The Energy Transition in a Scenario of Sustained Low Fossil Fuel Prices

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This HET report assesses the impact of sustained low fossil fuel prices on the transition to a low carbon energy system.

After a four-year period during which crude oil was trading at an average of $115/bl (Baffes et al, 2015), prices started to plummet in June 2014, raising immediate concerns about the resilience of energy transition processes. At that time, some argued that the expansion of clean energy solutions would not be derailed, referring *inter alia* to the cyclical nature of oil prices; because a swift rebound seemed highly likely, they considered that reducing the oil dependence remained the only valid strategy from an economic perspective[1]. This argument may have lost some of its appeal now that a "lower for longer" price scenario has gained credibility[2].

Initially supply-driven, the downward pressure on prices continued with prospects of a weaker global demand. While the recent deal struck by OPEC has pushed crude oil prices above $50/bl, doubts remain as to whether the output cut will be enforced and, even so, whether it will substantially reduce market imbalance. Taking into account the record stockpile surplus and the possibility for U.S shale and other non-OPEC production to rebound, the perception is that global oil oversupply will persist in the near future (e.g. IEA, 2016a).

The other fossil fuels have followed a similar trend, with Q2 2016 global natural gas prices down 59.8% compared to 2014 levels and global coal prices down 25.7% over the same period (IMF, 2016a). For both gas and coal, abundant supplies and lower energy demand growth in emerging markets are driving prices down, while the oil-indexation of some long-term gas contracts and the use of oil in coal mining and transportation strengthen this trend (IMF, 2016b). In summary, all fossil fuels have become increasingly affordable, although thermal coal prices have started to rebound in spring 2016, owing to supply restrictions in China.

Sampling the views of energy experts and market players, the World Energy Council 2016 survey reveals that commodity prices are currently viewed as the most crucial uncertainty facing the energy sector (WEC, 2016). Such finding highlights the need to carefully assess energy system dynamics and recent developments in terms of energy use and investments, in order to contain the long-term implications of low fossil fuel prices.

Low Fossil Fuel Prices and Energy System Dynamics

Lower fossil fuel prices result in two relevant effects for energy transition processes: an income effect and a substitution effect. The income effect originates from a real-income

[1] See for instance: The Global Commission on the Economy and Climate, Oil Prices and the New Climate Economy, May 2015

[2] For example, the IEA considers in its Medium-Term Oil Outlook of June 2016 that "today's oil market conditions do not suggest that prices can recover sharply in the immediate future".

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shift between net commodity exporters and net commodity importers. Because the propensity to spend is expected to be higher in commodity-importing economies, the result should be a higher global demand (Baffes et al, 2015). The substitution effect captures the changed demand structure because of a decreased relative price of fossil fuels in respect to the price of other energy carriers (and other products).

The **income effect** promotes the demand for energy (and other products) in general. The relative relevance of concerns about energy conservation and the environment may diminish; consumers may choose to drive more with gasoline/diesel-powered vehicles or to increase the temperature of fossil-fuel heating systems for instance. In parallel, the supply of renewables would also profit (in volume) from increased demand for energy carriers. However, the boost to overall energy demand will depend on how prices to final customers are designed; for example, refinery margins and floating fuel taxes can limit the price fall at gas pumps while network costs and renewable surcharges can limit the fall in retail electricity prices.

The income effect on oil and other fossil fuels demand will be supported by the **substitution effect**, due to changes in relative prices. Fossil fuels will substitute low-carbon energy carriers, unless prevented by technical constraints, e.g. fuel flexible engines are still not very common in Europe, or by environmental regulation. In the latter situation, two cases can be identified:

1) When low-carbon solutions benefit from a predefined financial support, for example in the form of tax credits for energy efficiency retrofits or grants for the acquisition of electric vehicles, falling fossil fuel prices imply longer payback periods for such investments.
2) To the extent that low-carbon solutions are fully protected by mandatory purchase requirements, for example in the form of feed-in tariffs or portfolio standards for renewable electricity production or blending mandates for biofuels, the widening of the competitiveness gap with fossil fuels should have no immediate influence. However, it increases the implicit cost of such regulations and potentially reduces the political support for them. For instance, the 1980's episode of falling oil prices led to the dismantling of support programs for renewable energies in particular in the United States, forcing the nascent renewable industry to scale down abruptly (Martinot et al., 2005).

In both cases, the competitiveness issue will be less stringent if the cost of clean solutions declines in the meantime. For example, Bloomberg New Energy Finance considers that a fixed $20 oil price scenario would only delay the mass adoption of electric vehicles until the early 2030's, as opposed to the 2020's if the oil price trends back to $70 by 2040 (BNEF, 2016). This is precisely because the consultancy report expects battery costs to fall in the meantime, from $350/kWh in 2015 to well below $120/kWh in 2030.

Whereas the income effect – via lower pressure on costs – diminishes the efforts in energy efficiency investments, the substitution effect puts an additional disadvantage on investment in renewables-demanding technologies. Typically corresponding R&D activities are negatively affected. Many studies have demonstrated that clean energy patenting activity increases during periods of high oil prices (see among others: Aghion, 2012, Bayer et al, 2013). Conversely, falling fossil fuel prices are expected to discourage

the search for alternative sources and energy savings solutions (Prognos et al, 2016).

Nonetheless, one should also note that the income effect of lower fossil fuel prices open the opportunity to invest more, including in environmental-friendly technologies and related R&D, provided that price dynamics are offset by sustainable development motives.

Recent developments in each sector – global perspectives

Global oil demand increased by 1.7%, in 2015, representing the highest growth rate in five years (IEA, 2016a). Meanwhile, the oil intensity of GDP increased from a ratio of 1.20 in 2014 to 1.28 in 2015 (IEA, 2016a). In particular, **demand for transport fuel**, accounting for half of global oil demand, increased sharply. In the United States, sales of less efficient vehicles (Sport Utility Vehicles) grew at a rate 2.5 times higher than sales of light duty vehicles (IEA, 2016a). In China, SUV sales accounted for 35% of total passenger-vehicle sales in the first six months of 2016, up from their 27% market share in the same period a year earlier[3]. Early estimates published by the French Energy Ministry in July 2016 indicate as well that CO_2 emissions from the transportation sector increased by 0.9% in 2015, while they had been decreasing by an average 0.7% per year since 2004. This is mainly resulting from a 2.2% increase in road traffic in France (MEDDE, 2016).

As expected, demand for biofuels is still protected by blending mandates and production increased by 4% in 2015 due to favourable agricultural fundamentals (REN21, 2016). However, global investment in biofuels decreased by 35% the same year (UNEP, 2016), suggesting that the biofuels industry is now less confident about future demand.

Finally, despite lower running costs for fossil-fuelled vehicles, new registrations of electric cars increased by 70% in 2015, with a total of 550 000 vehicles sold (IEA, 2016b). Key reasons for this surge in sales are the reduction in battery prices but also the introduction of new public incentives, the development of charging infrastructures and the diversification of products offered (UNEP, 2016). While still in the early-adopter days, the market for electric mobility is not showing any sign of slowdown.

Concerning **energy efficiency**, the IEA estimated in its WEO that 15% of investments, or $800 billion through to 2040, would be at risk in case of sustained low oil prices (IEA, 2015). However, this scenario is not yet confirmed; energy efficiency investments increased by 6% in 2015, reaching $221 billion (IEA, 2016c). In addition, the energy intensity of GDP continued to decline in 2015. The 1.8% fall in the amount of energy consumed per unit of GDP is three times the average of the last decade. These efficiency gains resulted from an expansion of supporting policies, in particular in China where dramatic progress was achieved over the last year (IEA, 2016d).

In addition, renewables have continued their rapid expansion in the **electricity sector**, with a record high $285.9 billion investment in new installations, excluding large hydro-electricity, in 2015 (UNEP, 2016). For the first time, non-hydro renewable capacity additions accounted for more than half of all additions last year, with a share of 53.6% compared to 49% in 2014 (UNEP, 2016). A key explanation for this result is the cost decline of wind and solar PV technologies. Utility-scale solar PV levelized cost decreased by 58% between 2010 and 2015 (IRENA, 2016), while onshore wind levelized cost fell by 50% since 2009

[3] http://www.bloomberg.com/news/articles/2016-07-08/china-auto-sales-grow-at-faster-pace-on-suv-electric-car-demand 16.09.16

(BNEF, 2016). These trends offset the reduction in fossil fuel prices and help reducing the implicit cost of renewables support programs.

Still in the electricity sector, changes in relative fuel prices are influencing the respective market shares of gas and coal.[4]. Low-priced gas continues to reduce coal's market share in the United States. Gas-fired generation is now expected to surpass coal in the US electricity mix in 2016 (EIA, 2016). In many European electricity markets, clean spark spreads have also moved into positive ranges over Q4 2015 and Q1 2016, despite the decrease in the price of carbon allowances. Consequently, gas deliveries to EU power plants went up and coal deliveries went down, reversing past trends (EC, 2016). If the price gap between gas and coal narrows, coal's market share in power generation is expected to reduce, with a positive influence on the GHG emissions performance[5], unless falling gas prices lead to displacing other low-emitting sources participating in wholesale markets (e.g. nuclear). In some deregulated markets in the United States, nuclear power plants' operators argue that they are excessively pressured by record low wholesale prices and request financial support from State regulators (Mathieu, 2016). More broadly, low wholesale prices imply that the incentive to invest in new (merchant) power plants declines. In 2015, only 5% of global power generation investment was based solely on competitive wholesale market pricing (IEA, 2016c).

Total capacity and generation of renewables continued to increase in the **heating and cooling sector** in 2015. However, growth slowed down. Solar heating investments grew by 6% in 2015, compared to an average annual growth rate of 12% from 2010 through 2015 (REN21, 2016). In Europe, biomass-based heat is also affected. For example, sales of wood pellet boilers and stoves in 2015 are 17% lower than the year before in Germany[6].

A look into the future

A recent study (McCollum et al, 2016) analyzed the impact of sustained low or high oil prices on the global energy system over the next several decades. In line with the IEA's previous findings (IEA, 2015), this new study shows that lower oil prices would lead to greater cumulative oil and gas demand and lesser renewables and coal demand. However, the shifts in energy demand are expected to be one or two orders of magnitude larger than those calculated by the IEA. Less CO_2 abatement is achieved with lower oil prices; between the two price cases, differences in global annual CO_2 emissions are 3.5 to 4$GtCO_2$ in 2030 and 6 to 7 $GtCO_2$ in 2050. The authors note that these results are not trivial, considering that national contributions submitted ahead of COP21 are expected to lead to 3.6 $GtCO_{2eq}$ of additional emissions reductions in 2030, compared to pre-COP21 policies. However, they also stress that cumulative emission differences over 2010-2050 would represent only 15% of the allowed 2010-2050 carbon budget for staying below the +2°C temperature limit.

The long-term impact of low fossil fuel prices depends crucially on the expectations of (industrial and households) investors regarding two elements: the permanence of low prices and the design of future regulations.

[4] Fuel oil represents only 5% of global electricity generation, while gas represents 21% and coal 41% (IEA, 2016)

[5] Default carbon emission factors in the 2006 IPCC Guildelines: 15.3 tC/TJ for gas, 15.7 to 26.6 tC/TJ for oil products and 25.8 to 29.1 tC/TJ for primary coals

[6] http://www.renewablesinternational.net/low-oil-prices-hurt-pellet-heater-sales-in-germany/150/453/93228/ 16.09.16

If low-carbon investments actually reduce, the desired break-even point of the energy transition investments may be prolonged. All in all, the implicit, but also explicit costs of the energy transition process may rise (Prognos et al, 2016). Rising costs could threaten supporting schemes, because the increasing burden on households and industry could be considered unbearable. In short, energy transition processes may reach a critical juncture; under unfavourable circumstances, like deteriorating economic conditions, lobbying activities against a continuation or at least for a slowing down of the energy transition will presumably gain momentum. In turn, chances for technology breakthroughs will decrease and the prospect of closing the cost gap between conventional energy carriers and clean solutions will be even more remote.

Implications for the European Union

In the first place, lower fuel costs can influence industrial competitiveness differentials between regions, in particular in energy intensive sectors. In principle, it could lead to additional production in regions that used to be affected by high energy and feedstock prices, e.g. Europe, and thus to increasing energy demand in these regions. For example, the competitiveness gap between the EU and cost leaders of the petrochemical sector (the Middle East and the US) has started to narrow down. Between 2013 and 2015, the EU's annual ethylene production grew by 7.3%, the annual propylene production by 2.9% and the annual butadiene production by 8.1%[7], suggesting higher energy demand and GHG emissions from the EU energy-intensive sectors. Beyond this example from the petrochemical sector, it is not clear whether the advantages of price competition will materialize, since other factors, like worldwide competition intensity on the relevant markets, could be more important.

As demonstrated above, each sector is expected to react differently to sustained low fossil fuel prices, thus requiring different policy responses. Despite many uncertainties, a sketch of possible outcomes for the EU can be summarized as follows:

1) The variable costs of fossil-fuel power plants will reduce, resulting in decreasing wholesale market prices. While renewables should be protected by policy mandates and continuous cost improvements, a (partial) fuel switch from coal to gas is possible, in particular if it is helped by additional policy measures such as the review of the Best Available Techniques Reference Document (BREF) for Large Combustion Plants (LCP). By this, lower GHG emissions can be expected. This said, investment in merchant power will be even more complex without appropriate market design adjustments.
2) Obviously, low fossil fuel prices will improve the relative price competitiveness of conventional vehicles. Strong policy support will be required to keep innovation going and decrease the purchase costs of alternative cars.
3) On the heat market, the expectation of continued low fossil fuel prices may have a considerable impact on investment decisions. Robust decarbonization strategies will need to be put in place swiftly, if any progress is to be achieved in this sector.

[7] Estimates based on data produced by Petrochemicals Europe in its Quarterly Petrochemical Production Statistics 2009-2016

4) Although the ETS is a cornerstone of the EU climate policy[8], the CO_2-certificate price did not react thoroughly to the changed oil and fossil fuel markets[9]. Changes in the design of the EU ETS need to be made, to ensure that the supply of certificates is tightened in response to lower fossil fuel prices (cf. Edenhofer, 2014).

Overall, the EU may need to reinforce policy certainty as a precautionary measure, to keep up pace of investments and technological progress. However, if only the European Union decides to restore incentives, by putting a higher price on carbon for example, while others decide to take advantage of low energy prices and to slow down decarbonisation efforts, it may result in stronger carbon leakage. Such prospect could in turn weaken the support for energy transition processes, even in Member States where this project is generally accepted. Thus, a low commodity-price environment makes international climate negotiations and coordinated actions all the more important from a European perspective.

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[9] http://www.investing.com/commodities/carbon-emissions-historical-data; 16.09.2016

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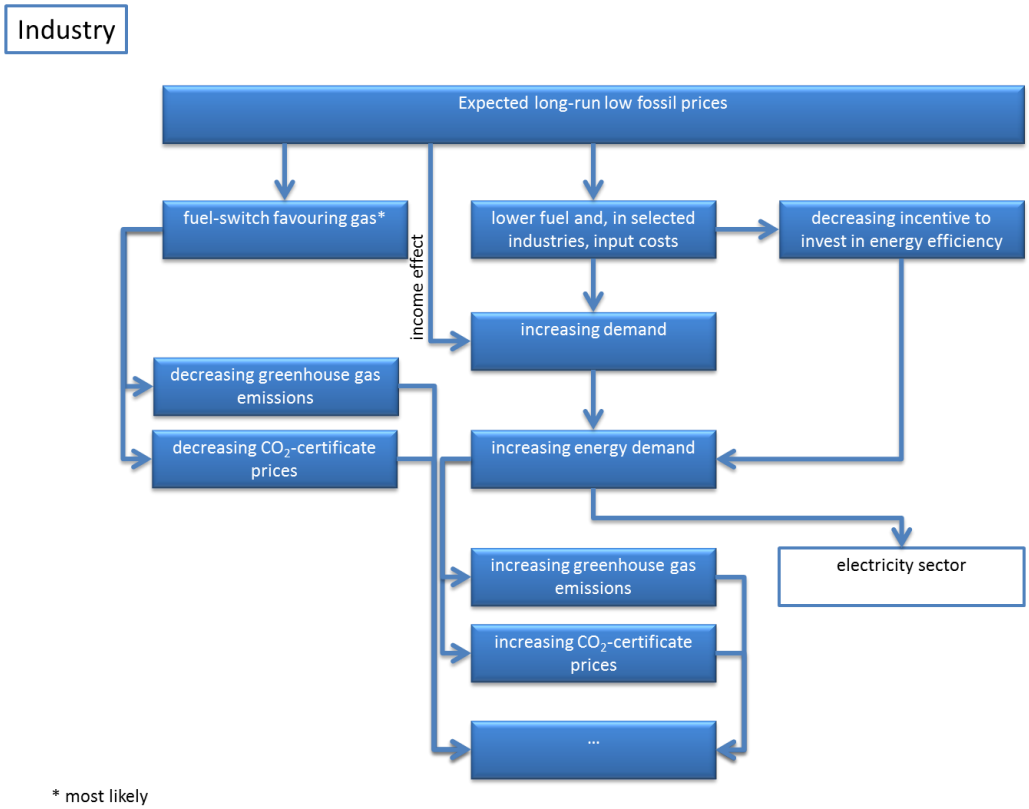
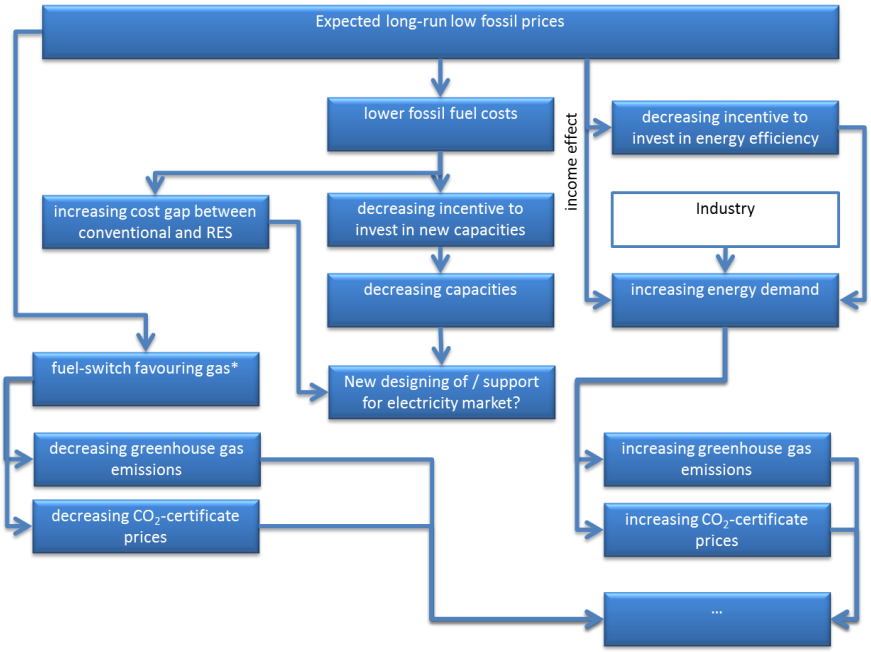
Appendix: Overview of the different, partly interconnected, impacts of lower fossil fuel prices in the Industry, Electricity, Heat and Transportation sectors.



Source: own compilation, based on Prognos et al, 2016

Electricity sector



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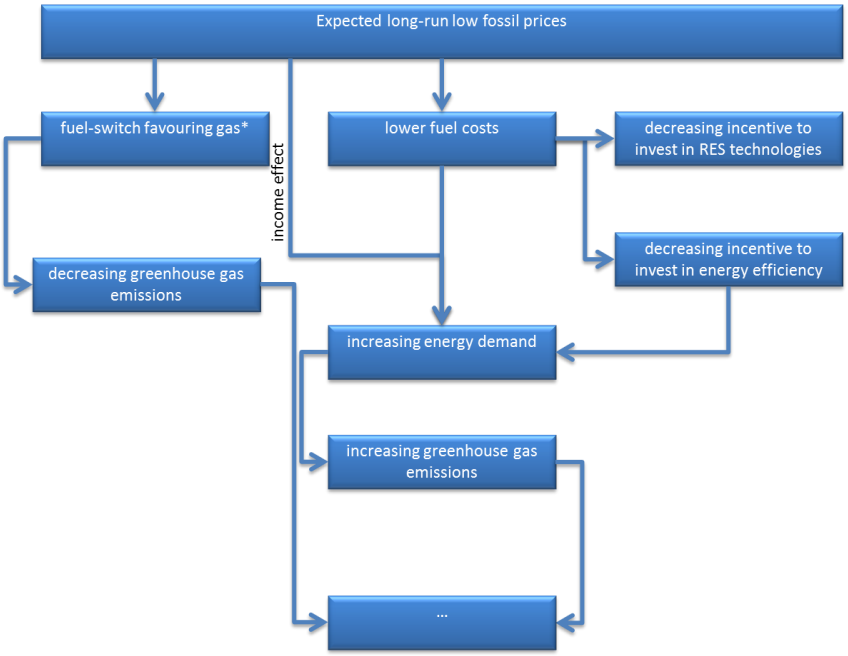
Source: own compilation, based on Prognos et al, 2016

Heat



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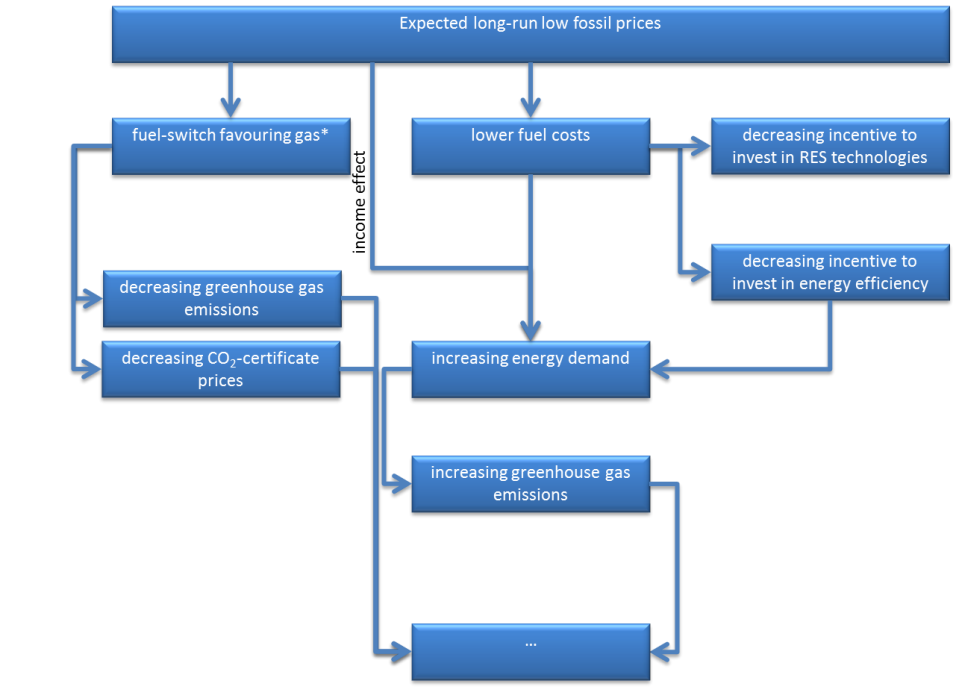
Source: own compilation, based on Prognos et al, 2016

Transportation



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