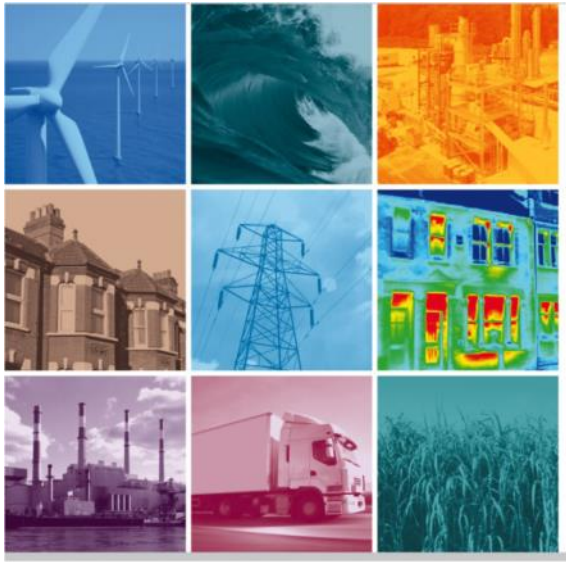

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Modelling Storage and Flexibility within the Whole Energy System

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Senior Analyst - Energy Systems Catapult

Analysis capability

A significant body of knowledge and skills developed in the ETI will be transferring to the Energy Systems Catapult

Consumers, Vehicles and Energy Integration Model

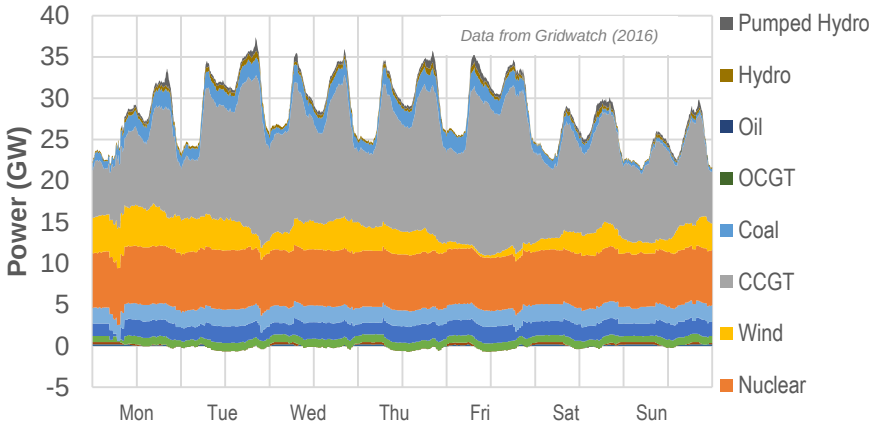
Storage and Flexibility Model

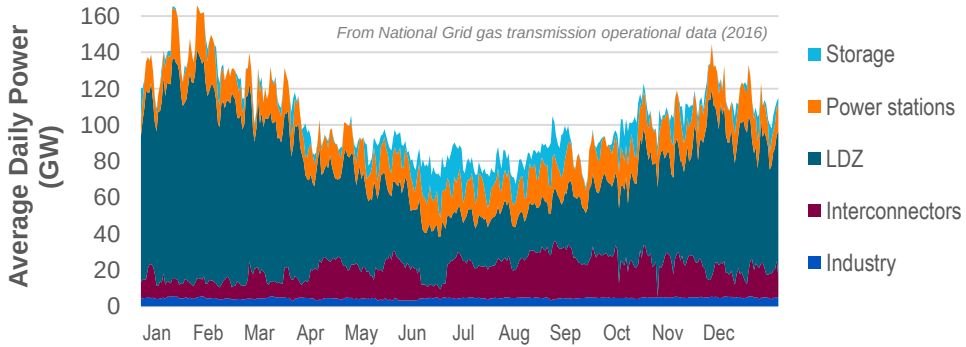
Infrastructure Cost Calculator

Heat Network Cost Model

Balancing supply and demand

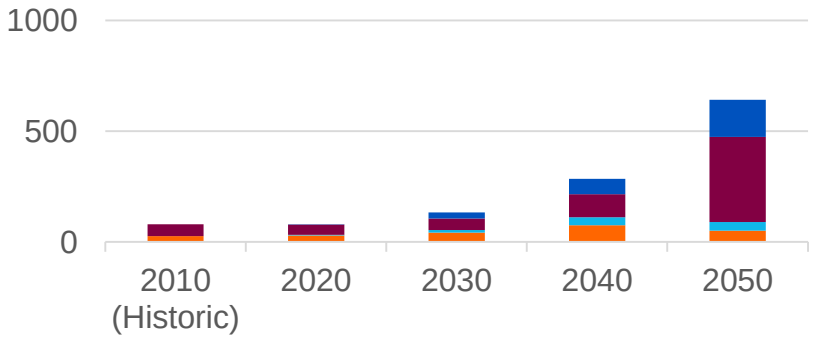
- Keeping supply and demand in balance is a key feature of a functional energy system.
- This already happens extensively in the electricity and gas systems
- One means of providing this system balancing is energy storage

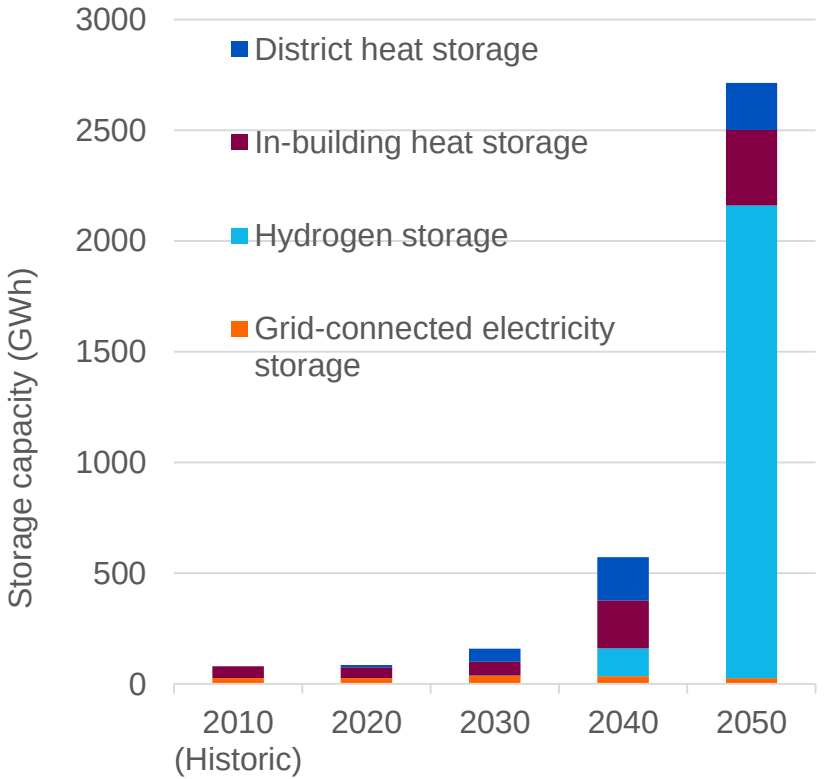




To what extent is energy storage needed?

- The need for storage depends on the make-up of the wider energy system in which it operates
- In a decarbonised energy system the availability of options such as CCS will have a profound effect on how decarbonised electricity is provided and in turn how much and what type of storage is needed
- Once deployed how energy storage is used is critical, affecting which investment models are most appropriate

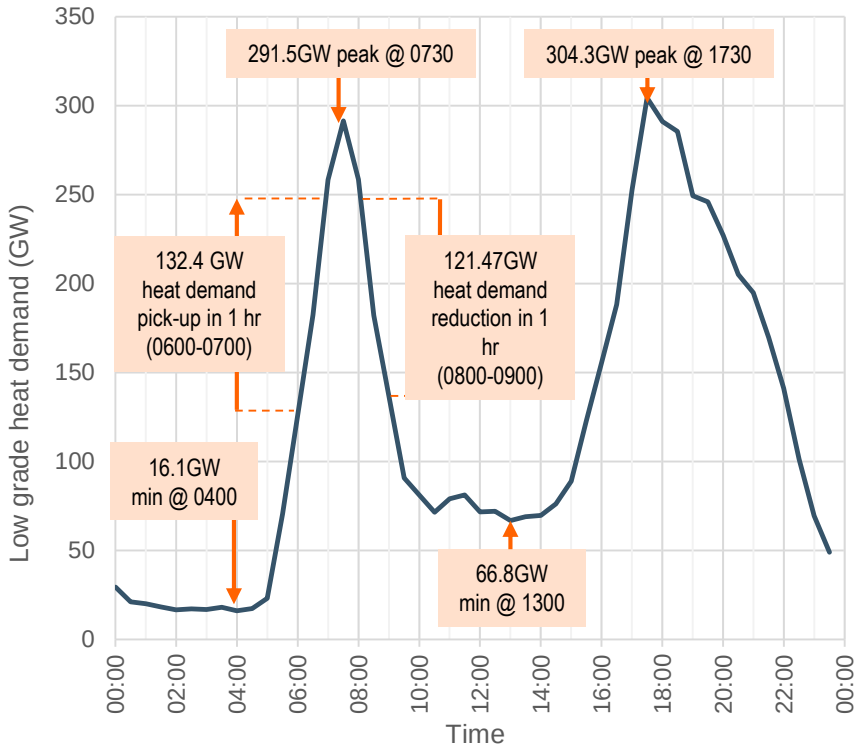




Data from ESME (2016)

Energy storage in networks

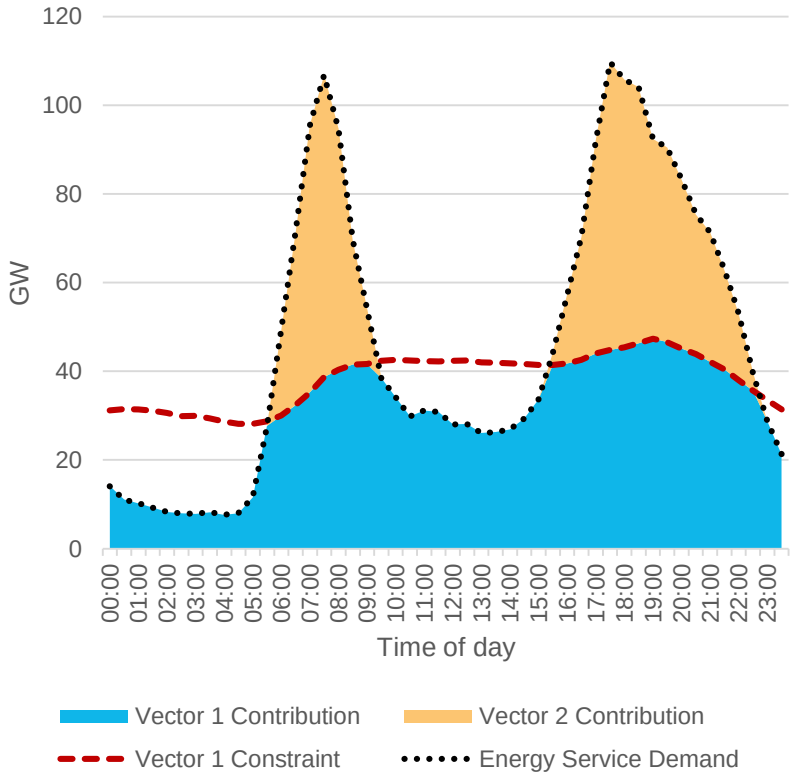
- The make-up of the energy system also affects the energy networks that are required
- The ability to provide storage varies amongst the network types:
  - Gas, hydrogen and heat networks all have a level of inherent storage (e.g. line-packing in gaseous pipeline networks); whilst dedicated storage is relatively low cost
  - Electricity supply needs to be in real-time balance; and electricity storage is generally expensive
- Beyond temporal factors networks also introduce spatial and hierarchical factors



Based on data from Robert Sansom (2011)

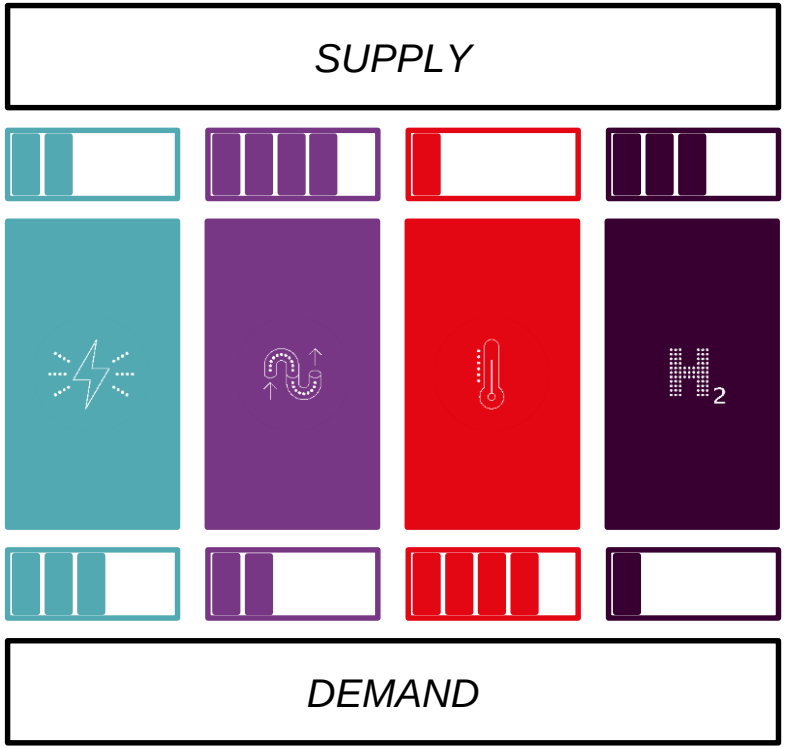
Flexibility provision beyond storage

- Future flexibility options extend beyond just grid-connected electricity storage, for example:
  - Gas and hydrogen fuelling peaking plant to help balance electricity supply
  - Heat storage in homes allowing the load on electricity networks to be reduced at peak times
  - Gas as peak support for heat pumps
  - Managed charging of plug-in vehicles
- How applicable and successful these are also affects the extent to which storage is needed



Storage and Flexibility Modelling

- Energy system modelling capability to increase understanding of the role of energy storage and system flexibility in the future energy system
- Providing holistic, techno-economic analysis of storage and competing sources of flexibility across multiple:
  - **Energy vectors**: electricity, heat, gas, hydrogen
  - **Points in the energy system**: transmission level, distribution level, behind-the-meter (industry, commercial, domestic)
  - **Services**: e.g. frequency containment and replacement, reserve replacement and wider system benefits such as peak shaving
- Accounting for different types of future energy systems
- Distributed across different regions in GB



Understanding the role of energy storage

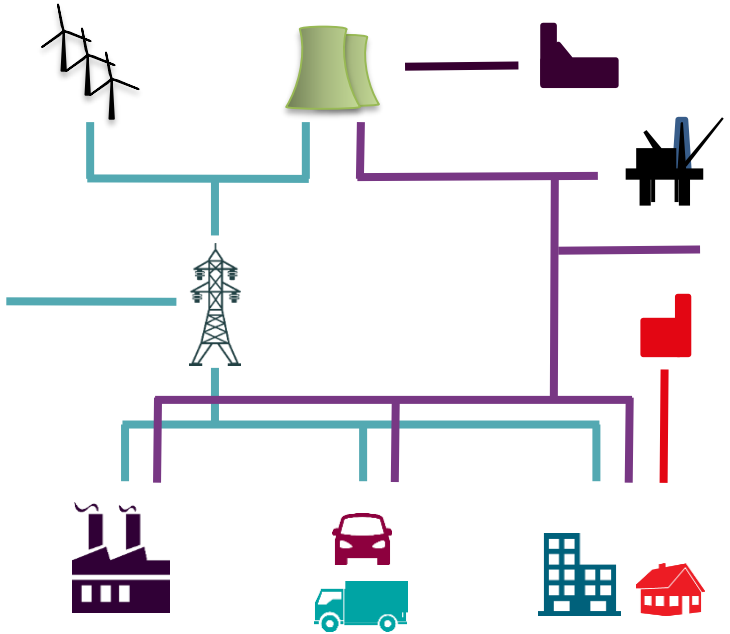
- Key research questions:
  - *What is the future role of energy storage in the energy system considering the aforementioned factors holistically?*
  - *What is the scale of the different future service requirements (e.g. in MW, MWh)?*
  - *What is the value of various forms of storage to the system?*
  - *How do the key drivers of uncertainty (both short- and long-term) affect the potential role of storage & alternatives?*

- Supplementary research questions (primarily qualitative)
  - *What might be required (e.g. policy support) to facilitate private investment in the level of storage suggested?*
  - *What new services / business models might emerge to maximise storage value from an investor perspective?*

Modelling approach (1)

The modelling capability accounts for:

- Underlying **demand** which the overall energy system needs to meet – *across industry, transport, housing, power generation*
- Different **generation mixes** – *e.g. different levels of intermittent renewables, nuclear and CCS*
- Available **flexibility options** – *including: storage, interconnectors, managed charging, heat storage, I&C DSR/Load shedding, peaking plant and gaseous storage*
- **Operating characteristics** of different generation assets and flexibility options
- Existing **network capacities**
- System **operational factors** – *technical requirements and system benefits*
- Long term **constraints** – *e.g. decarbonisation*



Modelling approach (2)

Capacity Investment Requirements

- Low temporal granularity
- Builds: generation, storage and demand side technologies
- Decides: the extent of electrification etc.
- Includes industry and domestic retrofits – such as CCS or thermal improvements
- Transmission and Distribution network costs

System operation to meet demand

- High temporal granularity
- Representation of system service requirements
- Shows storage utilisation to meet short, medium & long term requirements
- Power generation commitment and curtailment
- Represents how DSR and Managed Charging can contribute towards the whole system cost reductions.

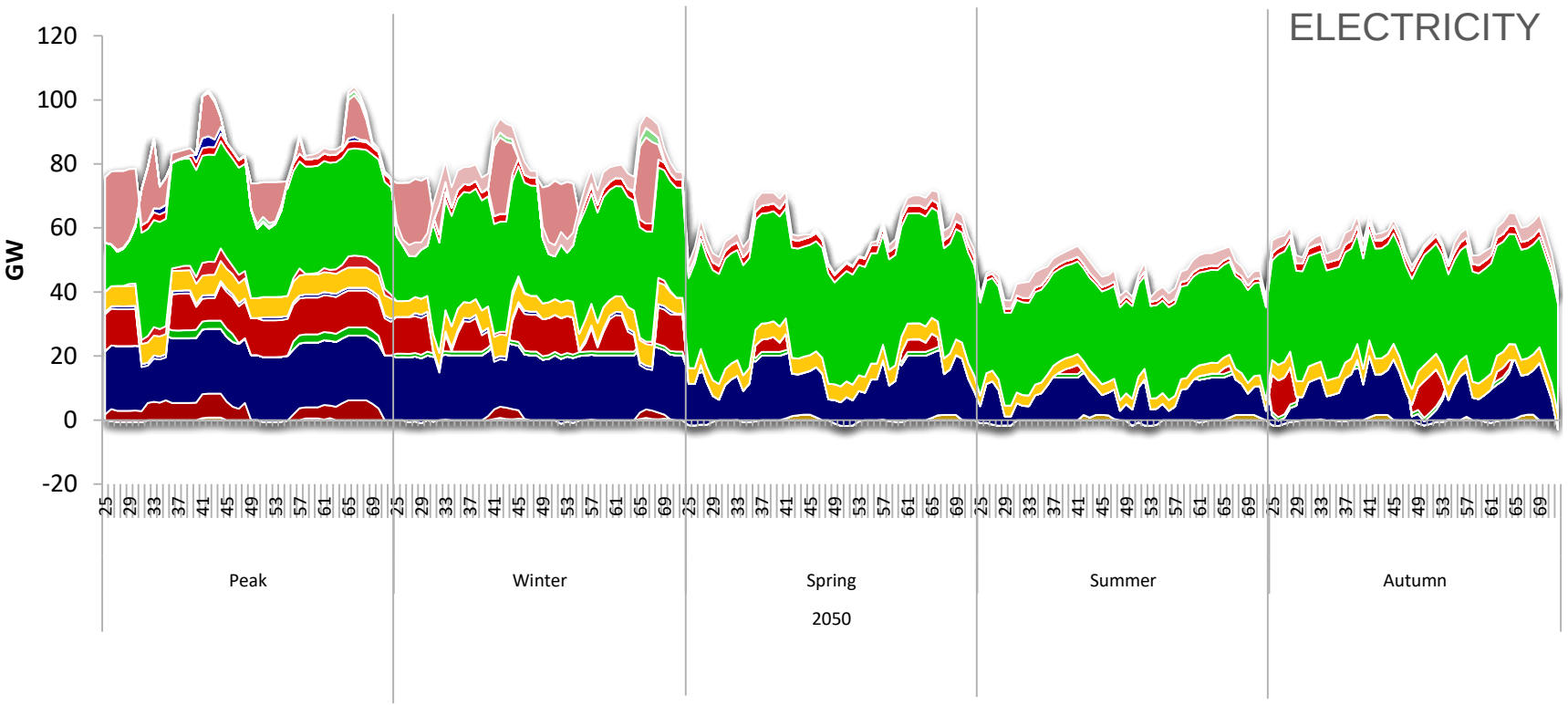
Achieved by…

Co-optimisation of energy vectors, supply, demand and system requirements
Network analysis across multiple levels of the grid
Integration of uncertainty around drivers (such as weather data, IC prices and behaviour)

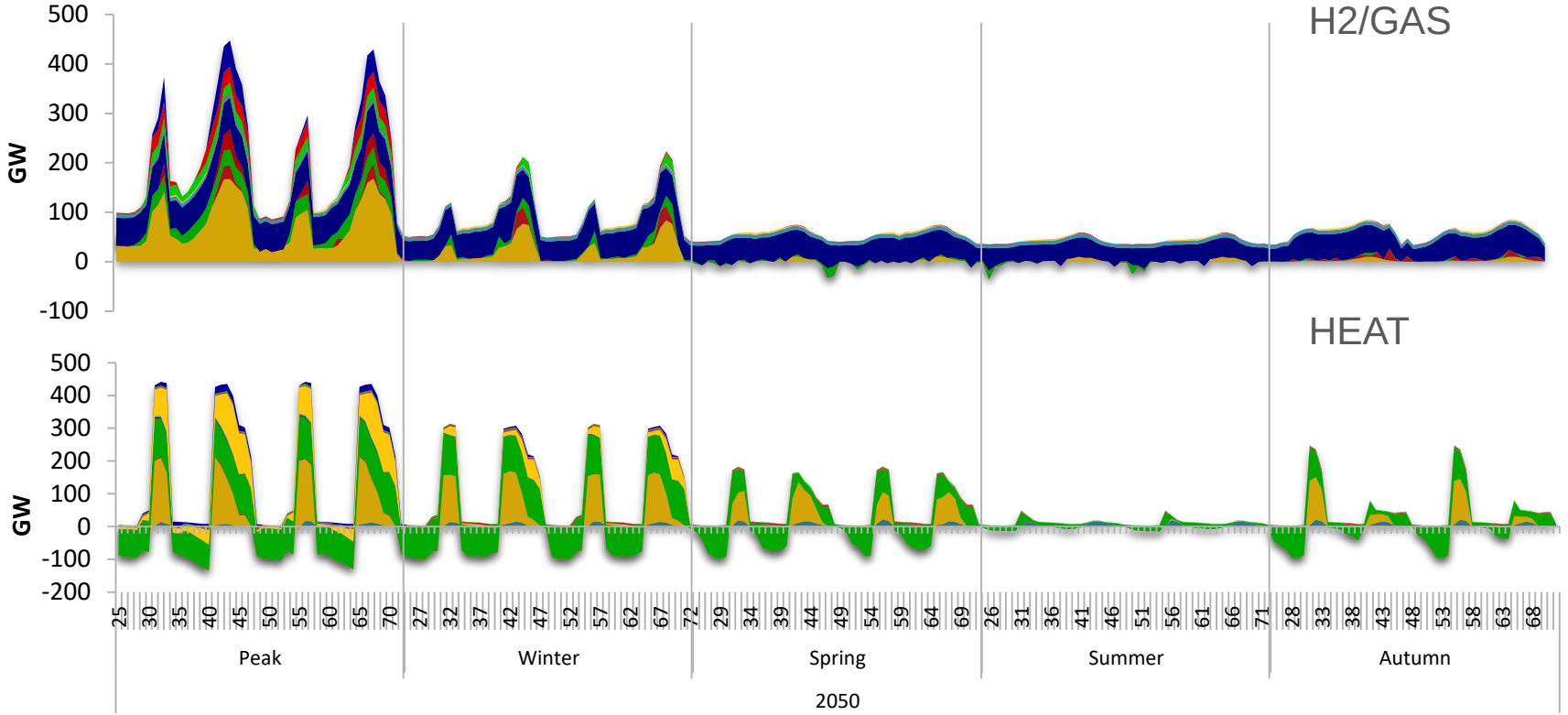
A demonstration of

CAPABILITIES

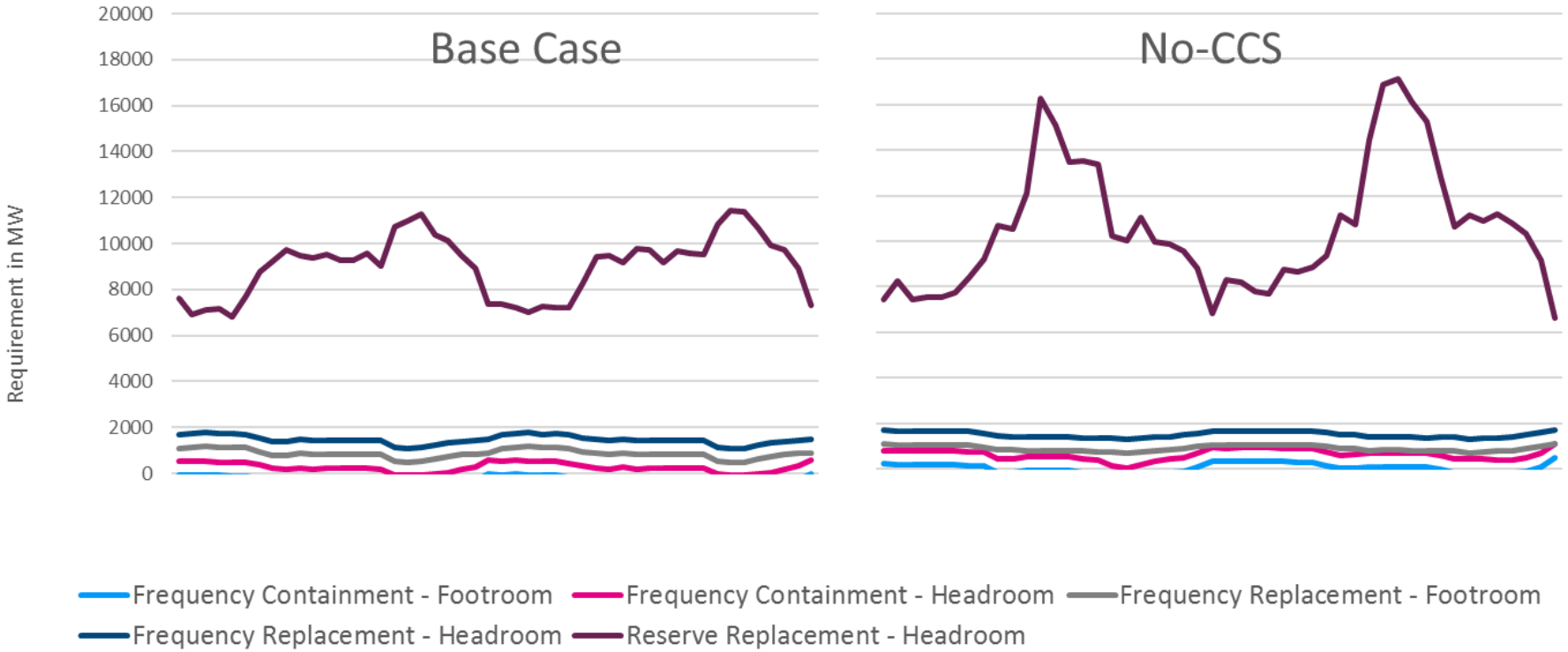
Energy Dispatch (Including Storage)



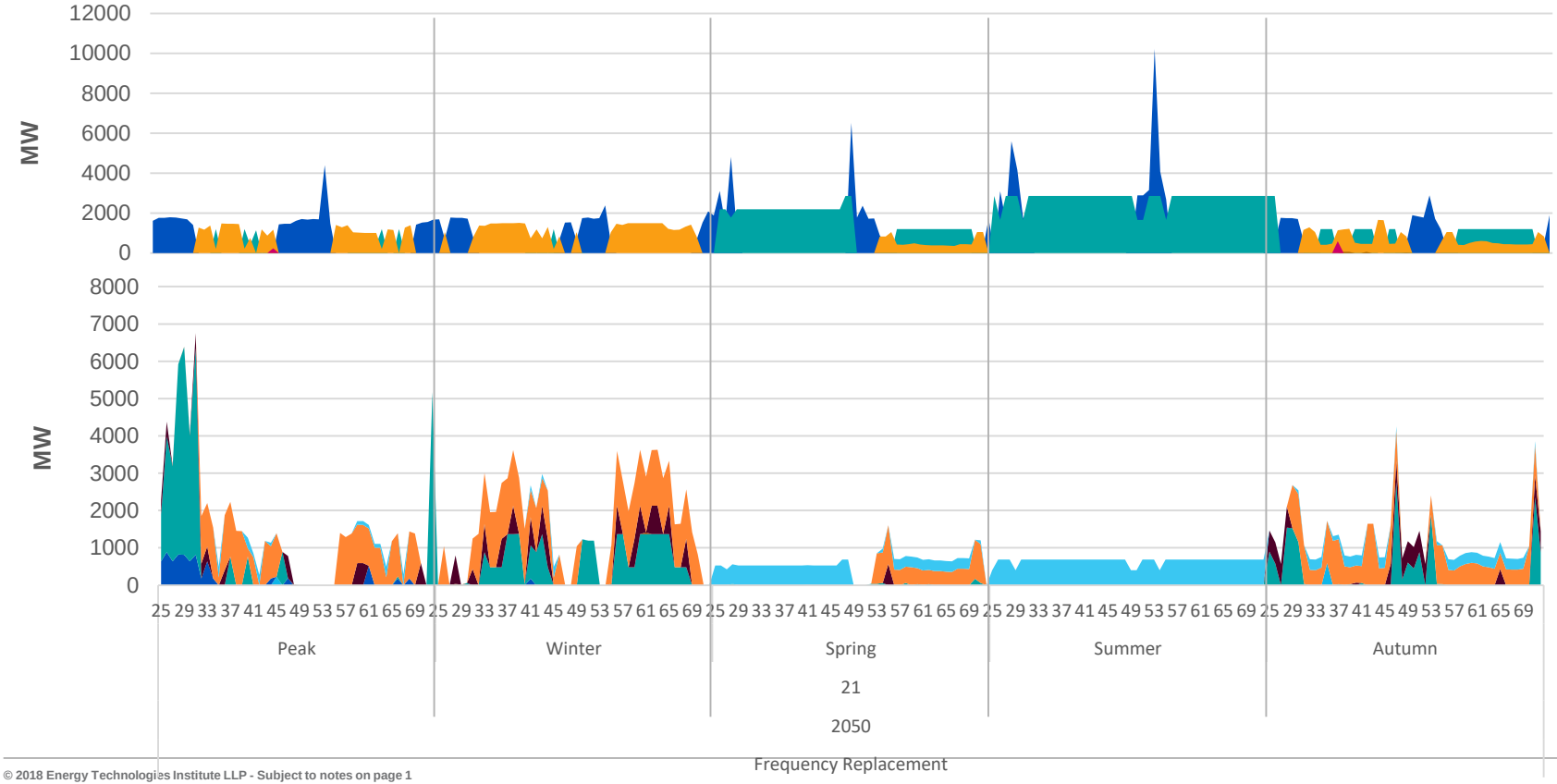
Energy Dispatch (Including Storage)



Electricity Service Requirements - Winter 2050



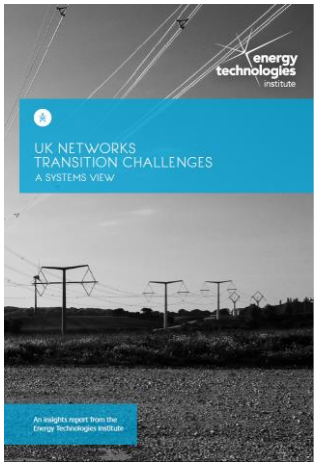
Service Contributions – Frequency replacement example

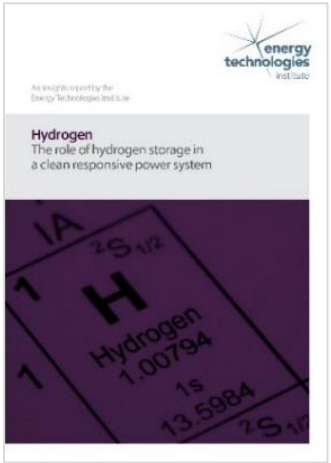


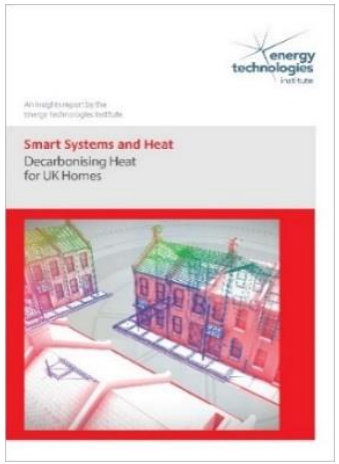
Summary

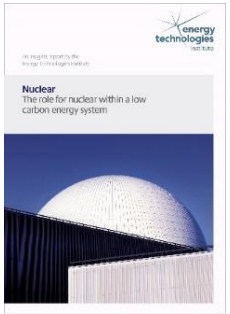
- Energy system balancing is critical and extends beyond the electricity system
- Changes to the energy system are shifting the emphasis on how much and what type of flexibility measures are needed – future changes will only increase these shifts
- There are opportunities to utilise a variety of flexibility measures to deliver system operability, including:
  - Energy storage
  - Gas and hydrogen fuelling peaking plant to help balance electricity supply
  - Heat storage in homes allowing the load on electricity networks to be reduced at peak times
  - Gas as peak support for heat pumps
  - Managed charging of plug-in vehicles
  - Interconnectors
- The ETI's Storage and Flexibility Model represents the role of storage and flexibility across multiple vectors, network levels, geographic regions and energy services through to 2050.

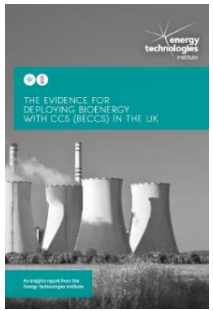
Available on the ETI's website











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