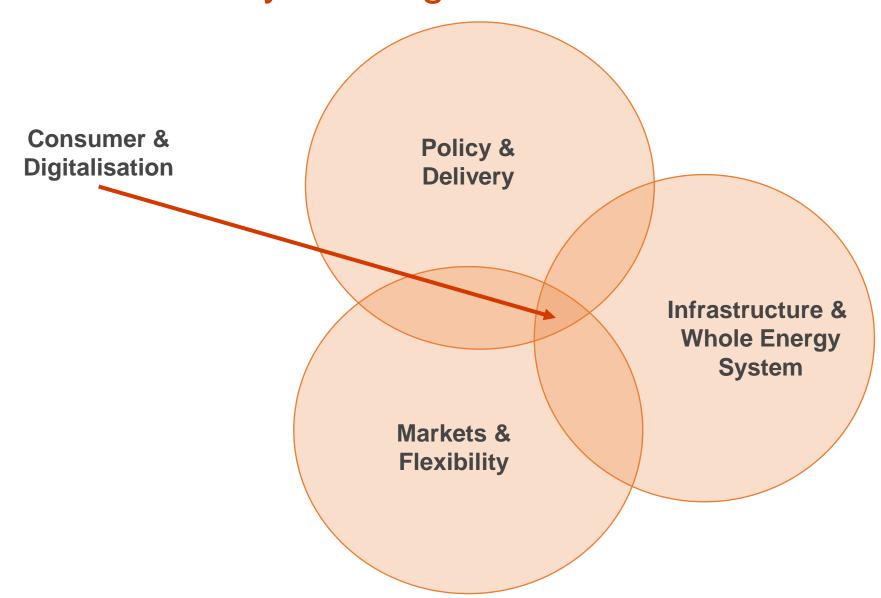
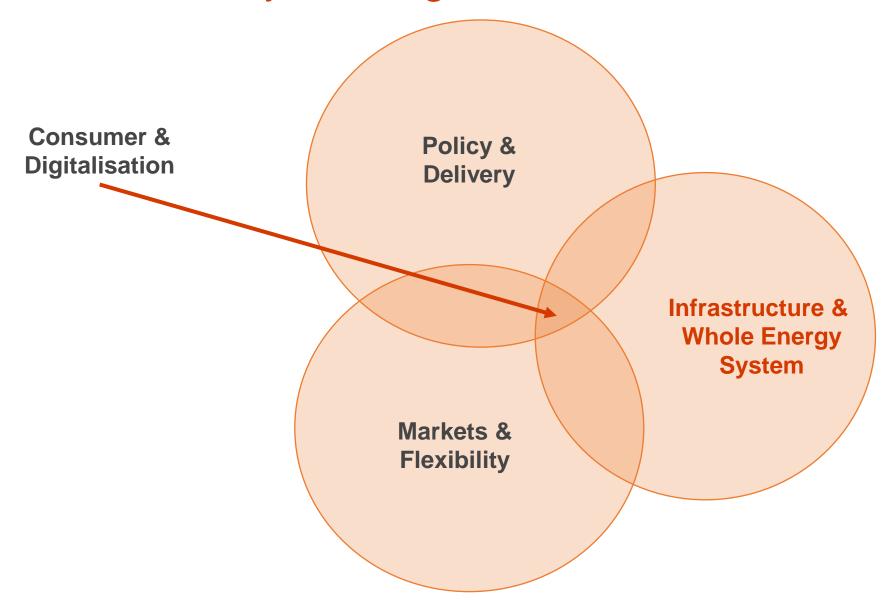


### The FES 2022 key messages are all connected



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in 2050



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#### Whole system competition

To ensure affordable delivery of new infrastructure, competition in delivery must be established for large projects.

Competition is also required at a local level to ensure different regions can adopt the low carbon solutions that are most suited to the needs of their consumers.



Strategic investment in the whole energy system is urgently required to keep pace with Net Zero ambitions and strengthen energy security.



Call to action



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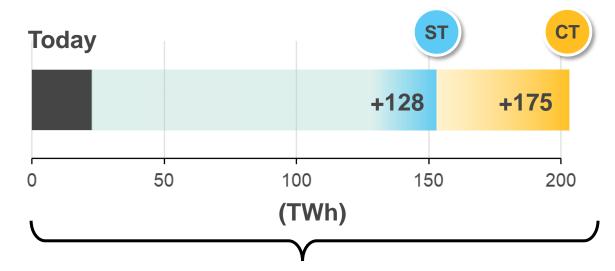
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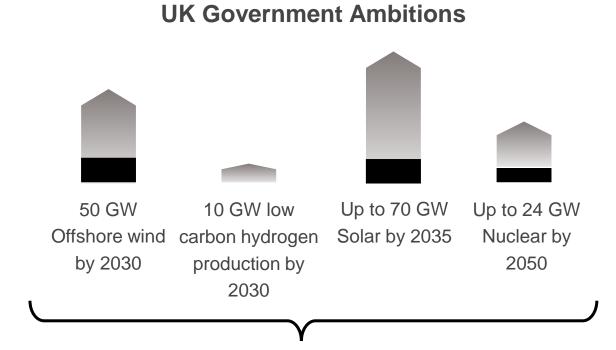
Competition is also required at a local level to ensure different regions can adopt the low carbon solutions that are most suited to the needs of their consumers.

# The UK has committed to decarbonising its economy and improving energy security

Total annual electricity demand for residential heat & transport in 2050



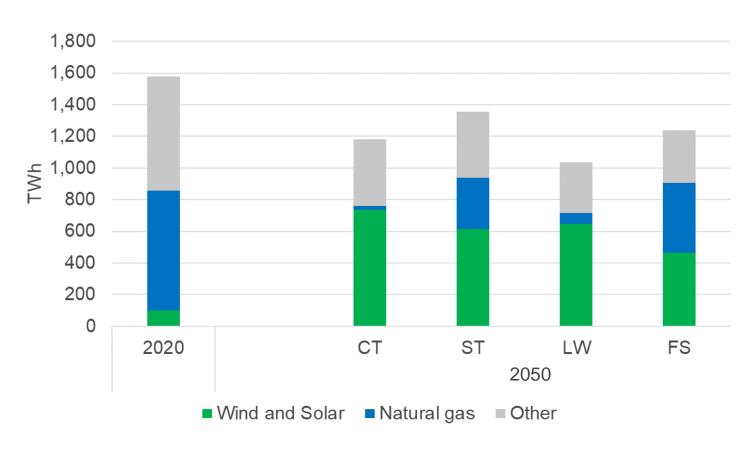
Significant electrification of demand in all scenarios – especially for heat and transport



Significant commitments to grow our generation capacity — especially wind and solar

# Wind and solar generation meet between 38% and 62% of total energy demand in all scenarios by 2050

#### Total annual energy supply (TWh)



#### This means...

- Proportionally less flexible generation over time
- We need to be able to flex demand and supply alike
- GB needs the infrastructure to move large amounts of energy around the country

# Strategic investment in the whole energy system is urgently required to keep pace with Net Zero ambitions and strengthen energy security. To deliver this we need...



Strategic whole system thinking



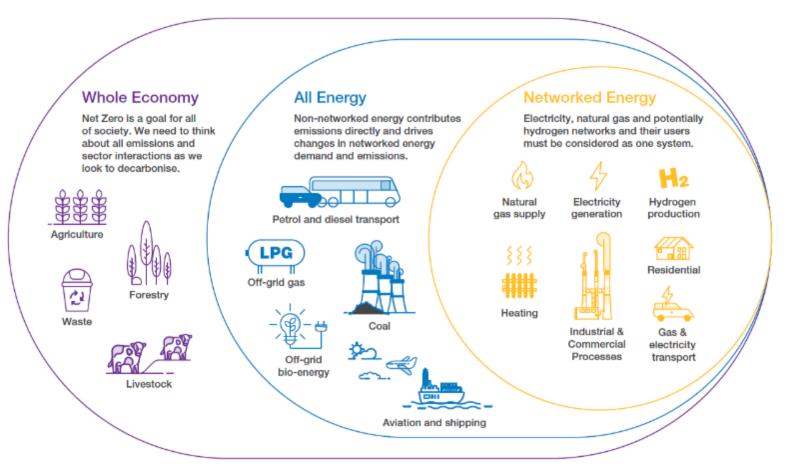
Inter-seasonal storage



Whole system competition

### Strategic whole system thinking includes...

...treating all energy value streams, and the people they serve, as one continuous system, where benefits in one area can solve challenges in another

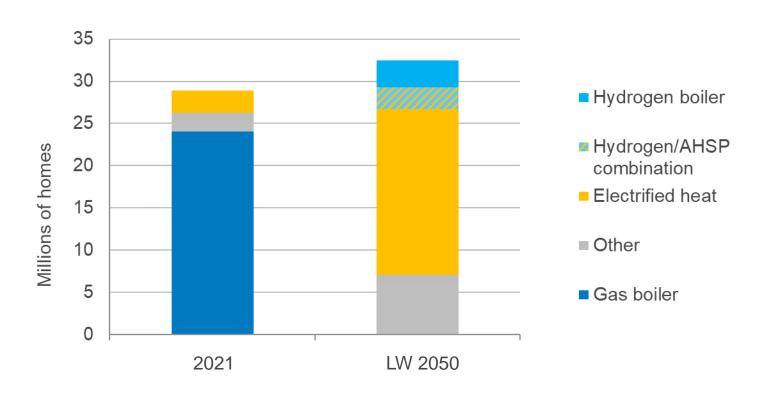


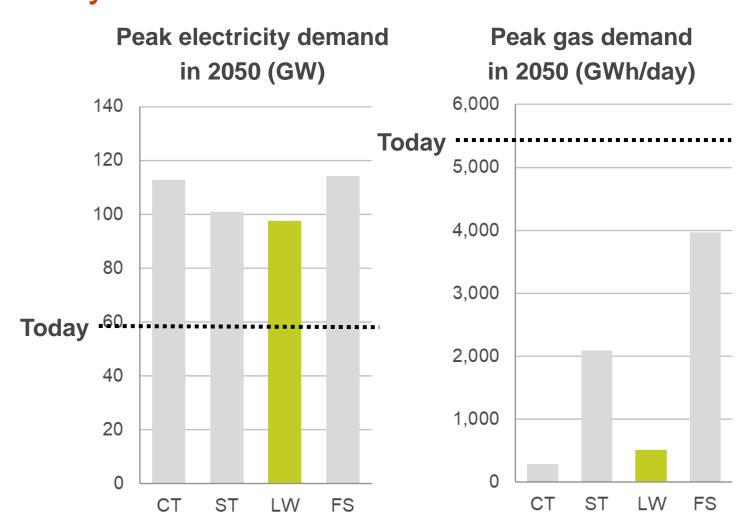
#### If done correctly, it helps to:

- Decarbonise the economy
- Reduce curtailment
- Improve Security of Supply
- Ensure the movement of energy around the country, and the creation of the infrastructure, happens as efficiently as possible

Increasing strength and speed of interactions between sectors (and value from whole system coordination and co-optimisation)

#### Combined technology for residential heat in Leading the Way





#### **Britain needs to:**

Combine green hydrogen and electrification for heat to minimise:

- natural gas demand
- increases in peak electricity demand



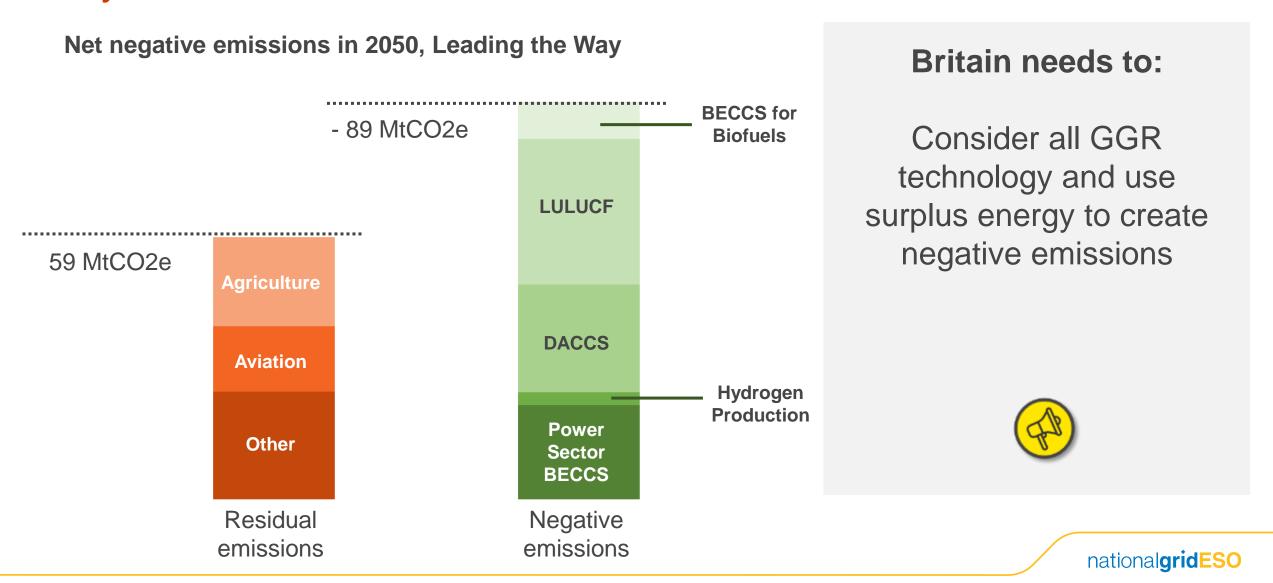
#### Supply and demand flexibility (GW)



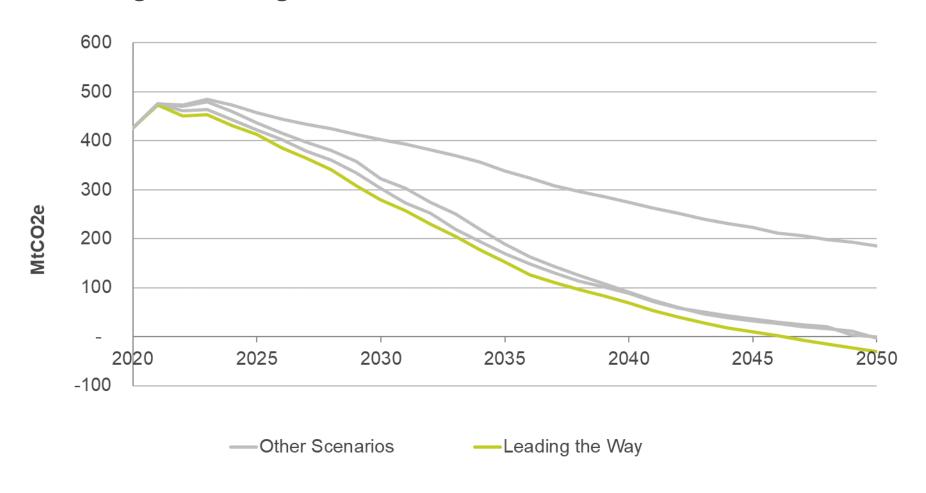
#### **Britain needs to:**

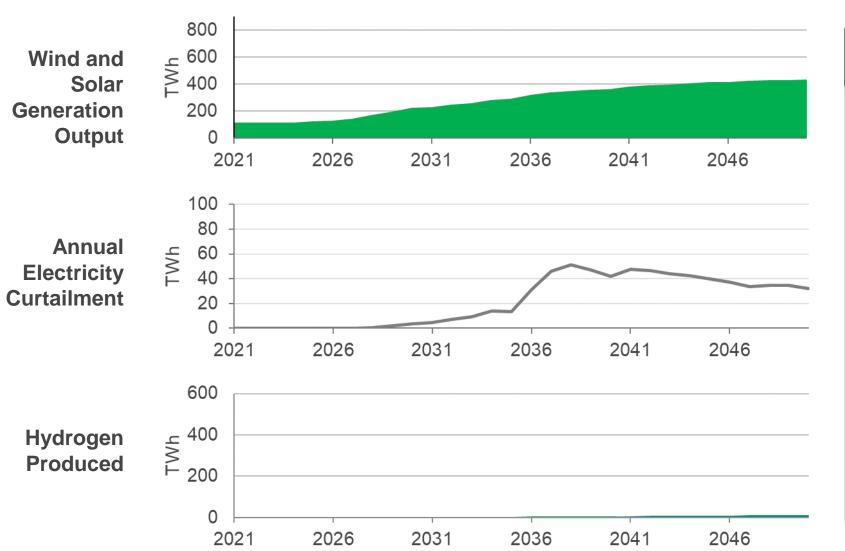
Invest in a balance of supply and demand flexibility to integrate the cheapest forms of renewable energy

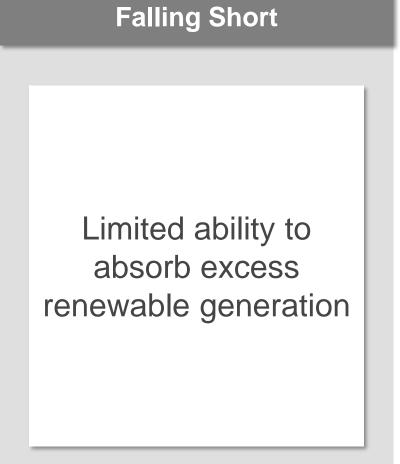


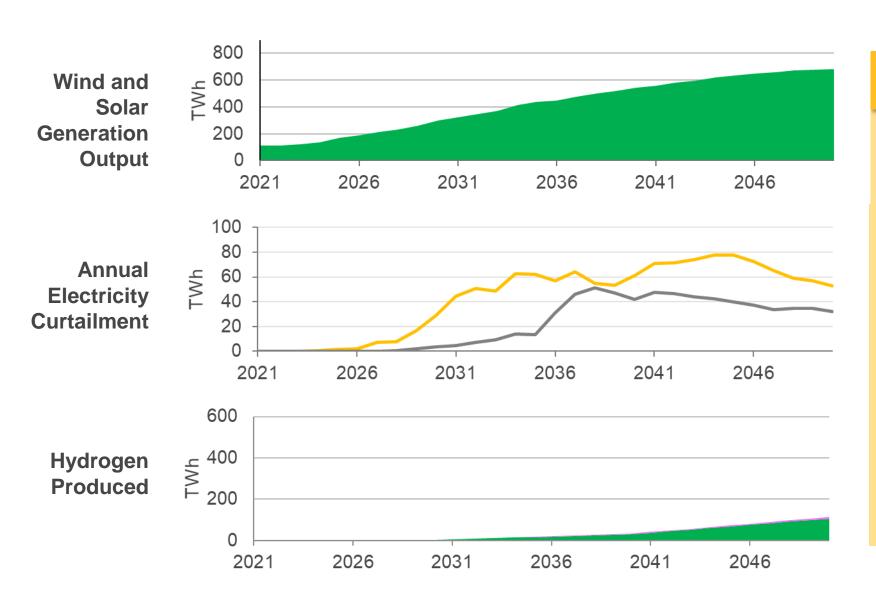


#### Total net greenhouse gas emissions



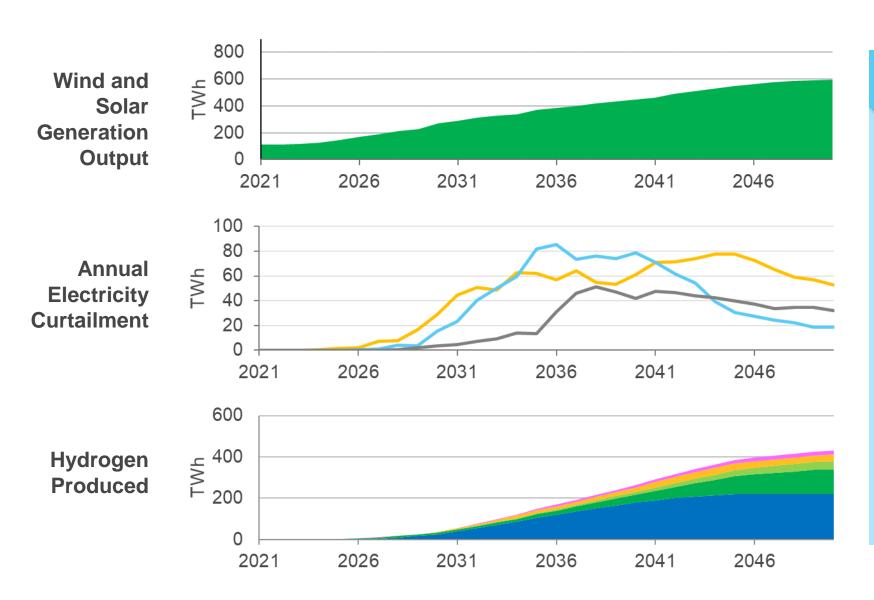






#### **Consumer Transformation**

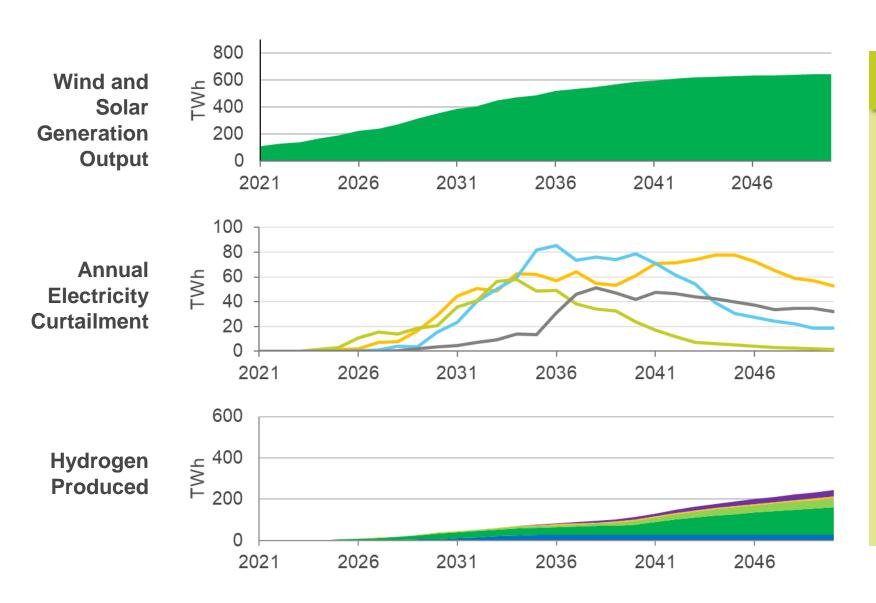
Limited ability to absorb higher, earlier renewable generation deployment



#### **System Transformation**

Blue hydrogen does not reduce curtailment.

Green hydrogen does.



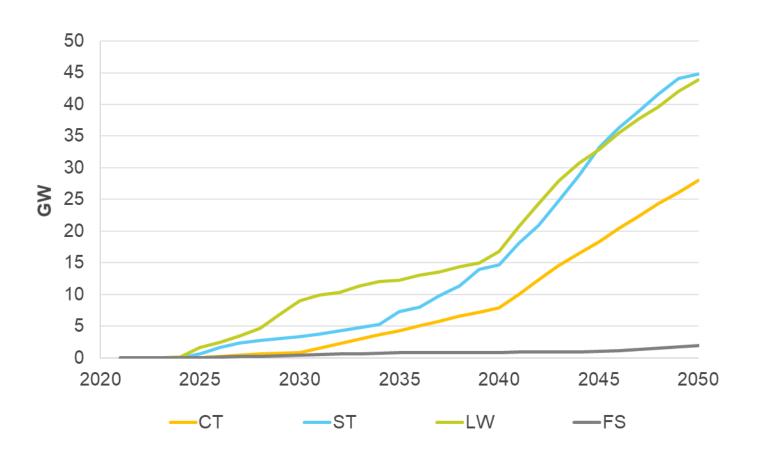
#### **Leading the Way**

Lots of green hydrogen production...

...growing in line with wind/solar output

# Demand side flexibility is needed to minimise curtailment and associated costs

Total electrolysis capacity inc. networked and nuclear



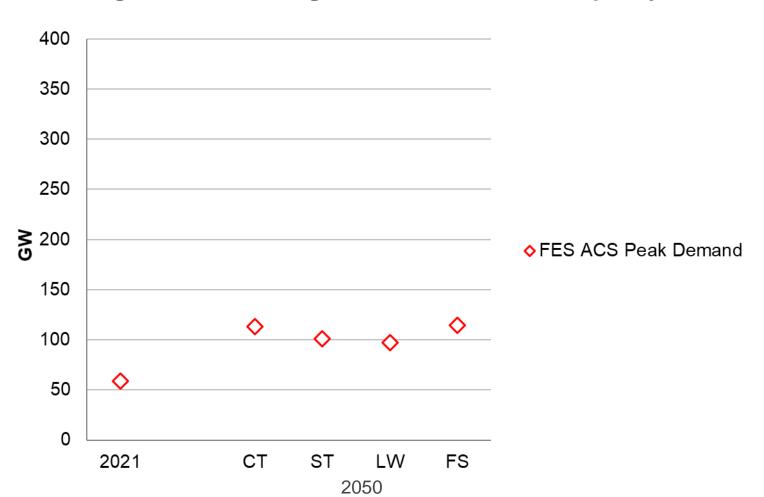
#### **Britain needs to:**

- Develop green hydrogen production in line with integration of weather dependent renewables to minimise wasted generation capacity
- Develop other sources of flexibility such as:



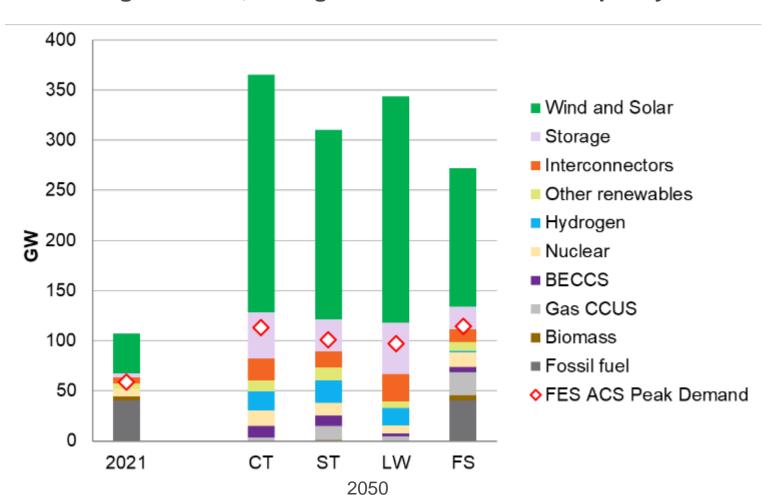
- Import / export
- 'Power to X'
- 'X' includes 24 MtCO2e of DACCS by 2050 in LW

#### Installed generation, storage and interconnector capacity



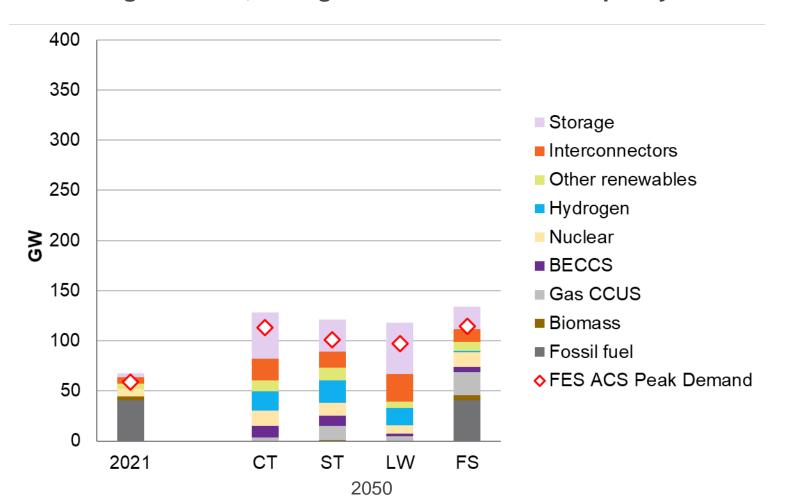
#### Because...

#### Installed generation, storage and interconnector capacity



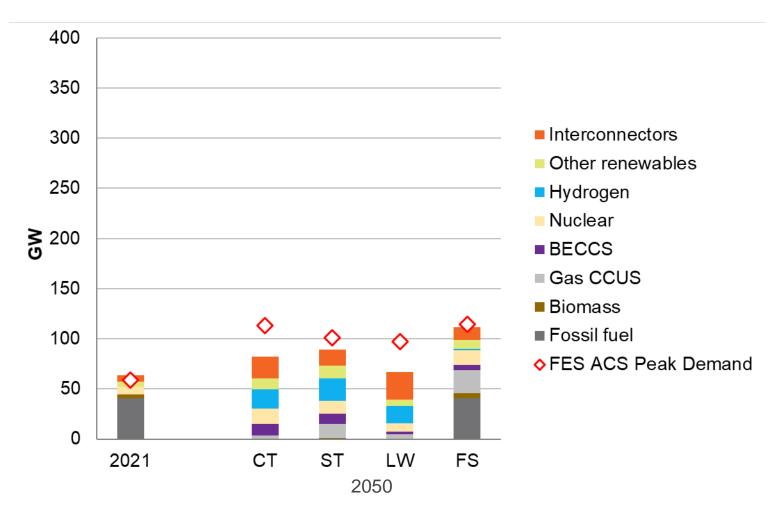
#### Because...

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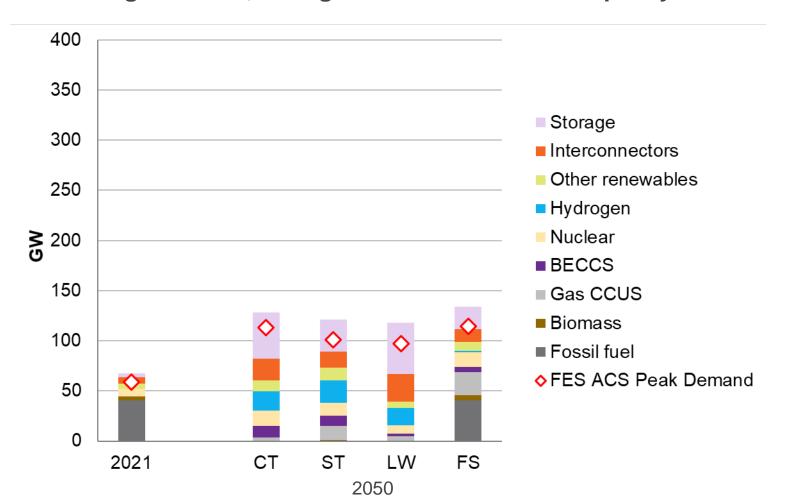
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#### Because...

#### Installed generation, storage and interconnector capacity



#### Because...

# Strategic investment in the whole energy system is urgently required to keep pace with Net Zero ambitions and strengthen energy security. To deliver this we need...



Strategic whole system thinking



Inter-seasonal storage

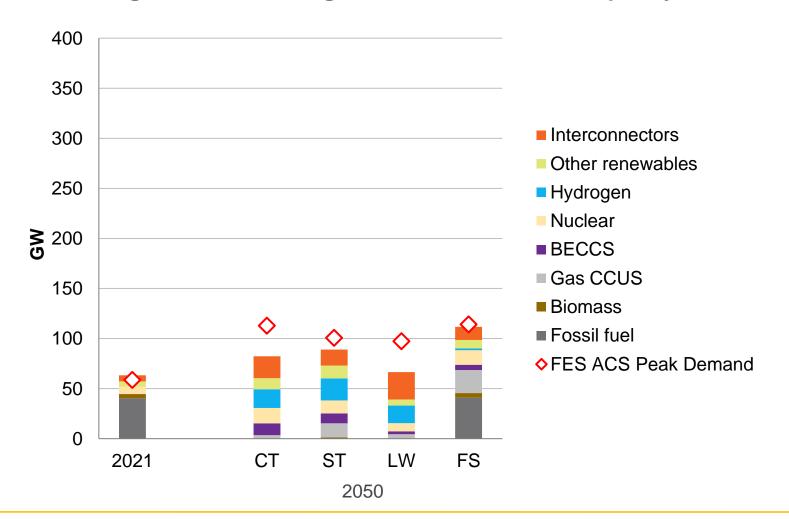


Whole system competition

### Inter-Seasonal Storage

What happens when the wind isn't blowing and the sun isn't shining?

#### Installed generation, storage and interconnector capacity



Britain needs inter-seasonal storage for providing security of supply during uncommon, prolonged, periods of low wind and solar generation (dunkelflaute)



# We have 17.6 TWh of long duration storage today

## - almost all in the form of natural gas

Sources of energy storage today

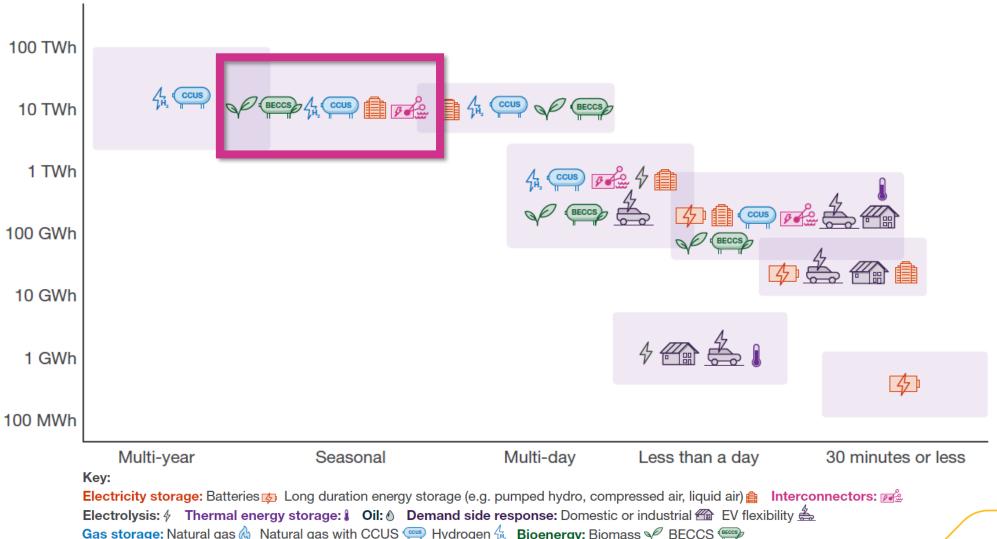
Less than **0.03 GWh** from other storage

17.3 TWh
Gas storage capacity (exc. LNG)

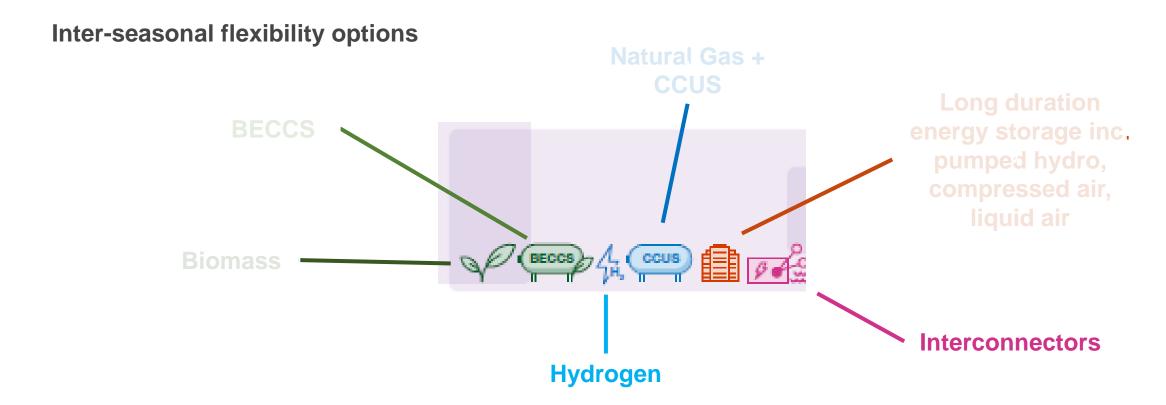
What takes its place in a decarbonised energy system?

### We have options for decarbonised seasonal flexibility

#### Flexibility options by duration and size

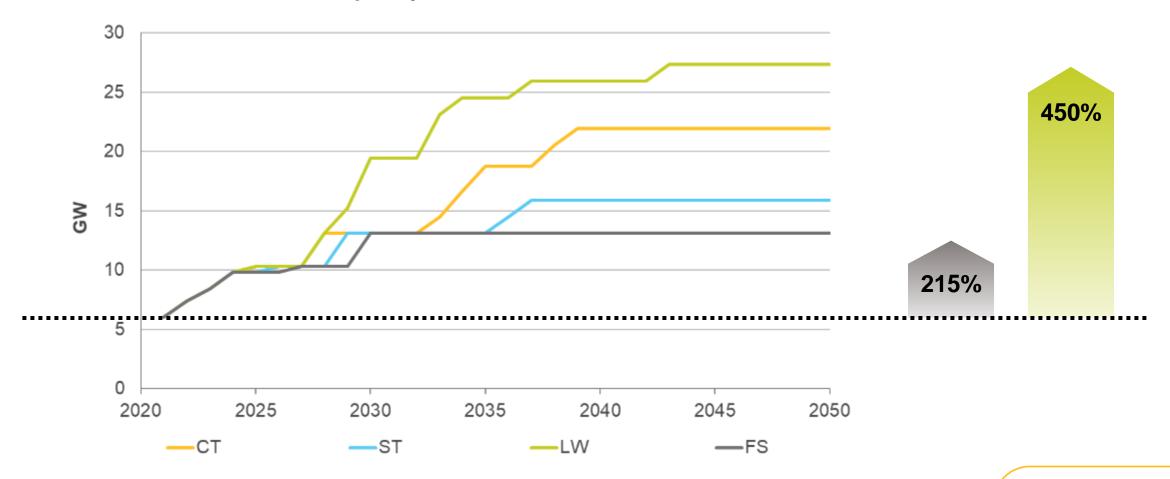


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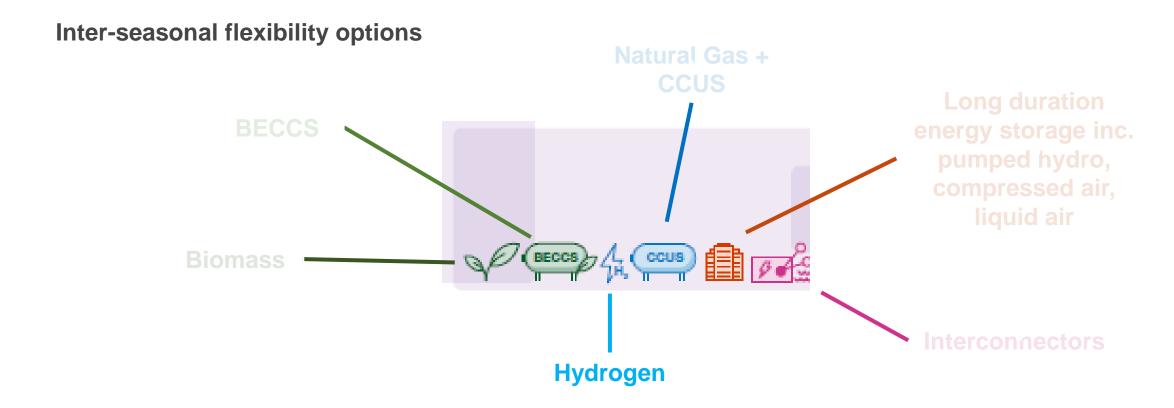


# GB interconnector capacity will grow between 215% and 450% by 2050

#### Installed interconnector capacity



### We have options for decarbonised seasonal flexibility

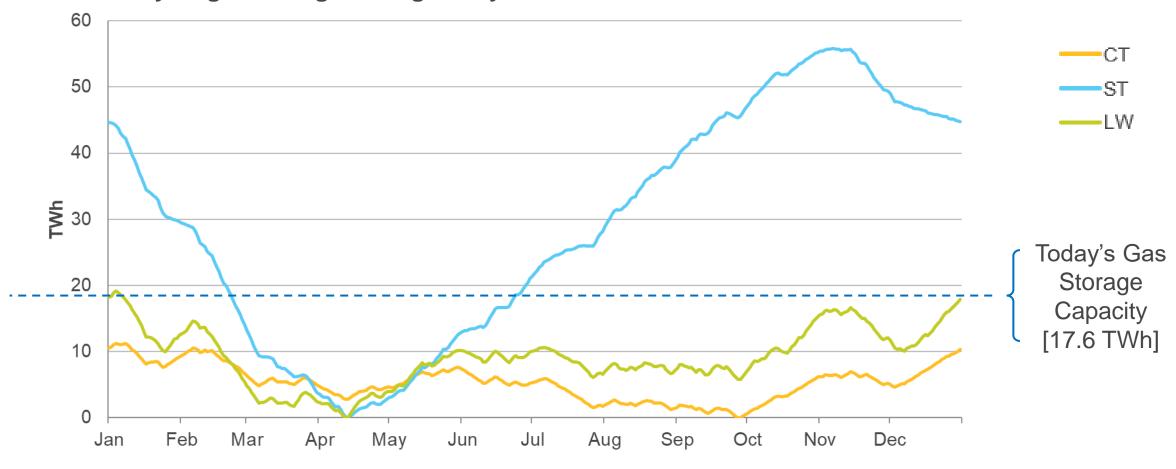




Hydrogen can be made and stored at scale in GB, using domestic electricity supply – It is essential for seasonal flexibility and has benefits across the whole energy system

### Hydrogen storage is used in different ways

Levels of hydrogen storage through the year in 2050

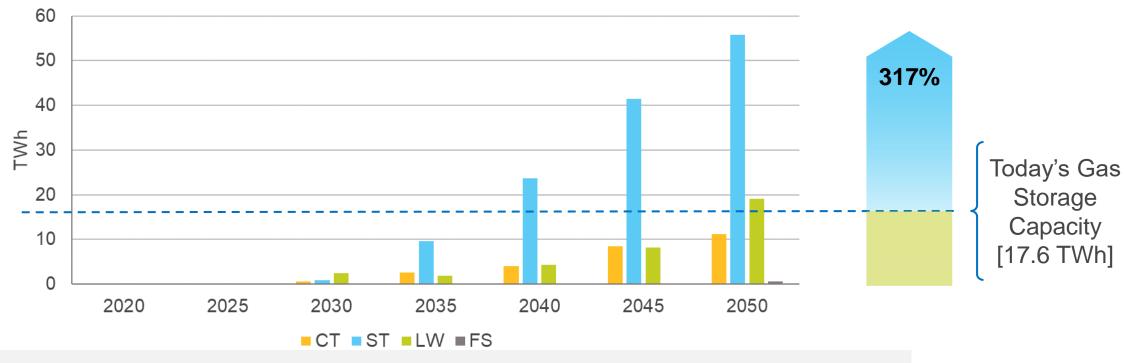




Britain needs significant amounts of hydrogen storage in all scenarios.

# Britain needs between 11 TWh and 56 TWh of interseasonal storage by 2050

#### **Hydrogen storage capacity requirements**





This range is very wide. Britain needs a clear vision for the role of residential hydrogen in the whole energy system by 2026...

## ... because geological inter-seasonal storage takes a long time to build...

	Examples	Approx. max. capacity	Making it happen
Gas storage	Salt Caverns	< 200 TWh*	10 year lead time
	Rough Storage Facility	12 TWh	Being actively explored
	Empty Natural Gas Wells	Very high	Economics vary for different sites
Other storage	Pumped Hydro	84 GWh	Large scale geological project
	Compressed Air	30 GWh	Emerging
	Liquid Air	18 GWh	Emerging

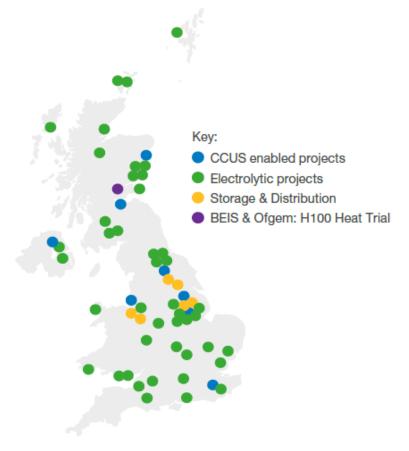
<sup>\*</sup> viable for hydrogen storage



... and we need to start now

### There are already projects in the pipeline





How do we get these to market?

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Strategic whole system thinking



Inter-seasonal storage



Whole system competition

### There are already projects in the pipeline

Latest NOA outputs (including HND) published 7<sup>th</sup> July





They need a clear vision for the future, strategic coordination and an attractive route to market.

## Britain needs a clear vision for the whole energy system Sli.c

Sli.do #KM4









Whole system

#### Sector specific





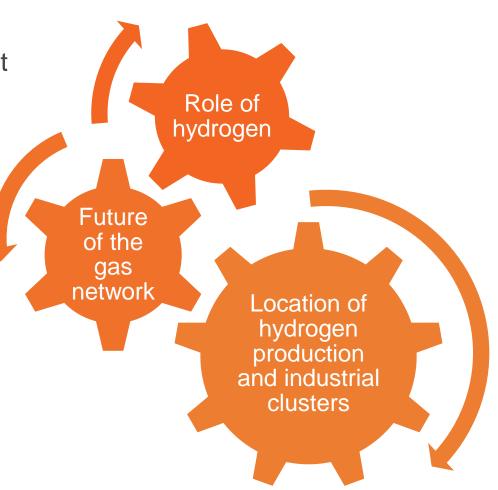






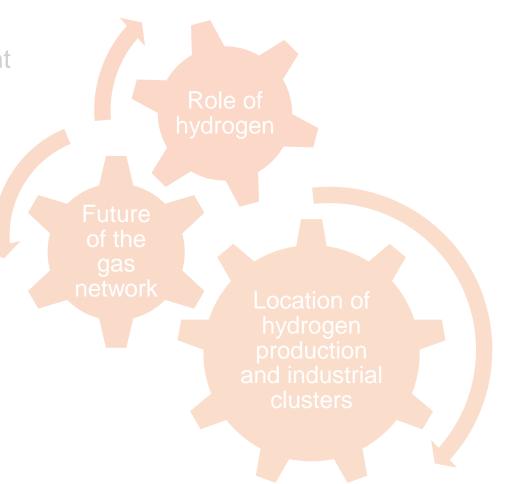


There are many inter-dependent infrastructure decisions to be made across the whole energy system



## Britain needs a clear vision for the whole energy system Sli.do #KM4 ... and competition in delivery...

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Competition in delivery providers

Best solution for the region

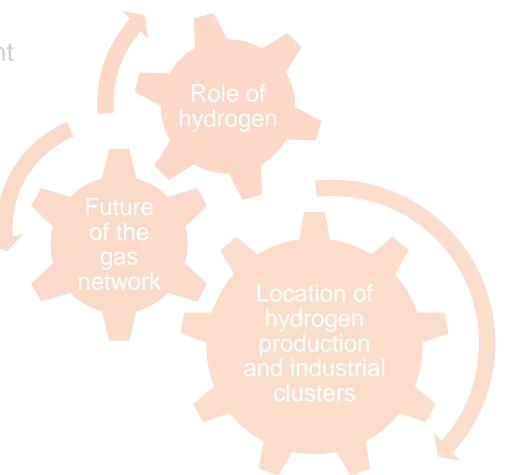
Stronger supply chain

Value for consumers

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Best solution for the region

Stronger supply chain

Value for consumers

... to deliver clean, secure, affordable energy, fairly

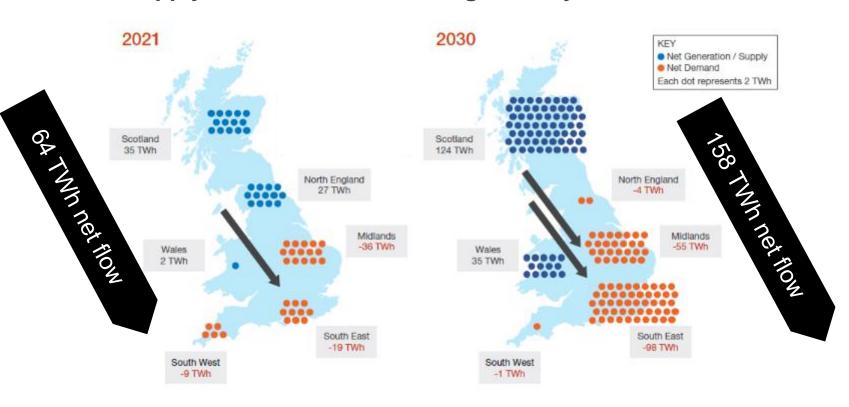
Network Reinforcement Offshore Coordination

Industrial Clusters and the NTS

Regional Solutions for Heat

Electric Vehicle Infrastructure

#### **Net supply and demand in Leading the Way**



Urgent network reinforcement is required on an unprecedented scale

The gas and electricity network could work together to overcome constraints



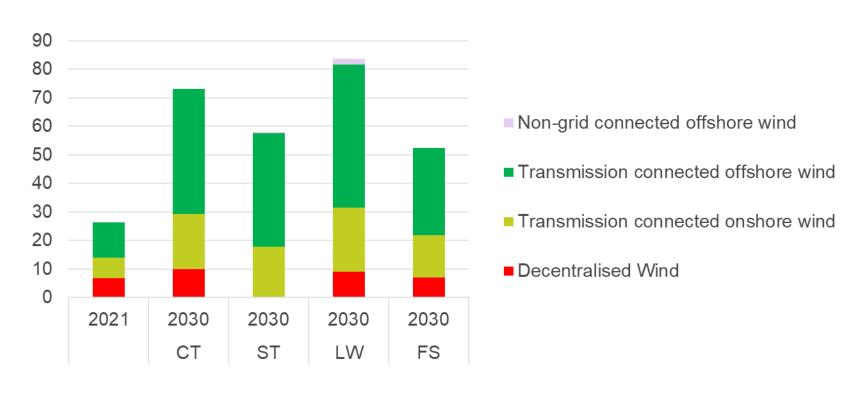
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#### Installed wind generation capacity by 2030



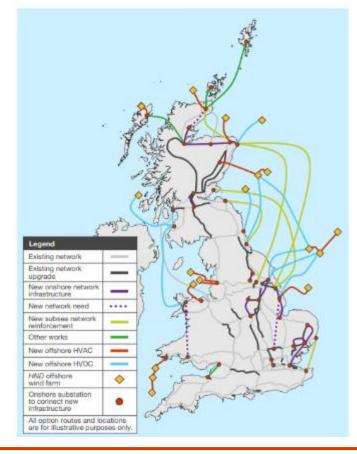
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Full set of major network requirements recommended by the HND [indicative]



Holistic Network Design enables offshore wind to connect to the shore and get the electricity to where it is needed efficiently.

It balances cost to consumer, delivery by 2030 and impact on the local community.



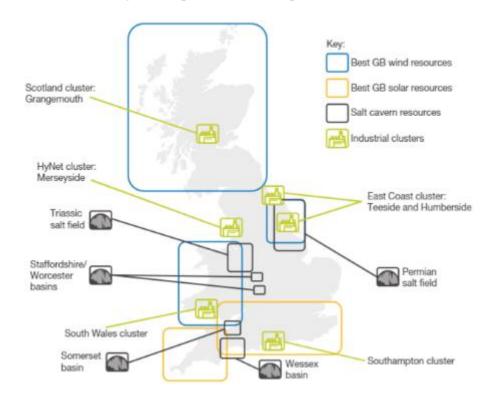
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#### Opportunities for hydrogen storage and industrial clusters



Clusters can be located near sources of renewable generation and hydrogen storage.

How far will the hydrogen network extend?

Source: Delta EE Innovation project for National Grid ESO

\*NTS (National Transmission System)



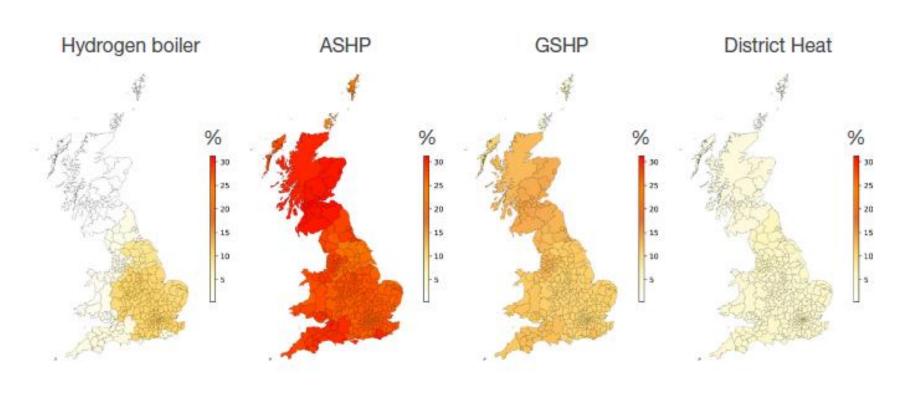
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#### Residential heat in Leading the Way, 2035



One size does not fit all — deploy the right solution for the region



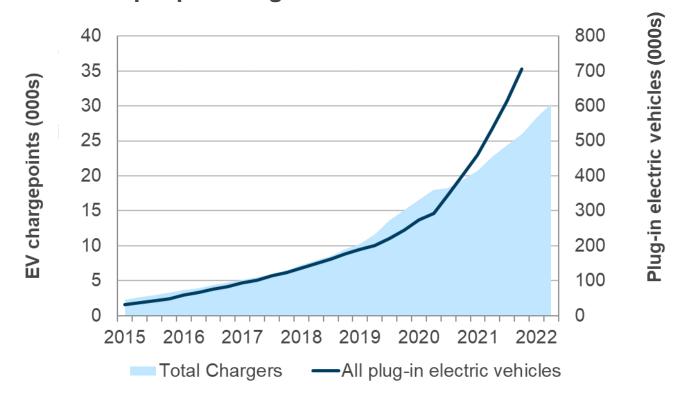
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#### Where will people charge their EVs?



Wherever consumer change is needed, there must be a plan to deploy the infrastructure for that change...



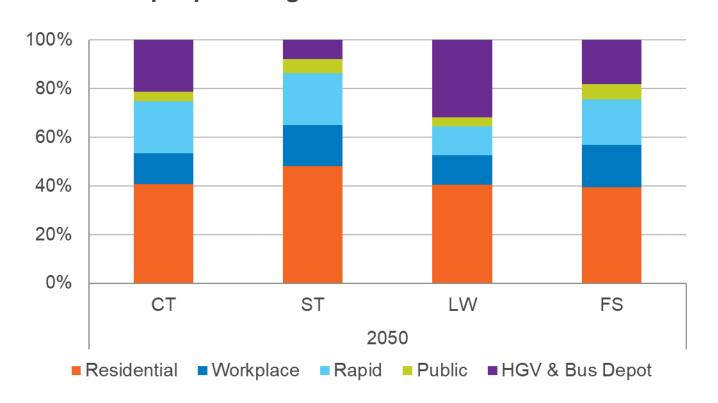
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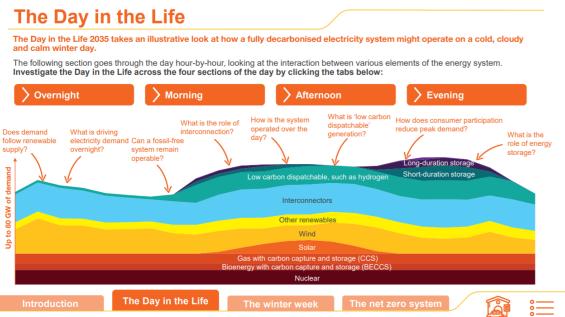


Wherever consumer change is needed, there must be a plan to deploy the infrastructure for that change... how much, when, and where?



## FES Bridging the Gap update







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