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BEIS call for evidence for a Smart, Flexible Energy System

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Innovation
Power-to-fuels is an under-represented part of the UK's research and demonstration portfolio – this needs to be reconsidered

- Great Britain is falling increasingly behind Europe in this field, especially in power-to-fuels demonstration projects that use modular reactors with catalysts
- The power-to-fuels sector therefore requires significant additional funding in the next 5 years, targeted at applied research with demonstration projects

Flexibility in energy systems is required over a number of different timescales. Much of the focus for the UK is at a sub-weekly level, *e.g.* various types of energy storage, interconnectors and demand side management to achieve increased (and very necessary) levels of flexibility, primarily for the electrical system. This is good news, and undoubtedly much of the representation to this call for evidence has a focus at this sub-weekly level.

However, the area that seems to be under-represented in terms of the research and demonstration funding landscape is energy storage that can be credibly scaled to TWh hours of energy to cater for weekly -> interseasonal levels of storing energy. To put this in perspective, Great Britain's energy demands on a cold winter weekday are about 1 TWh of electrical energy, about 1.3 TWh in total for diesel and petrol, and between 3.5 and 4TWh for natural gas - IN ONE DAY.

Great Britain uses fossil and nuclear fuels to provide the TWh levels of weekly -> interseasonal stores of energy, and will continue to do so for the foreseeable future. In the medium to long-term, there will still be a strong role for fuels to provide these seasonal forms of storage that are required to balance the energy needs of a nation such as Great Britain, precisely because they are cheap to store at TWh scales in comparison to other forms of storing energy.

Figure 1 shows the natural gas, transport fuels and electrical demands in Great Britain over the last 4 years on a daily basis. The data is collated from National Grid, Elexon and BEIS and is metered data. In this diagram, the scale and seasonality of the natural gas demand becomes clearer.

The magenta coloured box provides a scale of 15,000 GWh of energy, which could for example be catered for by part of the Rough long-term gas storage facility. For comparison, the capacity of Great Britain's existing pumped storage is represented by the barely visible horizontal dashed line at 30 GWh a day (near the x-axis), which represents the amount of electrical energy that could be stored if all the pumped storage was to charged and discharged every day.

Figure 1 also shows the seasonal variation for natural gas – which is caused by the changes in Great Britain's seasonal heating demand. The Figure suggests a sense of the challenge to move part of this heating demand from natural gas to the electrical network through the installation of heat pumps.

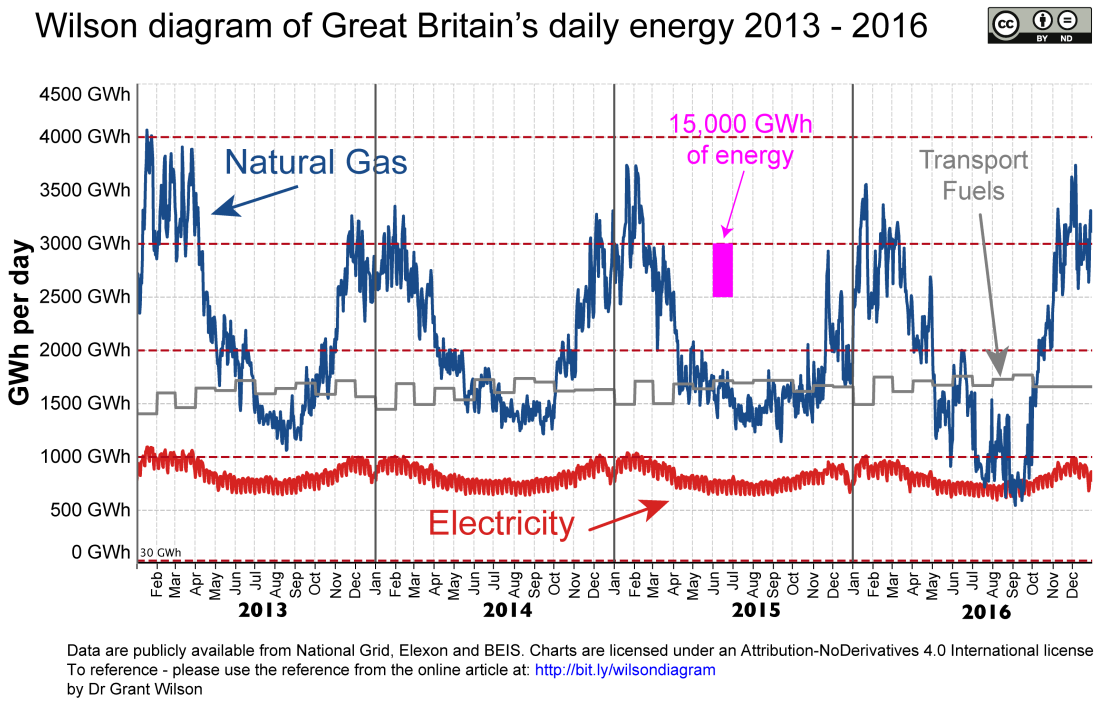

Figure 1 – Wilson diagram of Great Britain's major energy supplies, 2013 - 2016

If we accept that there is likely to be an ongoing role for fuels in any future energy system, the next question must surely be, which type of fuels are likely to be used?

As future energy generation becomes more and more decarbonised, then it is logical to have fuels themselves that are low-carbon or close to carbon neutral *e.g.* fossil-fuels with CCS, biomass and biofuels, synthetic hydrocarbons, renewable methanol, and hydrogen. It is probable that future

markets will utilise different fuels that are suited to different purposes, rather than having one fuel that would cater for all markets.

An additional factor that in particular favours synthetic fuels (over fossil fuels with CCS) is that their creation has the ability to provide a managed demand to balance 'excess' electricity at times of oversupply. If the oversupply cannot be used – then it is curtailed to balance the electrical network, which is already commonplace at a local level in areas with network congestion. The oversupply is a thought to be consequence of greater and greater levels of deployment of weather dependent renewable electrical generation (wind and solar), and although the level of future electrical curtailment is not known with accuracy, the concept of power-to-fuels has attracted significant levels of funding through research to the demonstration phase in Europe *e.g.* http://www.storeandgo.info/ and http://www.jupiter1000.com/

These projects have been funded with a major aim of understanding the cost and limits of power-to-methane technology, in order to understand how this sector might provide an option to balance networks in the longer term. Methane is created through the combination of carbon and hydrogen. The carbon typically can come from CO_2 but the hydrogen should be produced by electrolysers in order to link the hydrogen production to the power sector, and thus provide an additional benefit to be a flexible source of electrical demand.

Having similar projects funded in Great Britain is suggested as an area for consideration by BEIS as part of its Smart Flexible Energy Systems call. Great Britain has an established natural gas infrastructure, a robust scientific research base in biomethanisation and catalytic methanisation, and is becoming increasingly import dependent for natural gas.

Having an ability to link the electrical network back to the natural gas network through power-to-methane provides the ability to manage the energy system on a whole system level (see Figure 1). This gives access to natural gas infrastructure including its TWhs of storage. In the medium to long-term, this could become an increasingly important asset for Great Britain, especially if it does not wish to fully outsource the swing demand of seasonal energy supply, by expecting imports to satisfy the changing demand.

In short; fuels will still be required in the future at significant scales for the storage of energy; power-to-fuels offer the added advantage of soaking up excess electrical supply; Great Britain has a well-developed natural gas infrastructure and an increasingly import dependent natural gas supply; Great Britain is falling behind in terms of this sector's innovation.

Yours sincerely

Dr Grant Wilson