Seasonal variations in electricity demand

Introduction

This article outlines how demand for electricity in Great Britain differs between a summer's day and a winter's day and the differences in the fuel used for electricity generation between the two seasons. DECC's energy volume statistics cover electricity demand on a monthly aggregated basis. However, to examine demand trends on a more detailed basis, data of a higher frequency is required. Half hourly generation data for Great Britain is available from the National Grid (NG) via Elexon. NG runs the Great Britain electricity transmission system, balancing supply with demand[1]. To assist with balancing the system, NG measure generation connected to the high voltage transmission system in real time from operational metering.

Aside from covering Great Britain only, NG's operational metering does not apply to all power plants (it is required for all plants over 100 MW in England and Wales, and over 5 MW and 30 MW in the Scottish and Southern Energy and Scottish Power areas respectively). As such, the coverage differs to that reported in DECC's monthly electricity statistics (which also cover smaller stations and Northern Ireland)[2]. The difference is greater for wind data where the operational metering requirements mean that currently only around 70 per cent of the installed capacity is included in the half hourly data. More information on the data coverage and definitions of the half hourly data can be found on the following website: www.bmreports.com/bsp/bsp_home.htm

The sum of all the National Grid half hourly data is called the total Transmission System Demand (TSD) – this includes all demand met by the transmission system, including exports, pumping and power station demand. This measure is used as an indicator of demand.

Background

Electricity demand is subject to fluctuations on a seasonal basis, across the week, and during the day. Demand can also be influenced by irregular events, such as particularly extreme weather conditions. They can also be swayed by television programmes or televised events, known as "TV pick-ups". These demand peaks and troughs are met by different types of generation, according to their different characteristics.

Electricity demand

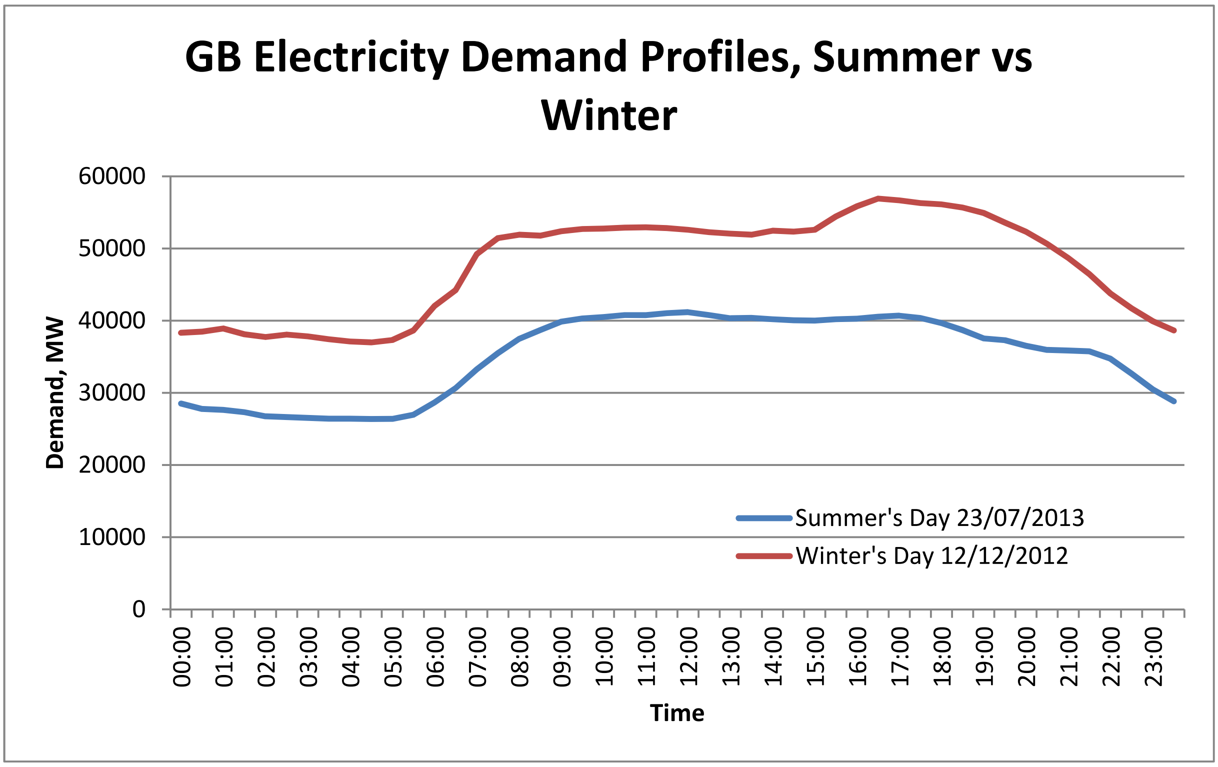
Typically, demand is higher in the winter than in the summer. The peak demands in the summer are usually lower when compared to the peak demands of the winter and the low demands of the summer are low when compared to the low demands of the winter. Demand for electricity tends also to fluctuate over the course of the day, determined by human activity. This is demonstrated in Chart 1[3], which compares demand profiles on a winter's day and a summer's day. The two lines both show a similar trend, but with the winter's day showing a higher demand for all of the 48 half-hour periods. On average, the demand on the winter's day was 36% higher than on a summer's day.

[1] For Northern Ireland, the transmission system is part of an all-Ireland electricity network operated by the Single Electricity Market operator (SEMO)

[2] An article summarising the main differences between the two data sources can be found here www.gov.uk/government/uploads/system/uploads/attachment_data/file/65923/6487-nat-grid-metering-data-et-article-sep12.pdf

[3] Chart 1 compares demand profiles on a winter's day, Wednesday 12th December 2012, to a summer's day, Tuesday 23rd July 2013. This is comparing the day with the highest total daily demand for Winter 2012/13 to the day with the highest total daily demand for summer 2013, with winter classified as December, January and February and summer classified as June, July and August.

Chart 1



Electricity demand is usually lower during the night hours, with little domestic or commercial consumption. In both seasons, there is a visible surge in demand in the morning, when people wake-up and begin using electrical appliances such as kettles, toasters and power showers, but this surge increases more rapidly over a shorter space of time during the winter.

Demand continues to rise but then starts to stabilize at around 9:00am as offices and shops open and electrical equipment such as computers are increasingly utilized.

In the winter a second surge then occurs later in the day, between 3:30pm and 5:30pm, as school children begin to return home and the working day starts to come to an end. As people return home they will be turning on electrical equipment – lighting, televisions, and kettles and begin to start cooking dinner. Demand then begins to fall and drops off as people begin to retire to bed.

This evening surge is not evident in summer, as people return home when it is still light and perhaps a preference for cold beverages/food in the warmer weather. As well as evening domestic electricity use being lower in the summer any use at home in the evening will be counteracted by the switching off of air conditioning units in shops and offices.

Generation used to meet demand

Chart 2 shows the pattern of demand and component generation technologies, across the whole of a winter's week, Monday 10th December 2012 to Sunday 16th December 2012, with the graph beginning at 00:00 hours (midnight) on Monday 10th December and ending at 23:30 hours on Sunday 16th December. Chart 3 represents the equivalent for a summer's week, Monday 22nd July 2012 to Sunday 28th July 2013.

Chart 2

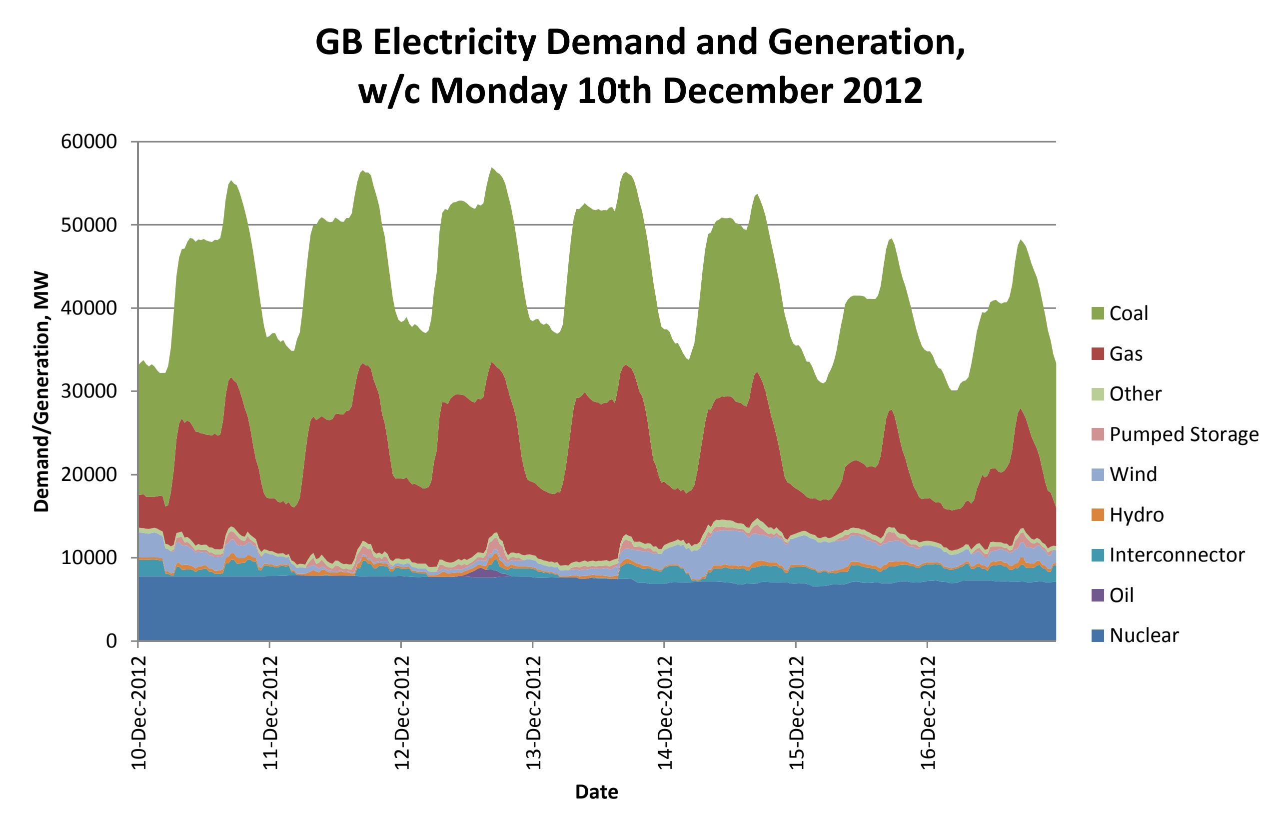
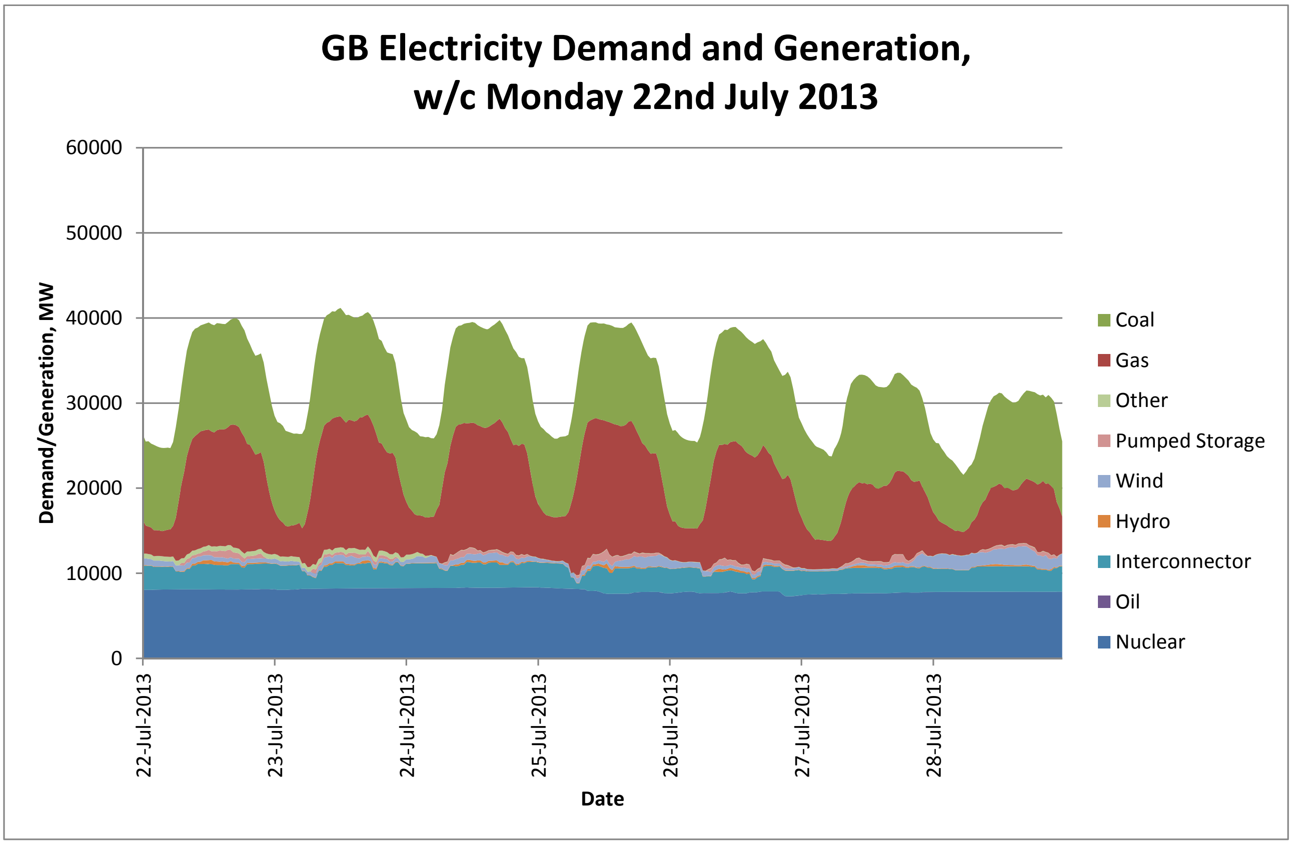


Chart 3



With long start-up times, low marginal costs, and little flexibility in adjusting output, nuclear stations to generate continuously, regardless of time, day or season. This accounts for the virtually constant amount of nuclear generation across the week visible in both Charts 2 and 3.

Coal and gas generation is, however, more flexible and will adjust according to the level of demand and thus price. Coal generation is particularly responsive due to limited running hours available under the Large Combustion Plant Directive, making it economical to only generate at higher wholesale prices. However, in 2012 and 2013 coal prices were relatively low in comparison to gas prices. Chart 2 shows that in the winter week almost twice as much coal generation took place compared to gas generation, in the summer week coal and gas operated at similar levels. This has not always been the case, for example during 2006-2009.

Wind generation is utilised whenever it is available; however, its intermittency due to its reliance on weather conditions means its output varies, particularly during summer months when it is typically less windy. December 2012 saw an average wind speed of 9.3 knots, similar to the long term mean. However, July 2013 had an average wind speed of 6.4 knots, lower than the long term average and also noticeably lower in comparison to the winter month of December. The effect of these lower wind speeds can be seen in Chart 3 where there is less wind generation present than in Chart 2.

Hydro generation is particularly flexible and can start generation quickly, so long as there is water available in the reservoirs. December 2012 had an average rainfall of 188.1 mm, which was higher than the long term average. This was comparatively a lot higher than the 62.8 mm seen in the summer month of July 2013. July 2013's rainfall was lower than the long term average and also the driest July since 2005. When comparing Chart 2 to Chart 3, there is less hydro generation in Chart 3 (summer's week) to Chart 2 (winter's week).

The supply through interconnectors is dependent on the price differential between the UK and the market at the other end of the interconnector. When wholesale prices are high in the UK, there will be more supply from this route, whatever the time of day. When they are lower, or an interconnector is undergoing maintenance, supply will be lower or in the opposite direction. The UK currently has interconnectors with France and the Netherlands, as well as an interconnector between Wales and Ireland. There is also the additional Moyle interconnector between Scotland and Ireland. However, this is not included in the National Grid's half hourly data. There is more electricity supplied in the summer's week in Chart 3 when compared to the winter's week in Chart 2. This could be explained by the aforementioned weather conditions effecting hydro and wind generation in the summer's week, wholesale prices, and the generation mix in continental Europe.

Pumped storage generation is extremely responsive, and is used to meet demand peaks. This is illustrated in both Chart 2 and Chart 3, where pumped storage generation is almost always present at times of high demand and absent at times of low demand, when prices are low and electricity is used for pumping water uphill. Despite lower overall electricity demand in summer and the lack of an evening peak, pumped storage is still utilised on a daily basis.

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