

Shale Gas and Market Impact

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SHALE GAS IN EUROPE: A REVOLUTION?

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1. Overview of European and UK gas markets
2. Market Impact of US Shale Gas Revolution
3. Shale Gas in Europe
4. Economics of Shale Gas in the UK
5. Conclusions

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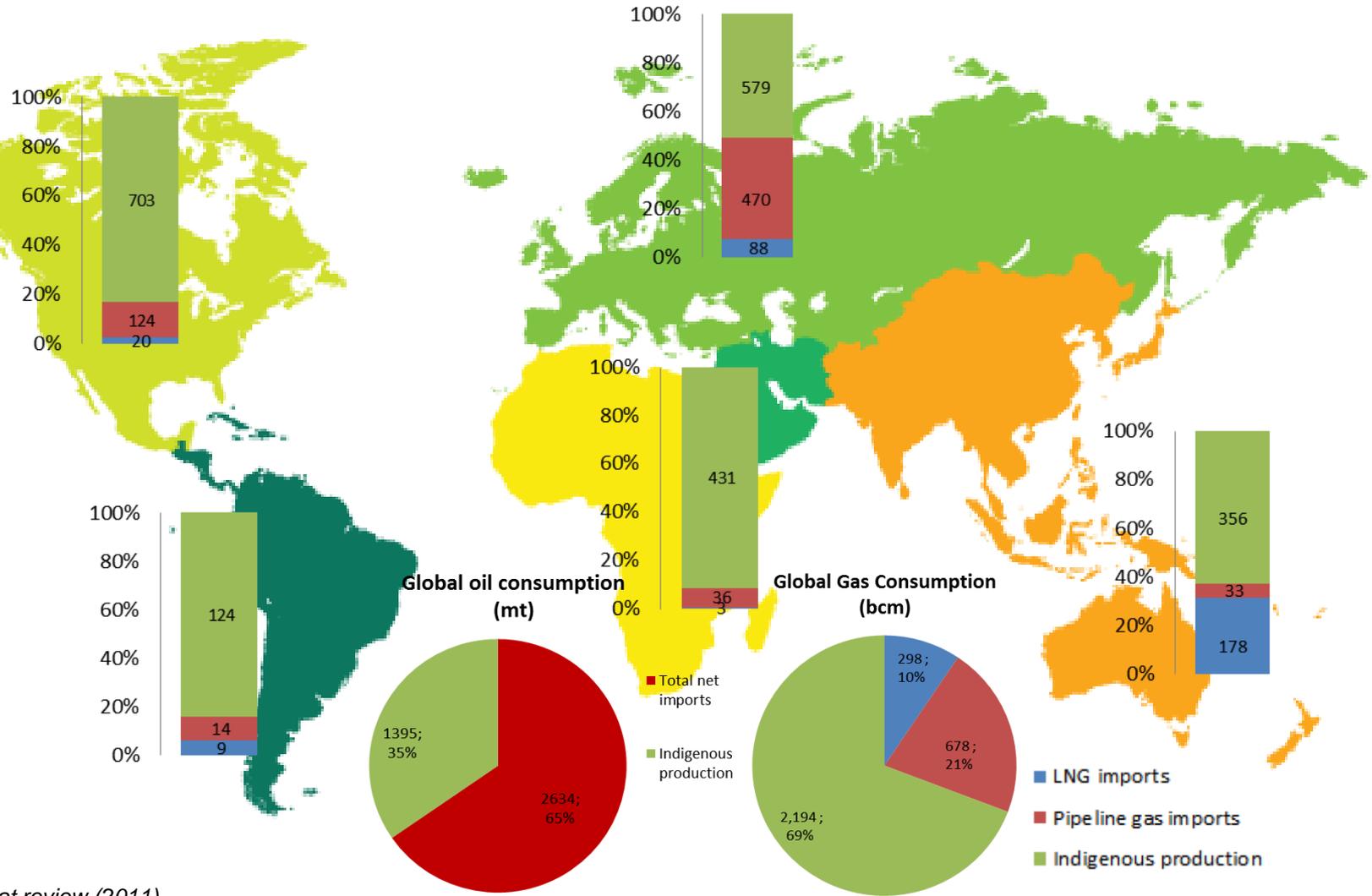
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- EPRG is supported by **UK research councils** as well as by industry stakeholders via our Energy Policy Forum:



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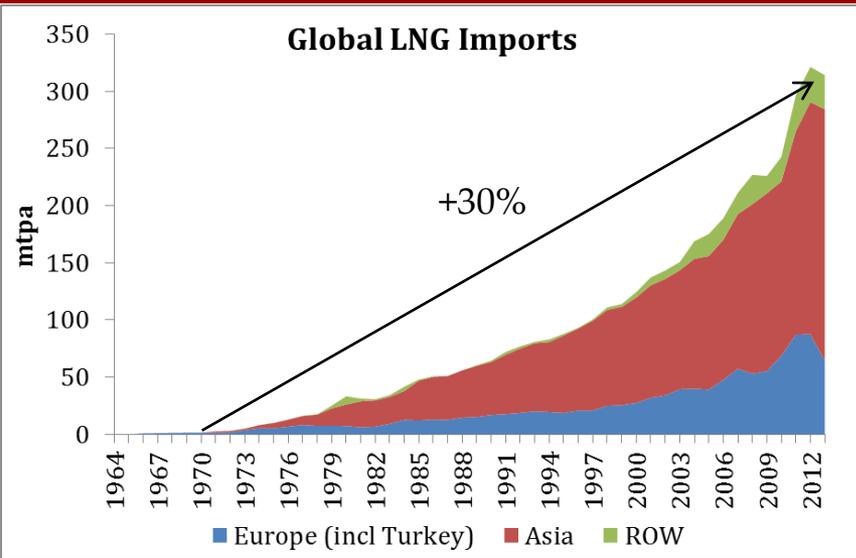
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Global Gas Market is still regional...

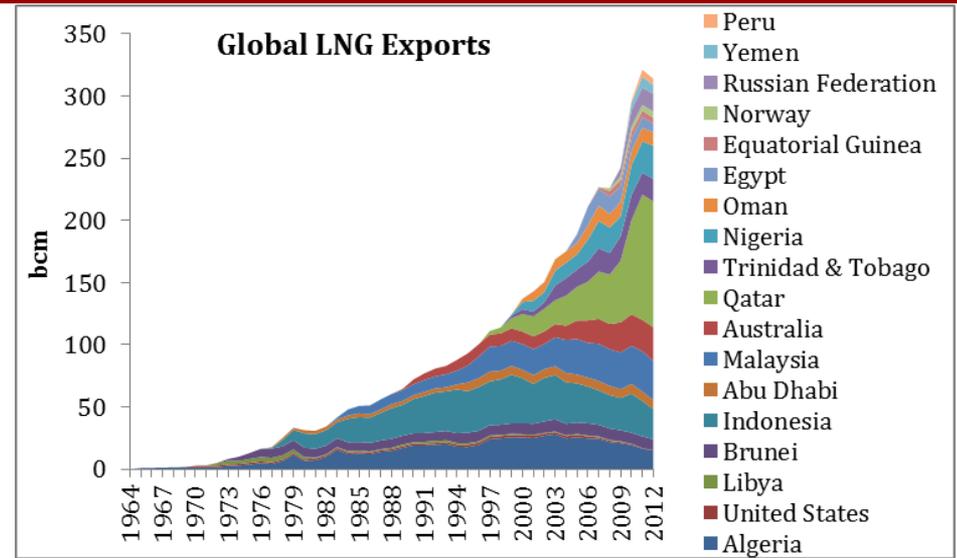


Source: BP Stat review (2011)

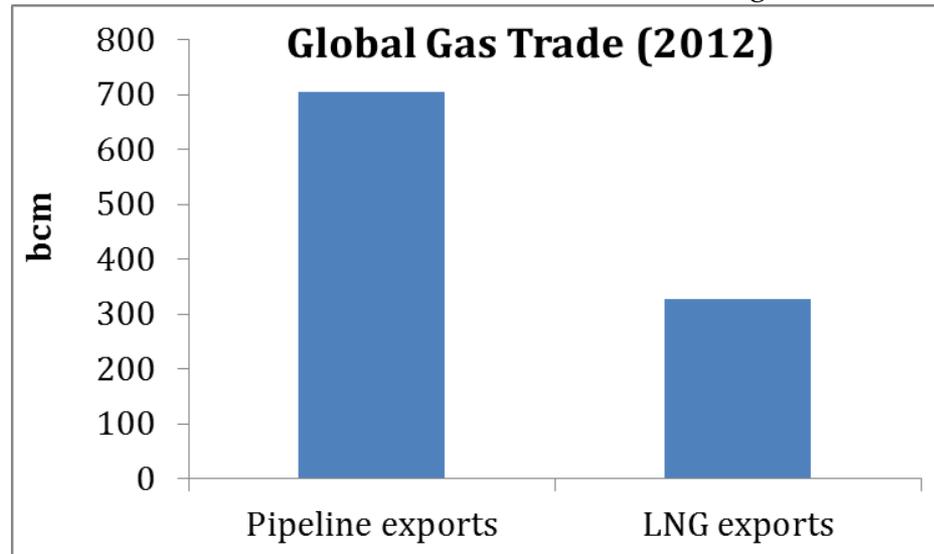
Integration of regional markets through global LNG trade



Source: Bloomberg



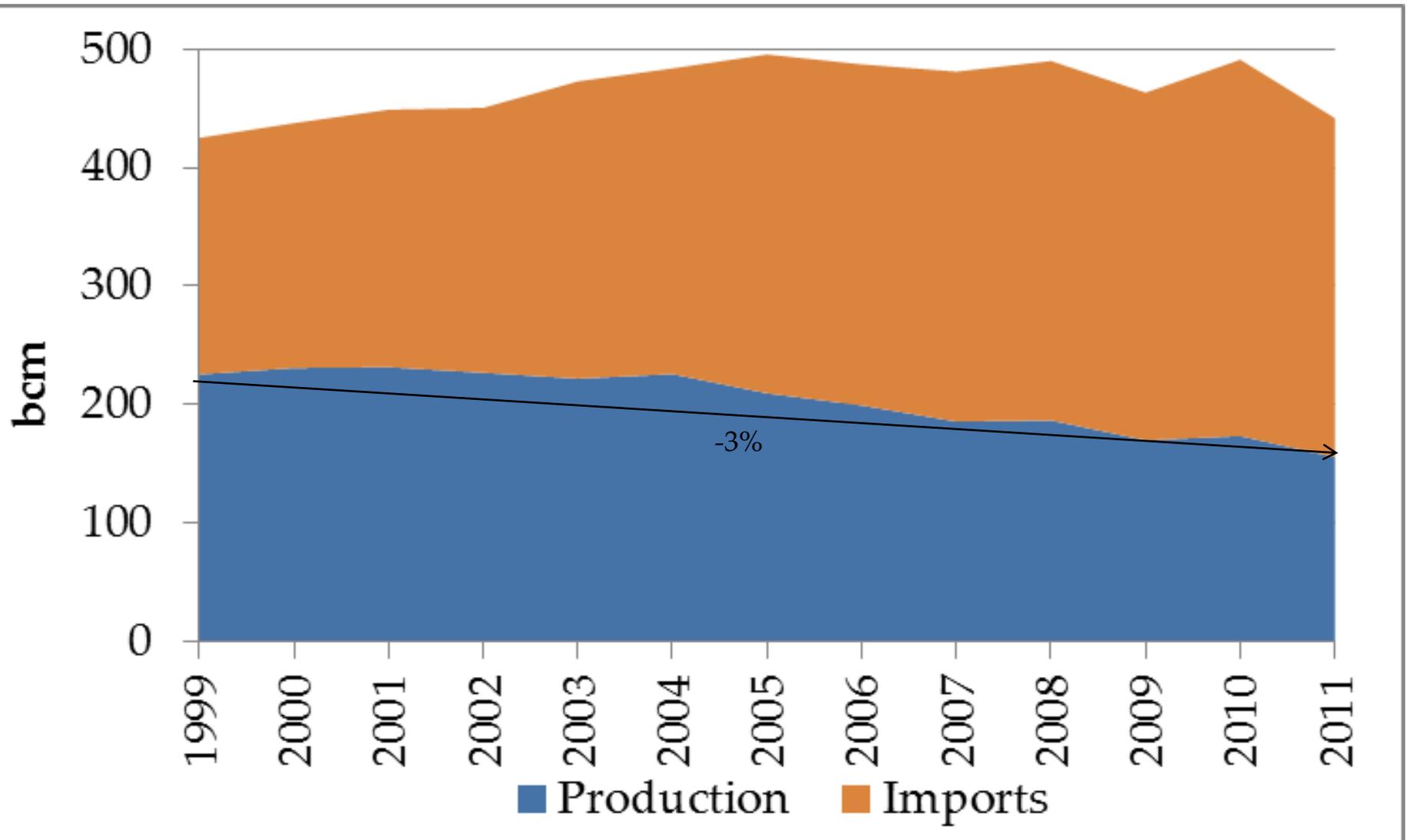
Source: Bloomberg



Source: BP Stat Review 2013

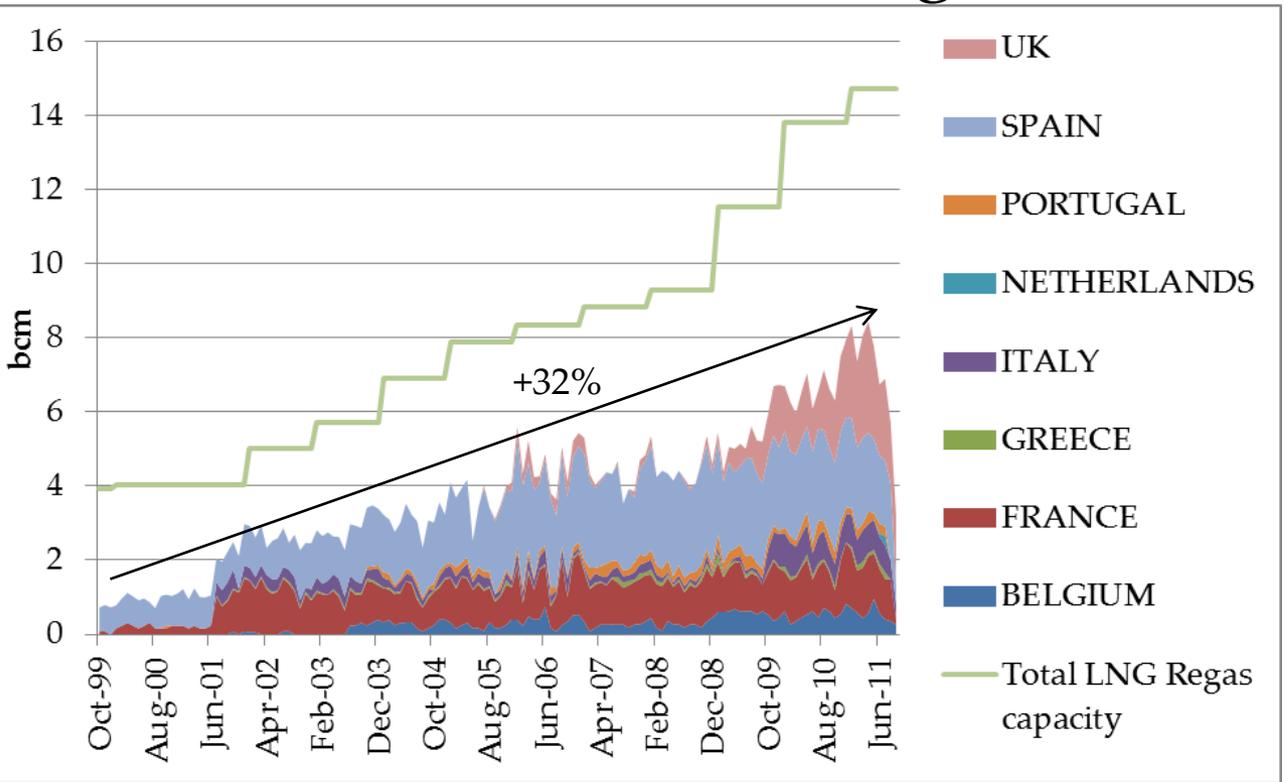
European Gas Market

Europe's indigenous gas supply has been steadily falling



Source: Eurostat

Globalization of Europe into Global Gas Market through LNG

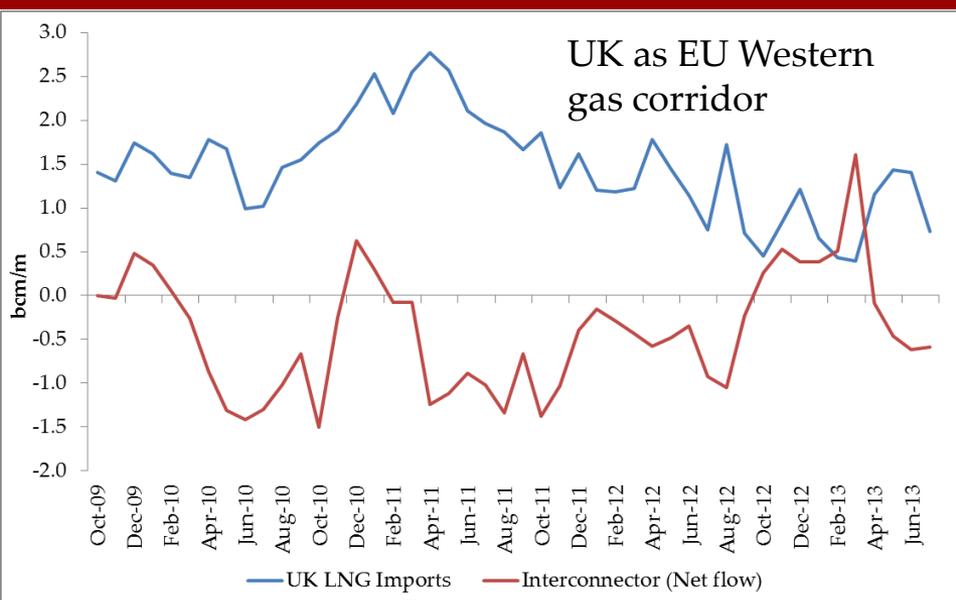
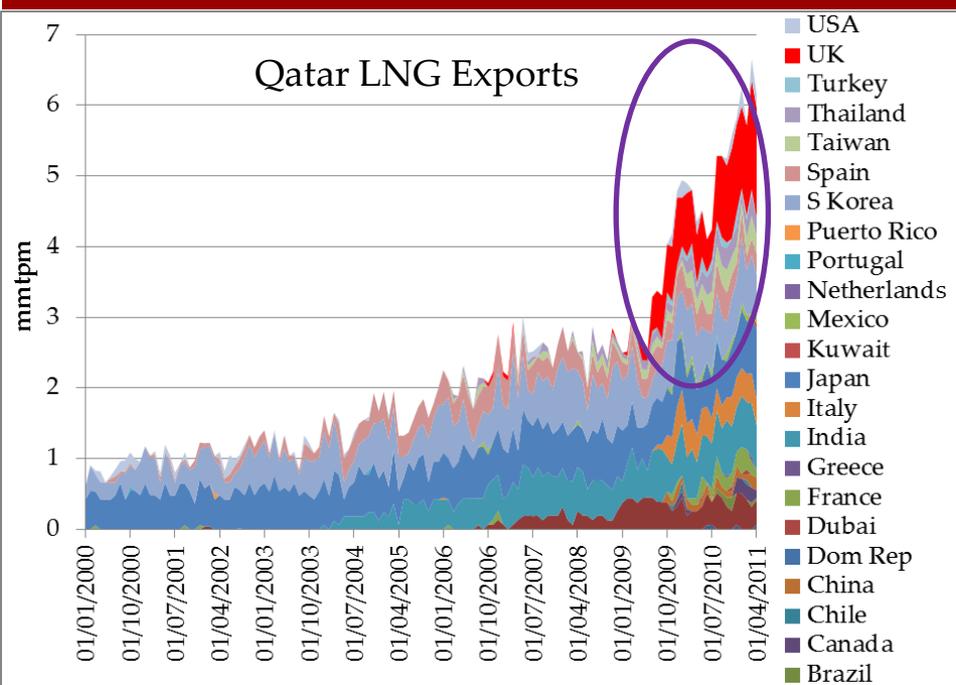


- Annual European LNG re-gasification capacity exceeds 185bcm/year, and a further 24bcm/year is under construction, with a further 244bcm/year proposed

- This far exceeds LNG imports of just a few years back, at nearly 70bcm of imports in 2009

Source: Bloomberg

UK is part of Continental European Market



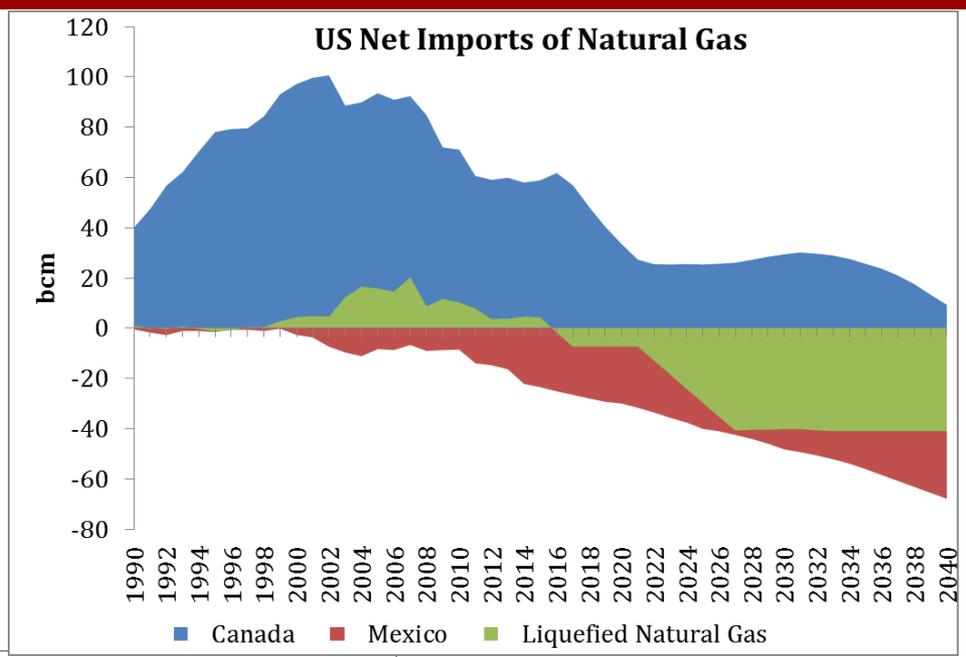
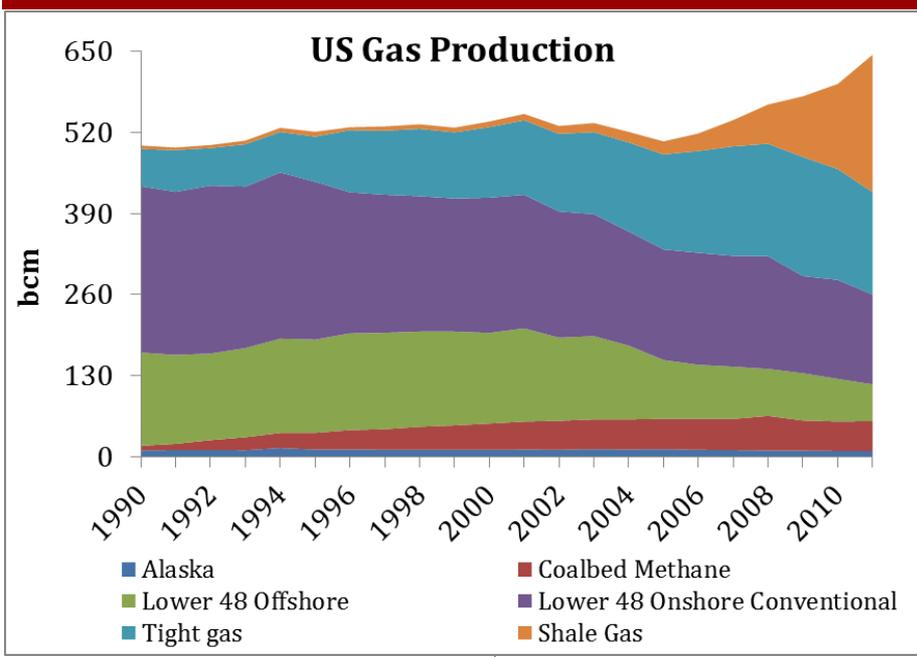
Source: P. Noel

Source: Bloomberg

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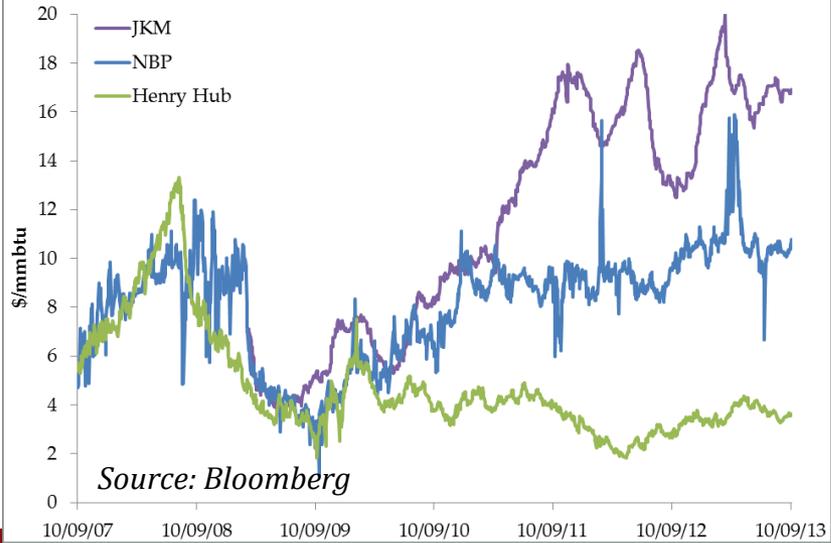
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Shale Gas Revolution in the US



Source: US DOE

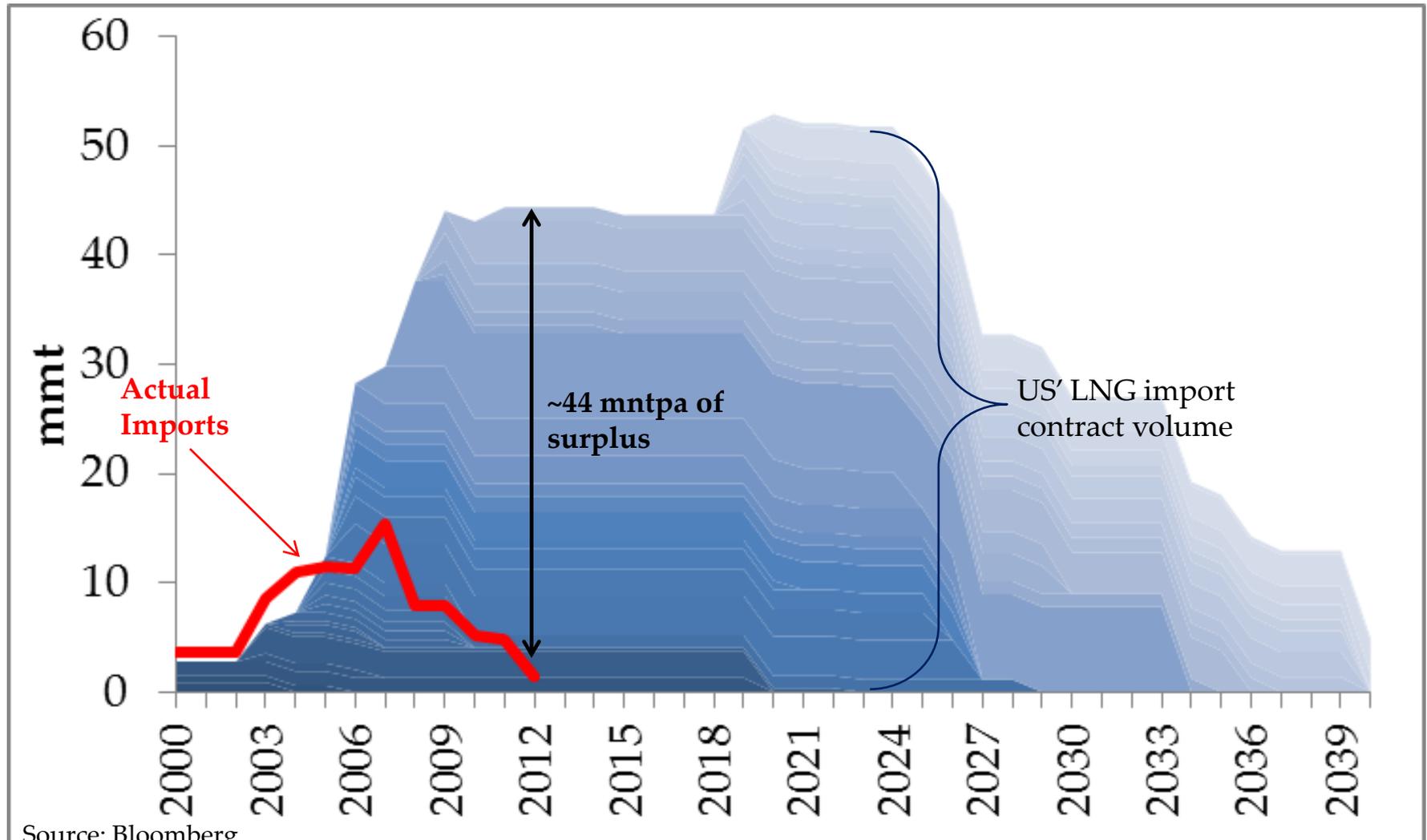
Source: US DOE



Source: Bloomberg

Implications of Shale Gas Revolution in the US (1)

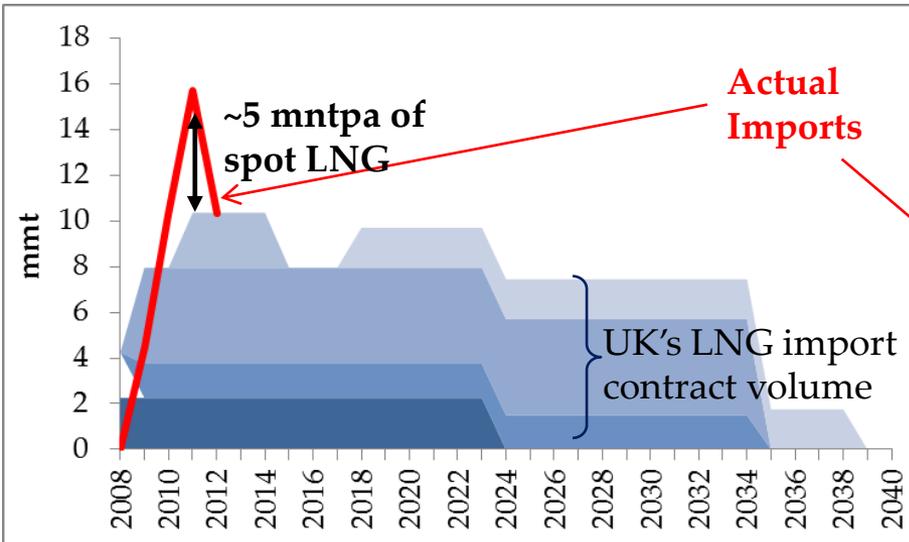
1. Surplus of 260 mnt of LNG (2006-2012)



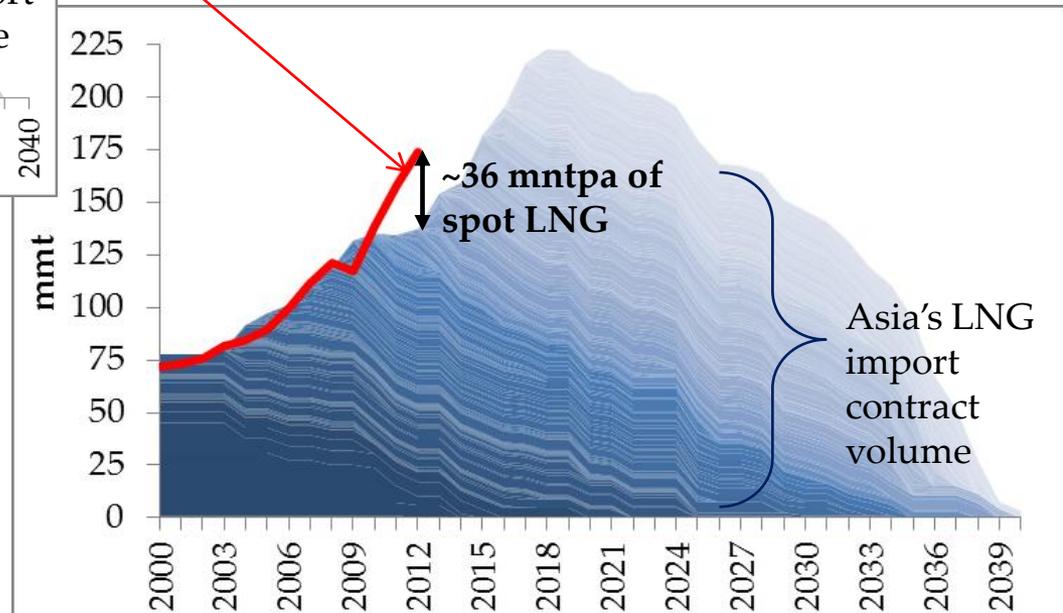
Source: Bloomberg

Implications of Shale Gas Revolution in the US (2)

- This LNG surplus was diverted to serve the UK and NW European markets but increasingly to serve high premium Asian gas market after the Fukushima disaster

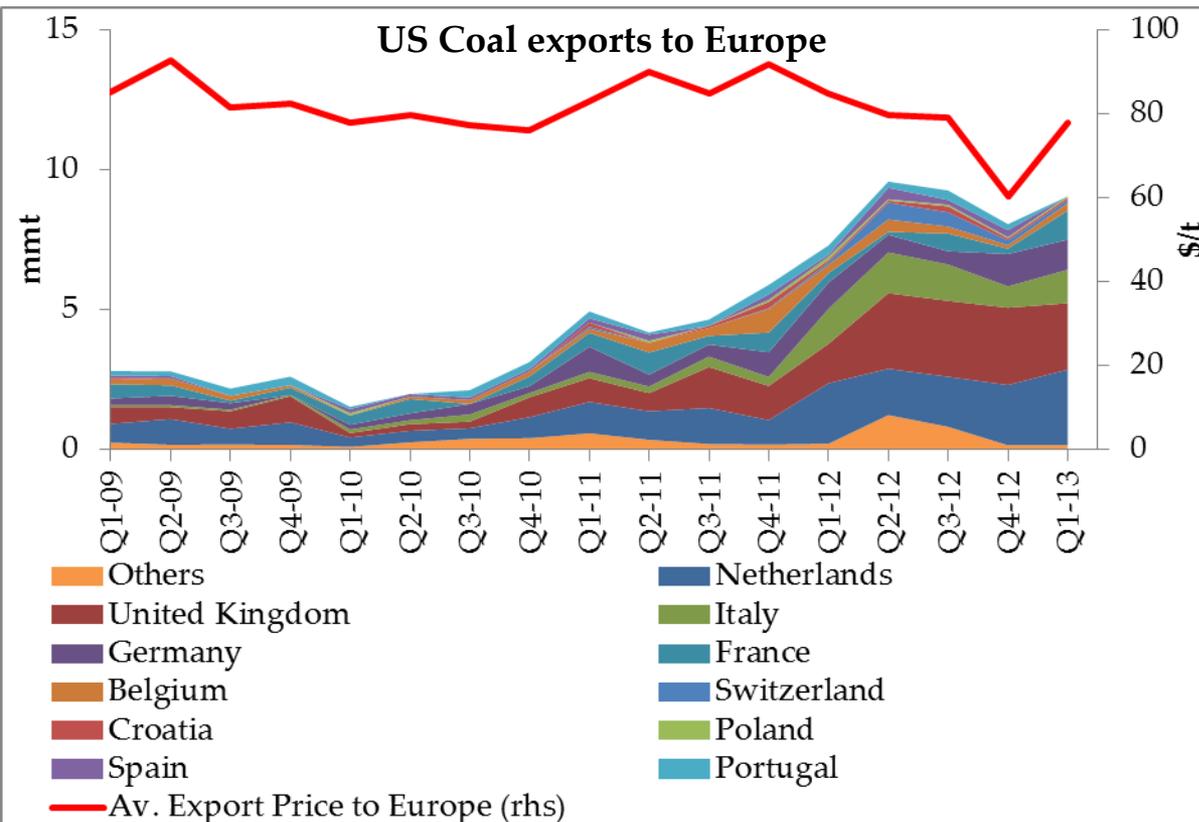


Source: Bloomberg



Source: Bloomberg

Implications of Shale Gas Revolution in the US (3)

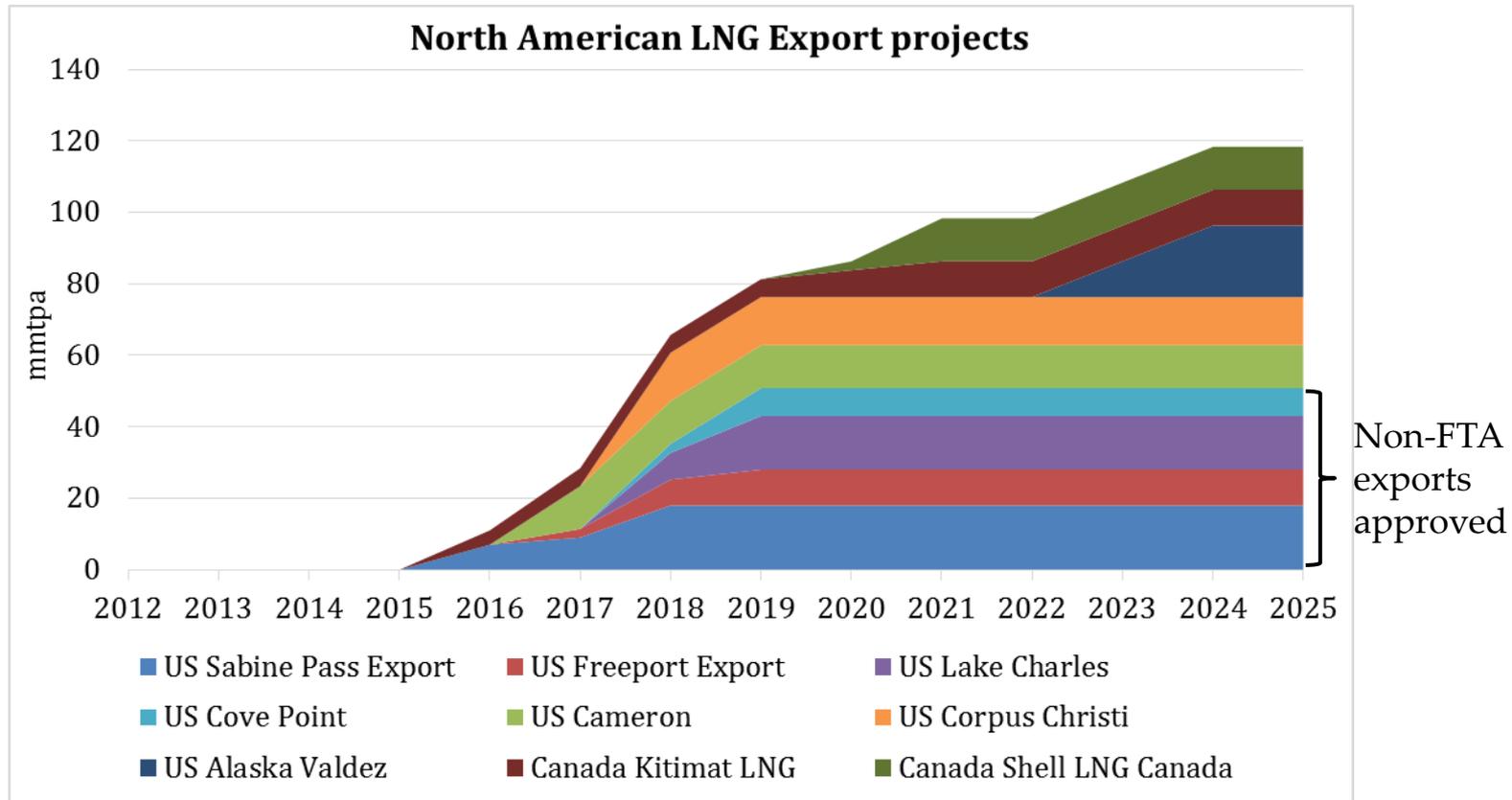


- Cheap gas replaces coal in power generation in the US --> cheap US coal exports to Europe displace gas in electricity generation

Source: US DOE

Implications of Shale Gas Revolution in the US (4)

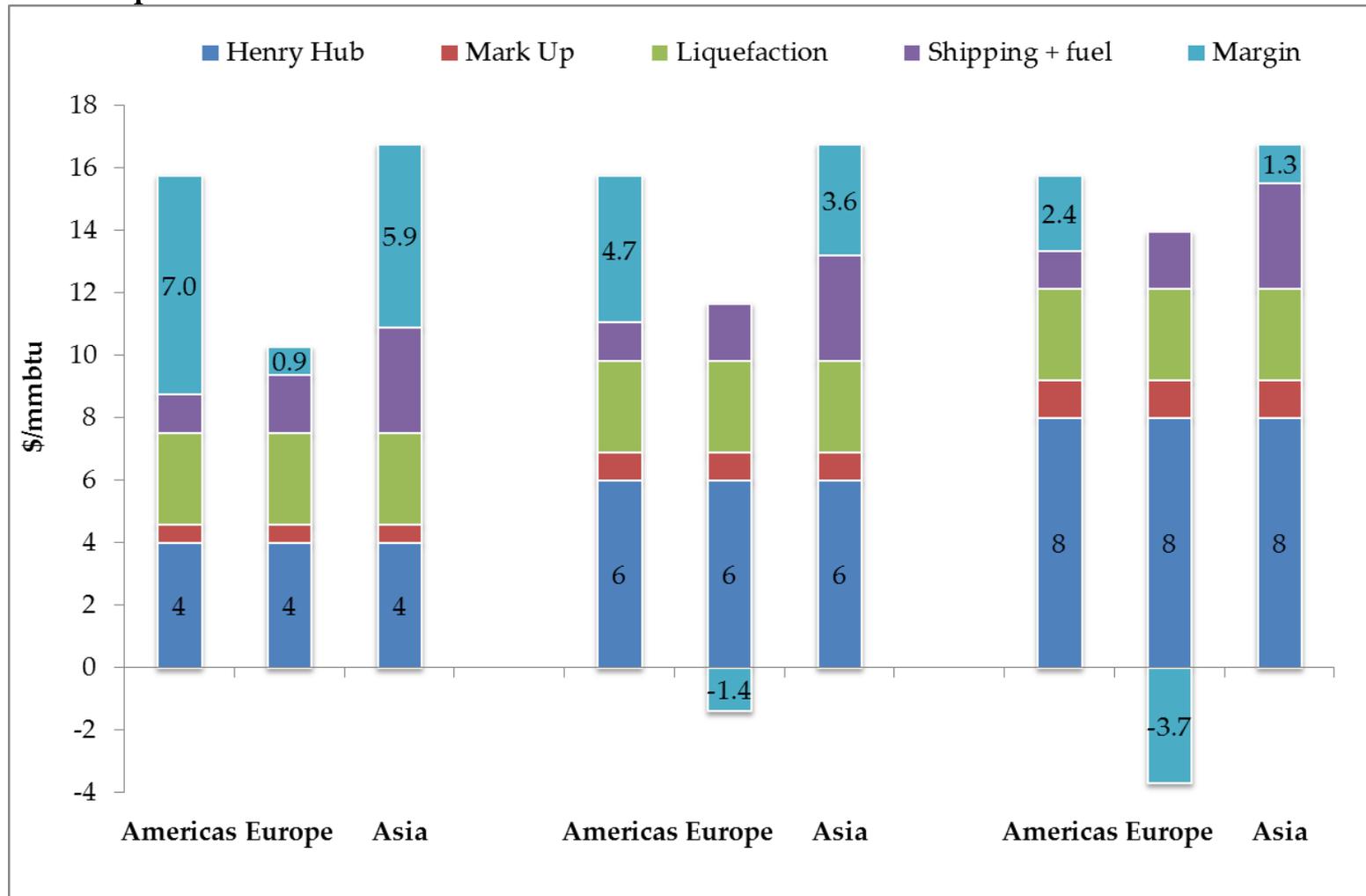
US Shale Gas Exports Projects



Implications of Shale Gas Revolution in the US (5)

US Shale Gas Export Profitability

- For US shale gas exports, Americas and Asia offer better margins than European markets



US Shale Gas Export contracts

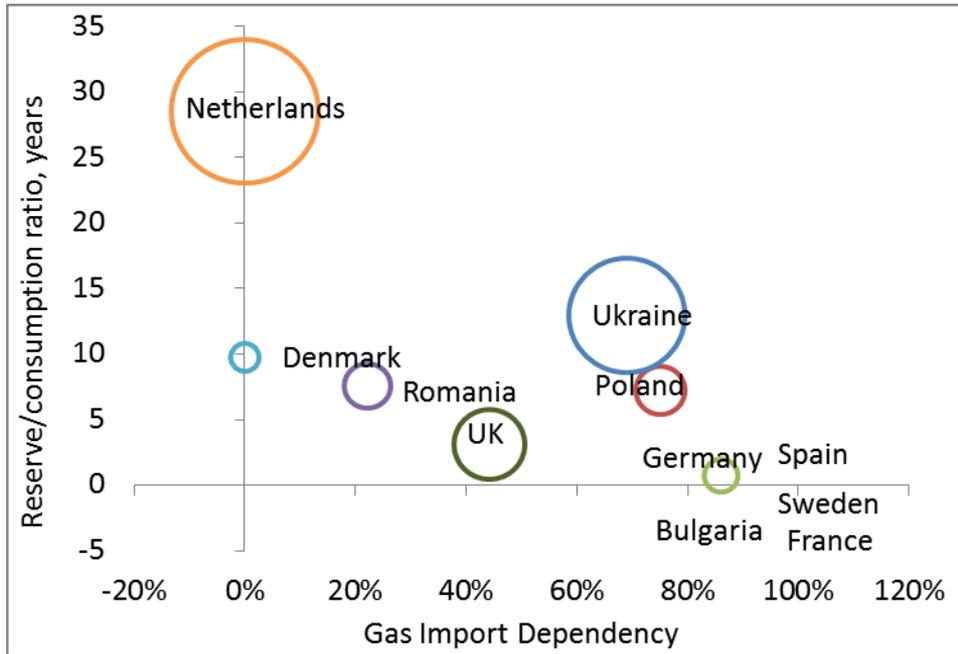
Country	Buyer	Project	Volume (mtpa)
Japan	Mitsui	Cameron	4.0
	Mitsubishi	Cameron	4.0
	Chubu Electric	Freeport LNG	2.2
	Osaka Gas	Freeport LNG	2.2
	Toshiba	Freeport LNG	2.2
	Sumitomo	Cove Point	2.3
S. Korea	Korea Gas	Sabine Pass	2.8
	SK E&S	Freeport LNG	2.2
India	GAIL	Cove Point	2.3
	GAIL	Sabine Pass	3.5
Total			27.7

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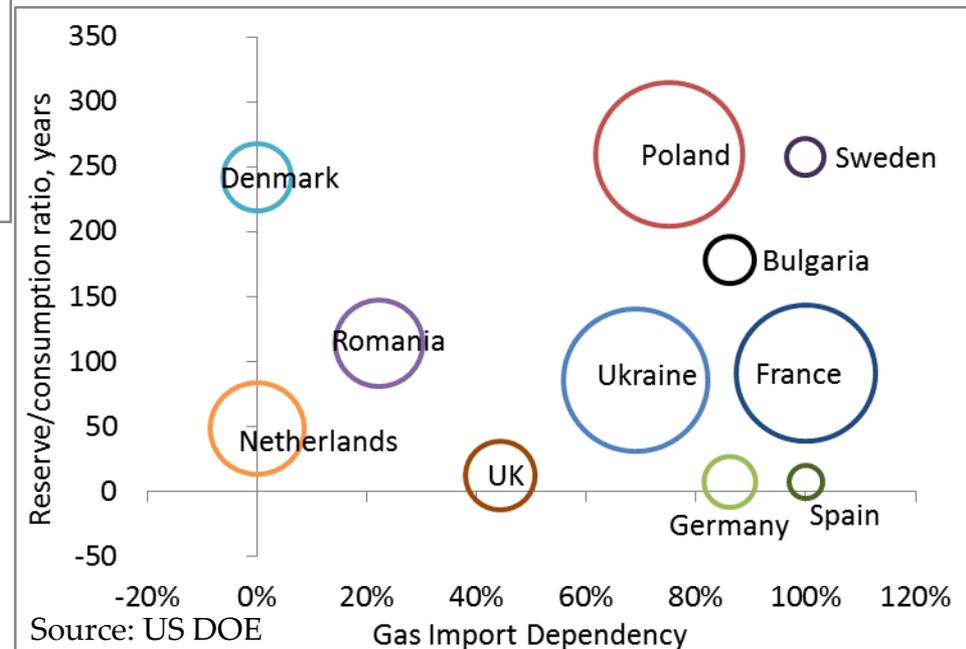
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Shale Gas in Europe

Conventional Gas Total = 2.42 tcm



Conventional & Shale Gas Total = 19.2 tcm



Source: US DOE

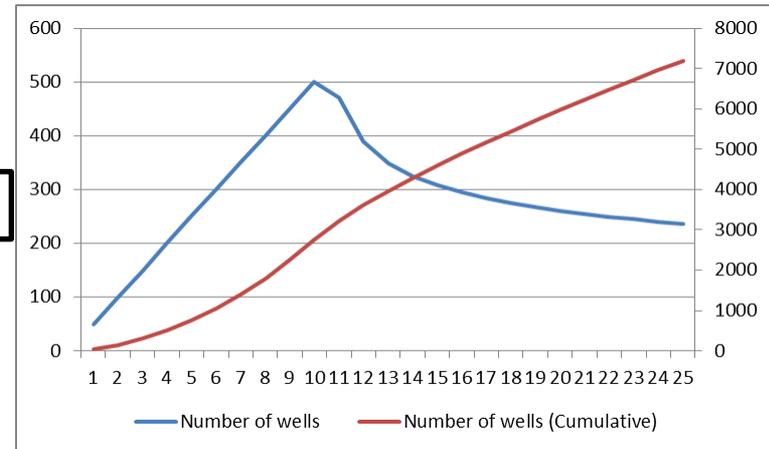
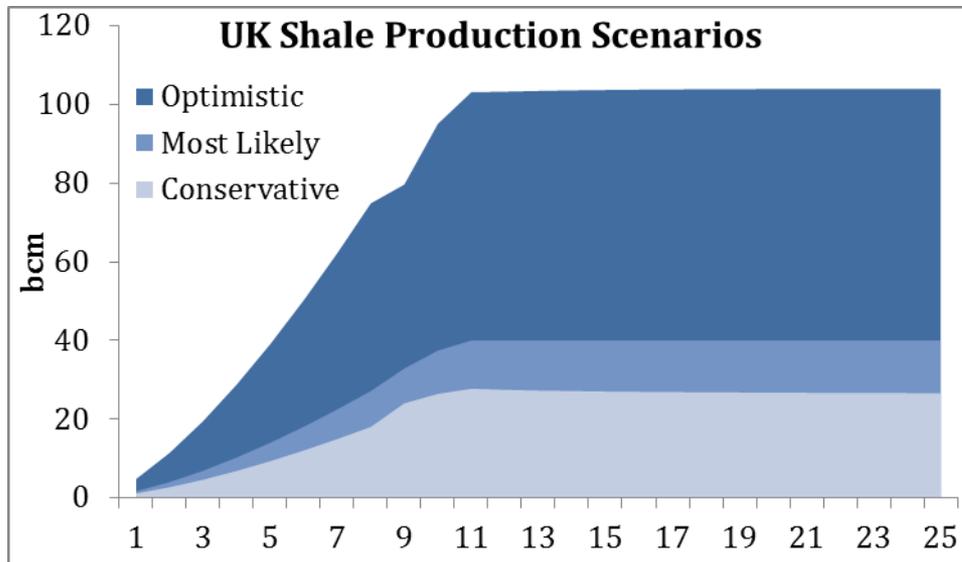
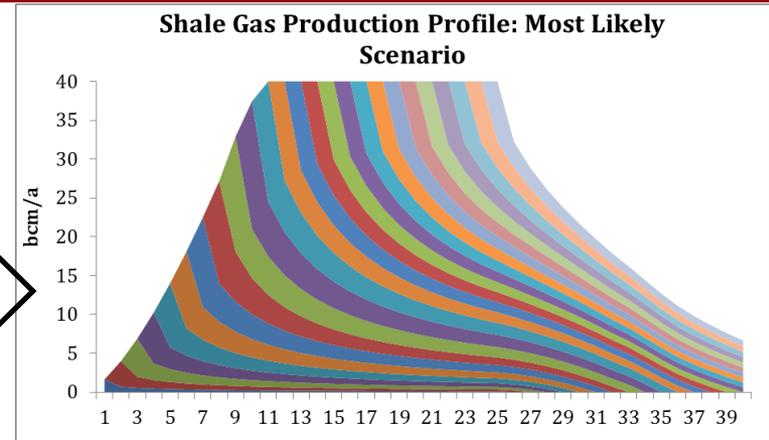
Source: US DOE

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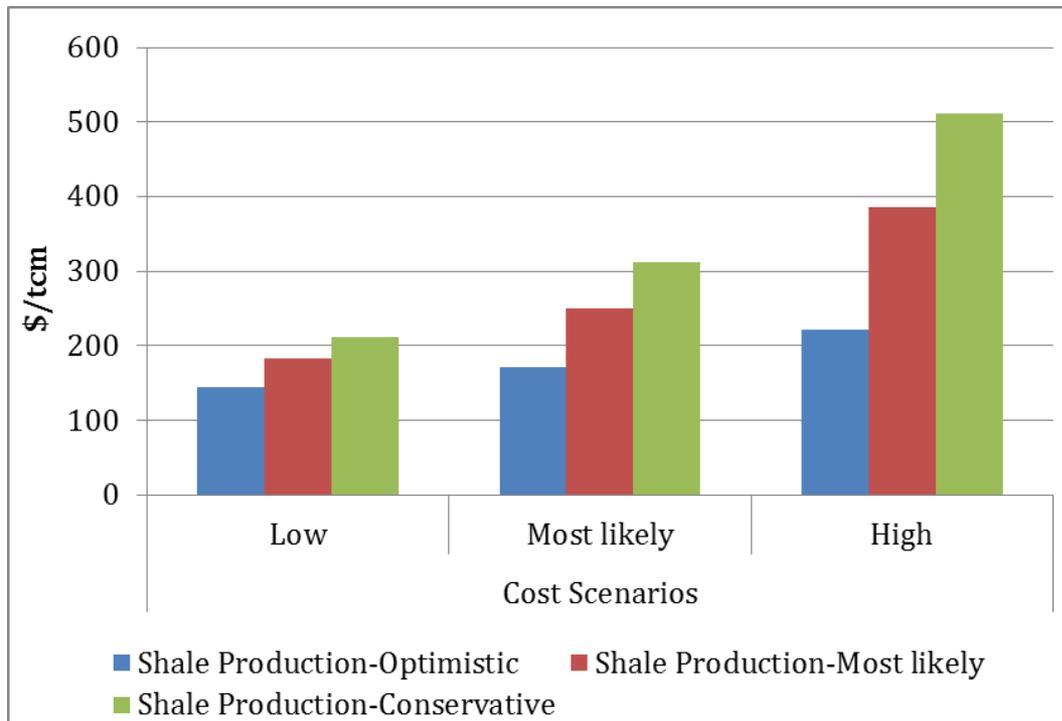
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UK Shale Gas Production Scenarios

	Arps constant (b)	Initial Decline Rate	Initial Production Rate, bcm/a
Optimistic (Haynesville)	1.1	82%	0.10
Most Likely (Marcellus)	1.1	70%	0.03
Conservative (Barnett)	1.1	73%	0.02

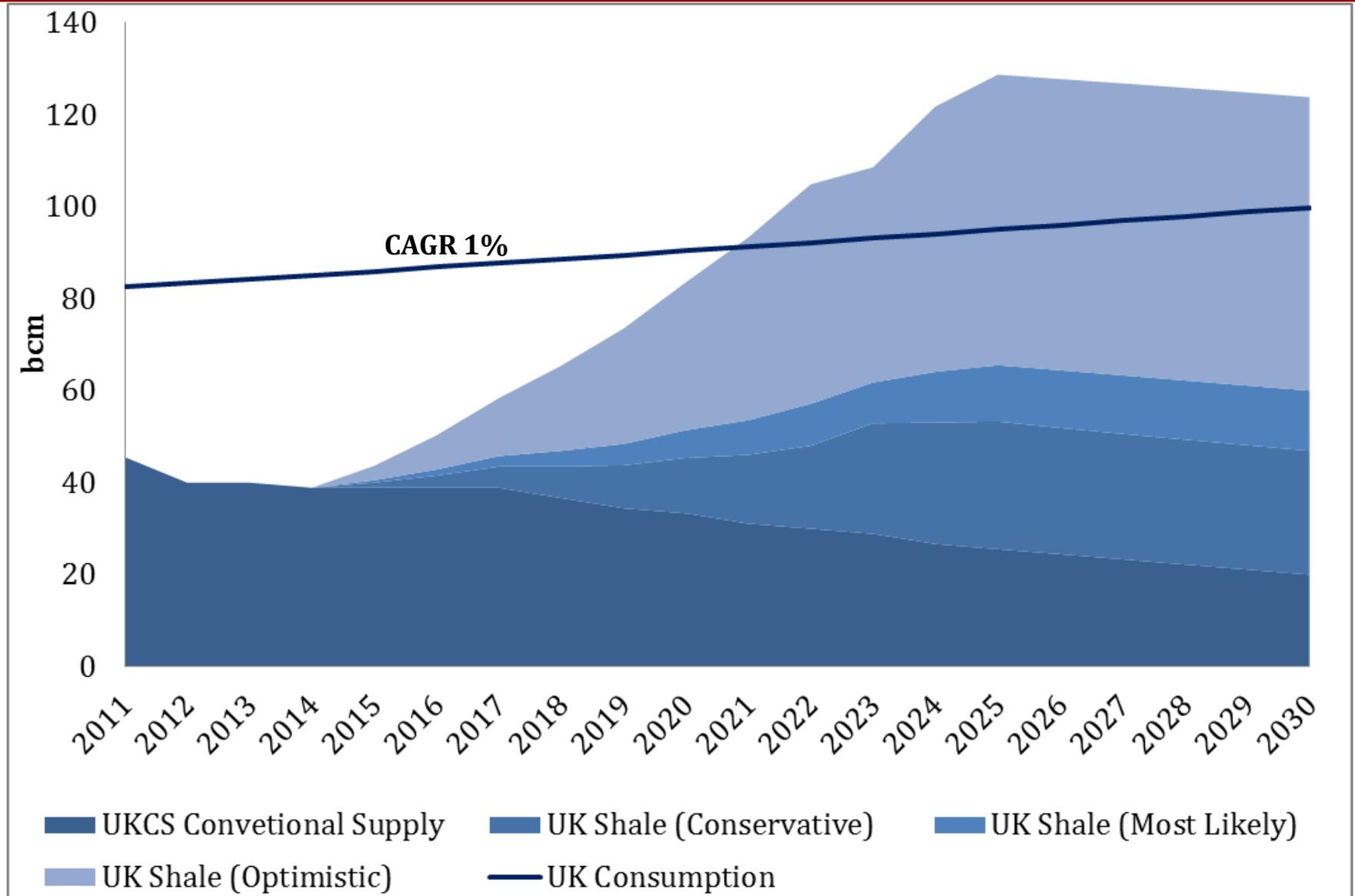


Cost of UK Shale Gas

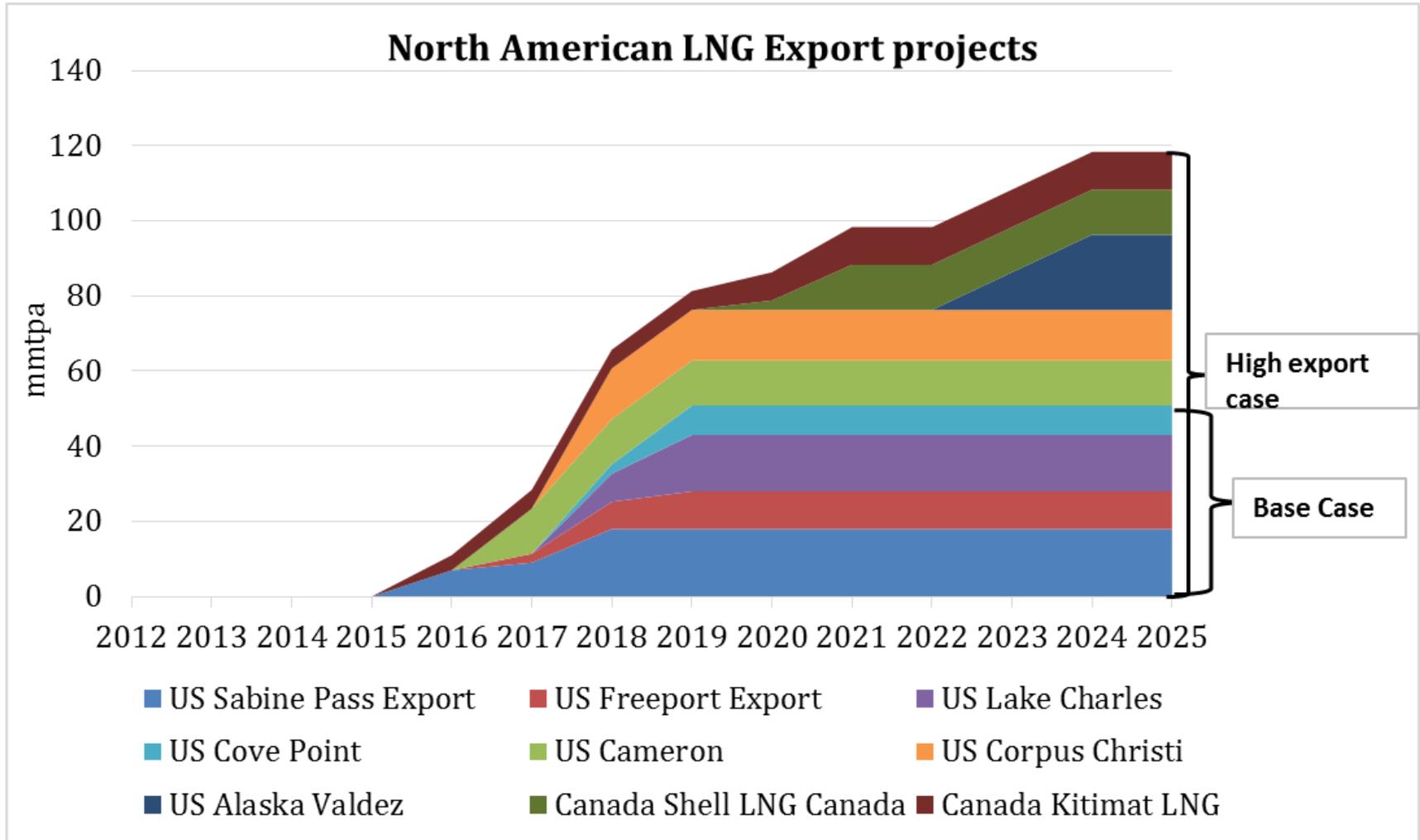


- Costing of shale gas development and production in the UK is based on a detailed, bottom-up analysis of major unconventional gas production components (JRC, 2012):
 - Typical well configuration
 - Depth-based cost
 - Drilling performance
 - Drilling operations day-rate-based costs
 - Fracturing cost
 - Field development, infrastructure and processing costs

UK Supply and Demand

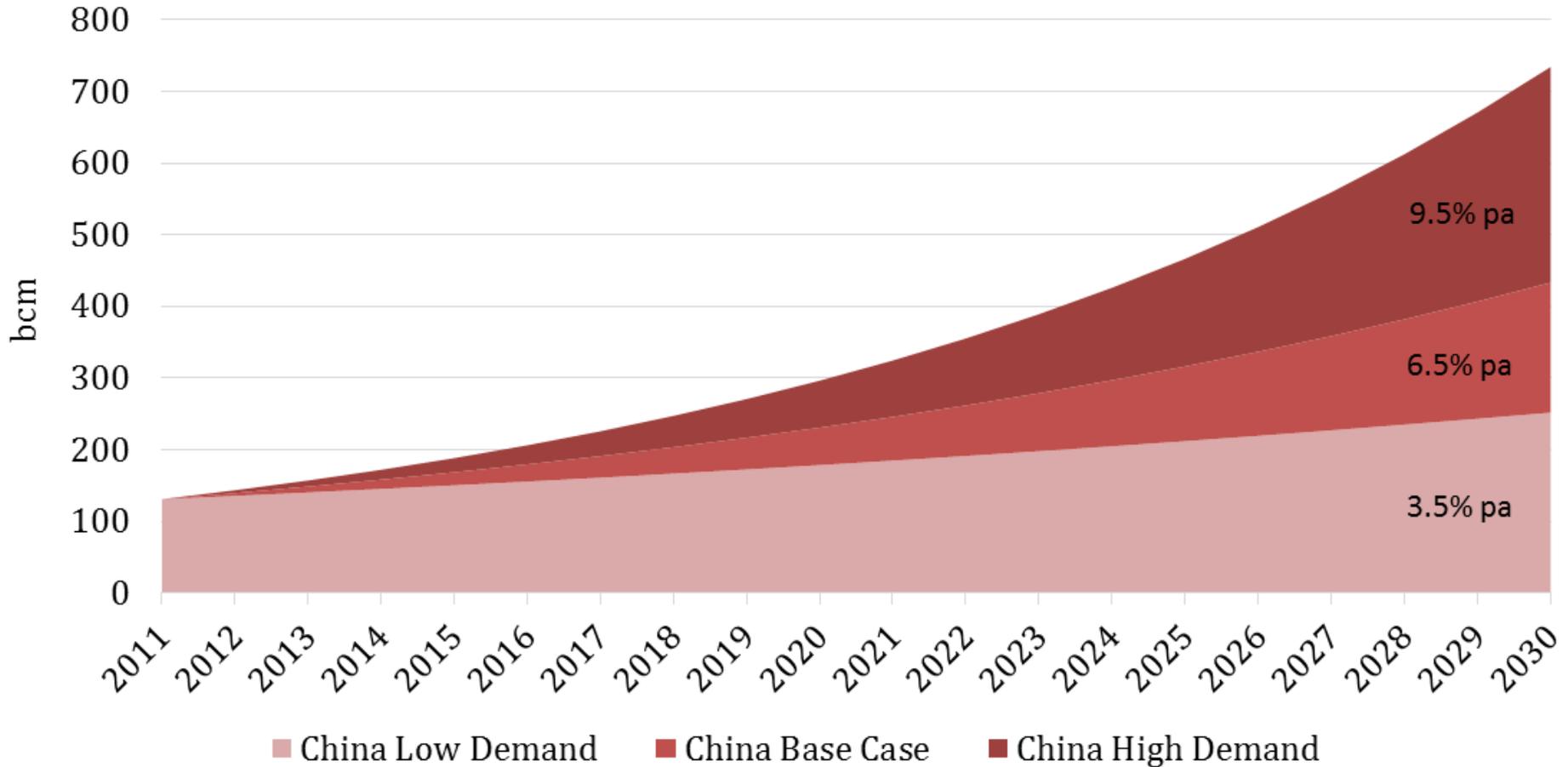


Global Gas Market Scenarios

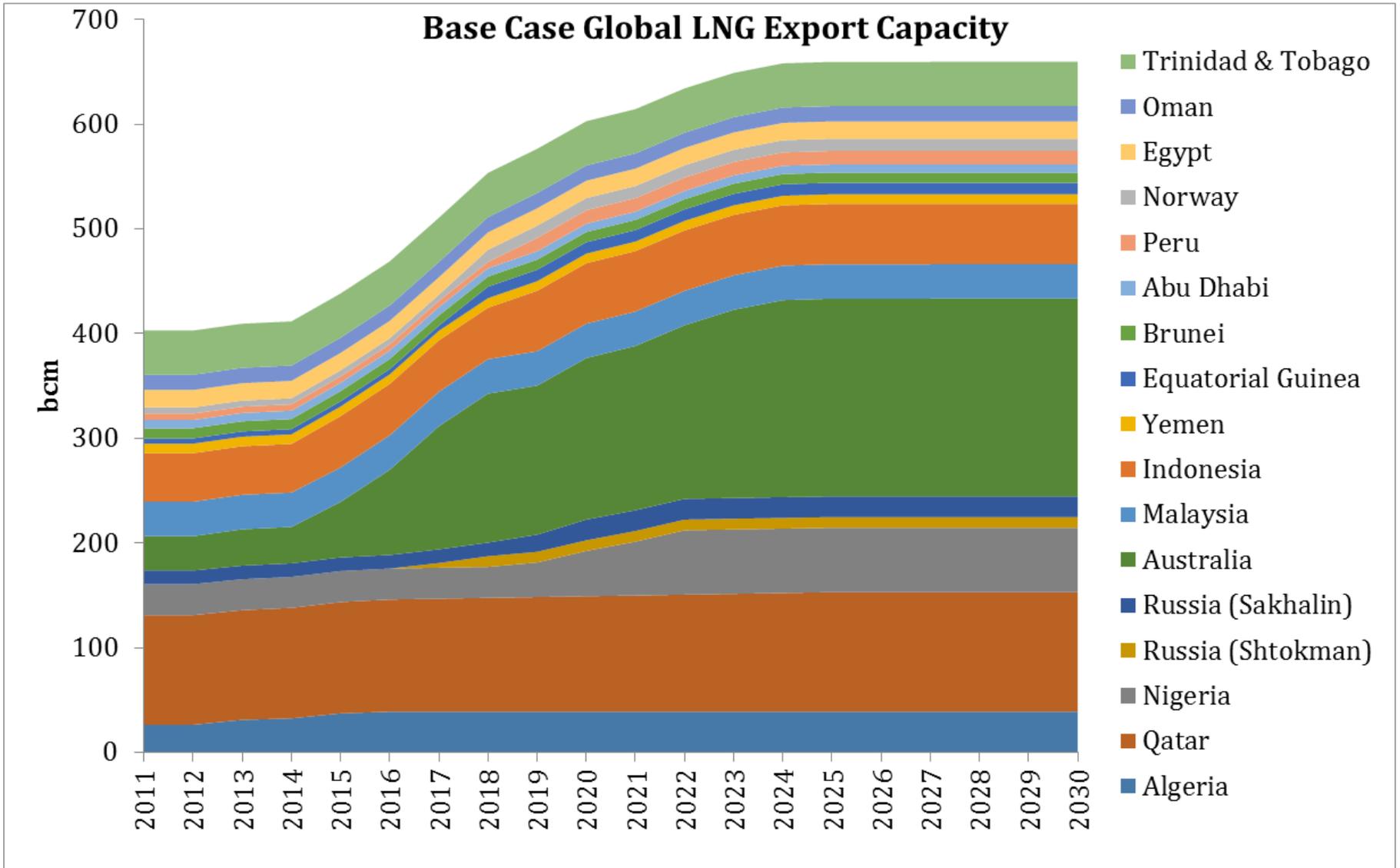


Global Gas Market Scenarios

China Gas Demand Scenarios



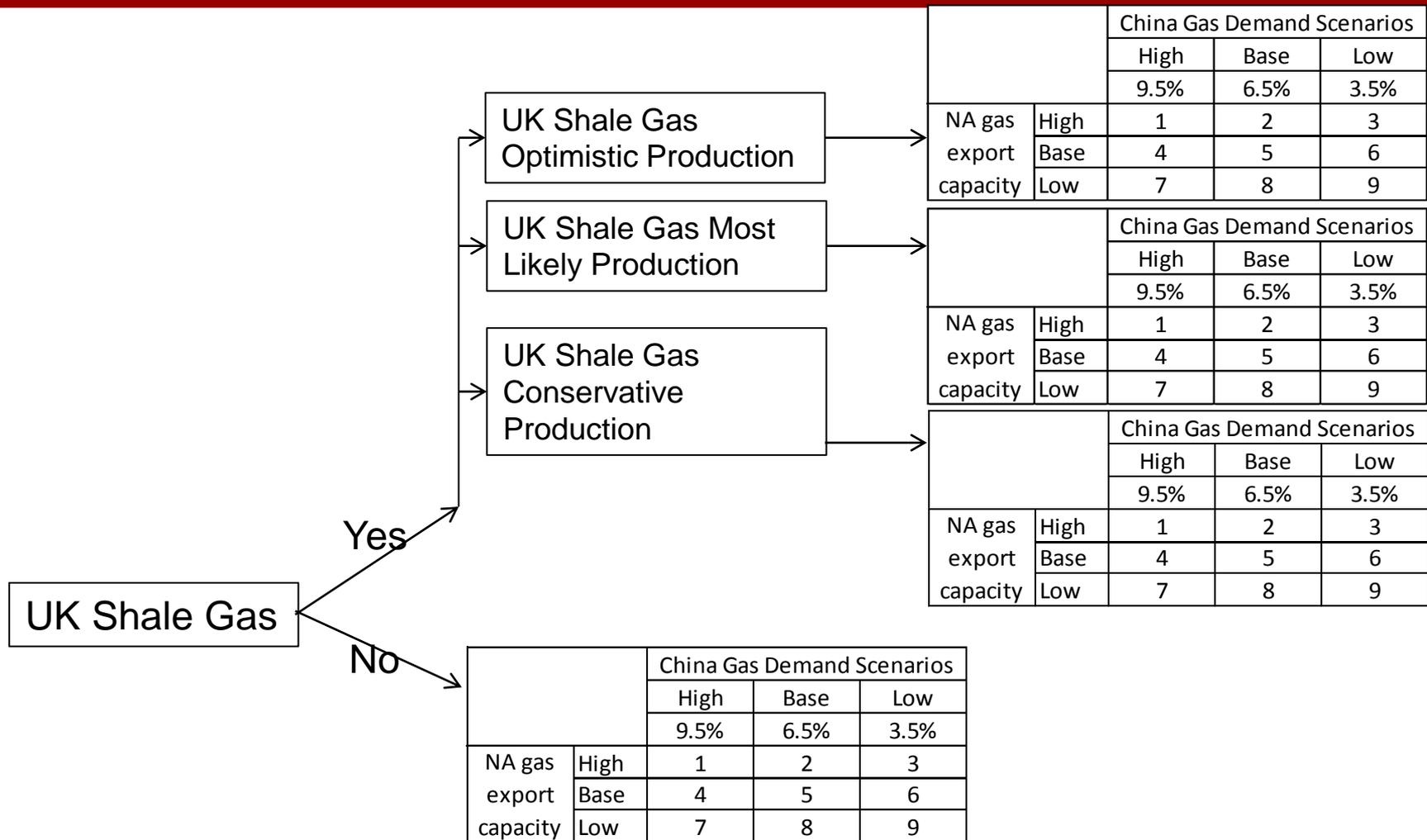
Global Gas Market Scenarios



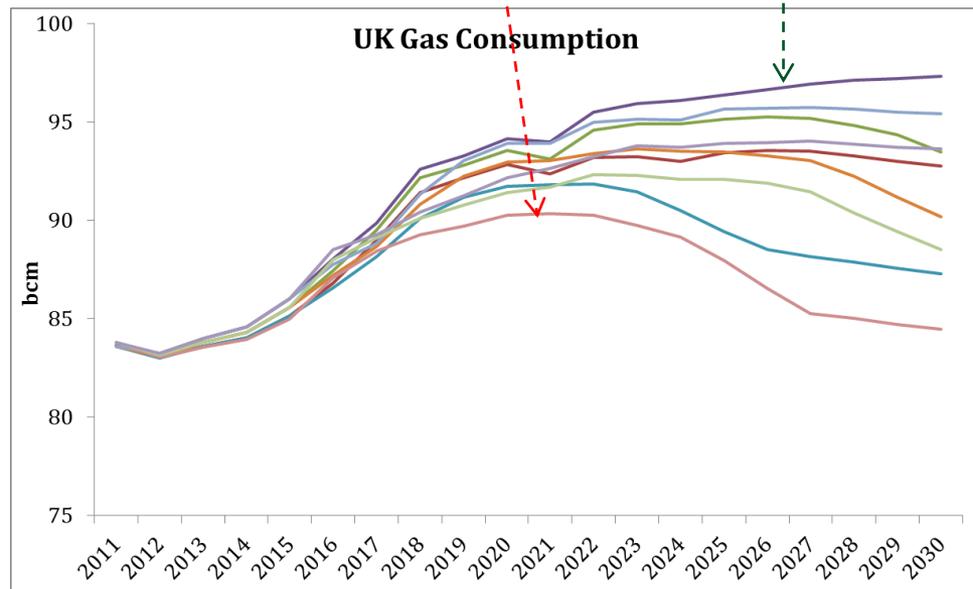
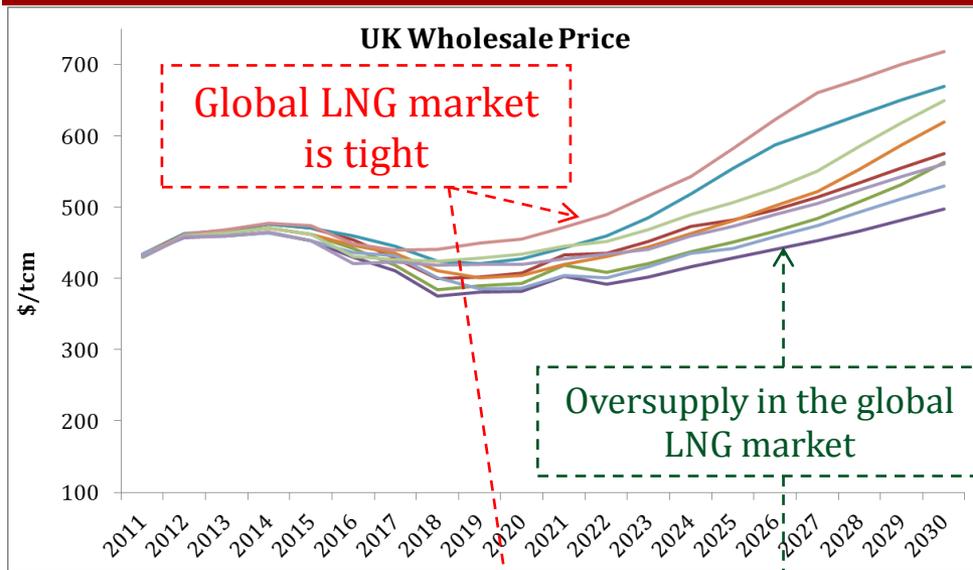
Assessing Potential Market Impact of Shale Gas Production in the UK

- Global Natural Gas Market Model (equilibrium model) is used for the analysis of potential impact of shale gas on the UK gas market under:
 1. Different gas demand scenarios in China,
 2. Different export capacity in the North America, and
 3. Different shale gas production scenarios in the UK
- Major assumptions:
 1. Large gas producers (Russia, Norway, Qatar etc) behave strategically by adjusting respectively their production/sales levels in order to raise prices and hence marginal revenue
 2. Shale Gas Producers in the UK behave competitively

Scenario Tree for UK Gas Supply

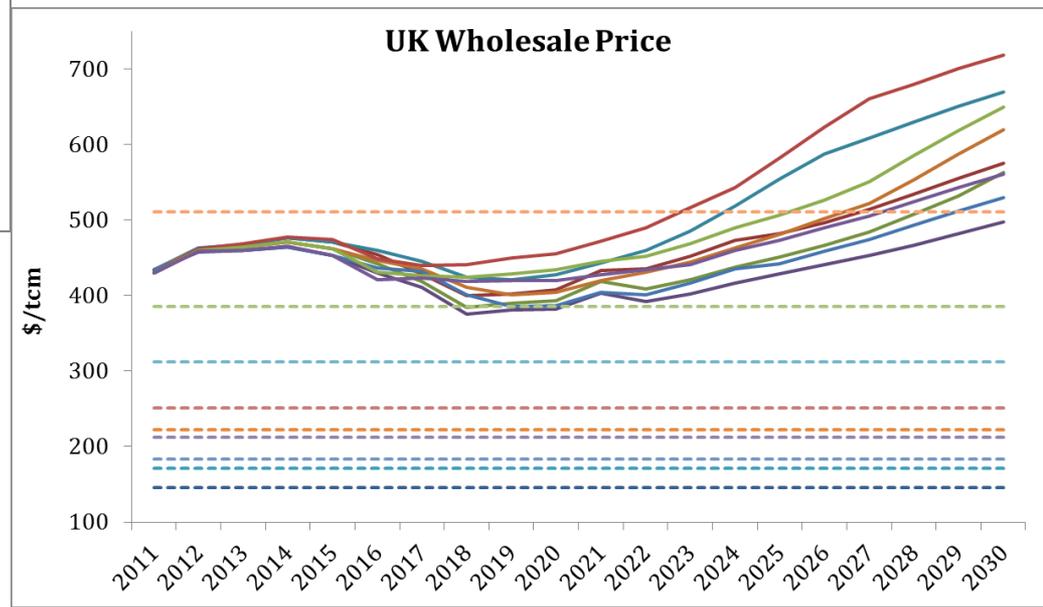
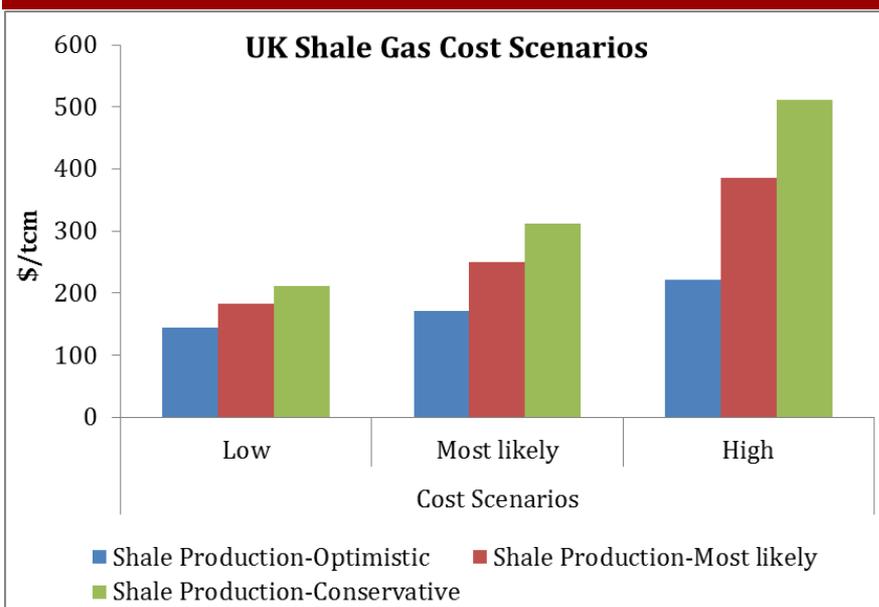


The UK without Shale Gas



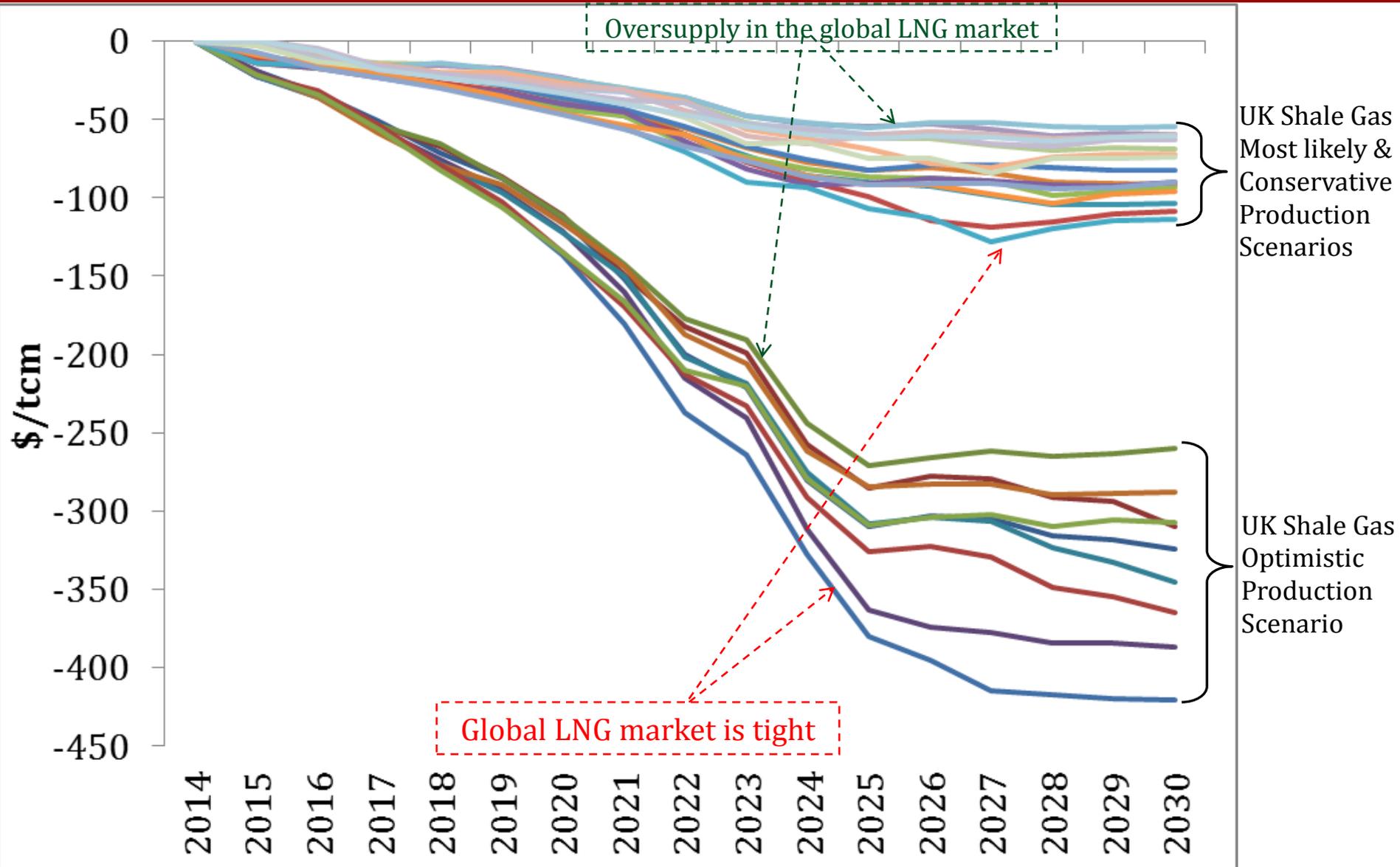
- Long term gas supply insecurity for the UK means that you do not know which price path you are on
- The price path depends on e.g.:
 - US government’s policy towards LNG exports
 - China’s energy and environmental/climate policy (i.e. reform of the power sector to encourage investment in gas-fired powergen) and energy security concerns (oil vs. gas import dependency)
 - Qatari government’s decision on the future development of new LNG export projects

Potential Impact of Shale Gas for the UK



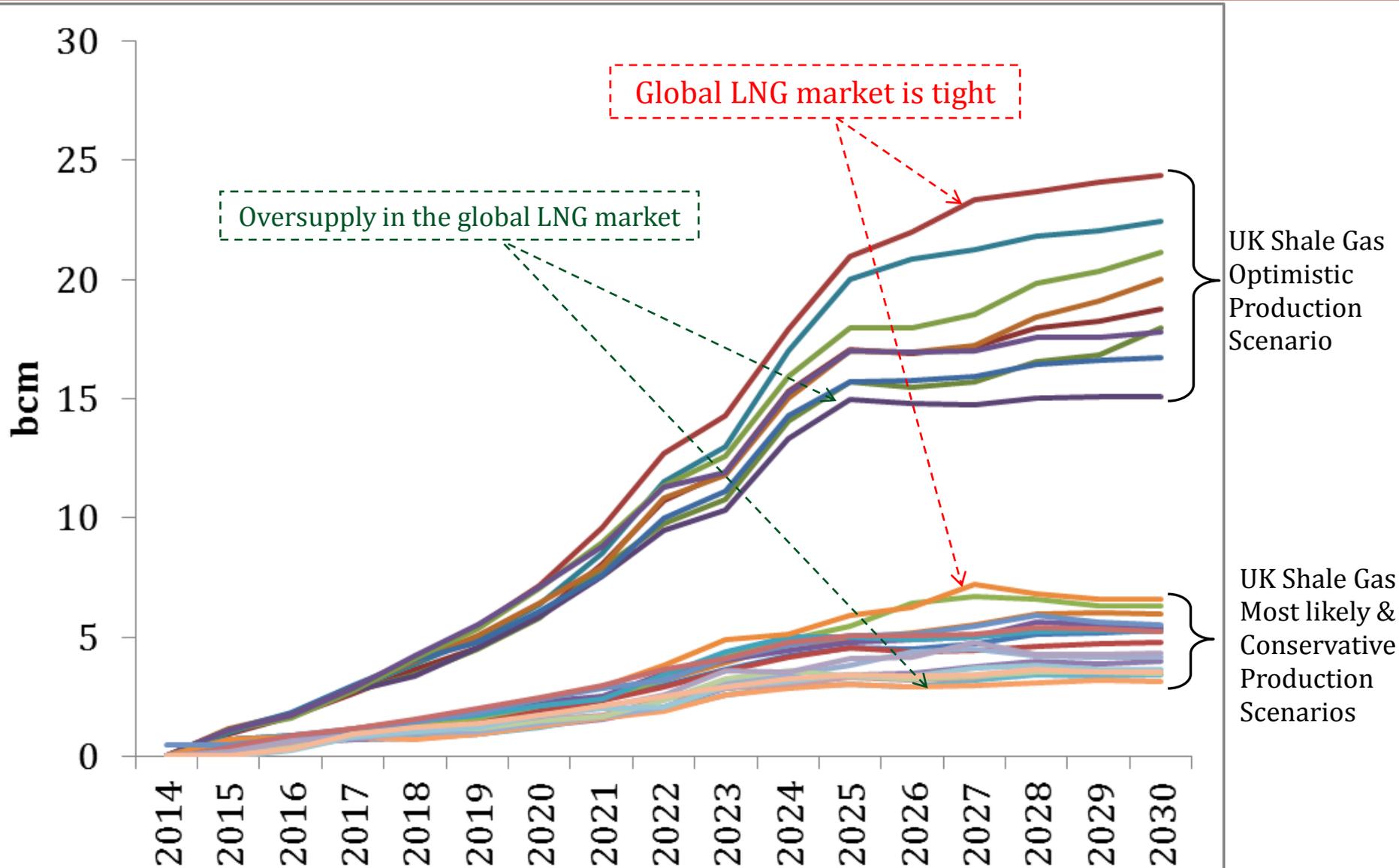
Results

Changes in wholesale price relative to “No Shale Gas” Scenario



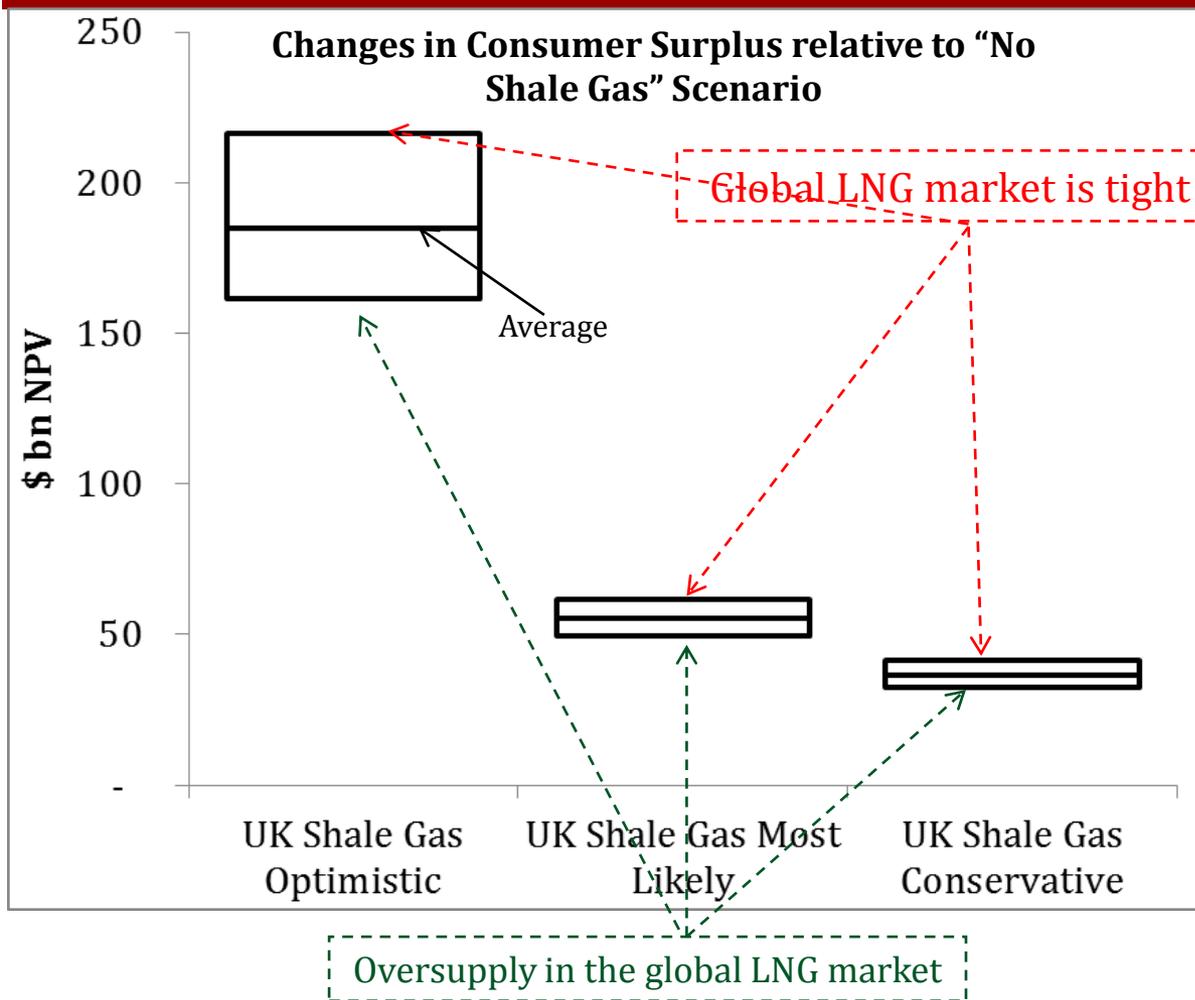
Results

Changes in gas consumption relative to “No Shale Gas” Scenario



Results

Benefits to consumers



- **Consumer surplus** : the difference between the total amount that consumers are prepared to pay and the total amount that they actually pay
- Depending on global gas market dynamics, we see benefits to consumers of shale gas development in the UK under our three shale gas scenarios:
 - Changes in consumer surplus ranges from \$32-41 bn (NPV over 15 years) in our conservative shale gas scenario and between \$161-216 bn NPV in our optimistic scenario of shale gas development in the UK

Conclusions

- There are economic benefits of developing shale gas in the UK;
- However, compared to the US shale gas experience:
 - Drilling rigs and fracture stimulation equipment availability is limited in Europe
 - In general, drilling, production and all service costs are higher in Europe
 - Policy/regulatory uncertainty associated with dense onshore drilling
 - Landowner incentives – property rights limit access, and no royalty system leads to little motivation to lease land from personal land owners.
 - Europe has smaller fragmented shale plays with limited data and few existing wells
 - Demographics – population density is high in some areas
 - Access to midstream infrastructure is difficult

Thank you for your attention

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