

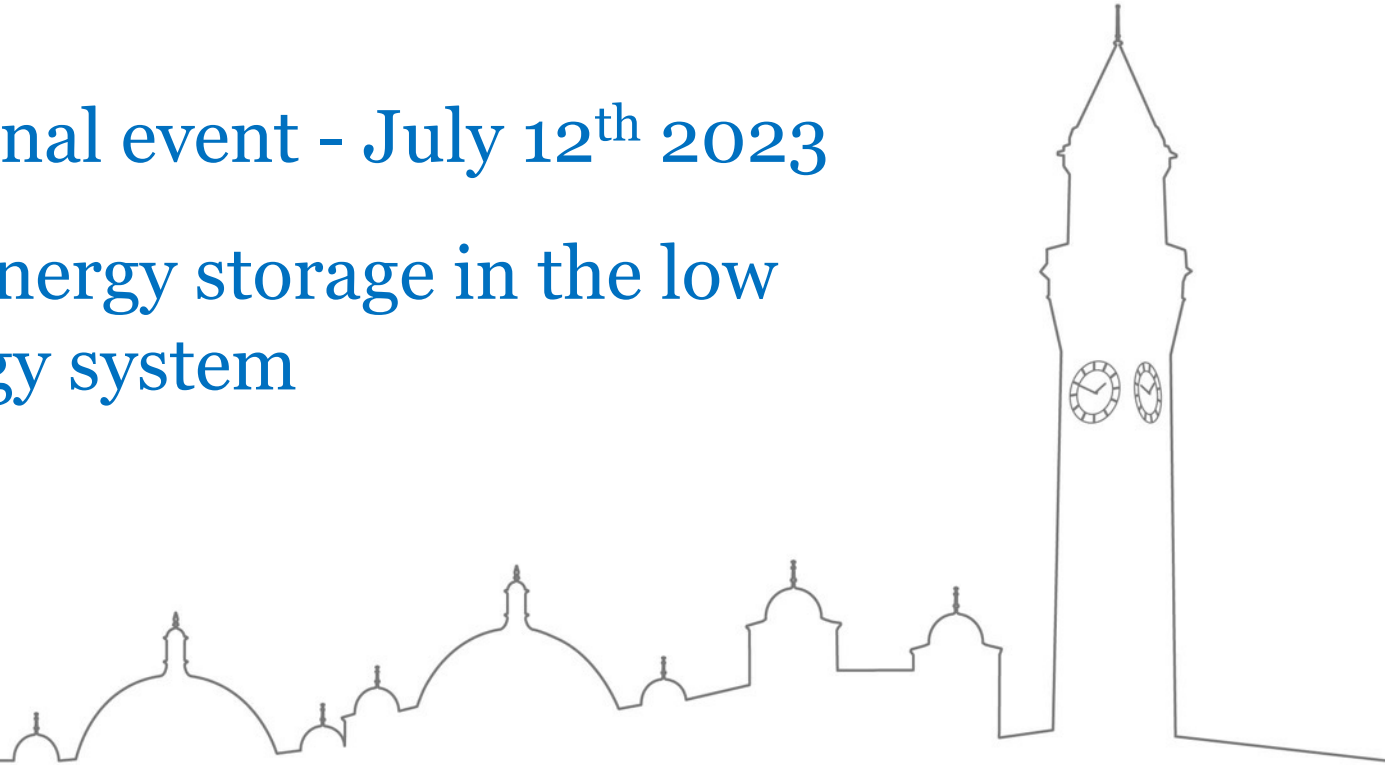


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HyStorPor final event - July 12th 2023

The role of energy storage in the low
carbon energy system

Dr Grant Wilson



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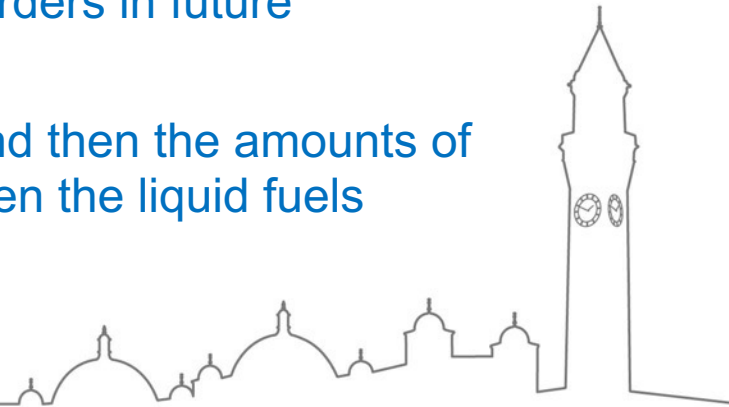
University of Birmingham



<https://www.linkedin.com/in/iagwilson/>

Leads the Energy Systems and Data Group: activities include analysis on energy system flexibility, using multi-vector, multi-scale data analytics

-
- An honour to present at this HyStorPor final event to help set the scene on why I believe that the geological storage of hydrogen is a critical element of Great Britain and Scotland's Net-Zero energy systems
 - The presentation will use visualisations to provide a sense of scale of Britain's current energy systems – and suggest that we will still require 10s of TWhs of stored energy within national borders in future
 - The visualisations will cover supply / demand and then the amounts of storage for the electrical, the gas system and then the liquid fuels systems



3 main points to consider throughout the presentation

- The needs of storage in the past may not be reflective of the needs of storage of the future. For example, as stored energy becomes more expensive then it is likely that we would want to use less of it overall
- GB energy trends are for an increase in end use electrical demand that takes 'market share' away from gas and liquid fuel forms of energy
- As the electrical system becomes more important as a source of final-use energy there is a need for wider energy systems to support electrical generation through multiple low-wind events, i.e., sources of stored energy in the 10s of TWhs range and generation to transform the stored energy to electricity



Most charts are available on an online interactive version

<https://public.tableau.com/app/profile/grant.wilson/viz/GreatBritainsenergydailydata/GBenergyperday?publish=yes>



GB Electrical system



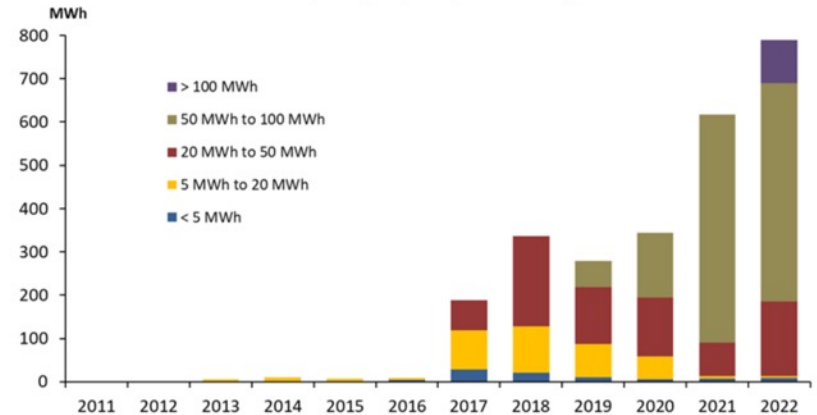
GB Electrical system stored energy 2023

How much non-fuel energy storage for the electrical system?

- 2.6 GWh of battery storage¹
- ~ 30 GWh of pumped storage
- Estimate of battery storage in EVs and Hybrids at 20-30 GWh

With other forms of electrical storage an estimate of 100 GWh of electrical storage

UK | Energy Storage | Utility Segment
Built Capacity by Project Size by Year



© Solar Media Ltd., 2023
Source: UK Battery Storage Project Database report, January 2023.



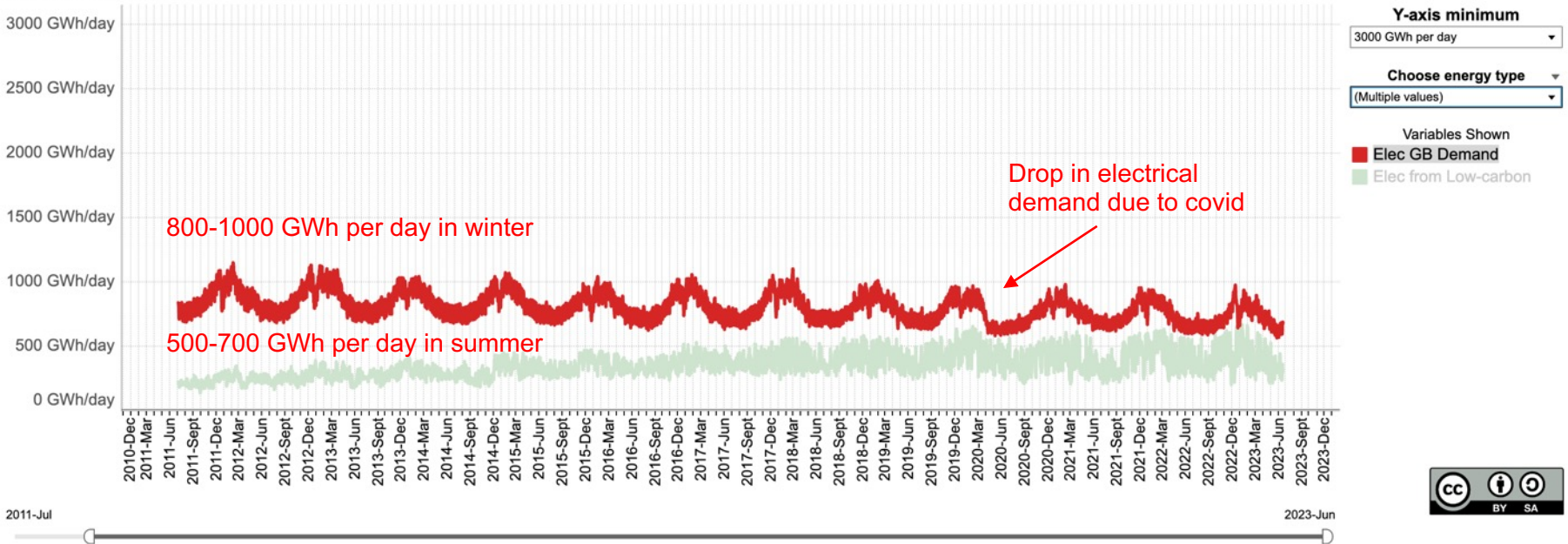
UK energy storage deployment had the highest annual installed capacity in 2022 at 569MW/789 MWh.
Image: Solar Media Market Research.

¹ <https://www.energy-storage.news/800mwh-of-utility-scale-energy-storage-capacity-added-in-the-uk-during-2022/>

Daily GB electrical demand

READ ME GB energy per day GB energy by day of year Energy types date range

Great Britain's energy in GWh per day



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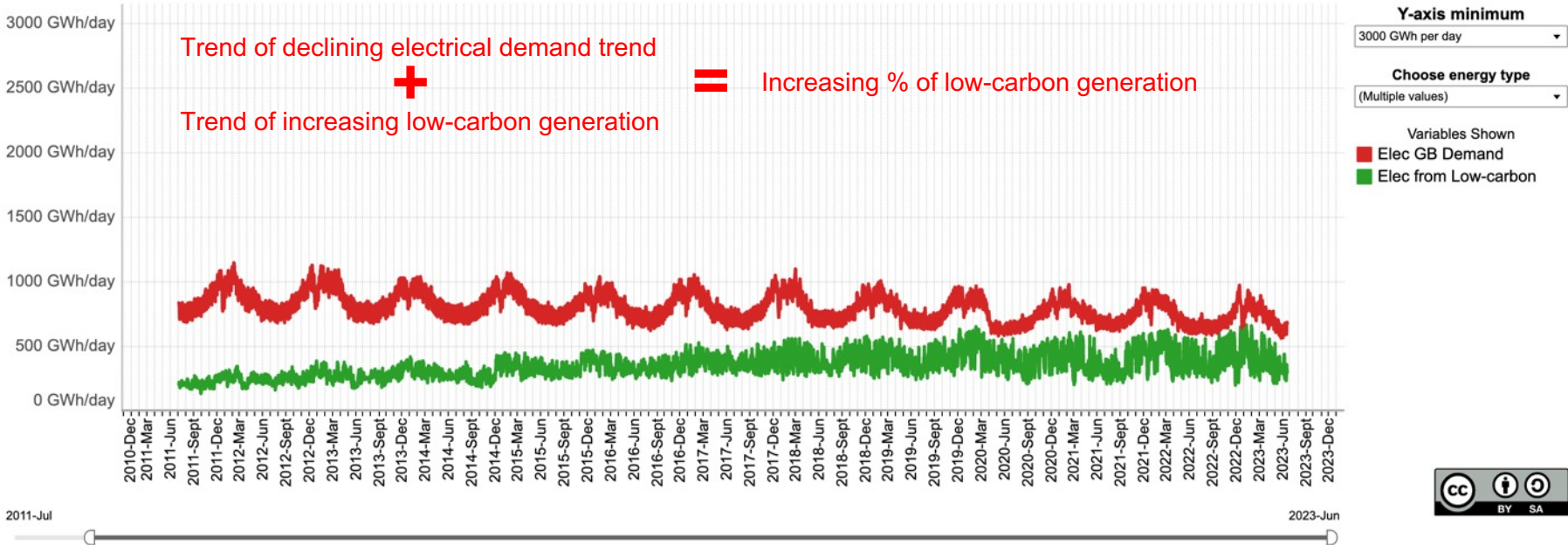
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Underlying data are from National Grid ESO, National Gas, Elexon and DESNZ
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Daily GB electrical demand, above 50% on an annual basis since 2019

READ ME GB energy per day GB energy by day of year Energy types date range

Great Britain's energy in GWh per day



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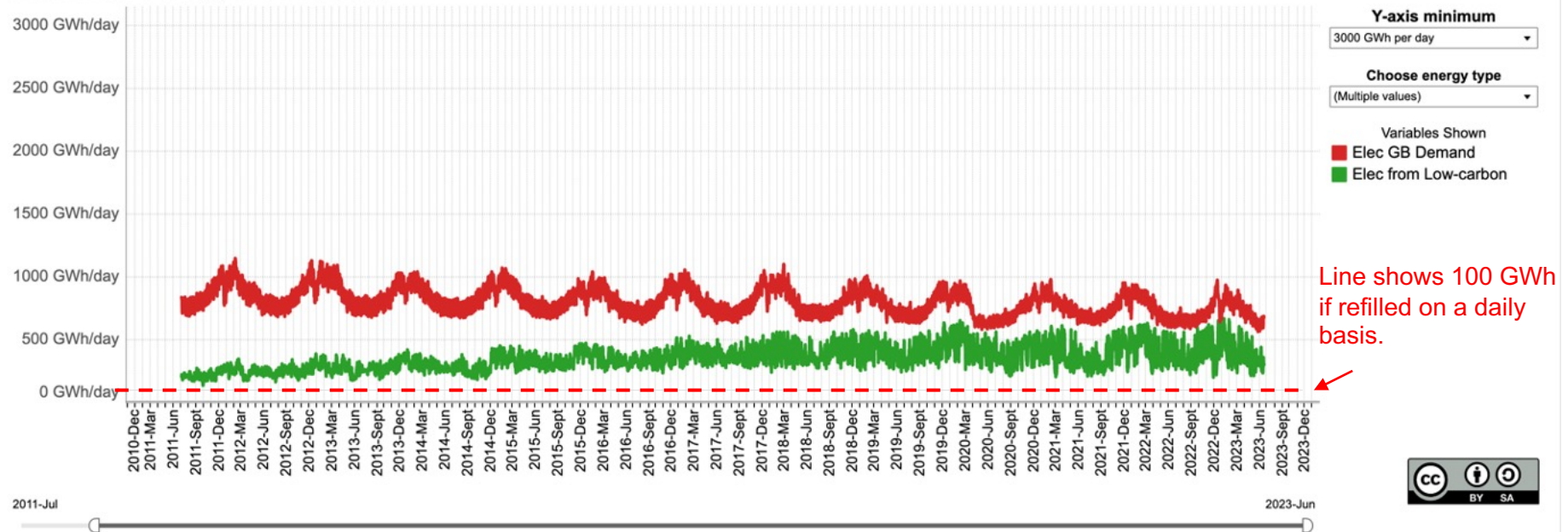
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100 GWh of electrical storage (does not include fuels)

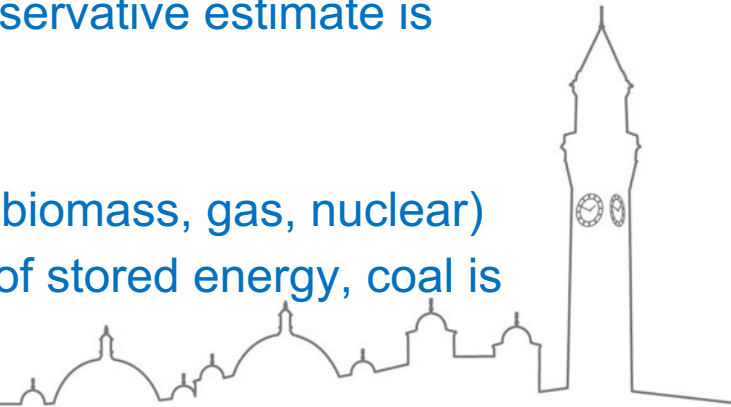
READ ME GB energy per day GB energy by day of year Energy types date range

Great Britain's energy in GWh per day



Stored energy available to electrical system (non-fuel based)

- Estimated at 100 GWh
- As with all storage – this would need ‘refilled’ once depleted
- Depending on the time of year, day of week and time of day – somewhere between 2 and 5 hours of stored energy in pumped storage, batteries, EVs (if they were V2G) and others such as liquid air. EVs are not widely available for V2G so – a conservative estimate is 1.5 – 4 hours of electrical energy equivalent
- Does not include the storage of fuels (e.g. coal, biomass, gas, nuclear)
- Nuclear in particular offers months and months of stored energy, coal is running down, gas is increasing

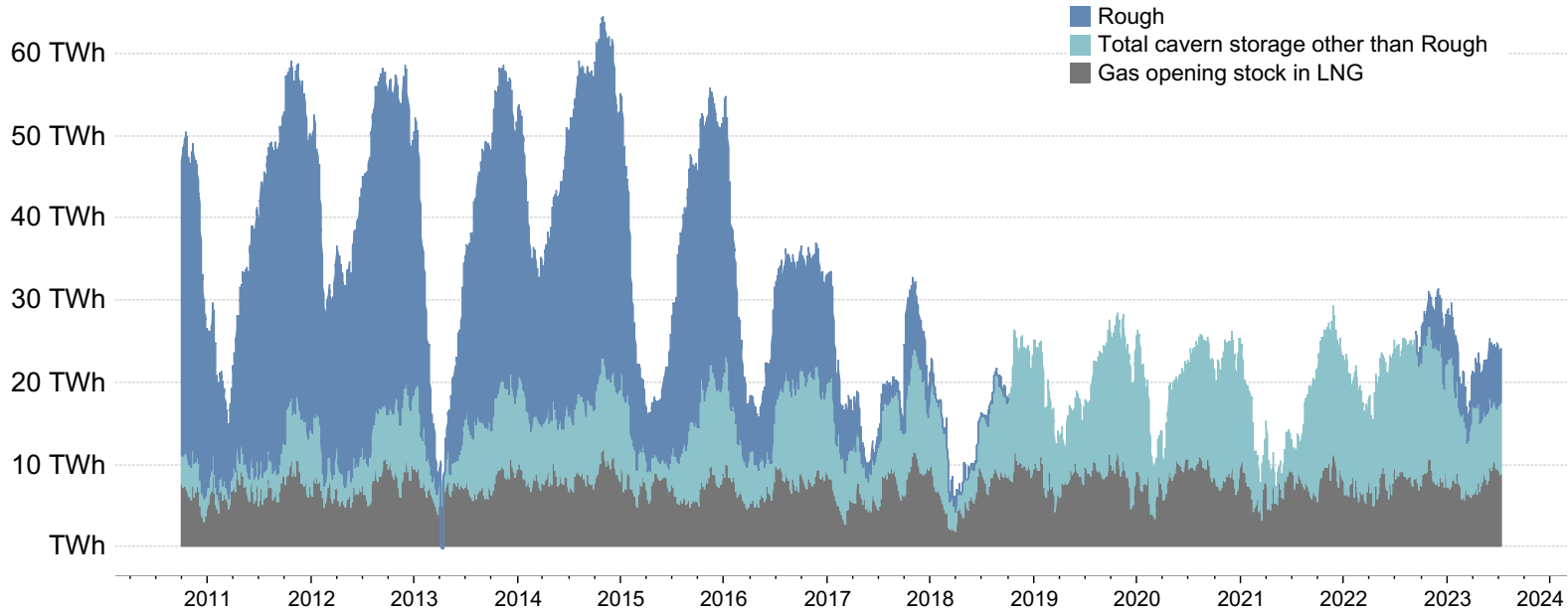


GB Gas system



GB natural gas system storage, note y-axis is in TWhs (none in Scotland)

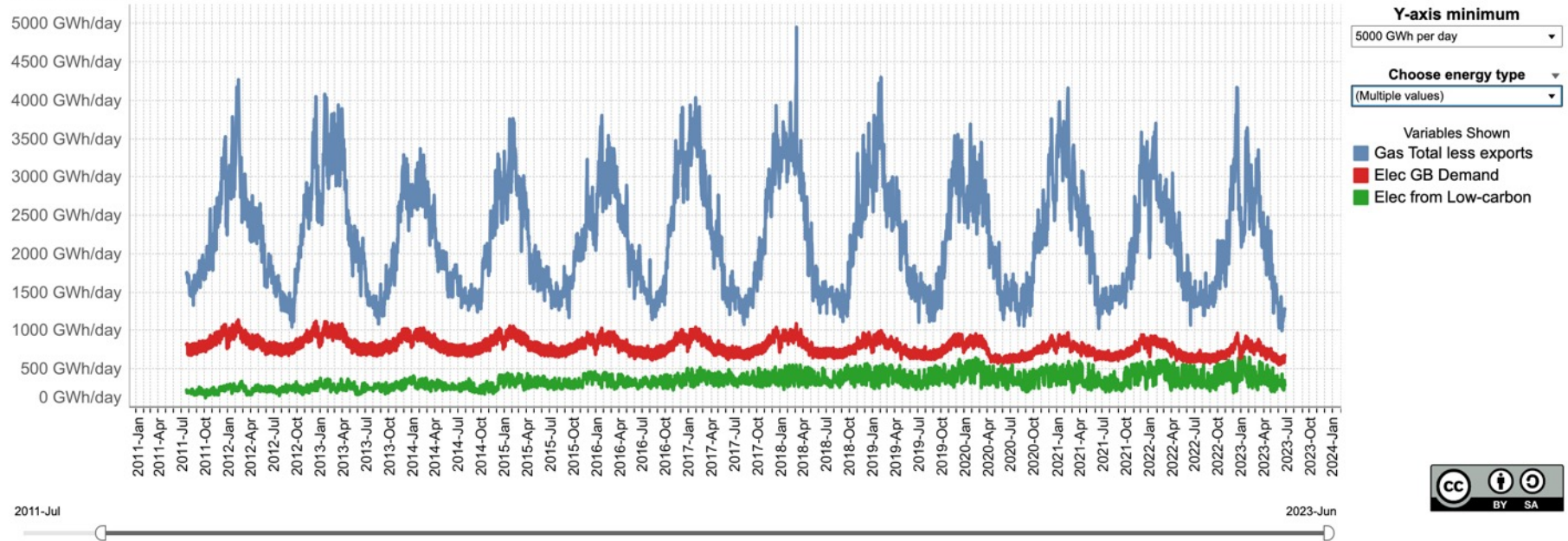
Gas opening stock in 'Storage' (Caverns + Rough) and LNG



GB natural gas system. Note: y-axis change to 5000 GWh per day

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Great Britain's energy in GWh per day



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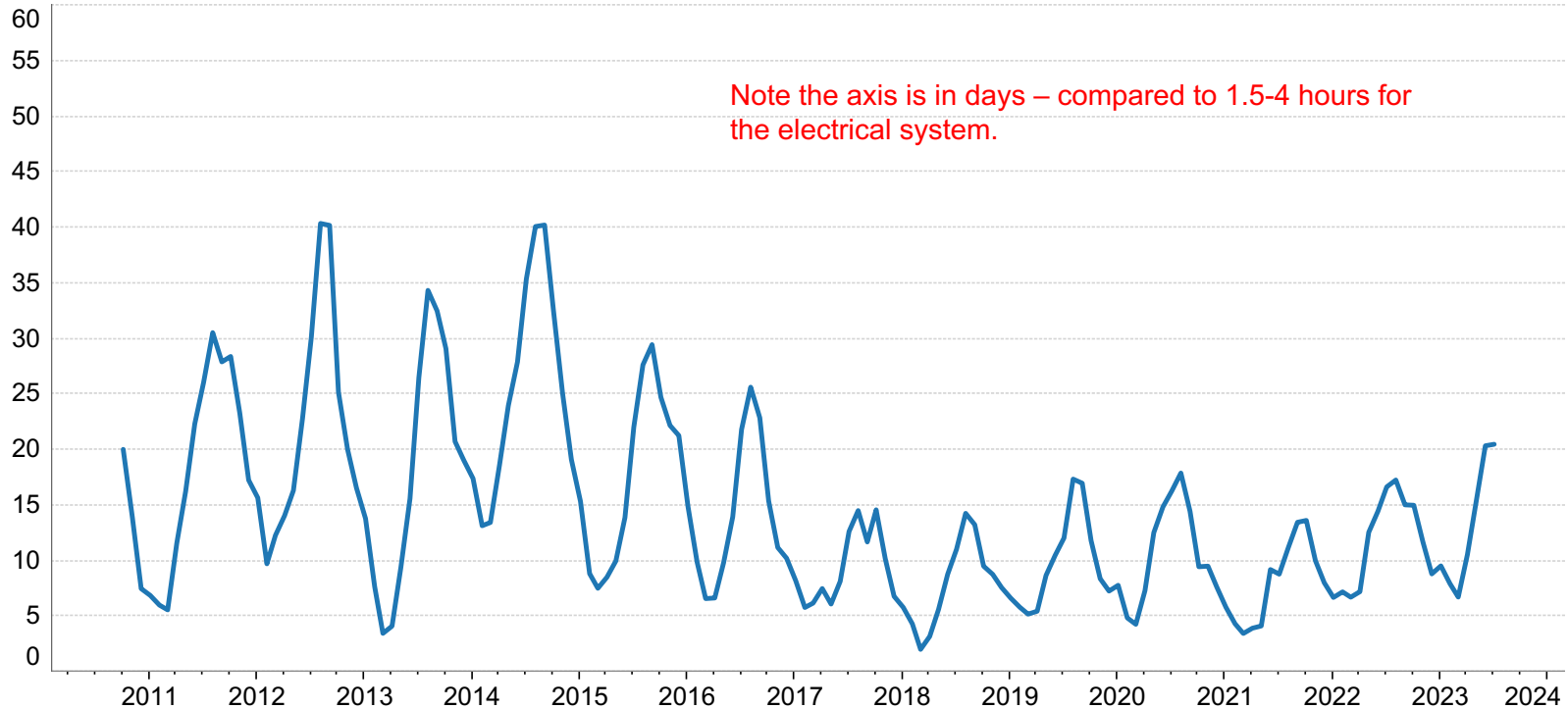
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<https://public.tableau.com/app/profile/grant.wilson/viz/GreatBritainsenergydailydata/GBenergyperday?publish=yes>

Average days of gas in storage in GBs national boundaries

Average days of gas in storage (gas storage and gas demand averaged over a month)



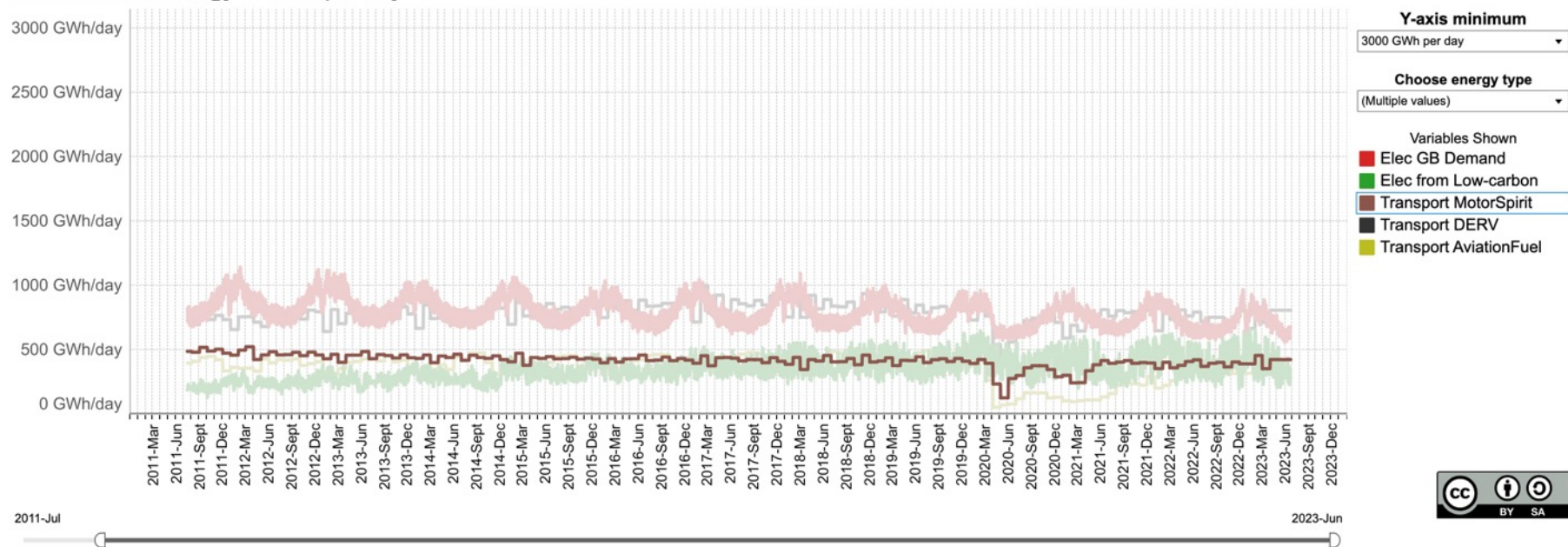
GB liquid fuels



GB liquid fuels: Motor spirit = petrol, subtle declining trend

READ ME GB energy per day GB energy by day of year Energy types date range

Great Britain's energy in GWh per day



2011-Jul

2023-Jun

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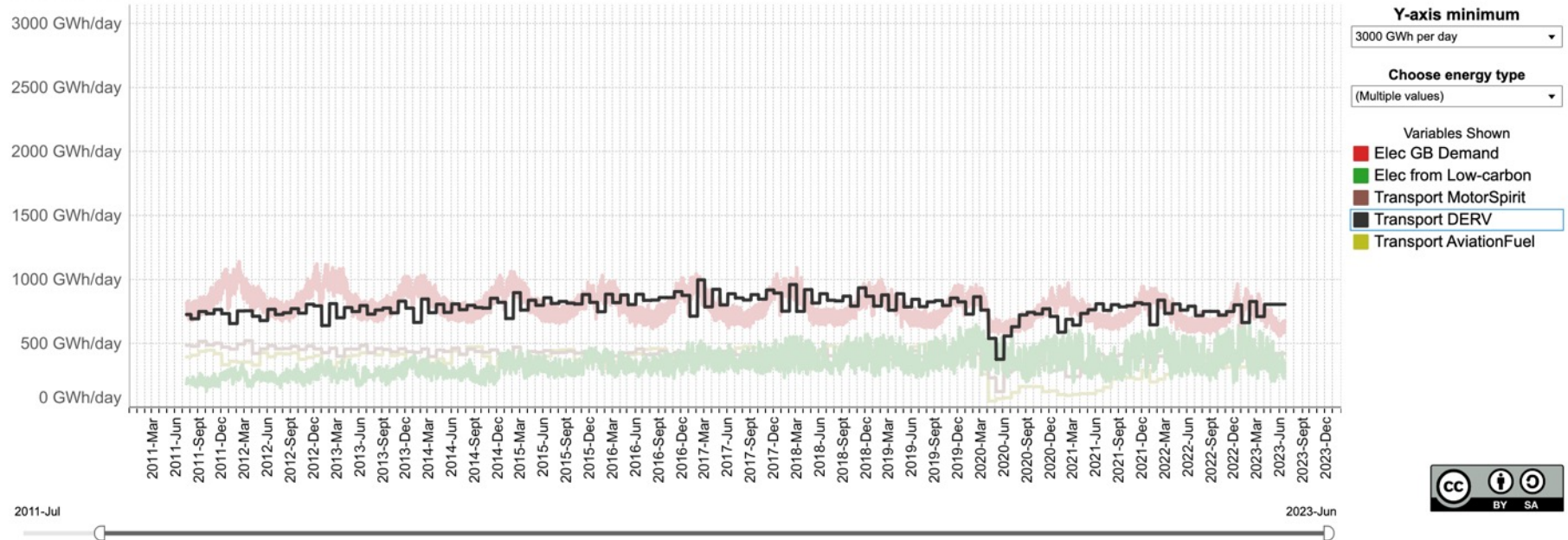
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GB liquid fuels: DERV == diesel, plateau or subtle declining trend?

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Great Britain's energy in GWh per day



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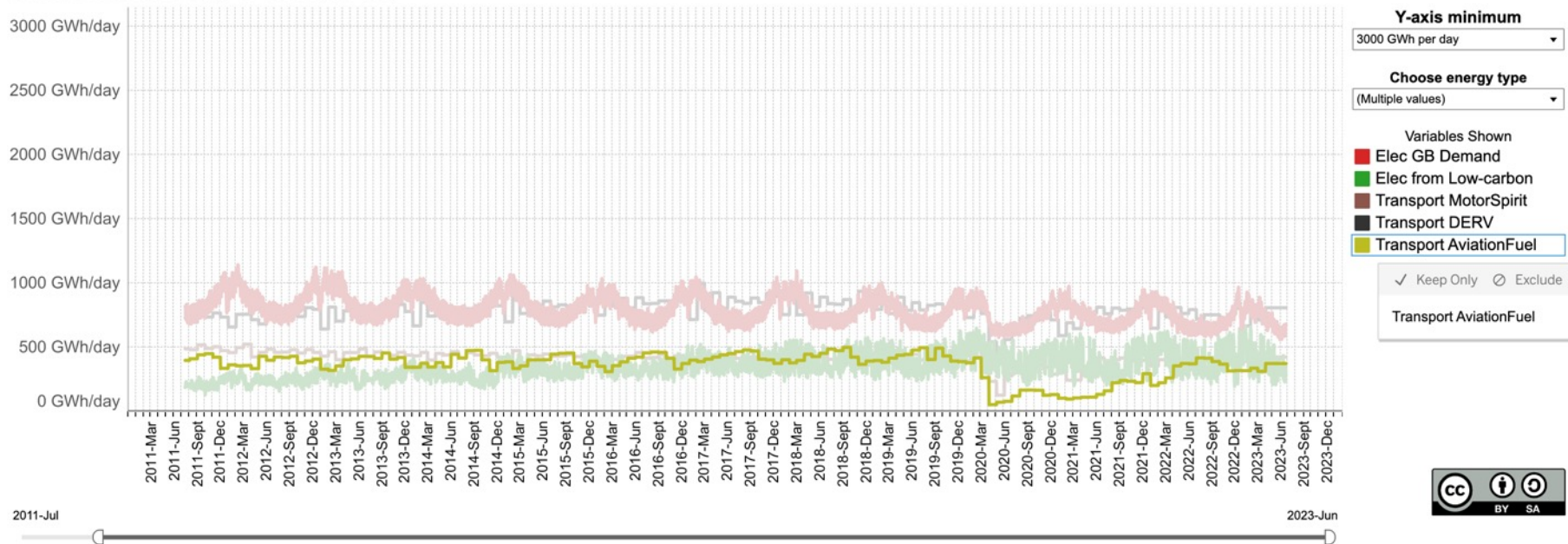
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GB liquid fuels: aviation fuel – shows some seasonality as expected

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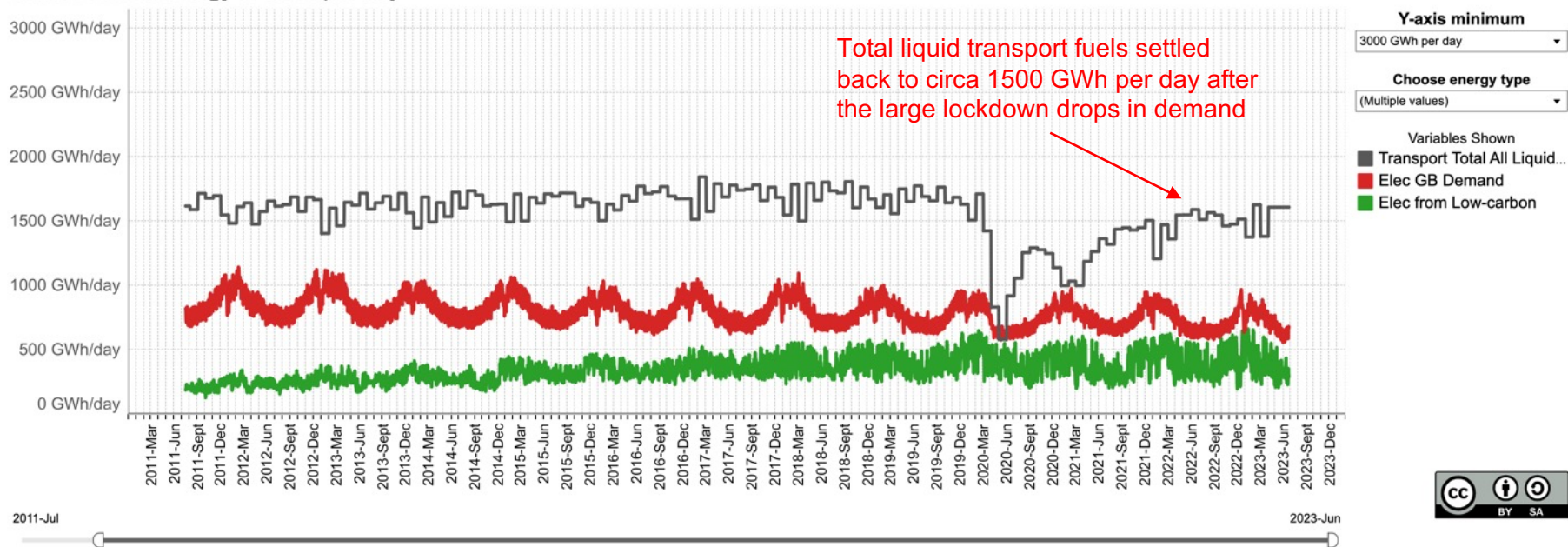
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GB liquid fuels: total of petrol, diesel and aviation fuel

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Great Britain's energy in GWh per day



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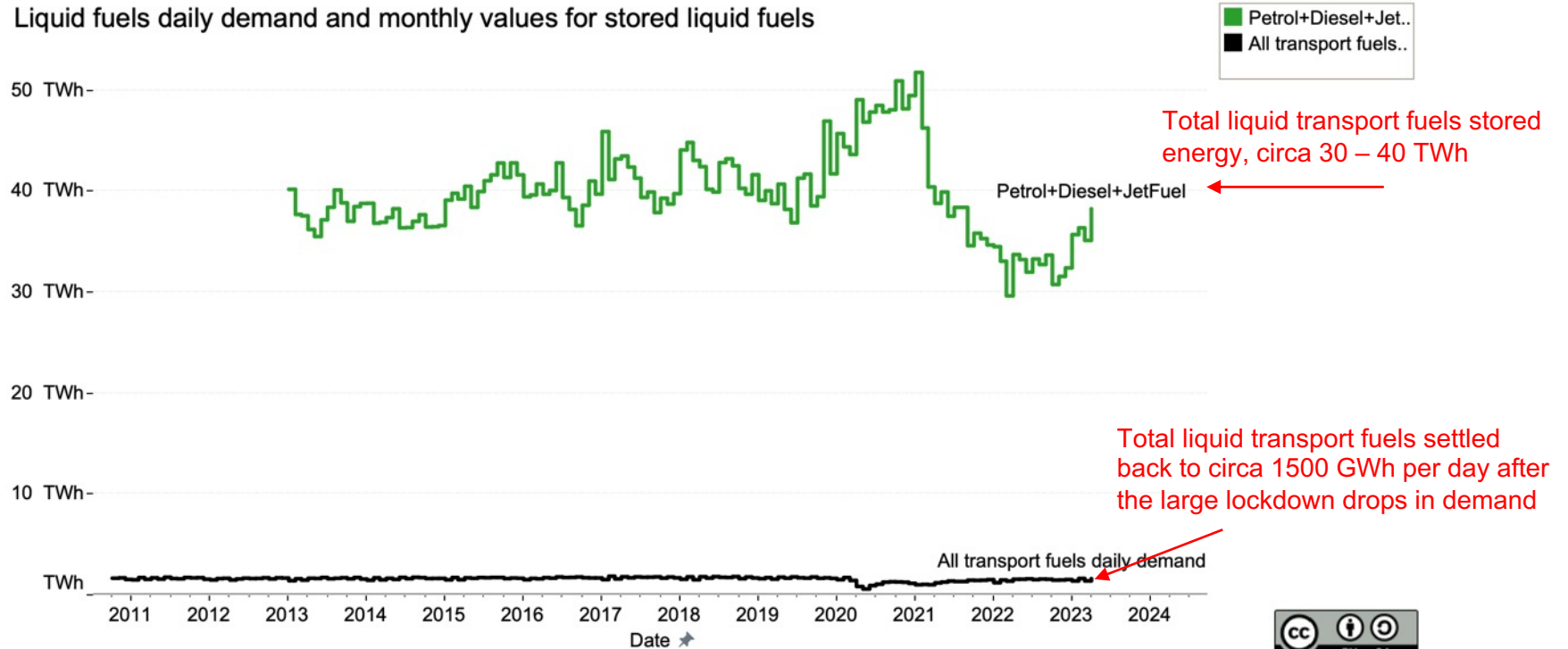


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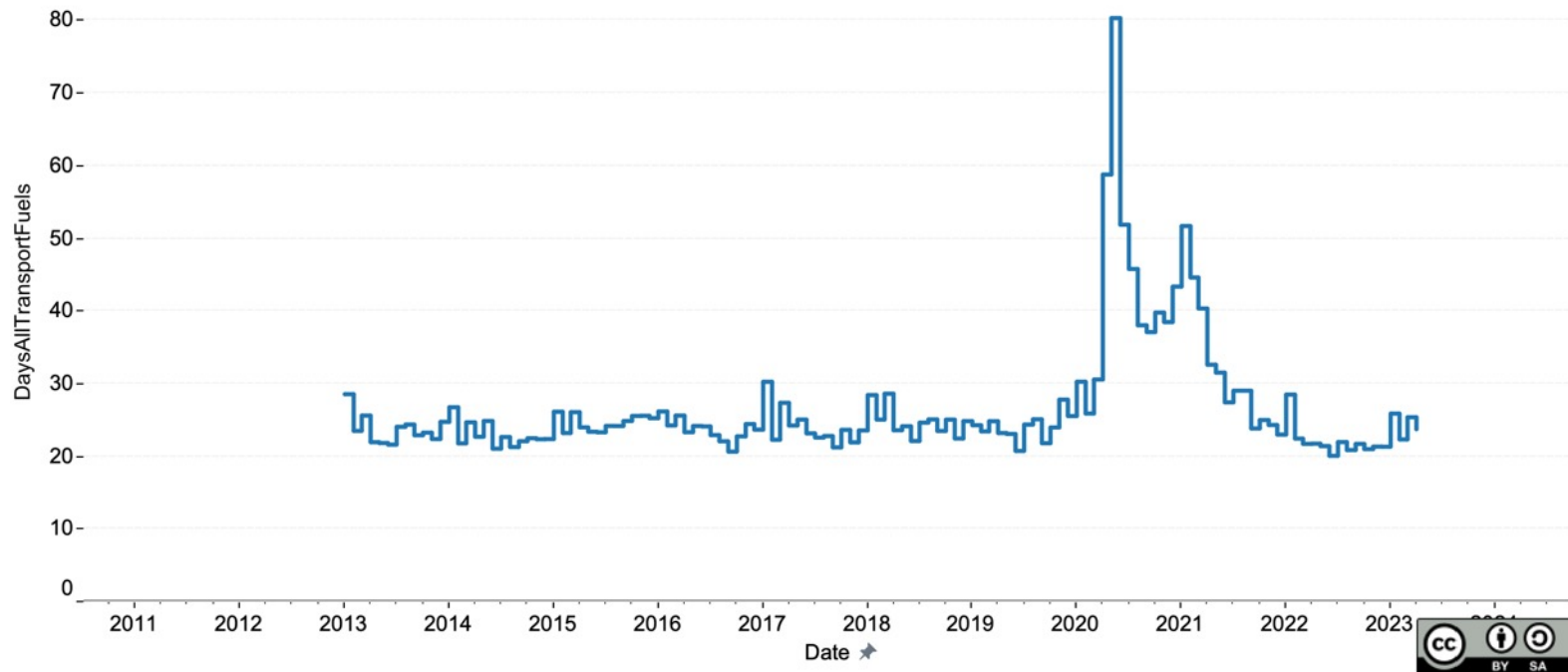
GB liquid fuels: total of petrol, diesel and aviation fuel

Liquid fuels daily demand and monthly values for stored liquid fuels



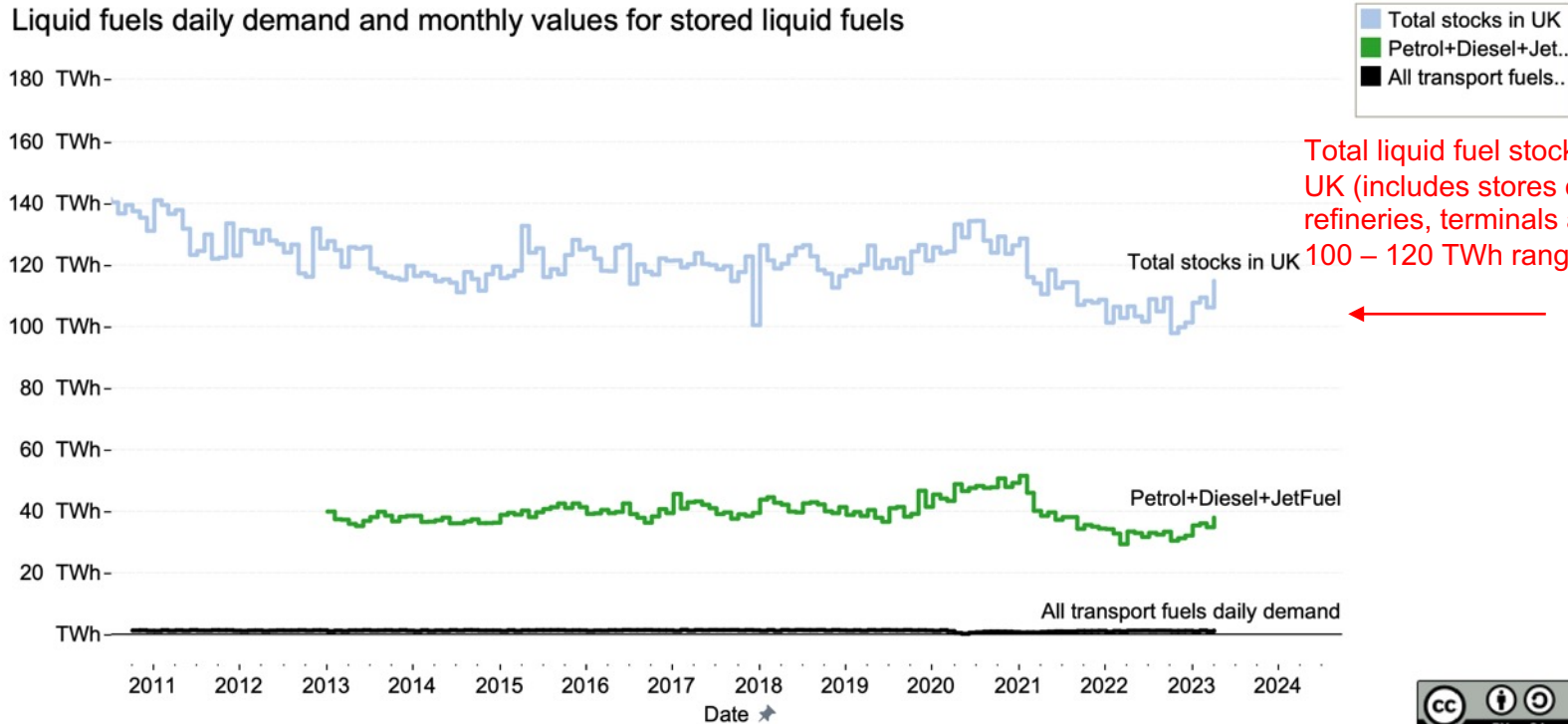
GB liquid fuels: days of liquid fuels in storage

Days of liquid fuel demand in storage



GB liquid fuels: days of liquid fuels in storage

Liquid fuels daily demand and monthly values for stored liquid fuels



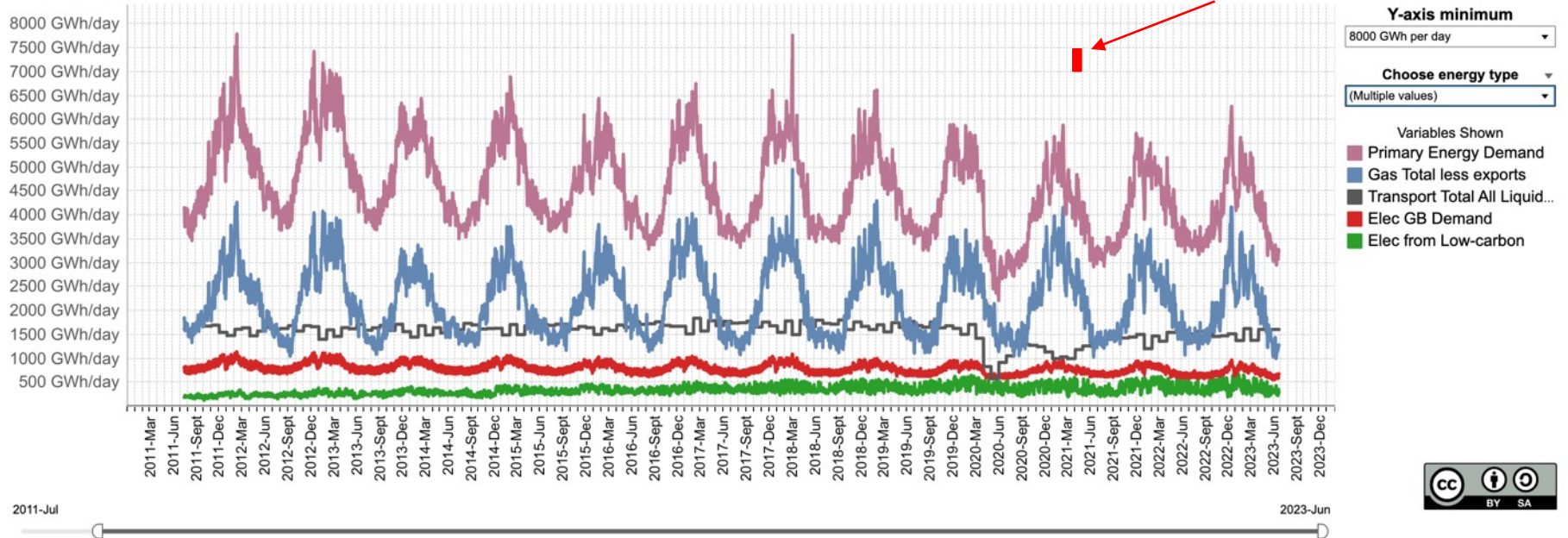
Primary energy



GB daily primary energy demand

READ ME GB energy per day GB energy by day of year Energy types date range

Great Britain's energy in GWh per day



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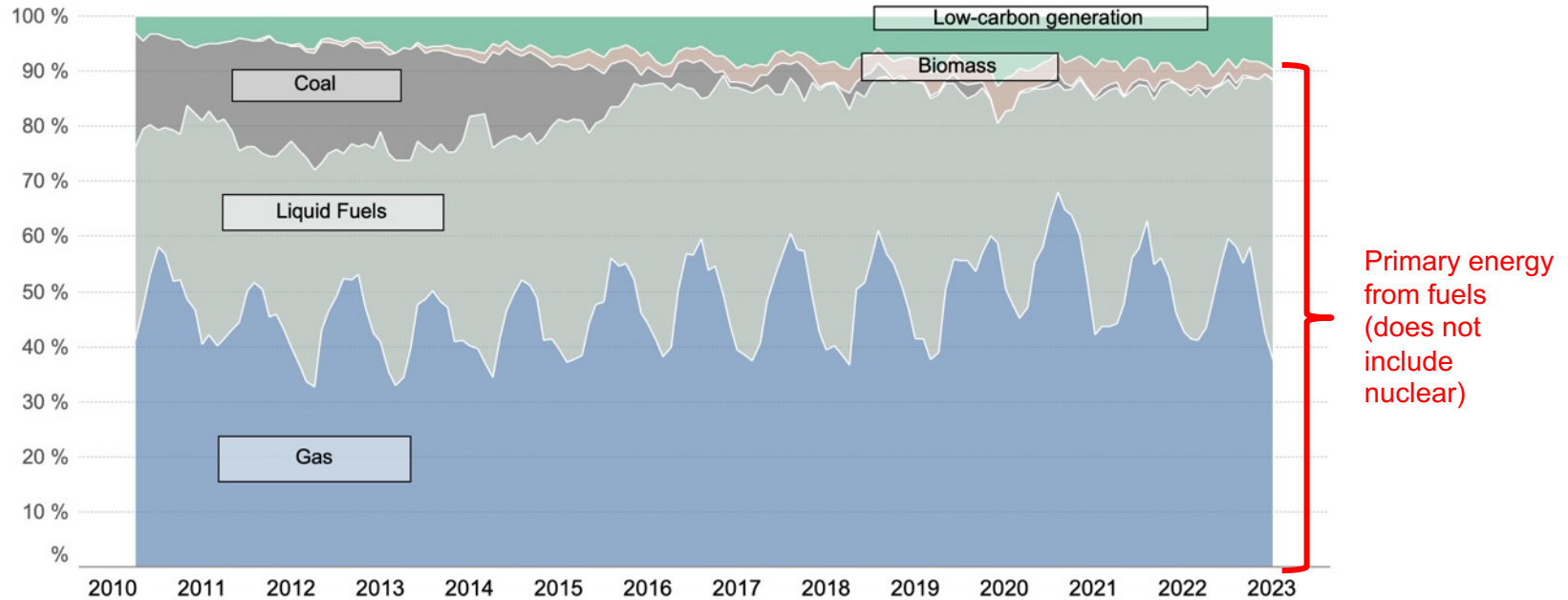
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Britain's monthly primary energy % by type

Britain's monthly primary energy % by type

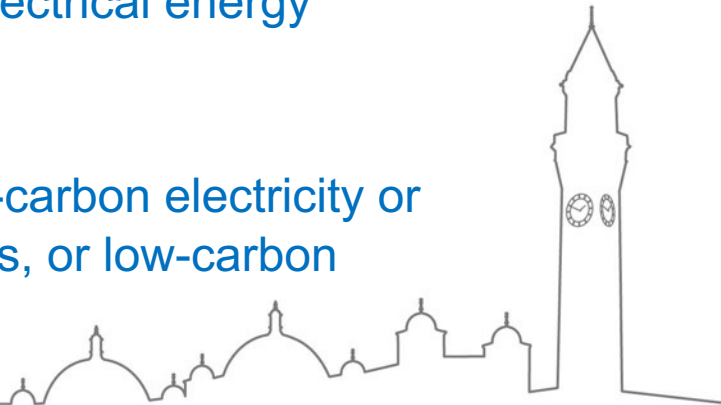


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Why is hydrogen storage a critical element of low-carbon energy systems

- Regardless of the reduction in the overall need for stored energy as final use demand is increasingly electrified, the wider system will need to cope with back-to-back low-wind events, potentially at times of year during the heating season
- This strongly suggests the need for low-carbon sources of stored energy at a minimum range of 10s of TWhs of electrical energy equivalent to be drawn upon over days to weeks
- These could be nuclear, interconnections of low-carbon electricity or gas, hydrogen storage within national boundaries, or low-carbon energy imports of some sort via shipping



Low-carbon fuels and sub-surface storage

- Likely that all of the options on the previous slide will be used to some degree in Great Britain, as a portfolio approach to energy system balancing over days-to-weeks and seasonal timeframes has benefits
- The presentation has only really considered the scales of energy for Great Britain, but this what would happen if generation and storage within GB's national boundaries was scaled to provide a service to neighbouring countries too? An open question
- Very much looking forward to the talks throughout today – thank you for listening – I am happy to answer questions during the breaks



Net electrical imports, cumulative sum for years 2011 to 2023

Net electrical imports

