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# Hydrogen demand, production flexibility and storage

Dr Michael Wagner, Special Advisor
Management Consulting Division

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# Our strategic framework

**WHO WE ARE**

OUR VISION
Making Future

OUR MISSION
We accelerate the transition towards a sustainable society

OUR VALUES
Brave
Devoted
Team players

OUR PEOPLE
Inclusive and diverse teams with deep sector knowledge

**OUR AMBITION**

A leader in sustainable engineering, design and advisory with a global reach

# Our hydrogen expertise

**KEY FIGURES**

1. Over 100 projects delivered globally in over 30 countries since start of 2021
2. Technical/engineering on project capacity over 10GW electrolyser capacity
3. Expertise covers the entire value chain from production to end-use
4. Expertise in Ammonia, e-methanol and Sustainable Aviation Fuels
5. Over 50 experts located globally involved in projects

INDUSTRY

TRANSPORT

POWER

HEAT



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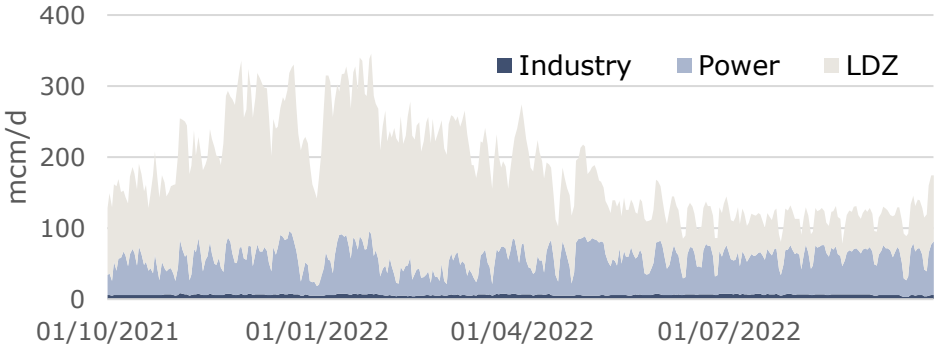
ENERGY SECURITY

# GB energy systems provide consumers with high levels of energy security

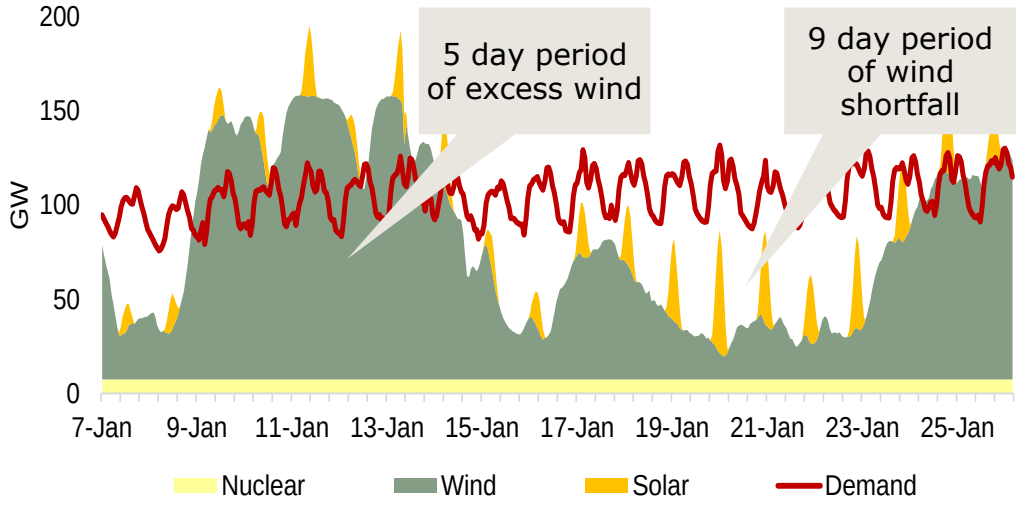
## ENERGY SECURITY AND RESILIENCE

- Energy security and resilience is **key to consumers**, we have to maintain this trust as we decarbonise
- The flexibility of **gas supplies** and **gas storage** has been key to meeting variability of demand in both the gas and power sectors
- As the use of **gas decreases** and the level of **renewables increases** the challenges of supplying demand will increase
- Energy demand has strong **seasonal patterns** and heating demand is **highly temperature sensitive**
  - Creates challenges for delivering heating load, whether we are using electricity or hydrogen for decarbonisation
- Solar and wind generation have **diurnal and seasonal** output patterns, but also suffer from intermittency due to **variable weather patterns.**
  - Increasing issues for **balancing** the **electricity system** but also creates intermittency for **green hydrogen production**
- **Hydrogen** can be **stored** in large quantities over long durations, so can play a key role in **providing security** across the **whole energy system**

**2021/22 GB GAS DEMAND**




**2050 POWER GENERATION AND CONSUMPTION GAP**



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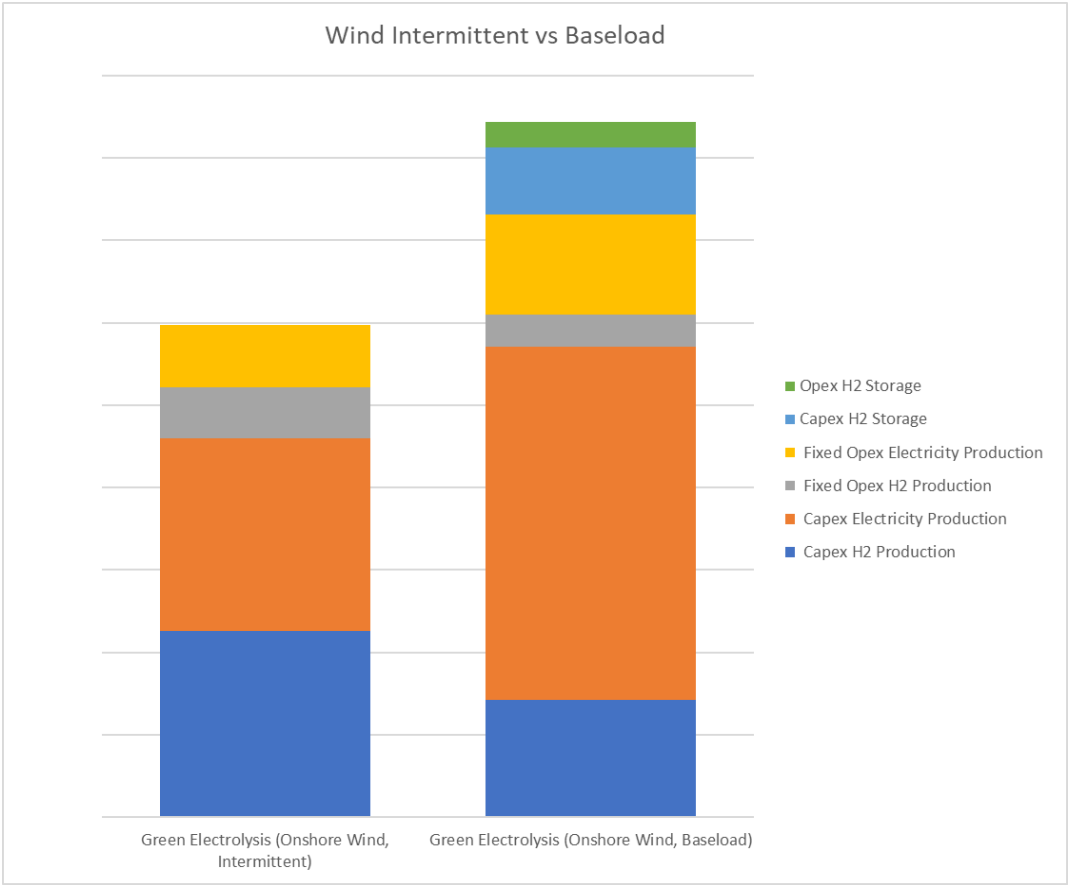
# Early hydrogen systems will have specific issues providing energy security

## ENERGY SECURITY IN EARLY HYDROGEN SYSTEMS

- Early Hydrogen systems may be **single sites** with individual production and supply or **industrial clusters**
  - Many early systems will be supplying **industrial demand** which is likely to have a relatively **flat demand** profile
  - **Consumers** will expect high levels of **energy security**
  - **Hydrogen production** will need to be designed with levels of **redundancy and storage**, increasing cost
  - Industrial processes may maintain the ability to switch back to gas, **demand side flexibility** will have significant value
- **Green hydrogen** will have particular challenges providing baseload hydrogen from **intermittent** renewable energy
  - Delivering **baseload hydrogen** will require optimising renewable and electrolyser capacity, and investing in **compression** and **tank storage**
  - The **additional cost** of meeting demand profiles could add over 40% to the cost of green hydrogen
  - The **Low Carbon Hydrogen Standard** provides some **flexibility** to use grid electricity, but periods of low renewables will be when power costs and grid carbon intensity are high

## THE COSTS OF SUPPLYING BASELOAD GREEN HYDROGEN

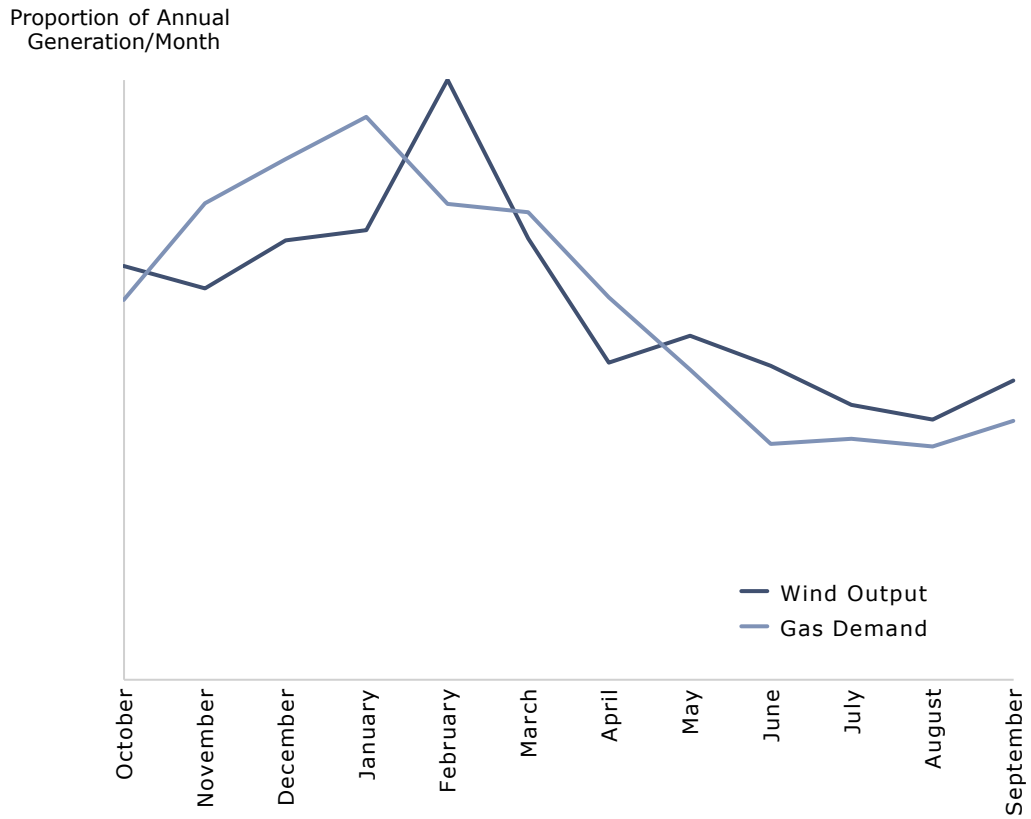


# Decarbonising heat will require the future energy system to deliver meet a seasonal demand profile

## MEETING FUTURE HEAT DEMAND

- Heat demand in Great Britain is currenly predominantly met by gas, with **flexibility in gas supplies and gas storage** delivering the demand profile
- The **decarbonisation** pathway for heat is still uncertain, but is likely to require some mix of **hydrogen and electrification**
- Blue hydrogen could potentially use the **existing flexibility** in gas supply (requiring flexibility in blue hydrogen production) or would need **hydrogen storage**
- **Electrification or green hydrogen** would both be higly dependent on offshore **wind generation** which is likely to provide over 60% of electricity generation in 2050
  - Wind generation output is also **highly seasonal** with much stronger winds over winter months than summer
  - The seasonal profile of **wind and heat** are relatively well **correlated**
  - This correlation will **reduce** the need for **seasonal storage** capacity...but the system will still need significant long duration storage!

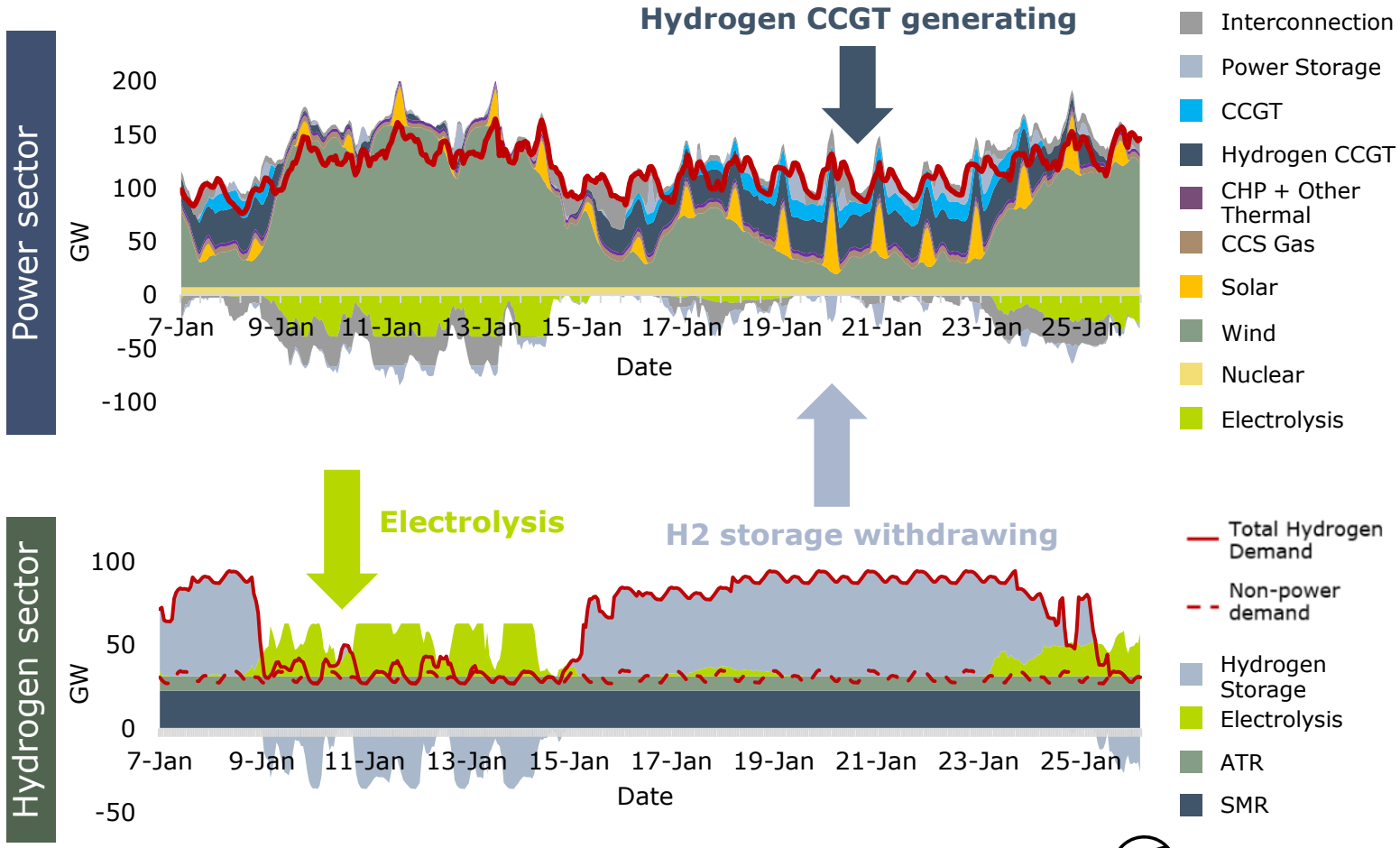
## GB WIND OUTPUT & GAS DEMAND PROFILES (2019-21)



# The energy system will need significant long term storage - hydrogen can provide this flexibility

**HYDROGEN PROVIDES FLEXIBILITY TO THE SYSTEM**

- **Hydrogen** is likely to be the one of the most optimal technologies for managing **longer term energy imbalances**
  - **Geological hydrogen storage** is cost effective for storing large volumes of energy over long time periods
  - Meeting **hydrogen demand profiles** and for **balancing the electricity system**
  - **Electrolysers** utilise **'excess' renewable energy** during periods of high wind, with **hydrogen fuelling CCGTs** during periods of low wind
- Balancing the **electricity system** in 2050
  - **33GW of electrolysers** producing 124TWh of hydrogen, mainly using excess renewables
  - **73TWh of hydrogen** withdrawn from storage per year
  - Total hydrogen **storage capacity of 15TWh**, with injection/withdrawal capability of 2TWh/day



# Conclusions

- Consumers have recieved **high levels** of **energy security** from our current energy sytems
  - They will expect similar levels of security from **hydrogen supply**
- Inital hydrogen systems **single sites** or **industrial clusters**
  - Providing security of hydrogen supply will require increased investment in production redundancy and storage
  - Providing baseload green hydrogen can add significantly to hydrogen costs
  - Demand side flexibility will have significant value
- **Heat demand** fluctuates with temperature and has **significant seasonality**
  - **Wind generation** also has significant **seasonality** which is relatively well correlated to current gas demand
  - This will **reduce** requirements for **seasonal storage** if we electrify heat or use green hydrogen
- The energy system will still need **significant long duration storage**
  - **Hydrogen storage** is cost effective for storing large volumes of energy over long time periods
  - We expect requirements for over **15TWh** of **hydrogen storage** capacity in 2050
  - The storage will need to be capable of **cycling** to balance **intermittent weather** patterns

CONTACT INFORMATION

# Hydrogen and Power-to-X

**DR MICHAEL WAGNER**
Special Advisor - Hydrogen
Management Consulting Division

michael.wagner@afry.com
+44 7384 215988