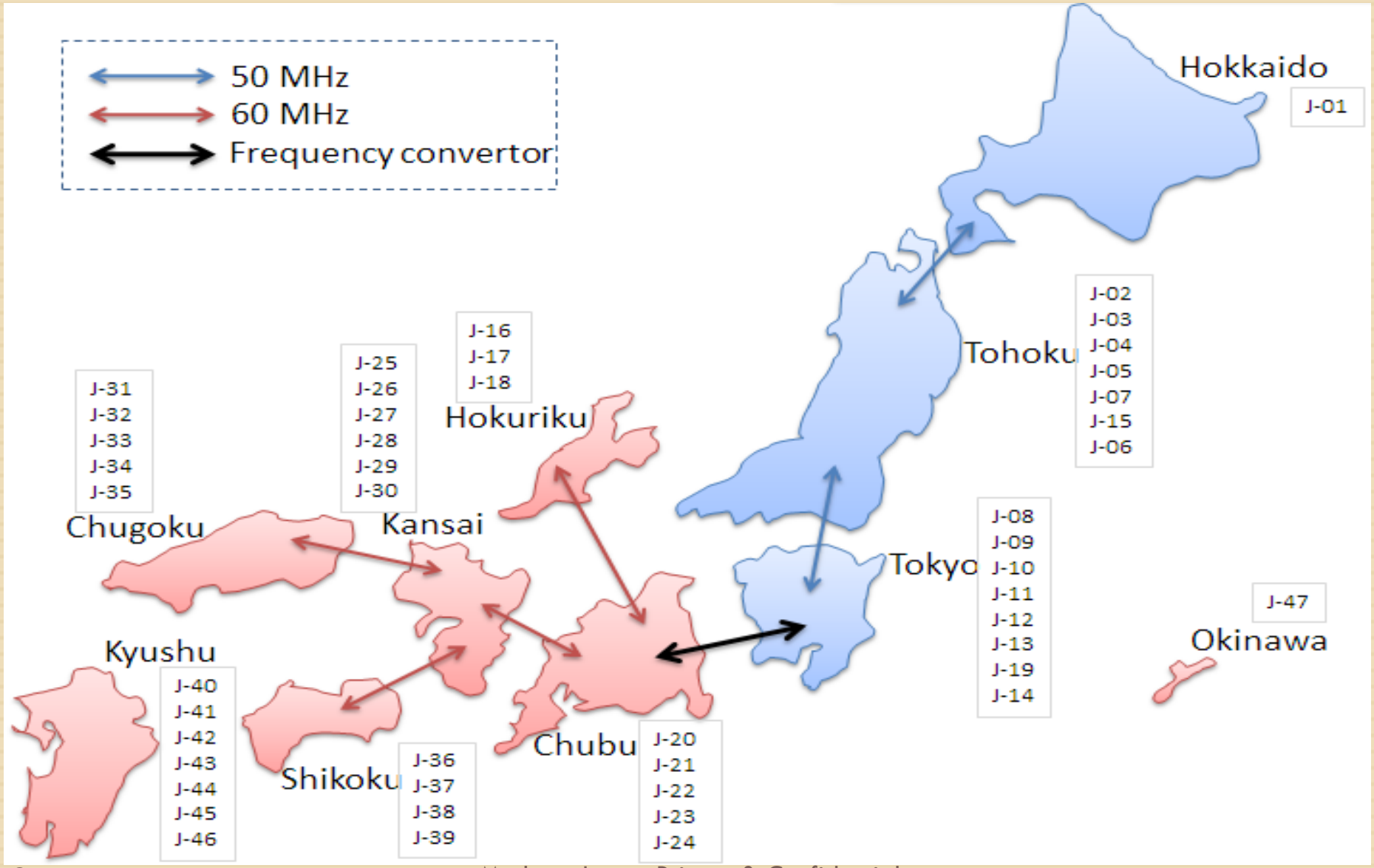
Mathyos
GLOBAL ENERGY SOLUTIONS

CANADIAN CHAMBER OF COMMERCE IN JAPAN

JAPAN POWER SECTOR UPDATE FOR CANADIAN LNG EXPORT CONFERENCE

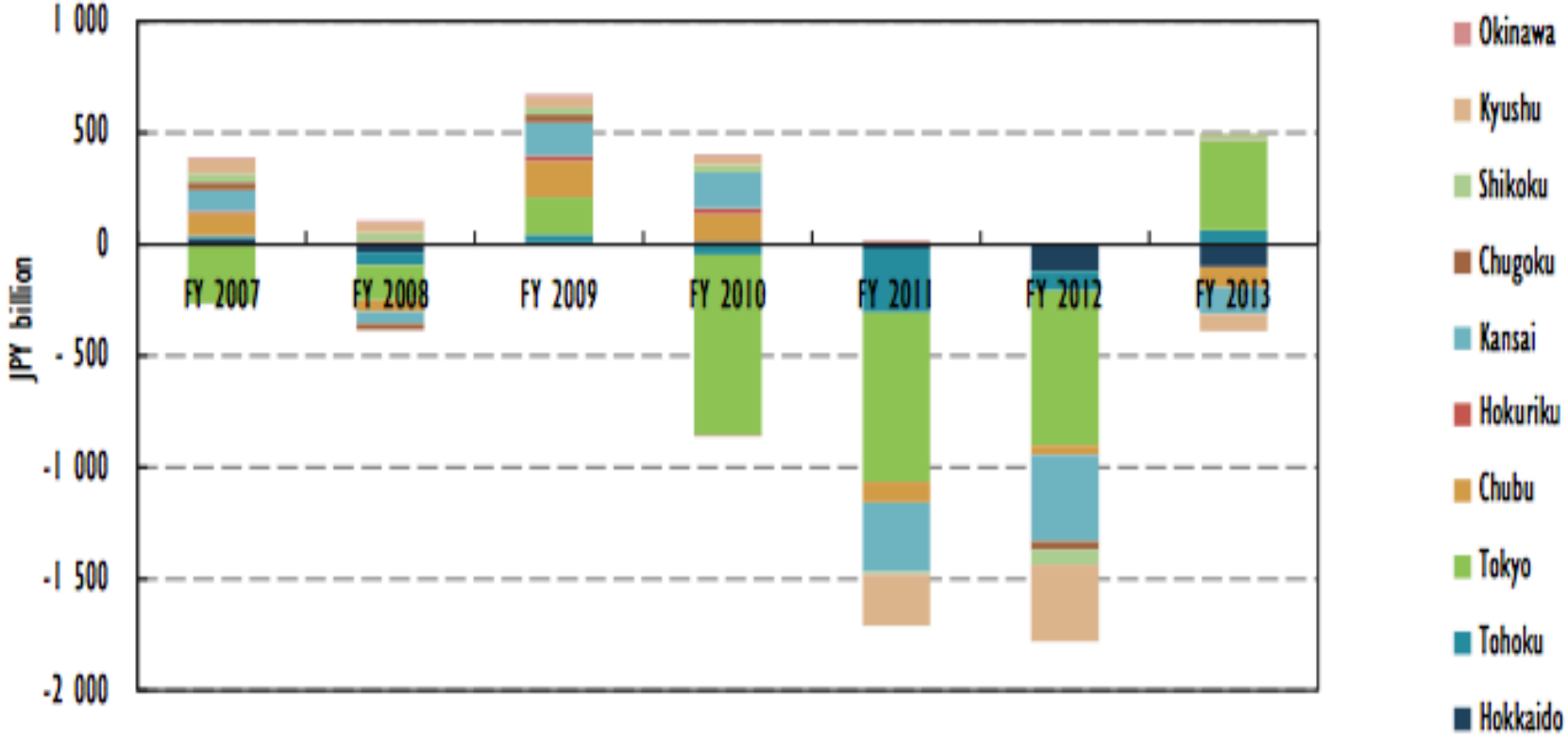
25 November 2014/Tom O'Sullivan

Japan's Power Split



Recent Financial Performance of the Japanese EPCs

Figure 11 • Profits and losses of Japanese power companies, 2007-13



Note: FY = fiscal year.

Source: Based on data from the Federation of Electric Power Companies of Japan.

Annual Fuel Usage by the Japanese EPCs

- 56 million tons of LNG ($48.0 billion)
- 150 million barrels of crude and fuel oil - 400,000 bpd or around 10% of Japan's oil imports ($15.0 billion)
- 100 million tons of thermal coal ($10.0 billion)
- # Total Fuel Inputs: $73 billion
- = Y8/ kWh

About 30% of Japan's Fuel Imports are currently consumed by its Power Sector

Japan has very limited gas strategic reserves-16 days vs 90 days for oil

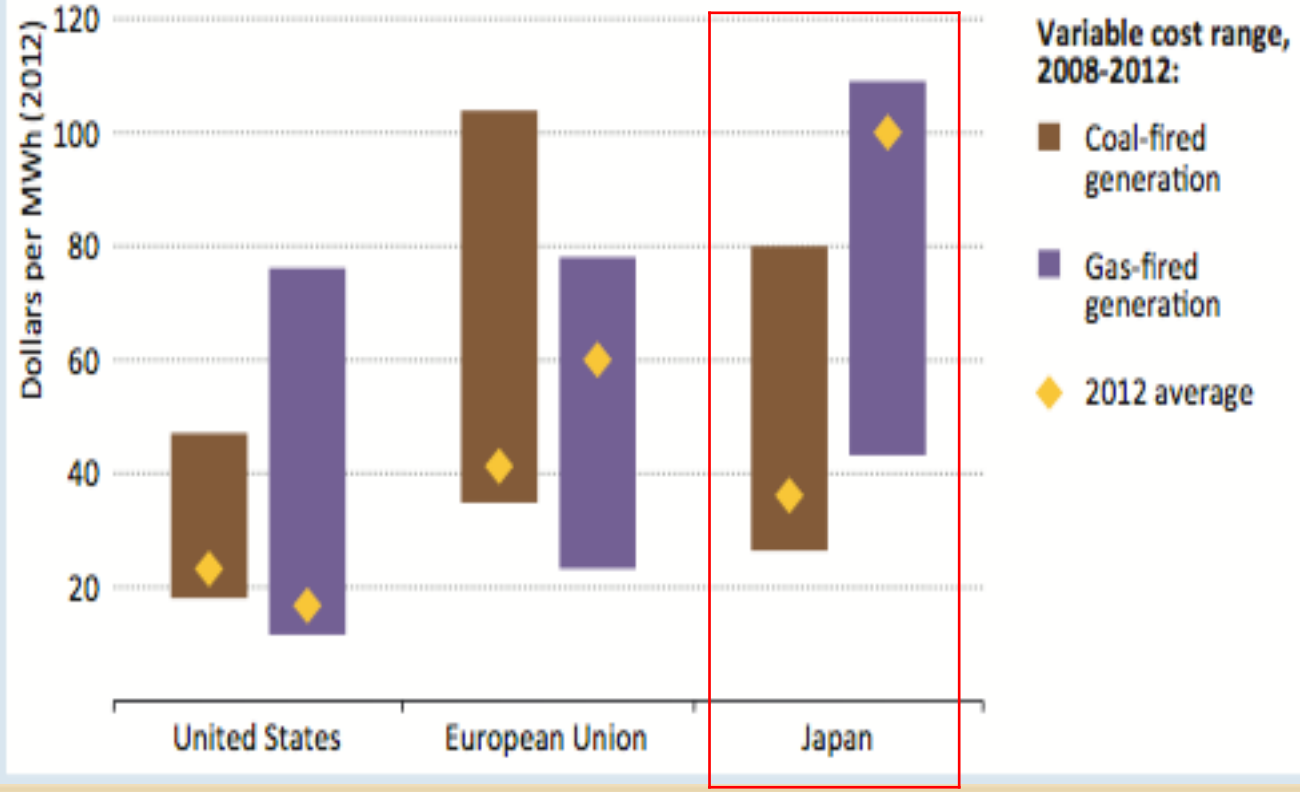
Current Generation Mix of the Japanese EPCs

- LNG : 43% - 390 billion kWh
- Coal : 28% - 252 billion kWh
- Oil : 18% - 160 billion kWh
- Hydro : 8% - 72 billion kWh
- Others : 3% - 26 billion kWh

100%-900 billion kWh

Coal vs LNG in Japan

Figure 5.11 ▷ Electricity generating costs for coal and gas by selected region and for 2008-2012 fuel prices

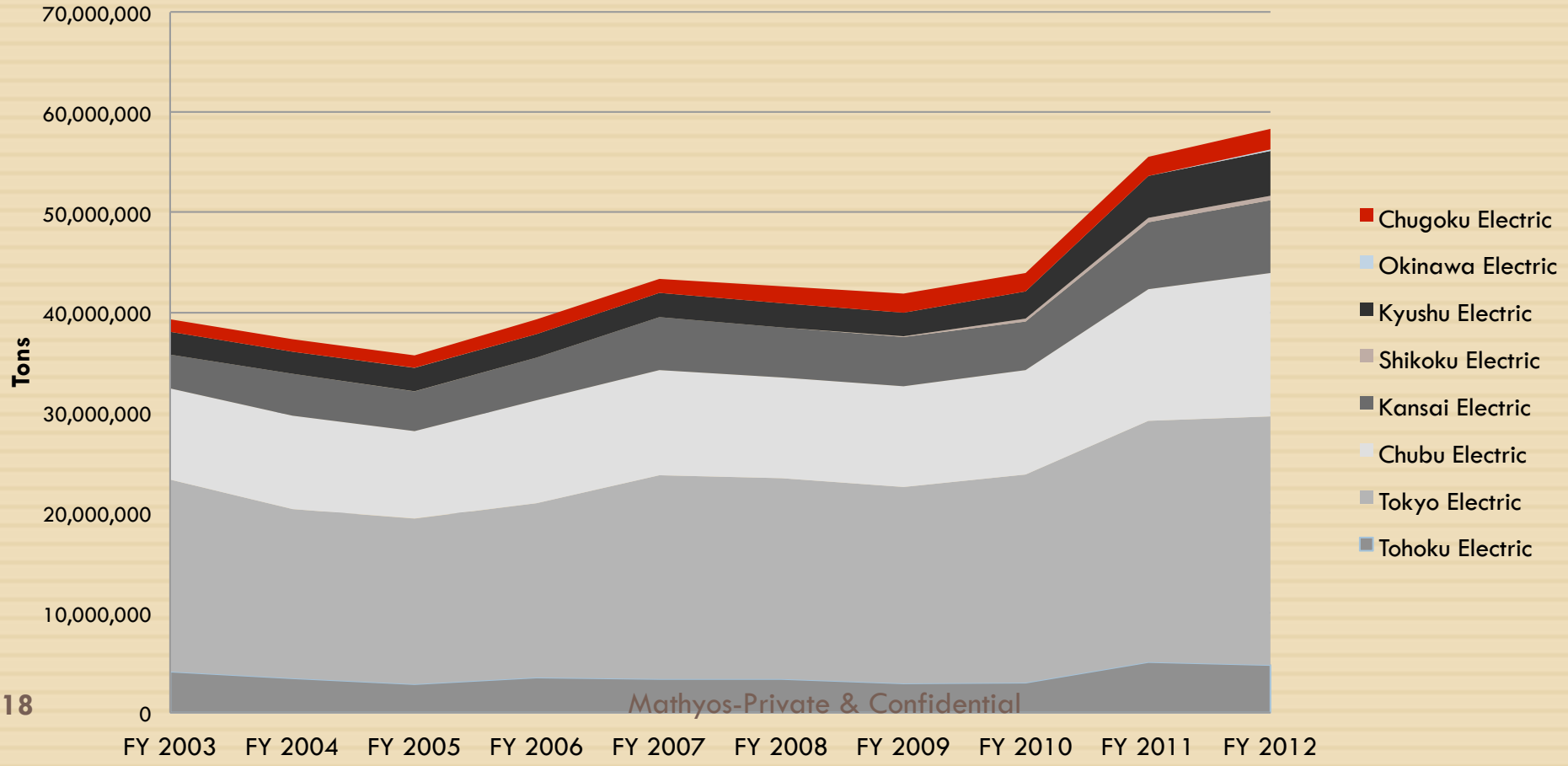


Source:IEA

Japan's LNG Imports for Power Generation

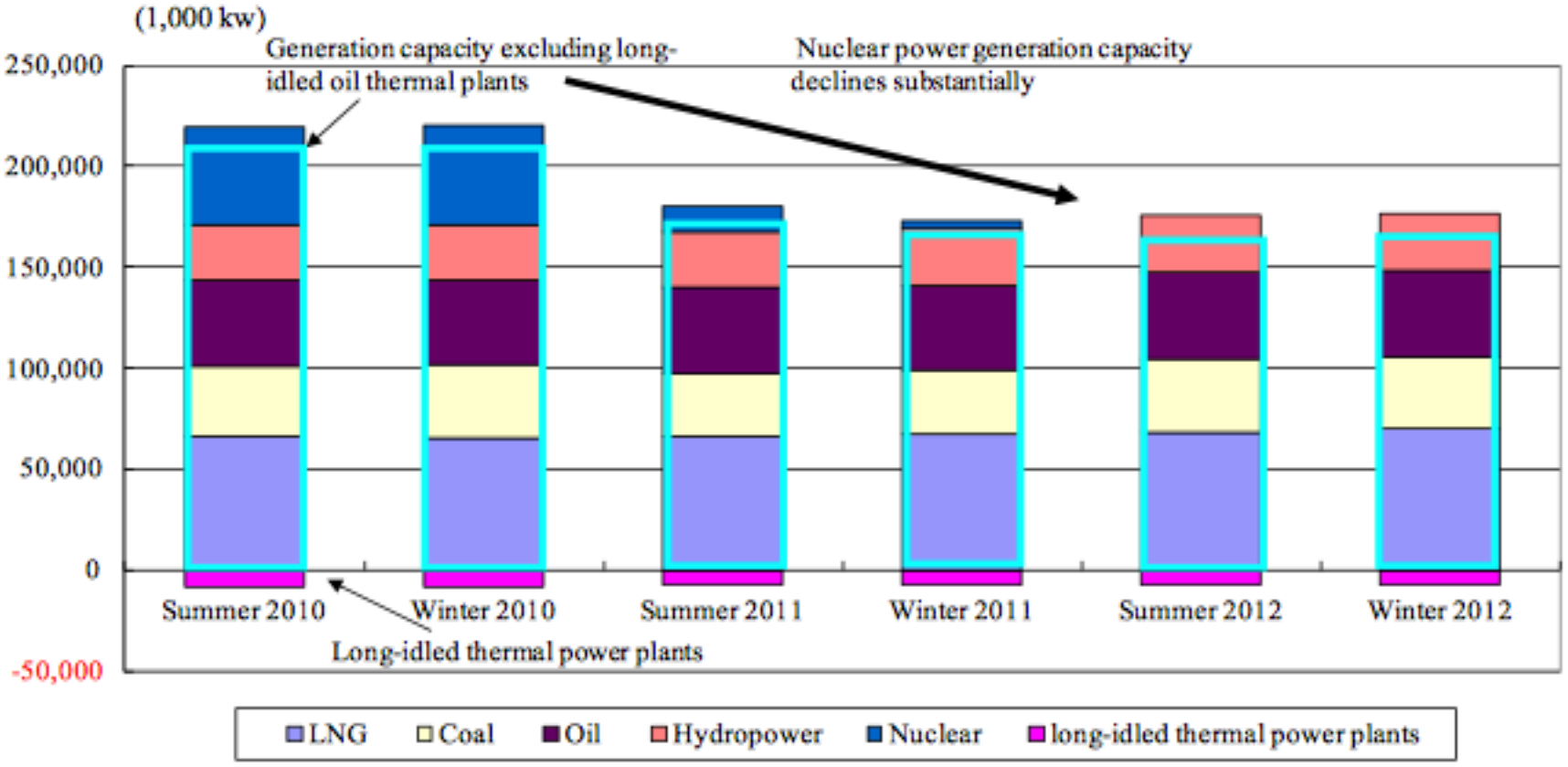
LNG imports by Japan's regional power providers spiked after the Fukushima accident caused the shuttering of the country's 50 nuclear power plants, with 2013 imports closing in on 60 million tons. Limited or no nuclear restarts would mean that Japanese EPCOs would have to secure additional fuel supplies for power generation. New term contracts will have to replace those expiring, and potentially those volumes currently secured on a shorter term or spot basis.

Japan's EPCO LNG Imports

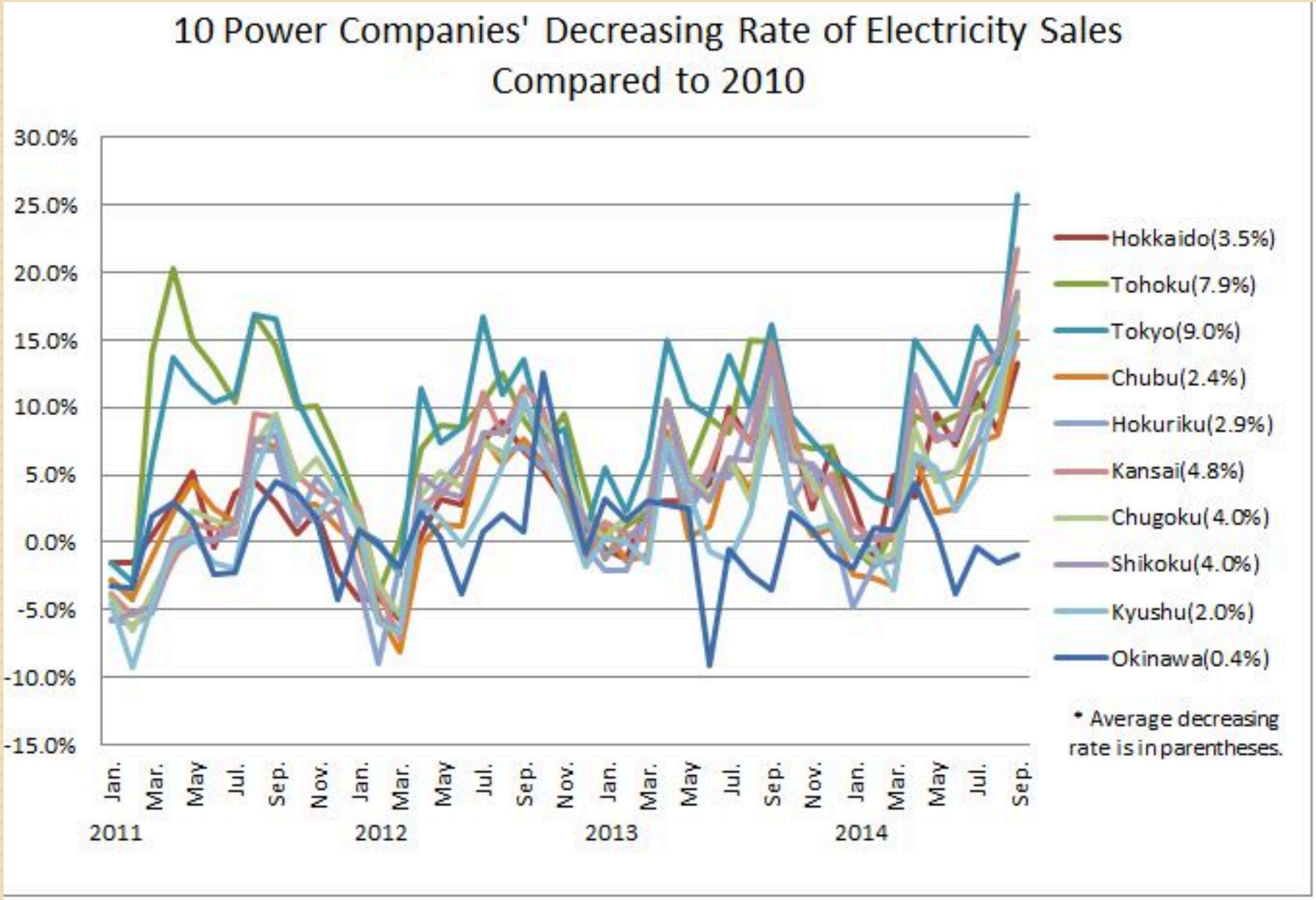


Japan's Generation before/after Fukushima

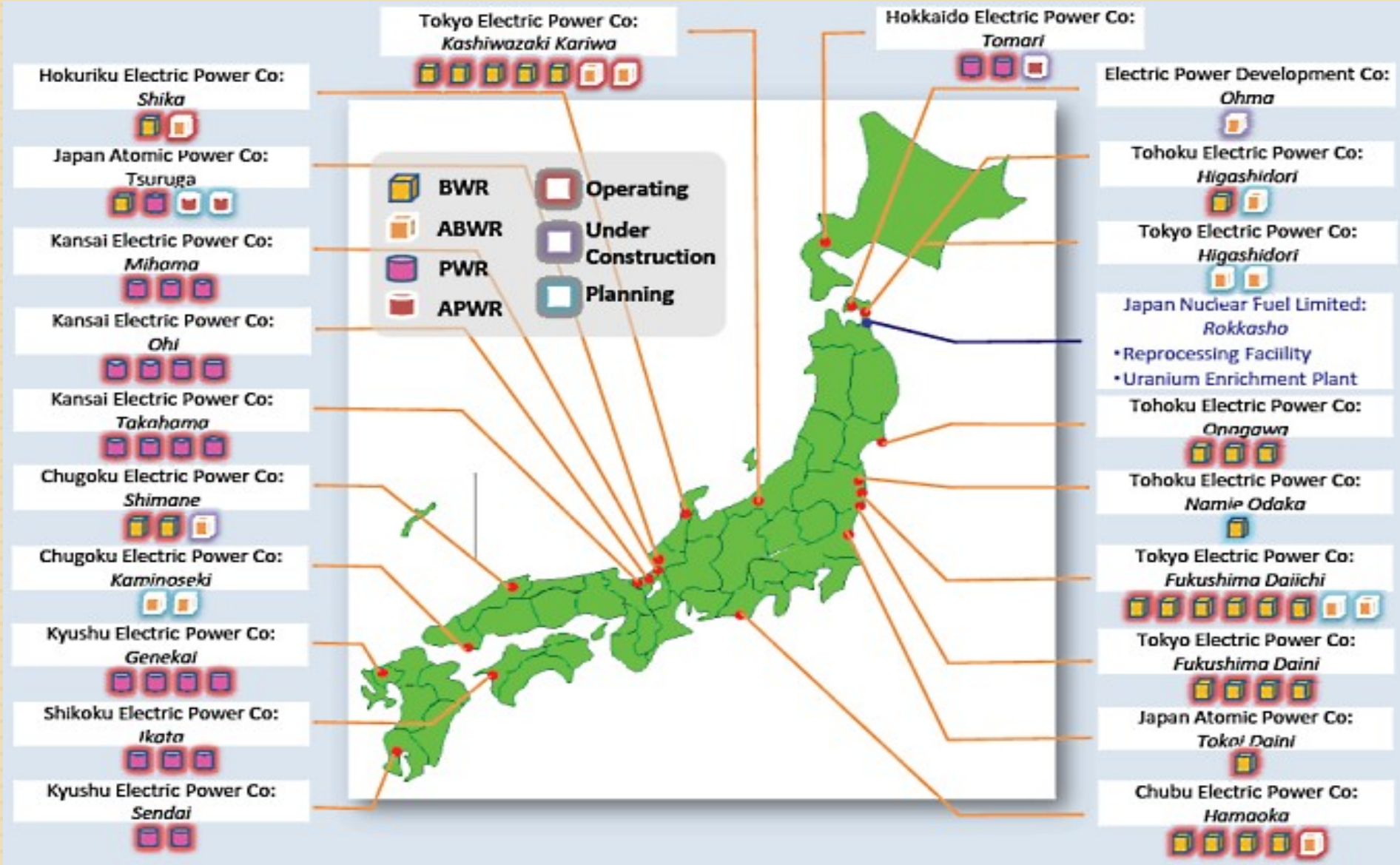
Figure 2-1 Japan's total power generation capacity



Source : IEEJ



Status of Nuclear Power in Japan @ Nov 2014



Status of Nuclear Re-Starts

Ohi Reactor shut down on 16 September 2013 and since then no reactor has been activated. FY2014 will be the first year in four decades that no nuclear reactor has been in operation in Japan.

The average numbers of years that Japan's reactors have been non-operational is now 3.5 years or a cumulative 152 years of non-operation or approximately 880 TWh of output has been lost over this period that is almost equivalent to one year of power consumption in Japan or $150 billion of revenues.

Ten reactors (9.6 GW) may re-start in FY 2015 subject to NRA clearance.

#1 & #2 Sendai: Kyushu EPC
#3 & #4 Genkai: Kyushu EPC
#3 & #4 Takahama : Kansai EPC
#3 Ikata : Shikoku EPC
#3 & #4 Oi: Kansai EPC
#3 Tomari :Hokkaido EPC

Four reactors are now aged over 40 years:-

1 Tsuruga -JAPC

1 & 2 Mihama-Kyushu EPC

#1 Shimane – Chugoku EPC

Three more reactors will reach 40 years by July 2016:-

#1 and #2 Takahama-Kyushu EPC

#1 Genkai – Kyushu EPC

Government efforts now underway to decommission up to 12 reactors starting with #1 and #2 in Mihama.

Y2.2 trillion ($19 billion) has been the spent so far on upgrading reactors to meet new NRA standards.

TEPCO, Tohoku, Chugoku, Chubu, Hokuriku unlikely to re-start any reactors in FY 2015.

Fuel Sourcing Uncertainities Across Major Economies Asia Pacific

Table 2 • Key long-term uncertainties faced by Asian countries

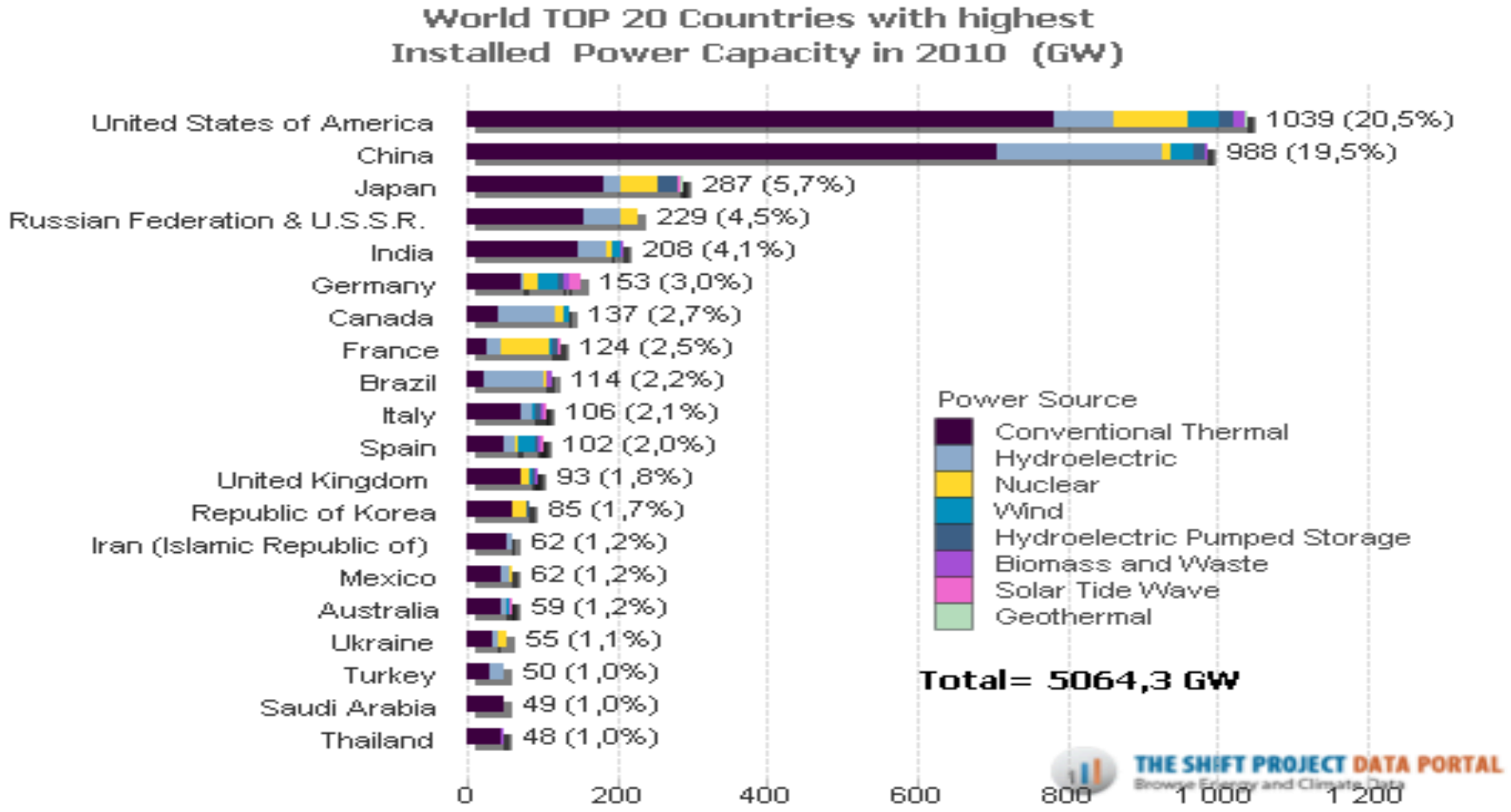
	China	India	Indonesia	Japan	Korea	Malaysia	Singapore	Chinese Taipei	Thailand	Viet Nam
Production	+++	++	+++	+*		+			+	+
Demand	+++	+++	++							
Coal/gas	+++	+++	+++	+	+	+				
Nuclear	++	+		+++	++			++	+	
Exports			+++			++				
Pipeline imports	+++	++		+	+		+			

Note: +++ = game changer; ++ = significant impact; + = limited impact; " " = no impact/irrelevant.

* Methane hydrates.

Source : IEA

Global Top 20 Countries Generation Capacity:Japan #3



Source: The Shift Project

Global Top 20 Countries Generation Output

North East Asia occupies 1st, 5th, 11th, and 17th spots

RANK	COUNTRY	(KWH)	DATE OF INFORMATION
1	China	5,398,000,000,000	2013
2	United States	4,099,000,000,000	2011 est.
3	European Union	3,255,000,000,000	2011 est.
4	Russia	1,057,000,000,000	2013 est.
5	Japan	936,200,000,000	2012 est.
6	India	871,000,000,000	FY11/12 est.
7	Canada	618,900,000,000	2011 est.
8	France	561,200,000,000	2012 est.
9	Brazil	530,700,000,000	2011 est.
10	Germany	526,600,000,000	2012 est.
11	Korea, South	485,100,000,000	2011 est.
12	United Kingdom	365,700,000,000	2013 est.
13	Italy	299,300,000,000	2012 est.
14	Mexico	296,000,000,000	2012 est.
15	Spain	276,800,000,000	2011 est.
16	South Africa	257,900,000,000	2012 est.
17	Taiwan	252,200,000,000	2011 est.
18	Iran	239,700,000,000	2011 est.
19	Saudi Arabia	239,200,000,000	2011 est.
20	Australia	225,500,000,000	2011 est.

Facts & Figures on the Japan Power Sector

- Generation Capacity of EPCs: 220 GW
- Self-generation capacity: 80 GW
- Transmission & Distribution: 18,200 km
- No. of Residential Customers : 54 million
- No. of Commercial/Industrial Customers:30 million
- Revenue Base : $150 billion
- Equity/Debt Split of the Industry:4:1
- Carbon Emissions of the sector: 700 million tons
- CAPEX: FY03/14 : $24 billion

Japanese Generation Assets by EPC

Company Data (Fiscal year ending March 31, 2013)

Company	Capital Stock (Million yen)	Total Assets (Million yen)	Generating Capacity (MW)	Electricity Supplied (GWh)	Electricity Sales (GWh)	Revenues from Electricity Sales (Million yen)	Number of Customers (Thousands)	Number of Employees
Hokkaido	114,291	1,607,002	7,549	34,938	31,184	558,860	4,007	5,689
Tohoku	251,441	3,996,559	17,766	85,106	77,833	1,578,135	7,668	12,872
Tokyo	1,400,975	14,619,772	65,581	289,704	269,033	5,660,091	28,869	37,142
Chubu	430,777	5,592,806	34,032	137,140	126,552	2,429,840	10,519	17,277
Hokuriku	117,641	1,366,144	8,061	30,989	28,075	477,750	2,097	4,861
Kansai	489,320	6,757,662	34,958	153,320	141,754	2,439,435	13,560	22,554
Chugoku	185,527	2,715,200	11,989	63,984	58,647	1,089,109	5,223	9,884
Shikoku	145,551	1,318,731	6,963	30,099	27,410	488,195	2,844	6,163
Kyushu	237,304	4,201,704	20,137	90,302	83,787	1,408,339	8,558	13,089
Okinawa	7,586	415,087	2,183	8,313	7,314	158,754	859	1,609
Total	**3,380,413**	**42,590,667**	**209,219**	**923,895**	**851,590**	**16,288,508**	**84,204**	**131,140**

Source: Handbook of Electric Power Industry

Source : FEPC

Japan is invested in all LNG regions

Table 3 • Investments of Asian companies in selected regions

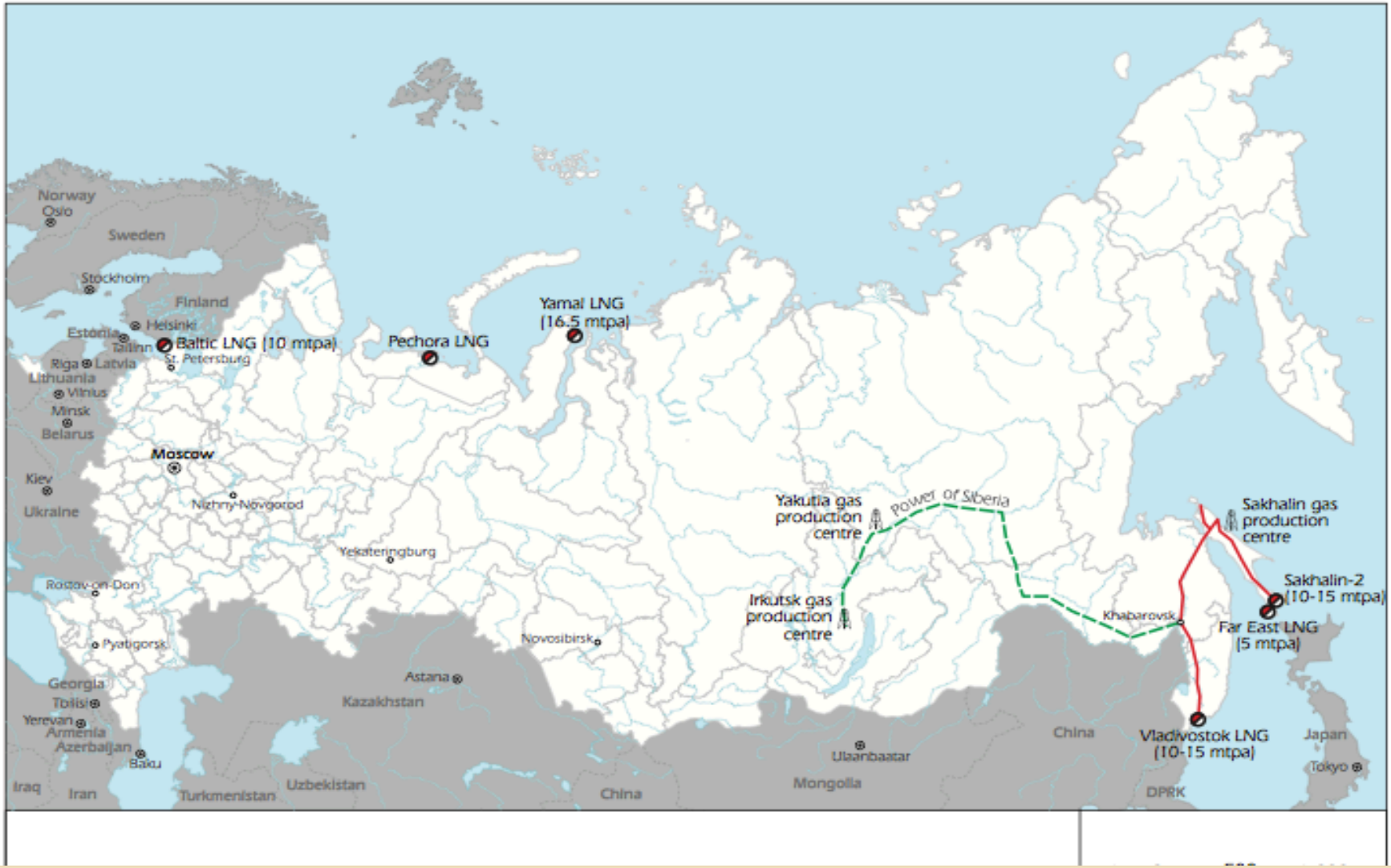
	China	India	Indonesia	Japan	Korea	Malaysia	Singapore	Chinese Taipei	Thailand	Viet Nam
North America										
Upstream	✔	✔	X	✔	✔	✔	X	X	X	X
LNG	✔	✔	X	✔	✔	✔	X	X	X	X
Contracts	✔	✔	✔	✔	✔	✔	X	X	X	X
Russia										
Upstream	✔	✔	X	✔	X	X	X	X	X	X
LNG	✔	X	X	✔	X	X	X	X	X	X
Contracts	✔	✔	X	✔	✔	X	X	X	X	✔
Australia										
Upstream	✔	✔	X	✔	✔	✔	X	✔	X	X
LNG	✔	X	X	✔	✔	✔	X	✔	X	X
Contracts	✔	✔	X	✔	✔	✔	✔	✔	X	X
East Africa										
Upstream	✔	✔	X	✔	✔	✔	✔	X	✔	X
LNG	✔	✔	X	✔	✔	X	✔	X	✔	X
Contracts	✔ (?)	✔ (?)	X	✔ (?)	✔ (?)	X	✔ (?)	X	✔	X

Notes: No long-term contract except for PTTEP has been announced for East African LNG, but some key investors are expected to take some of their equity gas back home. Symbols: ✔ = investments have been made; X = investments have not been made; ✔ (?) = investments may have been made but it is currently unclear.

Source: IEA

Beware of the Russian "Gas" Bear

Figure 32 • Russian LNG projects



Gas Deregulatory Environment in Asia

Table 12 • Competitive market requirements of Asia's largest LNG importers

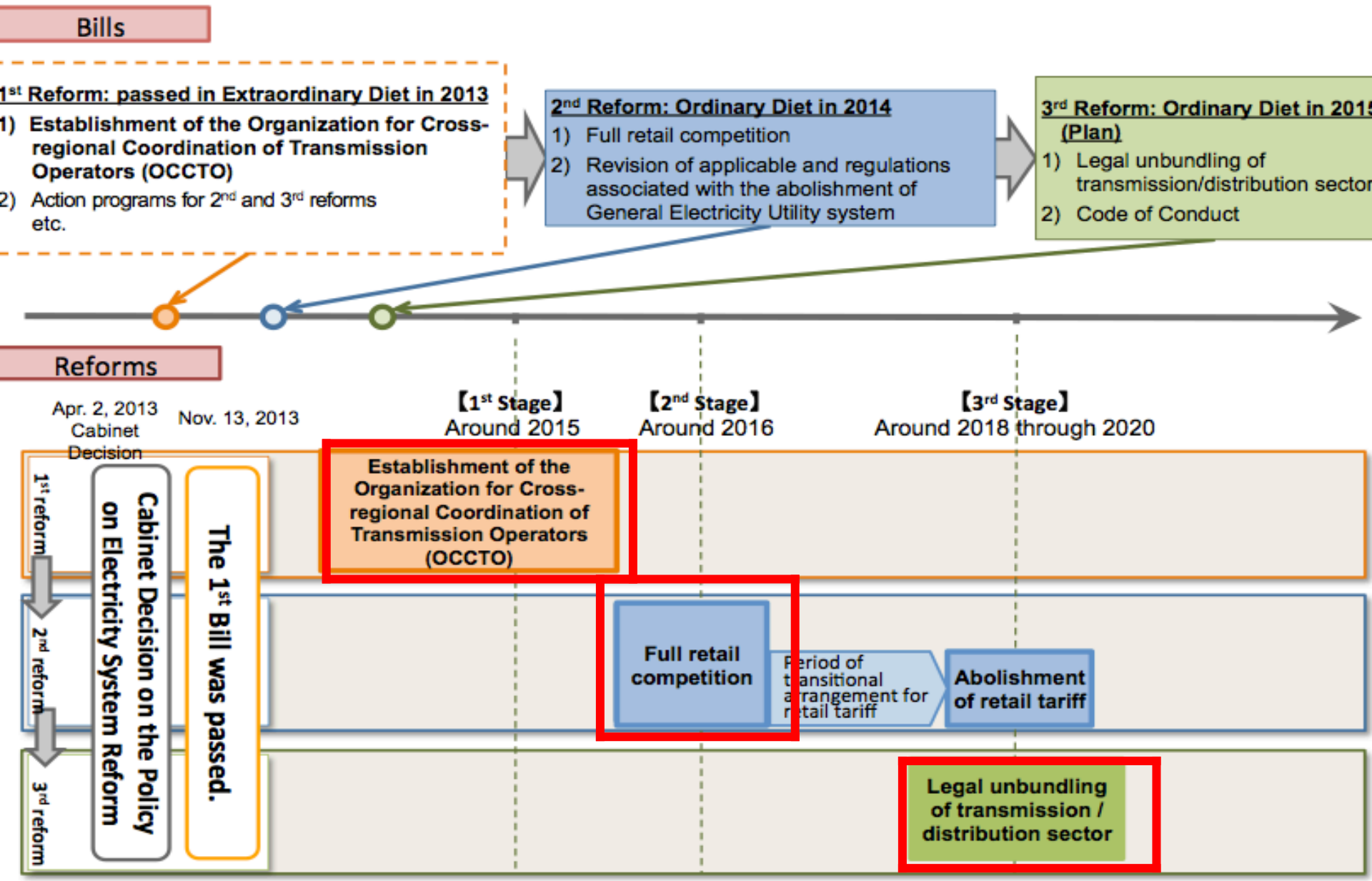
Requirement	China	India	Japan	Korea
Hands-off government approach	-	-	-	-
Separation of transport and commercial activities	+/-	-	+/-	-
Wholesale price deregulation	+/-	-	-*	-
Third-party access (TPA)	??	??	-*	-
Sufficient network capacity	-	-	+	-
Competitive number of market participants	-	+	+	-

Notes: + = currently contributing towards a competitive natural gas market; - = currently not contributing towards a competitive natural gas market; +/- = making progress; ?? = currently unclear.

* Japan is undertaking a gas reform which would result in wholesale price deregulation and efficient TPA; it can be considered to be at the very early stages of the process.

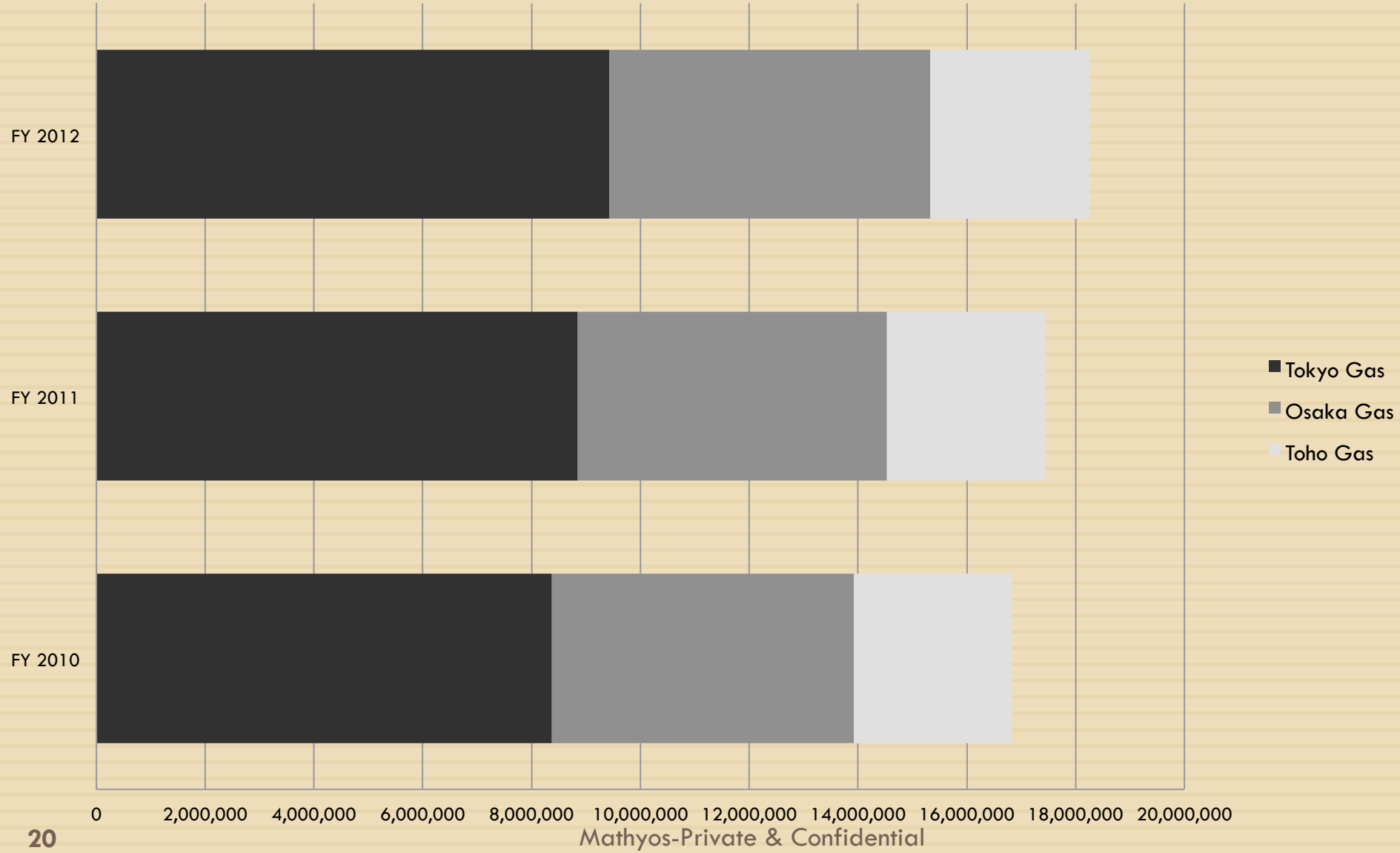
Source: IEA

Roadmap for Electricity Market Reform in Japan



Source : METI

Japan City GasCo LNG Imports



Japanese Gas Importers & Related Companies

Trading Companies	EPCOs	Gas Utilities	Others
Marubeni	Chubu Electric	Hiroshima Gas	Itochu Corp
Mitsubishi	Chugoku Electric	Nippon Gas	JAPEX
Mitsui	Kansai Electric	Osaka Gas	Gas Bureau, City of Sendai
Itochu	Kyushu Electric	Toho Gas	Nippon Steel
	Shikoku Electric	Tokyo Gas	Idemitsu
	Tokyo Electric	Saibu Gas	
	Tohoku Electric	Shizuoka Gas	

Shipping Companies	Owners of Regasification Installations	Construction of LNG Facilities
Mitsui OSK	EPCs	JGC
NYK	City Gas Cos	Chiyoda
Kawasaki KK		
Tokyo LNG Tankers		
EPCs and City Gas Cos		

Storage Infrastructure	Pipeline & Steel Companies	Road Distribution of Gas
IHI	Nippon Steel	City Gas Cos
EPCs and City Gas Cos	JFE	Niyaku Corp
	Toyota Tsusho	
	Mitsui	
	Mitsubishi	
	E&P Companies	

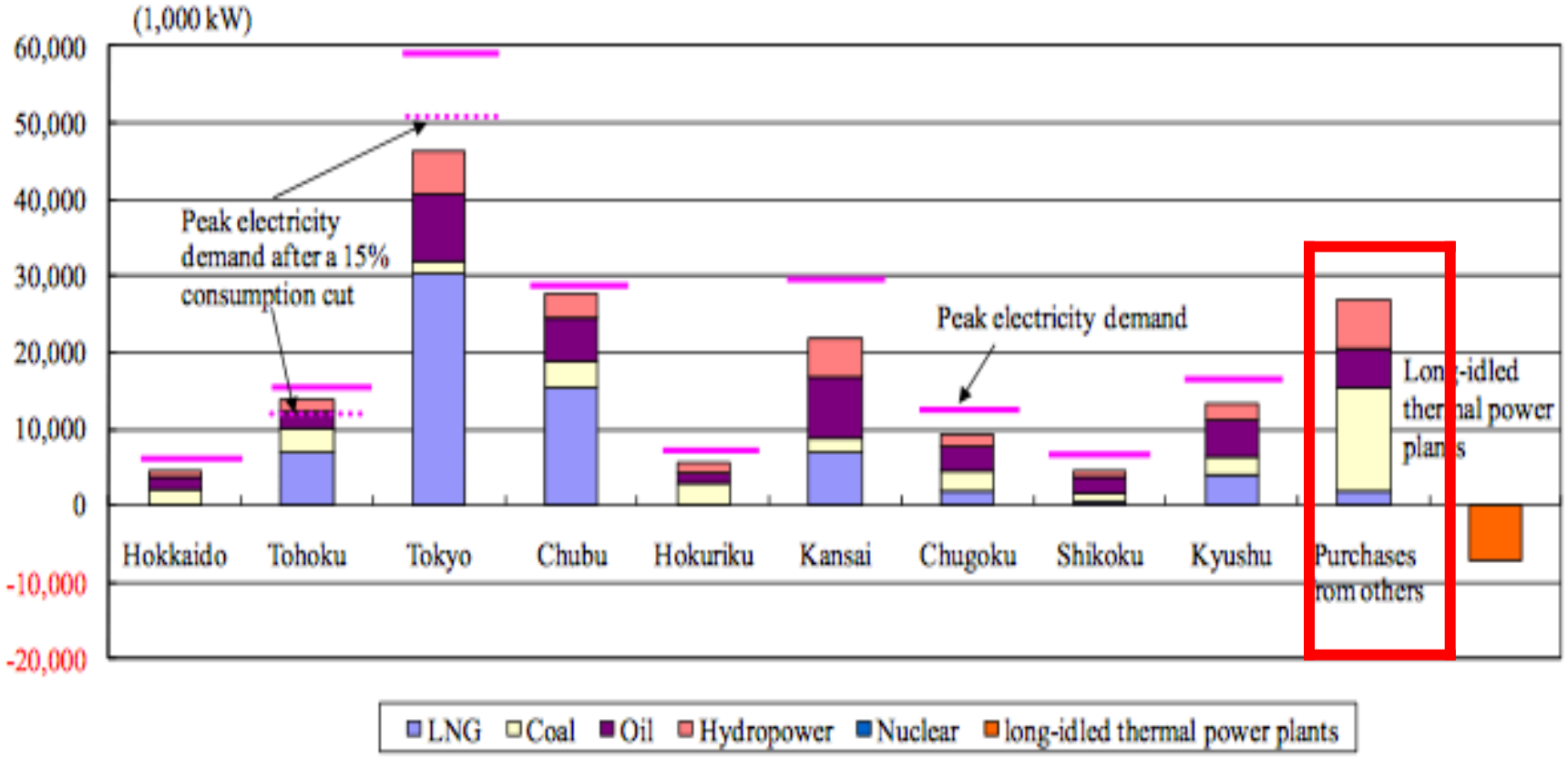
Figure 38 • LNG receiving terminals and main gas pipelines in Japan

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.

Source: IEA (2014b), *Natural Gas Information 2014*, OECD/IEA, Paris.

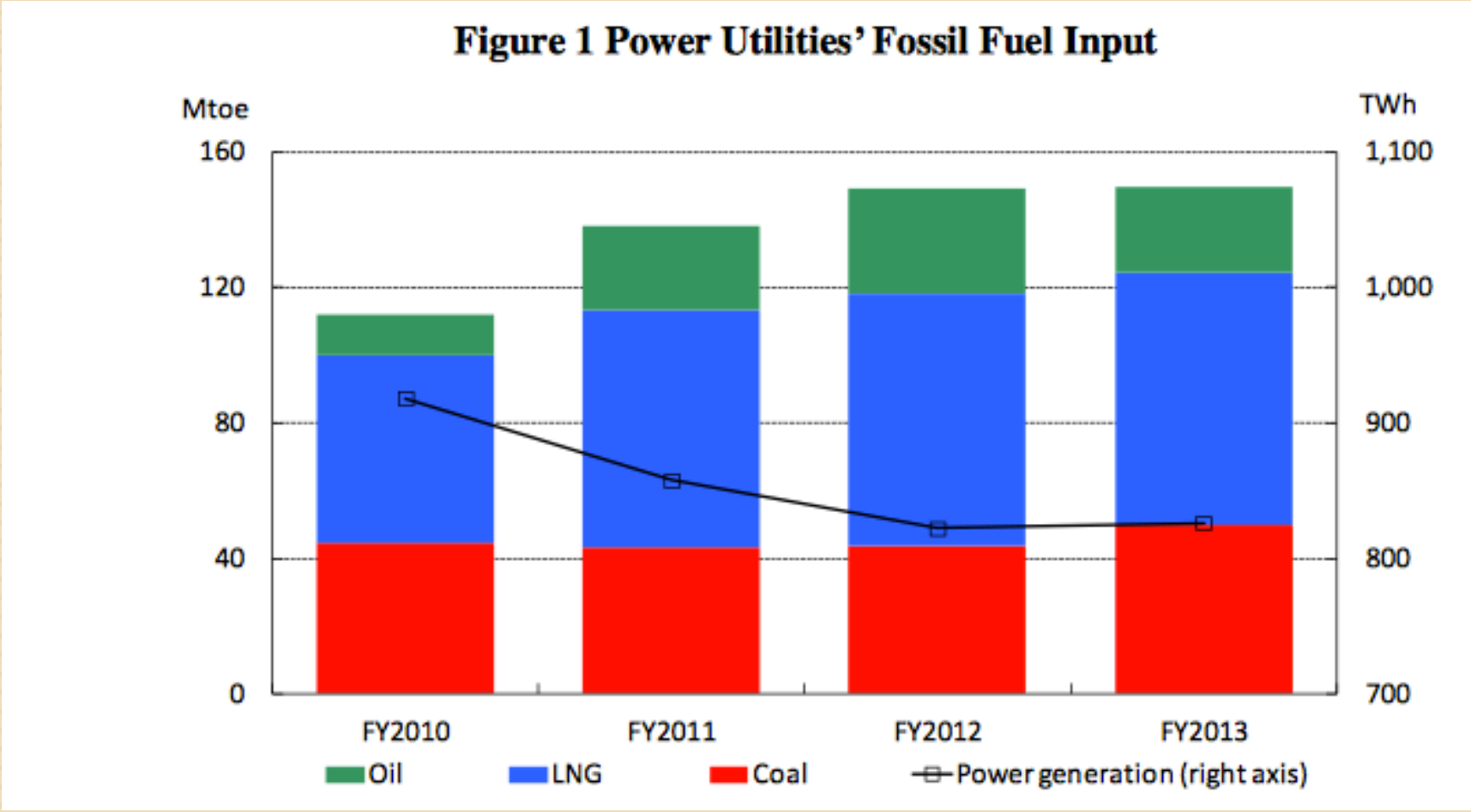
In FY 2014 Reserve Margins deteriorated significantly particularly in Kansai and Kyushu

Figure 3 Each electric power company's generation capacity and local peak demand



Source : IEEJ

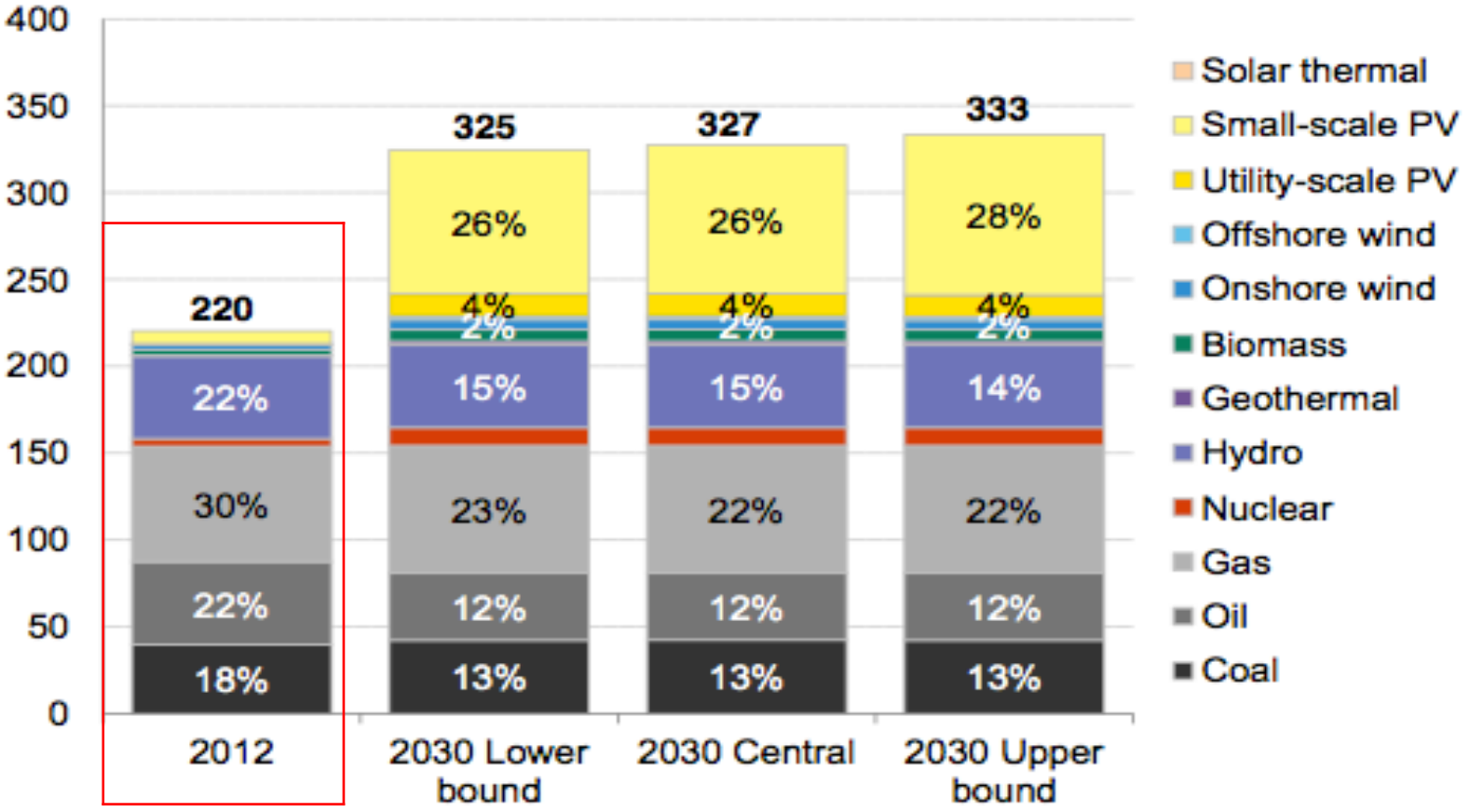
Fossil Fuel Usage by Japan EPCs



Source : IEEJ

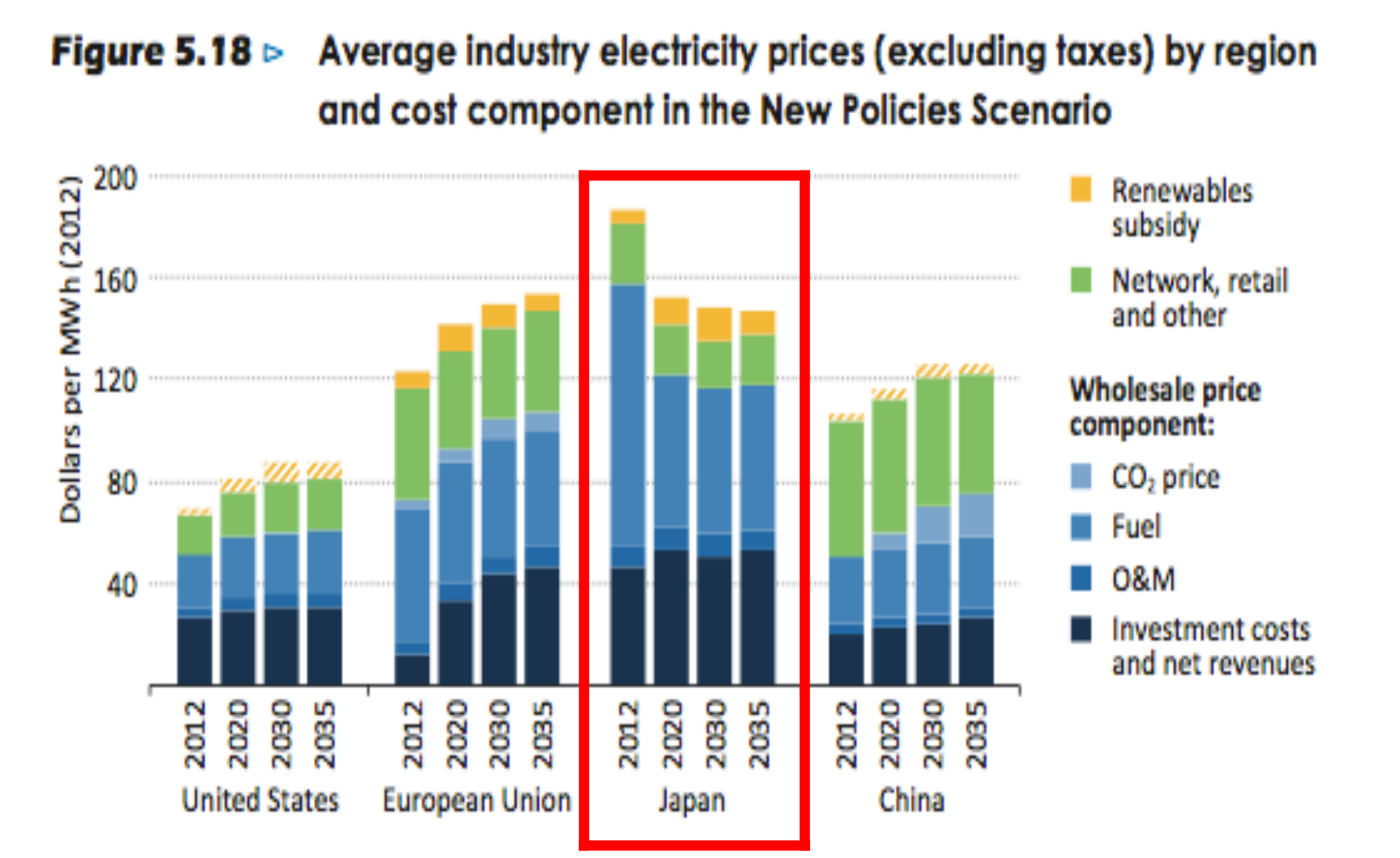
Forward Projections of Japan's Generation Capacity

Figure 41: Japan cumulative installed capacity by technology (GW)



Source: Bloomberg New Energy Finance

Cost Performance:Japan vs the Rest: Industrial Power Rates



Deregulation in 2004 appears to have had little impact on relative pricing for Japan's industrial consumers

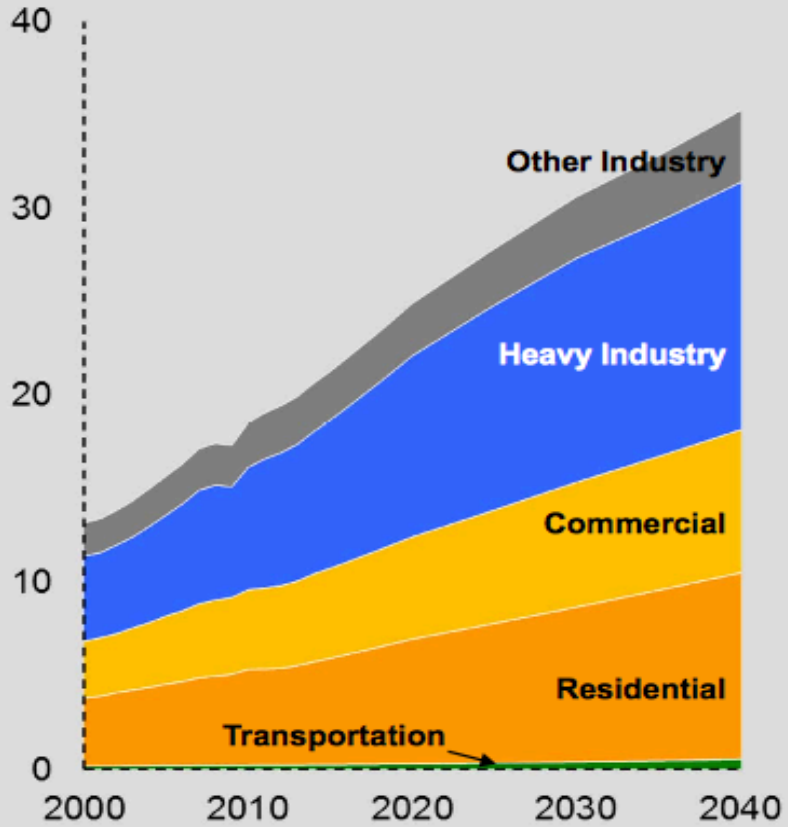
Source IEA

4x Increase Between 2000 and 2040

Electricity Demand

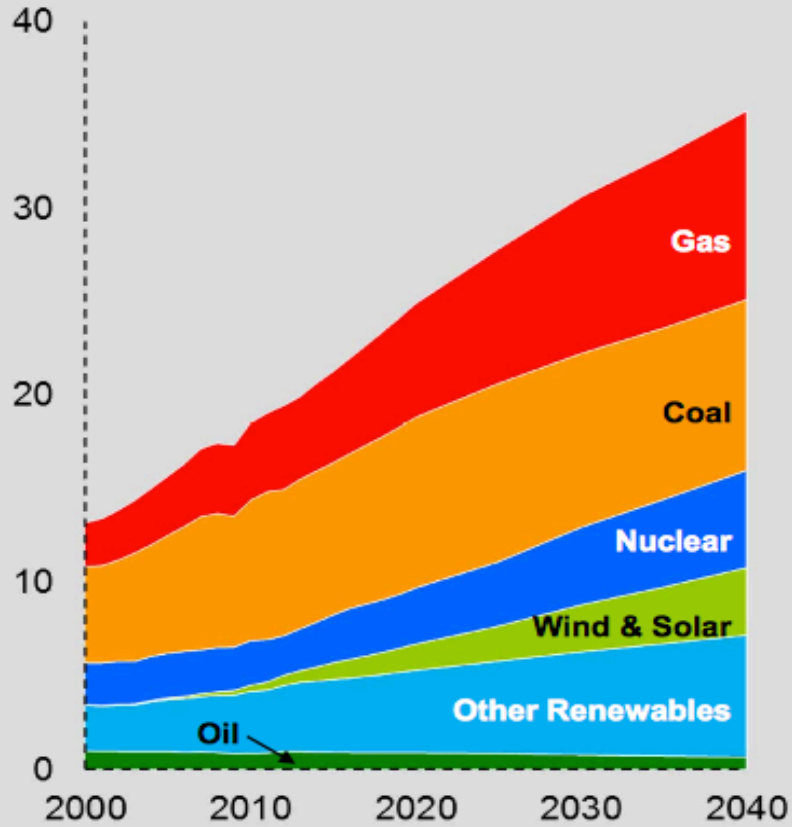
Global Electrical Demand by Sector

Thousand TWh



Global Electrical Demand by Fuel

Thousand TWh

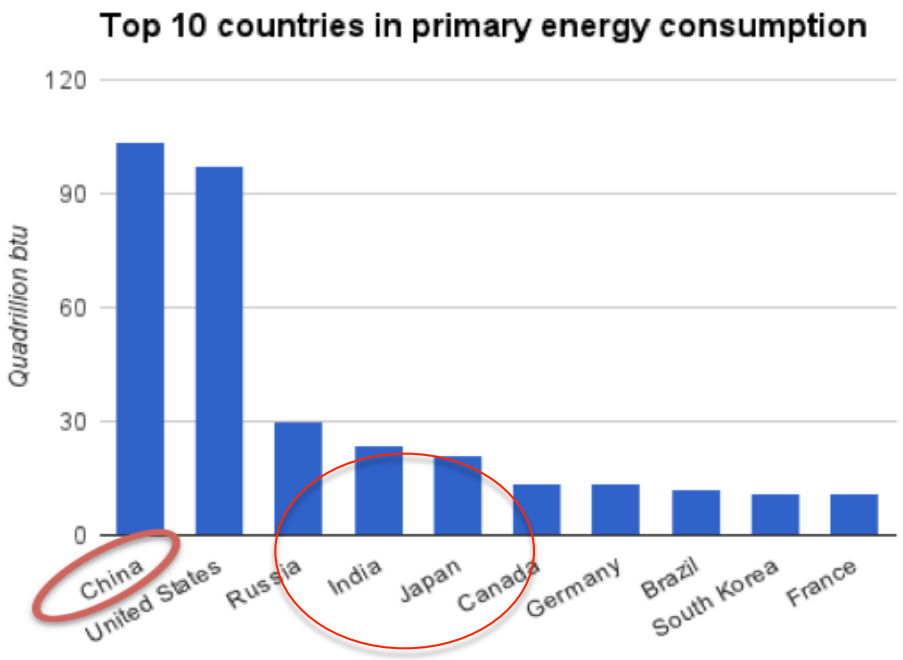


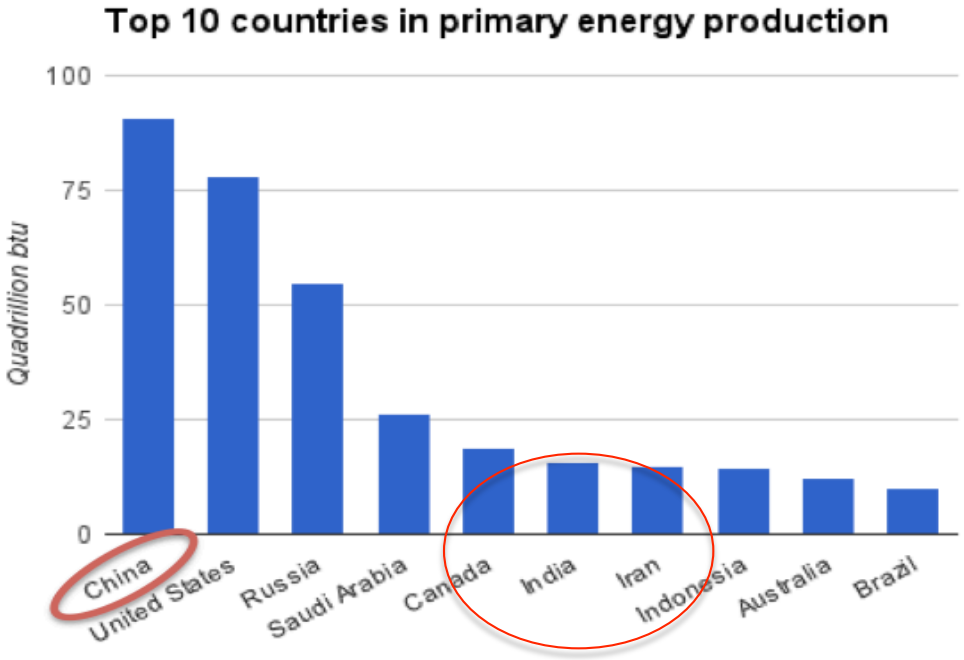
ExxonMobil

ExxonMobil 2014 Outlook for Energy

Japan's Energy Hungry Neighbour

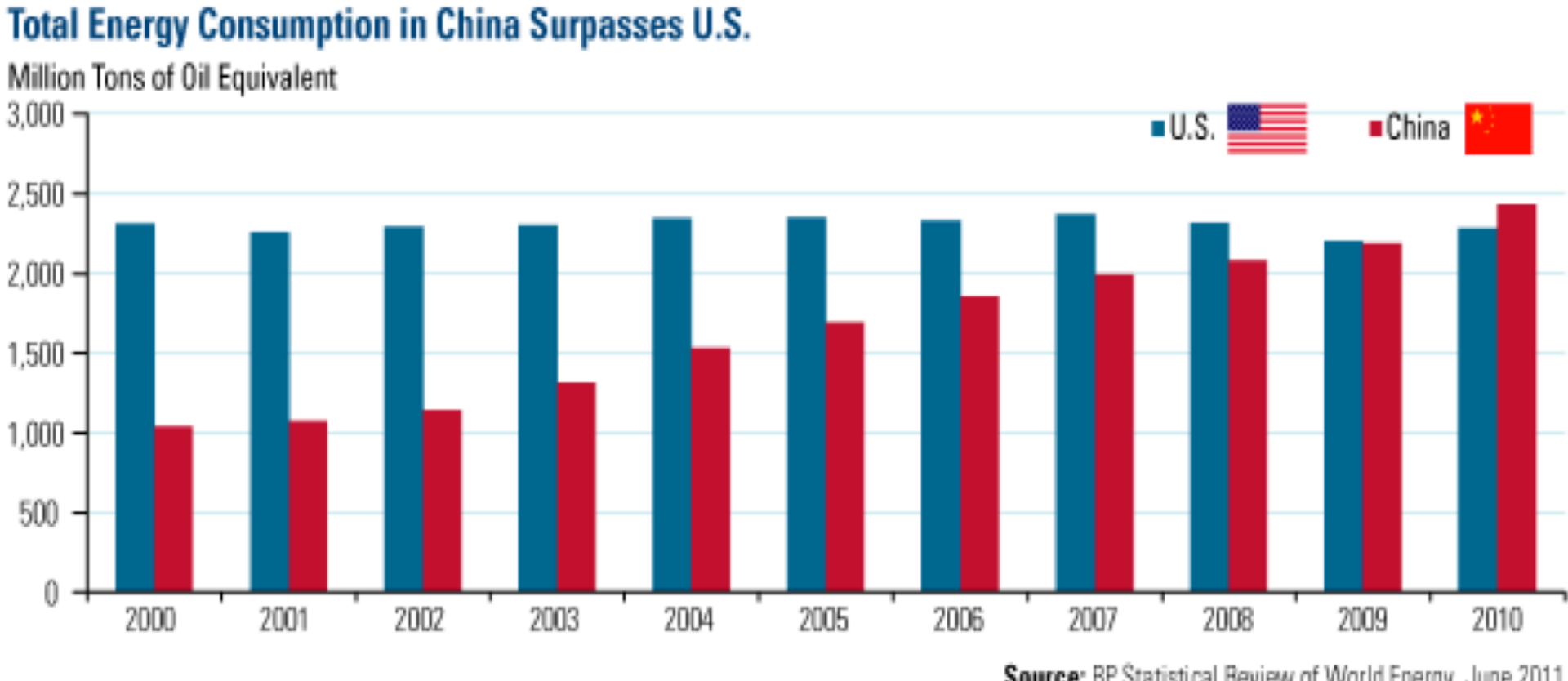
China Is World's Largest Energy Consumer And Producer



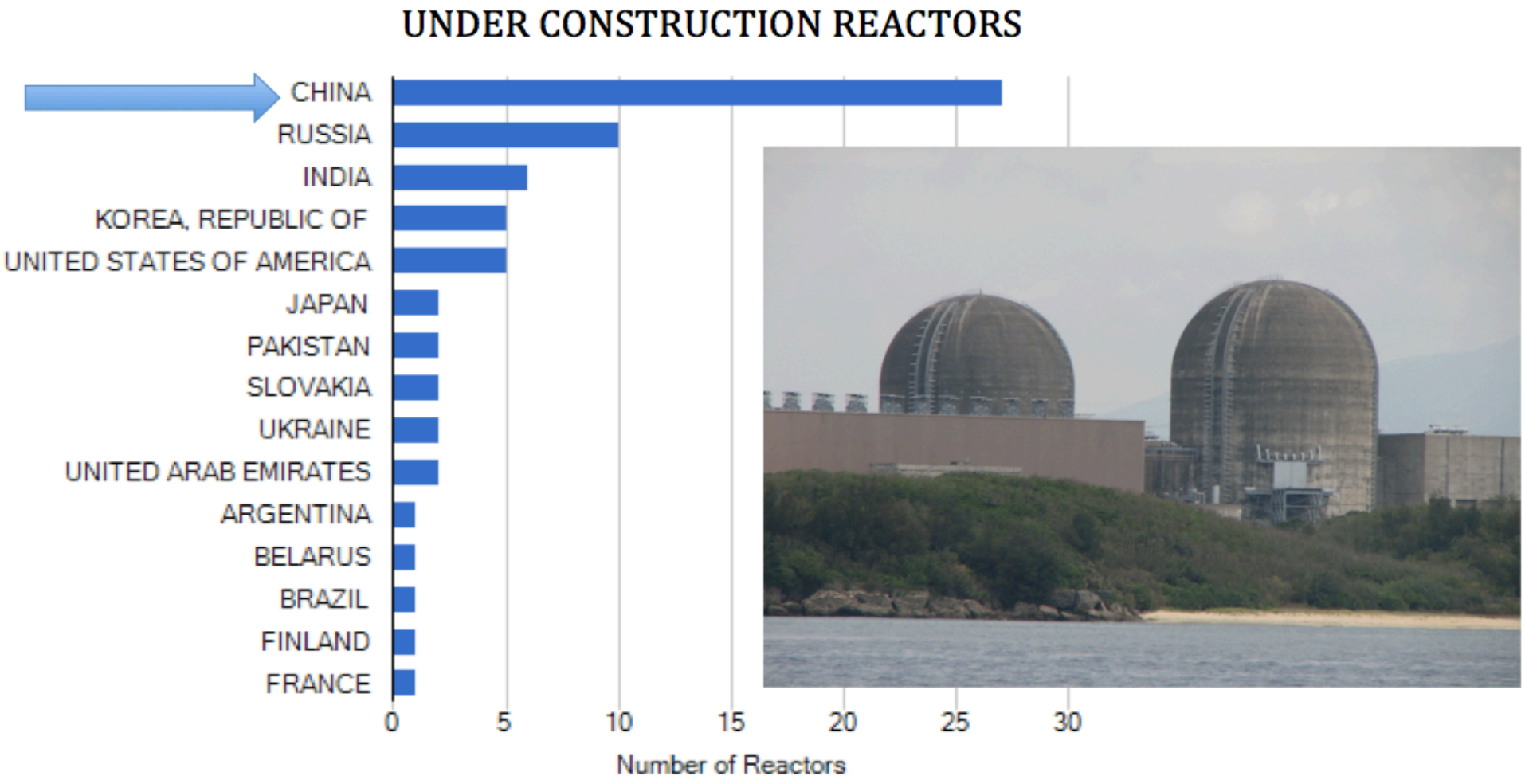


Sources: U.S. Energy Information Agency, International Energy Statistics (2011)

U.S. and Chinese Energy Consumption 2000-2010



China Is Building Half The World's New Nuclear Plants



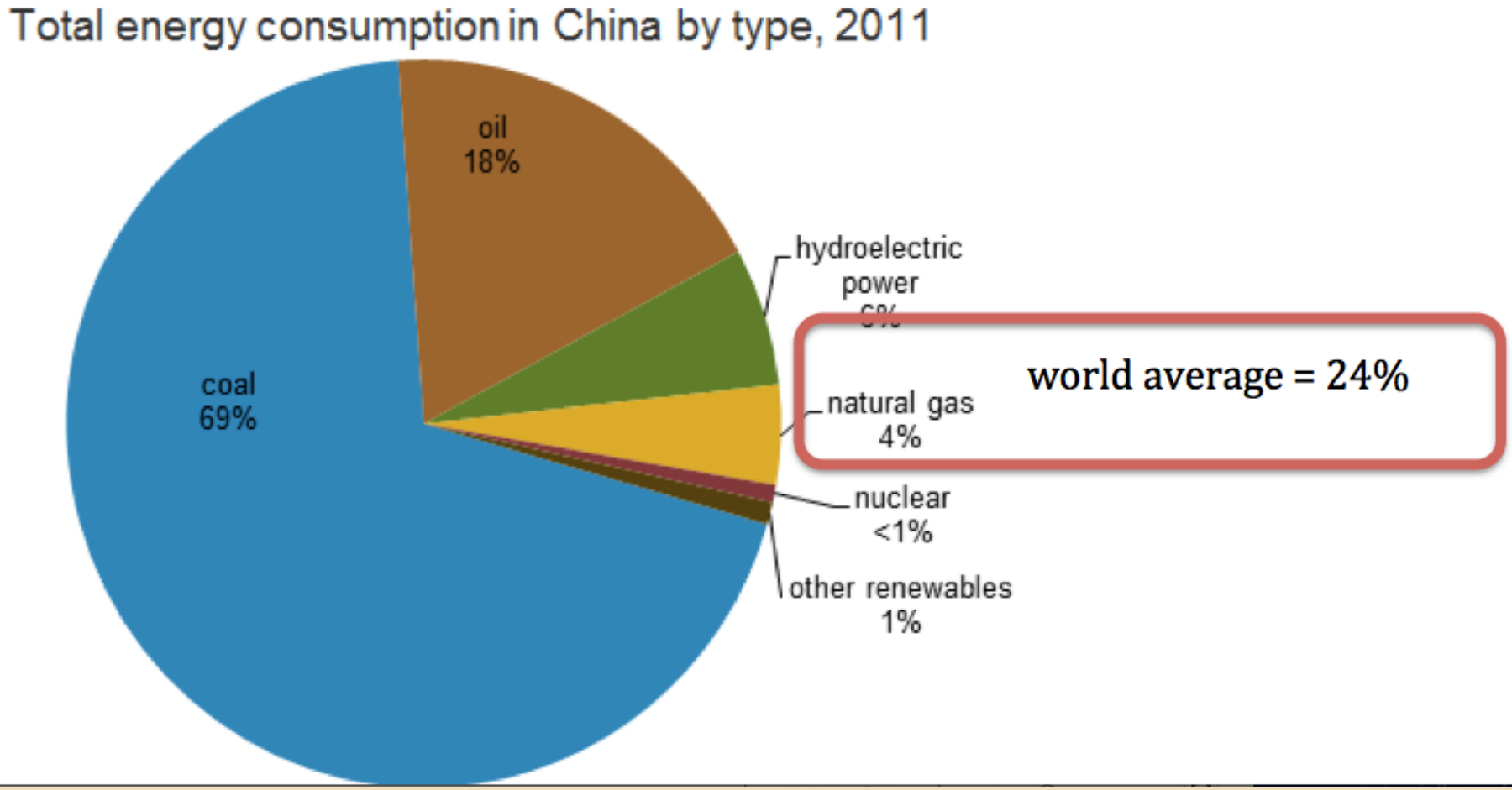
China Uses HALF of the World's Coal

Photo Credit: Wikimedia Commons

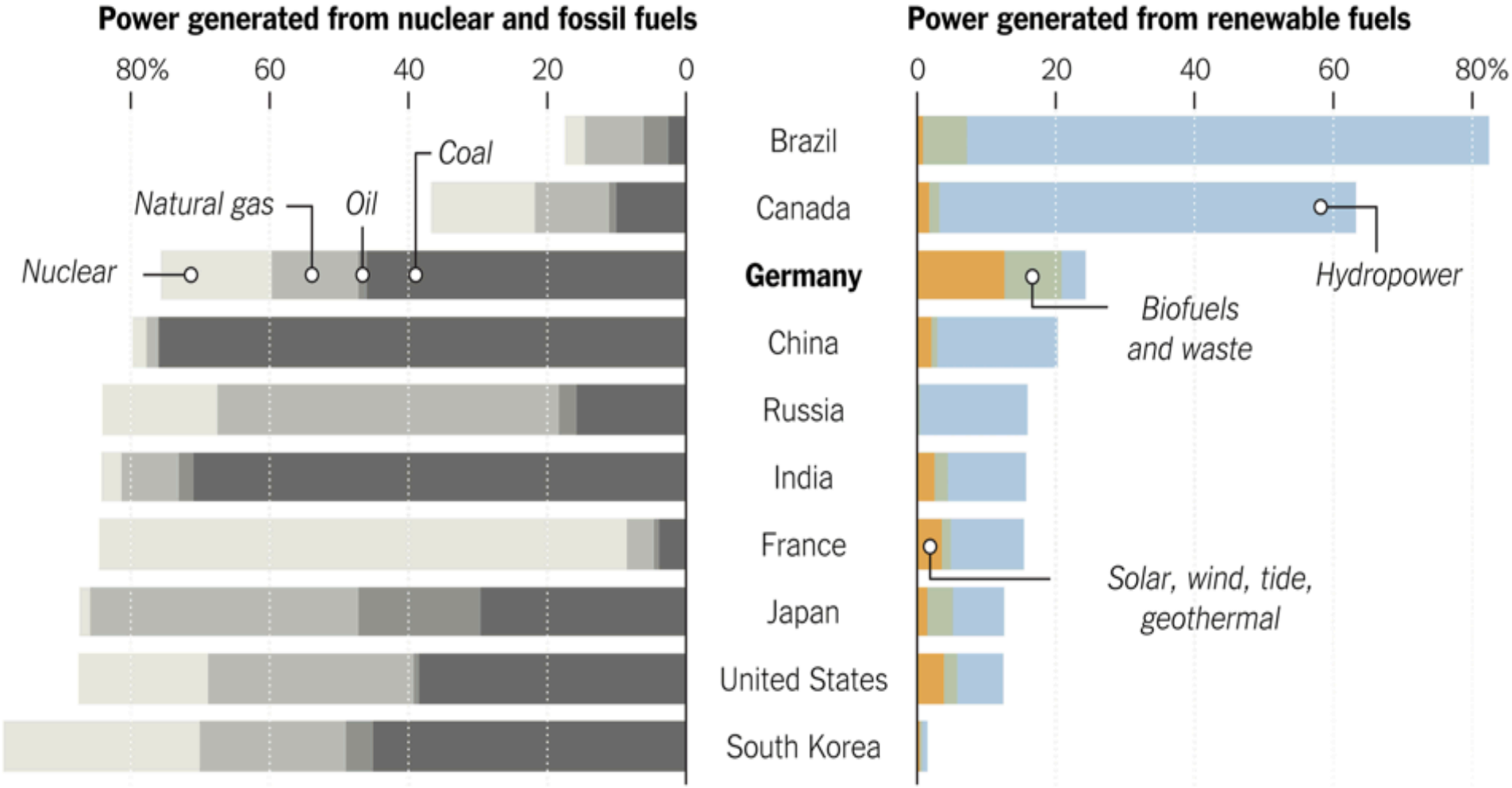
Coal consumption (2012)

$$\frac{\text{CHINA}}{\text{WORLD}} = \frac{\text{4.15 bn short tons}}{\text{8.45 bn short tons}}$$

China Natural Gas Use Is Small



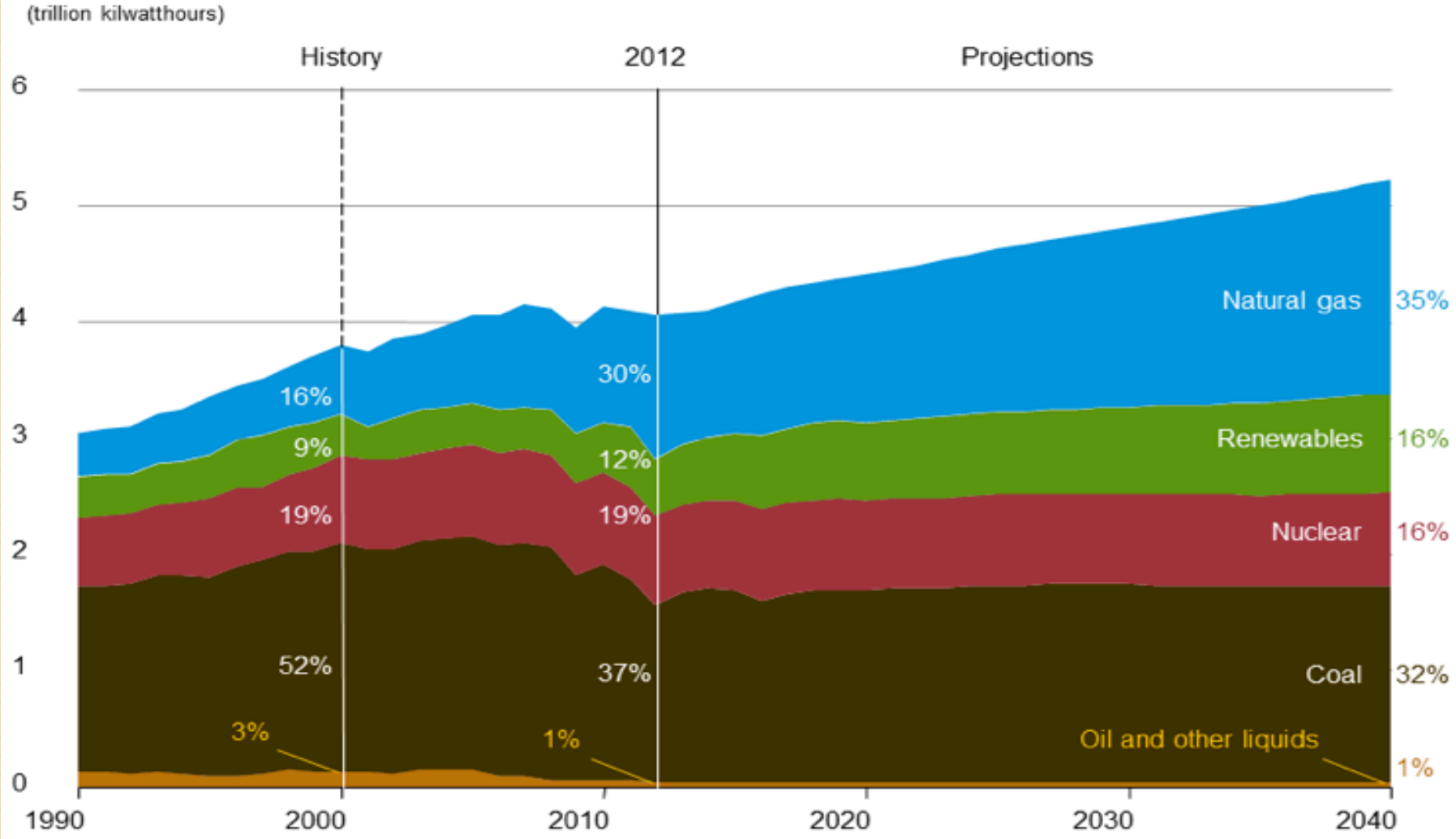
Global Power Mix by Selected Countries



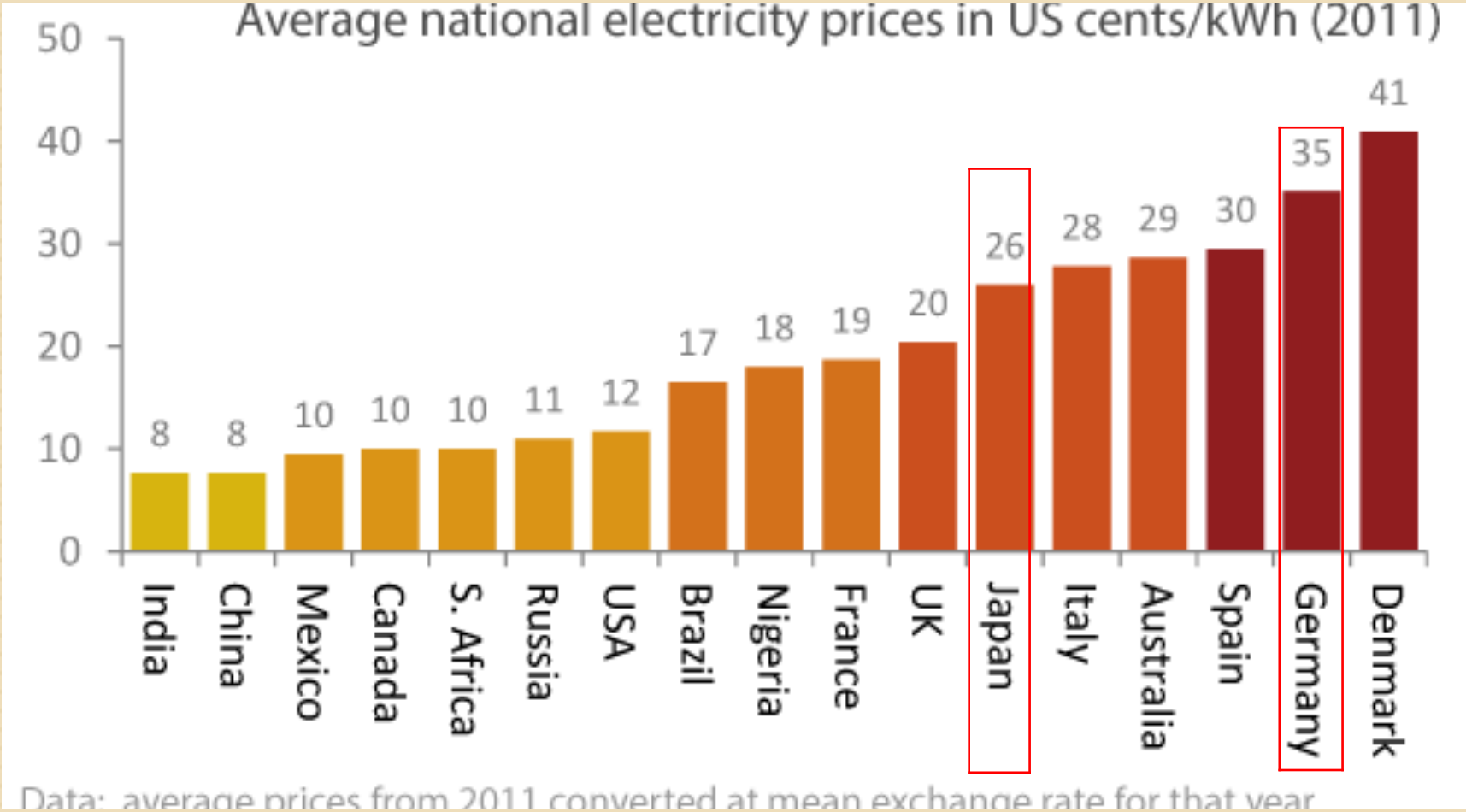
Source : NY Times

United States

Figure 13. Electricity generation by fuel, 1990-2040



Global Electricity Prices



European Spark Spreads: Coal now very competitive due to Collapse in carbon pricing

Figure 5. UK clean and dark spark spreads 2008-13[49]

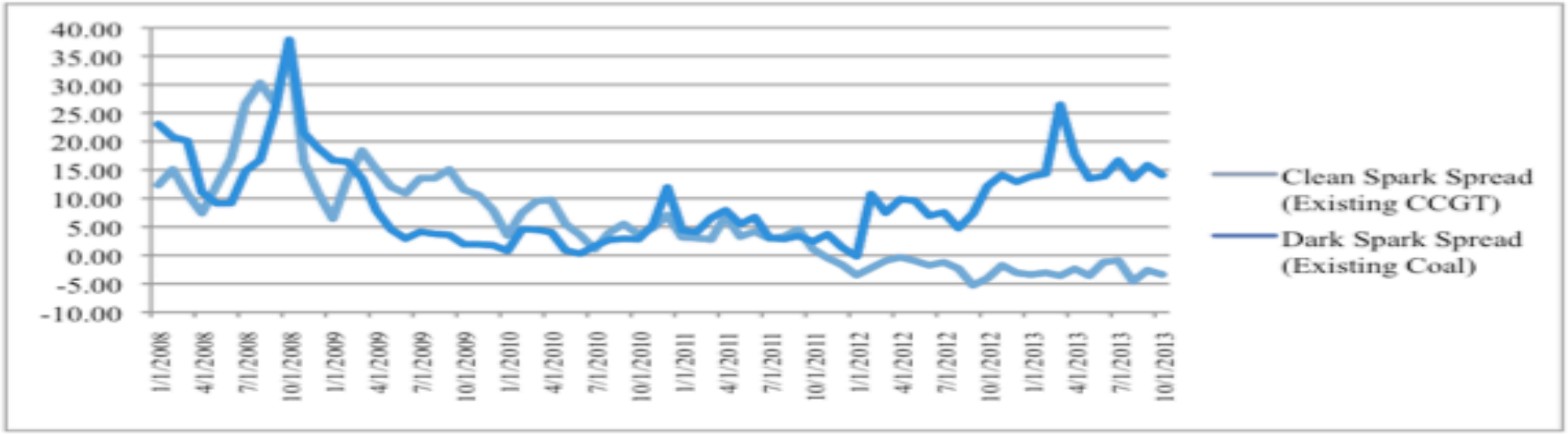
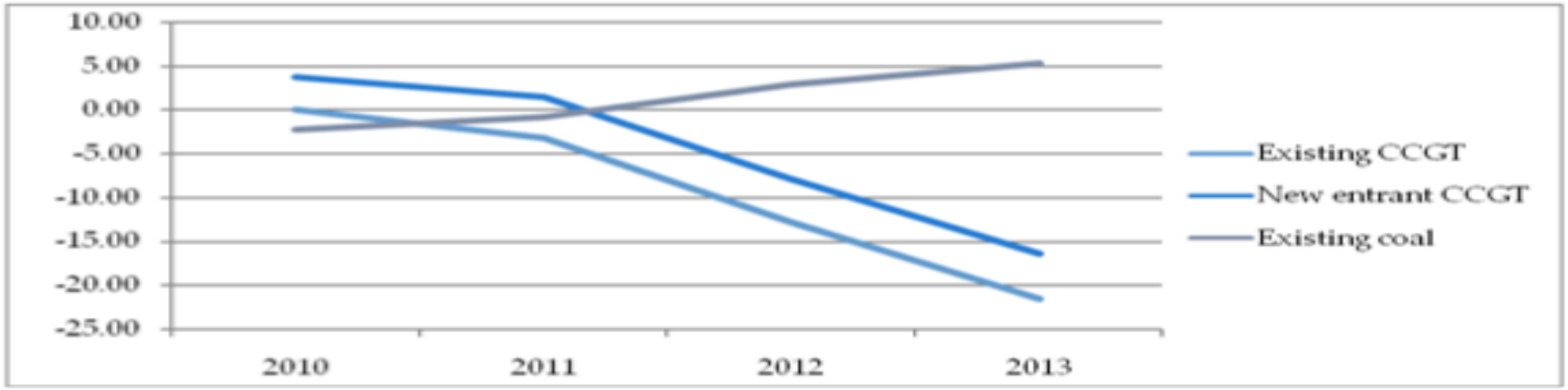


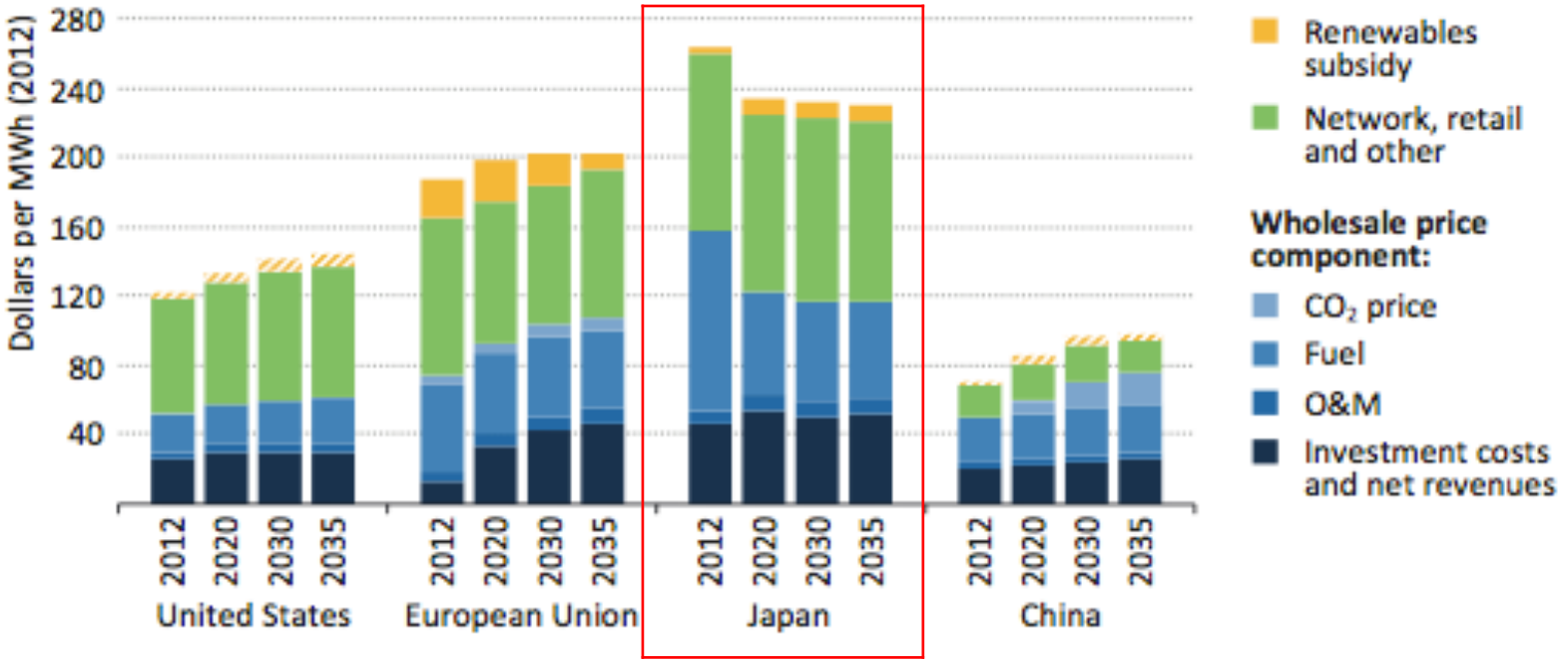
Figure 6. Germany clean and dark spark spreads, 2010-13[50]



Source: Oxford University

Cost Performance: Japan vs the Rest : Retail Power Rates

Figure 5.17 ▷ Average residential electricity prices (excluding taxes) by region and cost component in the New Policies Scenario



Notes: Hatched areas represent subsidies that are partly or fully borne by taxpayers rather than consumers. Chinese prices have a low component to cover network, retail and other costs, due to subsidisation.

Deregulation to commence in FY2016

Source: IEA

End/Out

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