The value of BECCS at Drax Power Station

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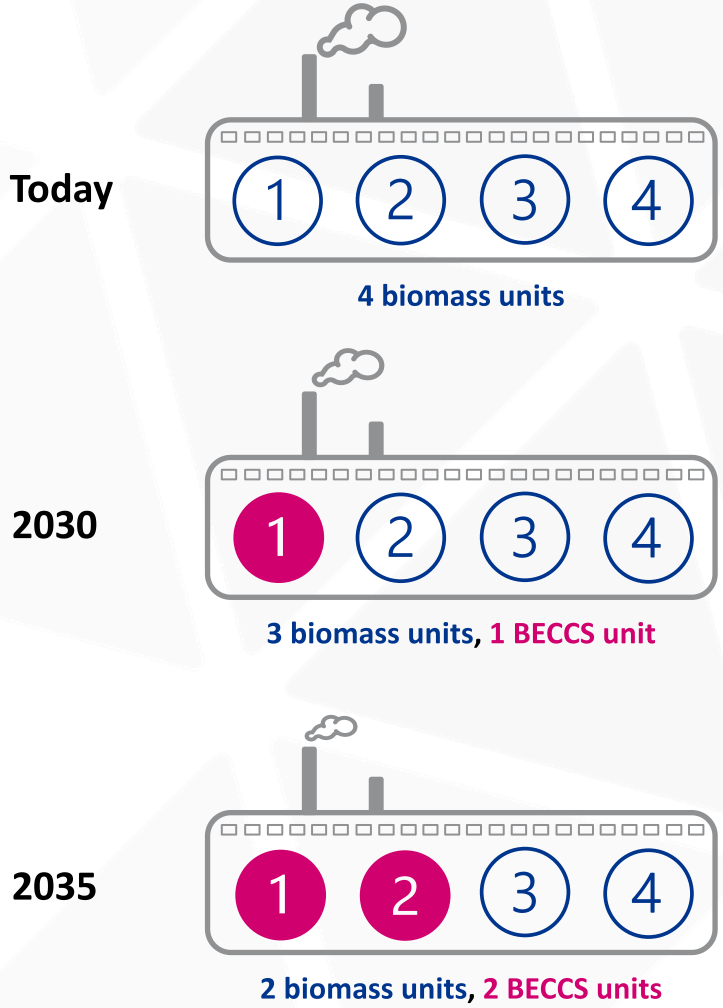
This report summarises the value of BECCS at Drax to the UK economy and the impacts of bridging support between 2027 and the conversion to BECCS

- Drax commissioned Baringa to assess the energy system impacts of deploying BECCS at Drax Power Station.
- Baringa has assumed that the first unit converts to BECCS in 2030 and a second in 2035, based on Government's GGR targets. The analysis assumes the remaining two biomass units continue to remain available as flexible generating units after BECCS conversion.
- The analysis used a whole energy system model to estimate the cost of meeting the UK's legally binding carbon budgets with and without BECCS at Drax Power Station.
- The analysis also used our pan-European electricity system model to assess the impact on electricity system costs of providing 'bridging support' between the expiry of current support for biomass generation in March 2027 to the implementation of BECCS at Drax. This assumes that bridging support enables Drax's biomass units to continue generating at around a 50% load factor during the bridging period.
- The following slide provides an **executive summary** of the findings from the analysis. Further information on the results can be found in slides describing the **value for money of BECCS at Drax** and **impact of bridging support**. The **Technical Appendix** provides more detail on the context for the study and the assumptions used for the analysis.

Assumed deployment pathway for BECCS at Drax



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Converting two biomass units at the Drax Power Station to BECCS provides significant benefits across the economy

Today

Drax Power Station provides **2.6 GW of firm low-carbon capacity** and **11% of the UK's renewable power**. It is the **largest single provider of secure supply** in the UK and **supports over 7,000 jobs**, directly and in the supply chain, mostly in the North of England.

2027 to 2030s

Bridging support between 2027 and BECCS conversion would secure continued reliable, low carbon generation at Drax and keep open the option to convert Drax to BECCS. The bridge would **save the equivalent to £5 per household per year** if gas prices remain similar to this winter. Even if gas prices fell to pre-crisis levels, the cost of bridging support would be relatively small, equivalent to around £1 per household per year on energy bills.

2030 onwards

Decarbonisation

BECCS at Drax provides the only credible option for large-scale, near-term carbon removals – converting two units would **remove 8 $MtCO_2$ per year**, roughly equivalent to cancelling all departing flights from Heathrow for a year.

Affordability

BECCS at Drax is projected to deliver **c.£15bn in whole economy cost savings by 2050** in the central case by avoiding investment in more expensive technologies, **equivalent to c.£25 per household per year.**

Energy Security

BECCS plus biomass units would enable Drax to provide both **firm, reliable power and flexible capacity** to complement intermittent renewables, while also increasing diversity of supply.

Growth

BECCS at Drax would support up to **10,000 jobs** at peak construction and **safeguard over 7,000 direct and supply chain jobs during operation**, mostly in the North of England.

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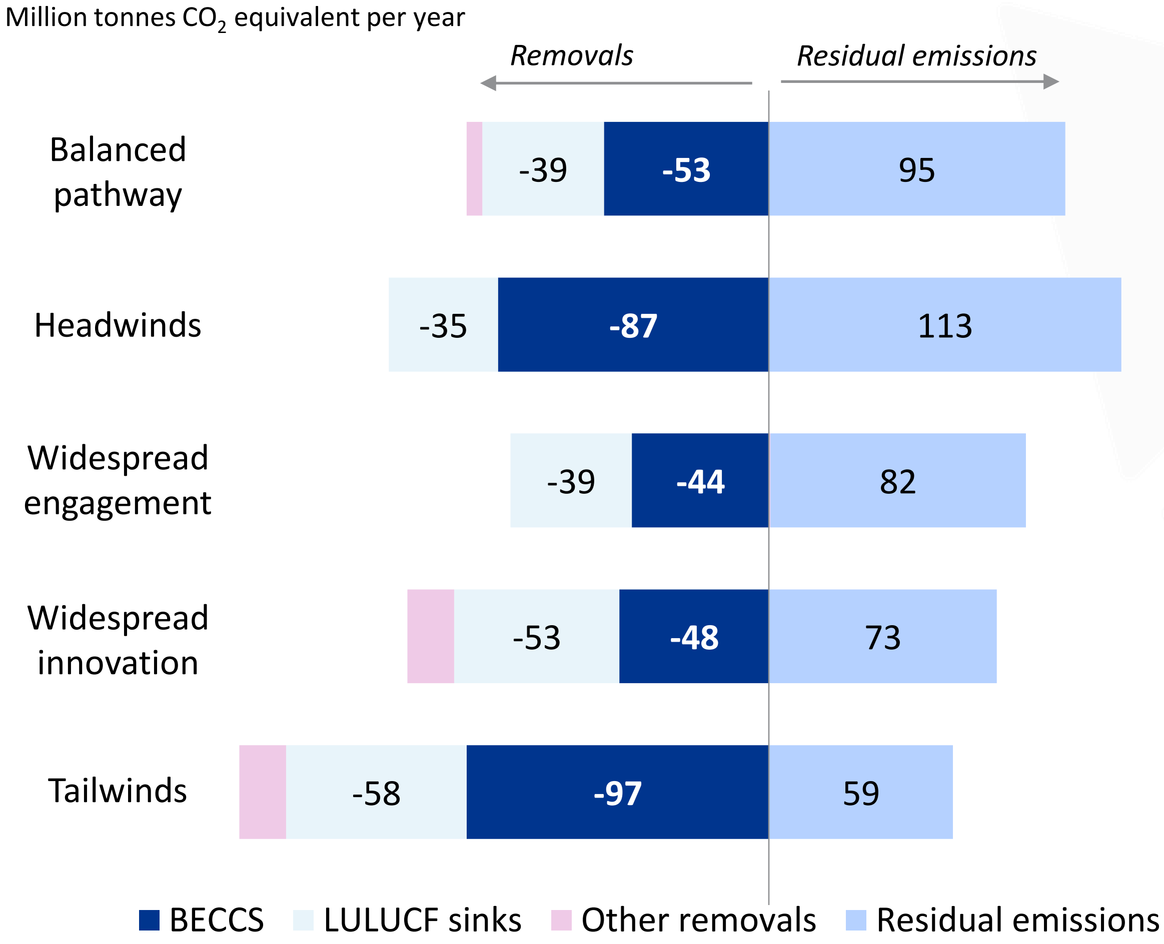
BECCS will be needed at scale to reach UK net zero emissions by 2050

Residual emissions and removals in 2050 in the CCC's Net Zero scenarios



Source: Climate Change Committee (2020), Sixth Carbon Budget Dataset
Notes: LULUCF is Land Use, Land Use Change and Forestry

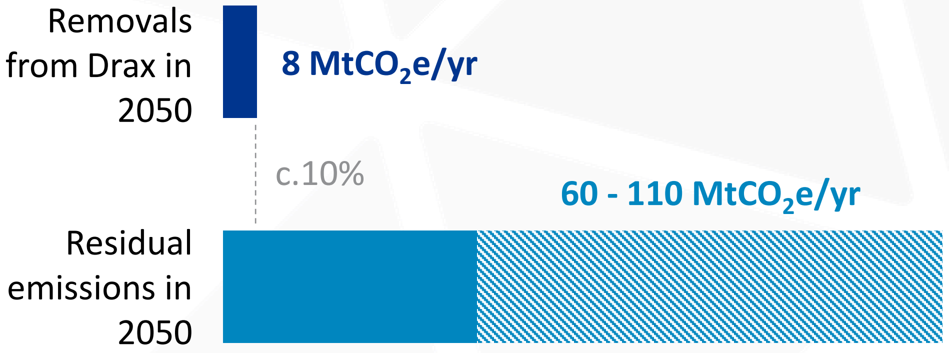
- Emissions reductions will be needed across all sectors to meet net zero targets.
- However, by 2050 there will still be a significant volume of residual emissions from hard-to-decarbonise sectors such as agriculture, aviation and certain heavy industries.
- To reach net zero, carbon dioxide will need to be removed from the atmosphere to compensate for these residual emissions.
- There is widespread agreement that BECCS at scale will be one of the critical carbon dioxide removal technologies.
- According to the Climate Change Committee, **BECCS will need to remove between 44 and 97 million tonnes of CO_2 a year** by 2050.
- Within the power sector, National Grid ESO estimates BECCS will provide between **2 and 9 GW of installed capacity** and between **2% and 4% of GB electricity generation** in 2050.

BECCS at Drax provides the only credible option for delivering near-term, large-scale carbon removals

- Converting one biomass unit to BECCS in 2030 and another in 2035 would deliver carbon removals of **4 $MtCO_2e$ per year from 2030** and **8 $MtCO_2e$ per year from 2035**.
- BECCS at Drax provides the only credible, large scale carbon removals available in the near-term to meet the Government's 2030 Greenhouse Gas Removals target, contributing **80% to the 5 $MtCO_2e$ target**.
- BECCS at Drax can also make a significant contribution to the 2050 Net Zero target, providing around **10% of the carbon removals needed** to compensate for the 60 to 110 $MtCO_2e$ residual emissions projected in hard to decarbonise sectors.
- The carbon reductions delivered by BECCS at Drax are significant and equivalent to:
  - Taking an additional **3 million** internal combustion engine cars off the road; or
  - Reducing the total number of departing flight passengers per year by **46 million**, roughly equivalent to cancelling all departing flights from Heathrow; or
  - All households having **1.5 beef, lamb and dairy free days per week**.

Contribution of BECCS at Drax to 2030 GGR target

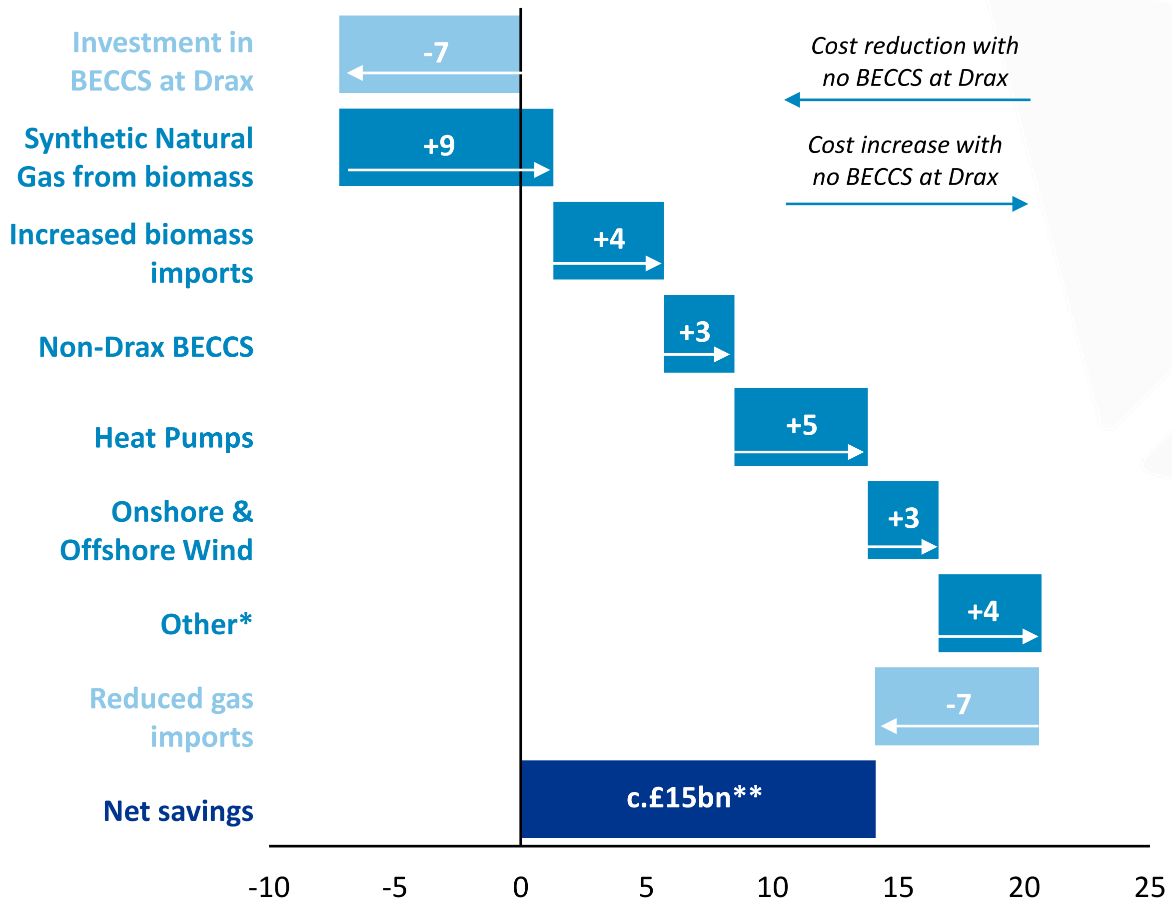
Contribution of BECCS at Drax to 2050 Net Zero target



Converting two biomass units at Drax to BECCS is projected to save billions of pounds to 2050 compared to the next best alternatives

Breakdown of £15bn in savings in the central case

£bn, 2023



**Other includes increased spend on biofuels with CCS, non-Wind renewables, electricity storage , network and transmission charges*

*** Total does not sum to £15bn. due to rounding*

- BECCS at Drax is projected to **save around £15bn in whole economy costs from 2030 to 2050** in the central case (range from -£5bn to £20bn), equivalent to c.£700m / year, or £25 per household per year.
- Without carbon removals from BECCS at Drax, there needs to be much larger carbon savings in other sectors.
- The lowest cost solution the model finds without Drax is to increase the **production of synthetic natural gas** from biomass. This involves:
  - **£8.5 billion** of investment in synthetic natural gas production facilities – a nascent technology today
  - A **10% increase in biomass imports** (compared to imports in the with Drax BECCS case) to feed syngas production
  - **A 260% (64 TWh) increase in syngas production**, at a price of c.50% more than natural gas (compared with Drax BECCS case)
  - **Replacement of c.7% of total gas consumed with syngas**, used in sectors such as shipping, metals and chemicals.
- In addition to syngas production, there would need to be:
  - **735,000 more heat pumps**, beyond existing stretching targets
  - **7 GW** increase in onshore & offshore wind generation
  - Additional **non-Drax BECCS** and other biomass technologies.

Converting two biomass units to BECCS earlier would deliver higher savings, as would converting a third unit

Converting one biomass unit to BECCS in 2030 and a second in 2035 is projected to deliver savings of c.**£15bn** (central case)

Bringing forward the conversion of the second unit to 2032 could increase the savings by c.£1bn, from c.£15bn to **c.£16bn**

Converting two biomass units to BECCS in the early to mid 2030s opens up the option to convert a third biomass unit to BECCS in the late 2030s, which could provide additional whole-economy cost savings

Converting two biomass units at Drax to BECCS would ensure Drax continues to provide important security of supply benefits

2.2 GW capacity

With two BECCS and two biomass units, Drax would provide up to **2.2 GW of generation capacity**, equivalent to c.6% of the total thermal capacity in 2035. The **two biomass units** would provide flexible generation to help balance supply and demand.

2 TWh in supply chain

The biomass inventory in the Drax supply chain contains energy that can generate around **2 TWh of electricity**. This is equivalent to **2.5 days of UK electricity demand**, providing resilience to supply disruptions.

7% of certain key system services

Drax would continue to provide **valuable system services** to the grid, such as inertia and reactive power, and support the integration of more renewables. The four biomass units at Drax Power Station provided c.7% of reactive power utilisation in FY 2022/23, according to data from National Grid.

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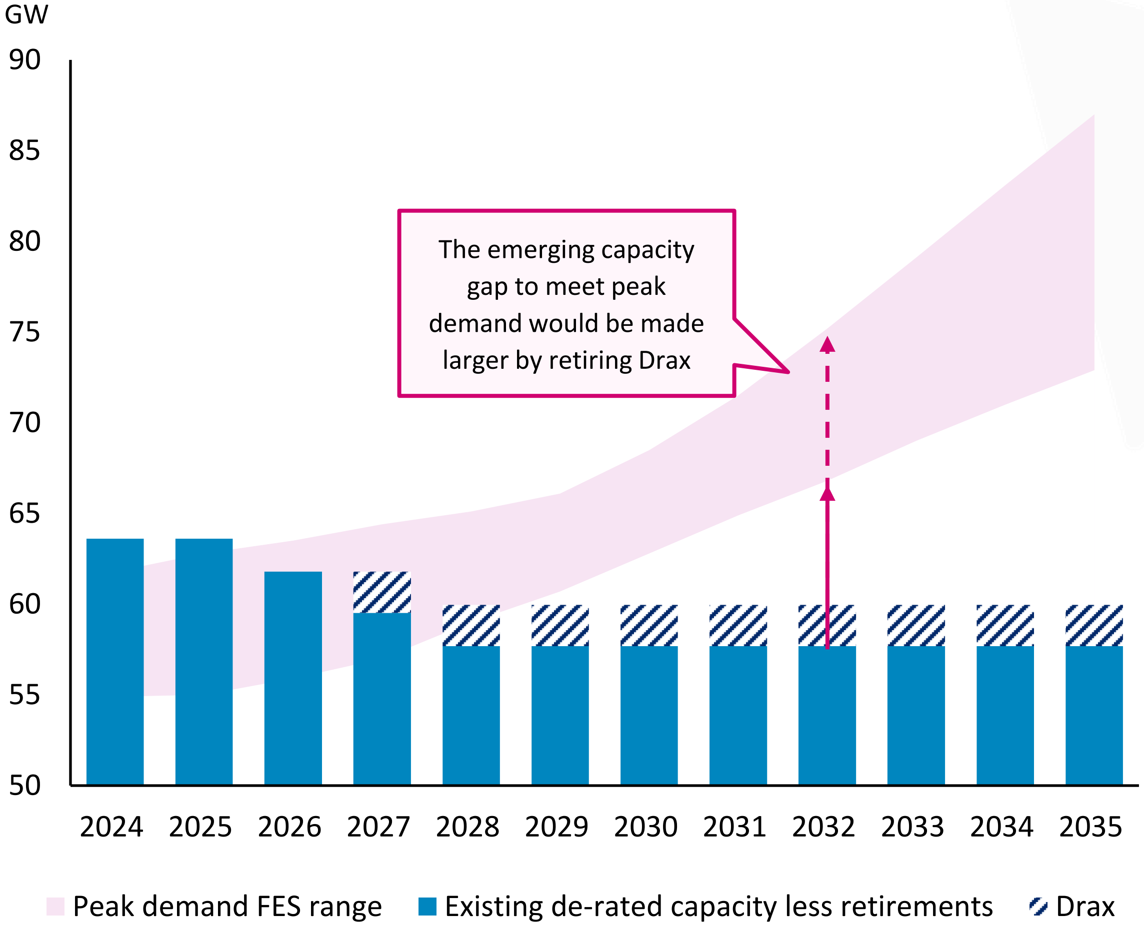
The increase in peak demand and retirement of several large power plants is expected to place additional pressure on security of supply in the late 2020s

Peak demand and de-rated capacity less announced coal & nuclear retirements

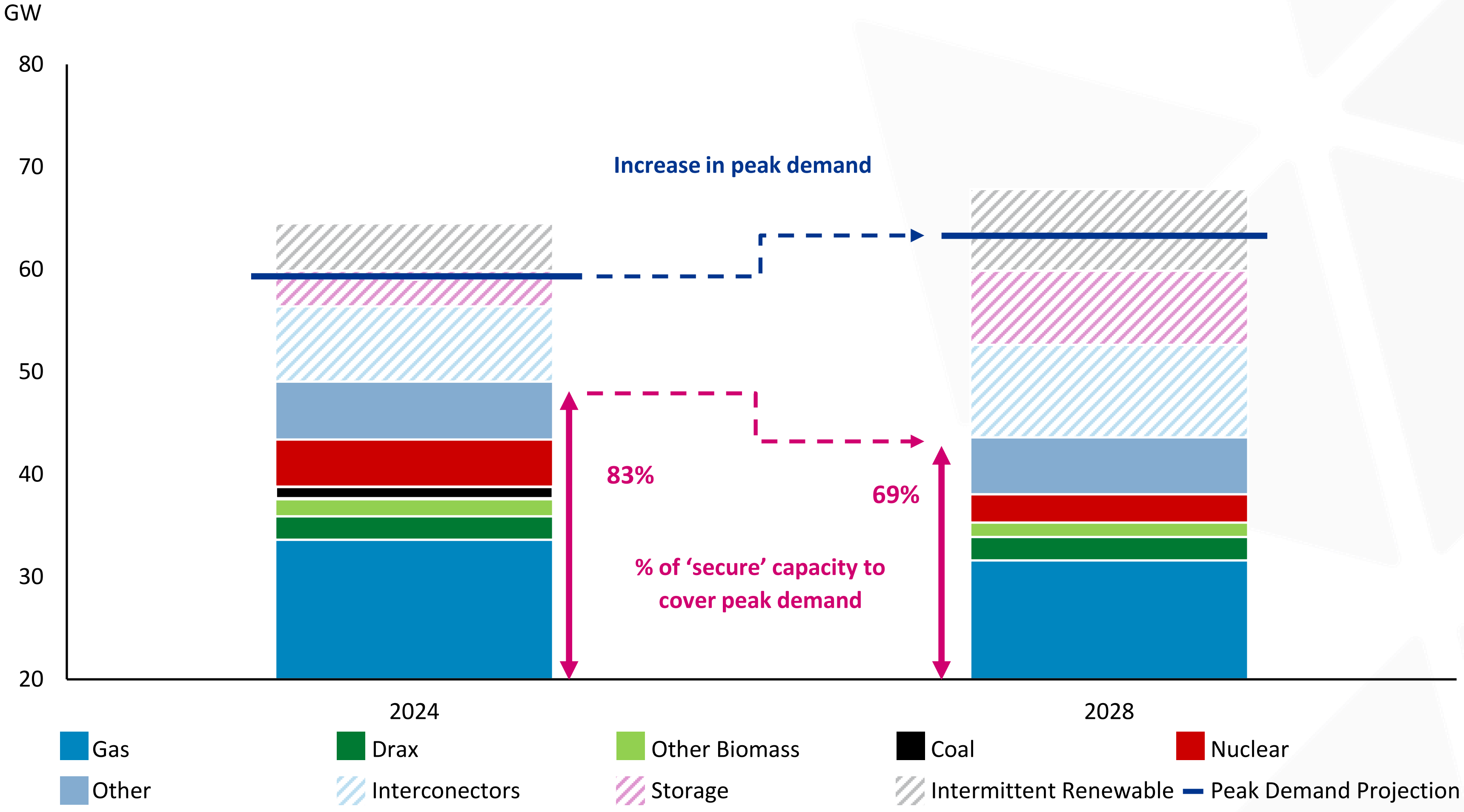


** Based on published closure dates from EDF*

- Around **7GW of nuclear and coal installed capacity is expected to close** between 2024 and 2030 (2 GW of coal in 2024, 2.3 GW of nuclear in 2026, 2.6 GW of nuclear in 2028*), and several GW of older gas plants could also retire during this period as they are pushed out of merit by increased generation from wind and solar.
- At the same time, **peak demand is expected to increase** from around 55-62 GW today to 63-69 GW in 2030, driven by the electrification of the heat and power sector with the uptake of heat pumps and EVs.
- There will **need to be a significant amount of new generation capacity as well as Demand Side Response** to bridge the emerging capacity gap; which would be further exacerbated by retiring Drax Power Station.
- Current **supply chain constraints** and **bottlenecks in the planning** and permitting system are **increasing the risk of delivering this new generation** capacity in time.

As large volumes of 'secure' capacity retire, GB will increasingly rely on intermittent renewables, storage and interconnector imports to meet peak demand

De-rated capacity mix and peak demand projections



'Secure' technologies include: Gas, biomass, coal, nuclear and other (biowaste, oil, hydro run-of-river). Intermittent renewables include: Solar, wind and marine.

Generation mix is based on Baringa projections, including any publicly announced closure dates for specific assets. Capacity is de-rated using NGESO's de-rating factors from the 2023-24 Winter Outlook.

- Baringa project that in future, GB will increasingly rely on intermittent renewables, storage and imports to meet peak demand.
- 'Secure' technologies, such as gas, nuclear and biomass, are **more readily available in times of electricity system tightness**.
- In 2024, 'secure' capacity contributes to c.83% of peak demand, but this is projected to drop to c.69% by 2028; **this would drop by a further 4% if Drax Power Station were to retire**.
- This is driven by a net **decrease in 'secure' de-rated generation**, as well as an **increase in peak demand of 4.1 GW**.

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Bridging support would improve security of supply by safeguarding the firm capacity and system services provided by Drax, and reducing import dependency

Safeguards **2.6 GW of low carbon capacity** at Drax, the largest power plant in the UK today

Avoids around £380m in Capacity Market payments that would be needed for new unabated gas capacity to compensate for loss of Drax

Reduces the risk of capacity shortages with the expected retirement of 7GW of coal and nuclear capacity and some gas plants in the 2020s

Provides energy storage in the supply chain that could generate electricity equivalent to **2.5 days of UK demand**

Provides 4% of GB dispatchable power and valuable system services needed to operate the power system safely and securely

Reduces electricity imports by **up to 30%** during periods of high demand and low wind output, improving fuel security

Bridging support would also provide insurance against high gas prices and secure low carbon generation at Drax

+£2.0bn

With high wholesale gas prices like this winter, bridging support would **save customers around £2bn** over the bridging period (compared with closing Drax), equivalent to a saving on energy bills of **£5 per household per year.**

+£3.5bn

If gas prices spike like they did in Winter 2021/22, bridging support would result in savings of **around £3.5bn over one winter period.**

-£0.5bn

Even if gas prices fell to pre-crisis levels, the cost of bridging support would be relatively small, equivalent to **around £1 per household per year** on energy bills and just **2% of the economy-wide savings** delivered by converting two units at Drax to BECCS.

CO_2

Drax generation would reduce power sector emissions by approximately **4 $MtCO_2e$** during the bridging period, equivalent to **5%** of emissions from the power sector.

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This report updates previous analysis on the value of deploying BECCS at Drax in the 2030s and summarises the benefits of bridging support ahead of conversion to BECCS

- In 2021, Drax commissioned Baringa to assess the role and value of BECCS at Drax in meeting the UK's Net Zero carbon target. The analysis was published by Drax and showed that deploying BECCS at Drax in the late 2020s was a no regret option for reaching net zero.
- Since 2021, there have been several changes in the energy sector that materially influence the value of BECCS at Drax:
  - The Drax BECCS project was not shortlisted in the Track 1 cluster sequencing process. As a result, our assumptions for the **conversion dates for the two biomass units to BECCS have changed** from 2027 and 2029 to 2030 and 2035. There is potential to deploy BECCS on the second unit earlier if there is sufficient capacity available in the T&S network.
  - The war in Ukraine has driven **commodity prices far higher than historical norms**. This has increased the cost of generation from alternative fossil fuelled technologies, such as gas CCS, but has also had a knock-on impact on biomass prices.
  - Inflationary pressures and supply chain issues have increased the **cost of deploying renewables and other low carbon technologies**, including BECCS.
- This report provides an **update to the 2021 analysis** of the value of BECCS to reflect these changes. In addition, it summarises the impacts on electricity system costs of providing Drax with bridging support between 2027 and the conversion to BECCS.
- The report shows that BECCS at Drax remains a low regret option for reaching net zero emissions. It also shows that providing bridging support will help maintain security of supply and would provide some protection to consumers against the risk of high gas prices.

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The BECCS analysis uses a whole-economy model to estimate the impact of the conversion of Drax to BECCS

Approach

- The value of BECCS at Drax has been estimated using the Energy System Catapult's ESME energy system model, originally developed by Baringa for the Energy Technologies Institute.
- The ESME model has been used to quantify the overall cost of meeting carbon targets both with and without BECCS at Drax, with the difference between the two scenarios showing the potential whole economy savings from BECCS at Drax.

Assumptions

- The central case is consistent with assumptions published by government and the CCC. The cost of each electricity generation technology comes from the DESNZ 2023 generation cost report where available. The cost of converting Drax to BECCS and biomass prices are based on figures provided by Drax. The cost of all other technologies are based on assumptions in ESME provided by the Energy System Catapult.
- The modelling assumes BECCS power plants run at a high load factor for the first 15-20 years of operation. This is aligned with the Government’s position that BECCS should operate largely as baseload generation to maximise the volume of negative emissions.

Sensitivities

- Three credible, internally consistent scenarios have been assessed:

Scenarios	Biomass prices	Drax BECCS capex	Other tech costs	Commodity prices	Biomass availability	Action in other sectors
Downside	High	High	Low	Low	Low	High
Central	Central	Central	Central	Central	Central	Central
Upside	Low	Low	High	High	High	Low

The bridging analysis draws on Baringa's in-house pan-European power market model to estimate the impact on system costs of different scenarios for support

Approach

- Baringa quantified electricity system costs with and without Drax Power Station from April 2027, when existing support arrangements are due to end, to March 2031.
- The 'with Drax' scenario assumed a CfD supporting up to 10TWh of generation per financial year across all four of the Drax biomass units. This drops to 5TWh after the conversion of the first biomass unit to BECCS. Electricity system costs were calculated using Baringa's in-house pan-European PLEXOS based model, simulating the least cost dispatch to meet demand. Separate analysis was carried out to estimate the impact of the Drax and no Drax scenarios on Balancing Market costs, CfD top-up payments (for other generators), and Capacity Market costs.

Assumptions

- Base Case assumptions were drawn from Baringa's Q1 2023 Reference Case Scenario, a central view of the evolution of the pan-European market. Assumptions on operational and fuel costs for Drax Power Station were provided by Drax.

Sensitivities

- The analysis tested sensitivities around different carbon and gas prices, as well as weather outturn for wind as described in the table below:

Scenarios	Carbon Price	Gas Price	Wind Output	Solar Output	Demand
Pre-crisis prices (Base Case)	Baringa **Reference Case Q1 2023**		2017 weather year	2017 weather year	2017 weather year
2023 prices (prices today)	Baringa **NZ High Scenario Q1 2023**		**Low Wind** Outturn, -2% LF	Base Case	Base Case
Winter 2021/22 prices	Base Case	**Q3 2022 Forwards**	**Low Wind** Outturn, -2% LF	Base Case	Base Case

