THE SHALE GAS BOOM: REVOLUTION OR EVOLUTION

STRUCTURAL CHANGE & GLOBAL GAS MARKETS: THE VIEW FROM ESPOO

Gasum

UNCONVENTIONAL BASICS

2.1. Unconventional Gas Reserves in Global Perspective

Global Gas Market Basic Structures

- Global conventional reserves are distributed unevenly.
- Markets are poorly integrated with proximate supplies underpinning regional market conditions
- Pricing reflects regionalization with demand & available volumes directly linked

Global Unconventional Reserves

- Unconventional reserves are more evenly distributed & under optimal conditions will serve as a potential game changer
- North America is the current leader in unconventional reserves with China close behind;
- Reserve potential is also significant for Russia, and countries in S. America (Argentina).

Critical Structural Drivers

- Accuracy of resource base estimates & recovery rates;
- Economic viability depends on geology of the plays with deeper more complicated fields necessitating increased sunk investments;
- Availability of technological knowledge & operational solutions to logistical issues such as water availability;
- Degree of govt. intervention such as balancing out subsidies for development & market mechanisms to bring gas to consumers.

2.2. Qualifying Unconventional Natural Gas

Shale Gas

- Occurs in shale rock structures at a depth of 1.8 to 4.3 km
- Technically recoverable resources 208 tcm = 2.3 x 10 ^ 6 TWh
- Production cost (IEA, 2012): USA: 8-19 EUR / MWh; Europe: 13 to 27 EUR / MWh & China: 11-21 EUR / MWh
- The production chain of greenhouse gas emissions (Skone, 2012): 13.7 to 14 g (CO_2eq) / MJ
- Extraction requires fracking

Tight Gas

- Occurs in tight sandstone thus production also requires hydraulic fracking.
- Typically, more than 3.5 kilometers below the surface.
- Technically recoverable assets 76 tcm = 0.83 x 10 ^ 6 TWh
- Production cost (IEA, 2011): N. & S. America: 8-18 EUR / MWh; Eastern Europe & Eurasia: 8-18 EUR / MWh; Middle East, Asian
- Pacific: 10-20 EUR / MWh
- Production chain of greenhouse gas emissions (Skone, 2012): 13.9 g (CO_2eq) / MJ

Coal Bed Methane (CBM)

- Occurs or absorbed into the pores of coal is stored in coal vein fissures typically from 0.8 to 1.2 km depth (up to 100 m depth)
- Technically recoverable resources 47 tcm = 0.52 x 10 ^ 6 TWh
- Production cost (IEA, 2011): N. & S. America: 8-20 EUR / MWh; Eastern Europe & Eurasia: 8-15 EUR / MWh; The Middle East, Asia and the Pacific: 8-20 EUR / MWh
- Production chain of greenhouse gas emissions (Skone, 2012): 8.2 g of (CO_2eq) / MJ
- Extraction requires water based technology

THE US BOOM

3.1. The US Shale Boom

US Unconventional Reserves

- Proven natural gas reserves stand at 317.6Tcf (2010)
- Increase of 12% (12 consecutive annual increase in reserve estimates)
- Texas, Louisiana, Oklahoma, Pennsylvania & Colorado are centers of production
- Texas & Louisiana's reserves are up 17.8Tcf; while
- Pennsylvania's reserves have doubled.

Behind the Boom

- Reserves
- Technological know-how & experienced workforce
- Existing transmission infrastructure
- Stable & conducive regulatory framework
- Contractual agreements which facilitated production

Next Steps

- Optimizing the value chain: labor, logistics, technology
- Developing the market: gas to liquids / transport; replacing coal / heat & power; arbitrage / LNG exports
- Quelling environmental concerns: water usage, methane emissions, CO2 abatement

WHAT ABOUT EUROPE?

4.1. Unconventional Gas & Implications for Europe

Development & Estimated Reserves

- All three types of unconventionals are present with economics of recovery the major question
- Poland & France followed by Norway & Ukraine are the most well endowed in terms of shale
- Structural conditions vary from country to country with very little policy guidance from Brussels beyond general environmental regulations
- Thus a US type of shale boom is highly unlikely

Possibilities for Europe: the Polish Case

- Technically recoverable resources: 5.3tcm (US est.) / 346-768bcm (Polish est.)
- Structural conditions mirror those in the US to an extent: existing infrastructure; fuel switching in heat & power
- 100 exploration licenses issued
- Initial flow rates in the wells are low with some wells deemed not economically viable.

European Gas Markets Outlook

- Paradoxical situation: declining conventional production coupled with environmental concerns
- Unconventionals come on line by 2020 with 10bcm increasing to 80bcm by 2035
- Hence, representing 10% of demand & 50% of the EU's production
- Increased domestic production should reduce price & improve demand

GLOBAL CONCLUSIONS

5.1. Future Global Impact

Domestic v. Export Markets

- Gas is still a proximate commodity, regionally priced & consumed
- Domestic political priorities will ultimately determine how much gas reaches the global market
- Hence, we anticipate the bulk of new production will go to domestic needs first thus underpinning economic competitive advantage
- Whatever volumes eventually flow to global markets will be intensely competed over.

Pricing

- Major concerns surrounding pricing center on transparency & accuracy
- As a result, current long term oil indexation is under increasing pressure from hub-based indices
- The shift in contractual forms is not a question of final price, but that of price formulation: a more accurate estimate of the economic cost for production of natural gas

Markets

- Integration of regional gas markets depends on several significant structural factors
- Increased supplies of natural gas must reach the market in order to increase liquidity of trading points (hubs)
- Infrastructure needs to be built not only to bring gas to market, but to support supply flexibility
- Consumers' demand will increase as increasing supply flexibility and price transparency are introduced to the gas markets