Unconventional Gas

Game Changer?

Edge Debate 23rd April 2012

Mark Whitby

Business as Usual

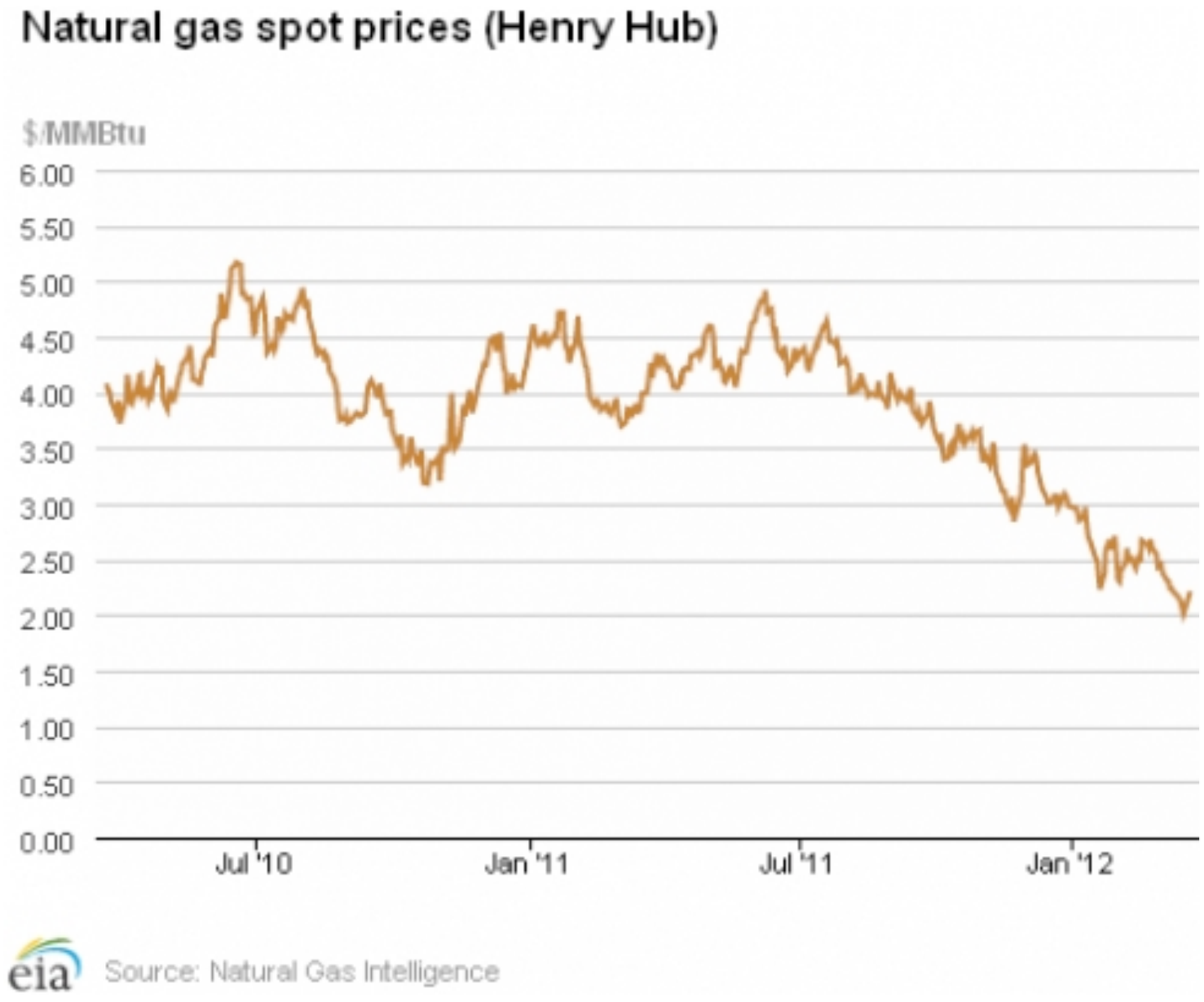
- Gas too dangerous to rely on
- Energy independence a national requirement
- Big drive towards renewables
- Nuclear Renaissance
- Russia has prominent role in global market
- Gas price linked to oil

What if?

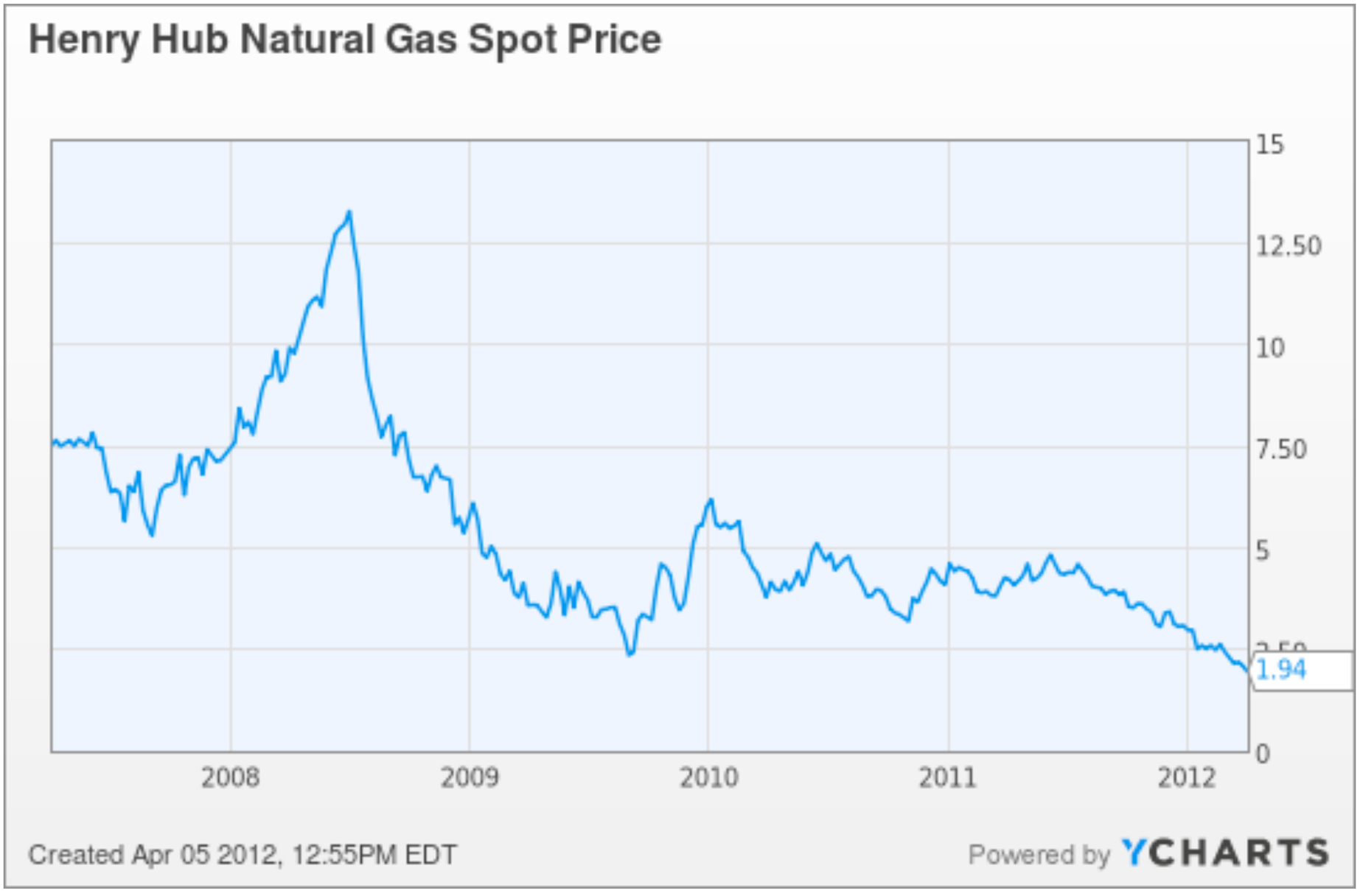
- No significant major exporters
- Gas price not linked to oil
- Significantly lower gas price
- Switch from coal to gas generation
- Gas acts as bridge to low carbon technology
- Wealth shift away from gas exporters

Tale of Two Continents

- America already at the *What If?*
- Europe still tied to *Business as Usual.*



Henry Hub Gas Price



Henry Hub Gas Price

Fig 18: Published estimates of US recoverable shale gas resource

Year	2003	2007	2008	2009
Published estimates of US recoverable shale gas resource (Tcf)	35	125	385	616
Source	NPC	EIA	ICF	PGC

Source: NPC, EIA, ICF and PGC

Estimate of US Recoverable Shall Gas Resource

	2009 Natural Gas Market[1] (trillion cubic feet, dry basis)			Proved Natural Gas Reserves[2] (trillion cubic feet)	Technically Recoverable Shale Gas Resources (trillion cubic feet)
	Production	Consump-tion	Imports (Exports)		
Europe					
France	0.03	1.73	98%	0.2	180
Germany	0.51	3.27	84%	6.2	8
Netherlands	2.79	1.72	(62%)	49.0	17
Norway	3.65	0.16	(2,156%)	72.0	83
U.K.	2.09	3.11	33%	9.0	20
Denmark	0.30	0.16	(91%)	2.1	23
Sweden	-	0.04	100%		41
Poland	0.21	0.58	64%	5.8	187
Turkey	0.03	1.24	98%	0.2	15
Ukraine	0.72	1.56	54%	39.0	42
Lithuania	-	0.10	100%		4
Others[3]	0.48	0.95	50%	2.71	19

Estimate of European Recoverable Shall Gas Reserves

Table 1. Estimated shale gas technically recoverable resources for select basins in 32 countries, compared to existing reported reserves, production and consumption during 2009

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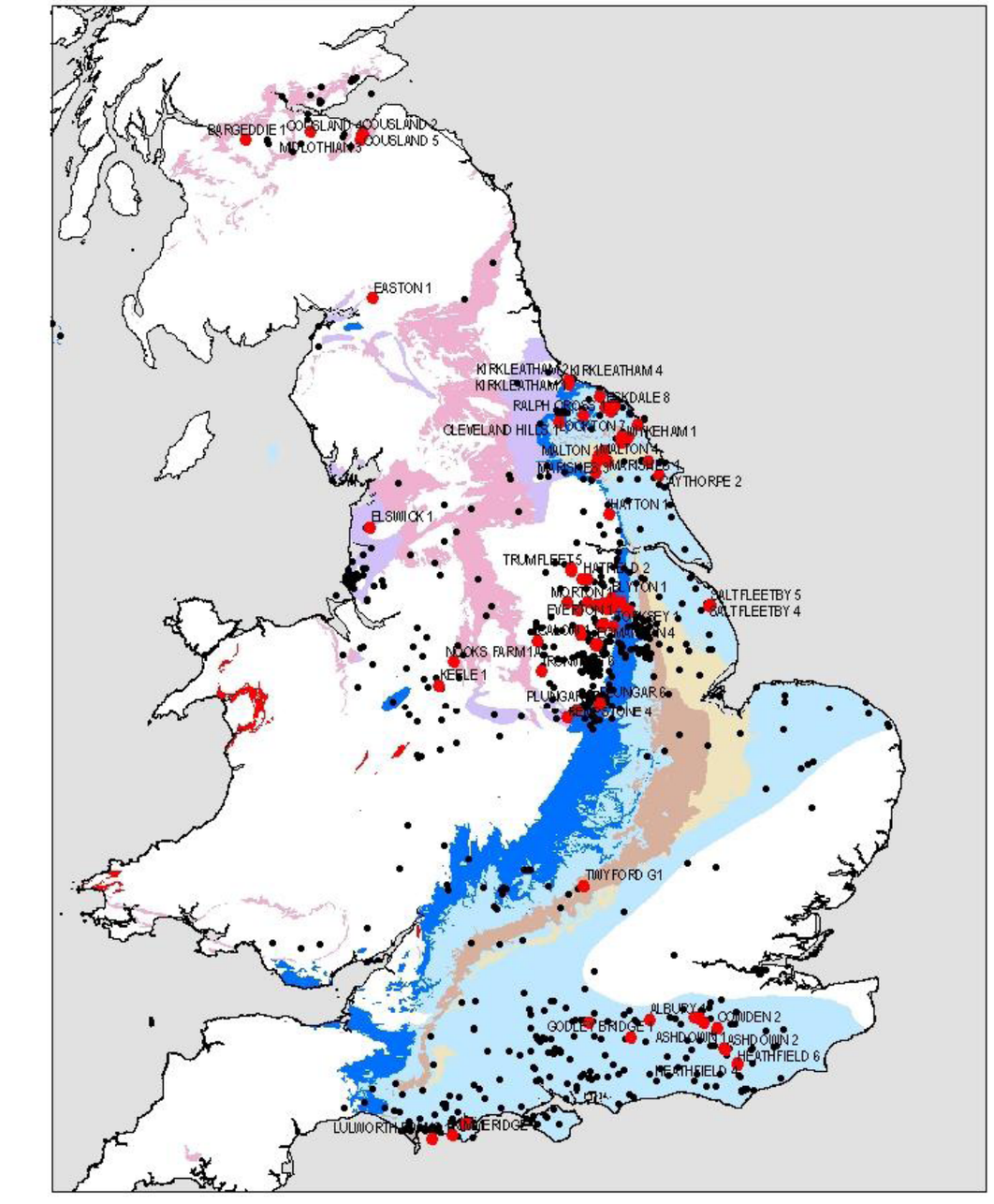
Others[3]	0.48	0.95	50%	2.71	19
North America					
United States[4]	20.6	22.8	10%	272.5	862
Canada	5.63	3.01	(87%)	62.0	388
Mexico	1.77	2.15	18%	12.0	681
Asia					
China	2.93	3.08	5%	107.0	1,275
India	1.43	1.87	24%	37.9	63
Pakistan	1.36	1.36	-	29.7	51
Australia	1.67	1.09	(52%)	110.0	396
Africa					
South Africa	0.07	0.19	63%	-	485
Libya	0.56	0.21	(165%)	54.7	290
Tunisia	0.13	0.17	26%	2.3	18
Algeria	2.88	1.02	(183%)	159.0	231
Morocco	0.00	0.02	90%	0.1	11
Western Sahara	-	-		-	7
Mauritania	-	-		1.0	0
South America					
Venezuela	0.65	0.71	9%	178.9	11
Colombia	0.37	0.31	(21%)	4.0	19
Argentina	1.46	1.52	4%	13.4	774
Brazil	0.36	0.66	45%	12.9	226
Chile	0.05	0.10	52%	3.5	64
Uruguay	-	0.00	100%		21
Paraguay	-	-			62
Bolivia	0.45	0.10	(346%)	26.5	48
Total of above areas	**53.1**	**55.0**	**(3%)**	**1,274**	**6,622**
Total world	**106.5**	**106.7**	**0%**	**6,609**	

Sources:
[1] Dry production and consumption: EIA, International Energy Statistics, as of March 8, 2011.
[2] Proved gas reserves: *Oil and Gas Journal*, Dec., 6, 2010, P. 46-49.
[3] Romania, Hungary, Bulgaria.
[4] U.S. data are from various EIA sources. The proved natural gas reserves number in this table is from the U.S. Crude Oil, Natural Gas, and Natural Gas Liquids Reserves, 2009 report, whereas the 245 trillion cubic feet estimate used in the Annual Energy Outlook 2011 report and cited on the previous page is from the previous year estimate.

Estimate of World Recoverable Shall Gas Reserves

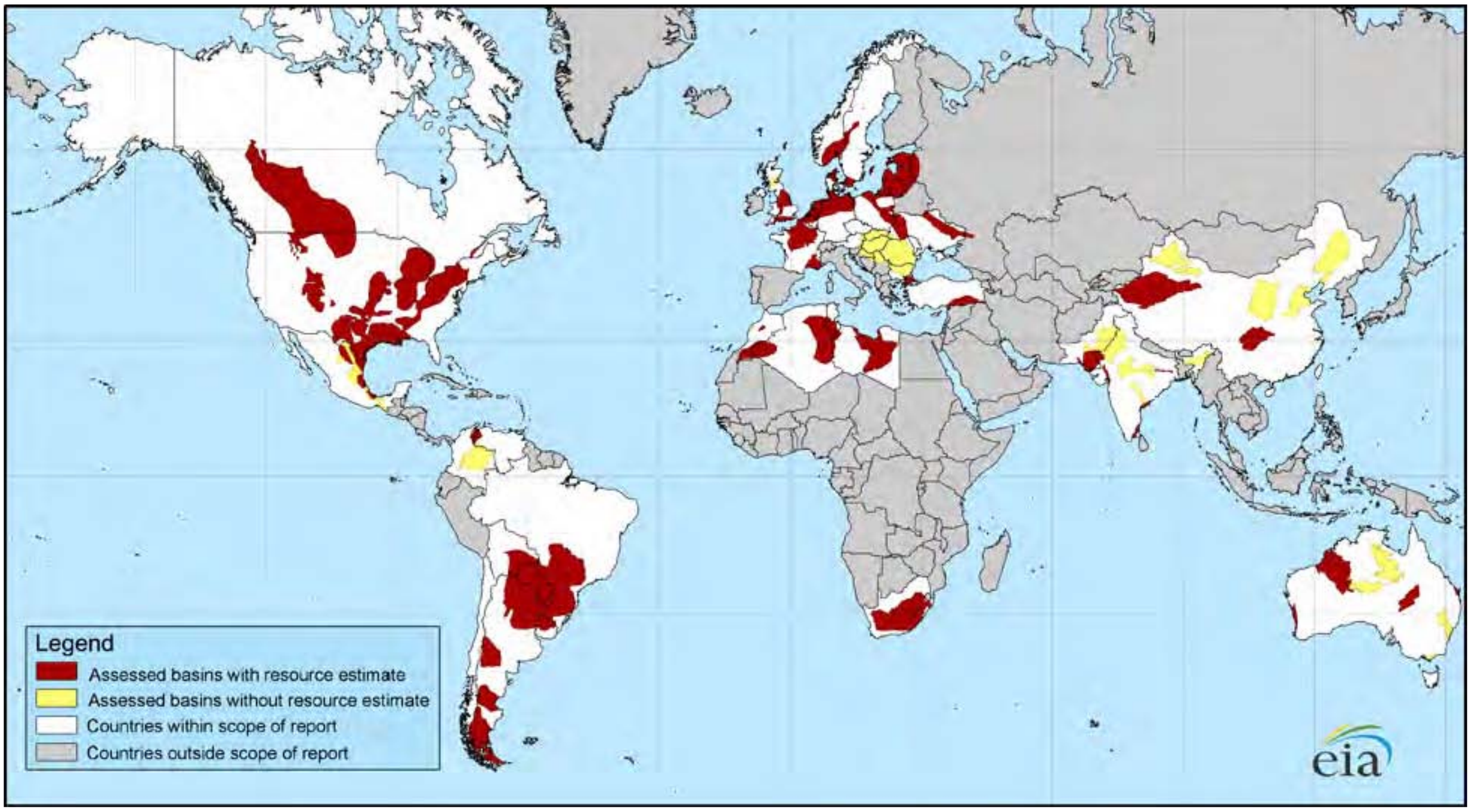


Map of UK Potential Shall Gas Resource

PACWEST
CONSULTING PARTNERS

Shale Gas
Tight Gas
Coalbed Methane

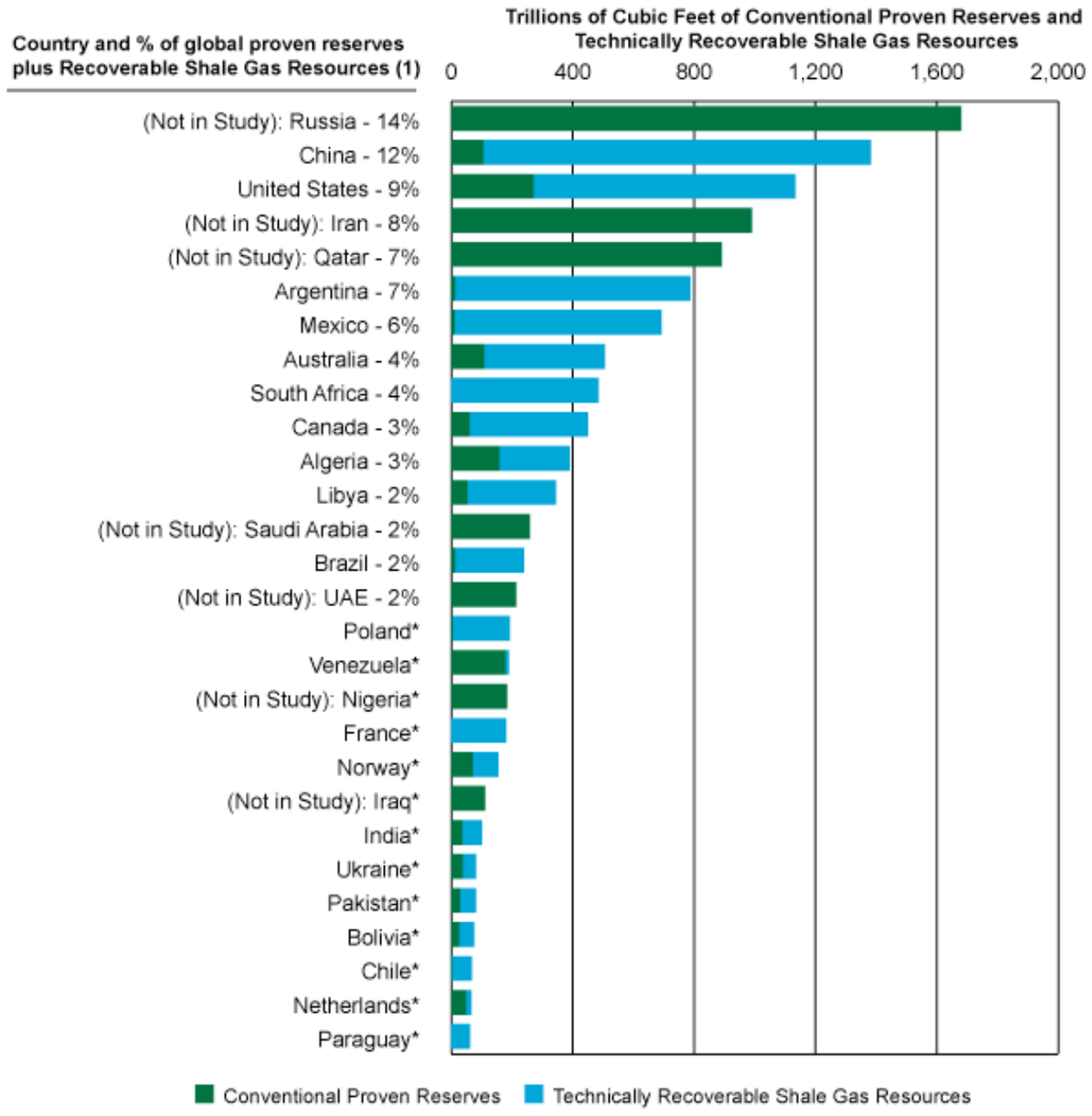
World Unconventional Gas Resource



World Shale Gas Resource Mapped

Shale Gas Resources Have the Potential to Dramatically Alter Both the Quantity and Location of Global Natural Gas Supply

Proven Conventional Natural Gas Reserves and Estimates of Technically Recoverable Shale Gas Supply for Selected Countries



* Indicates 1% or less of global proven natural gas reserves plus technically recoverable shale gas resources.
UAE: United Arab Emirates
(1) Percentage represents new share of global gas supply represented by country's combined Conventional and Shale Gas Resources

Sources: United States Energy Information Administration, Oil and Gas Journal, Dec., 6, 2010, P. 46-49.
Note: Russia, Iran, Qatar, Iraq, Saudia Arabia, the UAE and Nigeria were not included in the analysis of technically recoverable shale gas resources

Total Potential Gas Resource

Fig 11: Composition of wholesale gas transaction by price-formation mechanism and region, 2007

%	Gas–to–gas competition	Oil–price indexation	Bilateral monopoly	Netback from final product	Regulation: cost–of–service	Regulation: social/political	Regulation: below cost	No price	Unknown	Total
North America	99	0	0	0	0	0	0	1	0	100
Europe	22	72	2	0	0	3	0	1	0	100
Pacific	16	52	8	0	3	19	0	0	2	100
Former Soviet Union	1	0	24	0	0	2	73	1	0	100
Asia	8	20	5	11	8	48	0	0	0	100
Middle East	0	0	3	0	0	14	80	1	1	100
Africa	0	5	0	1	30	9	54	1	0	100
Latin America	3	12	11	0	19	51	3	0	0	100
World	33	20	8	1	3	9	26	1	0	100

The world total is calculated by weighting the share of each mechanism by each region's share of primary gas consumption in 2007. The netback market value pricing approach aims to ensure gas remains competitive with competing fuels, the prices of which can fluctuate strongly. It does so by setting the border or 'beach price' in each long-term sales contract marginally below the weighted average price of the cheapest alternative fuels across all customer categories, adjusted to allow for differences in efficiency, for gas transportation and storage costs from the beach or the border, and for any taxes on gas
Source: IGU, Redburn Partners

Current Pricing Mechanisms

Fig 33: LC results for four technologies using current forward fuel and carbon prices

In £/MWh (UK costs)	CCGT	Coal	Nuclear III+	Offshore Wind (R3)
Capital costs	13	32	83	139
Fixed operating costs	3	7	10	41
Variable operating costs	2	2	2	0
Fuel costs	37	28	5	0
Carbon costs	5	10	0	0
Total levelised cost	61	80	100	180

CCGT stands for combined cycle gas turbine without carbon capture and storage (CCS). Coal is based on advanced super-critical pulverised coal (SCPC) with flue-gas desulphurisation and selective catalytic reduction but without CCS. Nuclear is based on third generation plus reactors based on the Areva EPR or the Westinghouse AP1000. Offshore Wind (R3) stands for 400MW plant located c50 miles off the coast standing in over 150 feet of water

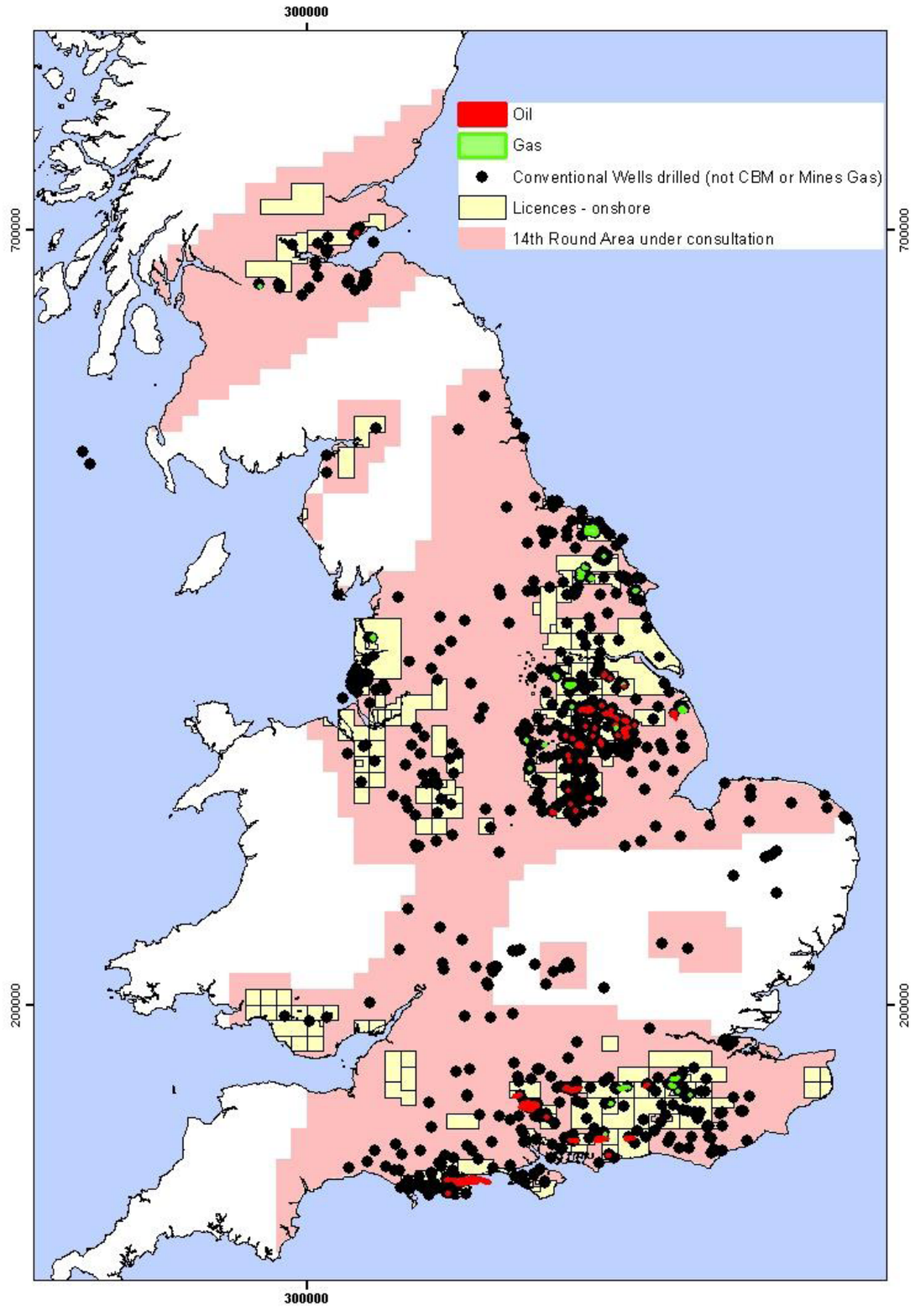
Source: Redburn Partners, Bloomberg, DECC

Fig 27: Estimated CO_2 benefits from US and China switching from coal to gas generation

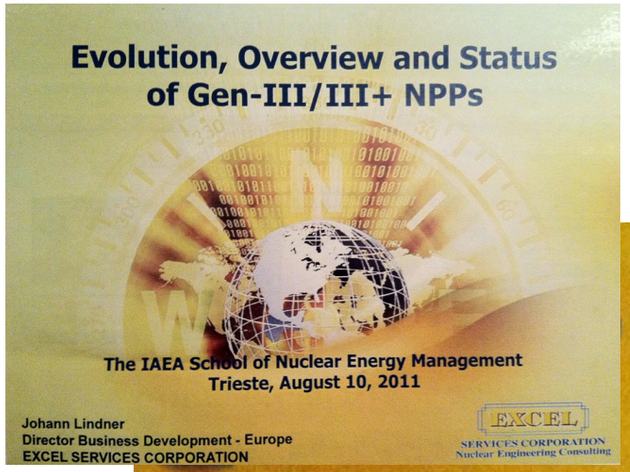
$MtCO_2$	Switching gain	CO_2 emissions from energy consumption (2008)	Gain as % of own CO_2 emissions from energy consumption	Gain as % world CO_2 emissions
China	1,483	6,534	23%	4%
US	1,075	5,833	18%	3%
US and China	2,558	12,367	21%	6%
World		30,377		

Source: Redburn Partners, EIA

CO2 Consequences of Switch from Coal to Gas



Current and Potential Licsencing



S. NNB – Main Challenges

- Nuclear Renaissance in U.S. has practically stalled:
  - Financial Risks getting too high to attract Investors
  - Costs of NNB plants have increased up to $10B per reactor
  - Loan Guarantees needed for several U.S. NNB Lead Projects
  - Only (2) NNB projects are still 'moving' forward:
    - Southern Co / Vogtle-3/4 AP1000
    - SC Electric & Gas / VC Summer-2/3 AP1000
    - (Constellation / Calvert Cliffs-3 EPR … dead)
    - (NRG / South Texas-3/4 ABWR … dead)
  - Cheap/abundant Shale Gas (not Fukushima) halted the Nuclear Renaissance

Game Changed in the US