Europe's shale gas competitiveness challenge and consequences for the petrochemical sector

"I think it's simply irresponsible to declare that we don't need [shale gas] and we don't want [shale gas] here in Europe". Kurt Bock, CEO of BASF[ii]

"Je suis un peu déçu que les autorités politiques européennes ne prennent pas la mesure de ce problème". Jean-Pierre Clamadieu, CEO of Solvay Group[iii]

"Energy-intensive industries, such as the petrochemical industry, may soon begin to leave Europe for the U.S. because of the abundance of cheap energy there". Gerhard Rois, COE of OMV[iv]

Inexpensive gas feedstock is essential to keep Europe's petrochemical and other energy intensive industries competitive. The shale gas bonanza in the US has massively increased available natural gas and has driven down prices from about $12/MBtu in the first half of 2008 to an average of $3/MBtu in 2012. In contrast, European prices ranged between $8 and $11/MBtu in 2012.

Safety and environmental concerns as well as a more complex regulation in Europe than in the US have stunted the growth of shale gas production. Further complicating the development of this new energy source, is the much higher shale gas development costs in Europe than in the US. Europe will need break-even prices that are at least 75% higher ($6-9 MBtu)[v] than in the US to make exploration and production attractive.

We review in this article where this cost gap comes from and what some of the implications are for European competitiveness, especially for the petrochemical industry.

The cost gap between European and US shale gas development and marketing

Developing a shale gas play and ultimately delivering the gas to the network requires several activities, from well evaluation to production and marketing. The following cost comparison of shale gas development in Europe and the US considers the entire chain of activities (See Figure 1).

Well evaluation and rights acquisition deals with the discovery and acquisition of reserves. This involves the analysis of aerial photographs and geological maps, data from offset wells[vi] and field geological assessments. The goal is to find the most favorable drill site or "sweet spot". After a company has been granted a concession and a right to drill by the mining authorities, the drilling company must gain access to the land. Compensations with the state and/or with the landholder must be negotiated.[vii]

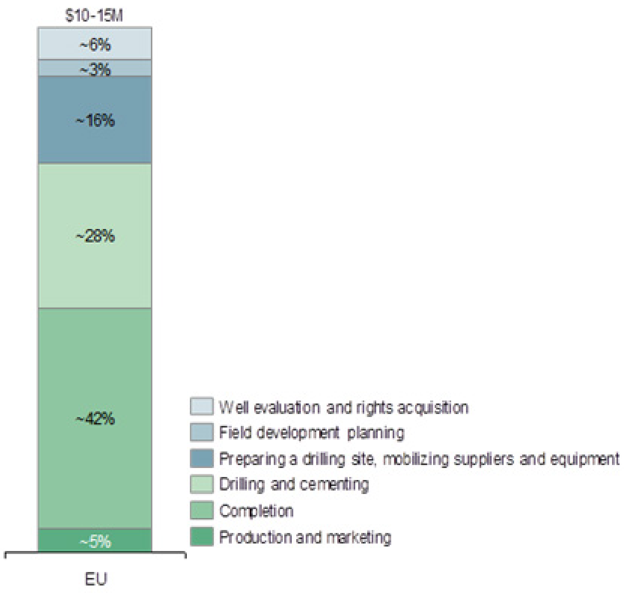

Figure 1: Estimated total cost of a shale gas well in Europe

Field development planning concerns the specification of the geometrical distribution of wellpads, the number of wells per pad as well as several other factors such as the length of the wellbore, its directional reach, the azimuth, and the inclination. Simulations are conducted in order to answer these questions. The costs associated with these activities are estimated to be about 20% higher in Europe than in the US due to the less developed service industry.Data from the Boston Consulting Group and Gény[ix] indicate that for a standard well[viii], the costs associated with this activity are about double the amount in Europe as in the US due to the less complete geological information in Europe than in the US, leading to higher R&D costs (+60% increase). Also increasing the cost in Europe is the higher land cost because of the higher population density (+20% higher), and the higher cost of service companies (+20% increase) as this sector is much less developed — and more expensive — in Europe than in the US.

Table 1: Comparison of the number of active rigs in the US and the EU (Source: Baker Hughes, Nov. 2012)[x].

Total rigs	Gas rigs	Land rigs	Horizontal rigs	
US	1,808	421	395	292
Europe	120	24	18	13

Preparing a drilling site, mobilizing suppliers and equipment refers to the activities for making the wells operational and involves mobilizing suppliers and bringing the equipment (rigs, casing, tubing, etc.) on site. The low number of drilling rigs in Europe is especially critical in that respect (see Table 1). Because of the poor rig availability and the higher costs of the oil service industry, it is estimated that costs for these activities are 50% higher in Europe than in the US.

Drilling and cementing is concerned with the vertical and horizontal stages of the drilling activity and the securing of the casings. Drilling costs range between €75,000 to €126,000 a day[xi] and can take up to two months.[xii] The cementing needs to be done to isolate the wellbore from the rock formations and water sources. As Europe has a higher geological heterogeneity of shale plays than the US, there is less scope for standardization of well drilling,[xiii] leading to a 40% higher cost for this activity. Also, shale plays in Europe are deeper than in the US, driving up the cost another 20%. The higher cost of the service industry in Europe adds another 20%.

Completion activities relate primarily to hydraulic fracturing or "fracking." This consists of perforating the casing and cement to allow the fracking fluid to enter the rock formation and the natural gas to find a path from the rock to the casing. The well is subsequently put under high pressure by pumping fracking fluid into the well. After the rock has been fracked, wastewater is pumped back to the surface and placed into pits. Completion amounts to more than 40% of the total cost of the well. The cost of water is a key cost component for this stage and is substantially more expensive in Europe than in the US. The OECD[xiv] notes that industrial customers in the US pay $0.33/m³ in rural areas whereas rates for comparable use are $1.5/m³ in Germany, $1.05/m³ in the Netherlands and $1.23/m³ in the UK. This generates an estimated increase of 10% for the completion costs compared to the US. The service industry is again required, adding another 20% extra to completion costs. Infrastructure (i.e. petrol, water treatment) is also more expensive in Europe than in the US, increasing the completion costs by a further 20%[xv].

Production and marketing refer to the actual production of the gas, its treatment and its transport through gathering pipelines to the gas system. The production and marketing costs represent in the US about 5% of the total cost of the well. In Europe, due to the higher costs for the service industry, these costs can be estimated to be higher by 20%.

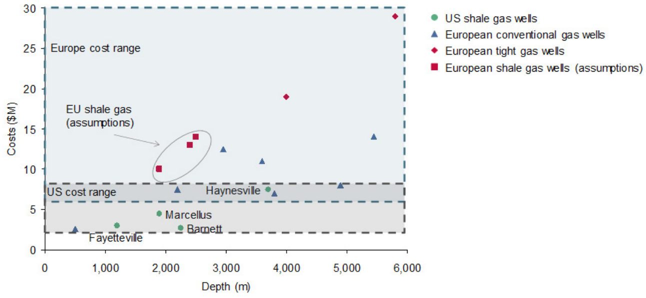

Figure 2: Shale gas well total costs in Europe and the US (Source: Gény, 2010)[xvi]

In sum, the less developed geological knowledge, the higher population density, the less competitive oil service industry, the dearth of rigs and qualified staff to operate installations, the reduced scope for standardization due to more heterogeneous shale plays, the higher depth of the shale plays, the scarcer water resources, and the higher infrastructure cost generate well costs in Europe that are estimated to be at least 100% higher than in the US, standing at about $10-15 million compared to $5-8 million in the US. Figure 2 shows estimated costs for wells in Europe. One can notice that the depth of the wells obviously matters for total costs, but that Europe tends to have a substantial cost handicap at all depth levels. These higher costs logically lead to higher break-even gas prices, as can be seen in Figure 3.

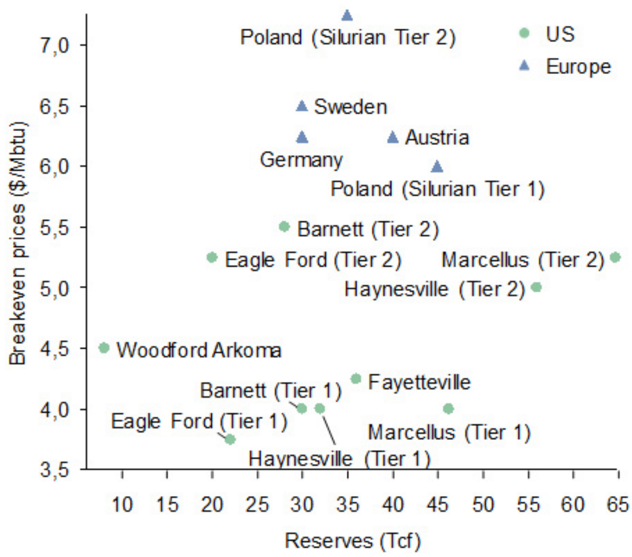

Figure 3: Break-even prices and reserves of shale plays in Europe and the US (source: Medlock et al, 2011)[xvii]

Competitiveness consequences for the petrochemical industry in Europe

Until 2008, the price of natural gas in the US, Europe and Japan was not far apart (in the $12 to $16 per MBtu range), dampening a possible cost advantage from cheaper raw material. Since then, shale gas development in the US has ramped up substantially, to the point that some shale gas producers have been shutting dry[xvii] gas rigs during 2012 following the substantial drop in gas prices to about $3/MBtu.[xix]

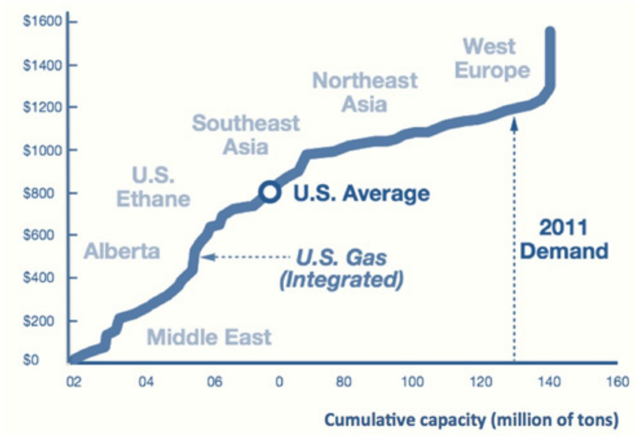

Figure 4: 2012 Global Ethylene Cash Cost by Plant (source: Adams, 2012)[xx]

This low gas cost however is a true global game changer for industries that rely on the feedstock, such as the petrochemical industry. The US petrochemical sector is now among the most competitive in the world and attracts massive investment. Figure 4 shows an estimate of the global supply curve or production costs for ethylene, the key ingredient for a large number of petrochemicals. The enviable position of US petrochemicals is clear – as is the unsustainable position of the European sector that relies on naphtha to produce ethylene. Since it is linked to the high oil price, the European petrochemical industry faces in the near future a major competitiveness challenge and will need to rethink its sourcing or location strategy.[xxi]

Naphtha crackers cannot be readily converted into ethane crackers, and a key prerequisite is a reliable source of ethane, either through import, local production or both. Even though local production of ethane would require break-even prices of $6-9/MBtu for shale gas (compared to $4/MBtu typically in the US), modeling by PricewaterhouseCoopers shows this could still bring down the ethylene cash cost into the $600-800 / ton range[xxii], going a long way towards improving Europe's competitiveness in petrochemicals – and derived sectors.

Conclusion

Developing shale gas plays in Europe requires solutions to the environmental challenges shale gas exploitation generates. However, not addressing the feedstock challenge is foolhardy – it clearly puts the petrochemical sector in Europe on the same long-term path as other sectors suffering from high costs and overcapacity, such as the car and steel industry, with consequences that are all too well known. To bolster its competitiveness, the Petrochemical industry in Europe will need to dramatically change its sourcing strategy – or its location.

[i] Respectively BCG, London and BP Chaired Professor of European Competitiveness, INSEAD. The authors would like to thank Jacques van Rijckevorsel of Solvay, Florence Gény of Statoil, Eric Oudenot of BCG and Garrett Gee of PricewaterhouseCoopers for their comments on the paper. The views expressed in this article are those of the authors and do not reflect those of BCG.
[ii] BloombergBusinessWeek, 25 October 2012.

[iii] Romandie, 6 July 2012.

[iv] See Wall Street Journal, 18 November 2012.

[v] Break-even prices in the US range, depending on the shaleplay, between $3.75 to $5 per MBtu (See http://www.sbc.slb.com/Our_Ideas/Executive_Presentations/~/media/Files/O... and Figure 3 for instance). Adding 75% to this delivers a range of roughly $6-9 per MBtu.

[vi] An offset well is an existing wellbore close to a proposed well. (http://www.glossary.oilfield.slb.com/Display.cfm?Term=offset%20well)

[v] In the USA, landowners own the resources below the surface. Hence, in the USA, landowners receive land use fees plus royalties on gas production (up to 25%), since they own the mineral rights. In Europe, landowners only own surface property rights. Therefore, accessing land in Europe is different. There are three possibilities: (1) negotiation of a "rental" fee for land use, (2) compulsory purchase by government, (3) acquisition of the land by the company.
http://www.oxfordenergy.org/2010/12/can-unconventional-gas-be-a-game-cha... and Philippe & Partners, *Final report on unconventional gas in Europe*, Energy DG, Brussels, pp. 44 and following, http://ec.europa.eu/energy/studies/doc/2012_unconventional_gas_in_europe....

[vi] BCG, "Medium-term tendencies on the gas market – Materials for Panel Discussion", Centre for Strategic Research for the North-West region of Russia, p. 6,
http://csr-nw.ru/upload/file_content_347.pdf. See also F.Gény, "Can Unconventional Gas be a Game Changer in European Gas Markets", The Oxford Institute for Energy Studies, December 2010, http://www.oxfordenergy.org/2010/12/can-unconventional-gas-be-a-game-cha...

[vii] Depth of 3km, horizontal length of 1km.

[viii]
http://investor.shareholder.com/bhi/rig_counts/rc_index.cfm?showpage=int. Regarding the number of horizontal rigs for Europe, we assumed that the proportion of horizontal rigs to the number of land rigs in the USA is the same as in Europe, ie : 13.3 = 292/395 x 18.

[ix] Joint Research Centre – Institute for Energy and Transport, *Unconventional Gas: Potential Energy Market Impacts in the European Union*, Joint Research Centre Scientific and Policy Reports, Luxembourg, 2012, p. 81,
http://ec.europa.eu/dgs/jrc/downloads/jrc_report_2012_09_unconventional_....

The Joint Research Centre study will be referred to as JRC in the future.

[x] Joint E&P Forum and UNEP Technical Publication, "Overview of the Oil & Gas exploration and production process", in Environmental Management in Oil & Gas exploration and production, Oxford, 1997, p. 7, http://www.ogp.org.uk/pubs/254.pdf

[xi] Gény notes that: "*Compared to North America, European unconventional gas basins tend to be smaller, and tectonically more complex, and geological units seem to be more compartmentalized. Furthermore, shales tend to be deeper, hotter, and more pressurized. […] Noticeably, there is a large span in formation ages in European shales compared to US shales.*". Source: F. Gény, o.c., p. 53.

[xiv] OECD – Environment Directorate – Working Party on Economic and Environmental Policy Integration, "Industrial water pricing in OECD countries", OECD, Paris, 1999,
http://search.oecd.org/officialdocuments/displaydocumentpdf/?doclanguage...

[xv] BCG, *o.c.*, p. 6.

[xvi] F. Gény, *o.c.*, p. 86.

[xvii] K.B. Medlock, A. Myers Jaffe and P. R. Hartley, *Shale gas and National Security,* James A. Baker Institute for Public Policy (Rice University), July 2011, pp. 24-25,
http://www.bakerinstitute.org/publications/EF-pub-DOEShaleGas-07192011.pdf. RWGTM is the Rice World Gas Trade Model.

[xviii] Hydrocarbons coming out of shale gas plays consist of methane, but also ethane, butane, pentane, etc. The latter elements are called natural gas liquids (NGLs), or condensates. The higher the percentage of condensates, the "hotter" or "wetter" the gas is. Dry-gas production refers primarily to

methane production (the primary constituent of natural gas). A well that produces wet-gas produces methane along with other NGLs. Plays such as Marcellus and Barnett in the US contain such liquids. NGLs are currently worth considerably more than dry gas. This is why some shale plays produce dry gas at a loss, as they still can sell wet gas profitably. The 2012 growth of US gas production consists entirely of combined oil and liquids production. See http://stateimpact.npr.org/pennsylvania/2012/01/26/what-makes-wet-gas-wet/ and R.J. Duman, *Economic Viability of shale gas production in the Marcellus shale; indicated by production rates, costs and current natural gas prices*, Michigan Technology University, 2012, p. 29, http://services.lib.mtu.edu/etd/THESIS/2012/Business&Economics/duman/the... and Naturalgas.org (2010)).

[xix] This was also influenced by the very soft 2012 winter in the US.

[xx] Gary K. Adams, "Leveraging a Fractured Future", IHS, 9 Feb 2012.

[xxi] Naphtha based crackers have other derivatives than ethane based crackers (e.g. butadiene, ABS) and this may be an important advantage for some European players.

[xxii] PriceWaterHouseCoopers, "Shale gas. Reshaping the US Chemicals Industry", October 2012.