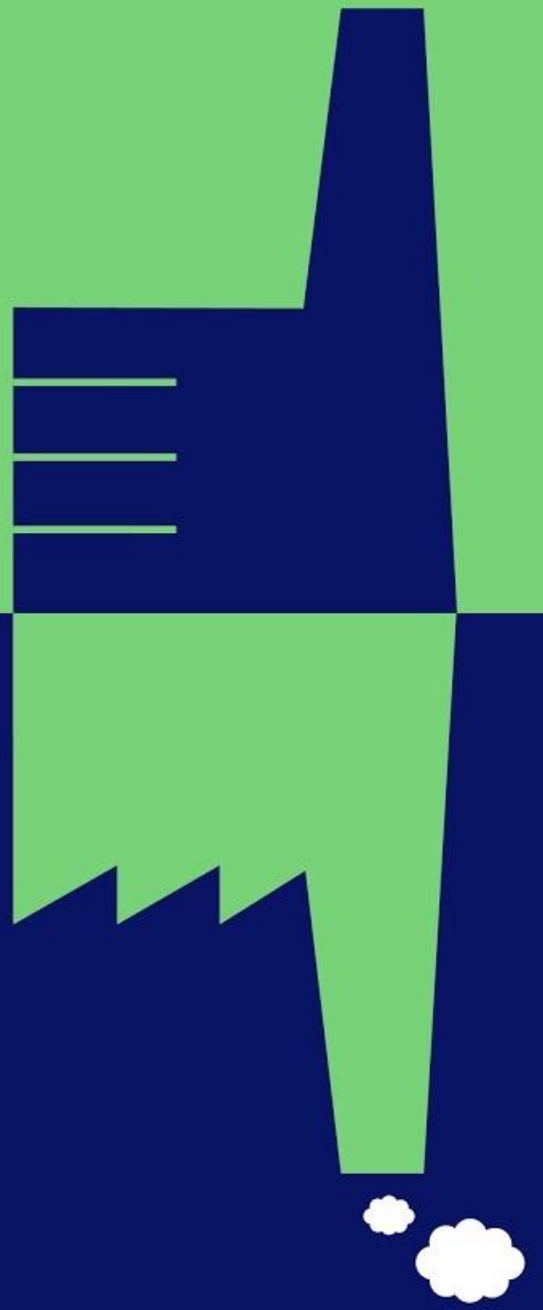
Carbon Capture | by drax



Value of Bioenergy with Carbon Capture and Storage (BECCS) to the UK Decarbonisation Pathway

8 April 2021

A vital contribution to UK decarbonisation

Drax is the largest decarbonisation project in Europe. Now we want to go further.

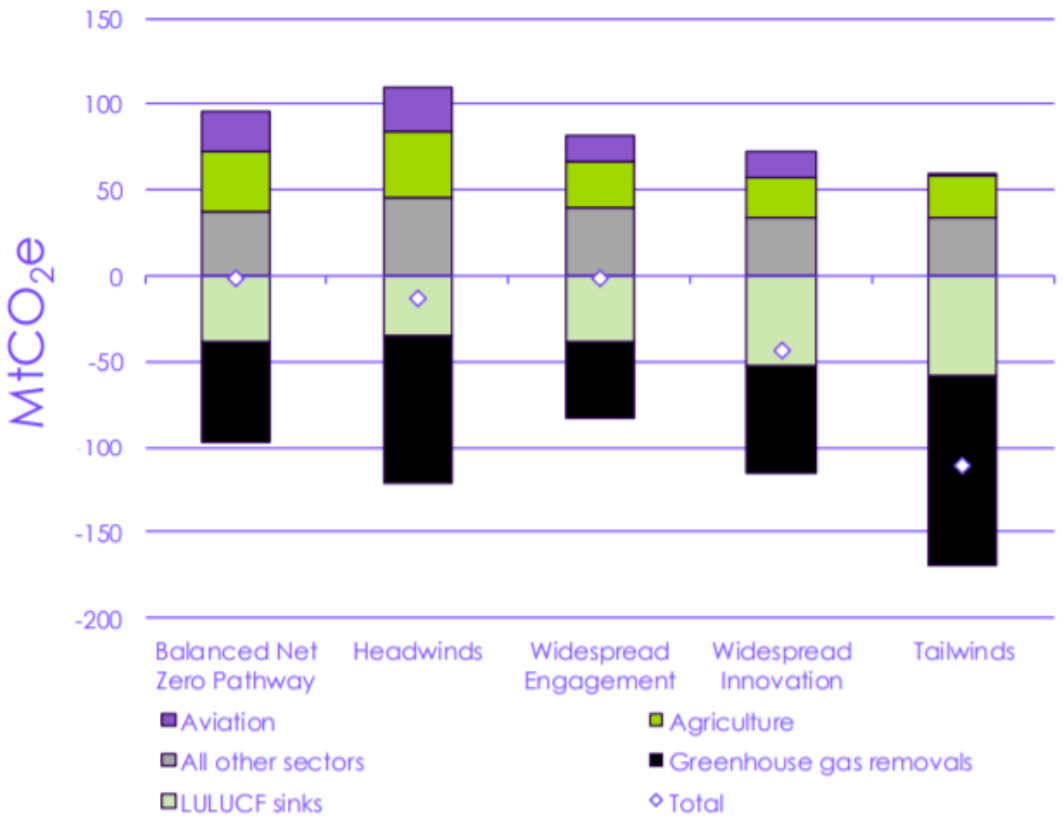
- Drax has already transformed its power station near Selby, North Yorkshire to become the largest decarbonisation project in Europe, having converted it to use sustainable biomass instead of coal.
- Now we have ambitions to go further by using bioenergy with carbon capture and storage (BECCS) to permanently remove millions of tonnes of CO_2 each year from the atmosphere.
- Drax has kickstarted the planning process to build this vital negative emissions technology, which will make a significant contribution to efforts to address climate change whilst creating thousands of new jobs and supporting a post-covid economic recovery.
- We have a unique window of opportunity to deliver a crucial element of the UK's decarbonisation infrastructure.

The need for negative emissions

To prevent harmful climate change, reducing emissions won't be enough.

- To reach net zero we need to reduce emissions across each sector of the global economy.
- But by 2050 a significant volume of emissions will still be emitted by hard-to-decarbonise sectors such as agriculture, aviation and certain heavy industries.
- To tackle climate change and reach net zero, we need to **remove carbon dioxide from the atmosphere** in order to compensate for any residual emissions.
- According to the Climate Change Committee's (CCC) 6th Carbon Budget, BECCS in power will need to remove 16-39 million tonnes of CO_2 a year by 2050 to meet net zero targets. The first phase of BECCS at Drax could deliver 8 million tonnes of CO_2 by 2030.

CCC emissions scenarios for 2050



Source: CCC 6th Carbon Budget Report

The need for BECCS

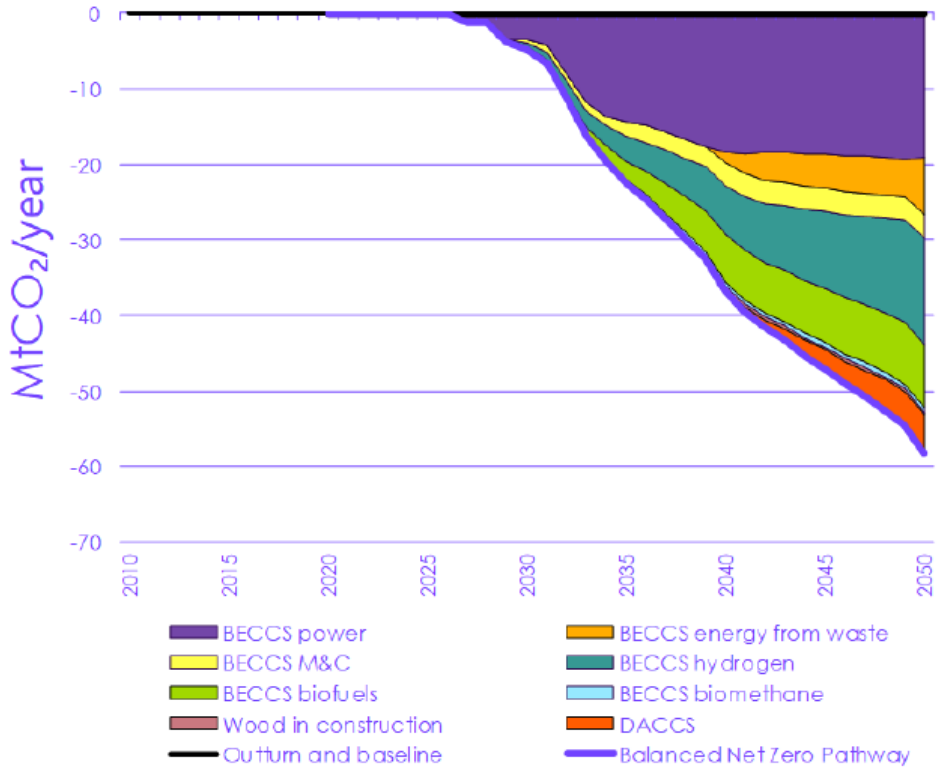
- In its “Balanced Pathway” scenario, the CCC estimates 58 million tonnes per year (mtpa) of negative emissions will be needed from greenhouse gas removals by 2050, of which 19mtpa will come from BECCS in power.
- BECCS in power is deployed from 2027 in all CCC scenarios.
- CCC scenarios have up to 39mtpa of greenhouse gas removals from BECCS power by 2050.

Table M12.1
Engineered GHG removals scenarios for the UK ($MtCO_2$/year in 2050)

	BECCS power	BECCS energy-from-waste	BECCS in industry	BECCS hydrogen	BECCS biofuels	BECCS bio-methane	DACCS	Wood in construction
Headwinds	39	10	4	23	10	0.6	0	0.4 (+1.0 in LULUCF)
Widespread Engagement	30	1	3	0	9	0.5	0	0.4 (+1.0 in LULUCF)
Widespread Innovation	16	5	3	12	11	0.5	15	0.4 (+1.0 in LULUCF)
Balanced Net Zero Pathway	19	7	3	14	8	0.6	5	0.4 (+1.0 in LULUCF)
Tailwinds	39	7	3	36	11	0.5	15	0.4 (+1.0 in LULUCF)
Baseline	0	0	0	0	0	0	0	NA

Source: CCC 6th Carbon Budget Report

Sources of abatement in the Balanced Net Zero Pathway for the GHG removals sector



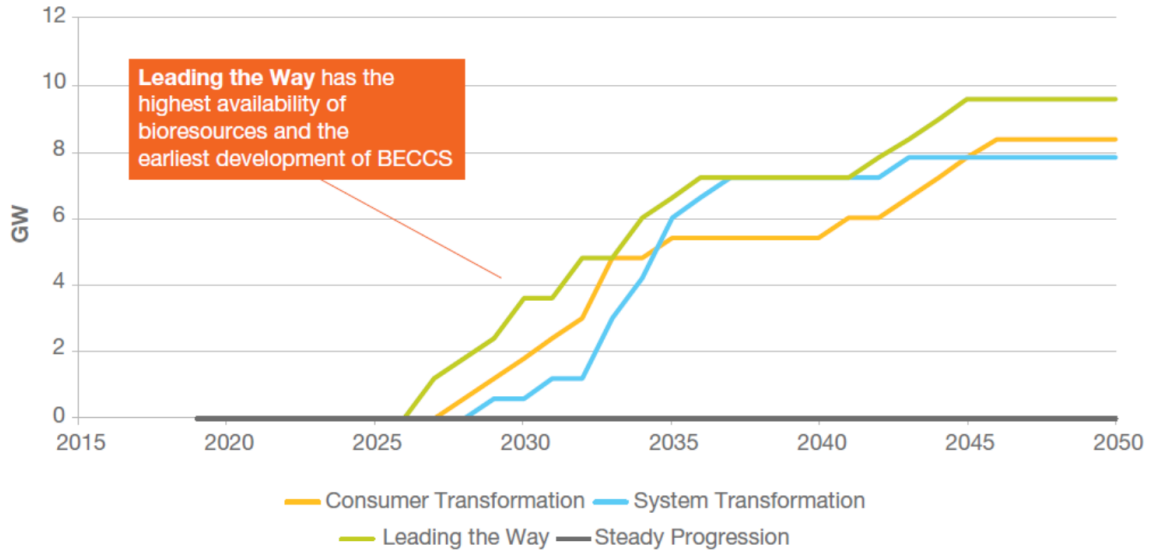
Source: CCC 6th Carbon Budget Report

BECCS-Power is needed to operate a decarbonised power grid

All National Grid's Net Zero Future Energy Scenarios deploy BECCS by 2028 and see a rapid increase in capacity in the 2030s

- This enables the power sector to be net zero by the early-mid 2030s.
- National Grid has committed to being able to run a zero carbon grid by 2025. To achieve this, it needs reliable sources of low carbon power.
- BECCS provides valuable power system services, such as inertia and voltage control, which are increasingly important as National Grid manages a power system with more intermittent renewables.

NGESO FES 2020: BECCS electricity generation capacity



Putting the UK on track for net zero

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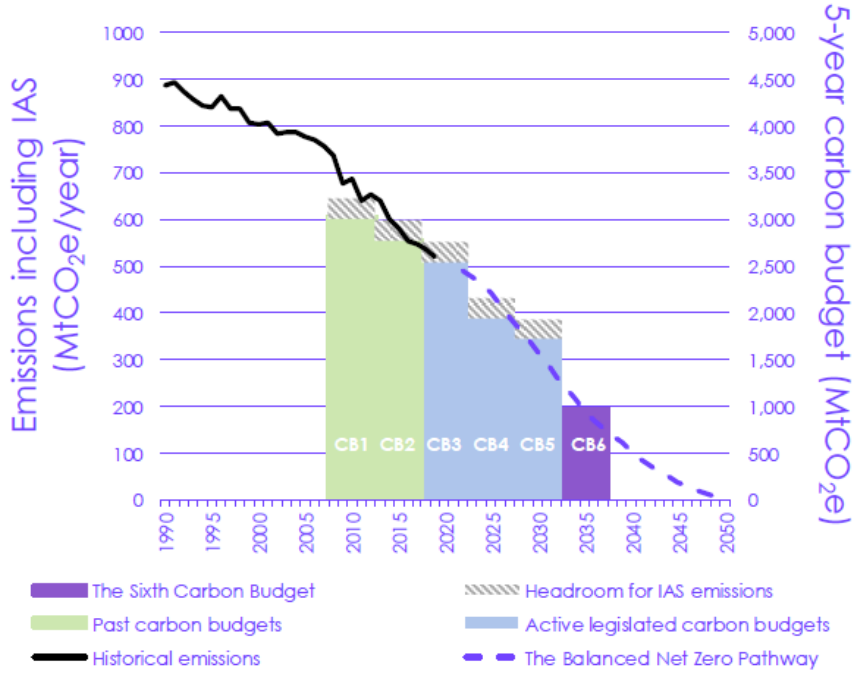
Without early deployment of BECCS, the UK's path to Net Zero is much more challenging

- Emissions have fallen by 40% in the last 3 decades – mostly from easy to achieve reductions in the power sector.
- Emissions will have to fall more quickly than the 4th and 5th carbon budgets to achieve the 6th carbon budget and net zero. This will require more action and engagement from individuals in society. Today…
  - Less than 5% of the energy used for heating homes and buildings is low carbon
  - 99% of all miles driven on UK roads are in vehicles with petrol and diesel engines
- **Deploying BECCS in 2027 would enable the Government to achieve the step change in emissions required to get from the 4th to the 5th and 6th carbon budgets,** providing headroom if other sectors of the economy prove harder and slower to decarbonise.

The recommended Sixth Carbon Budget



Source: BEIS (2020) *Provisional UK greenhouse gas emissions national statistics 2019*; CCC analysis
Notes: Emissions shown include 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 4-5 based on IAS emissions under the Balanced Net Zero Pathway.

Drax's 8 million tonnes of CO_2 will provide **13%** of the emission reductions required to achieve the 5th Carbon Budget

Executive Summary | Baringa Analysis

- Baringa were engaged by Drax to analyse the system value of Bioenergy with CCS (BECCS) both within the power sector and for whole system decarbonisation, as part of meeting the UK's Net Zero targets.
- They explored the role of BECCS-Power in driving cost-optimal pathways to meet net zero using three scenarios: **Central**, **Downside** and **Upside**, to test the role of BECCS-Power under different conditions.
- Key assumptions were aligned with published UK Government and Climate Change Committee (CCC) sources, in particular benchmarking results with analysis seen in the recent CCC 6th Carbon Budget publication.
- The analysis aimed to answer the following key questions:

The case for negative emissions

- To meet net zero is there significant demand for negative emissions in the energy system?
- How early do we need negative emissions?

Optimal build-out and the role of BECCS-Power

- What is the optimal build-out and role of BECCS-Power given competing abatement options?
- How do system costs change in the absence of building BECCS-Power?

The role and value of the Drax-BECCS project

- What is the role and value of the Drax-project as part of a broader need for BECCS-Power?
- How robust is the role for Drax given uncertainty around key BECCS and wider system factors?

Executive Summary | Baringa Findings

The case for negative emissions is clear

- Negative emissions are required to offset residual emissions from hard to abate sectors such as agriculture, aviation and certain heavy industries.
- Engineered solutions such as BECCS-Power can make a major contribution.
- The Government's 68% NDC commitment, alongside the findings of the CCC 6th carbon budget and the National Grid Future Energy Scenarios Report, all reinforce that **net zero is only achievable through negative emissions and BECCS-Power** in the UK.

Achieving net zero is significantly more expensive without BECCS-Power

- The deployment of BECCS-Power drives cost-optimal pathways to meet Net Zero.
- In the central scenario, **system costs would be c.£15bn higher by 2050 without BECCS-power**, equivalent to **£17/household/year to 2050**.
- Even in the 'downside scenario', which is unfavourable for BECCS-Power by design, BECCS-Power delivers a **£4bn** net benefit to the system.

Drax-BECCS deployment in the late 2020s is 'no regrets'

- Drax is progressing plans to deploy carbon capture and storage on two of its biomass units, which would capture 8 million tonnes of CO_2 per year by 2030. This means **Drax could deliver 40% of the CCC's Balanced Pathway 2050 BECCS power target by 2030.**
- With an effective negative emissions policy and investment framework, the first BECCS unit could be operational by 2027.
- In all scenarios, **the decarbonisation pathway is lower cost if Drax-BECCS is deployed in 2027**.
- There are **additional innovation and learning benefits** from the early deployment of Drax-BECCS.

The need for negative emissions | Baringa Analysis

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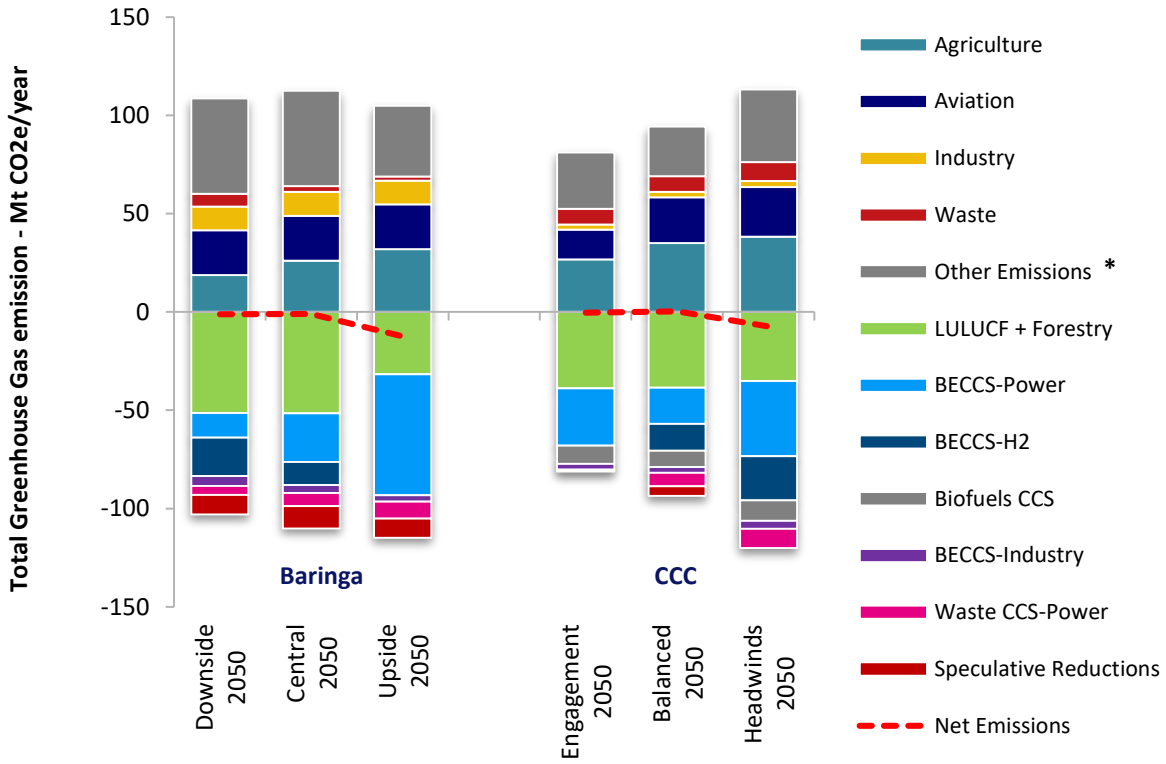
Negative emissions are critical to achieving Net Zero.

- Negative emissions are required to offset residual emissions across the economy. Engineered solutions such as BECCS-Power can make a major contribution.
- Baringa analysis suggests there is strong demand for CO_2 removals (50-80MT CO_2) in additional to LULUCF to offset residual emissions from sectors that are harder to decarbonise.
- BECCS-Power provides a large portion of negative emissions in all cases, even in scenarios where conditions for BECCS-Power are less favourable compared to other BECCS negative emission routes.

Modelling pathways to net zero: Comparison of CCC and Baringa



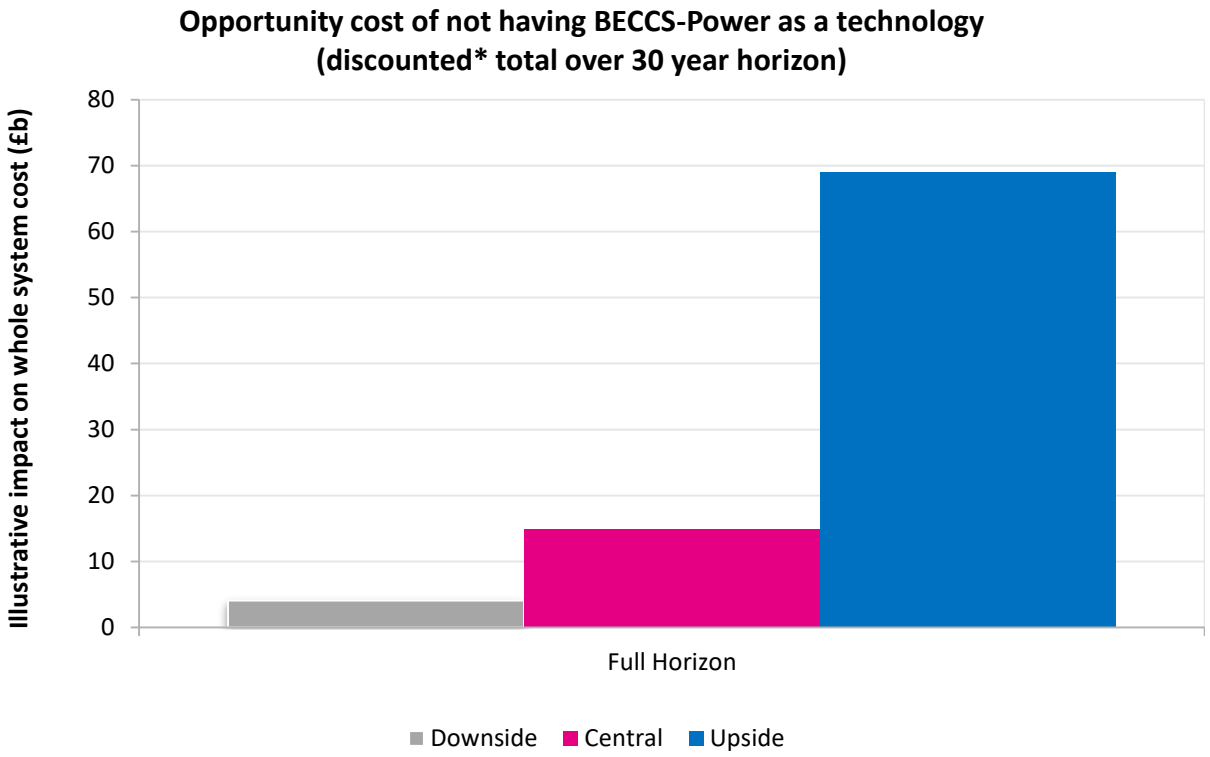
Baringa scenarios are framed by the degree to which assumptions are favourable or unfavourable for BECCS-Power, whereas CCC scenarios focus on different whole system pathways to Net Zero.

Baringa

Achieving Net Zero is significantly more expensive without BECCS-Power

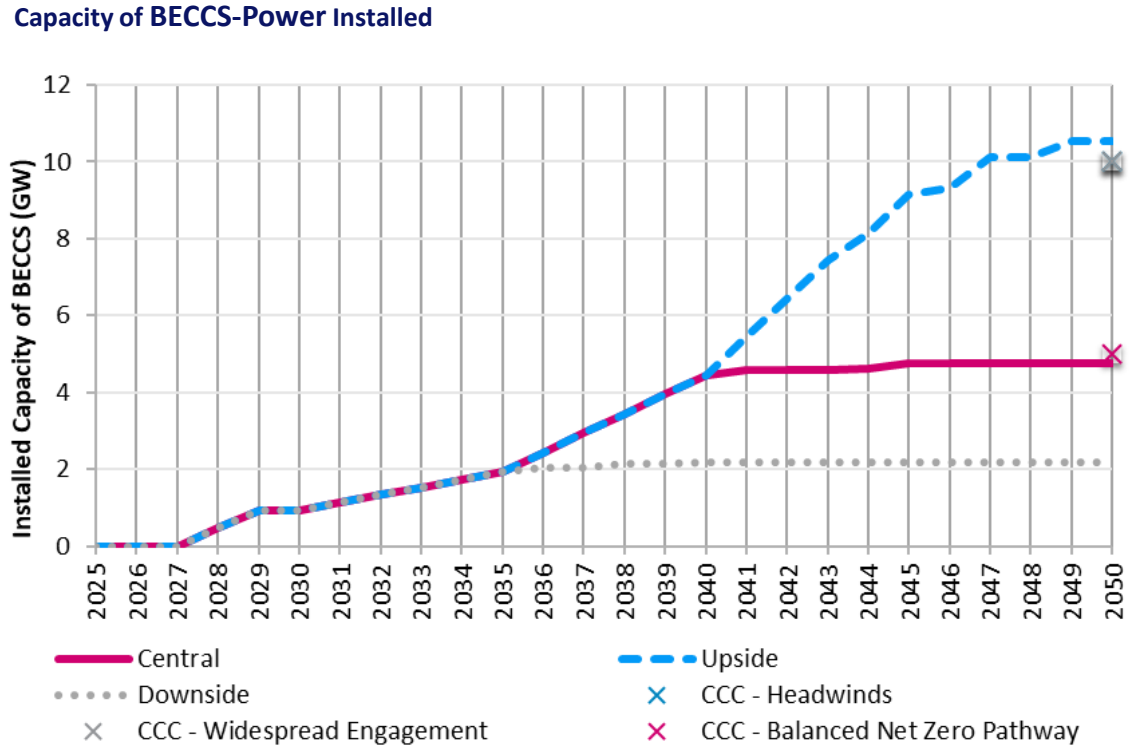
In the central scenario, system costs will be c.£15bn higher by 2050 without BECCS-power, equivalent to £17/household/year to 2050.

- The additional total system costs, in the absence of BECCS-power, range from a further £4-69bn across the pathway to 2050.
- Even in the Downside, which is unfavourable for BECCS-Power by design, BECCS-Power delivers a **£4bn** net benefit to the system.



This measure of the "value of BECCS" power is defined by an opportunity cost approach i.e. if BECCS-Power as a technology was not allowed, how much more expensive would the system design be in its absence to achieve the *same* outcomes in terms of net zero targets, security of supply, etc.

Drax BECCS in 2027 is "no regrets" in all scenarios



- Two Drax biomass units* are converted to BECCS in 2027-29 in all three scenarios. An additional 1 – 9 GW of new build BECCS is added from 2030 – 2050.
- In all cases, it is cost-effective to run the BECCS capacity at high load factors for a significant part of the pathway. In the last 10 years, some biomass is used for to BECCS hydrogen production, and BECCS in power operates more flexibly to complement intermittent renewables.

The deployment of BECCS-Power drives cost-optimal pathways to meet net zero.

- BECCS-power is deployed in all scenarios – with 2-10GW of capacity in 2050 – providing 13-73 MTpa of negative emissions. The central and downside scenarios are broadly in line with the 16-39 MTpa of negative emissions from BECCS-power suggested by the CCC.
- Running BECCS at high load factors will provide strategically important benefits, including:
  - Banking negative emissions to mitigate the risk of underperformance in other sectors
  - Providing a valuable source of firm, reliable negative carbon power to complement intermittent renewable technologies

**When converted to BECCS, Drax units are derated from 630 MW to 460 MW*

BECCS at Drax in the late 2020s is a ‘no regrets’ option

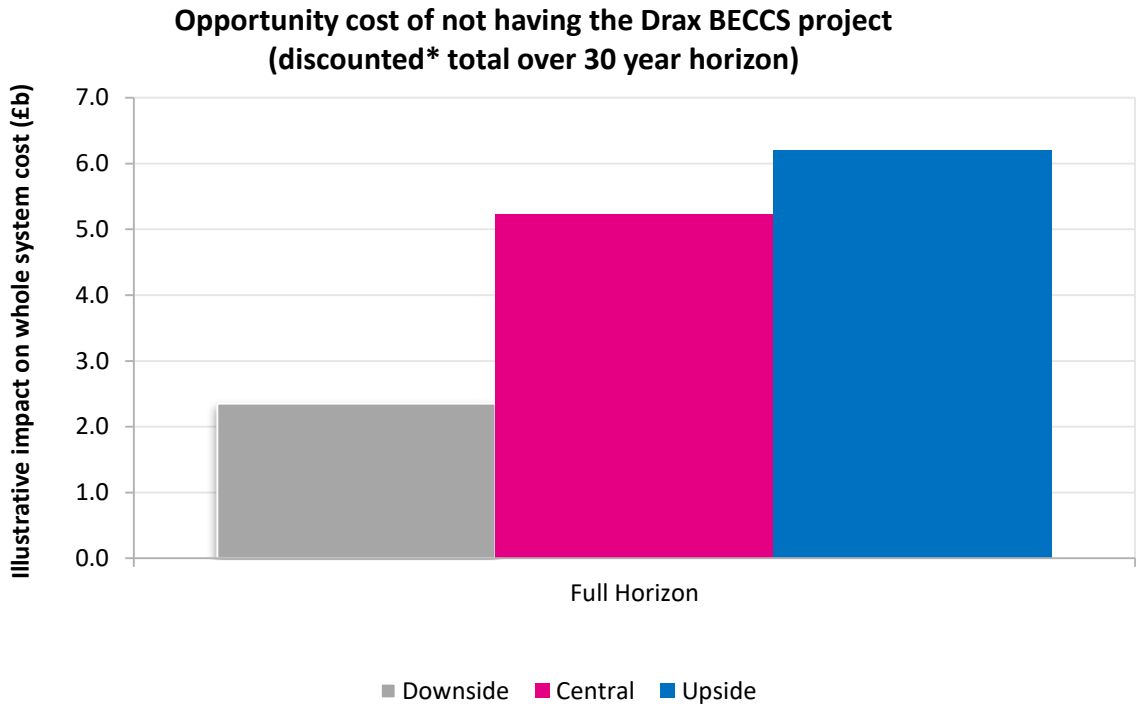
In all scenarios, the decarbonisation pathway is lower cost if BECCS at Drax is deployed in 2027

- Without BECCS at Drax, system costs rise significantly, ranging from £2-6bn across the pathway. By not deploying Drax BECCS in 2027, the system is unable to deploy any BECCS Power until the 2030s.

- There are additional innovation and learning benefits from the early deployment of Drax-BECCS:

    - Conversion of Drax’s existing biomass units can pave the way to a substantial programme of new build BECCS and other negative emissions technologies, with the optimum pathway being refined as technologies mature and costs evolve.

    - Drax-BECCS can also provide an important “anchor project” for development of the CO2 Transmission & Storage infrastructure as part of the Humber CCS cluster.



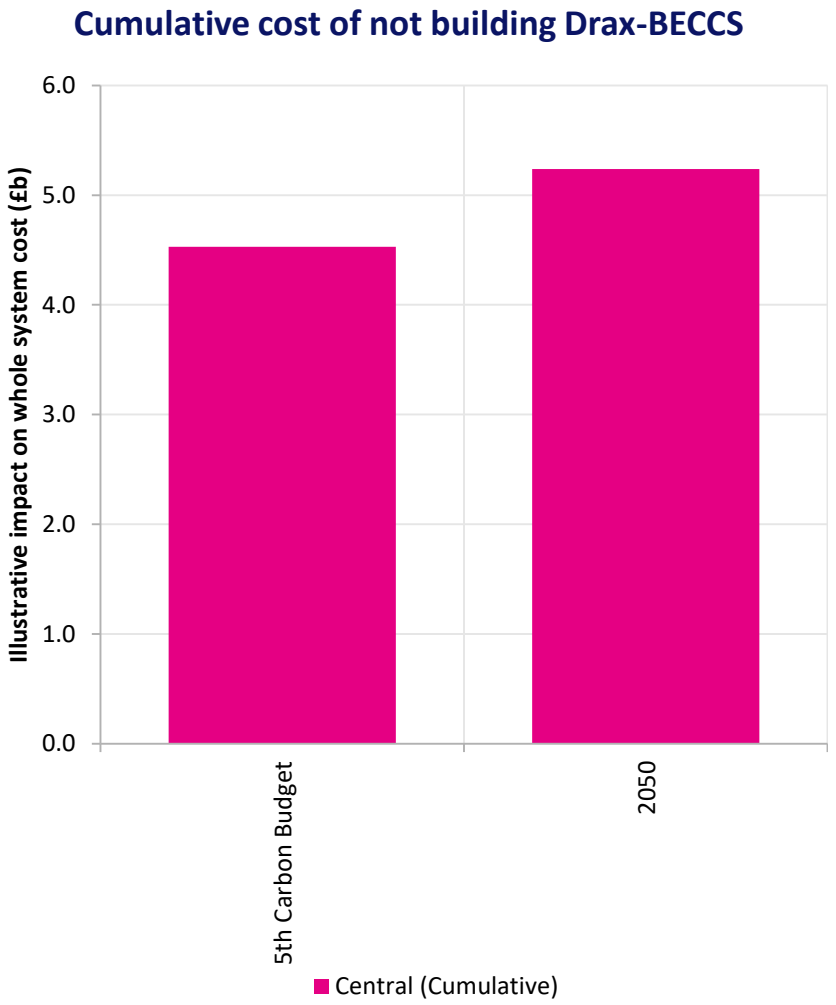
Drax BECCS is deployed in all scenarios – with between 1 and 9GW of additional new build capacity required by 2050.

The opportunity cost of not having the Drax-BECCS project is driven by both the lower cost of the Drax project compared to new build as well as the value of facilitating power sector and broader decarbonisation earlier in the pathway, particularly given the UK’s challenging target of a 68% reduction in emissions by 2030.

Achieving Net Zero is significantly more expensive without BECCS at Drax in 2027

It is much more challenging and more expensive to achieve the 5th carbon budget and net zero without early deployment of BECCS

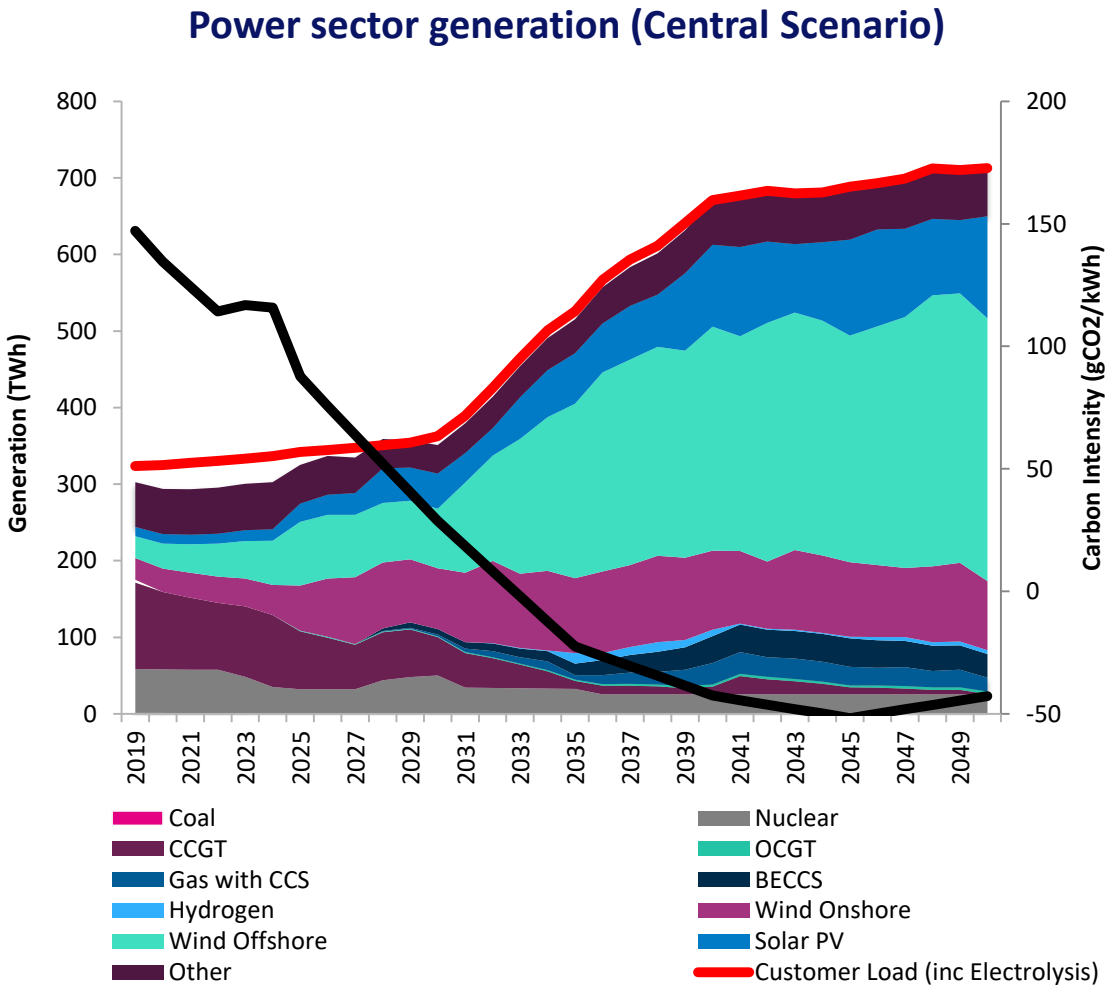
- If the option to build Drax BECCS in 2027 is not taken, **it will cost the UK £4.5bn more to achieve the 5th carbon budget, and over £5bn more to achieve net zero.**
- **If you don't deploy Drax in 2027 you have to spend more money sooner**, because of the lead times for deployment – you have to build more wind, solar and storage in the period 2021-27.
- **If you don't deploy Drax in 2027, the UK will be more reliant on measures that require consumer action in heat and transport** – both of which are much more challenging to achieve than a single large negative emissions project delivered by a private company.



BECCS-Power is critical to decarbonisation of the power sector

Overall electricity demand doubles by 2050, with generation dominated by renewables

- Managing a grid with an increasing proportion of intermittent generation is a challenge.
- National Grid has committed to being able to run a zero carbon power system from 2025.
- Low and negative carbon technologies that provide inertia and other ancillary services, such as BECCS, are increasingly important.
- As the proportion of intermittent generation increases further towards 2050, BECCS is able to operate flexibly to help balance supply and demand.



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