9th September 2021

Hydrocarbons and Net Zero

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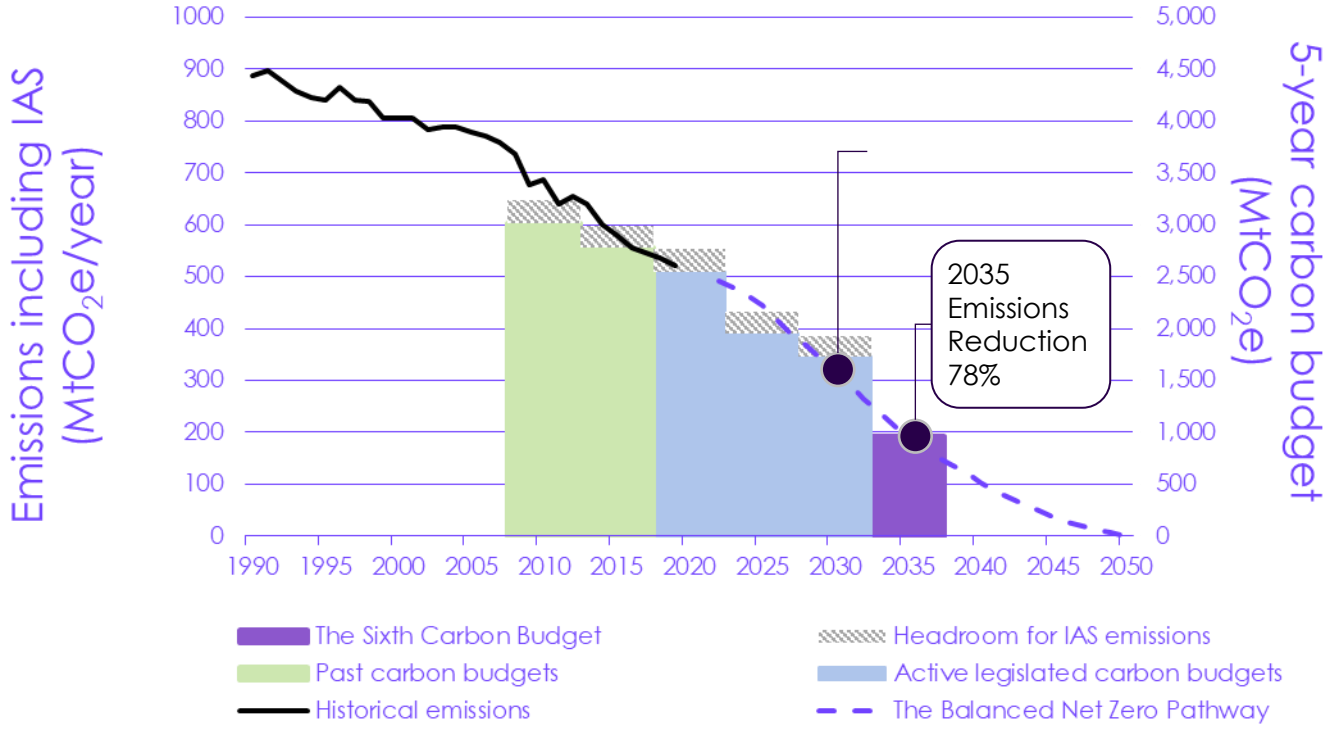
The UK's legislated path

The sixth carbon budget and 2030 NDC on the way to Net Zero by 2050

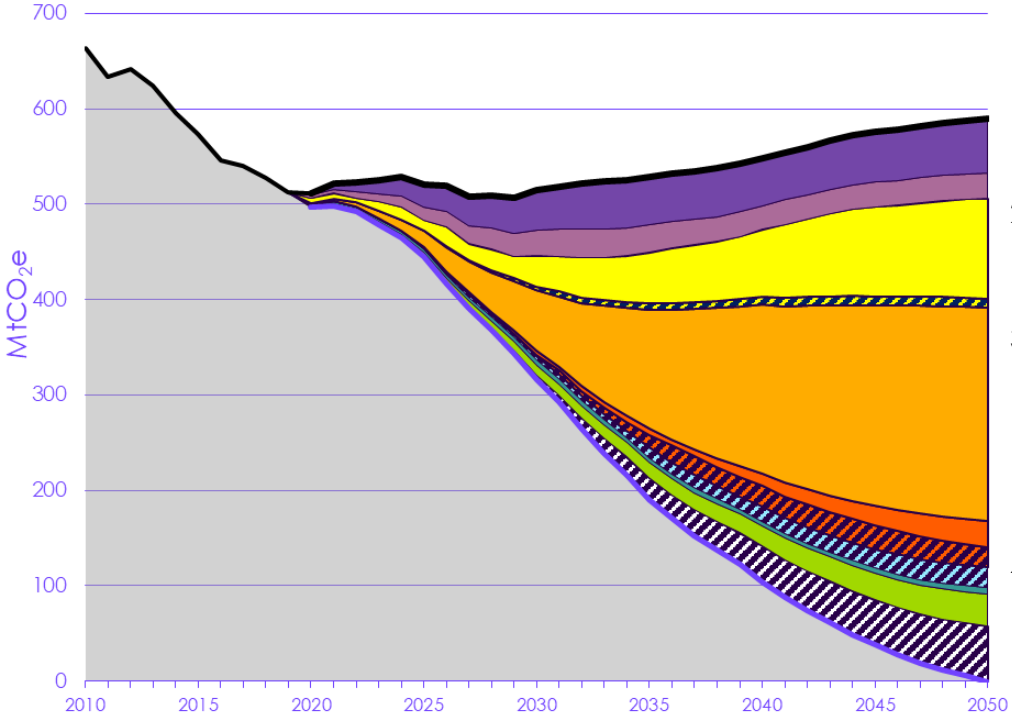


Notes:
Emissions shown including emissions from international aviation and shipping (IAS) and on an AR5 basis, including peatlands. Adjustments for IAS emissions to carbon budgets 1-3 based on historical IAS emissions data; adjustments to carbon budgets 4 and 5 based on IAS emissions under the Balanced Net Zero Pathway.

Source:
BEIS (2020) Provisional UK greenhouse gas emissions national statistics 2019; CCC analysis.

Emissions abatement

Meeting the Sixth Carbon Budget requires actions across four key areas: demand; decarbonize supply; electrify and use hydrogen; greenhouse gas removals

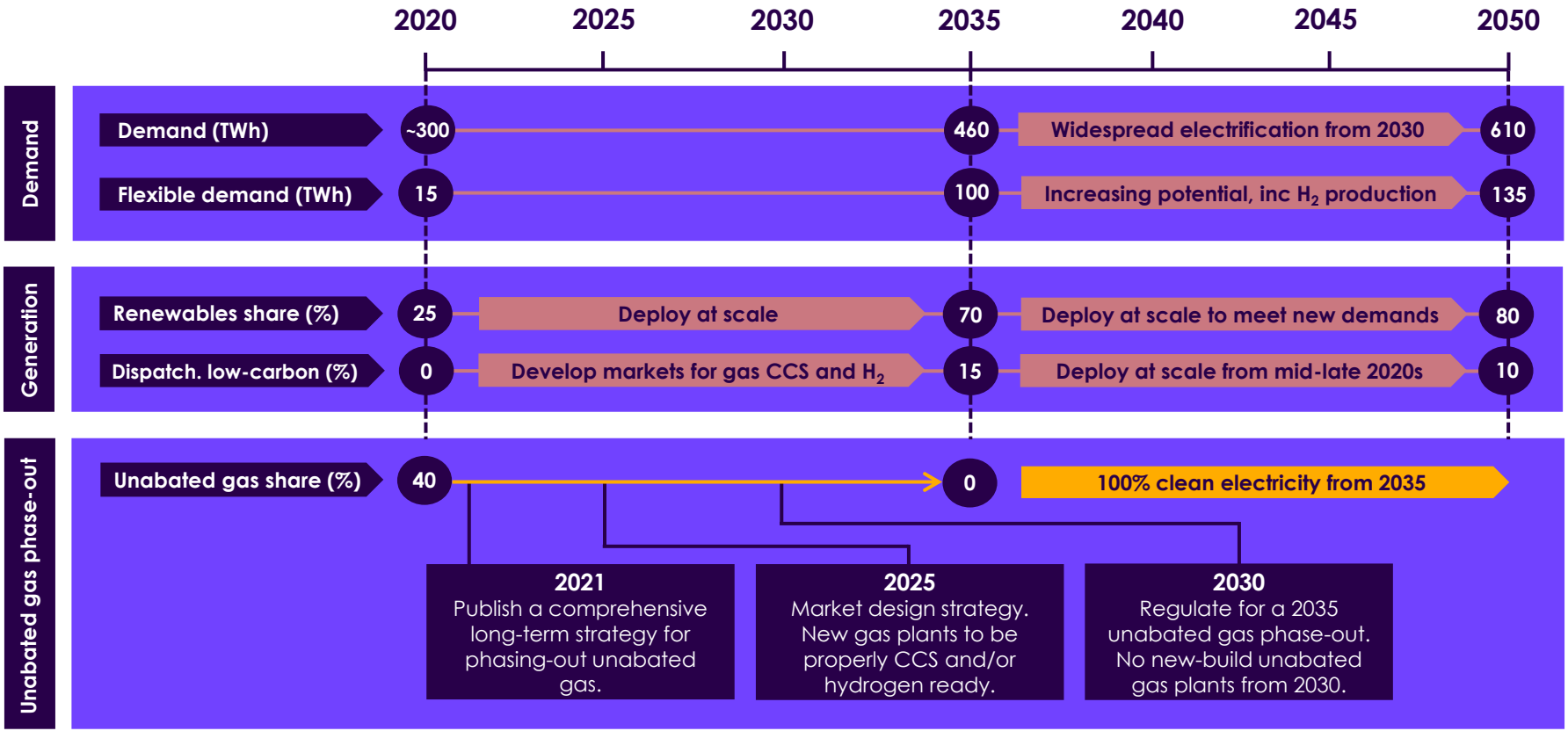


1. Reducing demand and improving efficiency
   - Reduced demand for carbon-intensive activities
   - Improved efficiency in use of energy and resources
2. Expansion of low-carbon energy
   - Low-carbon hydrogen and electricity production
3. Take-up of low carbon solutions
   - Electrification
   - Hydrogen and other low-carbon technologies
   - CO_2 capture from fossil fuels and industry
4. Offsetting emissions
   - Natural carbon storage
   - Engineered greenhouse gas removals

Principles for an energy system compatible with Net Zero

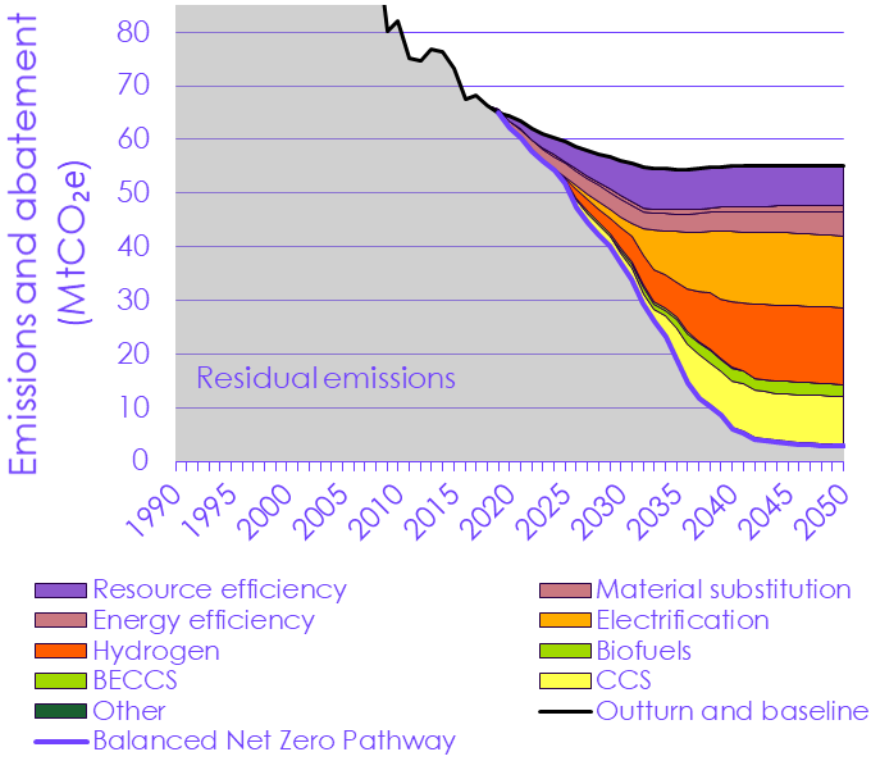
- **Reduce energy demands** through efficiency / behaviour where possible, especially in areas where zero-carbon solutions are unavailable / limited (e.g. aviation)
- Move energy end-uses to **zero-carbon energy vectors**:
  - ❖ Use electricity – especially high-efficiency applications such as EVs and heat pumps – where possible, together with hot water from heat networks
  - ❖ Where electrification of end-uses is not feasible, use hydrogen/ammonia
- On the supply side, **switch to zero-carbon energy sources** where possible and use hydrocarbons with CCS to fill the gaps
  - ❖ Zero-carbon electricity generation, especially offshore wind, should be the backbone of energy supply
  - ❖ Fossil fuels and biomass with CCS at high CO_2 capture rates can play a role in filling gaps (e.g. in power when there's less renewable generation; non-electrolytic hydrogen)
- Where hydrocarbon end-uses can't be eliminated (e.g. aviation), consider whether these should be biofuels / synthetic hydrocarbons or whether to sequester that carbon instead (e.g. with direct air capture of CO_2 + CCS)

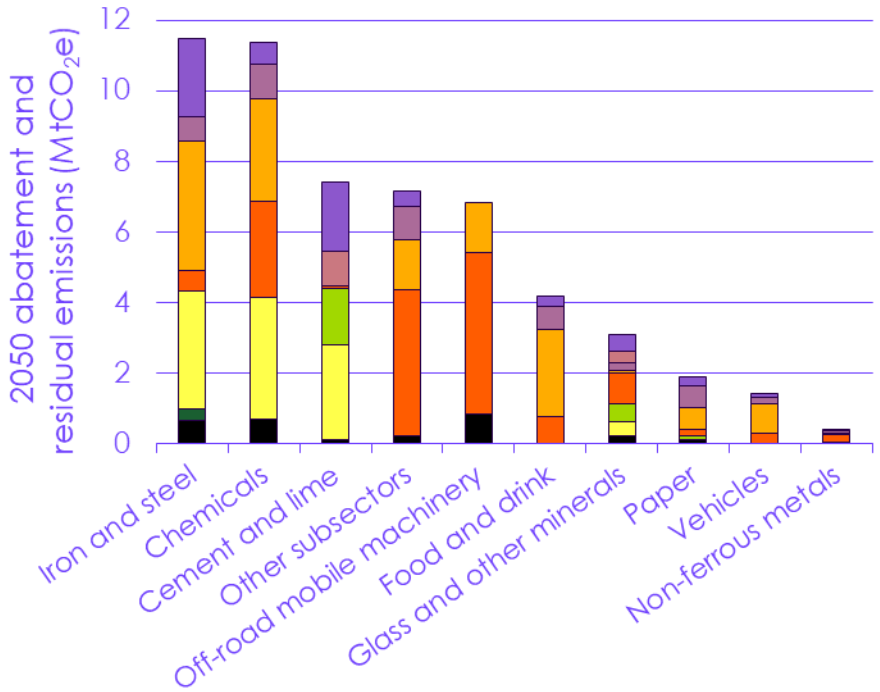
Summary of advice on electricity generation



Source: CCC Analysis

The Balanced Pathway for manufacturing and construction

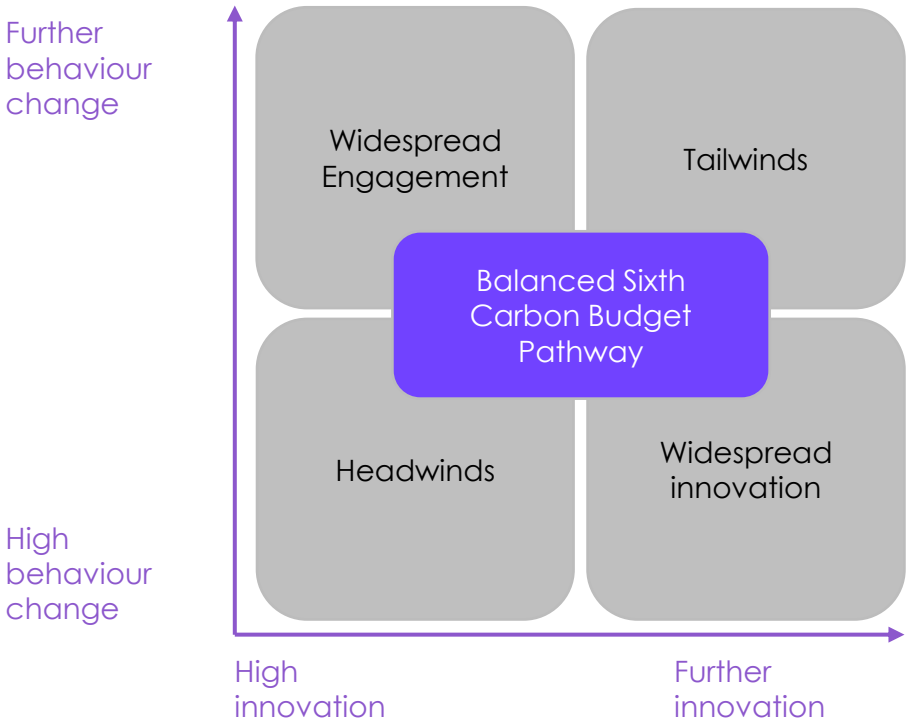




Note: Cement includes correction vs published report

Our approach

A balanced pathway, consistent with the Paris Agreement

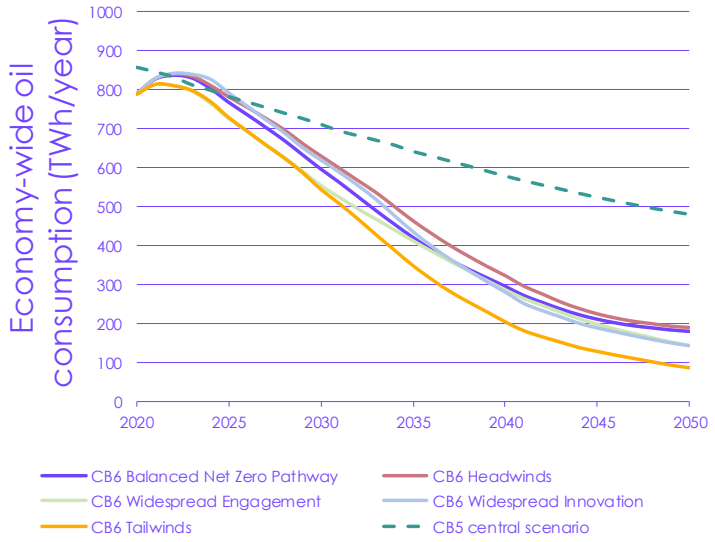


Climate science and international circumstances

- Need deep reductions globally to 2030 to keep 1.5°C in play
- Paris demands 'highest possible ambition'
- UK leadership matters as President of COP26
- Equity arguments reinforce need for strong UK action

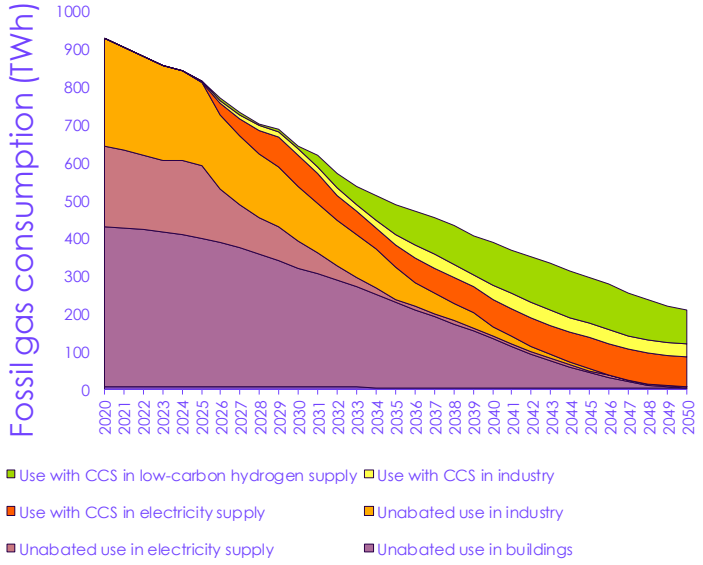
Fossil fuel consumption on the path to Net Zero

Figure 1 Oil demand under the Sixth Carbon Budget scenarios to 2050



Source: CCC analysis; BEIS (2021) *Energy Trends: March 2021*
Notes: CB5 and CB6 are the pieces of CCC advice on the Fifth and Sixth Carbon Budgets respectively. The Sixth Carbon Budget level was recommended on the basis of the Balanced Net Zero Pathway. Projected consumption includes non-energy use kept constant at 2019 levels (75 TWh/year).

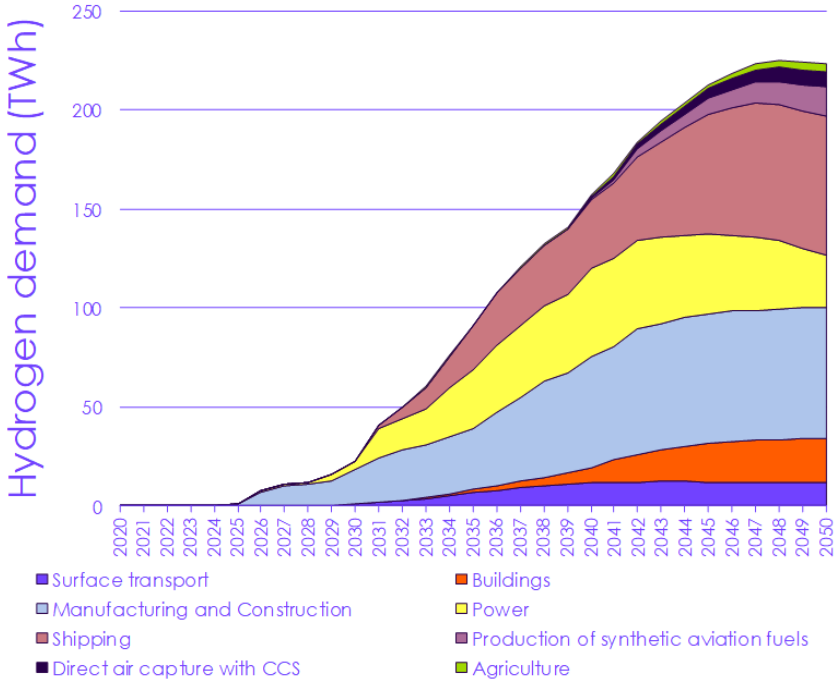
Figure 2 Fossil gas consumption under the Balanced Net Zero Pathway to 2050

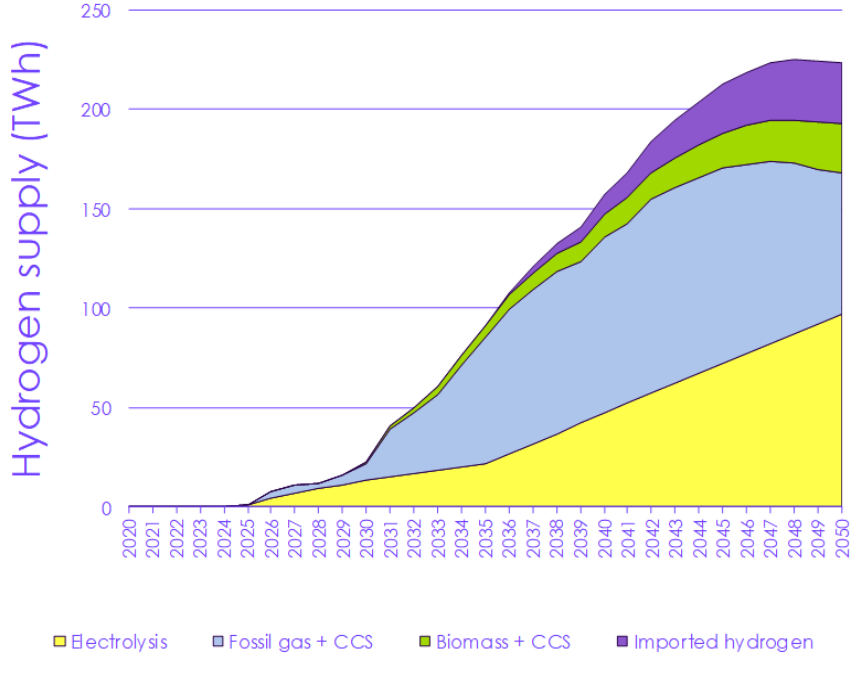


Source: CCC analysis; BEIS (2021) *Energy Trends: March 2021* .
Notes: Other use includes small amounts of consumption in agriculture and shipping, plus non-energy use kept constant at 2019 levels.

Hydrogen supply and demand

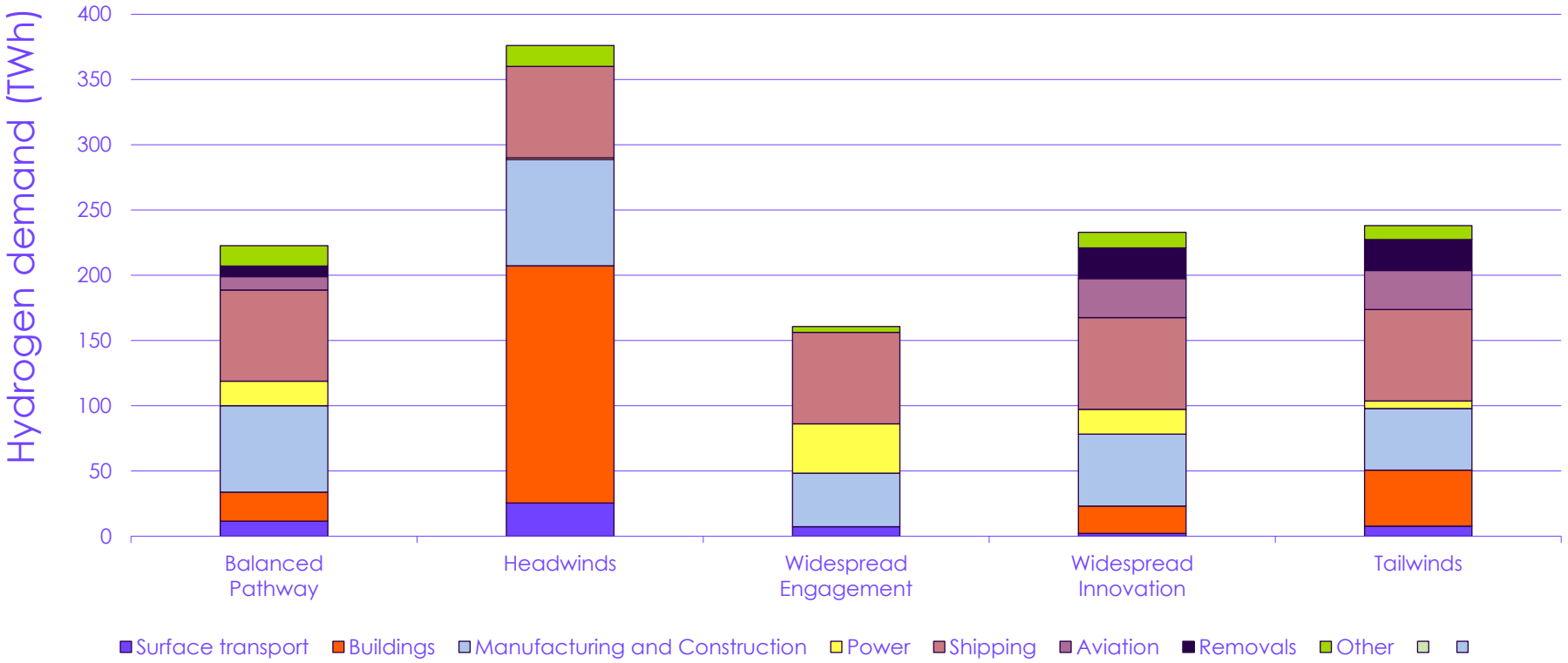
By 2050 the hydrogen economy is comparable in scale to existing electricity use





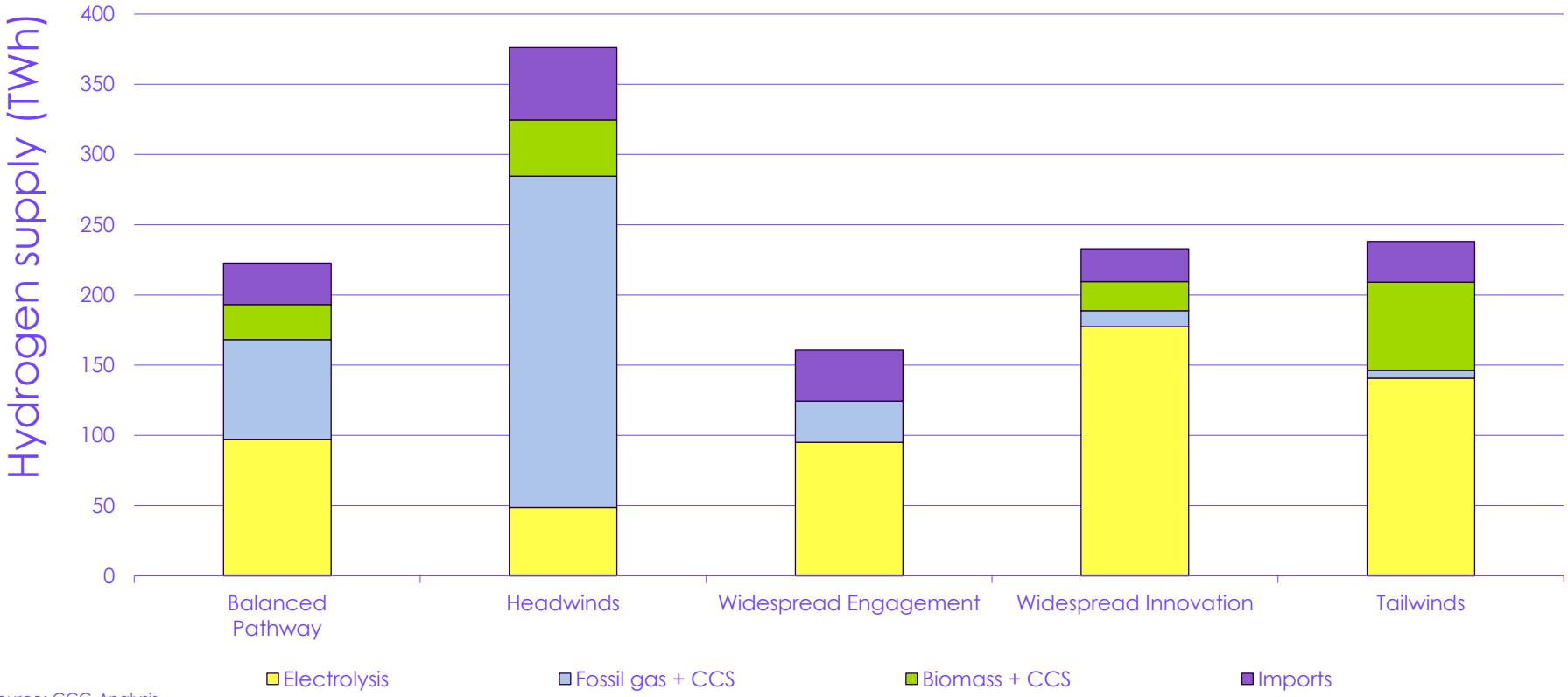
Source: CCC analysis.

Sectoral hydrogen demands in 2050



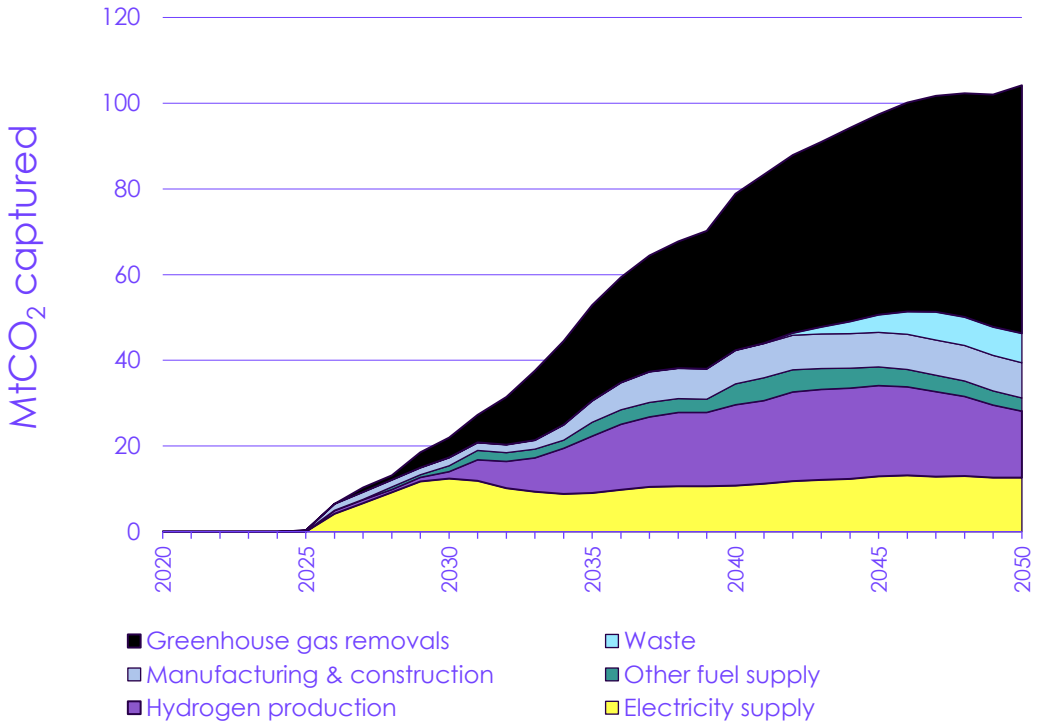
Source: CCC Analysis.

Hydrogen supply in 2050



Source: CCC Analysis.

Carbon capture and storage
Changes from now to 2050

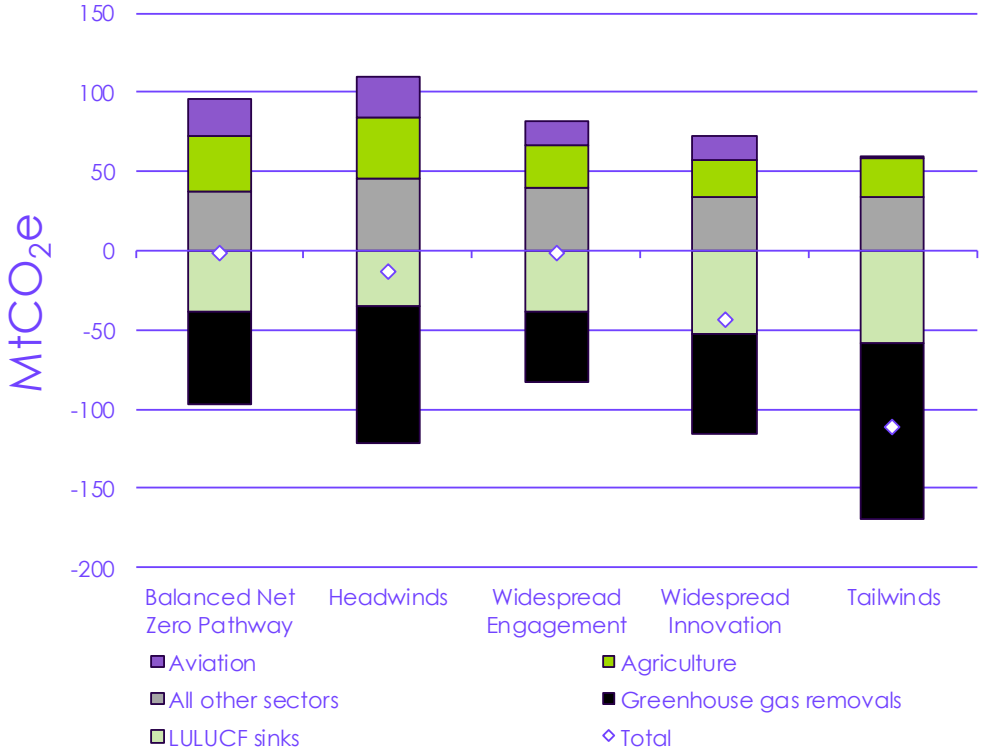


- Used to avoid further emissions from industry, alongside a role in permanent removal of CO_2 from the atmosphere and in electricity and hydrogen production.
- CCS is applied to the manufacturing & construction sector at scale in the 2030s, and continues to remove CO_2 at similar levels out to 2050.
- By 2050, around 60% of the carbon captured in the UK is in the greenhouse gas removals sector, primarily through the combustion of biomass for electricity generation, with a further 20% used for the production of hydrogen and 10% used with gas in the power sector.

Source: CCC Analysis

Scenarios for net emissions in 2050

Required removals are most sensitive to action across aviation, agriculture and land use



Assumes we can get to ~zero across a range of other areas:

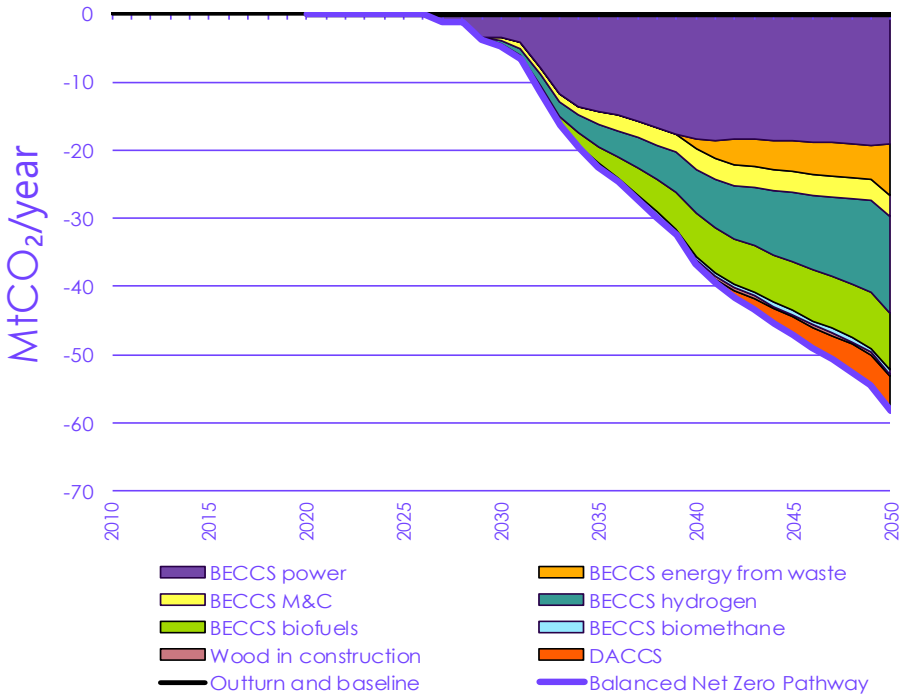
- Surface transport
- Power generation
- Buildings
- Shipping
- Most parts of manufacturing

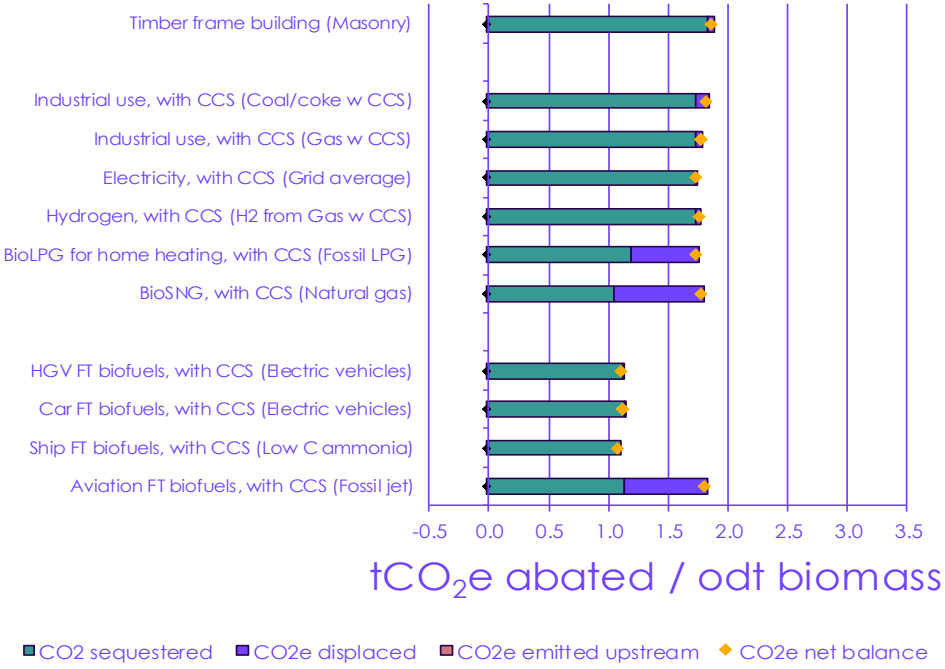
Engineered removals will have significant challenges too:

- Energy consumption of DAC, on top of stretching overall requirements for clean energy
- Availability of sustainable biomass
- Potential over-reliance on removals, due to shortfalls on the above

BECCS has many potential flavours

Many uses of BECCS give similar overall impacts on emissions





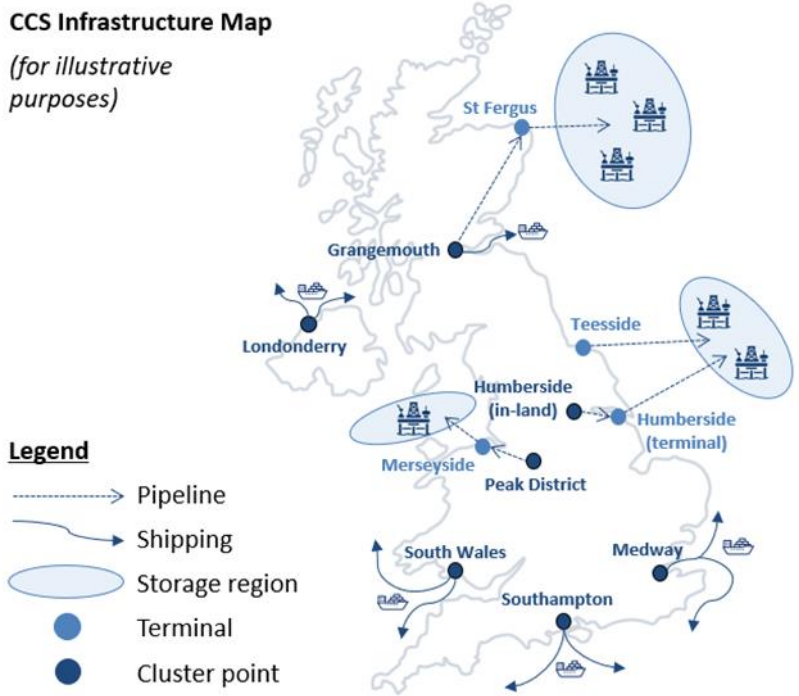
Key policy recommendations
Supporting policies

Infrastructure development

- Establish at least two CCS clusters in the mid-2020s, at least four by the late 2020s, and further clusters around 2030.
- Work with the minerals industries to develop a detailed joint plan for CO_2 transport from dispersed sites.
- Prepare to make decisions about whether initial areas of the gas transmission and distribution networks should be converted to hydrogen.
- Plan for a potential increase in large localised electricity network reinforcements for manufacturers.

Jobs and skills

- Design industrial decarbonisation policies to support and create jobs, especially in regions with reliance on industrial jobs. Prompt award of existing funding can help the recovery.
- Develop the capacity of skills and supply chains.



Source: Element Energy (2020) Deep-decarbonisation pathways for UK Industry, report for the Climate Change Committee

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