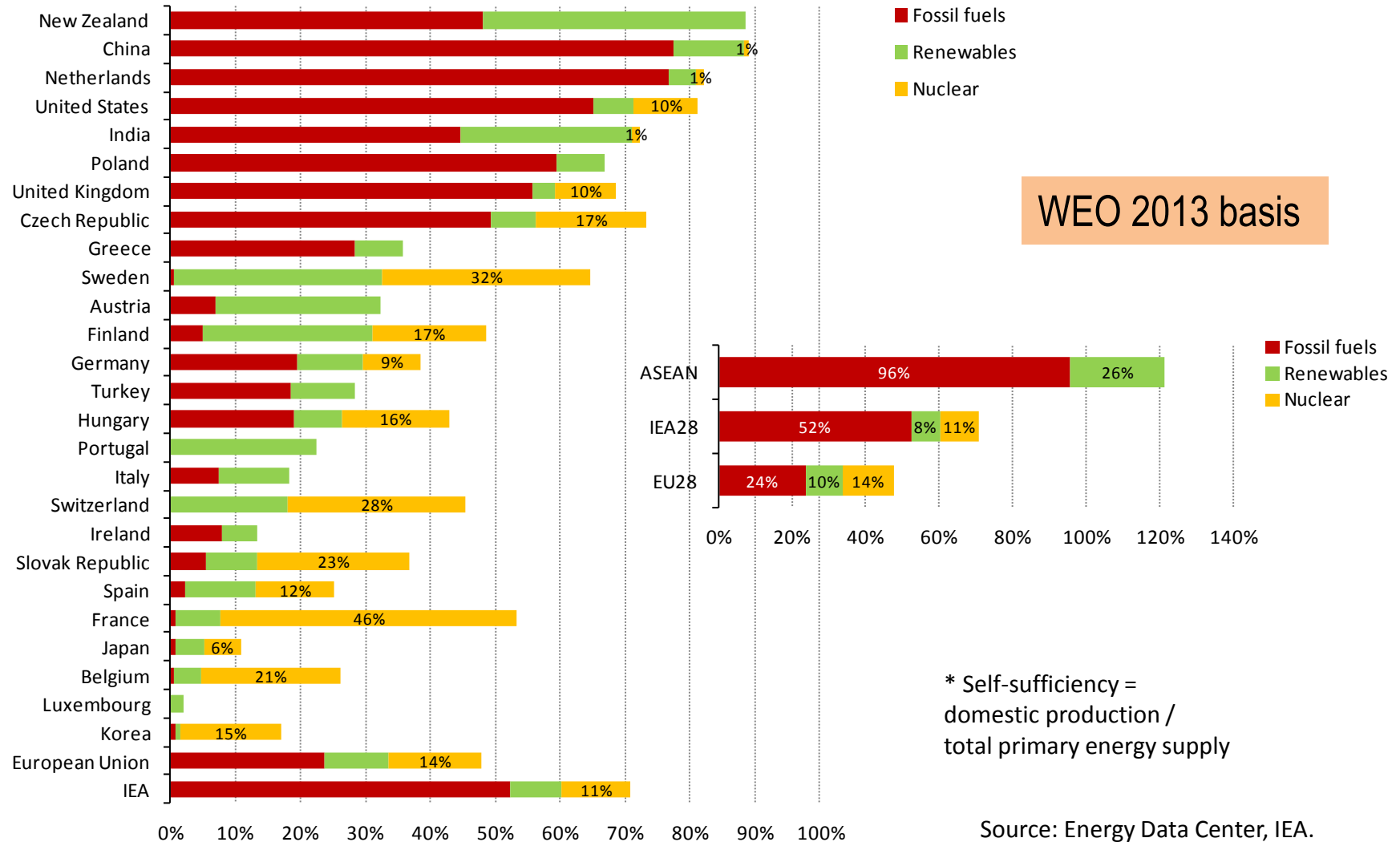
Blue Print for North East Asia Gas & Pipeline Infrastructure

Natural Gas Infrastructure Vision (As of September 2013)



Collective Energy Security and Sustainability by Diversity, Connectivity and Nuclear

Energy self-sufficiency* by fuel in 2011



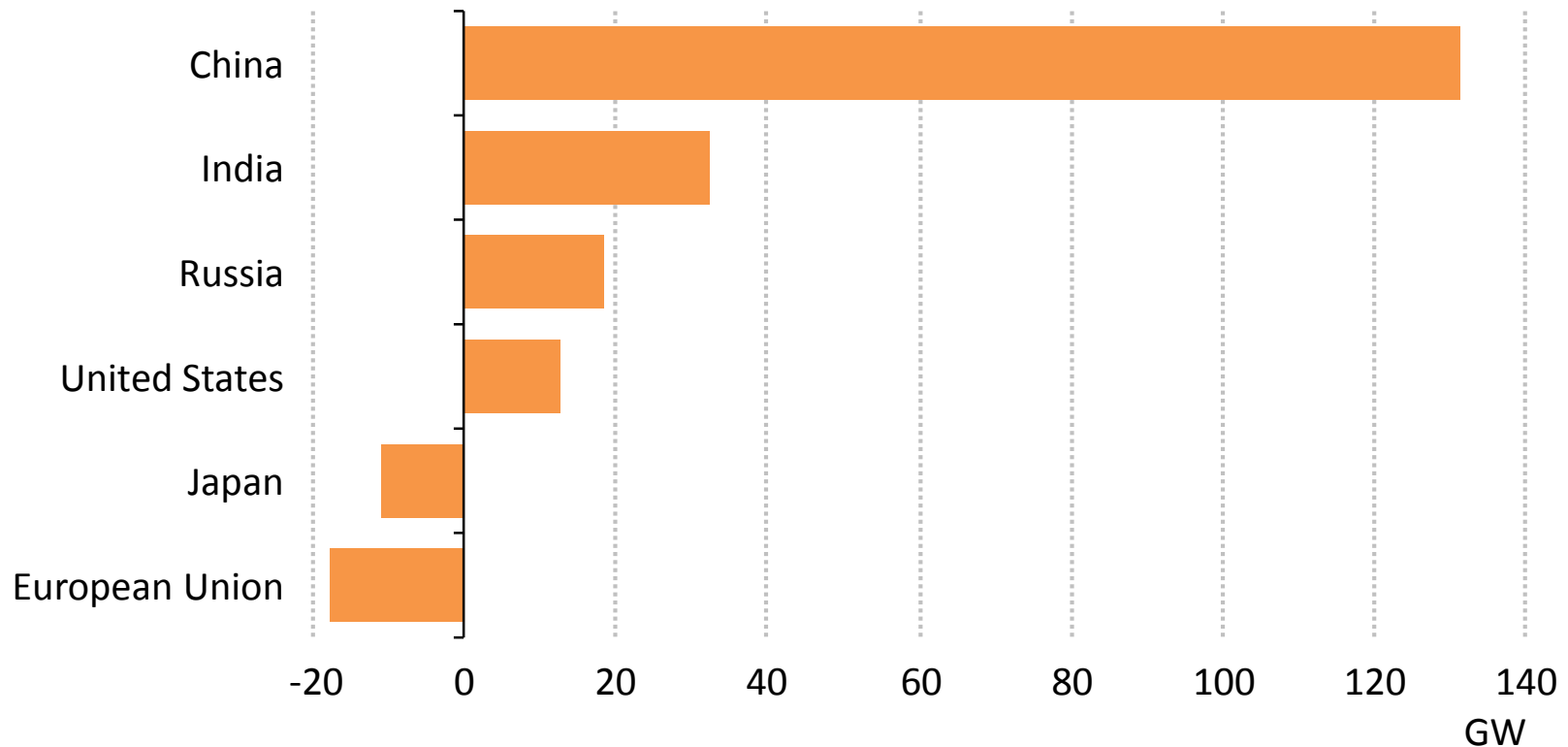
Source: Energy Data Center, IEA.

Note: Does not include fuels not in the fossil fuels, renewables and nuclear categories.

Nuclear capacity grows by 60%, but no nuclear renaissance in sight

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Net capacity change in key regions, 2013-2040

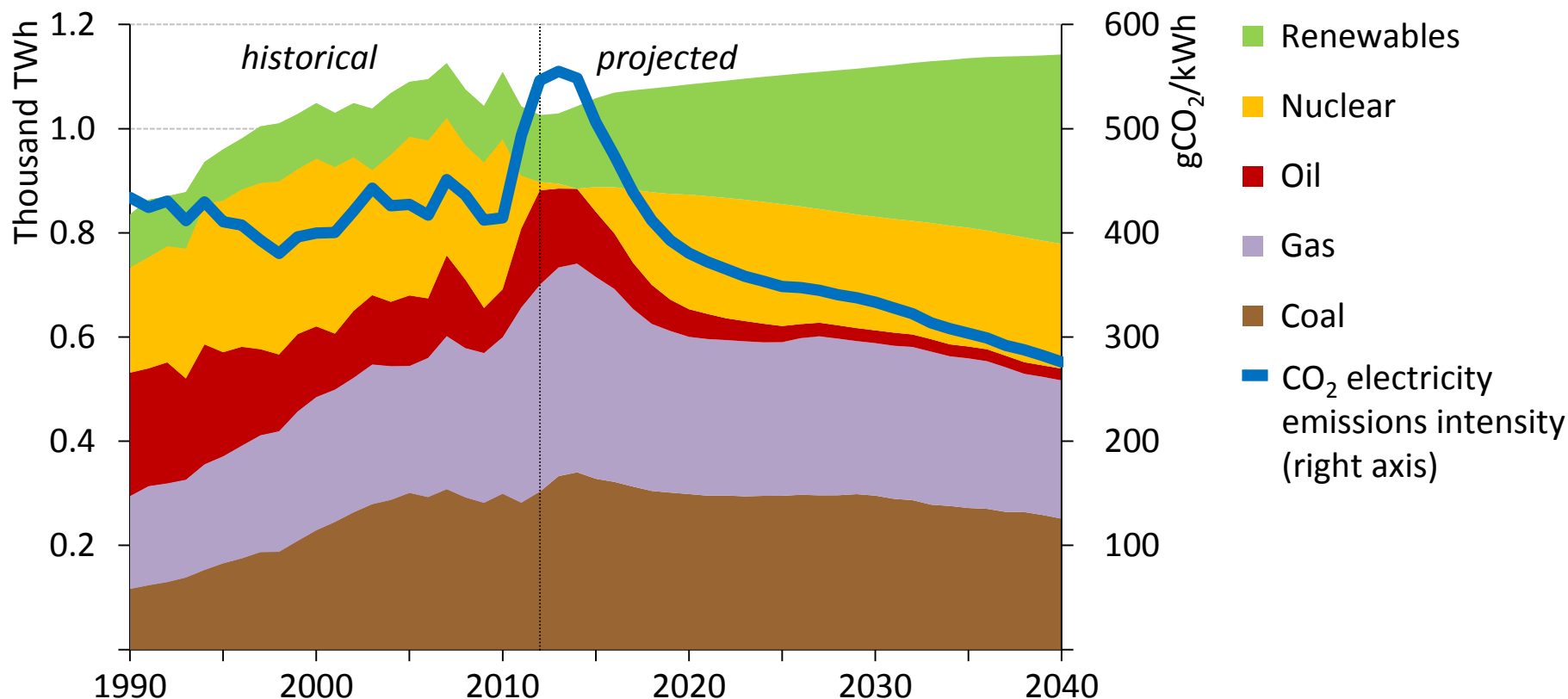


Capacity grows by 60% to 624 GW 2040, led by China, India, Korea & Russia; yet the share of nuclear in the global power mix remains well-below its historic peak

Japan's power system: moving to a more diverse & sustainable mix

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Japan electricity generation by source and CO₂ intensity

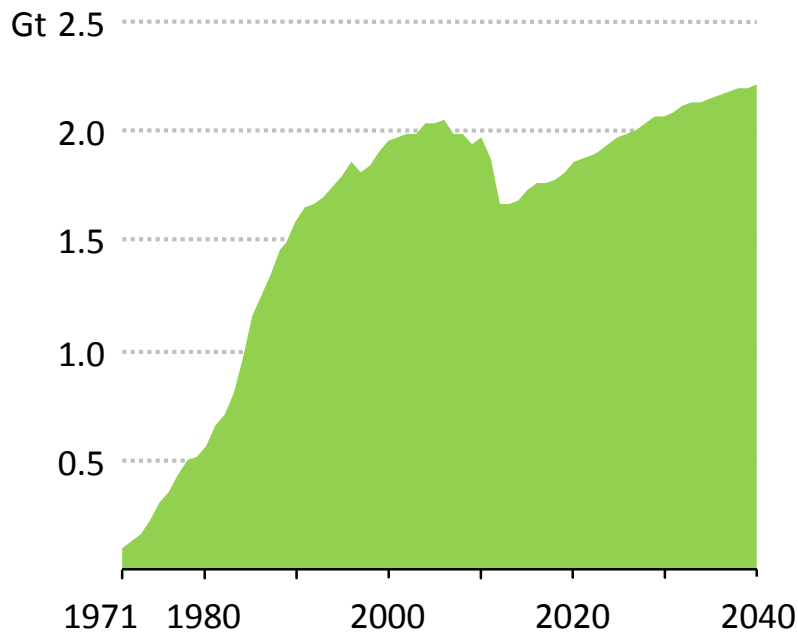


With nuclear plants expected to restart & increased use of renewables, Japan's electricity mix becomes much more diversified by 2040 (Renewables 32%, Nuclear 21%, gas 23%, coal 22%)

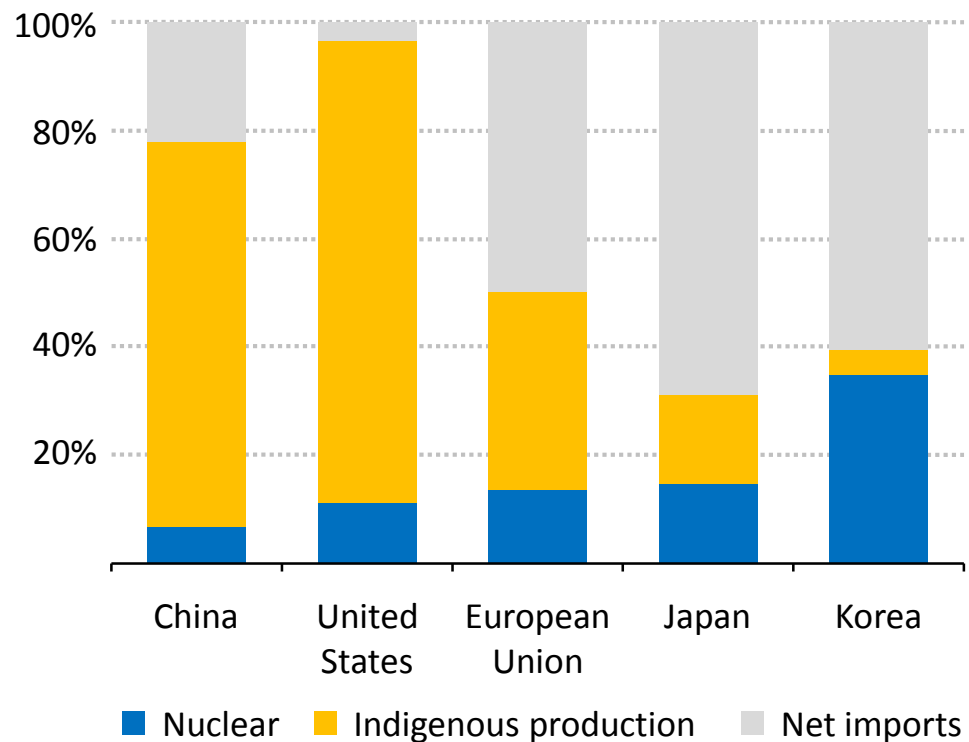
Nuclear power can play a role in CO₂ abatement & energy security

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CO₂ emissions avoided annually by nuclear power
1971-2040



Share of energy demand met by domestic sources
and nuclear power in 2040

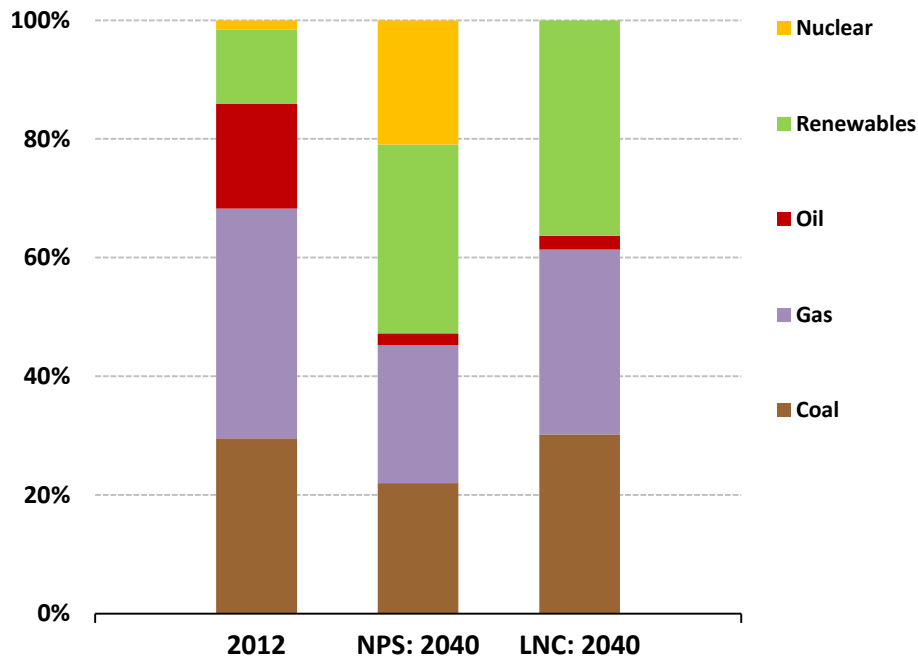


By 2040, an expanded nuclear fleet has saved almost 4 years of current CO₂ emissions & for some countries has improved energy security & balances of energy trade

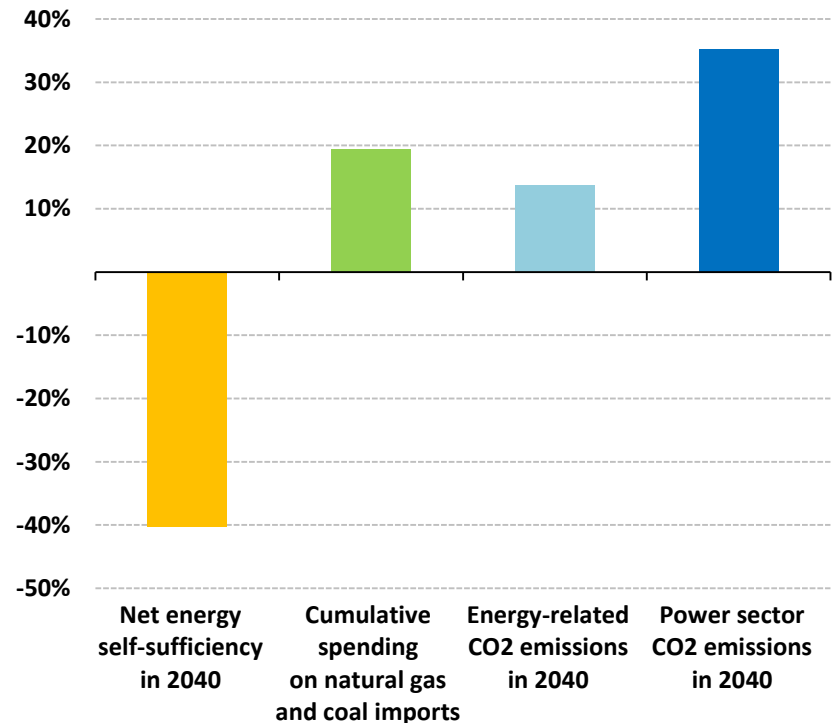
The Low Nuclear Case (LNC): implications for Japan

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Japan's power generation mix
in the New Policy Scenario (NPS) and LNC



Change in Japan's energy indicators
in LNC relative to NPS

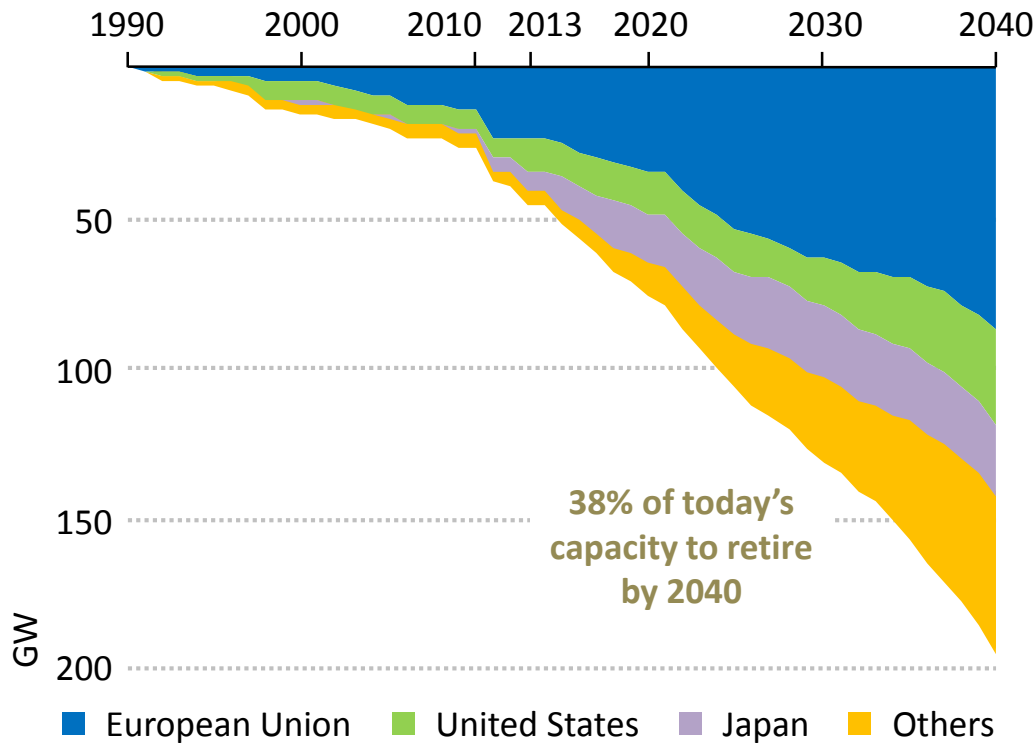


In the Low Nuclear Case, Japan faces greater risks to its energy security, a \$450 billion increase in fuel import bills & a 14% rise in total CO₂ emissions

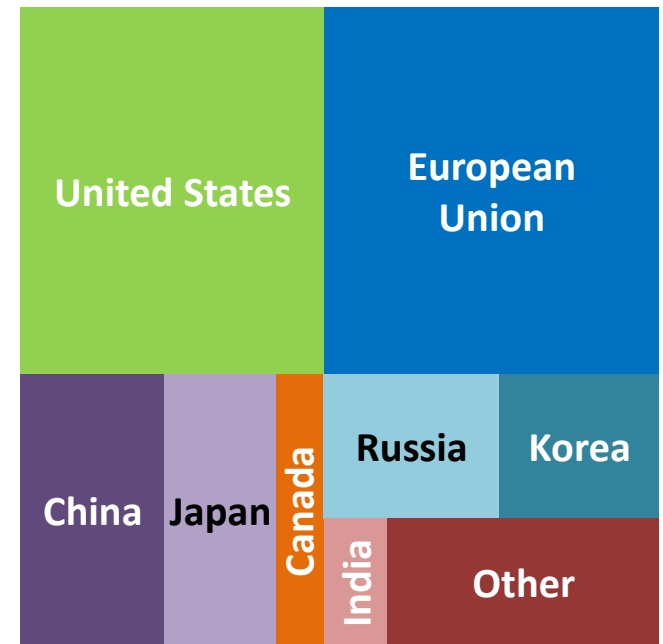
Nuclear power: public concerns must be heard and addressed

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Retirements of nuclear power capacity
1990-2040



Spent nuclear fuel
1971-2040: 705 thousand tonnes

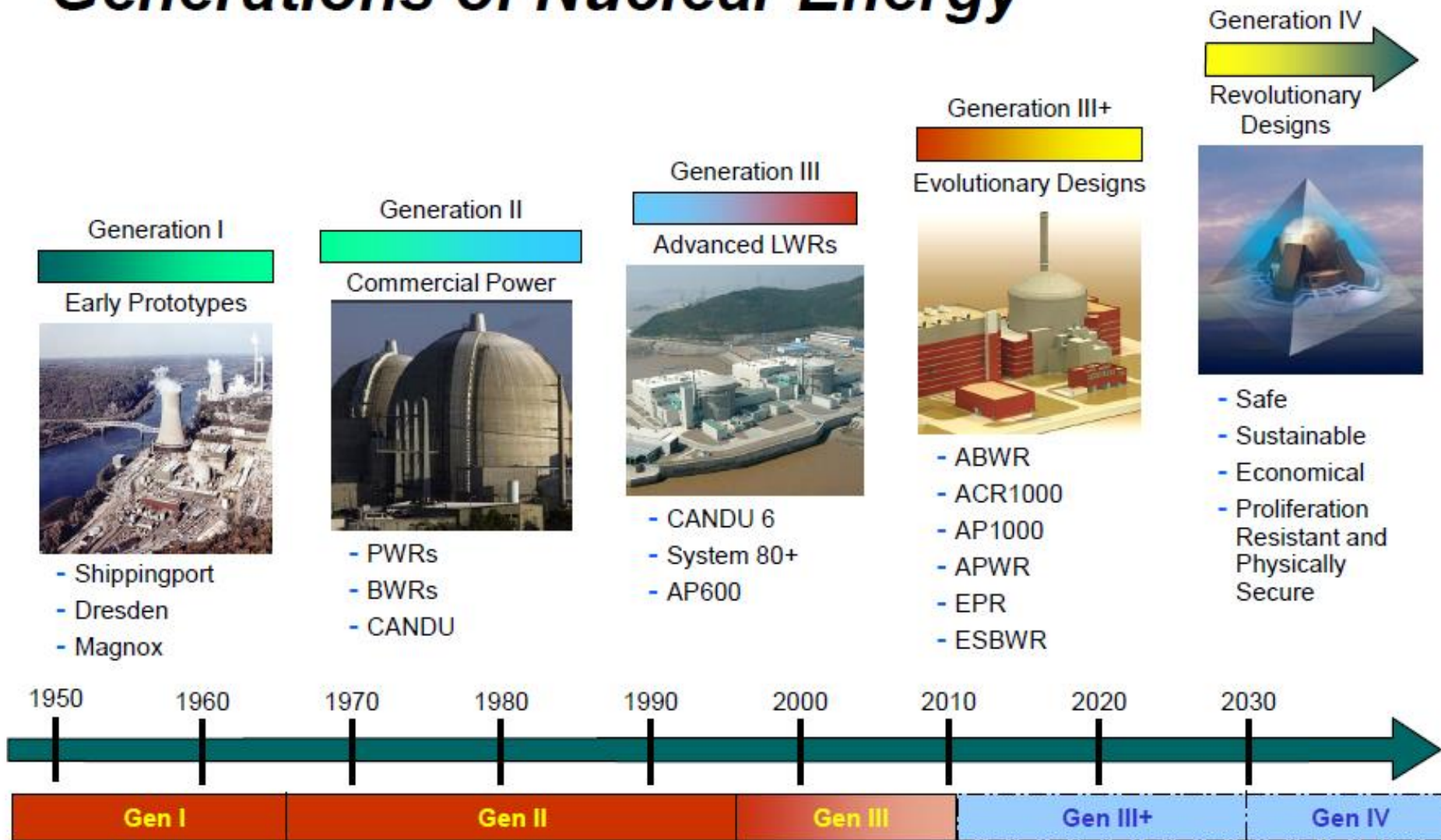


Key public concerns include plant operation, decommissioning & waste management; & the amount of spent fuel doubles
By 2040, almost 200 reactors are retired

Safety is still the public concern No 1 after four years : 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. NRC’s B-5-b clause was not accepted despite its suggestion.
 - Clarify why it happened only to Fukushima Daiichi and NOT to other sites like Fukushima Daini, Onagawa, Tokai-daini.
- 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.**

Generations of Nuclear Energy





"WHEN WAS THE LAST TIME YOU SAW A DOCUMENTARY
THAT FUNDAMENTALLY CHANGED THE WAY YOU THINK?"
OWEN GLEIBERMAN, *ENTERTAINMENT WEEKLY*



(ACTUAL SIZE)

WHAT IF THIS CUBE COULD
POWER YOUR ENTIRE LIFE?

FROM ACADEMY AWARD[®] NOMINATED DIRECTOR ROBERT STONE

PANDORA'S PROMISE

AT THE BOTTOM OF THE BOX SHE FOUND HOPE.

IF YOU WANT TO SEE THE MOVIE, PLEASE VISIT WWW.PANDORASPROMISE.COM

"PANDORA'S PROMISE" IS A FILM BY ROBERT STONE. © 2012 IFC FILMS. ALL RIGHTS RESERVED.



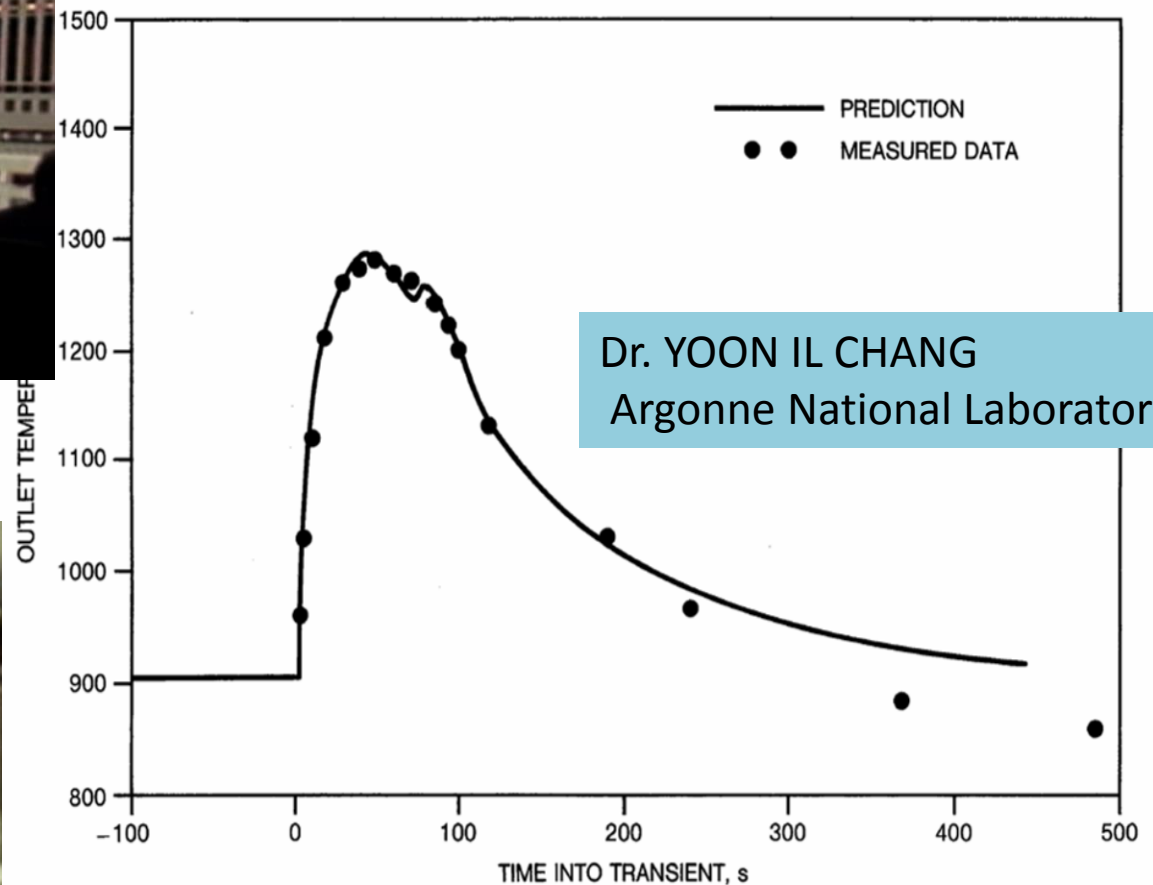
www.pandoraspromise.com



“Pandora’s Promise”, a movie directed by Robert Stone, is a documentary of environmentalists who changed their views about Nuclear Power. IFR (EBR2) story comes up as missed opportunity.

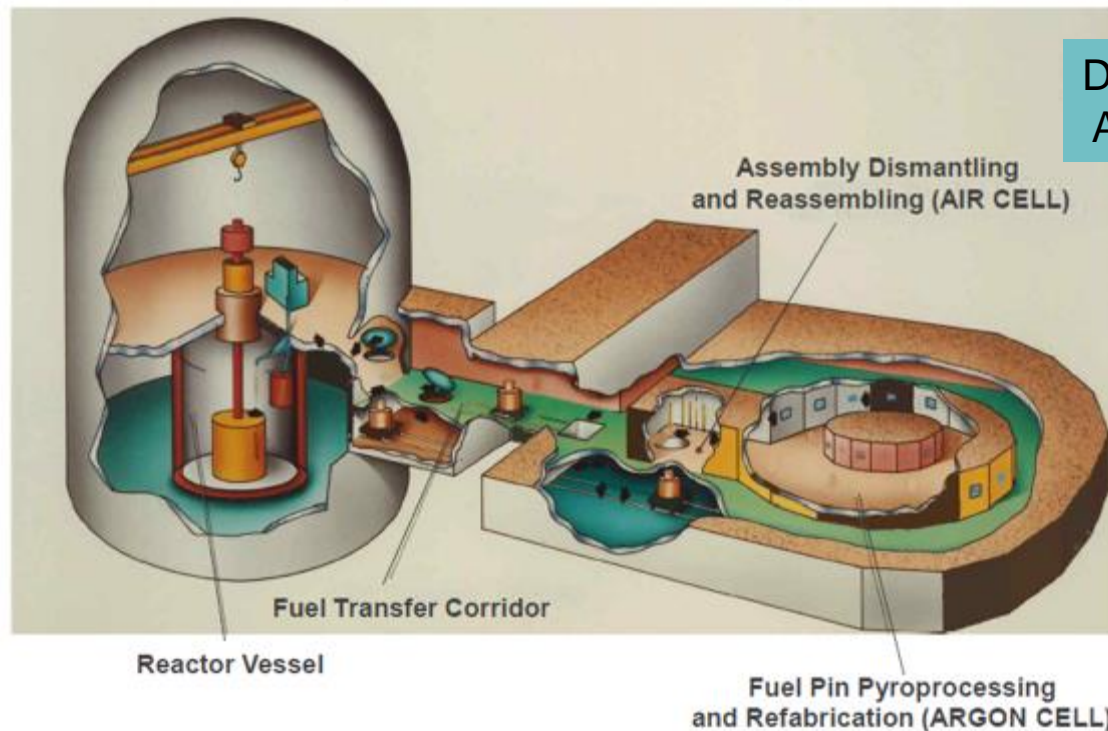
Passive Safety was proven by the 1986 Experiment very similar to the Fukushima event.

Loss-of-Flow without Scram Test in EBR-II



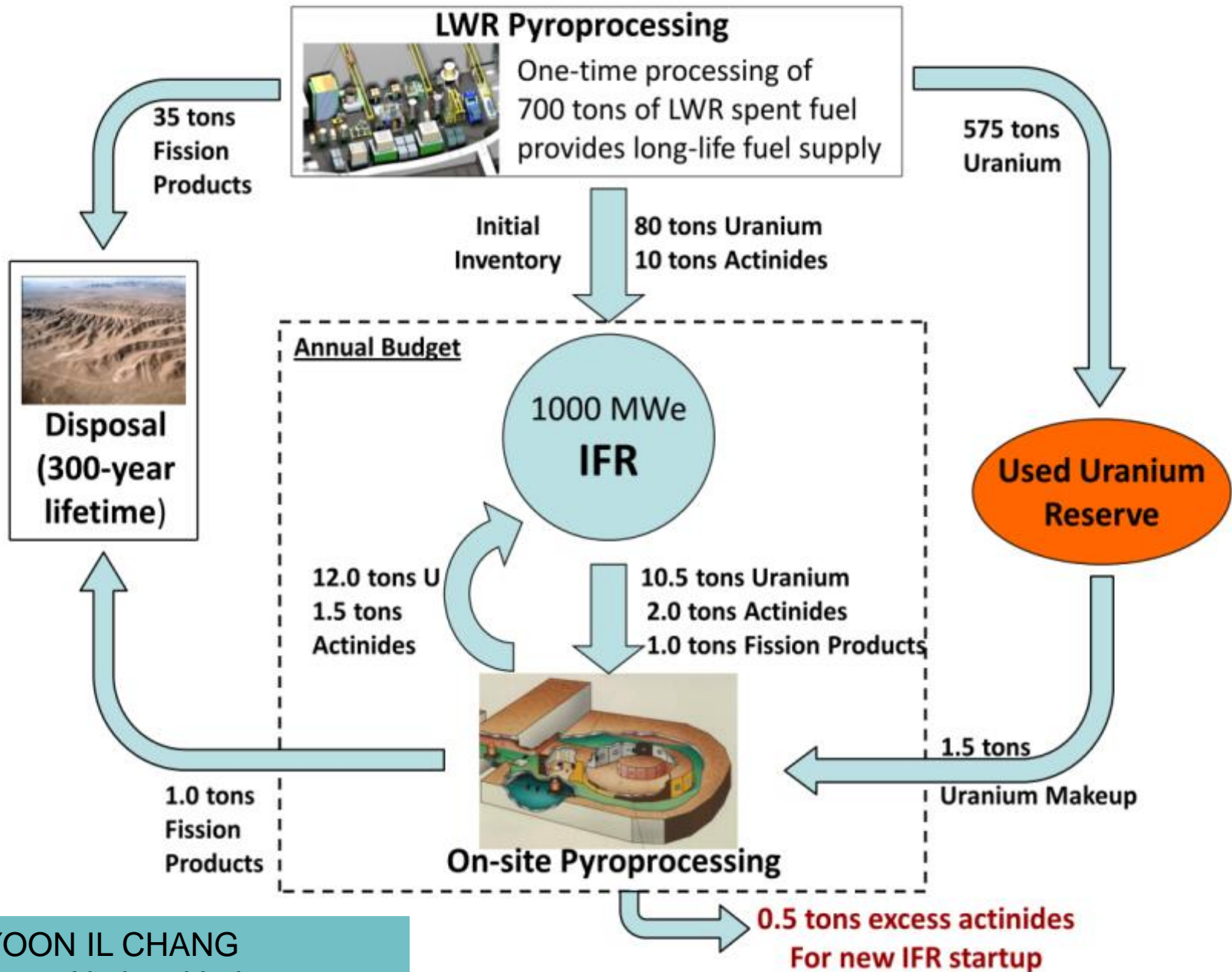
More Sustainable Nuclear Power Paradigm: Integral Fast Reactor and Pyroprocessing

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



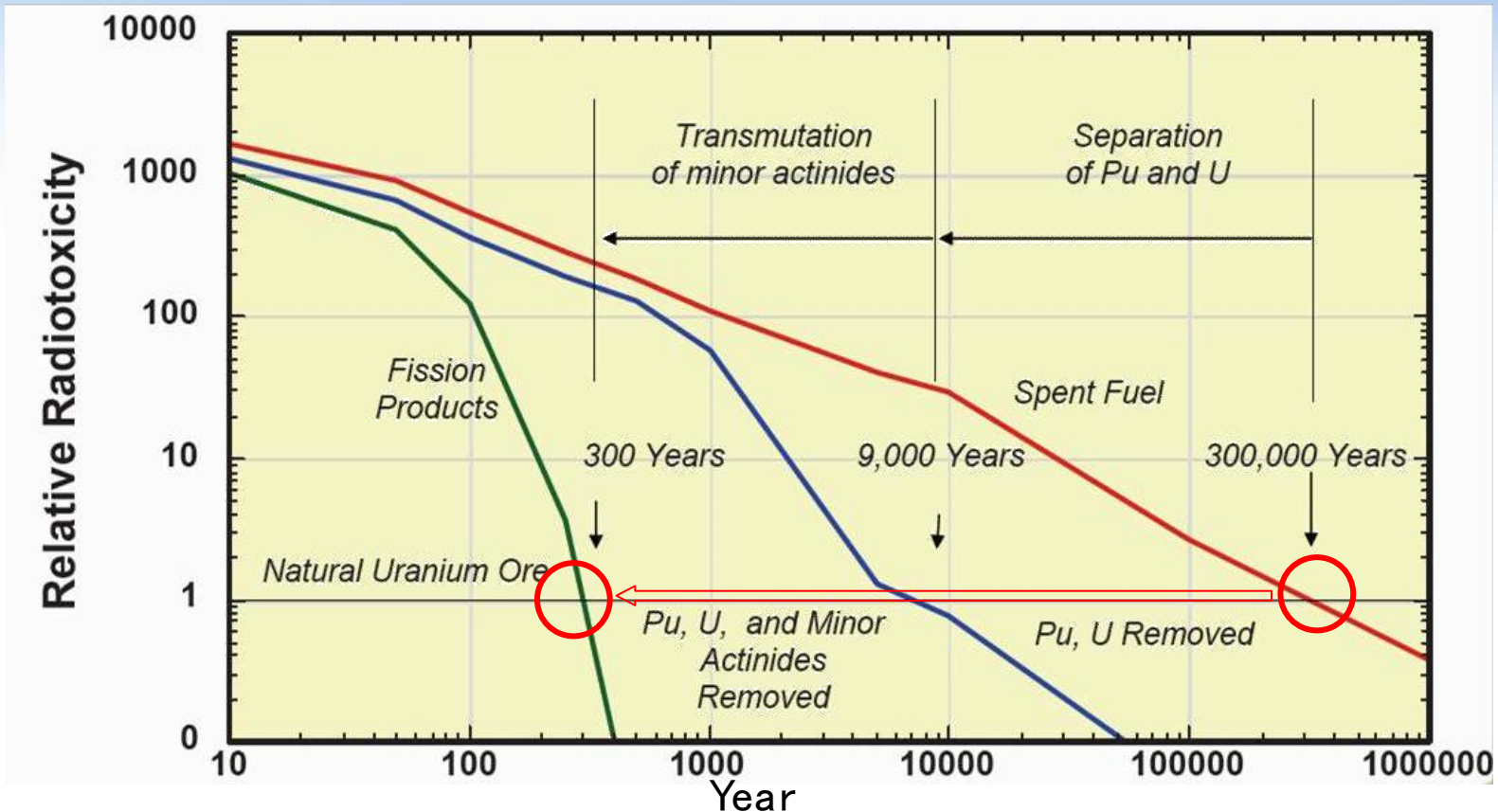
Dr. YOON IL CHANG
Argonne National Laboratory

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.



Transuranic disposal issues

The 1% transuranic (TRU) content of nuclear fuel is responsible for 99.9% of the disposal time requirement and policy issues



HITACHI

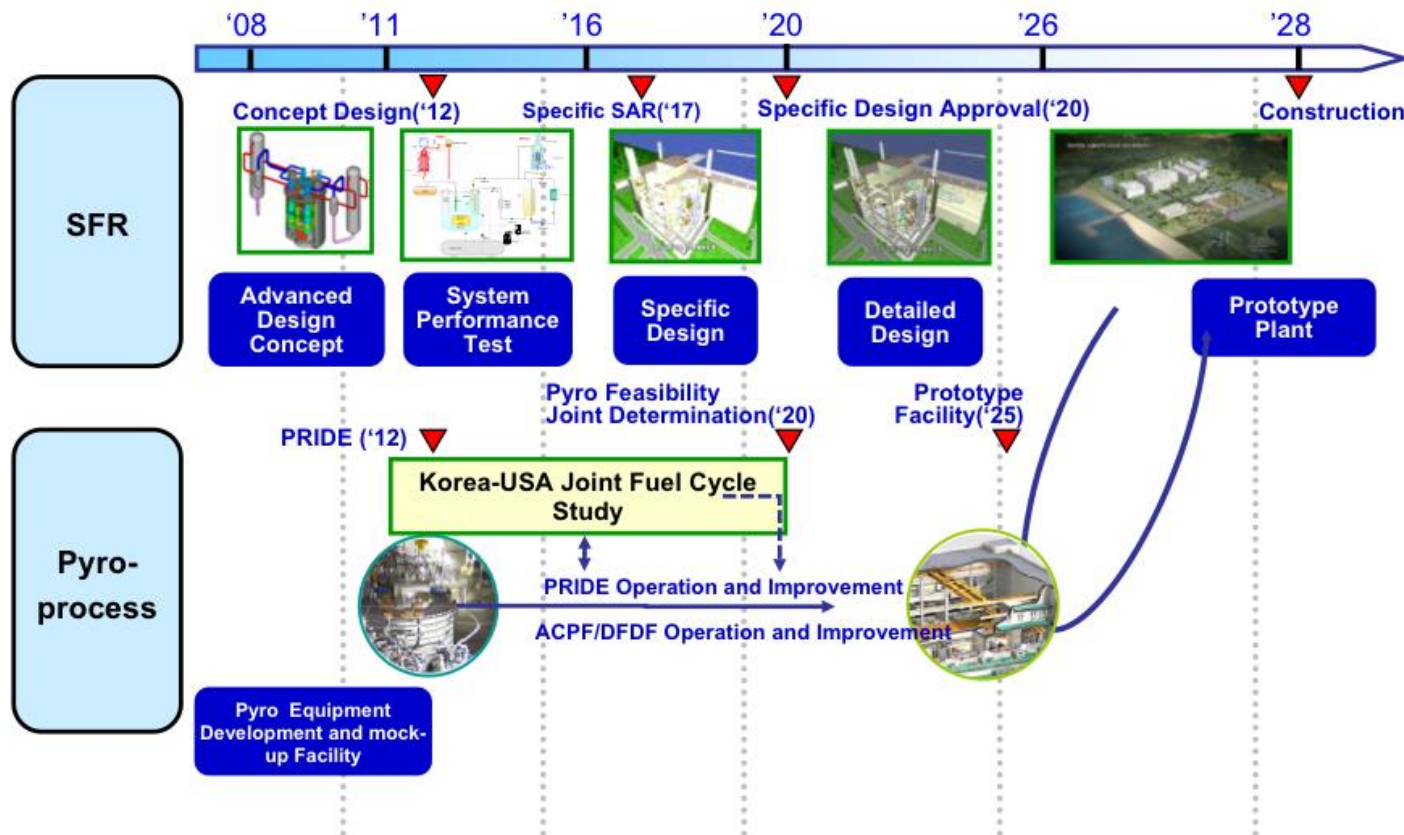
Removal of uranium, plutonium, and transuranics makes a 300,000 year problem a 300 year problem

Technical Rationale for the IFR

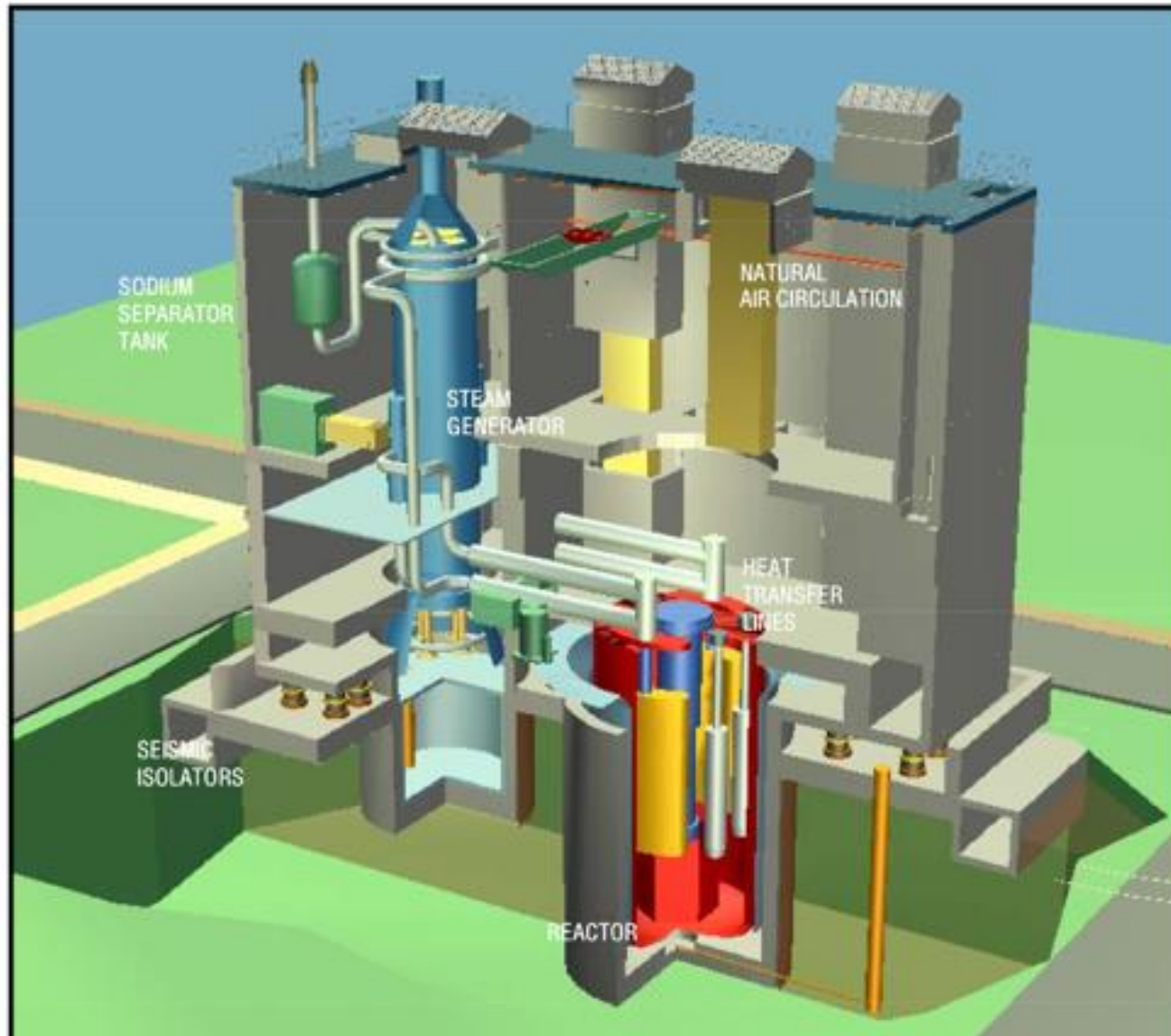
- ✓ Revolutionary improvements as a next generation nuclear concept:
 - Inexhaustible Energy Supply
 - Inherent Passive Safety
 - Long-term Waste Management Solution
 - Proliferation-Resistance
 - Economic Fuel Cycle Closure
- ✓ Metal fuel and pyroprocessing are key to achieving these revolutionary improvements.
- ✓ Implications on LWR spent fuel management

Korea is eager to build fuel cycle by IFR by revising the 1-2-3 Agreement with US

Long-term Plan for SFR and Pyroprocess



S-PRISM Nuclear Steam Supply System



GE-Hitachi

Proposal to Demonstrate IFR and Pyroprocessing at Fukushima Daini

- Melted down fuel debris and contaminated equipments will likely stay in Fukushima, though nobody admits so.
- Pyroprocessing is the most appropriate method for treating debris.
- Pu and MA from Debris and Spent fuels be burned in IFR. Electricity is generated as by-product.
- High level waste of 300 years be stored rather than disposed geologically while decommissioning of units be cemented for years.
- Fukushima Daini (Second) Nuclear Plant of TEPCO is best located to demonstrate GE's extended S-PRISM.
- International joint project of Japan-US-Korea will provide complementing regional safeguard for global non-proliferation regime.
- Provides ground for extension of Japan-US 1-2-3 Agreement in 2018 by demonstrating complementary fuel cycle options.

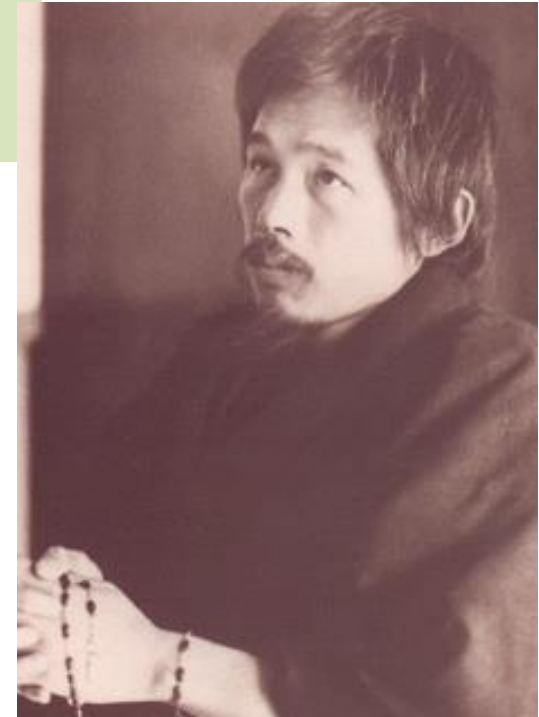
Legend of Admiral Rickover: Success of LWR for nuclear submarine has crowded out Fast Reactors

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Statement by Dr. Takashi NAGAI after Nagasaki atomic bomb. "How to turn the devil to the fortune."

Dr. Takashi Nagai, a Professor at Nagasaki University in 1945 when the atomic bomb was dropped, exemplifies the resilience, courage and believe in science of the Japanese people. Despite having a severed temporal artery as a result of the bomb, he went to help the victims even before going home. Once he got home, he found his house destroyed and his wife dead. He spent weeks in the hospital where he nearly died from his injuries. But just months after the atom bomb dropped, he said:



“Everything was finished. Our mother land was defeated. Our university had collapsed and classrooms were reduced to ashes. We, one by one, were wounded and fell. The houses we lived in were burned down, the clothes we wore were blown up, and our families were either dead or injured. What are we going to say? We only wish to never repeat this tragedy with the human race. **We should utilize the principle of the atomic bomb. Go forward in the research of atomic energy contributing to the progress of civilization. Devil will then be transformed to fortune.(Wazawai tenjite Fukutonasu) The world civilization will change with the utilization of atomic energy. If a new and fortunate world can be made, the souls of so many victims will rest in peace.”**

Comprehensive Energy Security and Sustainability

1. Prepare scenarios for the Hormuz Crisis. Jointly design Collective Self Defense Plan for Sea-lane Protection. China, India and ASEAN should join the IEA.
2. Golden Age of Natural Gas will come with golden rules including sustainability requirements and a new pricing formula. LNG exports from North America may be a game-changer. Need of Asian Gas Trading Hub. Russia remains being key player with pipelines and LNG facilities.
3. 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. Need the North East Asian Energy Security Forum. JCM for sustainability cooperation.
4. Japan needs domestic reform of power market: 50-60 hrz problem, FIT reform, unbundling of utilities, international grid connection with Korea and Russia. New technologies help; Hydrogen economy, Methane-hydrate, Super-conductivity grid, Smart grid and EVs, Storage, Cleaner Coal Tech with CCS.
5. 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. Need Paradigm shift from the LWR to the Safer, More proliferation resistant and Easier HLW management Nuclear system. Demonstrate International (US-Japan-Korea) collaborative project on IFR technology (GE's PRISM) at Fukushima Daini (Second) Power Plant.