Gas Supply Problems this winter in UK and in USA

Leading Analyses Ignore Bottlenecks in Fuel Supply

Cold weather boosted UK gas demand by 33%

On 1 March 2018, several media reported that the UK was running out of gas. The Russian "Sputnik International" described the misery in the freezing Britain (fig. 1).

Fig. 1 - Selected headlines 1 March 2018

According to The Guardian, the wholesale gas price reached a high of 275 pence per therm (9.40 pence per kWh) at lunchtime on 1 March against about 50 pence per therm the previous days.

The normal consumption of gas is about 300 mcm per day at this time of the year, but on this cold day, the forecasted consumption was nearly 400 mcm. The initial supply for that day was about 350 mcm. Therefore, National Grid issued a "Gas Deficit Warning (GDW)".

This is a part of National Grid's explanation of GDW:

> *A GDW is given at our discretion, based on our expectations of the impact of a significant supply/demand event. A GDW will be issued in advance of or during a gas day if a significant supply/demand event is experienced which instigates a material risk to the physical end-of-day balance.*

A reasonable balance was established during the day without serious consequences, but it was demonstrated that the gas supply system does not have transmission or storage capacity for serving the full demand on a cold day.

Coal was the Main Backup Energy during US Bomb Cyclone

The eastern half of USA was affected by very cold and stormy weather from 27 December 2017 to 8 January 2018. The winter storm is now known as the "Bomb Cyclone" (BC).

The increased electricity consumption challenged power supply systems under six independent system operators (ISOs). In this case, generation capacity was adequate, while bottlenecks in fuel supply and power transmission caused problems.

The incident has been analysed by the National Energy Technology Laboratory (NETL) for the Department of Energy (DOE). The result is published in a 46 pages report, "Reliability, Resilience and the Oncoming Wave of Retiring Baseload Units"[1].

The average daily electricity consumption during the Bomb Cyclone was 19% higher than during the first 26 days of December 2017 (table 1). For New York ISO the increase was 28%, but even Texas (ERCOT) was affected by the winter storm.

RTO/ISO	Total Daily Avg. Load (GWh) 1 Dec to 26 Dec	Total Daily Avg. Bomb Cyclone Load (GWh) 27 Dec to 8 Jan	Load Increase %
PJM	2.334	2.833	21.4%
MISO	1.692	2.041	20.6%
ERCOT	949	1.038	9.4%
SPP	707	819	15.9%
NYISO	353	452	28.0%
ISO-NE	283	348	23.2%
Total	6.318	7.531	19.2%

Table 1 - 19% additional electricity consumption

Constraints in gas and electric transmission caused all-time high gas prices in New York and elevated natural gas and electricity prices across each region.

There are geographical differences in gas spot prices in the United States. The average gas spot prices on 28 December was about $2/MMBTU for MISO and SPP and about $20/MMBTU for ISO-NE, PJM and NYISO. These differences indicate bottlenecks in the gas transmission system, even under normal conditions.

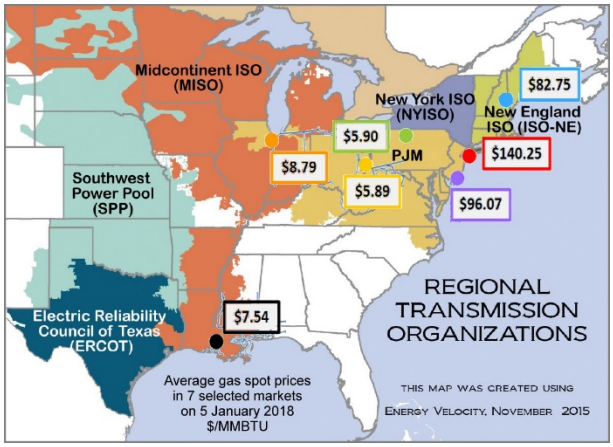

Fig. 2 - RTO/ISO map with gas spot prices in $/MMBTU. Source of map: Federal Energy Regulatory Commission (FERC)

The Bomb Cyclone caused dramatic rises of the gas spot prices for all regions. On 5 January, the daily average spot prices reached a peak of $80 for ISO-NE, $100 for PJM and $140 for NYISO (fig. 2).

The increased gas prices were reflected in the development of the marginal prices of electricity (table 2). The daily average prices climbed up to nine times over a few days (NYISO). This is not necessarily a problem when the markets are able to find a reasonable balance.

Electricity Marginal Prices Weighted daily average		
Max	Day	$/MWh
ISO-NE	5 Jan	295
PJM	6 Jan	250
NYISO	6 Jan	240
MISO	4 Jan	80
SPP	4 Jan	80

Table 2 - Max electricity spot prices

The interesting matter is the availability of reserves of both capacity and energy.

Different fuels responded differently to the demand for more energy (table 3). Coal provided 63% of the additional production compared to the first 26 days of December, while the gas-fired production was increased by 20% (table 3).

[1] https://netl.doe.gov/newsroom/news-releases/news-details?id=9e76d16a-f550-4ed5-bff6-3adbca28fa43

The installed capacity per fuel type does not emerge from the report.

Fuel	% Share of Increased Supply
Coal	62,9%
Natural Gas	20,2%
Nuclear	5,3%
Hydro	-0,2%
Wind	-11,9%
Coal/Oil	1,7%
Dual Fuel	5,8%
Residual Oil	17,3%
Other	-1,1%
Total	100,0%

Table 3 - Contributions by fuel type

Due to low fuel prices and cheap storage facilities, it is natural to have large coal stocks at each coal-fired power station. It makes coal-fired power the most resilient in the sense of the NETL report. *This is an undervalued quality of coal-fired power stations.*

The report discusses possible resilient alternatives to coal and nuclear power. It is a general view that the necessary backup to wind and solar power in the future should come from gas-fired CCGT units.

Gas seems to be the most realistic alternative, but it requires firm contracts on gas supply up to the full capacity of the power plants. The result would be gas pipes with low utilisation and consequently an expensive backup capacity for future wind and solar power. This solution would add a balancing cost to wind energy, which nobody considered so far.

The bottom-line is that we do not yet have a cost-effective solution for filling the gaps in large-scale wind power.

Concern about Future Power System Resilience

The NETL report makes a comparison with a similar incident in January 2014, the “Polar Vortex”. One remarkable difference is that the maximum spot price of gas was much higher in 2018 than in 2014. The resilience of the gas supply system seems to deteriorate.

The report discusses possible consequences of expected retirements of power plants, particularly coal and nuclear units. The power system resilience will inevitably be affected.

Most traditional reliability and security models would not identify fuel supply problems, because they assume the necessary stocks of fuel to be available at the power stations. ENTSO-E’s “Mid-term Adequacy Forecast” (2017 edition)[2] concentrates on generation and transmission capacities and does not mention possible fuel supply constraints. However, when gas-fired power plants without fuel storage together with non-dispatchable wind and solar power are replacing coal and oil fired units, the ability to maintain an increased production level, for instance during cold periods, will deteriorate correspondingly.

Therefore, the NETL report introduces *resilience* as *“the incremental daily average gigawatt hours during the BC event above those of a typical winter day”*.

By this definition, the report can indicate how each type of power plant has contributed to cover the additional electricity demand, but systematic analyses would require realistic models of fuel supply systems and fuel markets.

Even the most advanced model is a compromise. The NETL report has demonstrated that the supply chain has a weak link, which seems to have been ignored for several years.

[2] https://www.entsoe.eu/Documents/SDC%20documents/MAF/MAF_2017_report_for_consultation.pdf