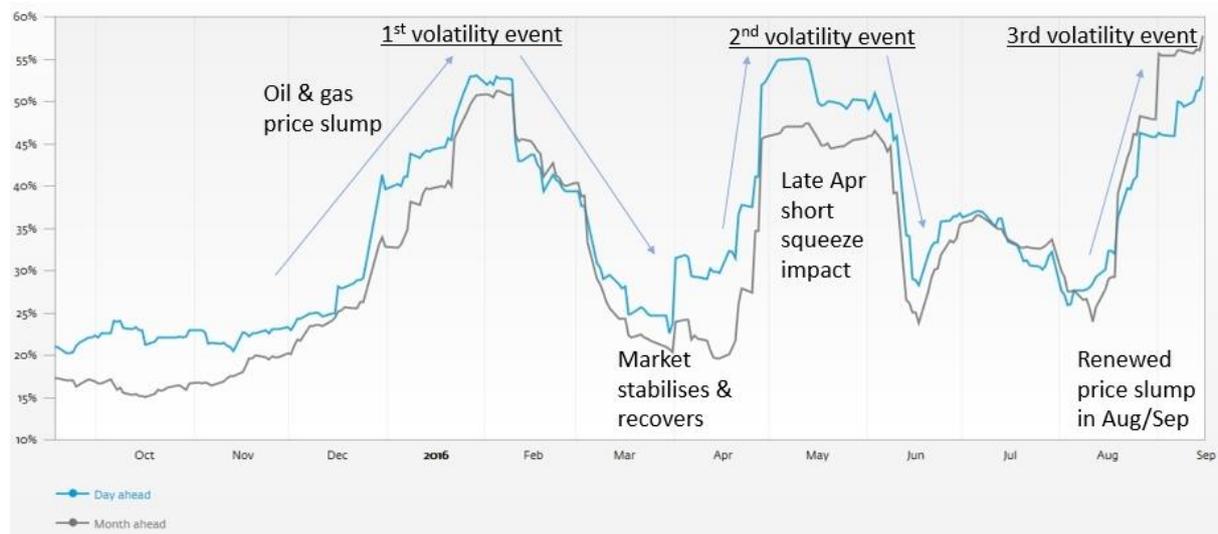


## Q3 2016: TTF volatility commentary

### Q3 jump in summer volatility

Each of the three quarters of 2016 has seen an event that has driven up historical price volatility. Higher volatility in Q1 was associated with a rapid decline in oil prices and associated European gas hub price weakness. The Q2 rise in volatility was due to an April short squeeze that saw prices move sharply higher (as described in our last quarterly commentary). Q3 has seen a renewed pick up in volatility as hub prices have weakened again in August and September. These three volatility events are illustrated in Chart 1 below.

**Chart 1: Evolution of the Energystock volatility indices over the last 12 months**



It is interesting to note that falling prices are behind the Q3 increase in volatility (as they were in Q1). This price weakness at TTF has been driven by three main factors:

1. Import flows: Oil-indexed gas contract price formulas contain a 6-9 month lag to oil prices. This means contract owners are incentivised to profile higher volumes into Q3, to benefit from the low oil prices in Q1. Pipeline gas flow volumes into European hubs have been robust as a result, in combination with a healthy flow of LNG imports.
2. Storage injections: Demand at European hubs for storage injection has been relatively low this summer given (i) the injection outage at the large Rough facility in the UK and (ii) high storage inventories across Europe.
3. NBP weakness: Summer maintenance on Norwegian export lines to the Continent has seen gas diverted to the UK. The injections into the Rough storage facility would normally play an important role in soaking up this surplus. But with the Rough outage, the UK has been exporting high volumes of gas to North West Europe. This has been accompanied by a slump in NBP prices in order to clear surplus gas in the UK market.

The combination of these events has caused lower TTF prices and a rise in volatility in Q3. While most of these factors are temporary in nature, events around the Rough storage facility may have a more structural impact on volatility in North West Europe.

### Implications of Rough issues

Rough accounts for more than 70% of the UK's working gas volume. It is a seasonal storage asset with a relatively low cycling rate. But the scale of storage working gas volume (3.1 bcm) means Rough plays

a key role in providing supply flexibility to the UK. Rough is also large enough to be important in a broader North West European market context.

Serious issues with Rough storage well integrity surfaced in 2015 and Rough's capacity was permanently reduced by around 25% (from 3.7 to 3.1 bcm). Deliverability rates were largely unaffected. However further well issues in 2016 have caused Rough's owner, Centrica Storage Limited (CSL), to curtail all injection into the facility until at least Q2 2017. This has meant that Rough inventory going into this winter is much lower than normal (~1.3 bcm). Deliverability rates have also been reduced.

The curtailment of Rough reduces the storage flexibility available in North West Europe this winter. But more importantly it raises questions as to the ongoing viability of Rough. The problems with the facility point towards ageing infrastructure and there is unlikely to be a viable business case for CSL to spend the lifetime renewal capex required to maintain Rough performance.

The loss of Rough flexibility does not create a significant seasonal flexibility issue within the UK. But it does exacerbate the UK's gas deliverability issues. During periods of high demand or supply outages, the UK can face constraints in delivering enough gas into the network to meet demand. It is the loss of Rough's deliverability, rather than working volume that poses a problem for the UK market. And higher volatility at NBP will feed through into TTF and other European hubs.

#### Why NBP volatility is contagious for TTF

The issues with Rough storage and NBP price slump over the summer have driven up UK price volatility. These UK gas market issues are contributing to the increase in TTF volatility and may continue to do so in the future.

There is a strong prompt and forward price relationship between the UK NBP and Dutch TTF hubs. This is driven by high levels of gas supply infrastructure that can respond to differences in prices between these locations. Significant volumes of Norwegian production are optimised against hub prices, with Statoil having the ability to flow gas both into the UK and TTF to arbitrage any price differences. In addition, there are two interconnectors (IUK and BBL) that allow capacity holders to arbitrage any difference between UK and Continental hub prices.

Despite the high volumes of physical interconnection between the UK and the Continent, there can be periods of hub price separation, particularly in the prompt. For example:

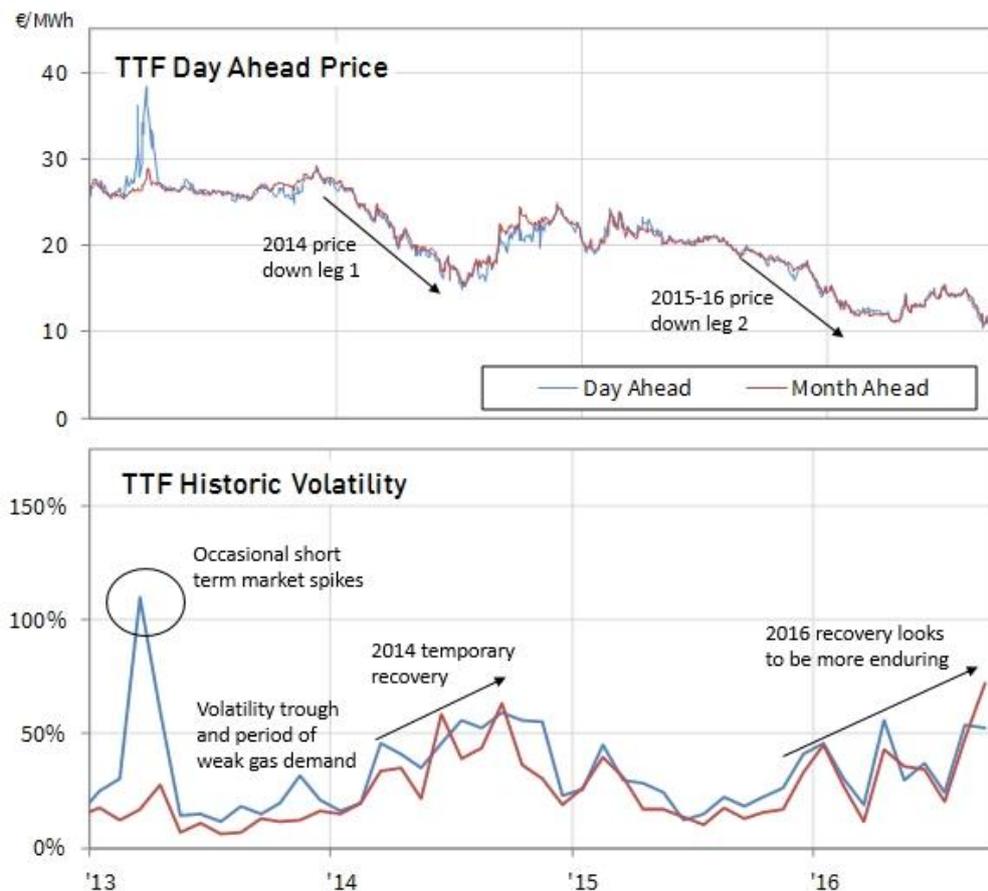
- Mar 2013: Price spikes at NBP were more severe than at TTF as import capacity into the UK became constrained as a result of a large NCS outage and failure of the IUK interconnector.
- Aug 2016: The gas price slump this summer (described above) has had a more pronounced impact at NBP than TTF as interconnector export flow out of the UK has been constrained.

But these periods of price separation tend to be limited to periods of high system stress. The 'triangle' of physical connectivity between Norway, the UK and NW Continental Europe typically ensures a strong relationship between NBP and TTF volatility.

#### 5 factors to watch out for coming into winter

Chart 2 illustrates what appears to be the start of a more enduring recovery in volatility taking place in 2016. The behaviour of volatility across the coming winter will be an important indicator as to whether this could be the start of a multi-year structural recovery.

Chart 2: Evolution of TTF prices vs TTF historical volatility



We finish this quarter's commentary by summarising 5 factors worth watching in relation to the volatility over the coming winter:

1. Rough impact: The injection outage, low inventory and lower withdrawal rates will reduce the available supply flexibility in North West Europe this winter. Any further issues with Rough will exacerbate this.
2. Higher CCGT swing demand: CCGT load factors have risen significantly in 2016 as gas hub prices have fallen and gas for coal plant switching gas occurred. This should mean higher volumes of power sector swing demand over the winter.
3. Groningen: Further reductions in the production levels and flexibility of Groningen have recently been passed by the Dutch government in response to earthquake risks. This reduces another important source of supply flexibility into North West European hubs.
4. LNG imports: LNG import flow into Europe has been increasing in 2016 as new liquefaction capacity comes online in an oversupplied global market. The volume and consistency of flows across the winter will impact hub price volatility.
5. Weather/outages: As always, European hub price volatility will be sensitive to more prolonged periods of cold weather or major infrastructure outages.

These factors should play an important role in determining whether the current pickup in volatility carries through to Q4.