

Shale gas revolution and its implication to international gas markets

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What is shale gas revolution?

Unit: Tcf

	Conventional 2011			Unconventional (Remaining Technically Recoverable Resources) (end-2011)			
	Reserves (end-2011)	Production	R/P (Years)	Tight Gas	Shale Gas	Coalbed Methane	Total
E. Europe/Eurasia	2,634	27	98	390	420	710	1,550
Middle East	2,826	19	149	320	140	0	420
Asia-Pacific	592	17	35	740	2,010	570	3,320
OECD Americas	382	31	12	390	1,660	320	2,370
Africa	513	7	73	350	1,060	0	1,410
Latin America	268	6	45	530	1,170	0	1,700
OECD Europe	145	9	16	140	570	70	780
World	7,361	116	63	2,860	7,060	1,660	11,580

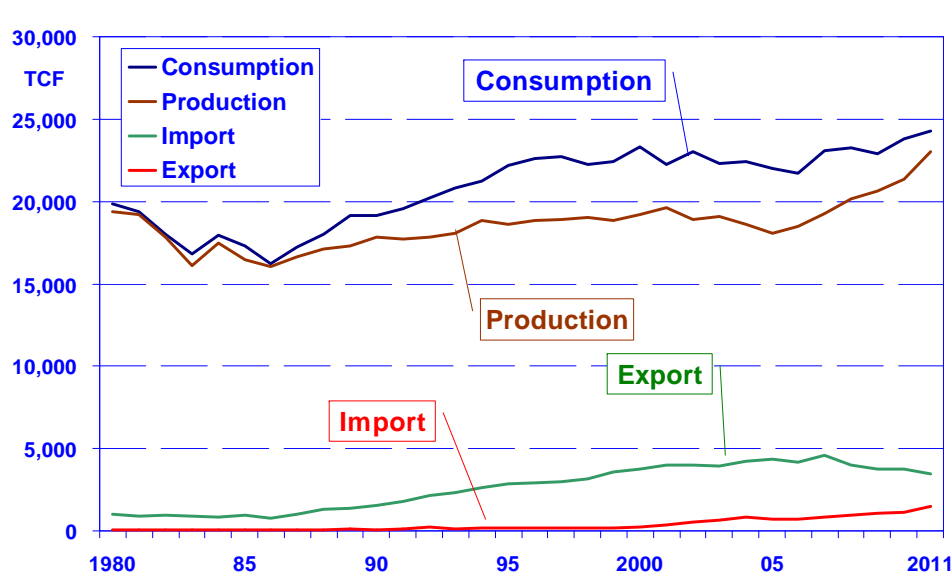
(Source) BP Statistical Review of World Energy June 2012、IEA World Energy Outlook 2012

- **The essence of shale gas revolution is huge expansion and less concentrated distribution of gas resources**

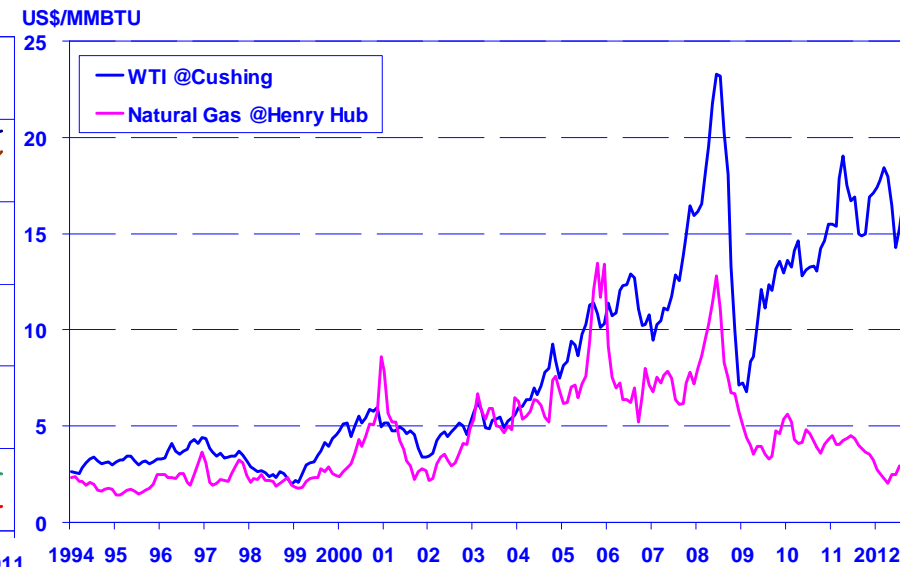
Natural gas demand, supply, and prices in the US



Demand/Supply



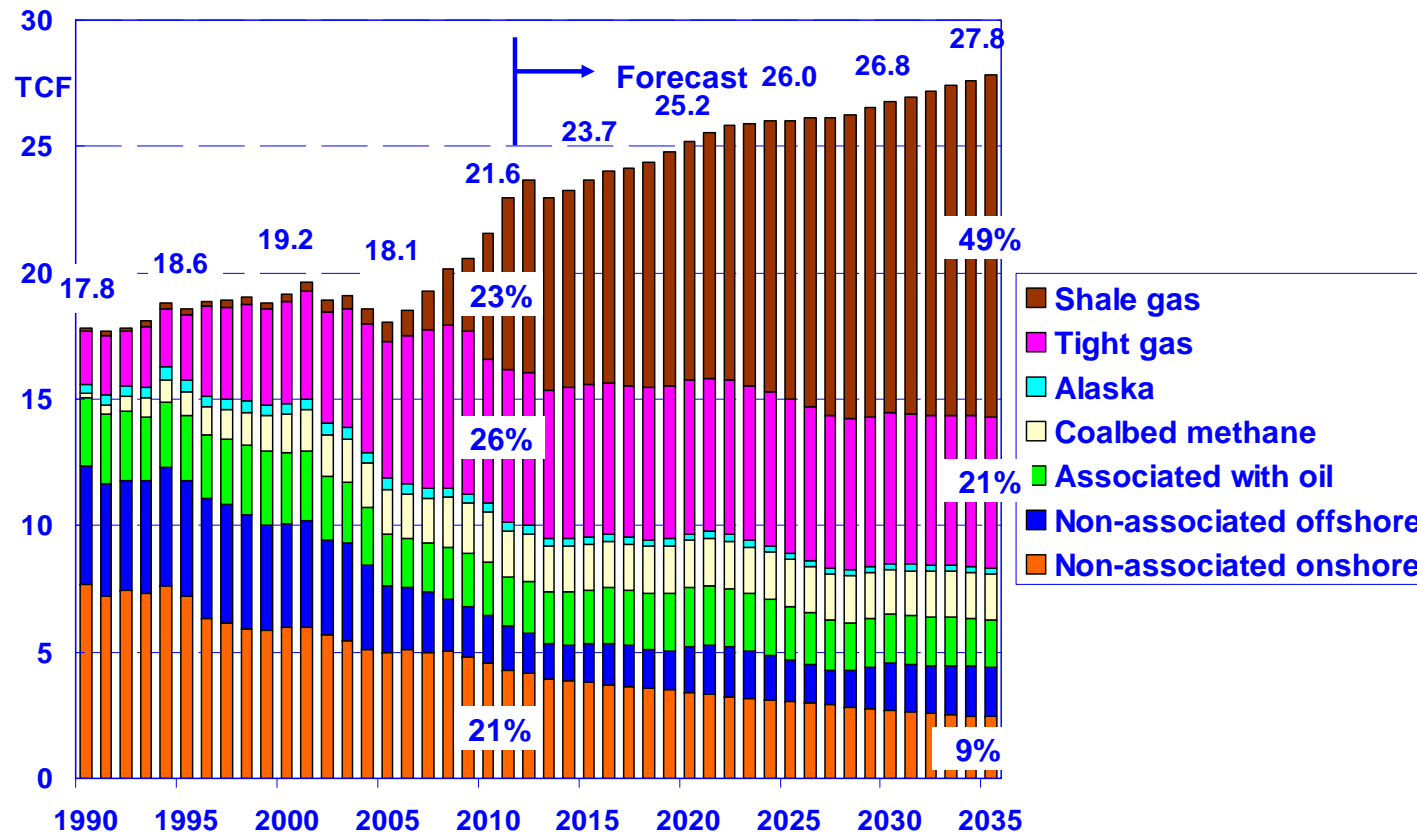
Spot Price@Henry Hub



(Source) DOE/EIA

- Demand and supply increasing at 2.3%/y and 4.2%, respectively
- Imports declining since 2007, exports increasing
- Henry Hub price declined rapidly since 2008

The US natural gas supply outlook



(Source) DOE/EIA Annual Energy Outlook 2012

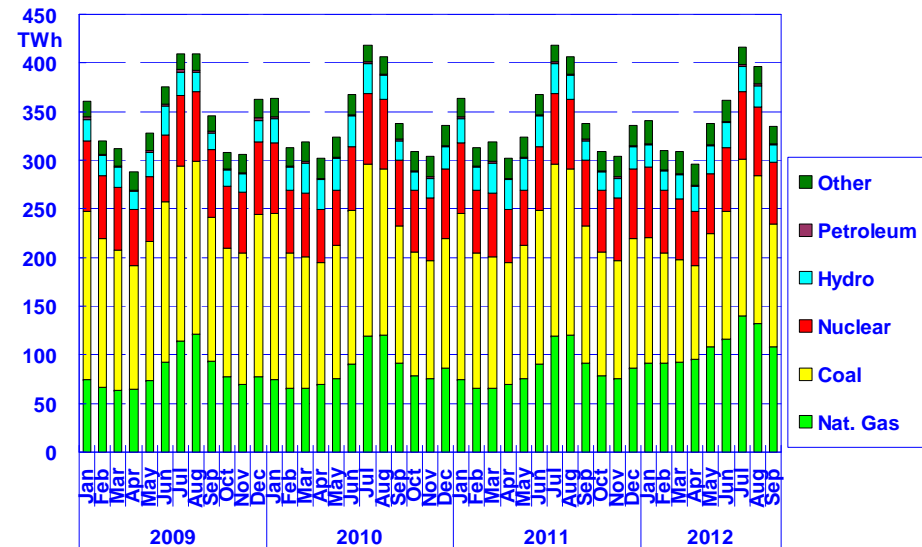
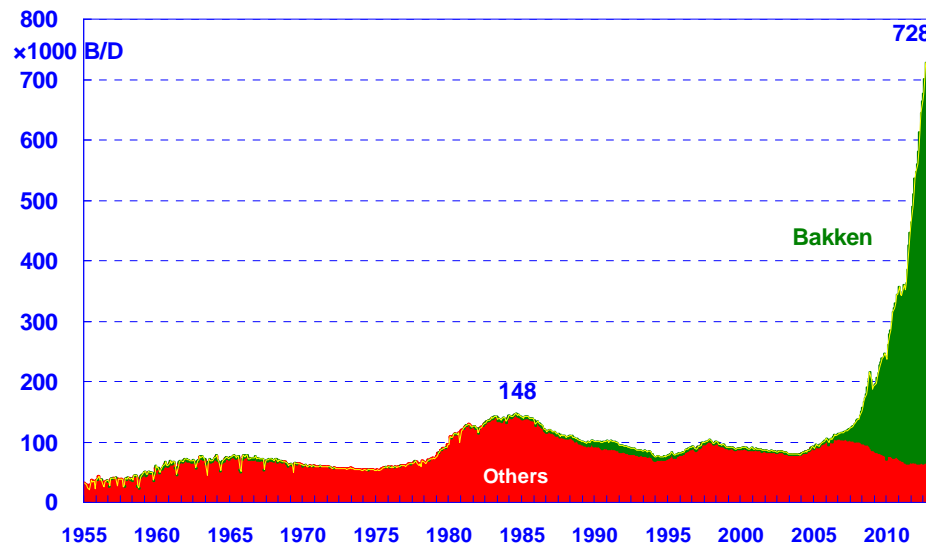
- Shale gas revolution still ongoing to share half of the gas production in 2035

Shale gas revolution aftermath(1)



Shale Oil Production (North Dakota)

Shift from Coal to Nat. Gas Power Station

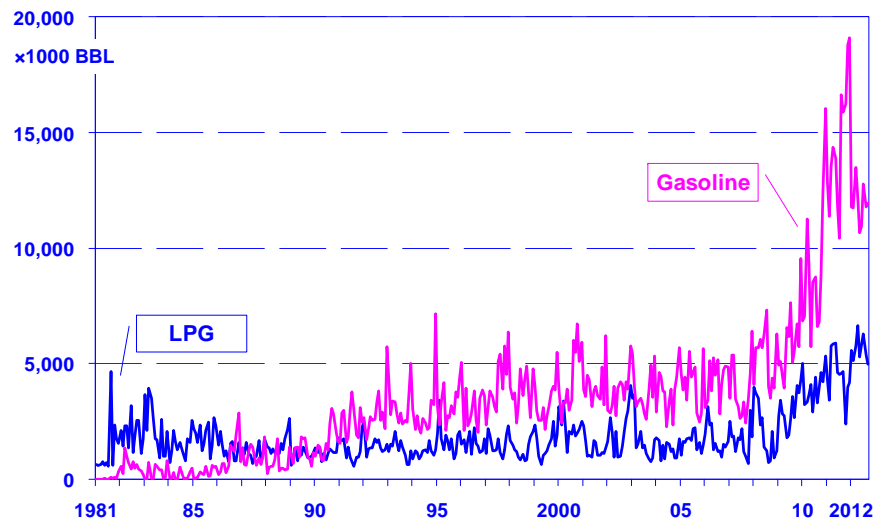


(Source) DOE/EIA

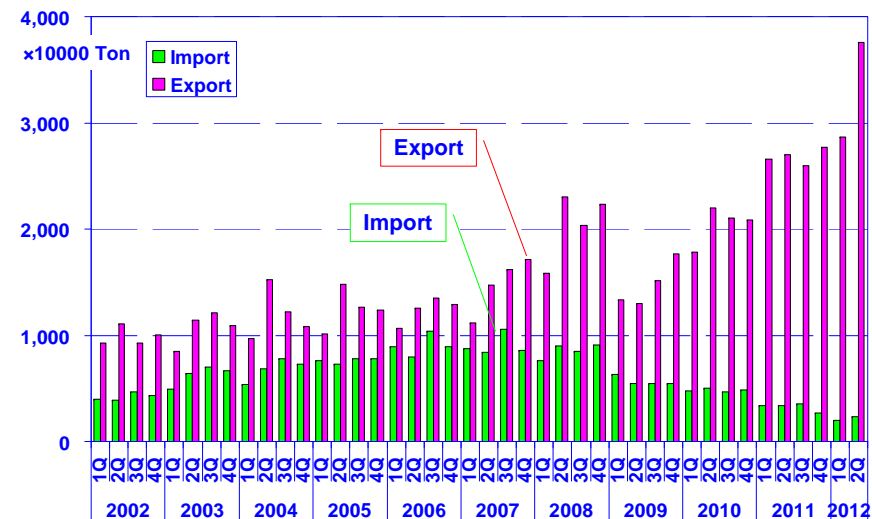
- Production shifting from shale gas to higher-value shale oil
- Power generators shifting from coal to natural gas

Shale gas revolution aftermath (2)

Export of LPG and Motor Gasoline



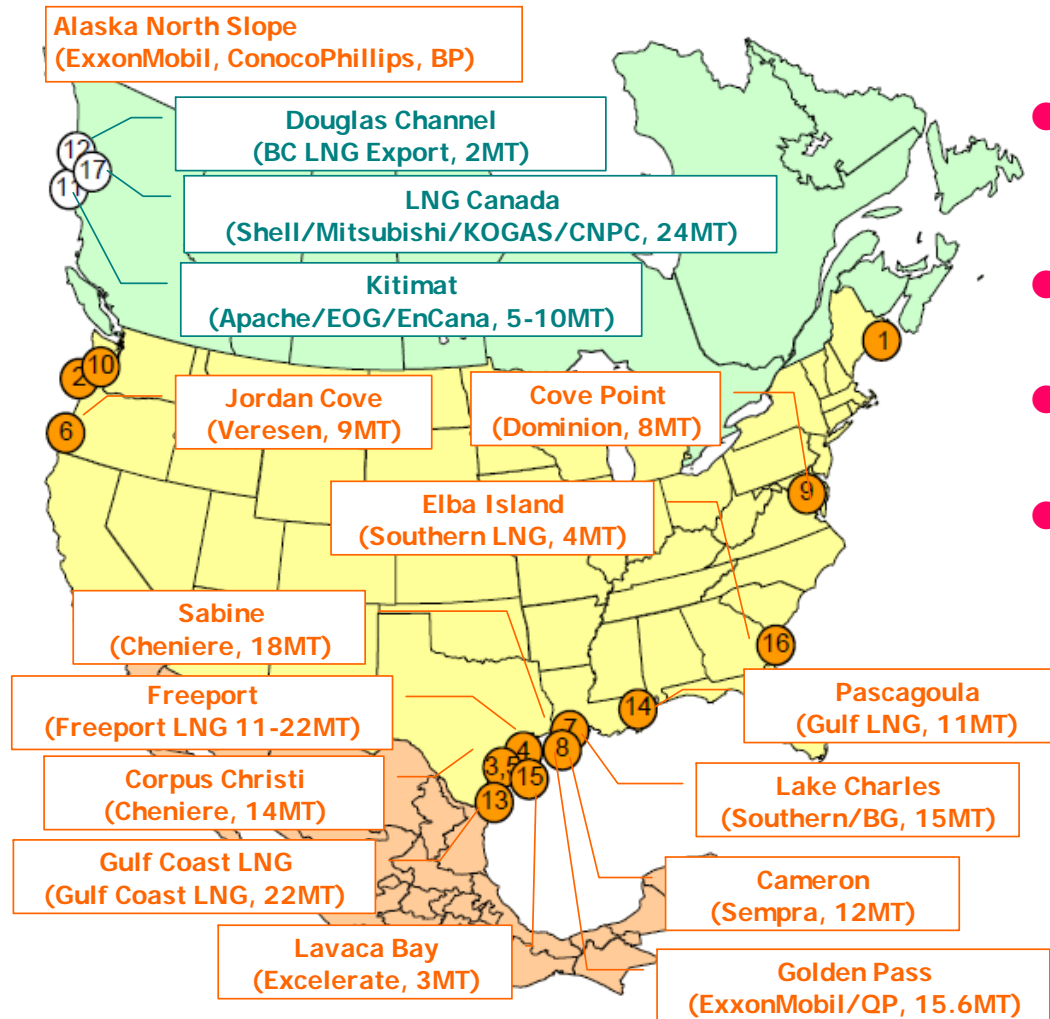
Export of Coal



(Source) DOE/EIA

- Increasing shale oil and NBL leading to more LPG and gasoline exports
- Coal: lesser imports & more exports
- Hopefully leading to lowering Japan's LPG and coal import costs

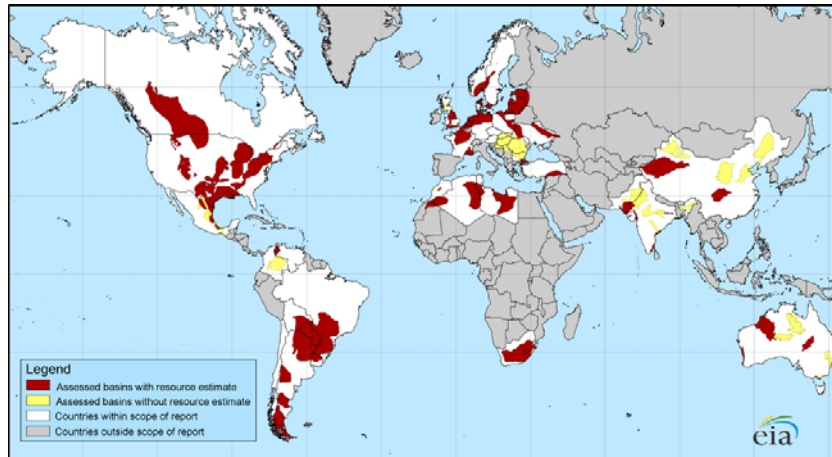
LNG export projects in North America



- Oversupply resulting in many LNG export projects
- Export potential close to 200MT/y
- Lowering Asian LNG price?
- Export authorization as a risk

(Source) FERC, Company websites

Global Shale gas revolution?

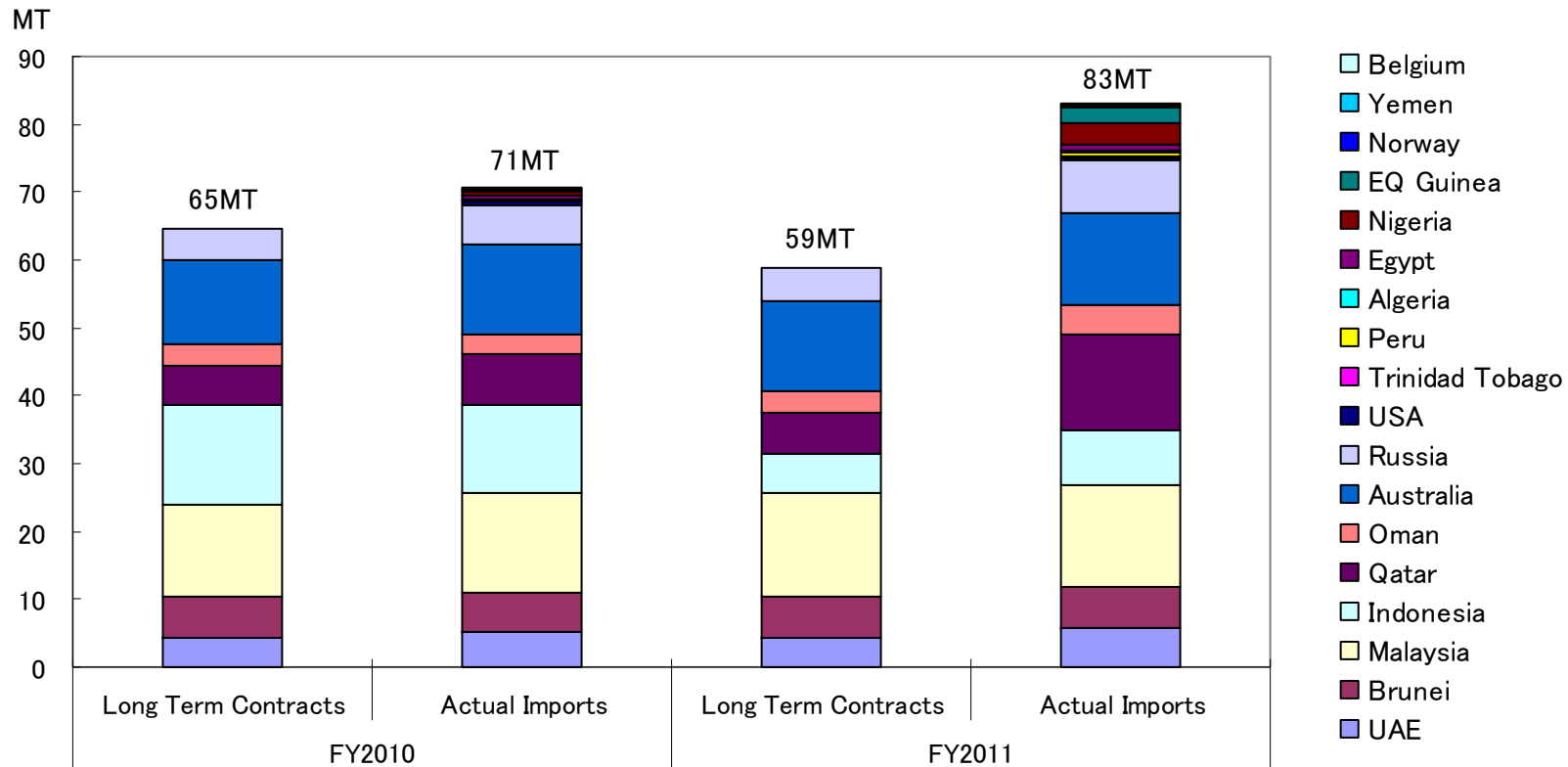


	2009 Natural Gas Market (Tcf)			Proved Natural Gas Reserves (Tcf)	Technically Recoverable Shale Gas Resources (Tcf)
	Production	Consumption	Imports (Exports)		
Europe	10.8	14.6	35%	186.2	639
France	0.0	1.7	98%	0.2	180
Germany	0.5	3.3	84%	6.2	8
Norway	3.7	0.2	-2156%	72.0	83
U.K.	2.1	3.1	33%	9.0	20
Poland	0.2	0.6	64%	5.8	187
Ukraine	0.7	1.6	54%	39.0	42
North America	28.0	28.0	0%	346.5	1,931
United States	20.6	22.8	10%	272.5	862
Canada	5.6	3.0	-87%	62.0	388
Asia	5.7	6.3	10%		
China	2.9	3.1	5%	107.0	1,275
India	1.4	1.9	24%	37.9	63
Australia	1.7	1.1	-52%	110.0	396
Africa	3.6	1.6	-56%	217.1	1,042
South Africa	0.1	0.2	63%	-	485
Libya	0.6	0.2	-165%	54.7	290
Algeria	2.9	1.0	-183%	159.0	231
South America	1.9	3.4	81%	239.2	1,225
Venezuela	0.7	0.7	9%	178.9	11
Argentina	1.46	1.5	4%	13.4	774
Brazil	0.4	0.7	45%	12.9	226
Total of above areas	53.1	55.0	-3%	1,274.0	6,622
Total world	106.5	106.7	0%	6,609.0	

(Source) DOE/EIA, World Shale Gas Resources: An Initial Assessment of 14 Regions Outside the United States, April 5, 2011

- Shale gas developments in China crucial for Asia

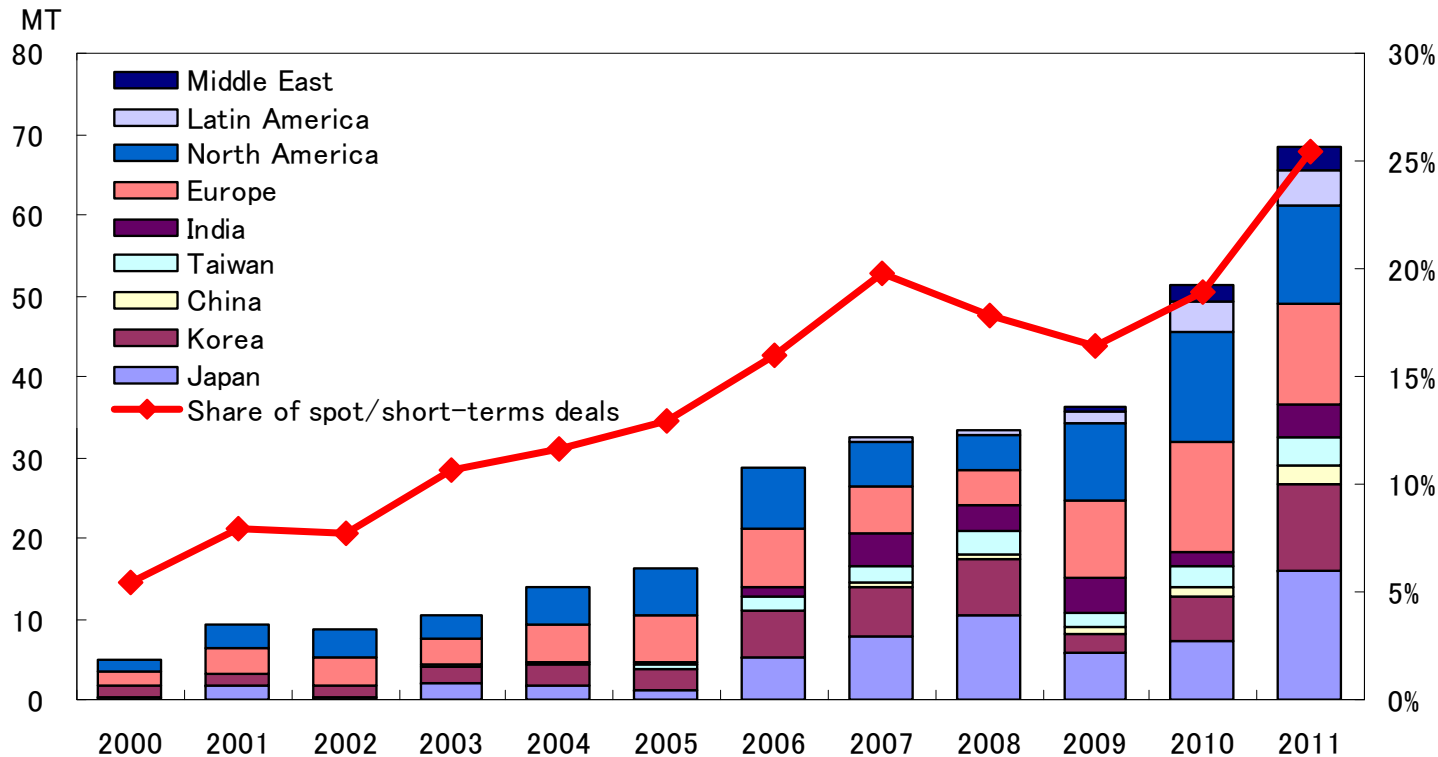
Japan's LNG imports



(Source) GIIGNL, Trade Statistics

- **Gas-fired generation as the major replacement of the lost nuclear capacity, and the LNG demand increasing rapidly**

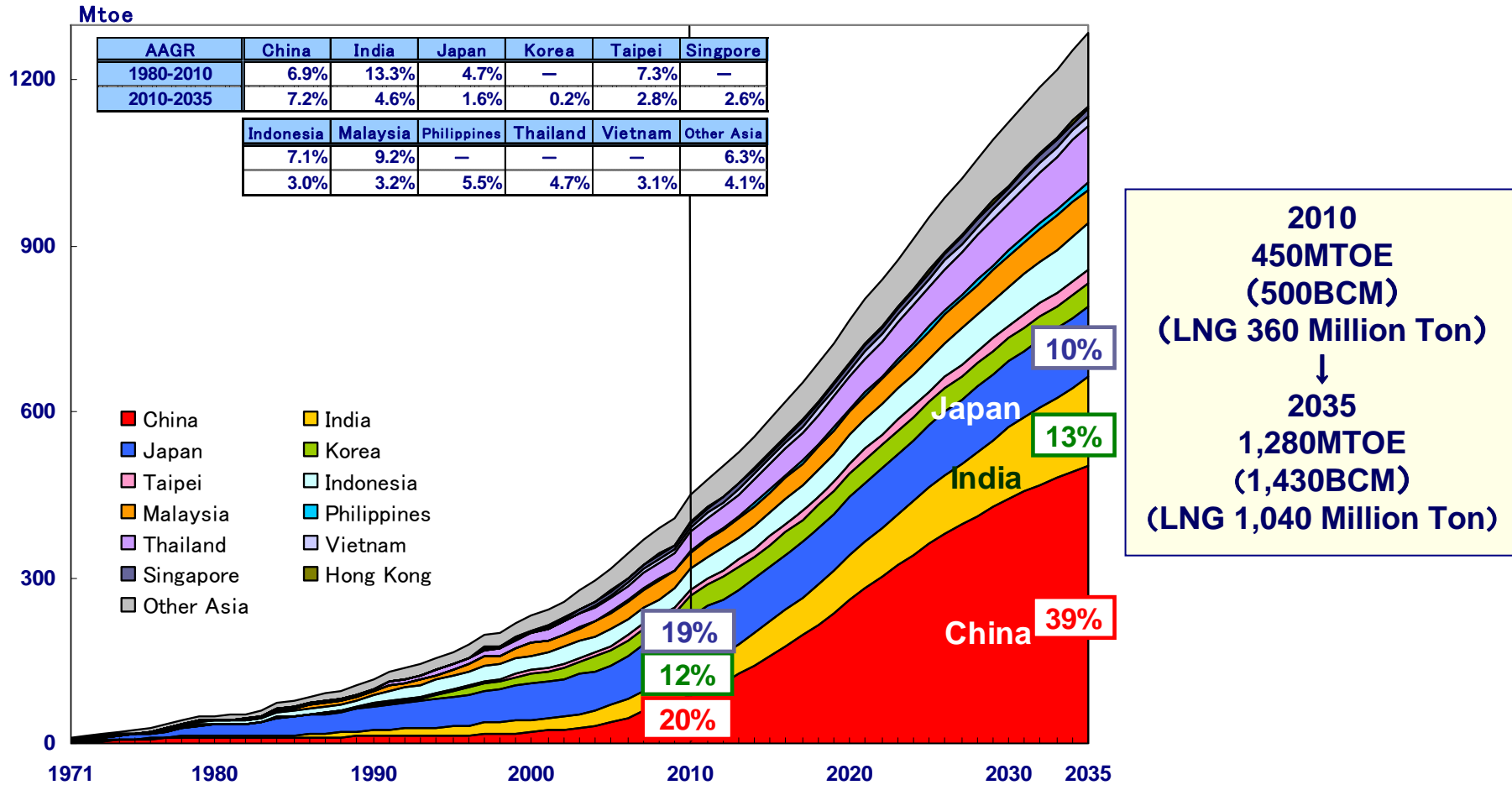
LNG trade by spot/short-term deals



(Source) GIIGNL, Cedigaz

- Spot supplies to Europe since 2009 as one of the reasons for gas pricing changes
- 61MT (16MT imported by Japan) traded by spot/short-terms deals in 2011

Natural gas demand outlook in Asia

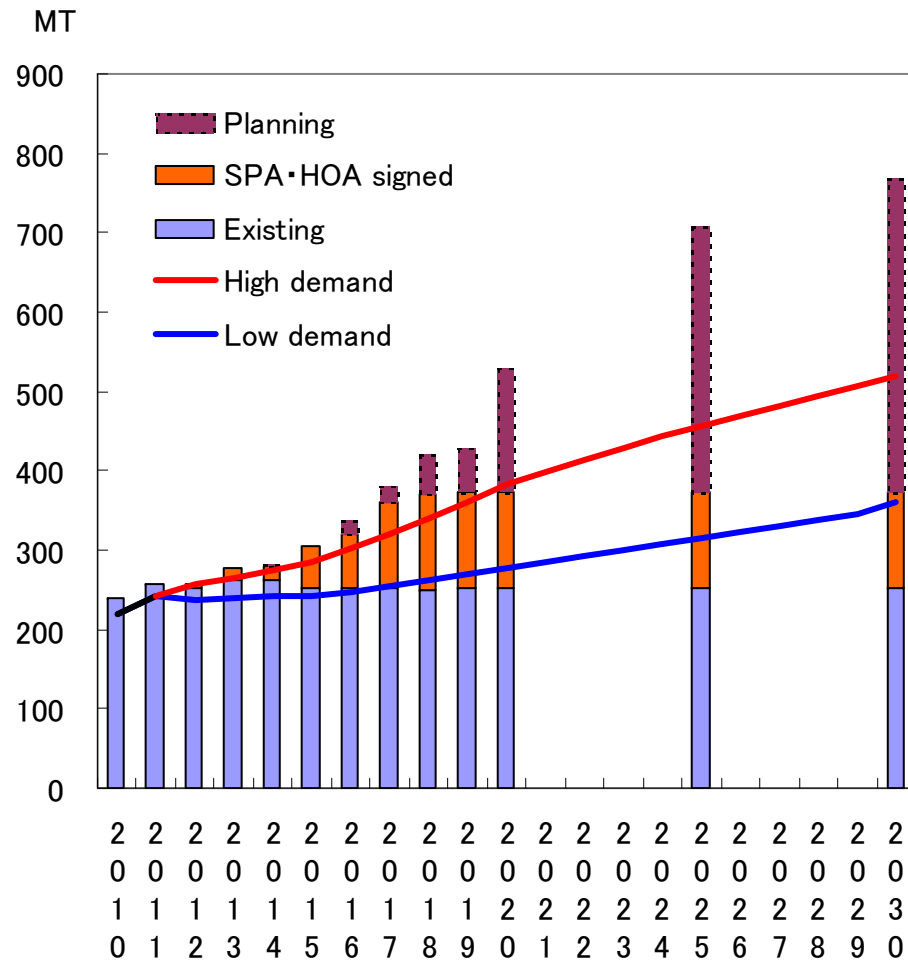


(Source) IEEJ, Asia / World Energy Outlook 2012

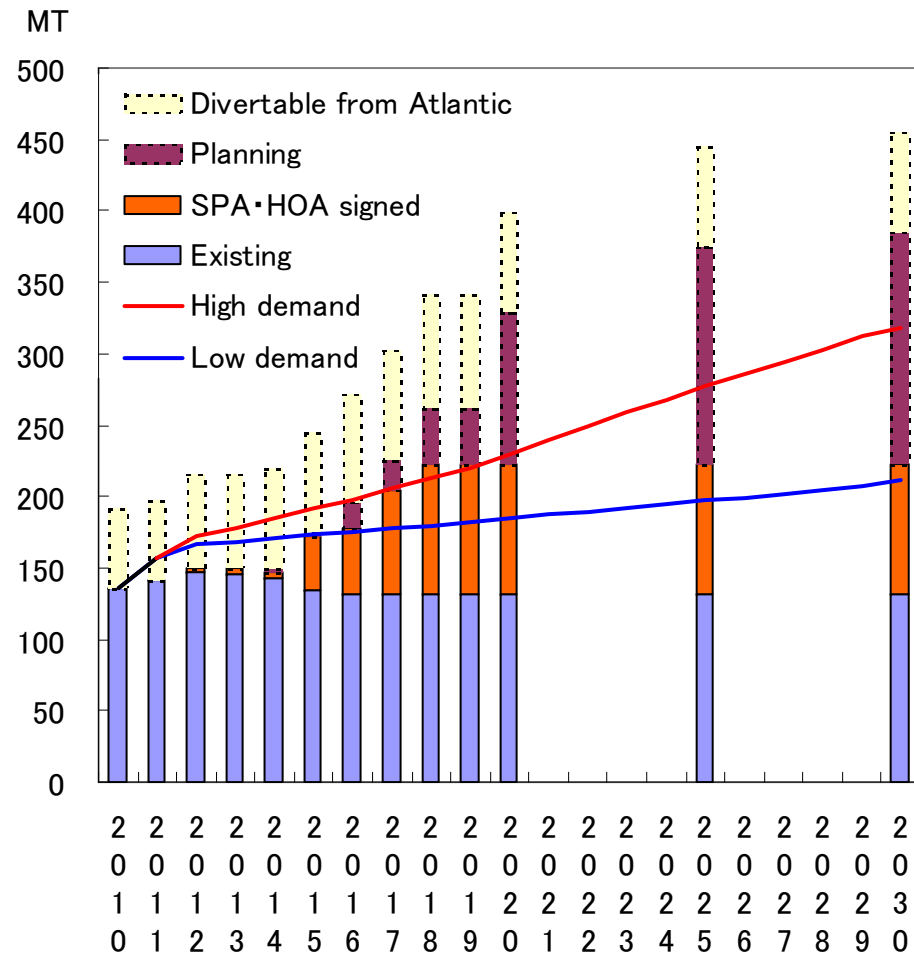
- Asian demand increasing at 4.3%/y to share 28% of the world demand

LNG demand supply outlook

World



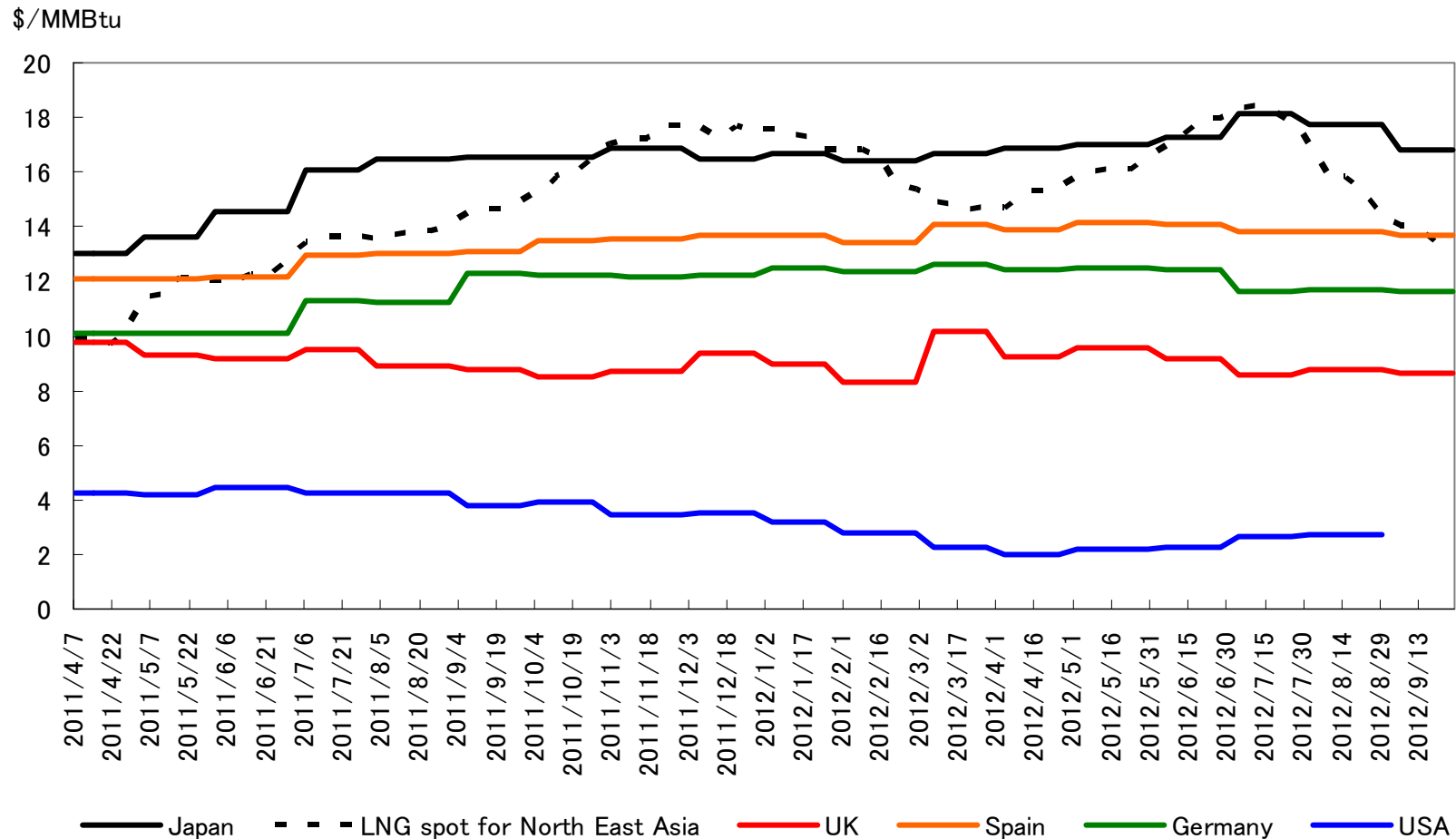
Asia/Middle East



(Source) IEEJ

- Adequate supply potential, but timely investment is the key

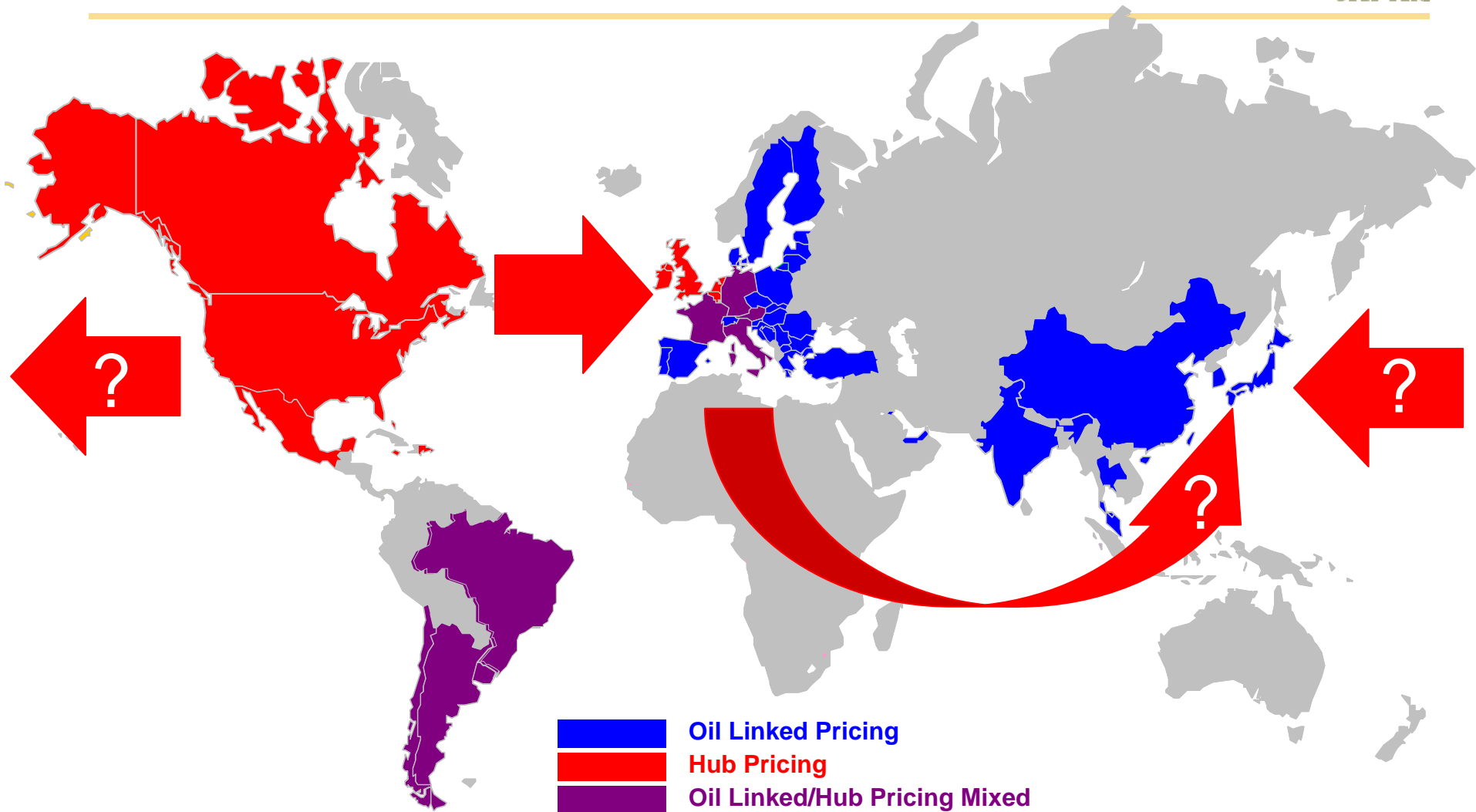
International gas prices (2011-2012)



(Source) World Gas Intelligence, DOE/EIA

● Price gap between Europe/US and Japan widening

International gas pricings

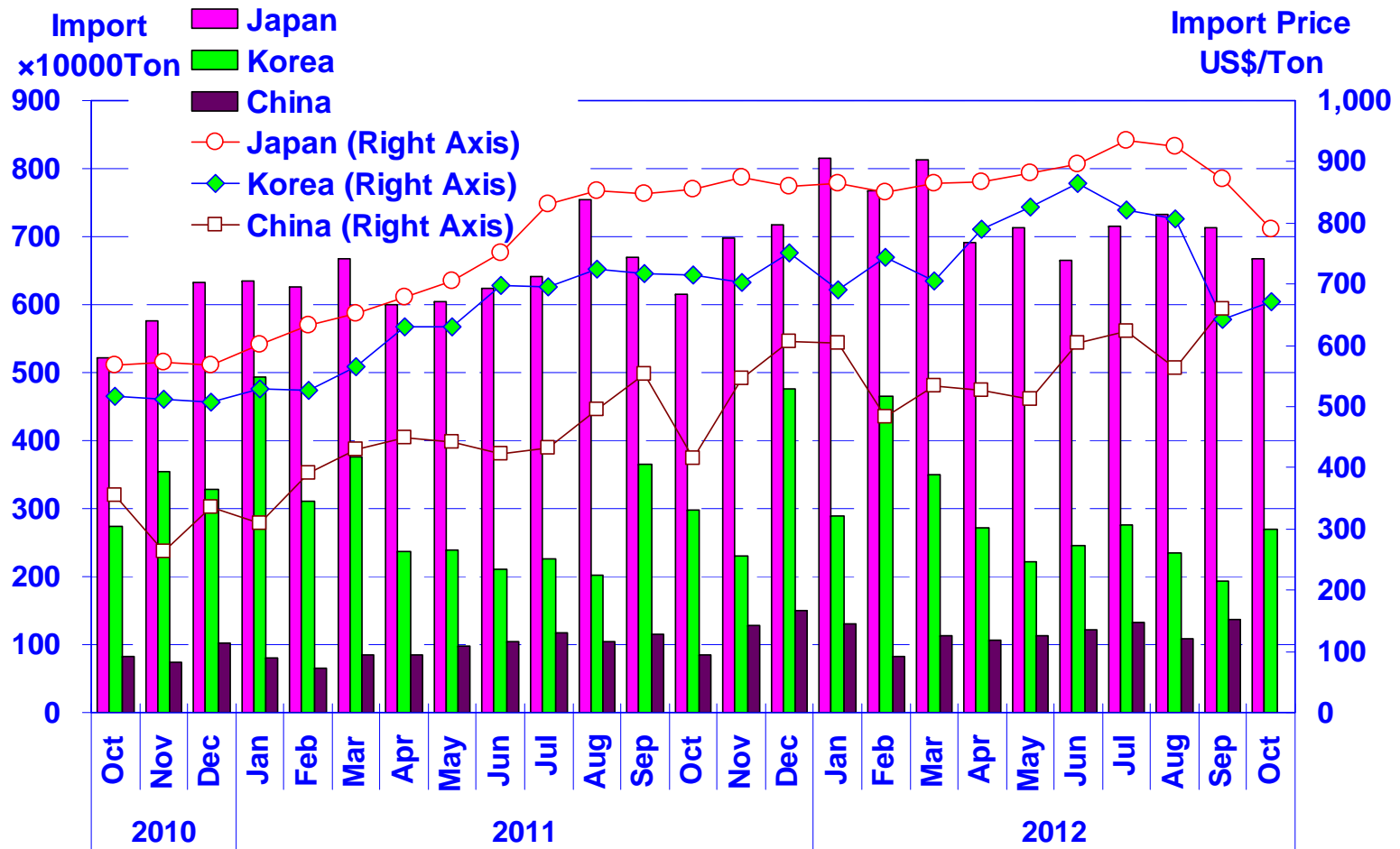


- Hub-based pricing penetrating into continental Europe, possibly into Asia

Gas pricing disputes in continental Europe

- Oil-link vs Hub
 - Exporters => Oil-link (Investment, both oil & gas hydrocarbons)
 - Importer => Hub (Competition, price transparency)
- Oversupply after the Lehman shock and dual prices
 - Demand destruction in 2009
 - Shale gas revolution and cheap spot LNG imports
 - Divergence of oil-link and hub prices
 - Huge loss of incumbent importers
- E.ON & Gazprom: seeking solution
 - Partial introduction of hub price (2010)
 - Arbitration (2011)
 - Price reduction while keeping oil-link as tentative solution (2012)

LNG imports and prices in North East Asia



(Source) Customs Data

● More imports & increasing prices

LNG Pricing Options for Asia



	Hub pricing		Spot pricing	Adjustment within oil-linked pricing	Link with other fuels (Electricity, Coal)
	Henry Hub, NBP	Hubs in Asia			
Advantages	<ul style="list-style-type: none"> • Already available • Lower prices (for now) 	<ul style="list-style-type: none"> • Possible to reflect regional market balance 	<ul style="list-style-type: none"> • Already available 	<ul style="list-style-type: none"> • Possibly quickest solution 	<ul style="list-style-type: none"> • Rational for power utilities
Disadvantages	<ul style="list-style-type: none"> • Higher volatility • Asia market balance not reflected 	<ul style="list-style-type: none"> • Not yet available • Higher volatility 	<ul style="list-style-type: none"> • Higher volatility • Limited liquidity (so far) 	<ul style="list-style-type: none"> • Rationality of oil-linked pricing • Gas market balance not reflected 	<ul style="list-style-type: none"> • Irrational for gas utilities • Lack of power market liquidity

Summary



- Shale gas revolution
 - ✓ Huge expansion of resource base
 - ✓ Less geographical concentration of the resource
 - ✓ Affecting oil & coal markets
 - ✓ A number of LNG export projects
- International gas markets
 - ✓ Asian gas demand to increase rapidly
 - ✓ Growing LNG demand and widening price gap
 - ✓ International gas pricing as the issue in continental Europe and Asia