

# Towards a virtuous energy cycle in the US and a vicious cycle in the EU?

Quentin Philippe and Karel Cool<sup>1,2</sup>

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“In Europe we have the most expensive energy and we are not prepared to exploit the energy resources we have, such as shale gas. We have relatively high wage costs and we have a stagnating market,” M. Kurt Bock, CEO BASF<sup>3</sup>

Shale gas remains very controversial in many European countries and the associated ecological concerns merit discussion. However, Europe’s trepidation towards shale gas is putting Europe at an increasing energy disadvantage, significantly handicapping energy intensive sectors such as petrochemicals, but it is also saddling households with higher electricity costs. A key reason is the switch of US electricity producers from coal to gas as a power source, and the increasing reliance on imported coal by European electricity producers. Beyond the ecological concerns of that choice,<sup>4</sup> Europe seems set for a vicious energy cycle while US industry is enjoying a virtuous energy cycle. This article sketches some of the key dynamics of the growing energy cost gap between the US and Europe.

## Lower US natural gas prices led to a coal-to-gas switch in electricity generation

It is now very well known that the shale gas revolution in the US has led to a massive drop in natural gas prices. Figure 1 shows that from the peak in 2008, gas prices fell by over 70% by January 2010 and have roughly remained at the very low level since, driven by the abundant shale gas supply. Meanwhile, the price of steam coal used for electricity generation has remained relatively stable, as shown in Figure 2.



Figure 1: Henry Hub Natural Gas Spot Price.<sup>5</sup>

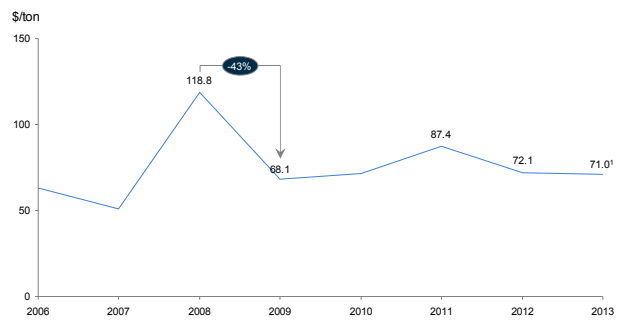


Figure 2: US Central Appalachian coal spot price index.<sup>6</sup>

As coal became relatively more expensive than gas as a feedstock for making electricity, one could expect that electricity companies would increasingly use gas-fired power rather than coal fired plants to supply electricity. Figure 3 shows the power plants in the US in 2005 in increasing order of electricity production cost. This so-called “merit order” or supply curve shows the marginal cost of electricity production in \$/MWh for the power plants in the US. The fuel that each plant used is color-coded and includes coal, natural gas, petroleum, nuclear and hydro & renewable fuels. Our calculations are based on data from SNL Energy and cover about 90% of total US electricity generating capacity.<sup>7,8</sup>

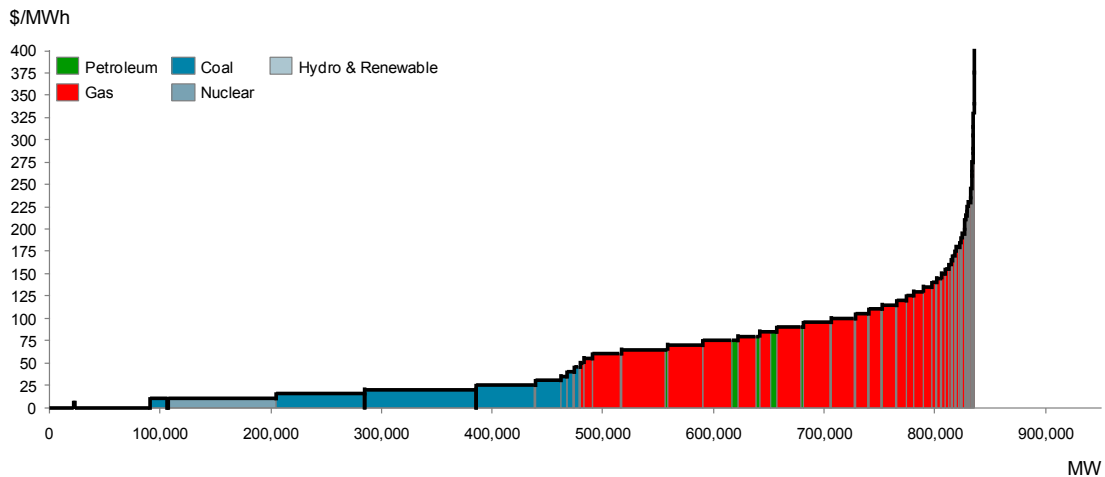


Figure 3: Estimated merit order curve in the US in 2005.

Figure 3 shows that before the massive arrival of shale gas in the US, coal was by far the cheapest and preferred fuel to generate electricity: the average coal fired power plant had half the marginal cost of the average natural gas plant, making the use of coal in the US an easy choice for electricity companies.

Figure 4 shows the merit order curve for electricity generation in 2012, after shale gas became abundant. It shows the dramatic shift in the choice of gas over coal. Most gas-fired capacity is now as cost efficient as coal-fired capacity, and in several instances is more cost efficient. A second effect of the abundance of shale gas is the drop in electricity costs. Whereas in 2005, only 55% of capacity had a marginal cost below \$50/MWh, this increased by 2012 to about 82%, potentially creating lower electricity costs for a large share of the US economy.

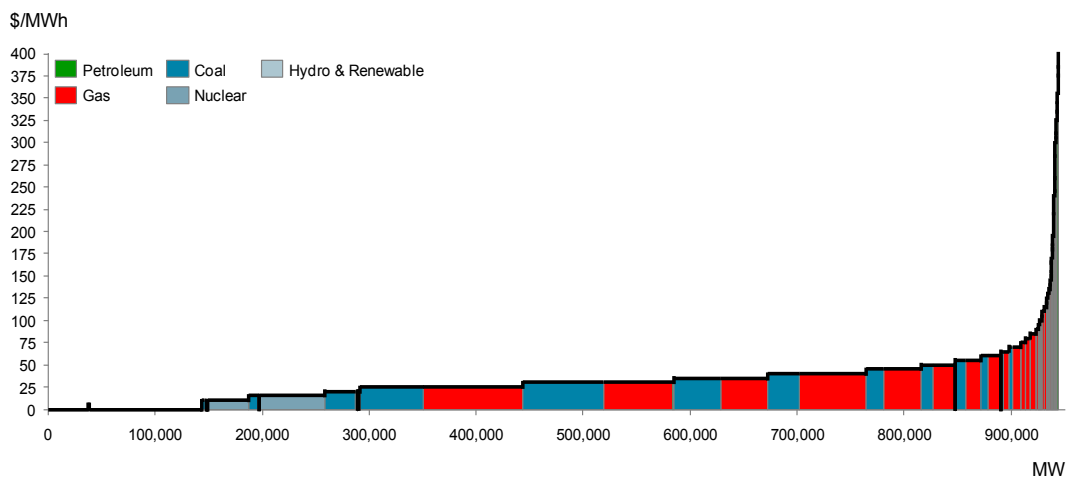


Figure 4: Estimated merit order curve in the US in 2012.

### Short-term margins from coal-based electricity have dropped substantially

The increase in the supply of natural gas to produce electricity may be expected to lead to a drop in electricity prices (assuming the supply of other low cost sources of power remain available). With more competition in the market for electricity generation following the massive increase of shale gas, one would also expect lower margins for electricity generators.

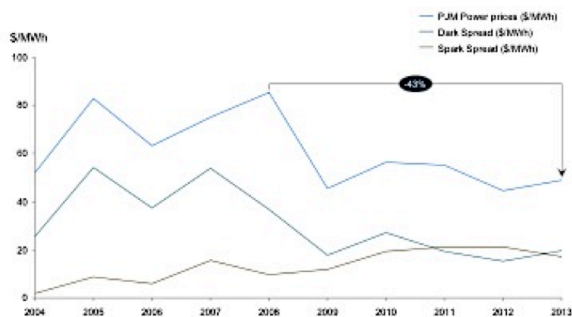


Figure 5: PJM power prices and spreads

Figure 5 shows the evolution of electricity prices (along the Pennsylvania-New Jersey-Maryland Interconnection – PJM) as well as the gross margins (called “spreads”) for electricity generators.<sup>9</sup> By 2012, electricity prices on the PJM market had dropped more than 40% since 2008, and remained at this level, creating an enormous saving for the US economy.

The evolution of margins for electricity producers is also remarkable. The difference between the market clearing power price and the power cost of production for a coal-fired plant is called the dark spread; the same for a gas-fired plant is called the spark spread. Figure 5 shows that the gross margins for coal-fired plants more than halved in the 2005-2009 period.<sup>10</sup> Clearly, electricity users were the big winners from the increasing cost efficiency of the US electricity sector.<sup>11</sup>

Also noticeable in Figure 5 is the increasing margin of electricity plants using natural gas. While margins are not higher than for coal-fired plants, it made the production of electricity with natural gas more profitable and thus attractive to investors. Figure 6 shows the share of each power source of total US power generation. One can notice the very significant shift in the use of gas versus coal in the production of electricity. From 2007 to 2012, gas-generated electricity increased by a compound annual growth rate (cagr) of 7%. Coal-generated electricity meanwhile fell by 6% cagr in the same period. Following the drop of production of electricity from coal, steam coal consumption for the power sector in the US logically decreased as can be seen on Figure 7. It dropped by about 100 Mt / yr by 2009 compared to 2004 – 2008 levels.<sup>12</sup>

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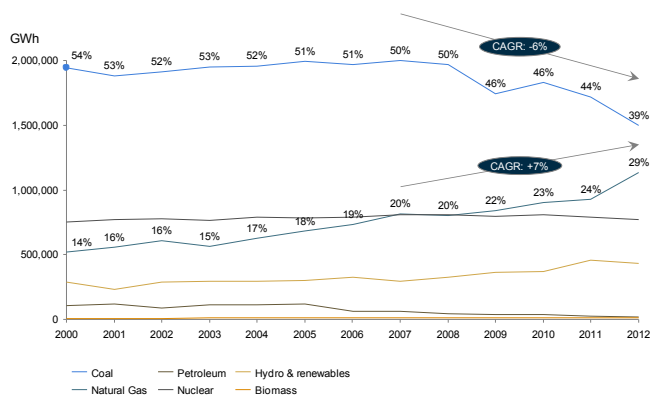


Figure 5: Evolution of the US Power mix.<sup>13</sup>

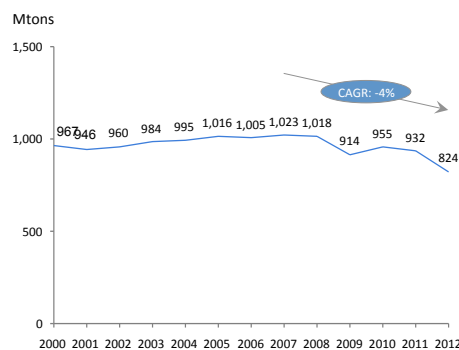


Figure 6: Steam coal consumption for the power sector in the US.<sup>14</sup>

### US coal manufacturers maintain production and look to export more coal

US coal producers thus have seen a declining demand in steam coal from the US electricity sector, certainly until 2013 as can be seen on Figure 7. While coal imports into the US dropped dramatically, the excess coal production needed to be stockpiled, exported or both. Figure 8 shows that US coal producers decided to maintain annual production volumes, banking on export markets to idle the stockpiles. A recent report of US Congress framed the issue very clearly: “One of the big questions for the [US

domestic coal] industry is how to penetrate the overseas market, particularly in steam coal, to compensate for declining domestic demand".<sup>15</sup>

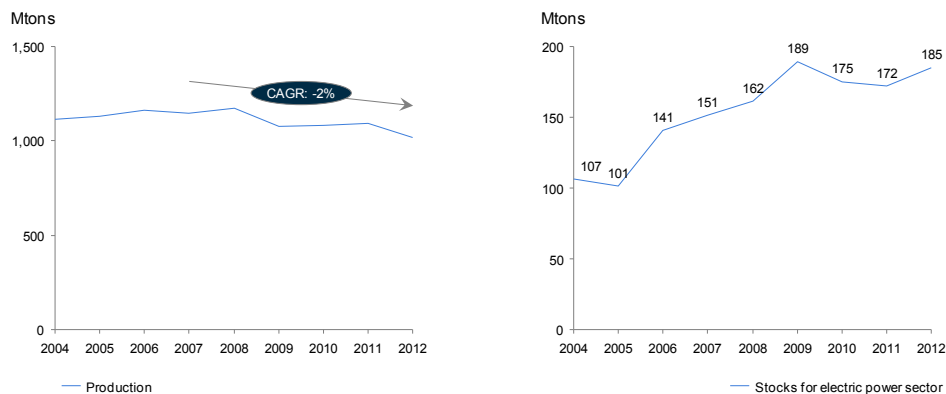


Figure 8. US coal production and steam coal stocks.

Figure 9 shows how successful US coal producers have been in increasing exports and reducing imports. From 2007 to 2012, coal exports more than doubled with Europe taking about 58% of total exports in 2012, up from 32% in 2007. Meanwhile imports into the US crumbled from about 35 Mt in 2007 to about 8 Mt in 2012. Of that, Europe represented 1-2%.

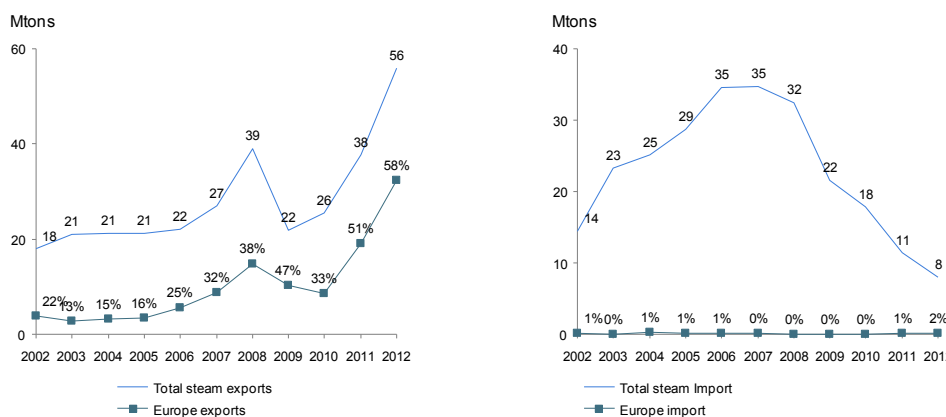


Figure 9. US steam coal imports and exports.<sup>16</sup>

### A shale gas revolution in the US and a steam coal revolution in Europe?

The shale gas boom in the US may have generated a more efficient US gas sector and lower electricity prices for the US economy; it also contributed to a drop in coal prices in Europe. Figure 10 shows the precipitous fall in coal prices in Europe – as represented by the McCloskey North West Europe steam coal marker price - from over \$120/ton in 2011 to about 85\$/ton early 2014. It is to be expected that European electricity generators would capitalize on this “coal price revolution.” Indeed, after seeing a drop in coal as fuel for electricity generation in Europe<sup>17</sup> from 25% of the total power mix in 2007 to 21% in 2010, the trend inversed, starting in 2011. In 2012, coal-fired electricity output in Europe even rose by 6%, an increase greater than Portugal’s total electricity generation. In contrast, the share of natural gas in the total power mix in Europe increased from 12% in 2000 to over 19% in 2008 but had already dropped to 17% by 2011<sup>18</sup>.

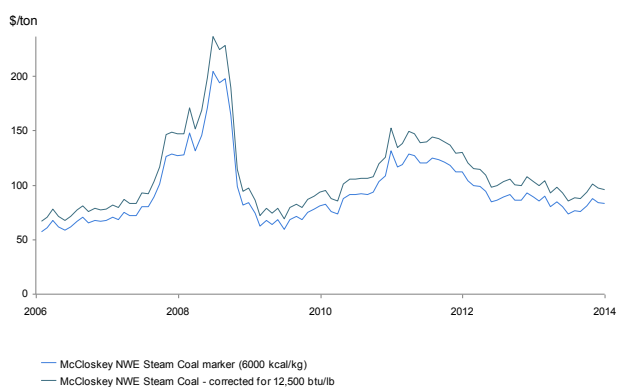


Figure 10. Price of steam coal in Europe<sup>19</sup>

### A vicious economic – and ecological -- energy cycle for Europe?

In the absence of a European supply of inexpensive shale gas -- or another competitive energy source --, the shift to coal is a rational economic decision for the power generators. The consequences of the shift, however, are detrimental on several fronts. In spite of the lower coal prices, Europe's energy cost position relative the US will only further deteriorate. The negative knock-on effect of relatively higher energy costs on Europe's energy intensive industries creates further disadvantage for Europe, already handicapped by very high structural costs [see [Why Europe needs shale gas](#)]. Also, greenhouse gas emissions which are roughly twice as high for coal-fired plants than for gas-fired plants, are saddling Europe with an ecological predicament.<sup>20</sup> Losing on both economic and ecological grounds is the worst of all worlds. Leaving the arbitration of Europe's energy feedstock to "market forces" is poor policy, especially if the market mechanisms are leaving Europe dangling between US coal and Russian gas. Policy makers and corporate leaders should urgently rethink Europe's energy situation before it becomes a quagmire. Developing local energy sources such as shale gas should remain on the agenda.

<sup>1</sup> Respectively BCG, London and BP Chaired Professor of European Competitiveness, INSEAD.

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<sup>3</sup> Chris Bryant, “BASF to focus investments outside Europe”, Financial Times, February 25, 2014.

<sup>4</sup> European Commission, On the Future of Carbon Capture and Storage in Europe, 27.03.2013,

<sup>5</sup> Source: EIA Energy Information Agency

<sup>6</sup> Source: 2013 BP Statistical Review and EIA (Energy Information Agency)

<sup>7</sup> The table below summarizes the fuel categorization used. The entire capacity of a power plant is allocated to a single fuel.

Fuel	Criteria
<b>Hydro &amp; Renewable</b>	<ul style="list-style-type: none"> <li>Technology type: Solar, Hydraulic Turbine, Geothermal, or Wind Turbine</li> </ul>
<b>Nuclear</b>	<ul style="list-style-type: none"> <li>Technology type: nuclear</li> </ul>
<b>Petroleum</b>	<ul style="list-style-type: none"> <li>Technology type: gas turbine and combined cycle<sup>i</sup>, with no natural gas burnt and petroleum burnt</li> <li>Technology type: steam turbine and internal combustion, with more petroleum burnt in energy content<sup>ii</sup> than natural gas or coal</li> </ul>
<b>Natural gas</b>	<ul style="list-style-type: none"> <li>Technology type: gas turbine and combined cycle burning natural gas</li> <li>Technology type: steam turbine and internal combustion, with more natural gas burnt in energy content than petroleum or coal</li> </ul>
<b>Coal</b>	<ul style="list-style-type: none"> <li>Technology type: steam turbine and internal combustion, with more coal burnt in energy content than petroleum or natural gas</li> </ul>

i. These two technologies do not use coal

ii. The following conversion factors were used : 1 Mcf (1 thousand cubic feet) of natural gas = 0.19 barrel of oil ;  
1 ton of coal = 4.79 barrels of oil

<sup>8</sup> The considered capacity vs. the total capacity of the production park for 2005 is 836 GW compared to the 931 GW total capacity, or slightly less than 90%. For 2012 the merit order curve considers 945 GW vs the 1,067 GW total capacity, or slightly less than 90%.

<sup>9</sup> Source: EIA (PJM West Real Time Peak), 2013 BP Statistical review (CAPP) and EIA (Henry hub prices)

<sup>10</sup> The spreads were estimated as:

Dark spread=PJM Power price [\$/MWh]-Coal price (CAPP) [\$/ton]/ 8.7 [MWh/ton]x 30% [efficiency]

Spark spread=PJM Power price [\$/MWh]-Naturalgas price (Henry Hub)[\$/MBtu] / 0.293 [MWh/MBtu]x 40% [efficiency]

<sup>11</sup> For instance, in the US, over the period 2008-2013, power prices for end-users remained stable for both industrial and commercial sectors, respectively around \$68/MWh and \$103/MWh, while slightly increased for residential consumers( from \$113/MWh in 2008 to \$121/MWh). Source EIA :

[http://www.eia.gov/electricity/monthly/epm\\_table\\_grapher.cfm?t=epmt\\_5\\_3](http://www.eia.gov/electricity/monthly/epm_table_grapher.cfm?t=epmt_5_3)). In the Euro area, on the other hand, electricity prices for the industry increased from EUR 88/MWh in 2008 to EUR 93/MWh in 2013, while prices for households increased from EUR 118/MWh in 2008 to EUR 137/MWh in 2013.

Source : Eurostat : [http://epp.eurostat.ec.europa.eu/portal/page/portal/energy/data/main\\_tables](http://epp.eurostat.ec.europa.eu/portal/page/portal/energy/data/main_tables)

<sup>12</sup> Note that from 2013 onwards, we are experiencing the opposite move with coal gaining share in the power mix vs 2012 due to upward dynamics in gas prices. Henry Hub Month Ahead contracts averaged \$3.73/MBtu in 2013 and \$4.75 so far in 2014.

<sup>13</sup> Source: EIA energy annual review.

<sup>14</sup> Source: EIA energy annual review.

<sup>15</sup> M. Humphries, U.S. and World Coal Production, Federal Taxes, and Incentives, Congressional Research Service, March 2013, p. 2, <https://www.fas.org/sgp/crs/misc/R43011.pdf>

<sup>16</sup> Source : EIA

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<sup>17</sup> Austria, Belgium, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, the Netherlands, Norway, Poland, Portugal, the Slovak Republic, Spain, Sweden, Switzerland, Turkey and the United Kingdom

<sup>18</sup> Source: IEA database and IEA World Energy Outlook (2013), p. 144.

<sup>19</sup> Source: McCloskey NWE steam coal marker (data from Bloomberg). The McCloskey NWE steam coal marker gives the price of coal with an energy content of 6,000 kcal / kg. The CAPP price – as shown on Figure 2 – is the price for coal with an energy content of 12,500 Btu/lb (British Thermal Unit per pound). We use the conversion factor: 1 kilocalorie/kilogram = 1.79879622 Btu/pound. Hence, the energy content of the McCloskey NWE steam coal is around 10,800 Btu/lb. For information, the price that the McCloskey NWE steam coal marker should fetch if it had the same energy content as that of the CAPP coal is indicated in Figure 10 as "corrected for 12,500 Btu/lb".

<sup>20</sup> European Commission, On the Future of Carbon Capture and Storage in Europe, 27.03.2013, p. 9.