Carbon Management and Oil and Gas Research Project Review Meeting
Carbon Dioxide Removal Research

Drax Group: Biomass & BECCS

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1

Introduction to Drax

Our Purpose

Enabling a zero carbon, lower cost energy future

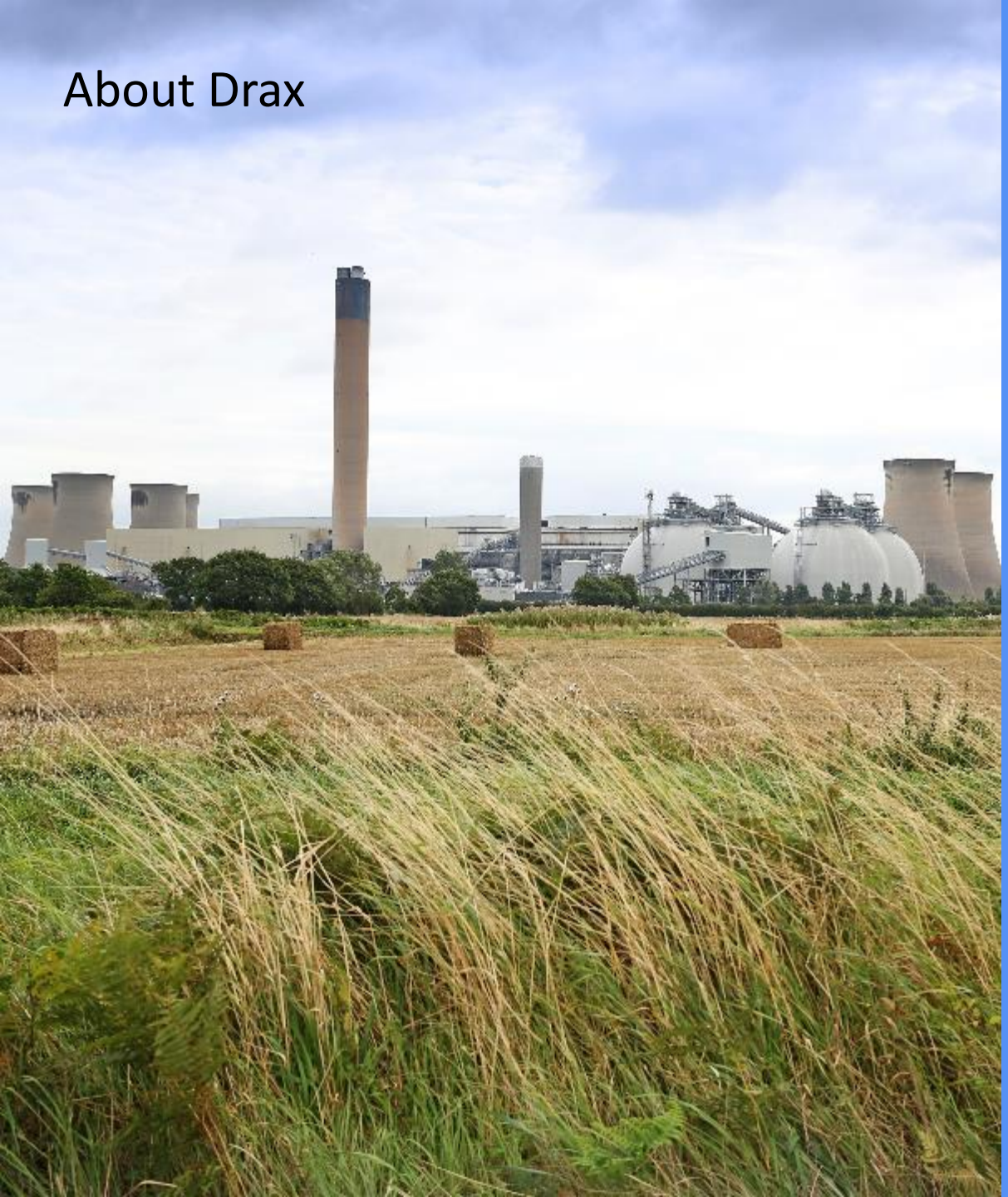
Our Strategy

We will build a long-term future for sustainable biomass
We will be the leading provider of power system stability
We will give our customers control of their energy

Our Ambition

To be a carbon negative company by 2030

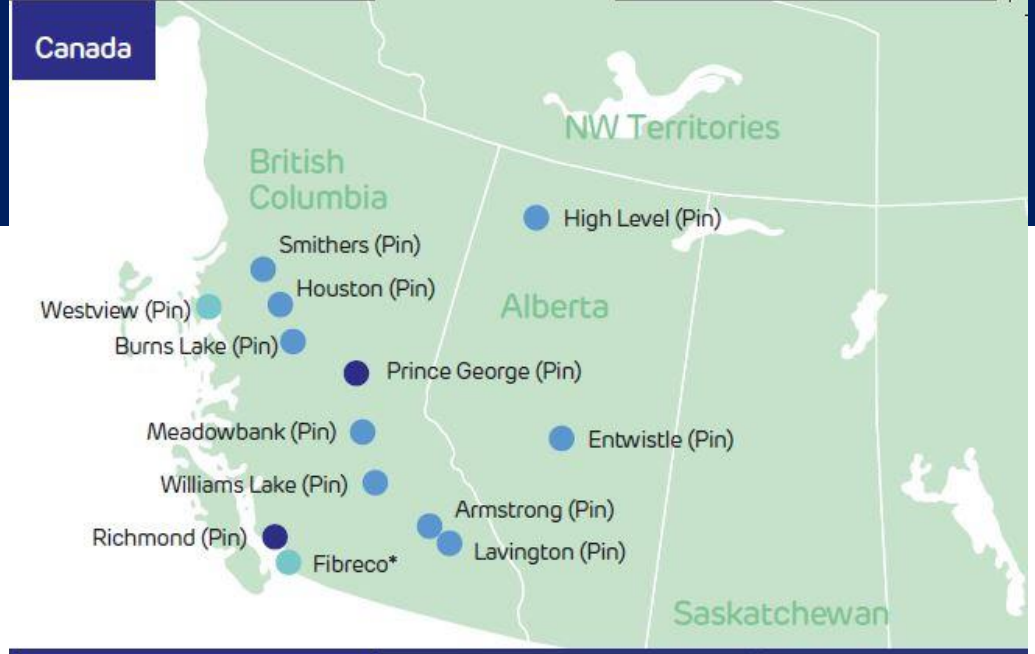
About Drax



- We've transformed from the UK's largest coal-fired Power Station, into **Europe's largest decarbonization project**
- Drax has now **slashed its CO2 emissions** from power generation **by over 90 percent since 2012**
- We're the **largest generator of renewable electricity in the UK** (12%)
- We're the **third largest generator in the UK** (8.3m homes)
- Drax also **operates 17 plants** across the US South and Western Canada
- Our operations and supply chain **support 18,000 jobs**
- We're the world's leading **bioenergy generator and supplier of sustainable biomass**
- Our BECCS project could create **the world's first carbon negative power station**

Our global footprint

drax



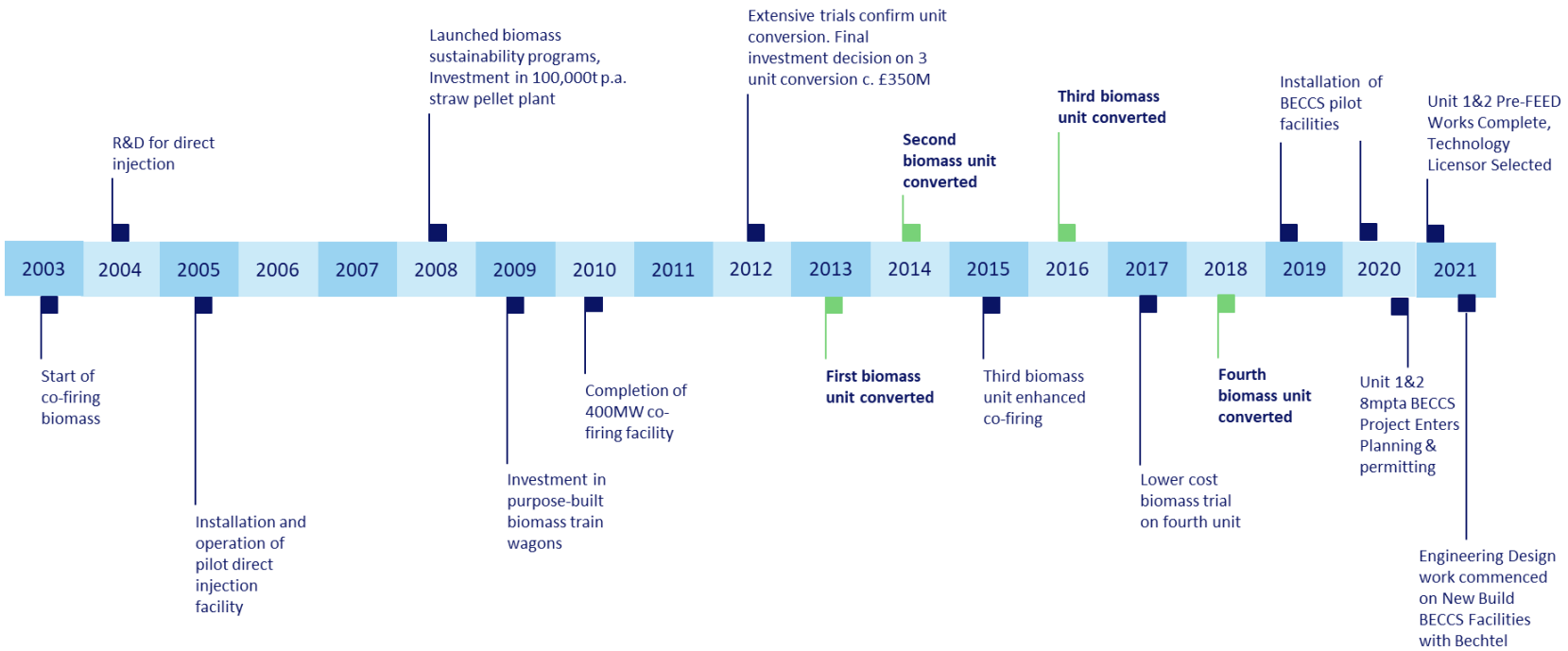
2

Drax Biomass

Biomass & BECCS Evolution at Drax

Drax's biomass journey began with co-firing in 2003, followed by investments in the power station and throughout the supply chain

Biomass evolution at Drax



Key Highlights

- Drax started co-firing with biomass in 2003 with the aim of reducing carbon emissions
- UK Government Renewable Obligation Certificates scheme provided Drax incentives to reduce coal, move to biomass and drive towards full conversion
- During 2003-12, Drax was co-firing at 10% and the first fully converted plant was launched in 2013 after extensive trials
- Drax trialled a number of different types of fuels (350+), before deciding on high quality wood pellets as the optimal fuel with the best chemistry for Drax plant, mills and boiler configuration
- During full conversion of the units (2.6GW), Drax has invested to build a sustainable pellets supply chain in the U.S. and via 3rd party suppliers, developed ports in the UK and U.S. and in UK logistics
- Support through Contracts for Difference (CfD), and carbon price support have been critical policy success factors

Drax Group are on the journey of bioenergy evolution with BECCS and sustainable pellet cost reduction to enable a subsidy-free future post 2027 and become a carbon negative company

The world's leading sustainable biomass generation and supply business

BIOMASS VALUE CHAIN

DRAX BIOMASS (US & Canada)

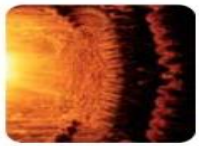
DRAX POWER












Forest, Harvesting & Transport	Drax Pellet Production	Transport to ports	Port storage and handling	Ocean Freight	Port storage and handling	Rail	Drax Power Generation	BECCS
Fibre and residue purchase contracts with accredited 3rd parties	**Drax produces 4.9 MT p.a** from 17 production facilities in the US and Canada	Rail wagons leased via logistics contract	**Drax developed Baton Rouge Transit** • 2mt/annum handling capacity • Northernmost deep water port	Shipping secured via contracts of affreightment	**Drax developed & invested in storage & handling at 4 ports***	**Drax invested +£50m in developing & owning rail wagons**	**Drax Selby 2.6GW biomass capacity (4 x 660MW units)**	**Ambition to create an 8mpta carbon negative power station by 2030**

Third Party Pellet Suppliers:

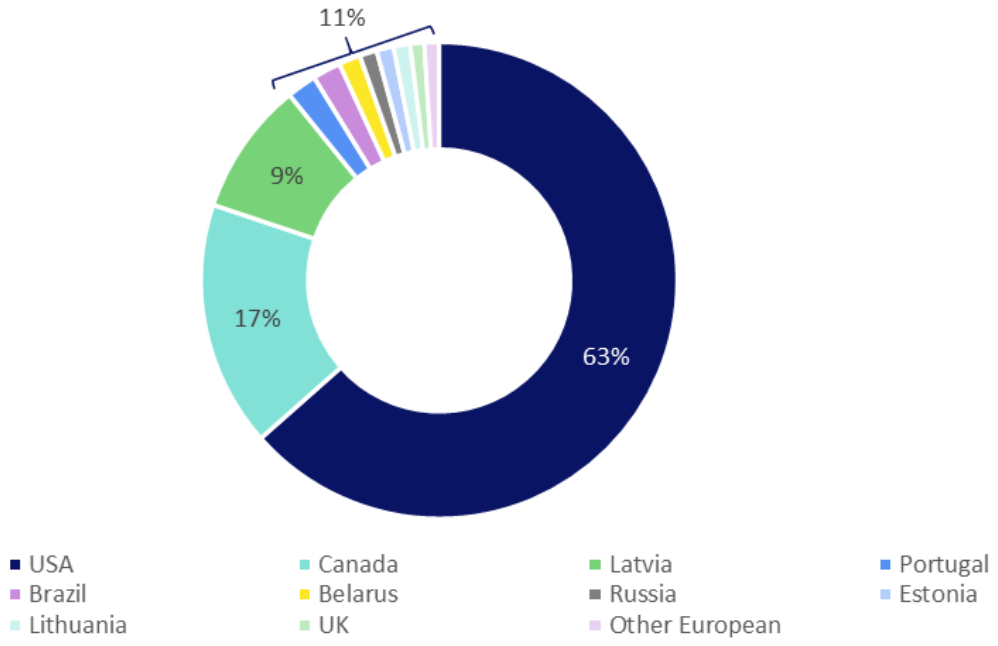
- Strong long term supply chain relationships with regular meeting and plant audits
- 99% Sustainability Biomass Program (SBP) compliant supply and monitoring system for non-SBP certified supply

Drax assets (owned/ managed)

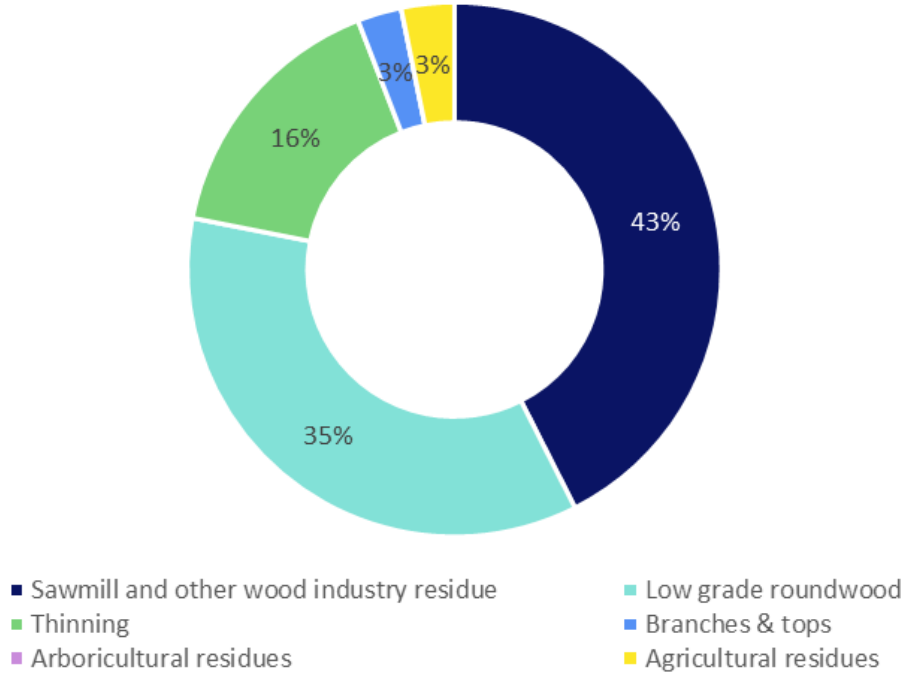
Contracted services

Biomass used at Drax

80% of Drax's supply comes from North America



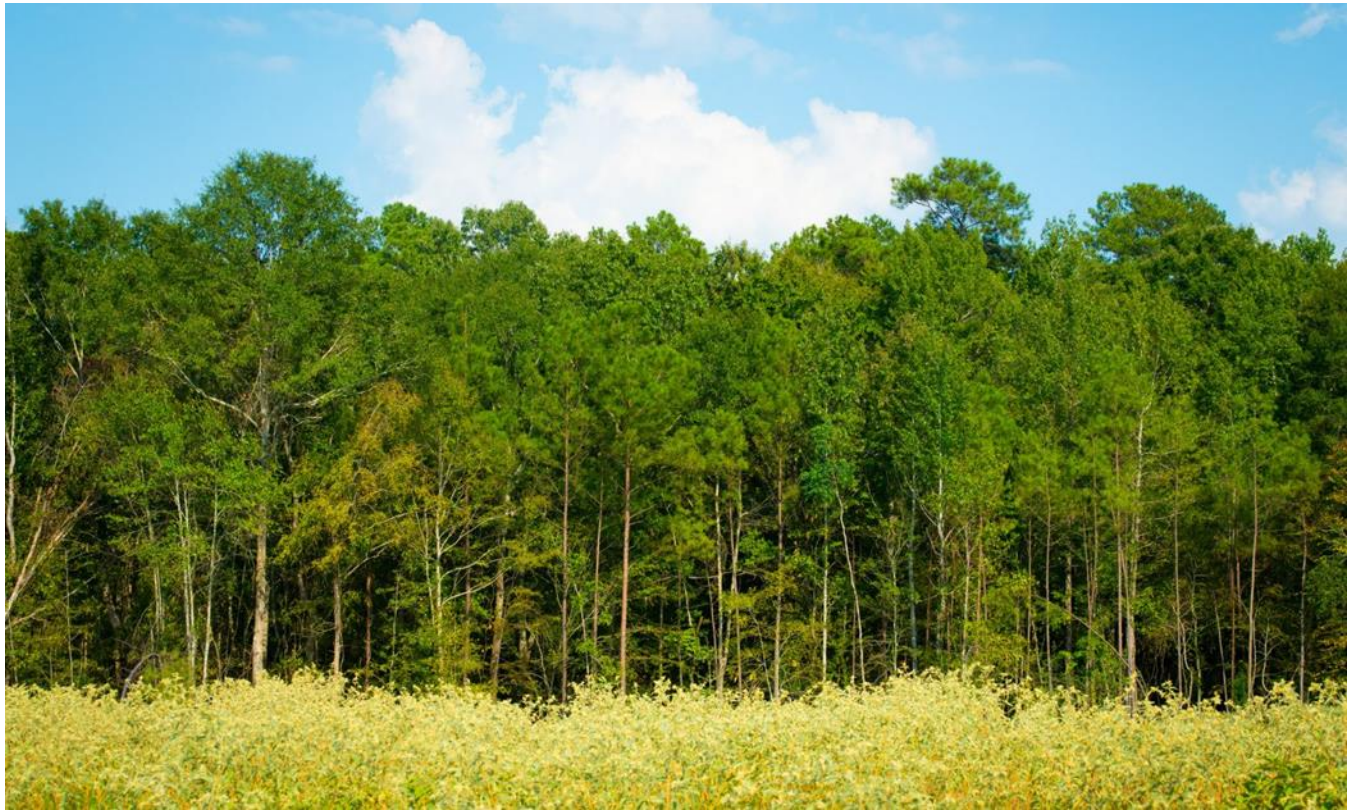
Drax's supply comprises a mix of sources, including wood pellets from sawmill residues



The benefits of forest biomass

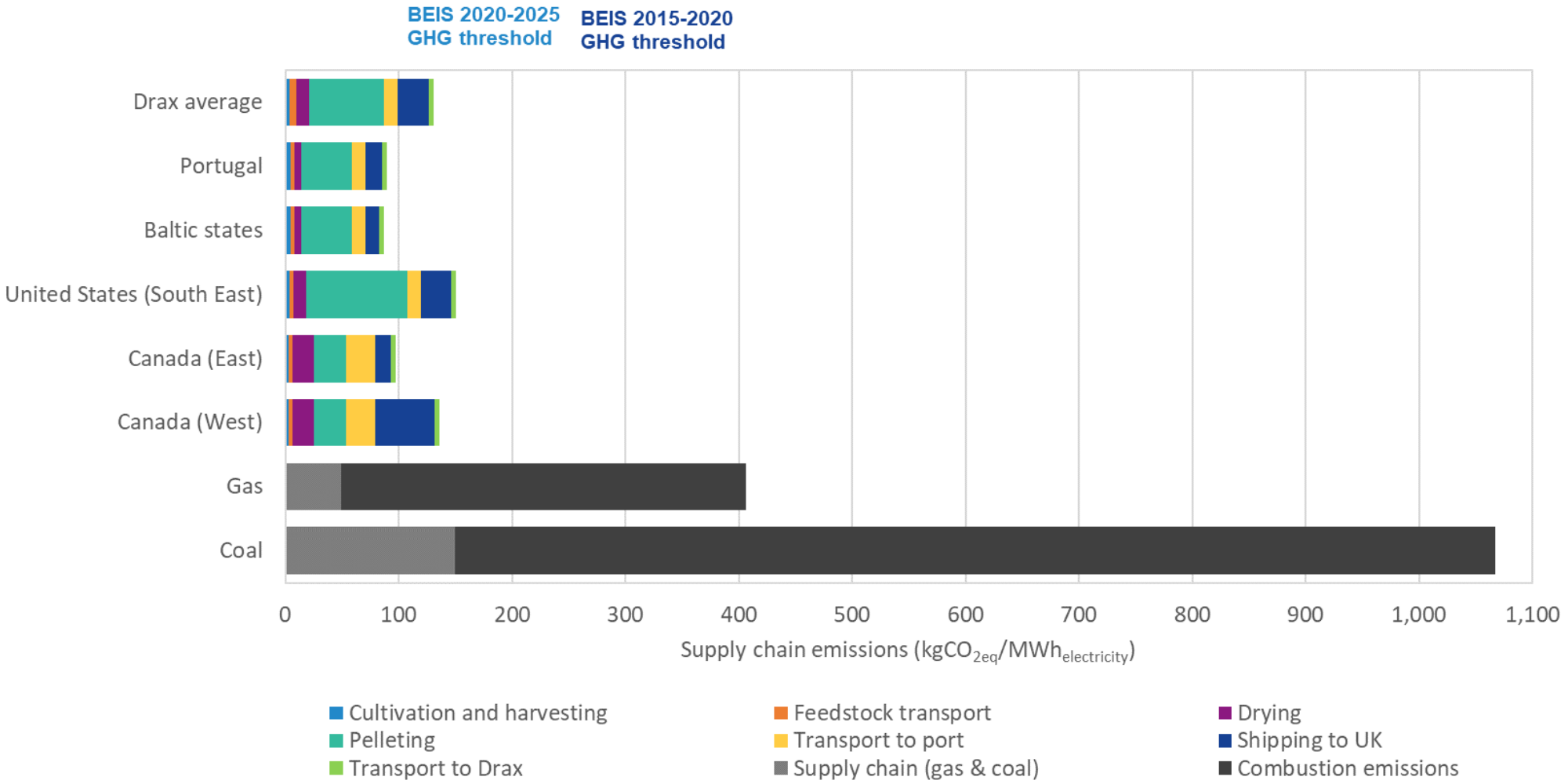
Biomass isn't a trade-off between decarbonising our economy and protecting forests. It delivers for both.

- **No evidence of deforestation:** Healthy demand for wood contributes to growing forests. Forest inventory has increased by 21% since 2000 with pellet producers using less than 0.1% of total forest inventory
- **Increasing rate of growth and carbon sequestration across the US South**: **:** Managed forests absorb more carbon than forests that are left untouched. Over the last 50 years, the carbon storage in the US South has more than doubled
- **A direct positive impact on our communities:** We directly employ 757 colleagues in Drax's locations and support thousands of jobs across our supply chains



Drax supply chain GHG emissions

A significant saving compared to fossil fuels in all supply areas



11

3

Drax Sustainability Policy

Drax sourcing policy and practice: going beyond regulatory compliance

Drax's sustainable biomass sourcing policy is the industry gold standard and is led by science, best practice and transparency

- Drax is independently audited and its biomass complies with **stringent Ofgem and EU standards.**
- Drax's suppliers' operations are **regularly audited by independent third-party bodies** to certify compliance with sourcing policies, forestry standards and regulatory requirements.
- **Drax's sourcing policy is in line with a recent Forest Research report which identified sourcing practices that maximise the positive carbon contribution that sustainable biomass can deliver.**
- Drax doesn't use biomass that causes deforestation, forest decline or carbon debt. This is a fundamental commitment in its sustainable biomass sourcing policy.
- Drax is committed to use only **sustainable biomass from** areas with **managed forests** where the forests are **growing at a greater rate than what is harvested**.

Drax responsible sourcing policy

1. **Sustainability Policy for sourcing forest biomass.**
    - Deliver good outcomes for the climate, environment and communities in which we operate
2. **We also created an Independent Advisory Board:**
    - A Board of scientists, civil society and leaders in the field of sustainability to provide impartial advice on sustainable biomass
    - Led by former UK Government chief scientific advisor Sir John Beddington

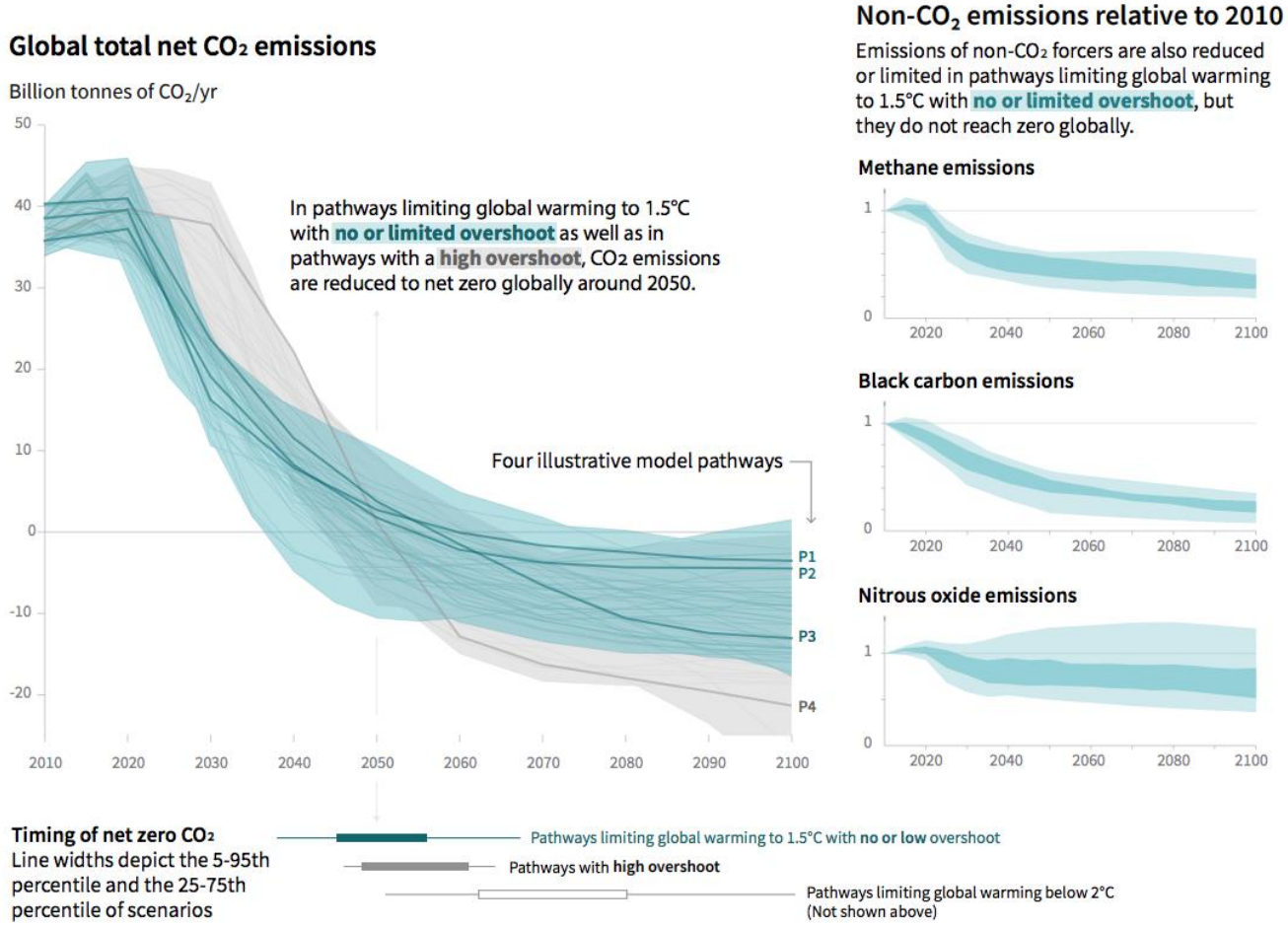
4

BECCS

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 aviation, agriculture and heavy industry.
- 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.



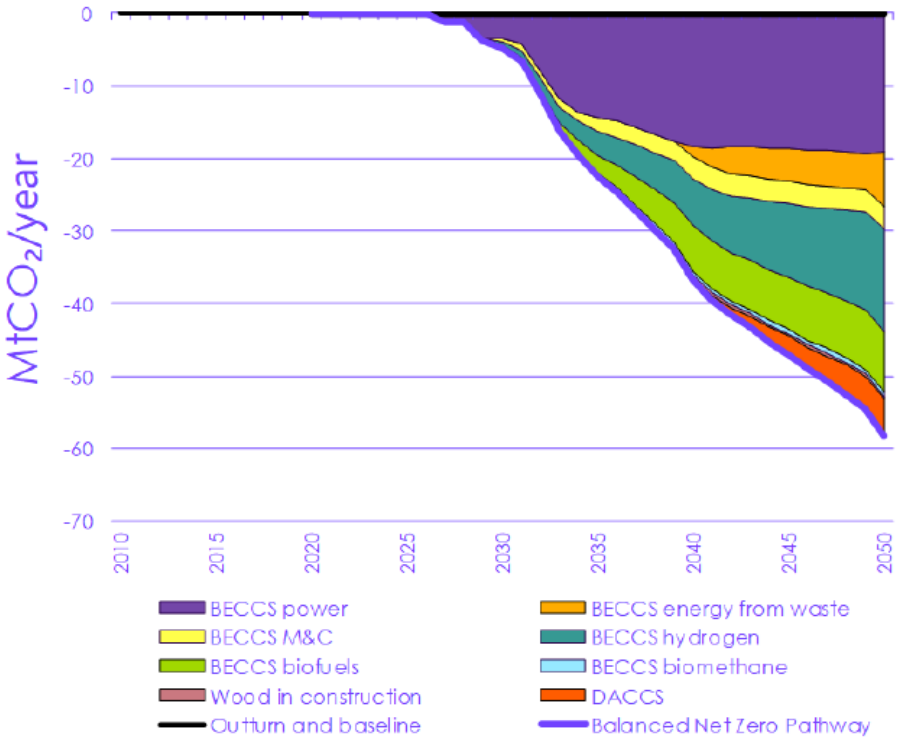
Source: IPCC SR1.5 report

Introducing BECCS

For the UK to reach net zero by 2050 we need to deploy negative emissions technologies, and fast.

- Bioenergy with carbon capture and storage (BECCS) is the technology that will provide the largest share of the negative emissions needed by 2050.
- The UK's independent Climate Change Committee estimates that 57mtpa of negative emissions will be needed from greenhouse gas removal technologies by 2050, of which **19mtpa will come from BECCS in power**. However, some CCC scenarios suggest up to 39mtpa of greenhouse gas removals from BECCS power could be needed by 2050.
- Relative to other negative emissions technologies, BECCS has **low costs**, is **scalable** and **commercially ready to go**.

Figure A3.11.a Sources of abatement in the Balanced Net Zero Pathway for the GHG removals sector



Source: BEIS (2020) *Provisional UK greenhouse gas emissions national statistics 2019*; CCC analysis. M&C = Manufacturing and Construction.

Our ambition is to use BECCS to create an 8mpta carbon negative power station by 2030

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POWER GENERATION FROM COAL

- 1970
- 2013 — 1st coal unit converted to biomass
- 2021 — End of commercial coal generation

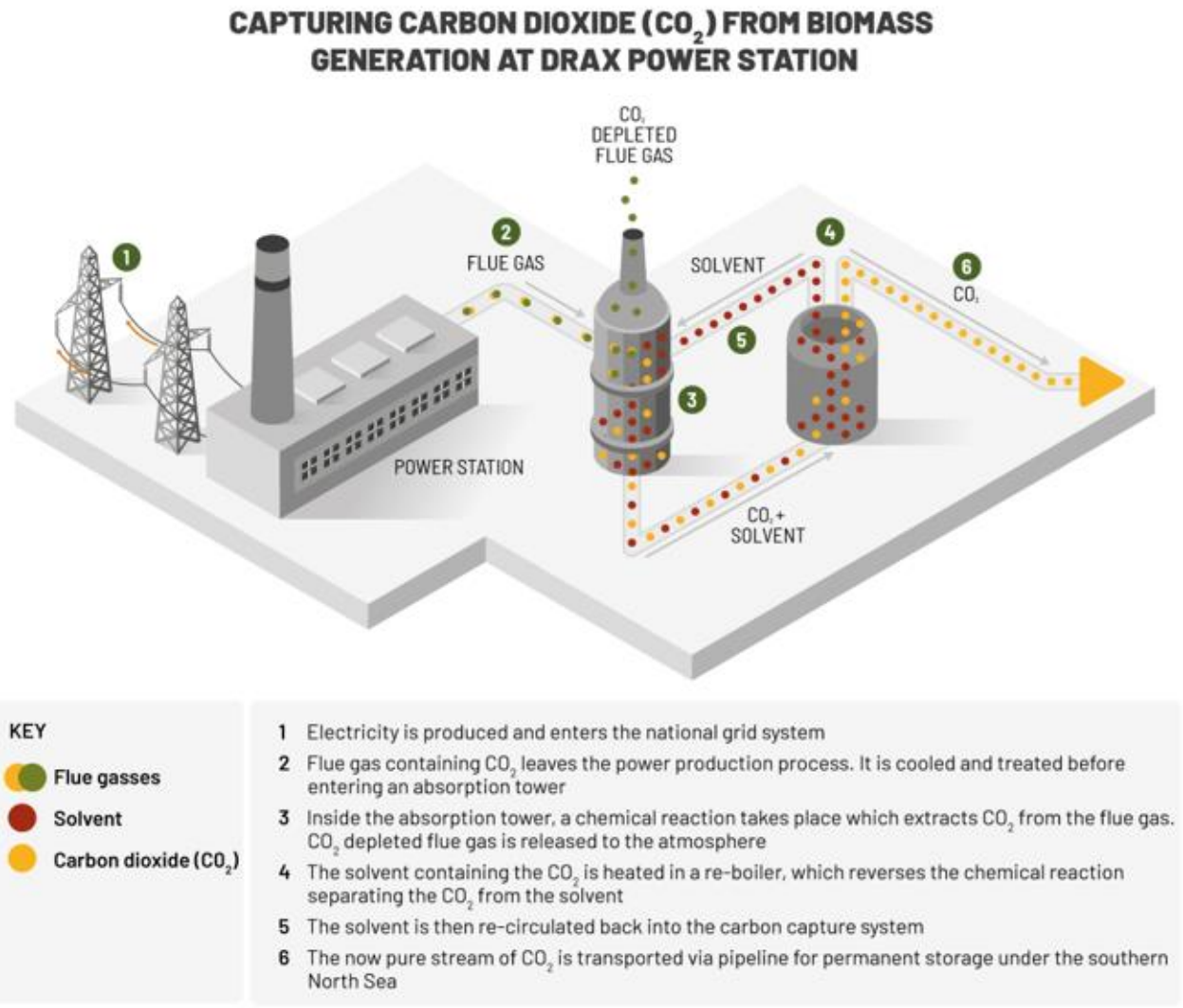
LOW CARBON POWER GENERATION FROM BIOMASS

- 2003 — Start of biomass co-firing, R&D & piloting
- 2018 — 4 of 6 units now run on sustainably sourced biomass
- 2019 — Drax generated 12% of GB's renewable electricity

NEGATIVE EMISSIONS FROM BIOENERGY WITH CARBON CAPTURE AND STORAGE

- 2019 — 1st carbon capture pilot, world first with 100% biomass feedstock
- 2020 — 2nd carbon capture pilot with MHI
- 2024 — Construction begins for BECCS at Drax Power Station
- 2027 — 1st biomass unit retrofitted with CCS, capturing 4 MtCO2/a
- 2029 — 2nd biomass unit retrofitted with CCS, capturing total of 8 MtCO2/a
- 2030 — Drax Power Station meets ambition by 2030

BECCS at Drax Power Station



- **The site has suitable locations and ducting infrastructure for retro-fitting post combustion capture technology, due to the mothballing and impending demolition of the facilities Flue Gas Desulphurisation equipment following the conversion to Biomass**

- **The BECCS AACE Class III Pre-FEED work was completed in March 2021, with the CO_2 Capture Technology Partner Selected in May 2021**

- **BECCS capture technology pilots at Drax Power Station**
  - *C-Capture* pilot installed in January 2019, capable of capturing up to one tonne CO_2 per day.
  - £5m awarded through BEIS CCUS Innovation Programme to test at Tiller in Norway in 2019 and TCM in 2020/21.
  - ***MHI*** pilot installed Autumn 2020, testing solvent technologies and capturing 300 kg/CO2 per day.

- **CCUS Incubation Zone** at Drax Power Station for pilot CCU projects (Deep Branch Bio, Econic)

Drax is the UK's most technically advanced CCS project

– **Two solvent pilots running** at Drax since 2019, providing significant data on the performance of solvents with biomass flue gas, alongside non-proprietary solvent BECCS testing at SINTEF

– **Pre-FEED work completed** in Q1 2021, focusing the CCS retrofit on two Drax biomass units

– **Development Consent process started**, with non-statutory engagement commencing Q1 2021; target date for DCO submission Q1 2022 for Secretary of State approval H2 2022

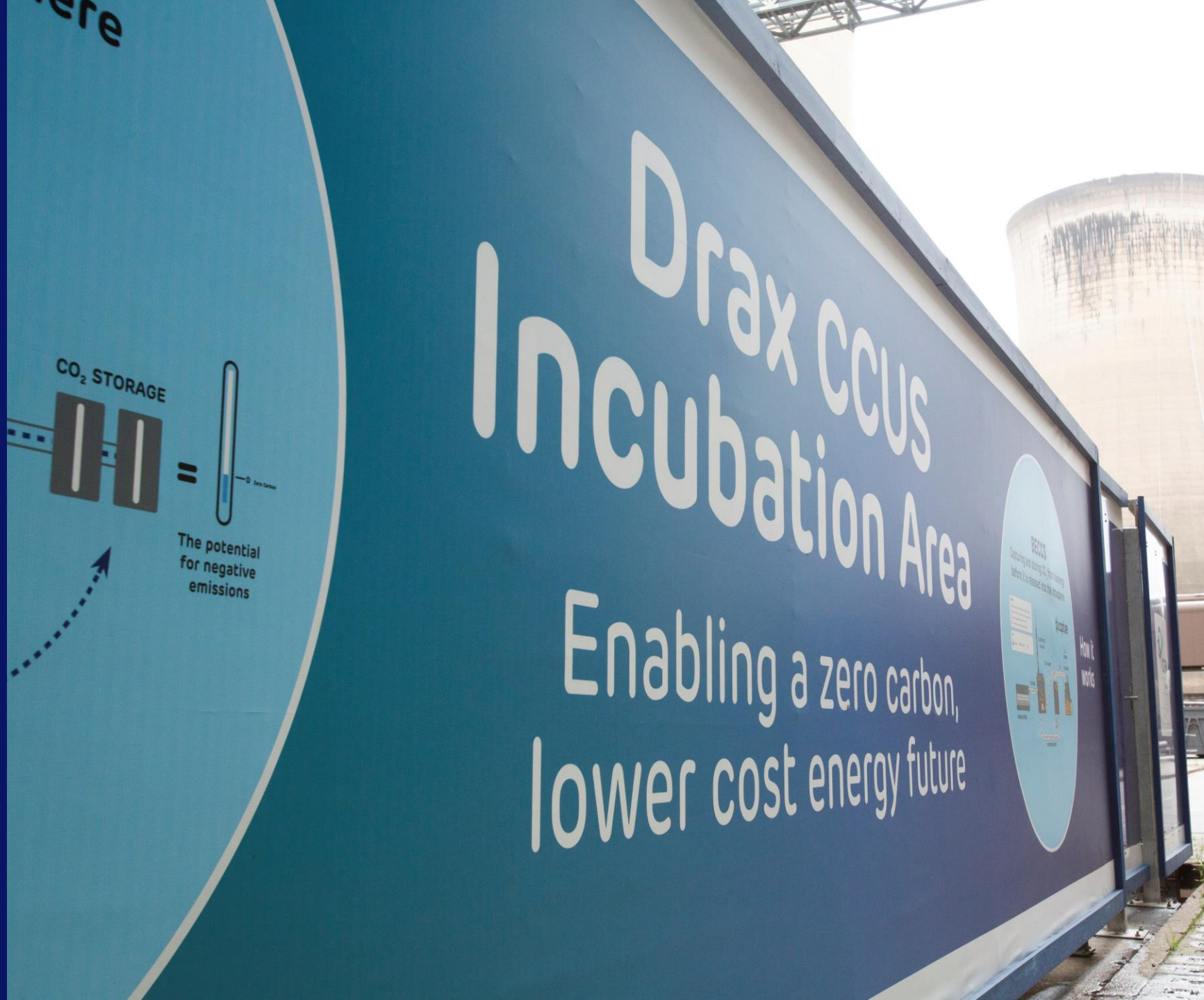
– **First CCS project to put in place a licence agreement for a capture technology**

– **Tendering ongoing for EPC partner**, with selection due Q3 2021

– **FEED study** earmarked for Q3/Q4 2021, subject to further clarity from UK Government on BECCS support framework

5

The next opportunity



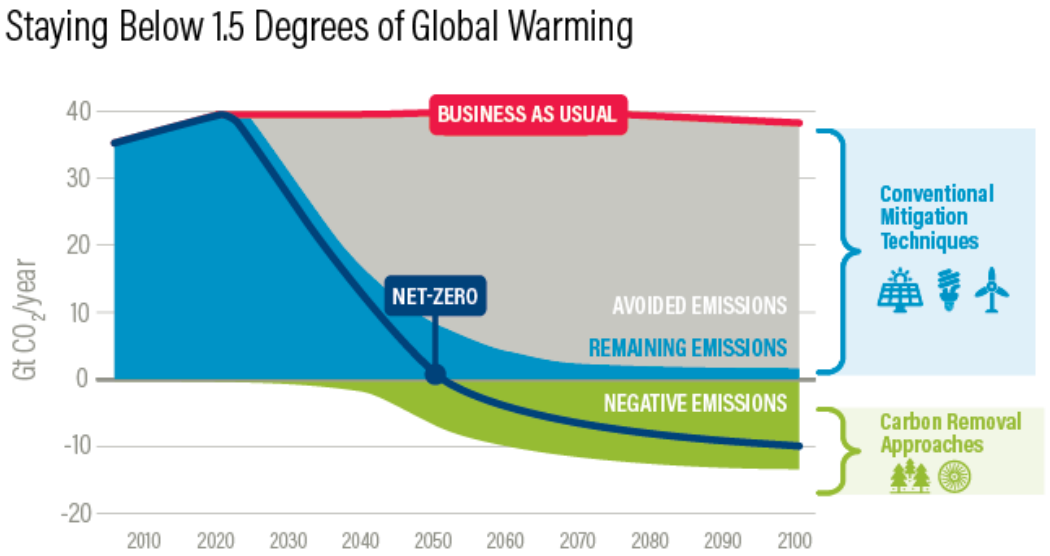
BECCS potential in the US

Expanding options and capacity for carbon removal will be critical for the US to achieve its climate objectives by 2050

– Avoiding the worst impacts of climate change will require not only steep reductions in US emissions but also the removal of CO2 at a massive scale

– WRI estimates that the US will need to remove about **2 gigatons of CO2 every year** by mid-century to reach net-zero — roughly 30% of U.S. 2017 greenhouse gas emissions

– BECCS could provide an estimated **180 MtCO2 per year in net carbon removal**, with the possibility of significant additional carbon gains (up to 125 MtCO2 per year in the power sector) from fossil energy displacement.



Our ambition: New Build BECCS project in the US to be fit by 2023

– We’re well-advanced in the process of developing an option to build a **new BECCS facility in the US**.

– Whilst the design of the facility has not yet been decided, we aim to build a **300 - 600MW facility**.

– It would generate between **2 and 4 million tonnes of carbon removal each year**, through the production and storage of negative emissions.

– Representing a capital investment from Drax of around **$2 billion USD.**

– Location-wise we have identified **two regions** - South East US and Pacific Northwest – that would work best in terms of: a) the need for firm renewable power; b) fibre availability; c) geology; d) availability to build a value chain.

Ongoing global BECCS Technical Work

Key focus areas for Drax in developing the next BECCS:

Policy

Where is there existing policies towards biomass, CCS & negative emissions that enable deployment of BECCS at scale

Fuel

Optimal location of facilities, placing the opportunity at the heart of fiber and fuel baskets, and direct access to CO_2 sequestration

Reforestation

Grow reforestation partnerships, developing fuel options to maximize abatement whilst maintaining sustainability & forest growth

Delivery of BECCS

Further refine the technical preparation and business case to deliver BECCS

Objectives:

- To establish an **integrated concept design** for a new build BECCS power plant.
- To **provide and validate assumptions** for an integrated new build BECCS plant, specifically to identify and quantify any **efficiency gains through the heat integration of the systems**.
- To assess the **viability of strategic locations** for a new build BECCS plant.
- Identify the optimal sites with a focus on deployment in the US South

Scope:

- **Technology assessment** – technology options and assessment of viability covering boiler, turbine and CCS islands
- **Innovation** – in technology and plant integration to optimise efficiency
- **Strategy** - market assessments of key geographies
- **Cost estimates** - CapEx & OpEx
- **Project planning** – development journey incl. planning and environmental

Why the US?

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Policy

President Biden clean energy goals, alongside existing federal and state incentives enhances the US carbon capture potential. Simple policy changes will enable deployment of BECCS at scale

Fuel

Access to one of the world's greatest fibre baskets, existing CO2 pipeline network and planned coal retirements by 2030 makes the US an optimal location to deploy BECCS

Reforestation

Established forestry sector with strong sustainability & forest growth practices. BECCS will be an exciting addition to the US sustainable forest products sector

Delivery of BECCS

Well- advanced workstreams are building up the technical, commercial & financial business case to deliver a BECCS facility

An **end-to-end US value chain** that will deliver for the climate while creating thousands of jobs in clean technology


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Thank You