



Impact of US Shale Gas Development on the Global Gas Balance

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Venice, 23rd May 2013

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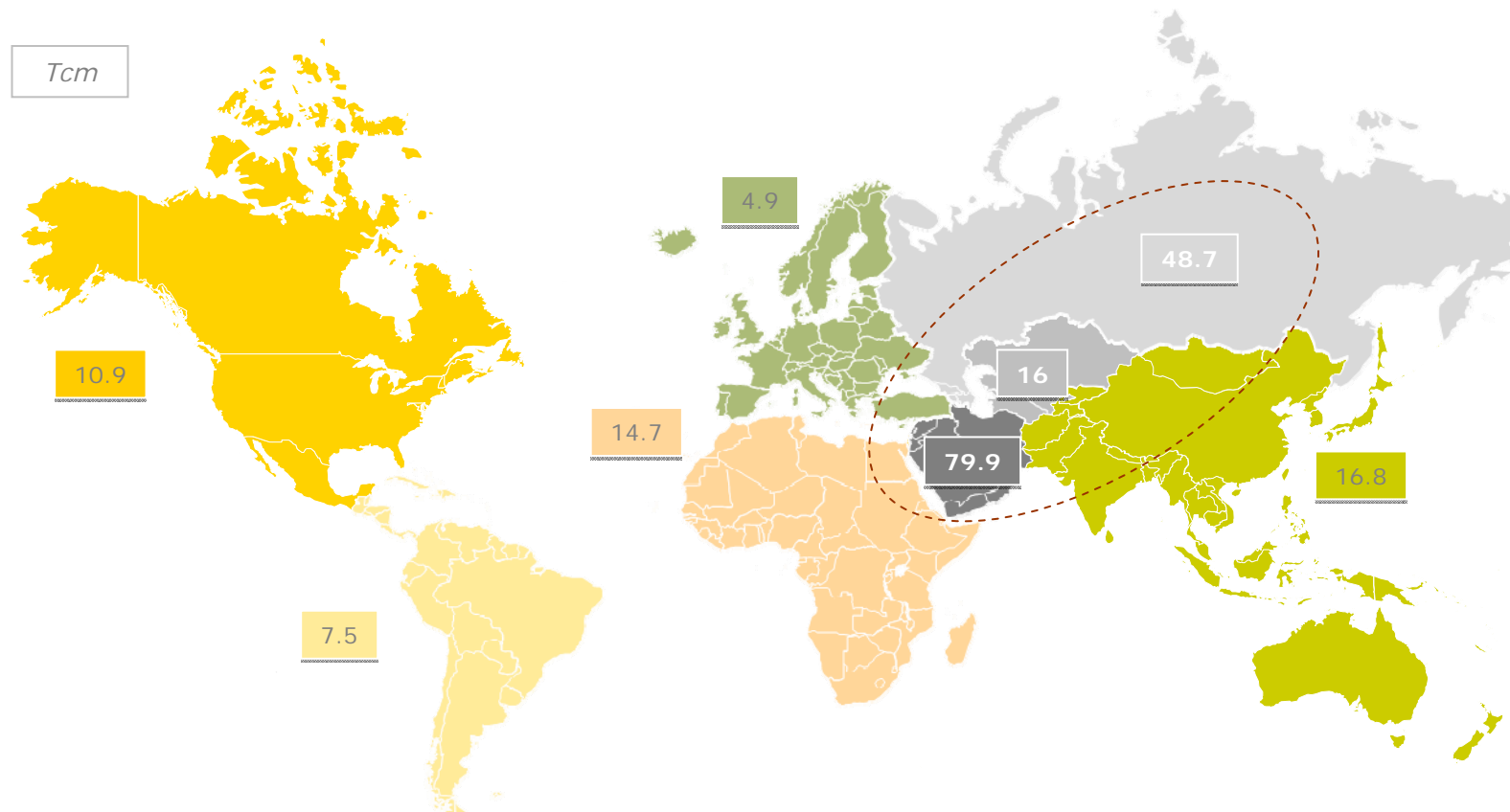
- Key issues of gas geopolitics
- The origin of shale gas in the US
- The impact of shale gas in the US and European energy markets
- Is the US experience replicable elsewhere?
- Can shale gas affect the global gas balance?



The four pillars of gas geopolitics



2012 global gas reserves



- The Middle East represents around 40% of global proved reserves (~ 200 tcm)
- More than 70% of reserves is concentrated in a single area: "Russia - Central Asia – Middle East" between the two main consumption basins: the traditional European market and the growing Asian market

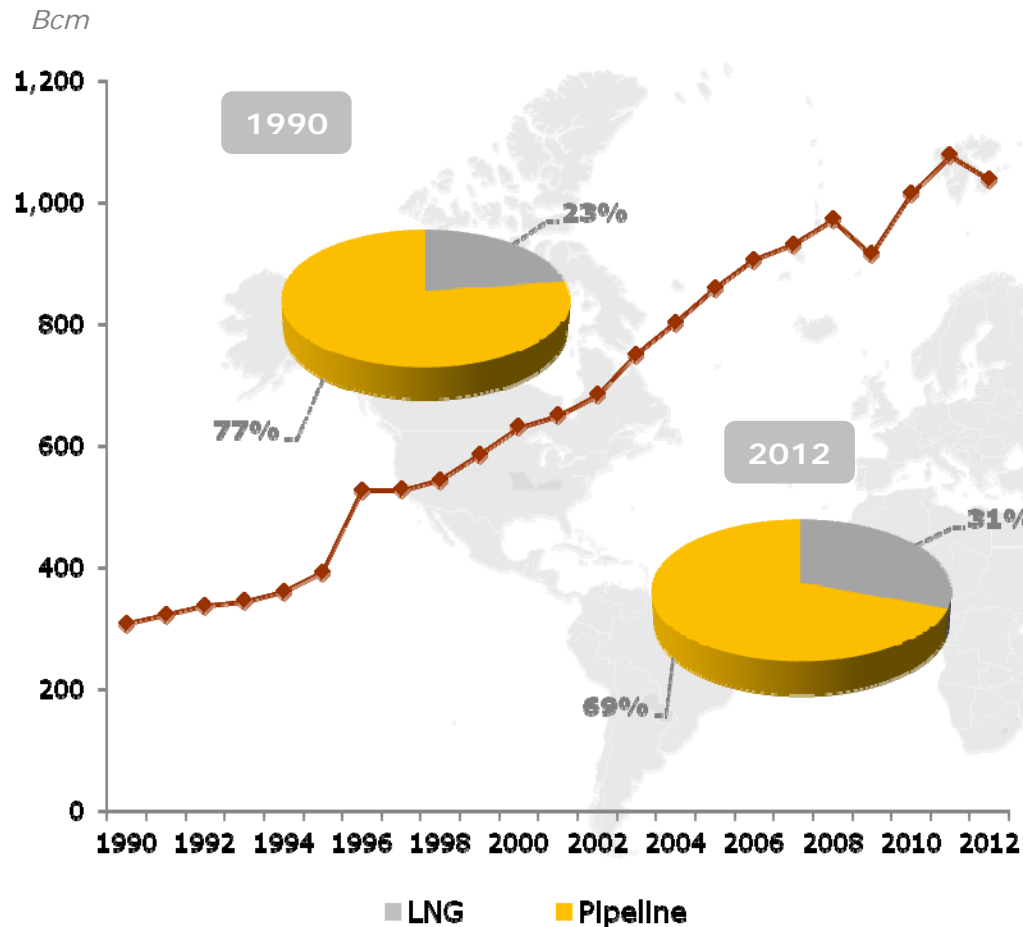


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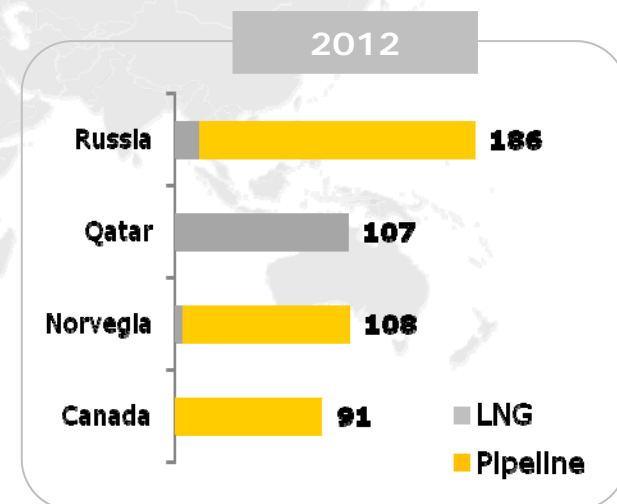
Fonte: Cedigaz

The evolution of global gas trade

International trade via pipe & GNL 1990 – 2012



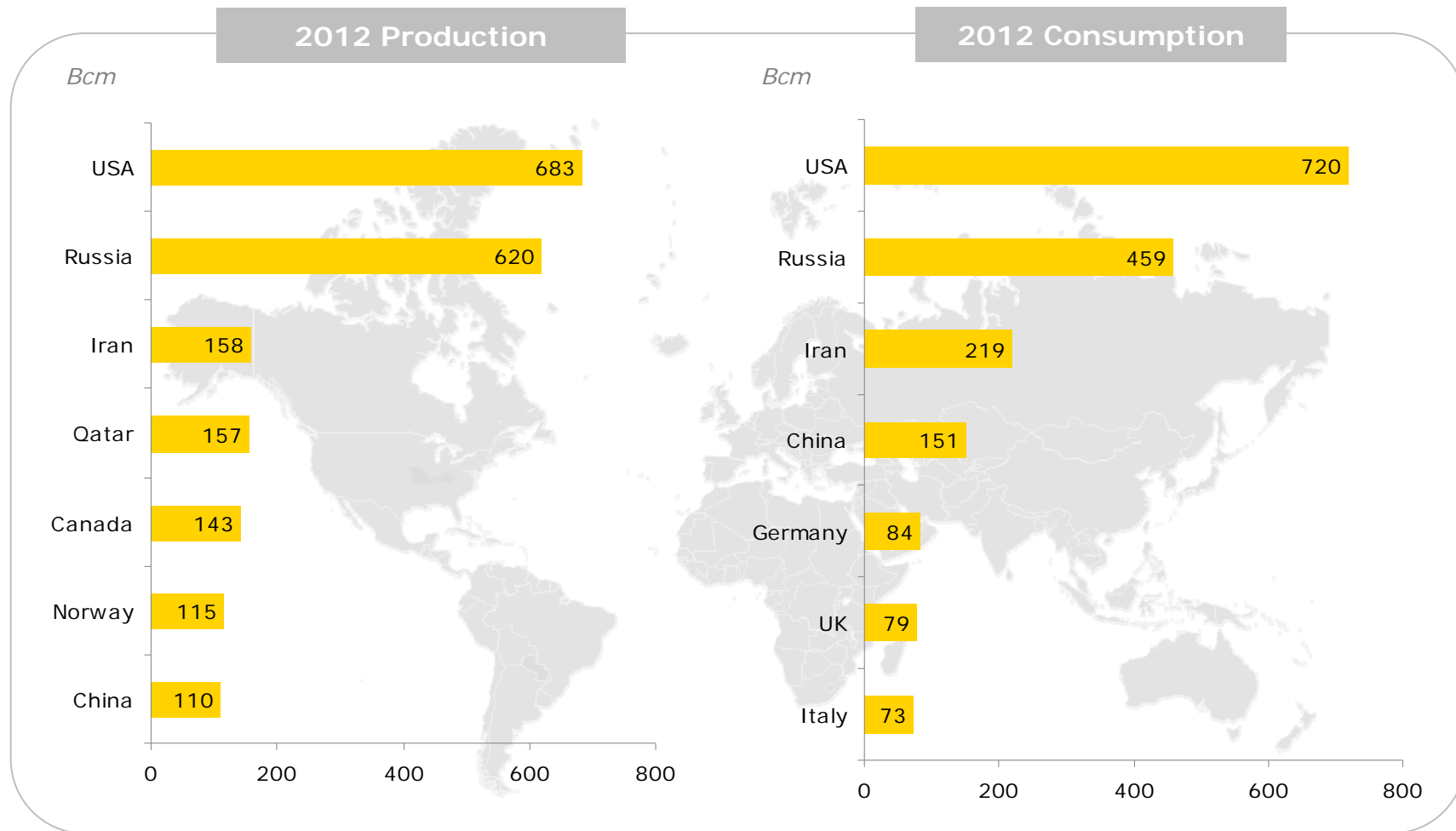
- In 2012 1,038 bcm of gas were traded or about 31% of total production
- Russia is the world's first exporter with a ~20% share
- Qatar is the world's largest exporter of LNG



Sources: Cedigaz, IHS CERA, Eurogas, Platts



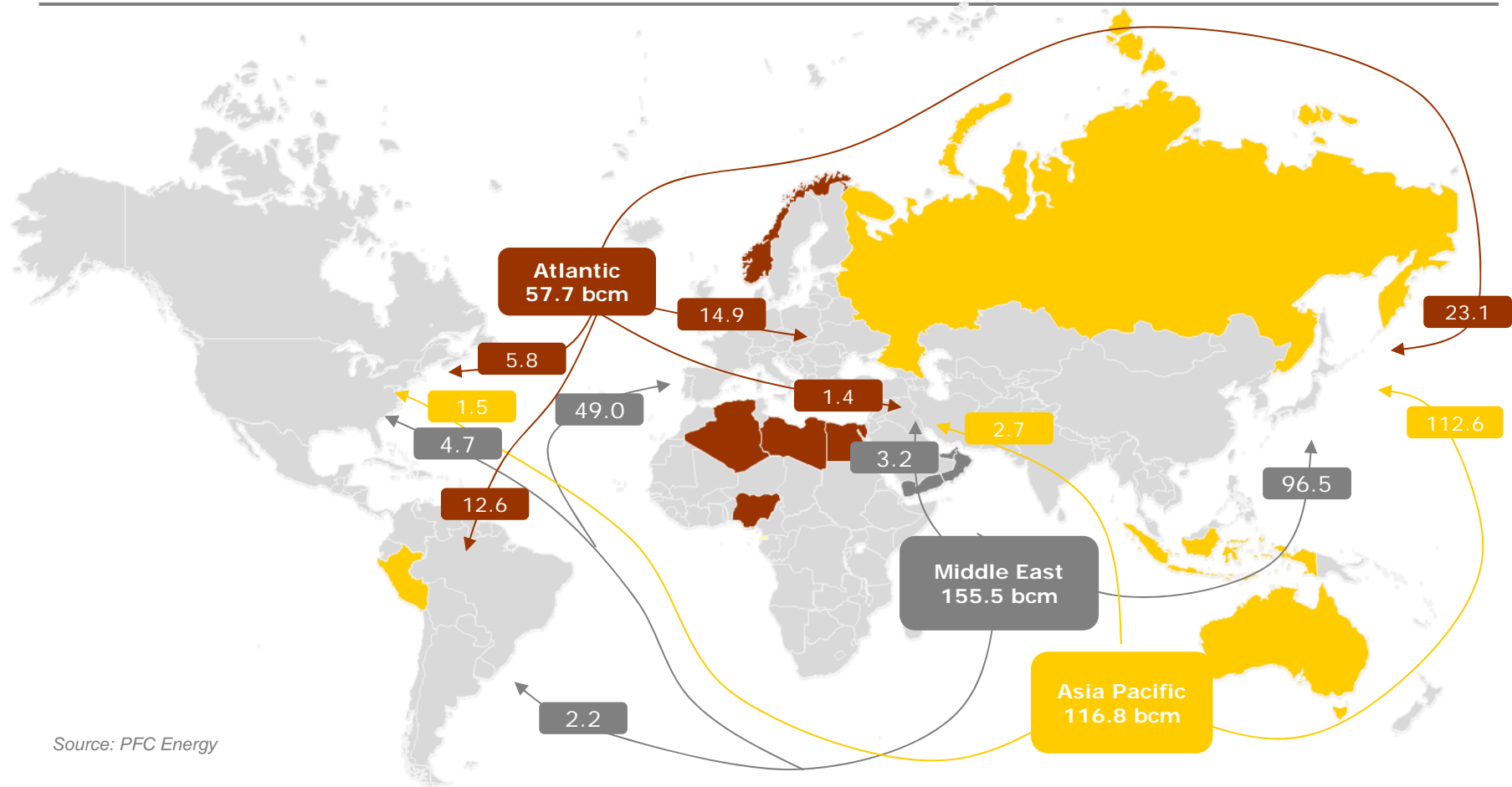
World gas production and consumption



Sources: Cedigaz, IHS CERA, Eurogas, Platts



2012 global LNG trade






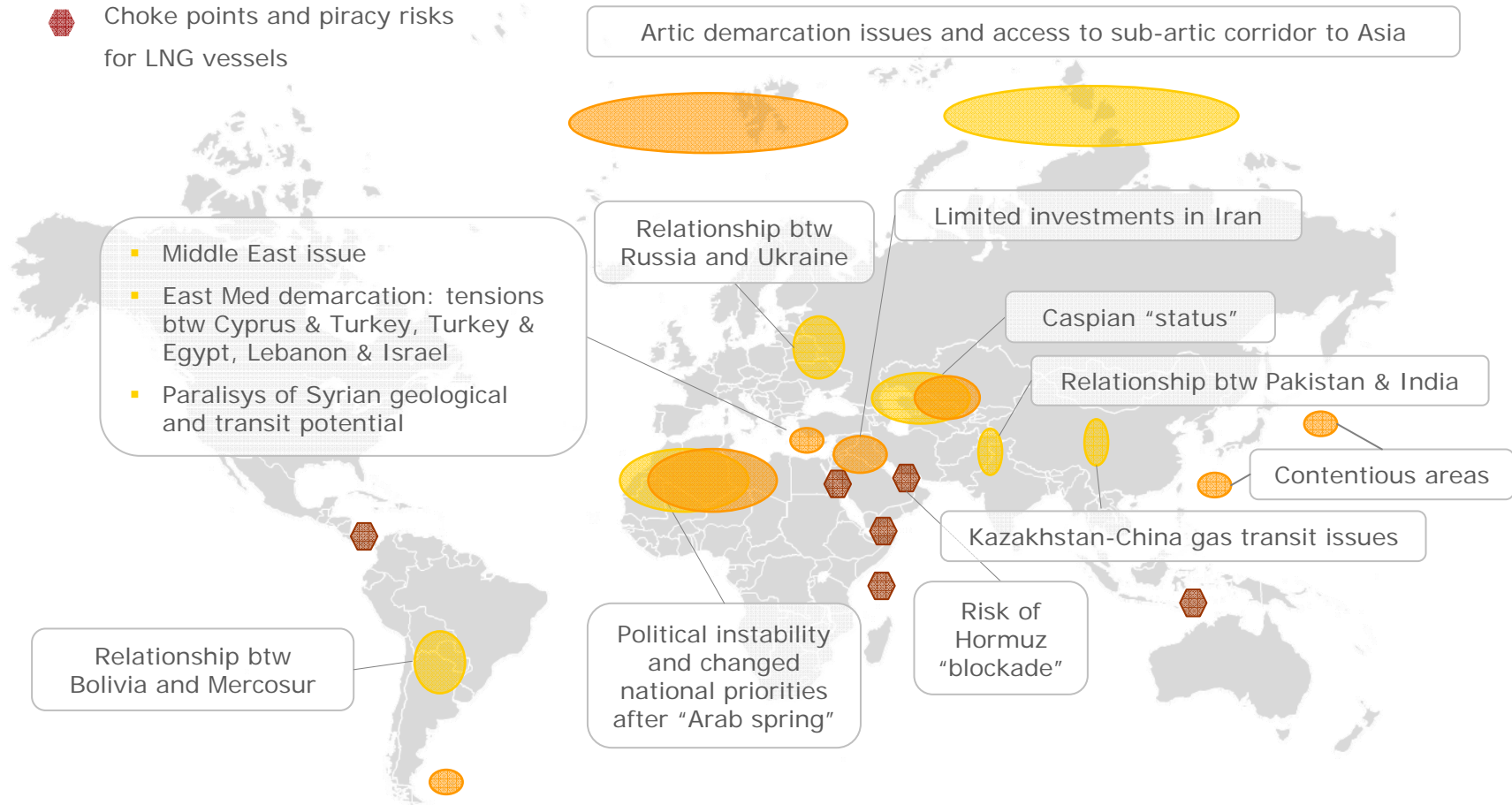
Source: PFC Energy

- Middle East liquefaction capacity is strategically positioned between the two largest consumer markets
- Asian Pacific production is nearly entirely bound towards Far East markets
- Atlantic liquefaction capacity holders have directed only ~26% of production to Europe



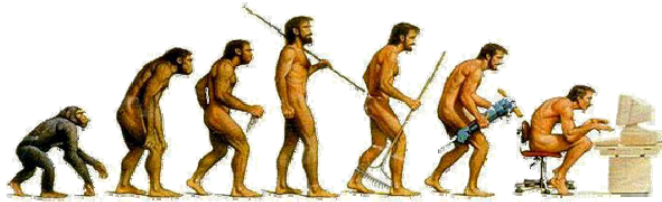
Geopolitics and security of supply

-  Contentious areas for accessing reserves
-  Transit issues
-  Choke points and piracy risks for LNG vessels



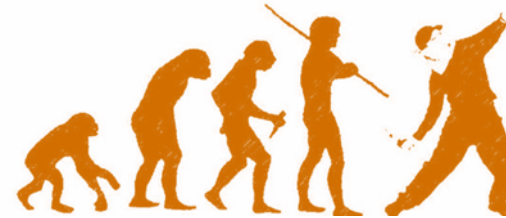
Shale Gas: Evolution or Revolution?

Evolution



- Comes with time
- Implies a slow progressive change
- Will lead to a long awaited, sought-after result

Revolution



- Comes unforeseen
- Implies a sudden change
- Will lead to an unpredicted result, creating uncertainty

Shale gas is an evolutionary phenomenon which has produced largely unforeseen revolutionary effects in the global energy equilibria

The *Evolution* of shale gas dates back to...

1825

- First extraction in Fredonia, NY, in shallow low-pressure fractures

1920's

- First field-scale development of shale gas (Ohio Shale, Kentucky, Antrim Shale, Michigan)

1950's

- Hydraulic Fracturing becomes commercially viable (> 1 million wells)

1970's

- First patent for directional drilling
- First demonstration of massive hydraulic fracturing

1980's

- Horizontal drilling becomes commercially viable
- First large-scale hydraulic fracturing on shale well (Barnett, TX)

1992

- First horizontal shale gas well with hydraulic fracturing (Barnett TX)

2005

- Shale gas production takes off

In 2012 US shale gas production alone ranks third globally, after US and Russia

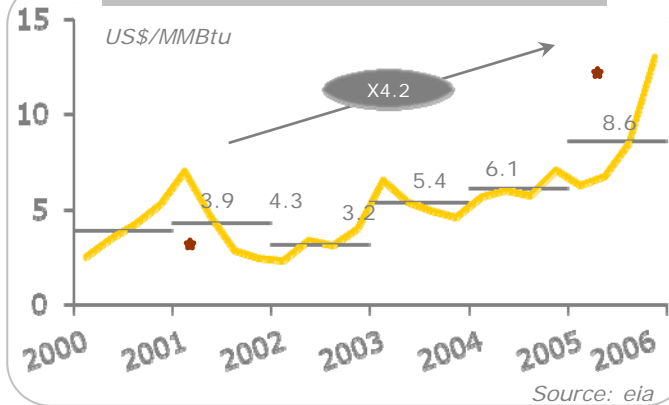


The *Evolution* of shale gas *the key success factors*

Technology Innovation

- Hydraulic fracturing
- Horizontal drilling
- Longer lateral well lengths
- 3D seismic imaging

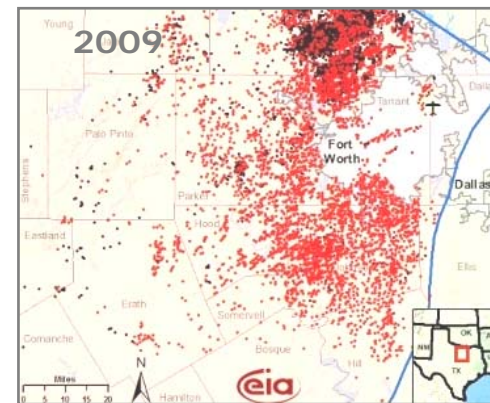
Yearly Average US HH Prices



Resource Availability

- Land and water
- Drilling rigs
- Skilled and competent labor
- Downstream infrastructure

Since 1997, more than 13,500 gas wells completed in the Barnett shale alone

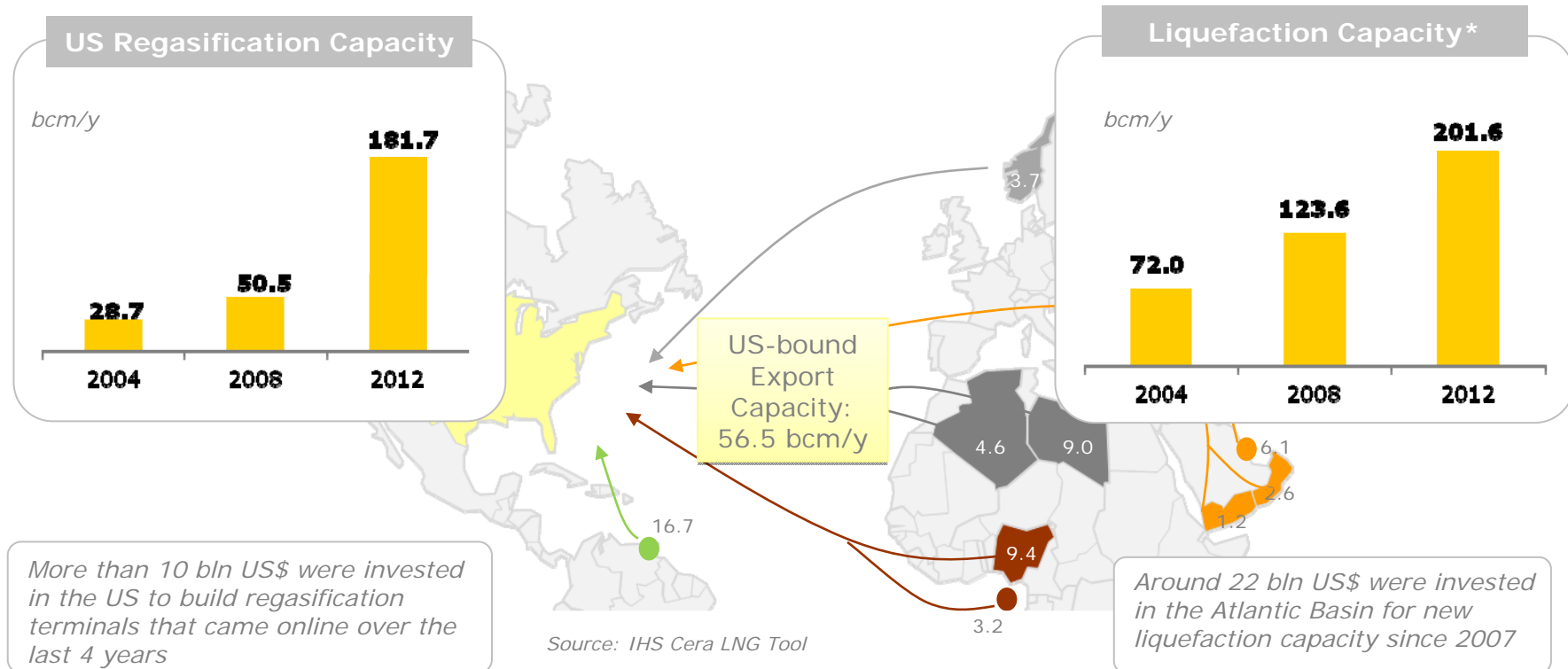


- Horizontal well
- Vertical well



The shale gas phenomenon was unforeseen *the evidence*

- The US expected a sharp decline in domestic gas production and LNG imports were the only solution to cope with gas demand
- Many IOCs invested in the LNG chain as a result of increasing US gas demand forecasts



Today the US could have been the second largest LNG importing country after Japan



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* Middle East and Atlantic Basin LNG plants only

What potentially *Revolutionary* consequences are we facing?

USA



- Reshaping the US gas balance:
 - Booming domestic production
 - Reversing of gas import trends
- Declining gas prices:
 - Moving drilling rigs away from dry gas plays
 - Stimulating domestic demand
 - Assessing export opportunities and potential

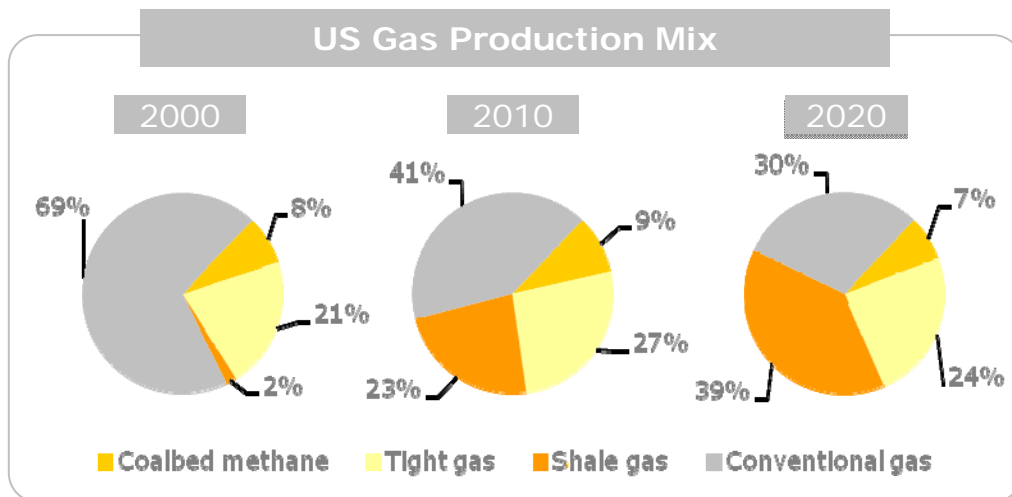
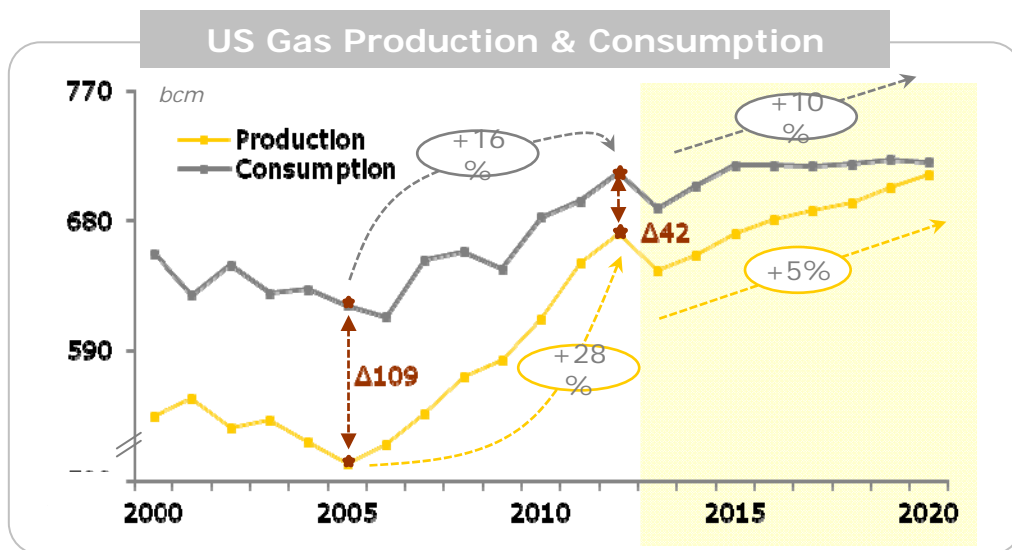
World



- Increasing reserve to production ratio from 60 to 250 years
- Widening price differentials across markets enhance arbitrage opportunities
- Global LNG trade is reshaping
- Unconventional gas production is also being considered outside the USA
- Changing geopolitical equilibria

Shale gas is reshaping the US Gas Market

gas production is booming...

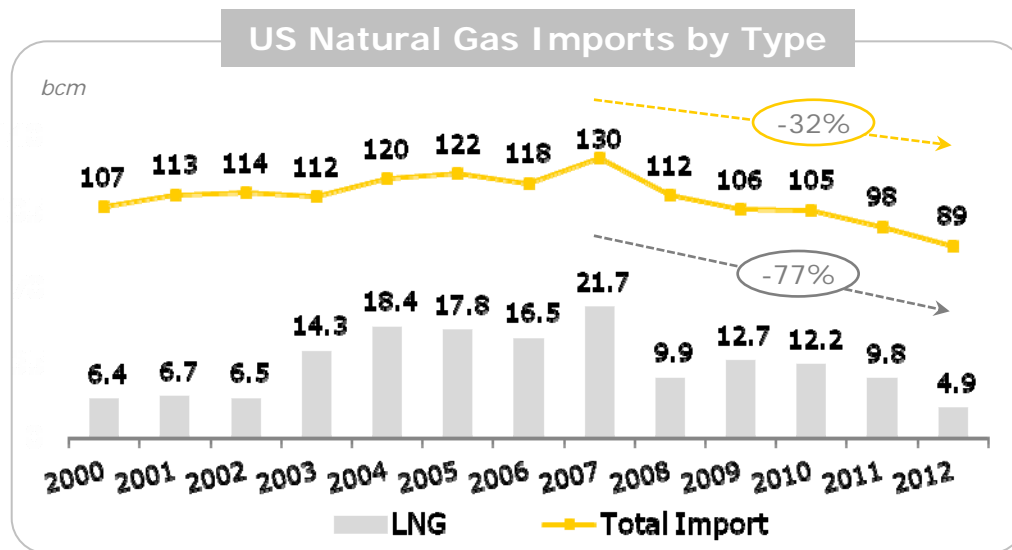


- Shale gas encouraged recovery and then growth of gas consumption after the financial downturn
- Consumption-to-production gap will slim down to less than 10 bcm in 2020
- Production will have to satisfy domestic consumption, to allow for LNG exports
- Shale production was less than 2% of total gas production in 2000 and reached nearly 35% in 2012
- In 2020, shale gas is expected to reach around 40% of total gas production although its growth will decrease to 5% yoy

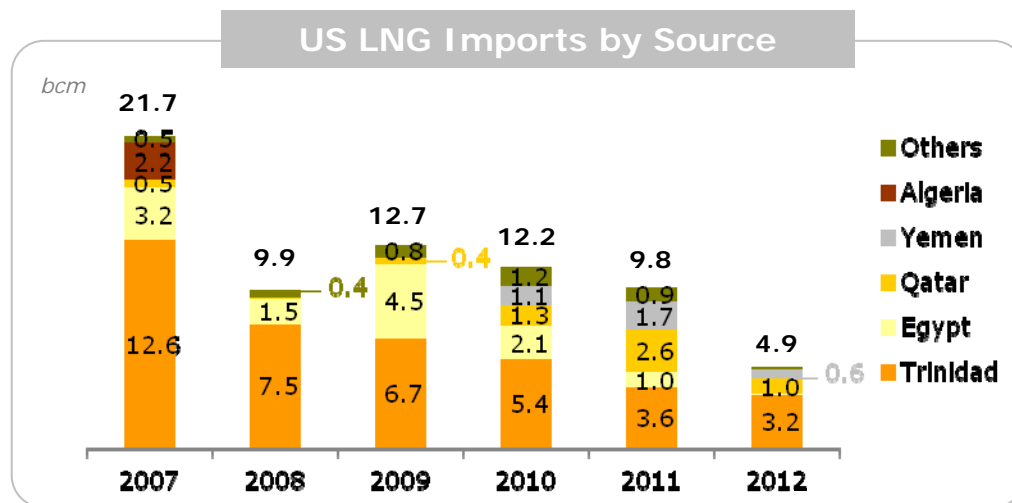


Source: eia

Shale gas is reshaping the US Gas Market *while imports are shrinking*



- US gas imports reached 130 bcm in 2007 or ~20% of US demand
- Since then, imports declined by 41 bcm/y and today represent only ~14% of US demand
 - Pipeline imports fell by 23% down to 84 bcm/y
 - LNG import decline left average utilization rate of regasification terminals @ 2% last year



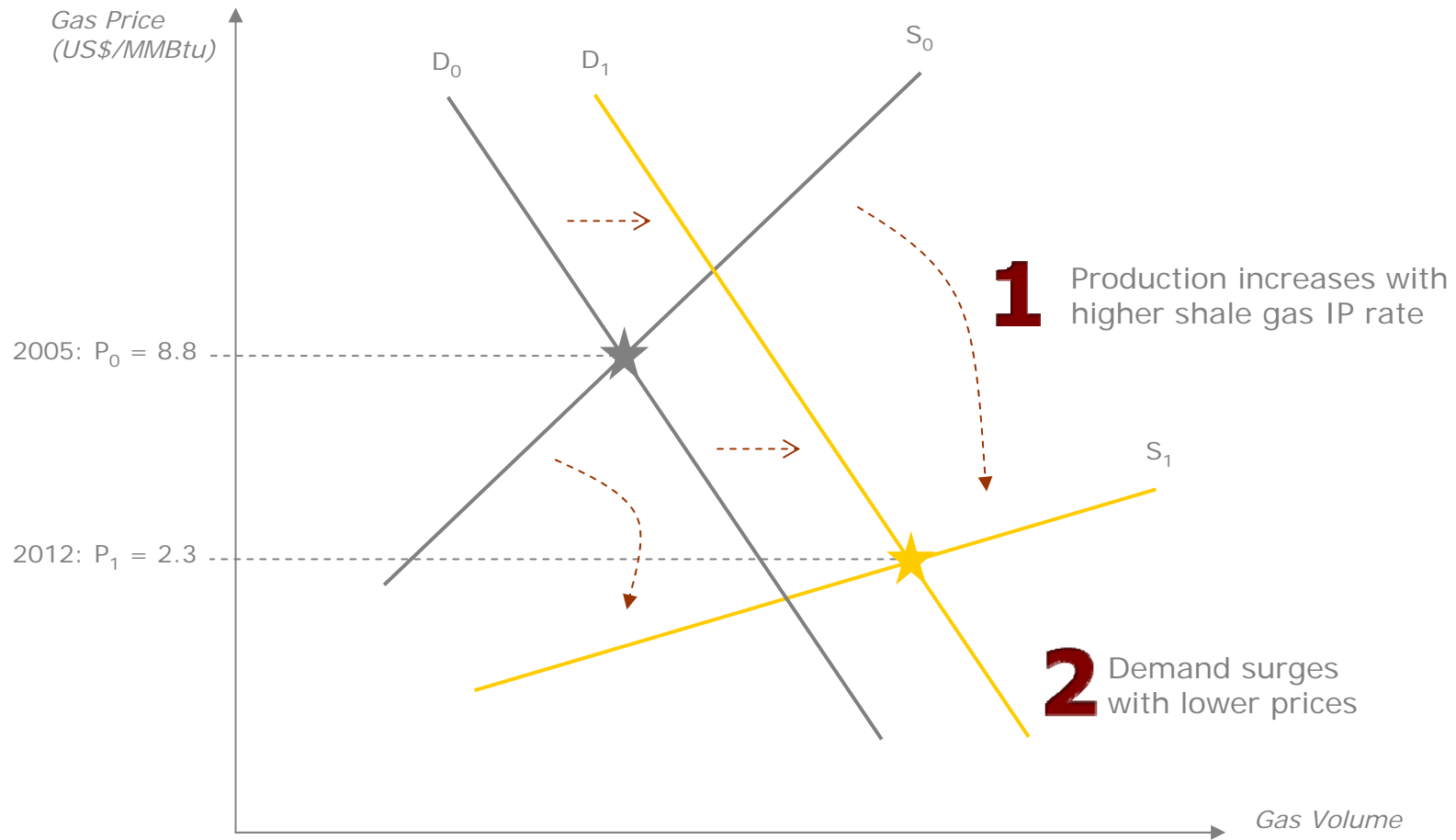
- The US still reloaded 0.7 bcm in 2012 (14% of imported LNG)
- In 2012, more than half of imported LNG went to Everett (Boston) to feed North-East markets, mainly from Trinidad & Tobago and Yemen



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Sources: eia, PFC energy

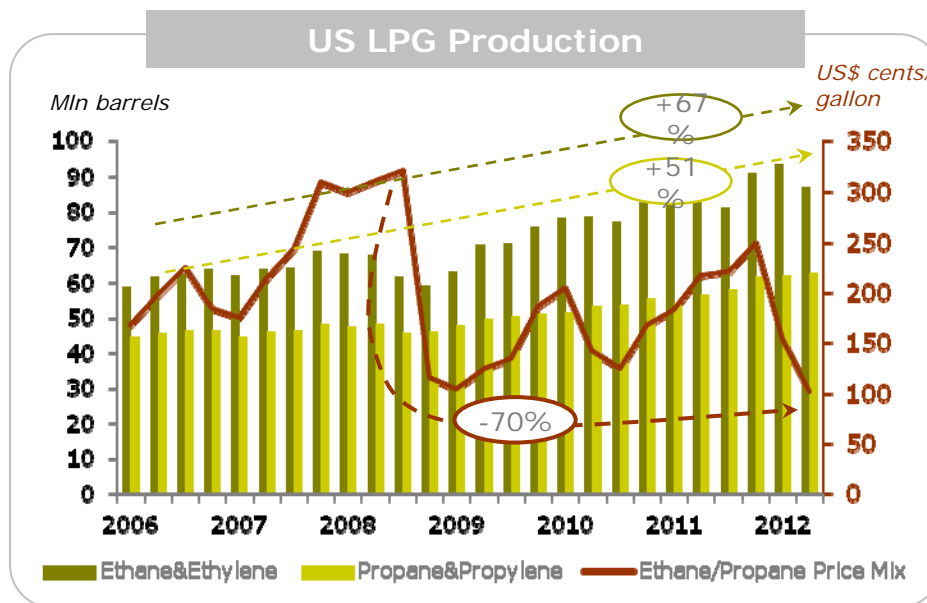
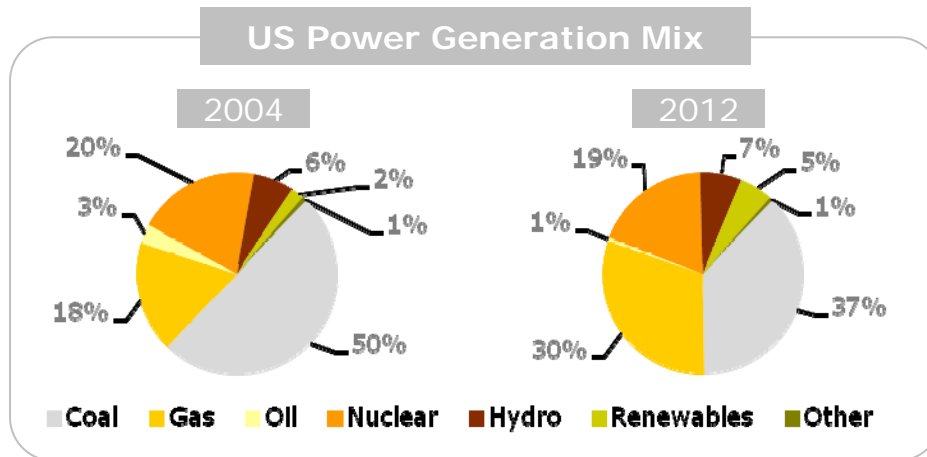
The new demand-supply equilibrium in the US gas market



Gas prices have gone from an all-time high to an all-time low



The effects of persisting depressed gas prices *power generation and LPG production in the US*



- Gas today has a very competitive price vs coal in power generation
- In 2012, 9,000MW of coal-fired generation capacity were shut down, and another 4,000MW are expected to close in 2013
- Limited effect of coal shutdowns due to low utilization rate of dismissed plants (17% in 2012, 28% in 2013)
- Lower gas prices pushed many shale gas producers towards more liquid-prone plays
- NGL supply could rise 30% by 2015-2016 (new petrochemical plants + relocation of industry in the US)
- Ethane price fell below that of gas in mid 2012 leading to "ethane rejection*" in ~1% of total gas supply



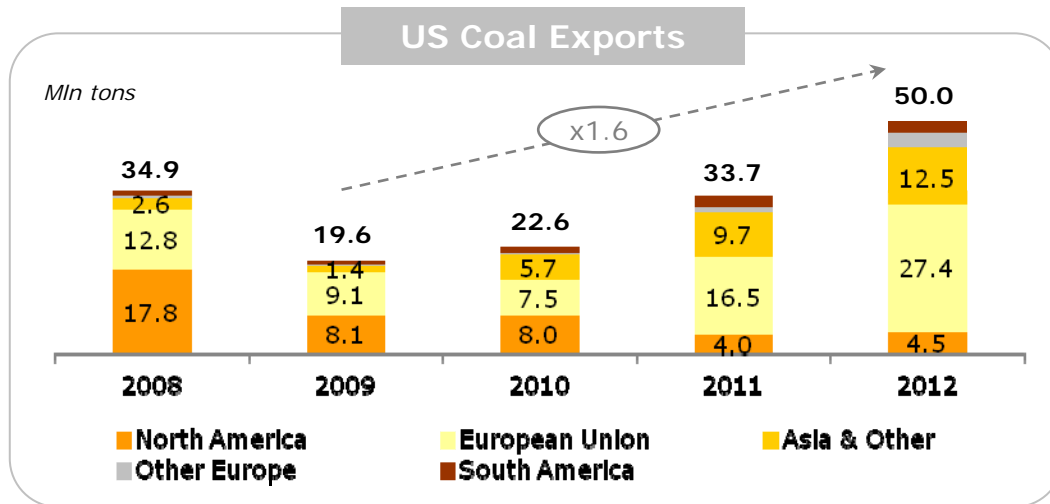
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Source: eia, Platts

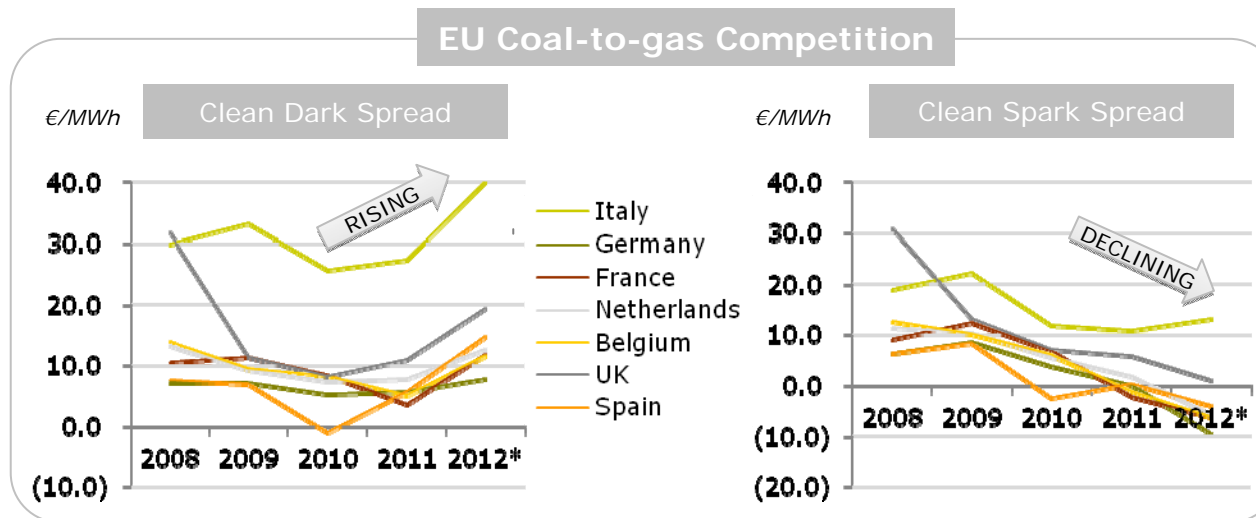
* Where ethane is left within the natural gas stream without breaching gas pipeline specification limits as production becomes unfavorable and infrastructure lags behind

The ripple effects of the shale gas revolution

the vicious circle caused by shale gas in Europe



- Strong competition from gas in powergen drove a 23% increase in coal exports from US in 2012
- Most additional exports were delivered to Europe, where coal imports from US rose by 67%



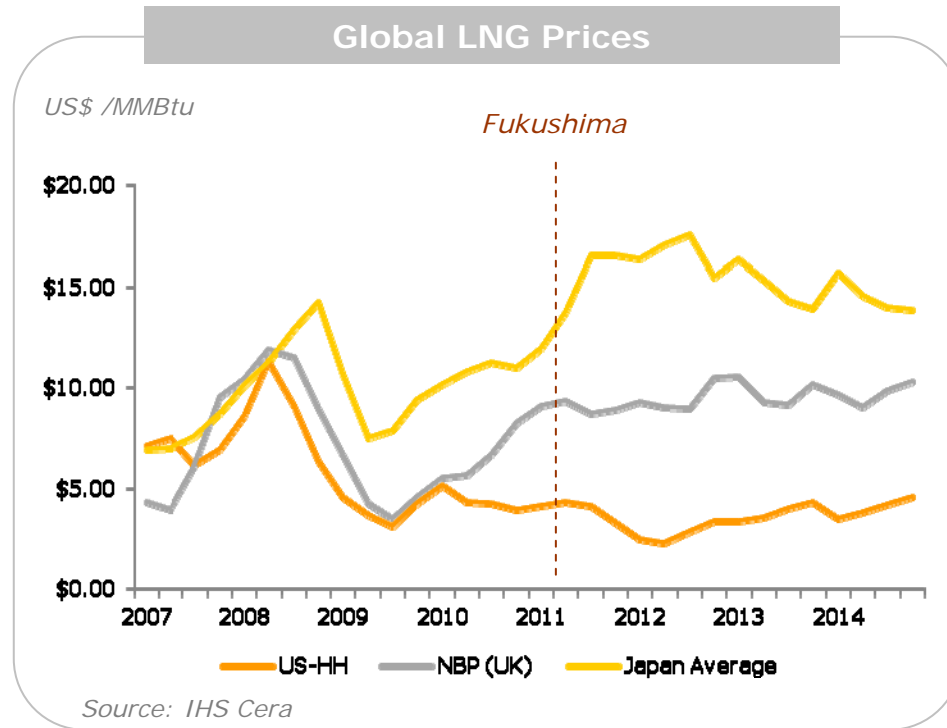
- Coal has gained a high cost advantage over gas
- EU gas consumption dropped by 8% since 2008
- In 2012 LNG re-exports from EU tripled vs 2011



* Jan-Sept, 2012 vs 2011

Source: IHS Cera

More revolutionary effects to come? *US LNG exports under global watch*



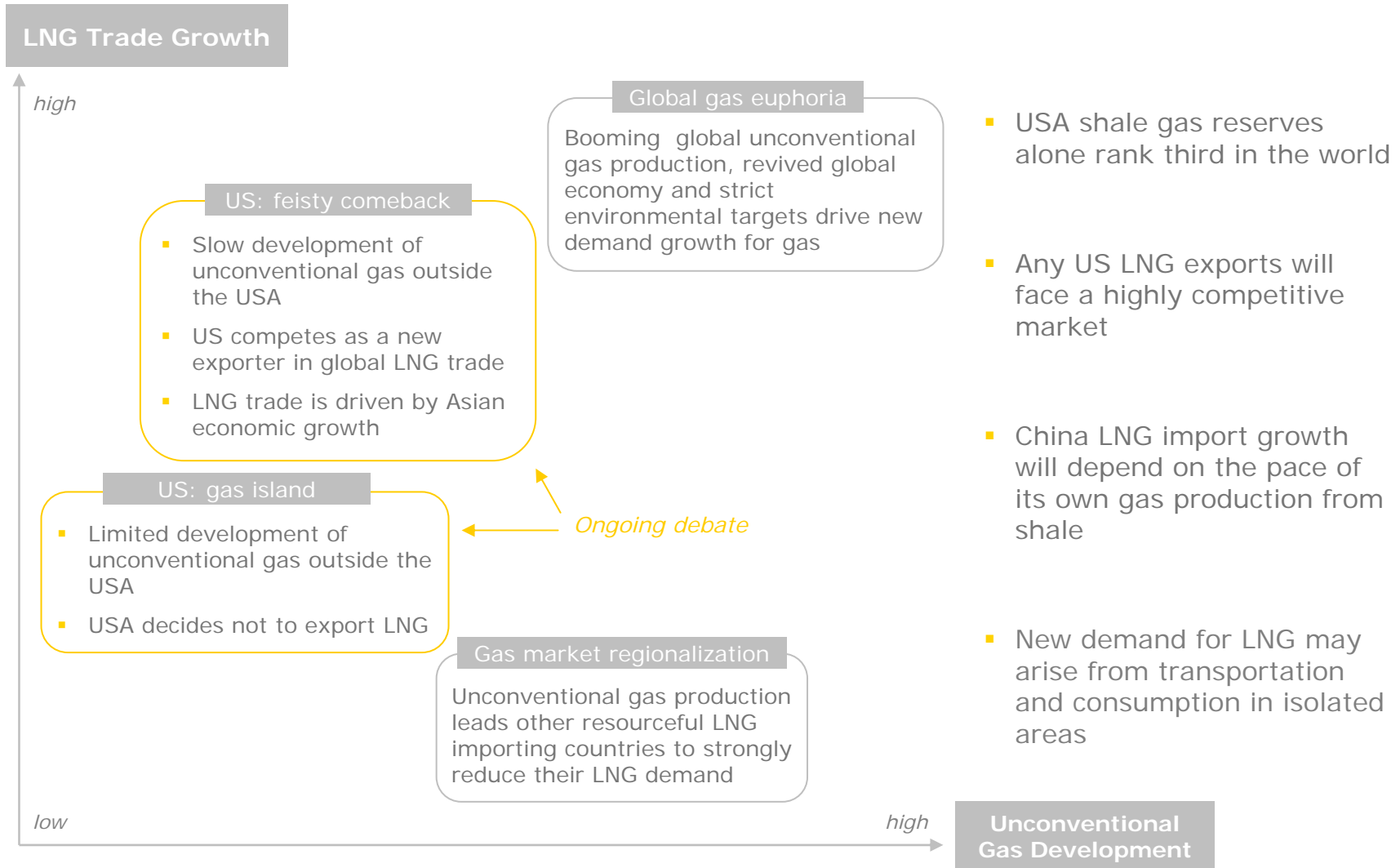
- East Asian demand for LNG boosted by Japanese nuclear outage
- With low gas demand, Europe will consolidate its role as a “sink market” (a second-best option to Asia and Latam)
- Regional price differentials favor arbitrage opportunities across markets
- The US is well placed to supply LNG to Asia, given its geographic vicinity and low gas prices

US debating on the possibility and feasibility that, and extent to which, shale gas exports could take place via LNG

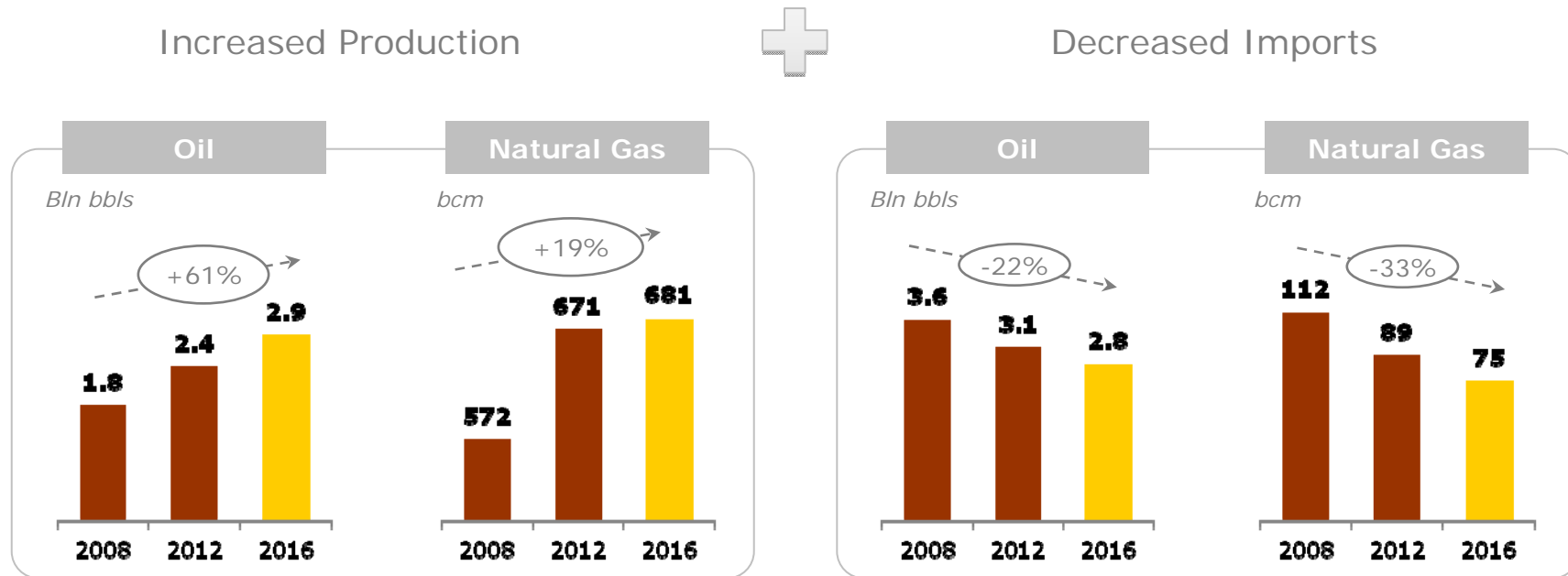


Global LNG trade is reshaping

Which role for unconventional gas?



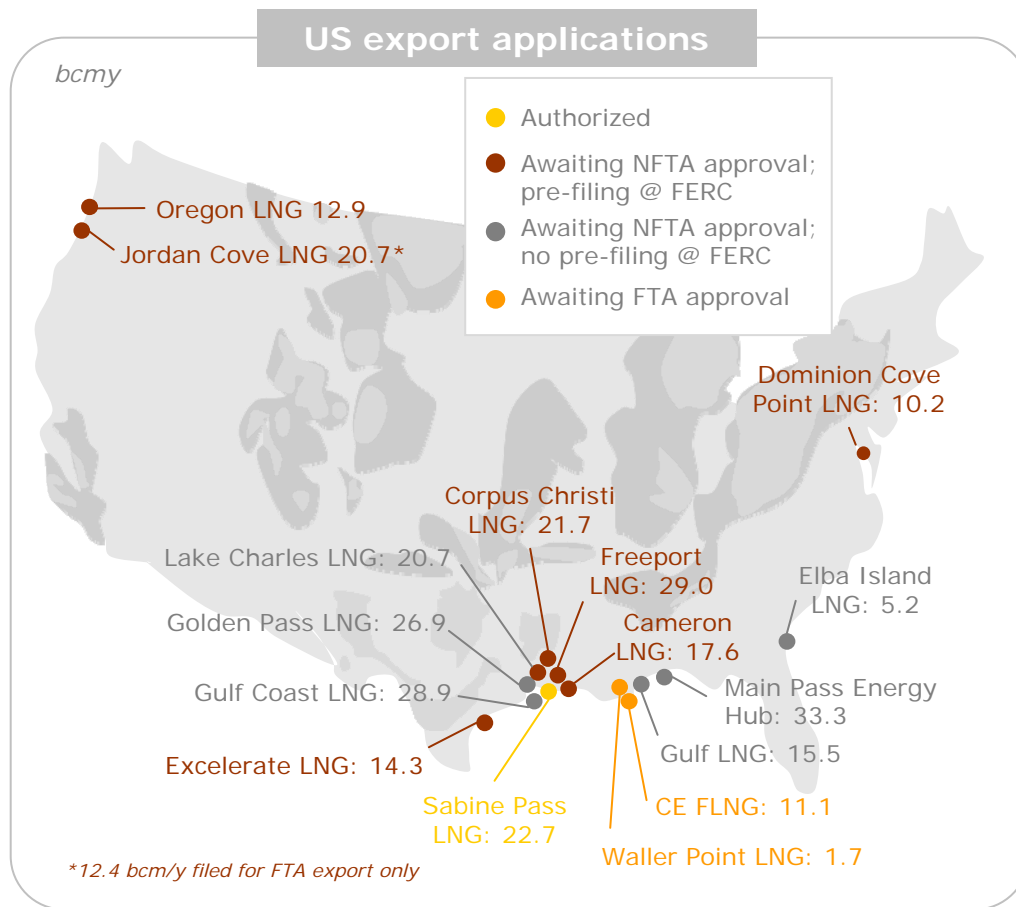
The effects of persisting depressed gas prices *Obama on US energy independence*



"Today, no area holds more promise than our investments in American energy. After years of talking about it, we're finally poised to control our own energy future. We produce more oil at home than we have in 15 years. We produce more natural gas than ever before -- and nearly everyone's energy bill is lower because of it."



Global LNG trade is reshaping *the ongoing debate on US LNG exports*



Maximum export potential: >280 bcm/y

Pro's

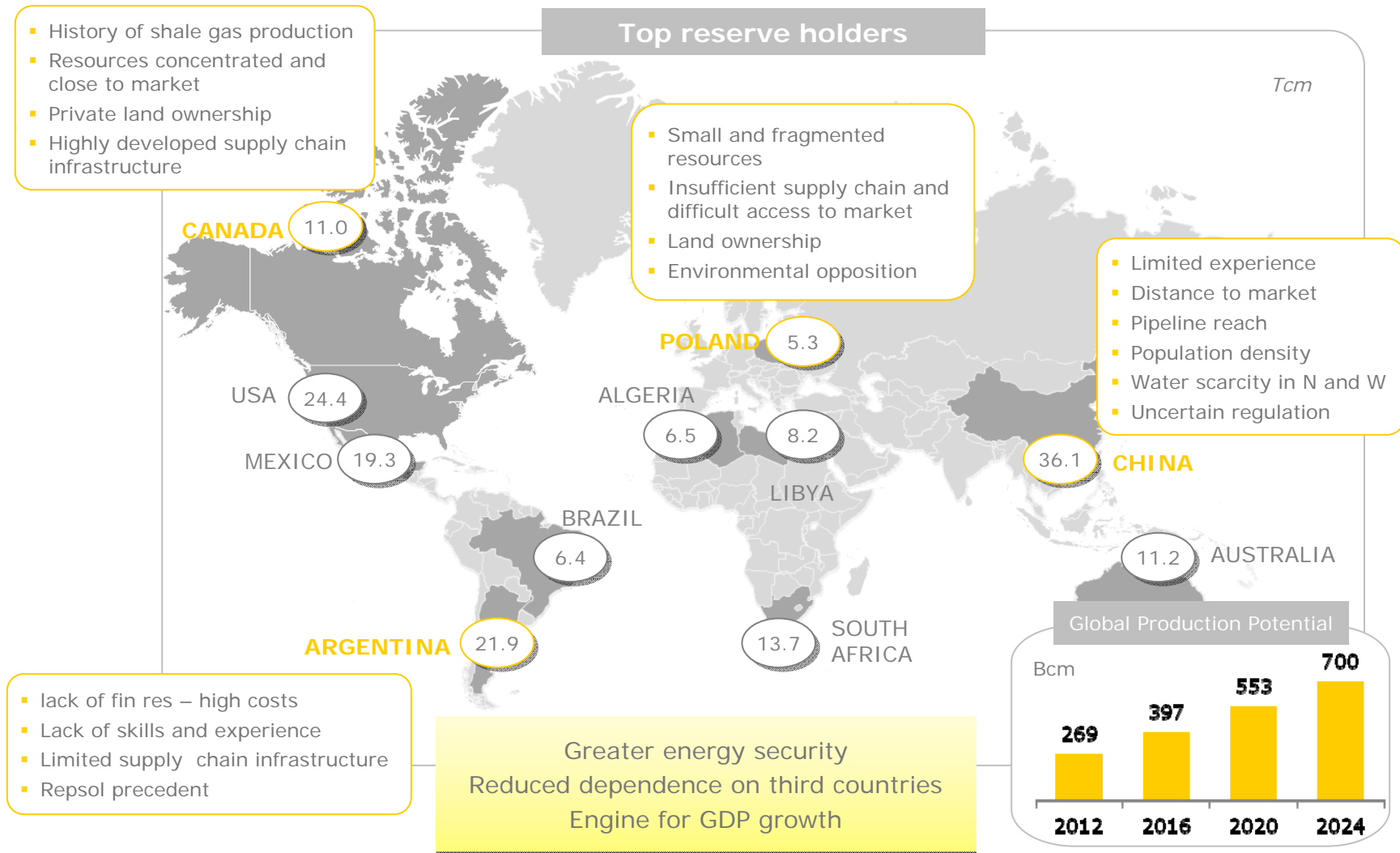
- Reduction of e&p payback times
- Use of idle regasification terminals
- Improvement of balance of payments with inflowing foreign currency
- Job creation and industry revival
- Obligations under free trade agreements

Con's

- Potential rise of domestic gas prices (effect on residential consumption and industrial growth)
- Potential impact on national energy security



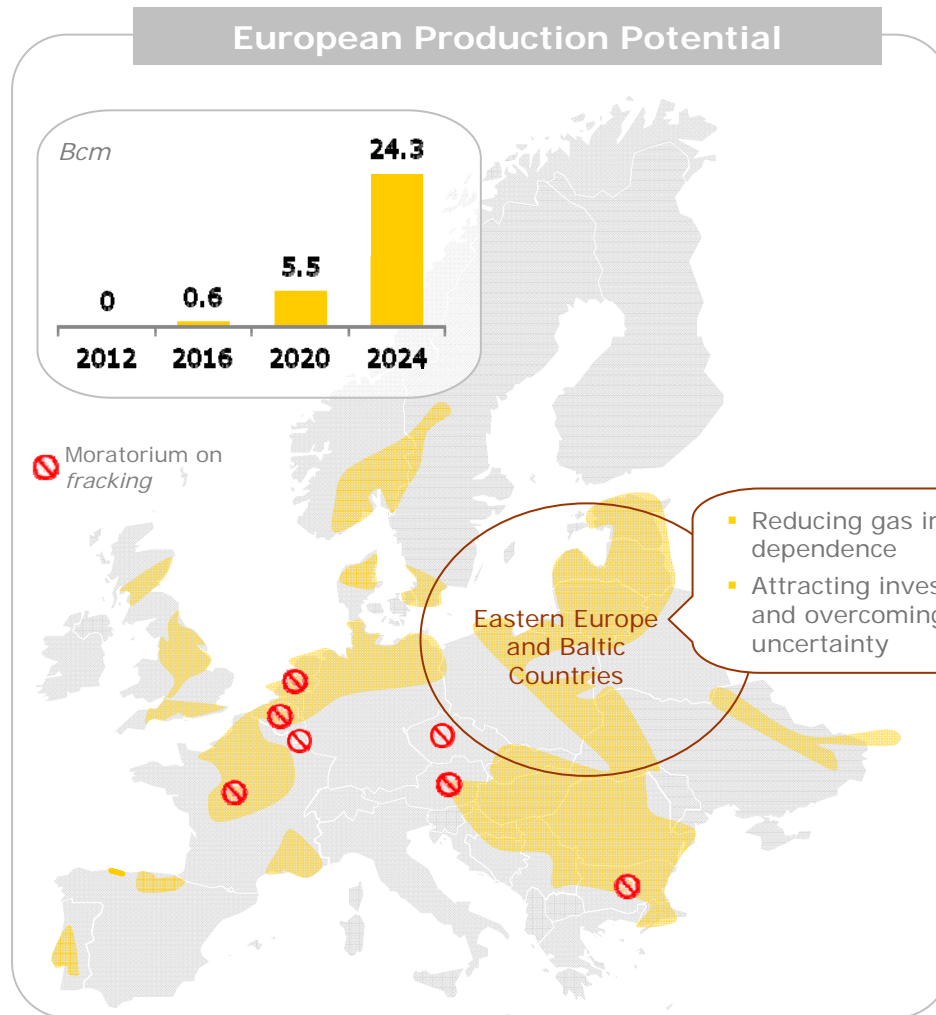
Global shale gas basins



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Source: Reuters, Woodmackenzie

Shale gas in Europe

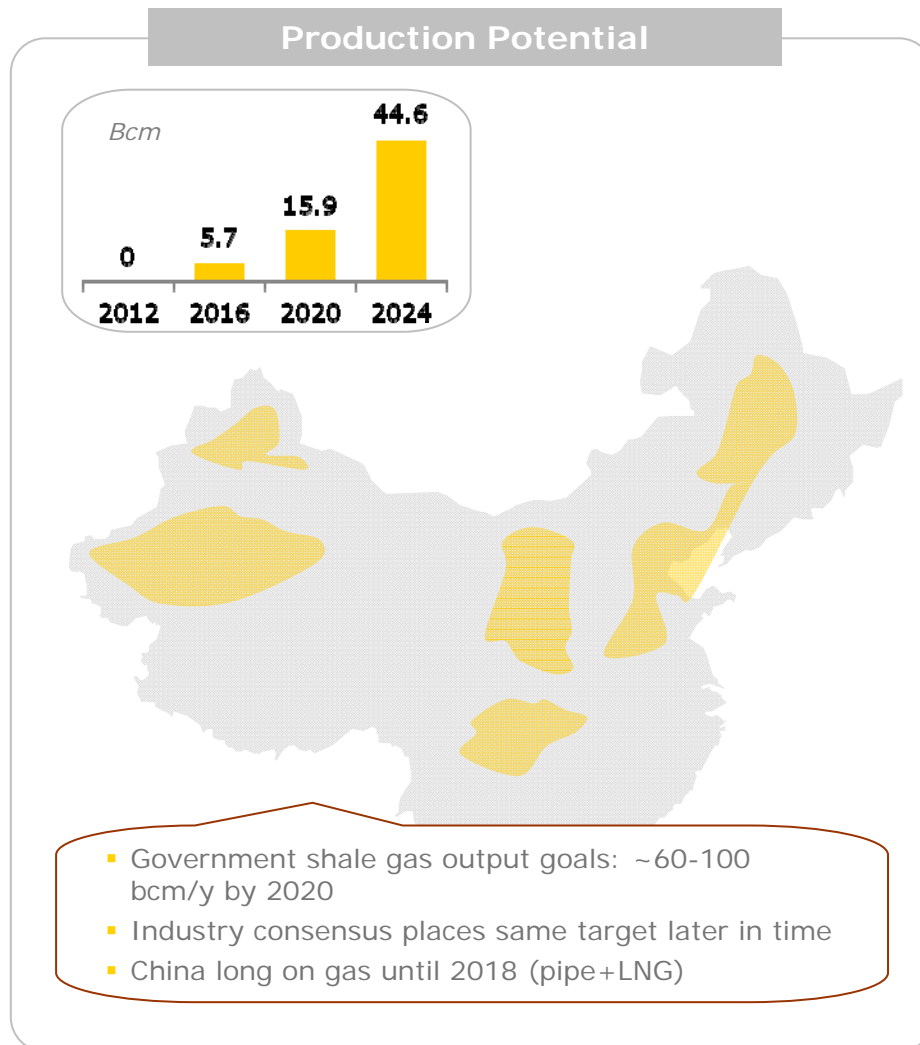


- Future production expected primarily from Poland, Germany and Romania
 - 42 wells drilled in Poland with target commercial production in 2015
 - Bans on hydraulic fracturing driven by environmental concerns (eg. seismic activity, water contamination)
- Exploration policy under assessment in UK, Germany, Netherlands, Romania, Italy, Ireland, Greece, Turkey, Austria
- Shale gas may become a strategic resource for Europe as indigenous conventional production continues to fall

Sources: IEA, Woodmackenzie



Shale gas in China



- China reserves estimated to be twice those of the USA
- Main production drivers include energy security and low expected shale gas prices compared to LNG
- Main production challenges related with technology and time-to-market due to limited pipeline reach and subsurface experience in shale production
- Favourable fiscal incentives promised to producers



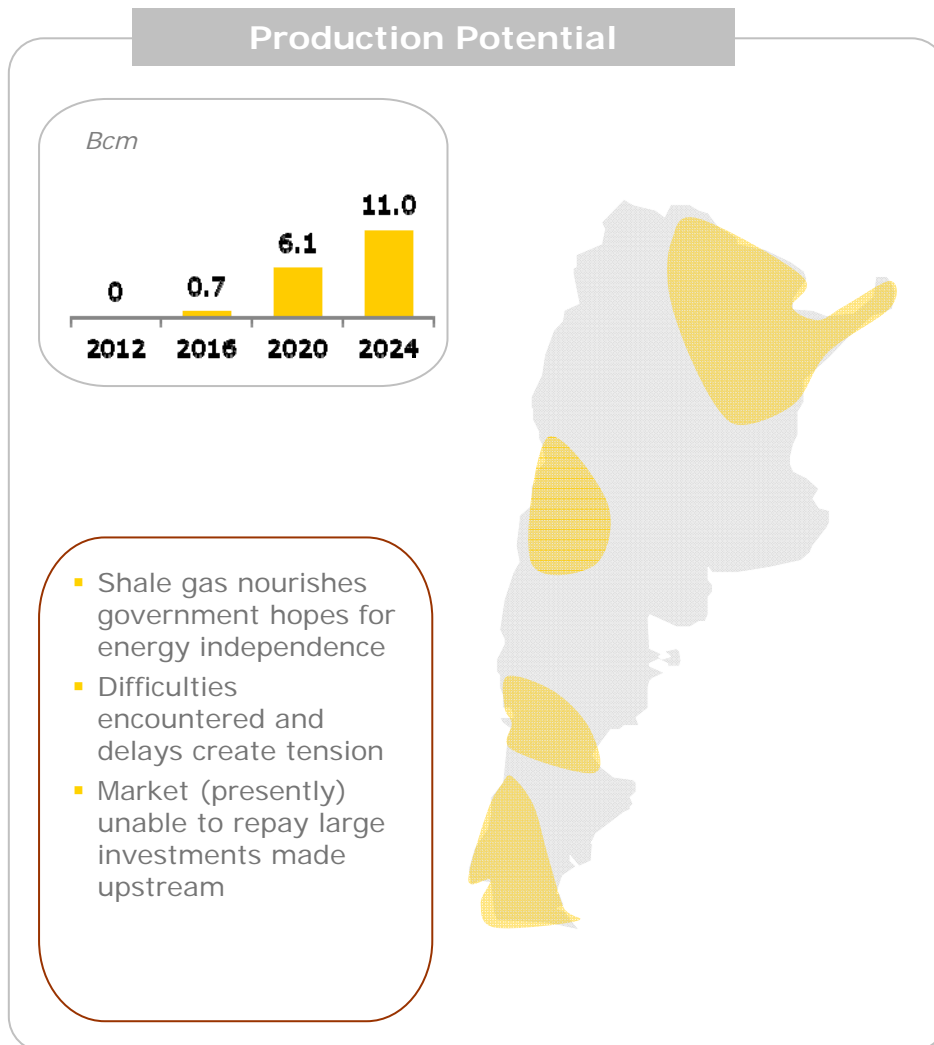
Gas: from forbidden fuel to sustainable choice
Chinese government aware of difficulties ahead?
Cooperation with foreign companies needed
One vision: find energy to grow more



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Source: IEA, Credit Suisse, WoodMackenzie

Shale gas in Argentina



- Successful drilling campaign by YPF in Vaca Muerta (Neuquén Basin in the mid-West)
- Top players already present in Neuquén Basin for conventional production
- Main challenges to shale gas production include:
 - Government price controls – recent rise injected a good dose of optimism but players still focus on shale liquids
 - Logistical difficulties with production in the desert
 - Power of labor unions
- YPF expected to invest more than US\$2.5 bln on shale gas through 2017 and drill ~500 wells



Country at a turning point

The reaction of historical producers

Russia

- Shale gas is a transitory phenomenon, therefore it does not matter to us
- Shale gas is too expensive therefore it will not last
- In any case we have a lot of it
- Nevertheless, because of shale gas, our future gas pipelines and LNG ships will be directed towards Asia, alongside our strategic interests



From denial to inclusion of shale gas in strategic decisions

Australia

- Create value out of our country's natural resources
- We will not be threatened by US shale gas phenomenon
- Grow stronger in the regional gas market
- Conciliate development and sustainability



Take advantage of time-to-market and distance from key markets