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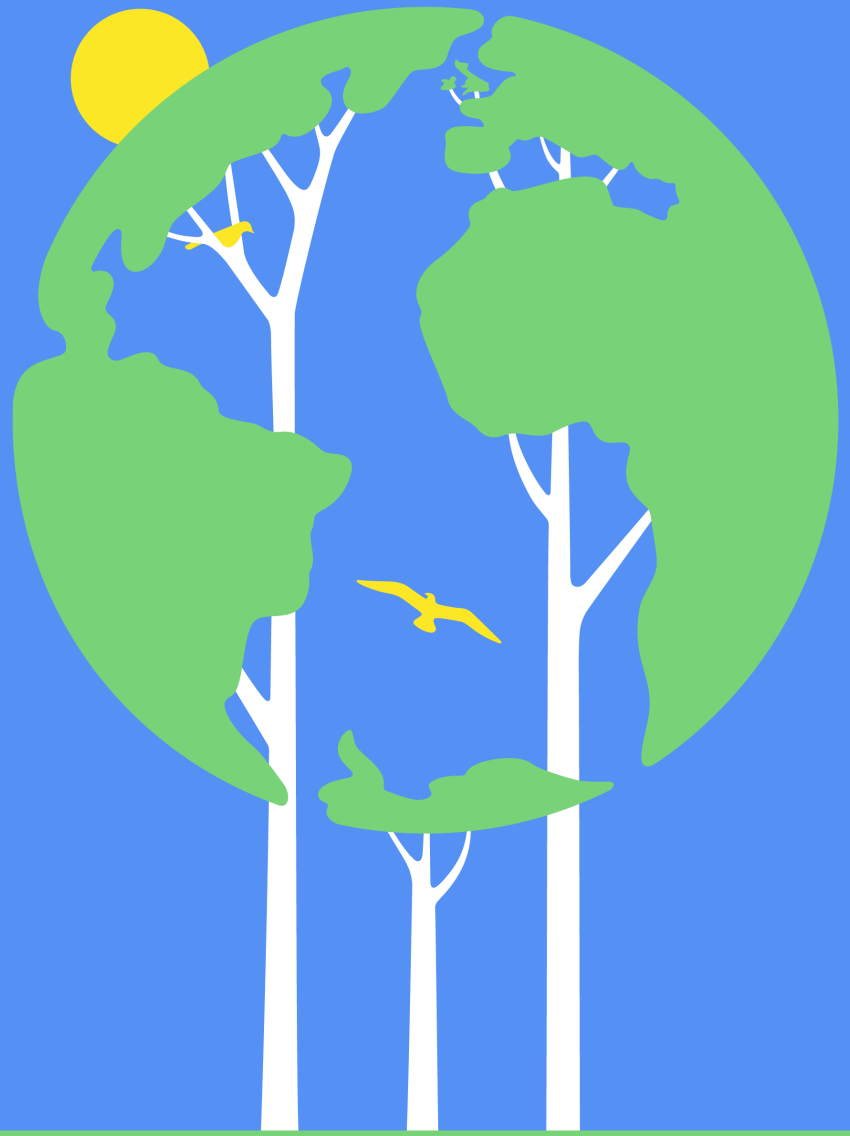
Bioenergy from forests – a generator's perspective.



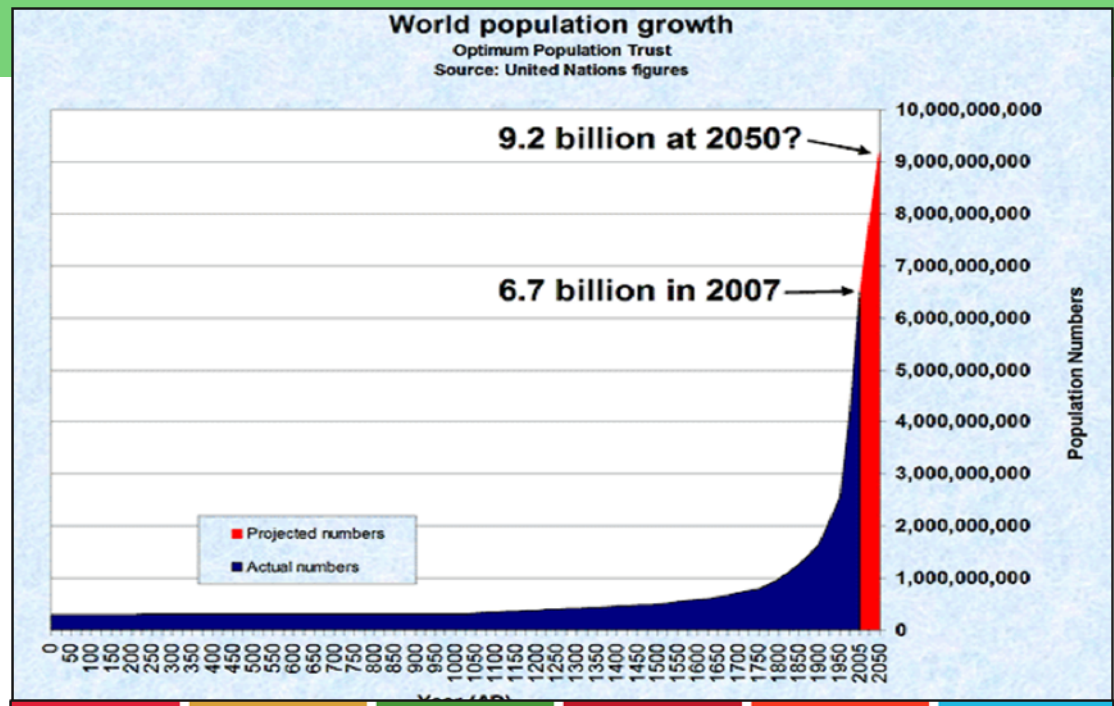
Richard Peberdy, 8th March 2022

Today's talk

Context is that we recognise we all live in a time of a climate crisis, with growing world population and a need for more low carbon energy (amongst all the SDG's) – and forests have a crucial role to play in achieving climate positive, nature positive and people positive outcomes.

In today's talk:

- Brief overview of Drax
- How we source
- Policy drivers for the move to renewables including biomass
- A look at the UK Grid – and the role of renewables including biomass
- Impacts on forest carbon – US South focus
- Intro to BECCS
- Summary & close



Our Purpose

Enabling a zero carbon, lower cost energy future

Our Ambition

To be a carbon negative company by 2030

Three main areas of activity

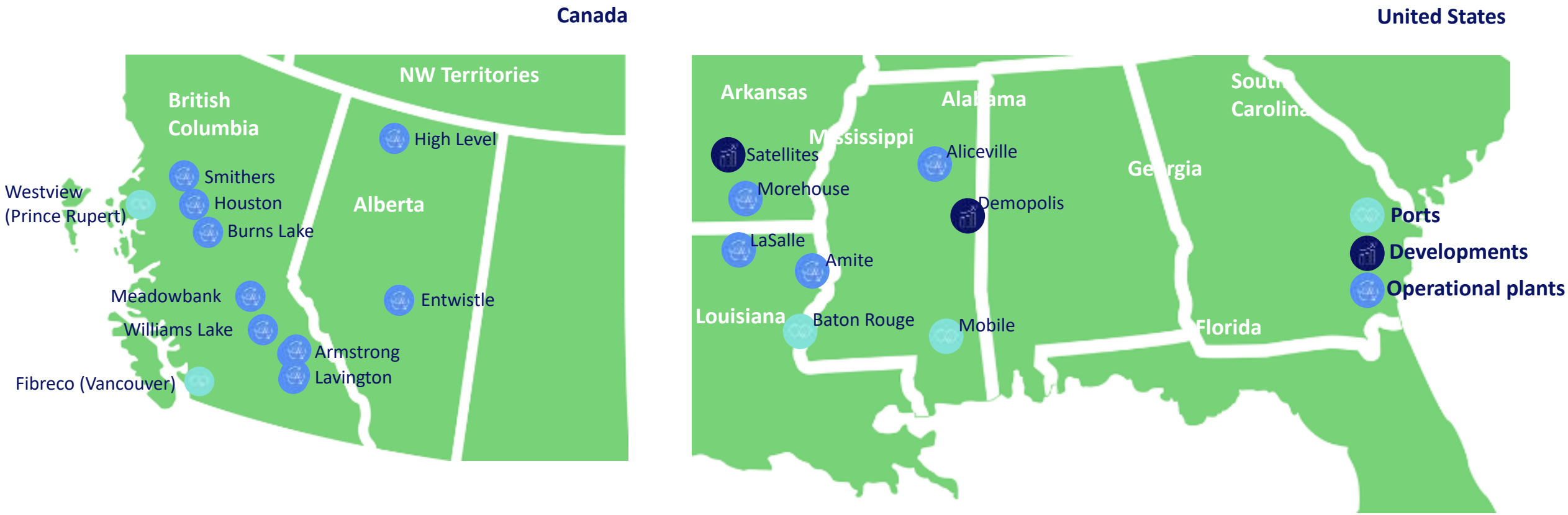
- Biomass production
- Power generation and system services
- B2B energy supply and electrification solutions

Not included today – discussion of our hydro assets or our B2B energy sales.

1 December 2021

Drax is a major producer and supplier of biomass to customers globally

A large and geographically diverse supply chain
Current capacity of 4 million tonnes (Mt) – rising to 5Mt when current developments are complete, and 8MT by 2030
13 operational pellet plants plus developments across 3 major fibre baskets and 4 deep water ports



Fibreco and Mobile facilities not owned/leased by Drax.

Country split - biomass sent to Drax Power Station or sold to 3rd party (in tonnes)

Calendar year 2021 – all biomass either produced by Drax pellet mills and sold to 3rd parties (750kt) or used at Drax Power Station (7.7mt)

	USA	Canada	Latvia	Estonia	Brazil	Portugal	Belarus	UK	Russia	Other European
3rd party	132,285	621,374	0	0	0	0	0	0	0	0
DPS	5,004,786	1,191,835	719,117	209,482	192,930	187,209	110,229	57,023	33,829	10,591

How we source https://www.drax.com/sustainable-bioenergy/responsible-sourcing/

– **Our forest biomass sustainability commitments:**

1. **We will reduce carbon dioxide emissions**

– We are committed to ensuring our use of biomass makes a positive contribution to tackling climate change and fulfilling the UK's net zero by 2050 target.

2. **We will protect the natural environment**

– We recognise our duty to keep forests thriving and to respect the many benefits they bring, including carbon storage, protection of soil and water quality, supporting biodiversity and provision of habitat.

3. **We will support people and communities**

– From state-owned forests to smallholdings, and from the US southeast to the Baltic states, forest owners, forest workers and communities in our sourcing areas are bound by their common reliance on forests for employment, wellbeing and quality of life.

4. **We will invest in research, outreach and intervention**

– The strength of our collaboration with others will improve the sourcing choices we make. We are committed to working with governments, non-governmental organisations, academia and other stakeholders to continually improve biomass sourcing and develop best practice.

Policy drivers - EU & UK

EU – Renewable Energy Directives 1 (2009), 2 (2018) & 3 (under consultation)

UK – Renewables Obligation (2003 continuing)

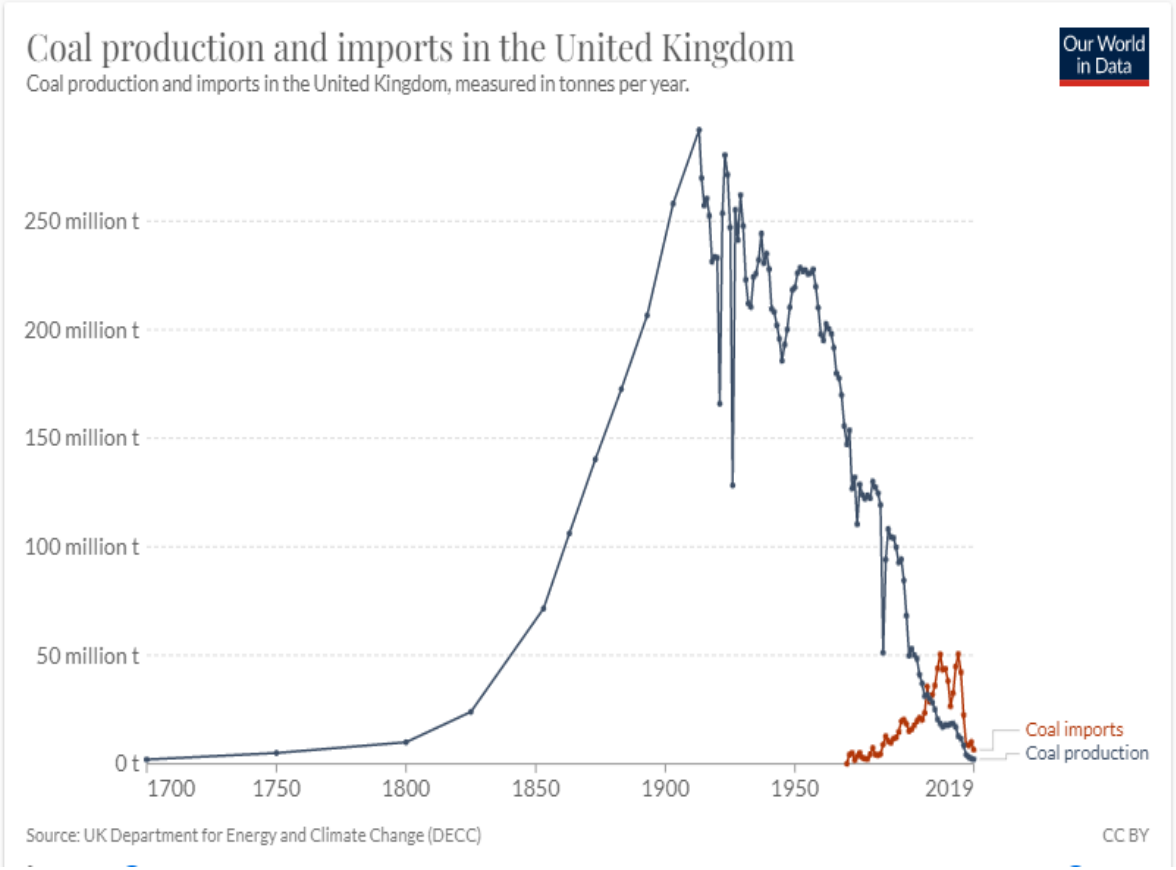
All have sustainability requirements built into them - Biodiversity, peat, wetlands, ecosystem services, minimise impact, social criteria maintain carbon etc.

'Carbon neutrality' is not assumed for biomass in international climate frameworks

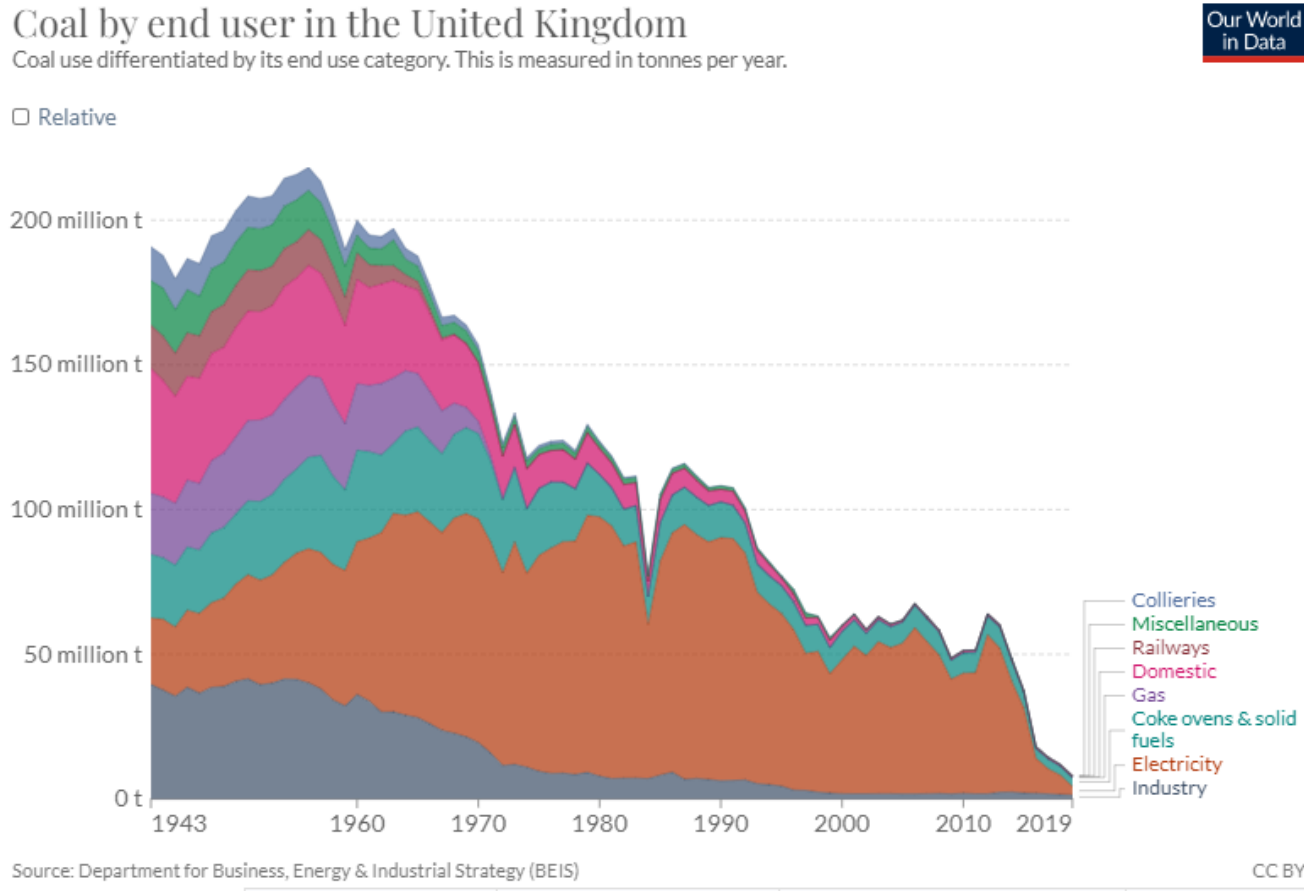
- Rather, emissions of biomass are accounted for in the Agriculture, Forestry and Other Land use (AFOLU) sector together with removals, in accordance with IPCC national inventory guidelines
- Harvested wood products for energy purposes are accounted for on the basis of instantaneous oxidation

Frans Timmermans, EU Climate Chief
Without biomass, we're not going to make it, we need biomass in the mix… but we need the right biomass in the mix.

What happened to coal?

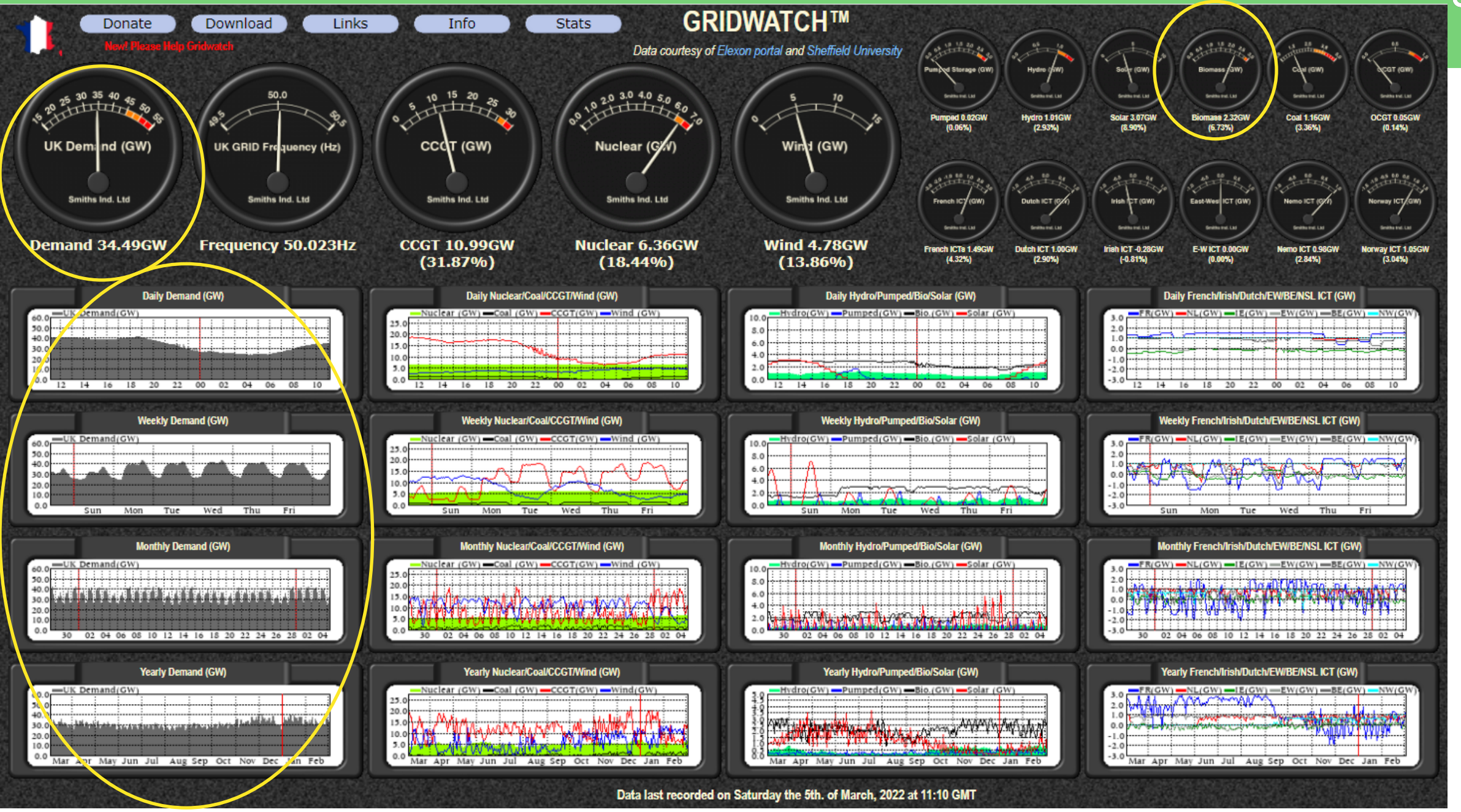


https://ourworldindata.org/death-uk-coal



8 March 2022

UK Grid – screen shot of live report - https://www.gridwatch.templar.co.uk/



A deeper dive into Grid dynamics

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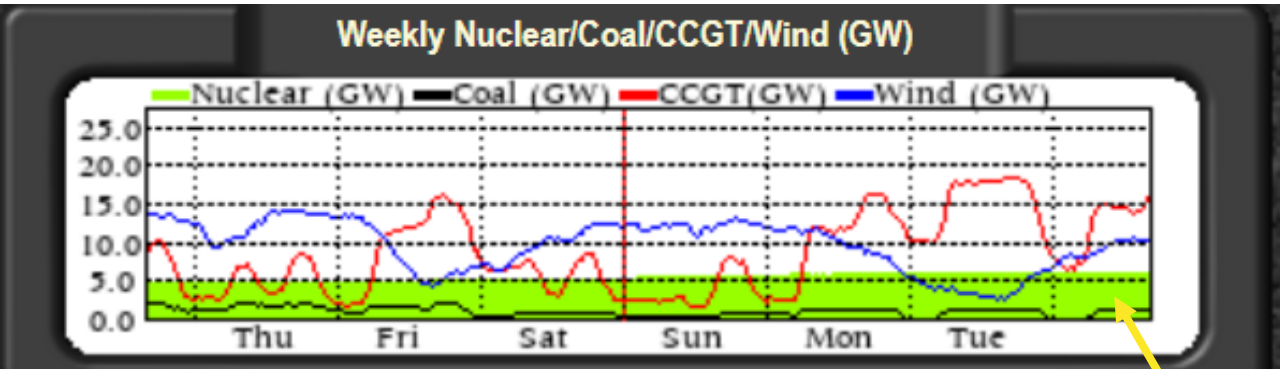
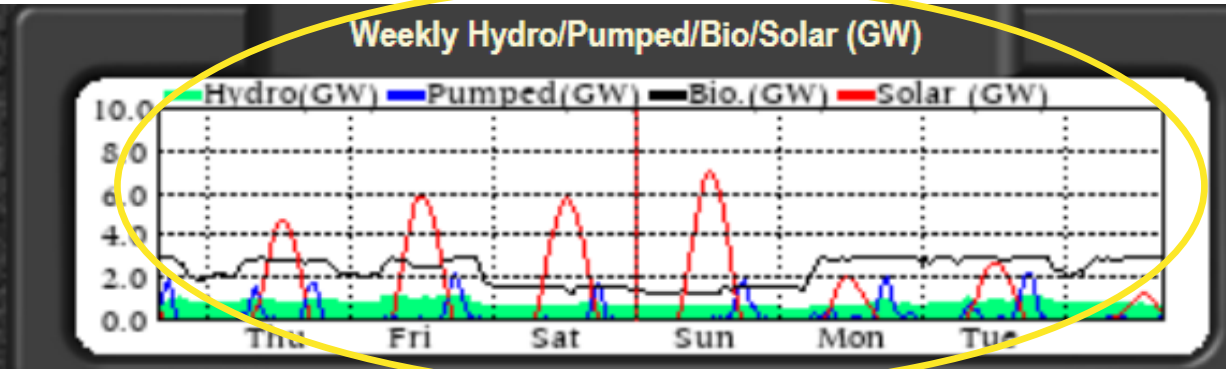
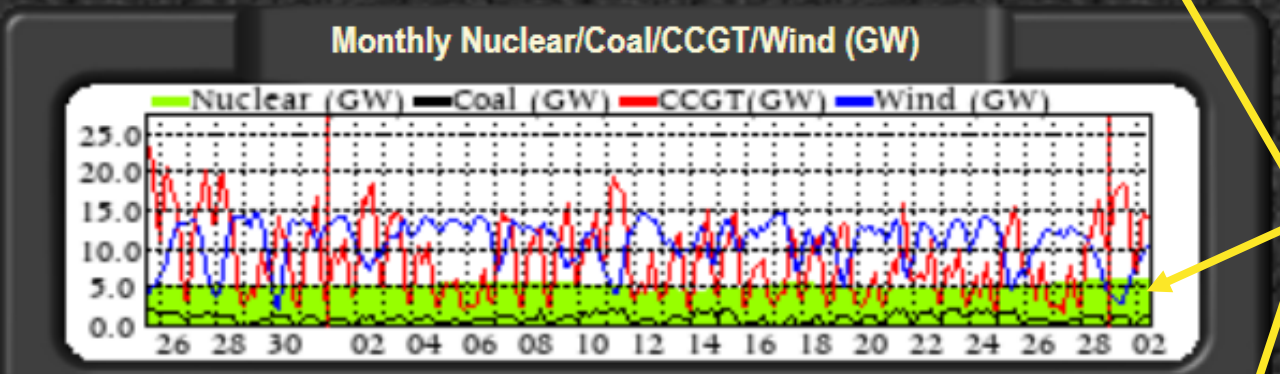
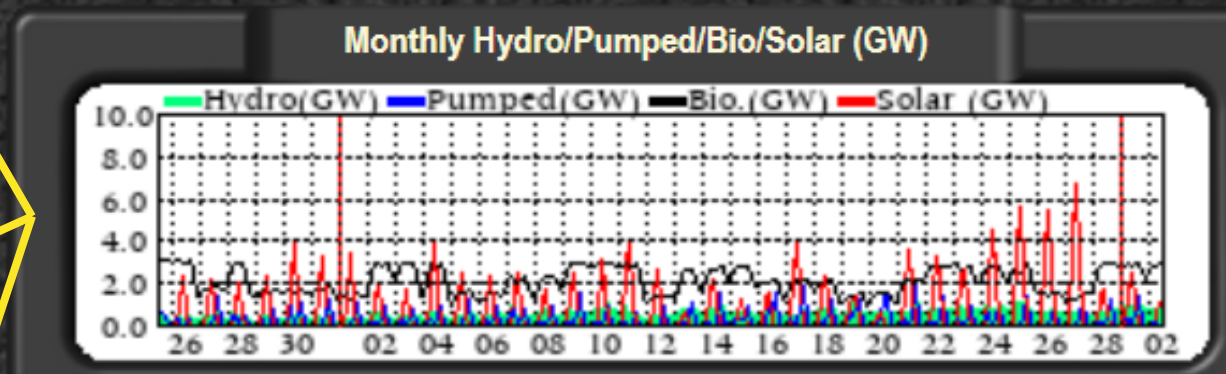
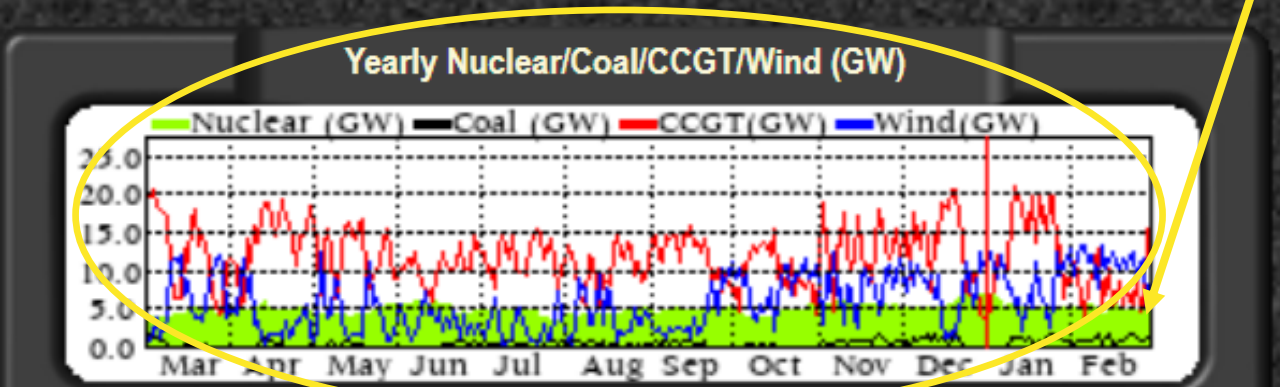
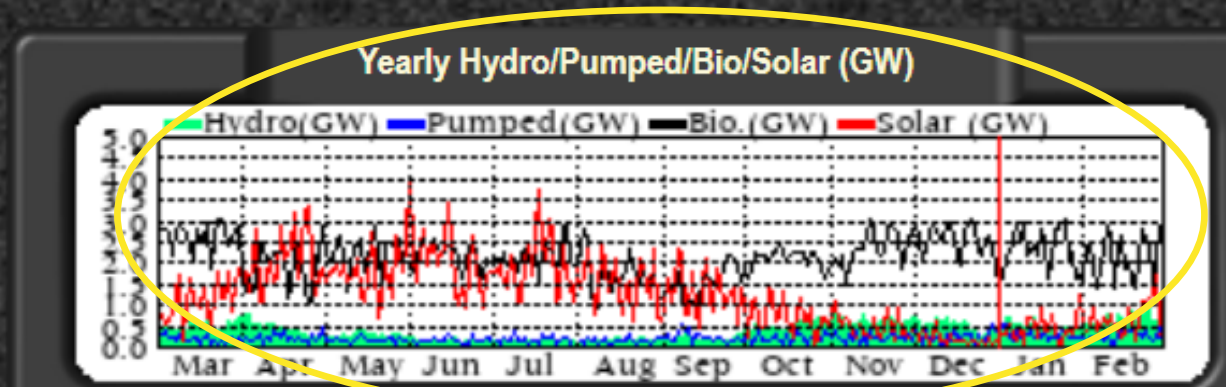












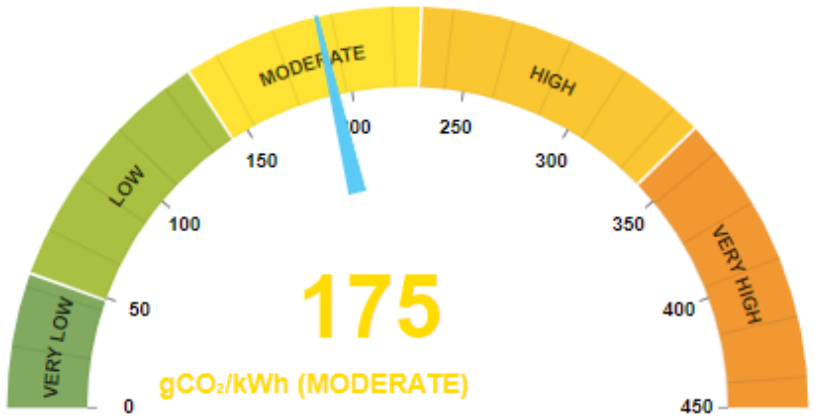
Carbon intensity of UK Grid. (Biomass @ 120g CO2/kWh)

nationalgridESO

ESO's Carbon Intensity Dashboard

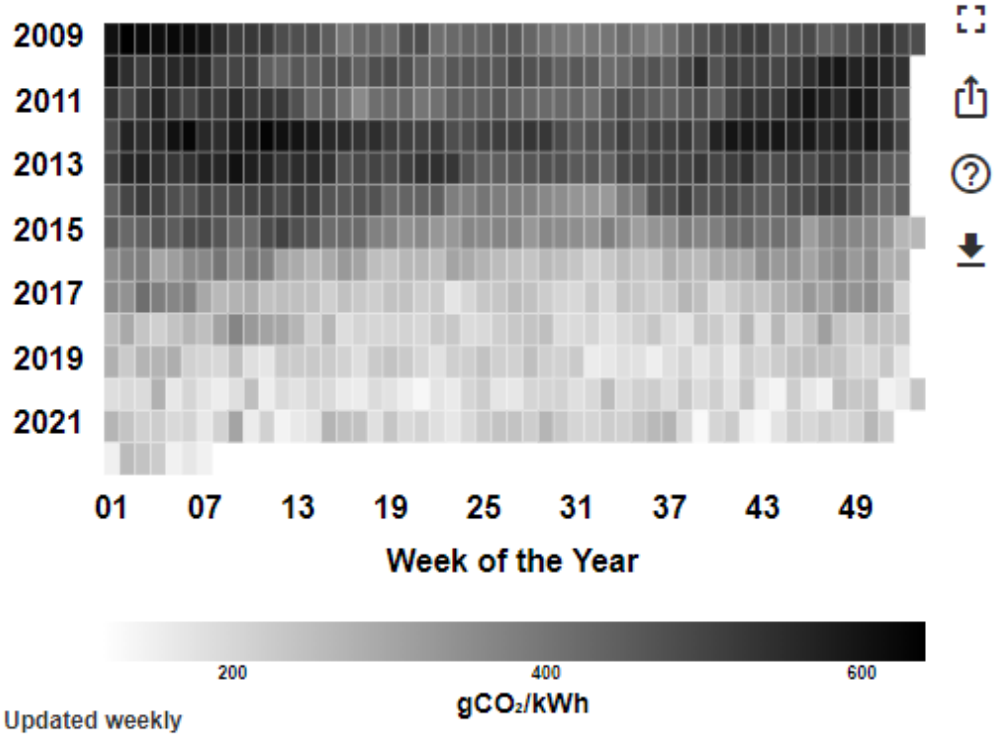
Share

Current Carbon Intensity



Updated every 30 minutes

History of Carbon Intensity of Generation



Updated weekly

https://www.nationalgrideso.com/future-energy/our-progress/carbon-intensity-dashboard

Takeaways from these first slides

- Policy has worked – grid has decarbonised
- Coal has all but stopped
- Less fossil fuels are being used
- Wind and solar cannot supply everything, biomass is valuable contributor.
- Biomass supplements intermittents, it does not prevent their deployment or displace them.
- Biomass use can lead to carbon negative generation – BECCS
- How we assess carbon impact overall is essential – let's look at that next.

Sourcing & Carbon – understanding how to achieve good climate outcomes, and avoid bad climate outcomes.

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- **Utilise properly scoped and defined full Life Cycle Analysis** as Prof Annie Lavasseur discussed in Seminar 3 of this series.

- **Use relevant assumptions, inputs, and counterfactuals** as Steve Hamburg (Chief Scientist of Environmental Defense Fund) said in Seminar 4

- **Landscape level, not tract level, analysis is relevant**, and counterfactual(s) need to be realistic.

Broadly:

- if there is a large 'pulse' of carbon due to using biomass for generation, and forests with reduced storage and sequestration, or displacement of fibre from long term stores (i.e. sawtimber) = bad climate outcome.
- If there is no/minimal 'pulse' and unchanged or improved storage and sequestration, and no displacement of fibre from long term stores (i.e. sawtimber) = good climate outcome

Strongly recommend the following for a full discussion:

Cowie AL, Berndes G, Bentsen NS, et al. **Applying a science- based systems perspective to dispel misconceptions about climate effects of forest bioenergy.** GCB Bioenergy. 2021;13:1210–1231. https://doi.org/10.1111/gcbb.12844

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Whole systems perspective is relevant – from Cowie et al

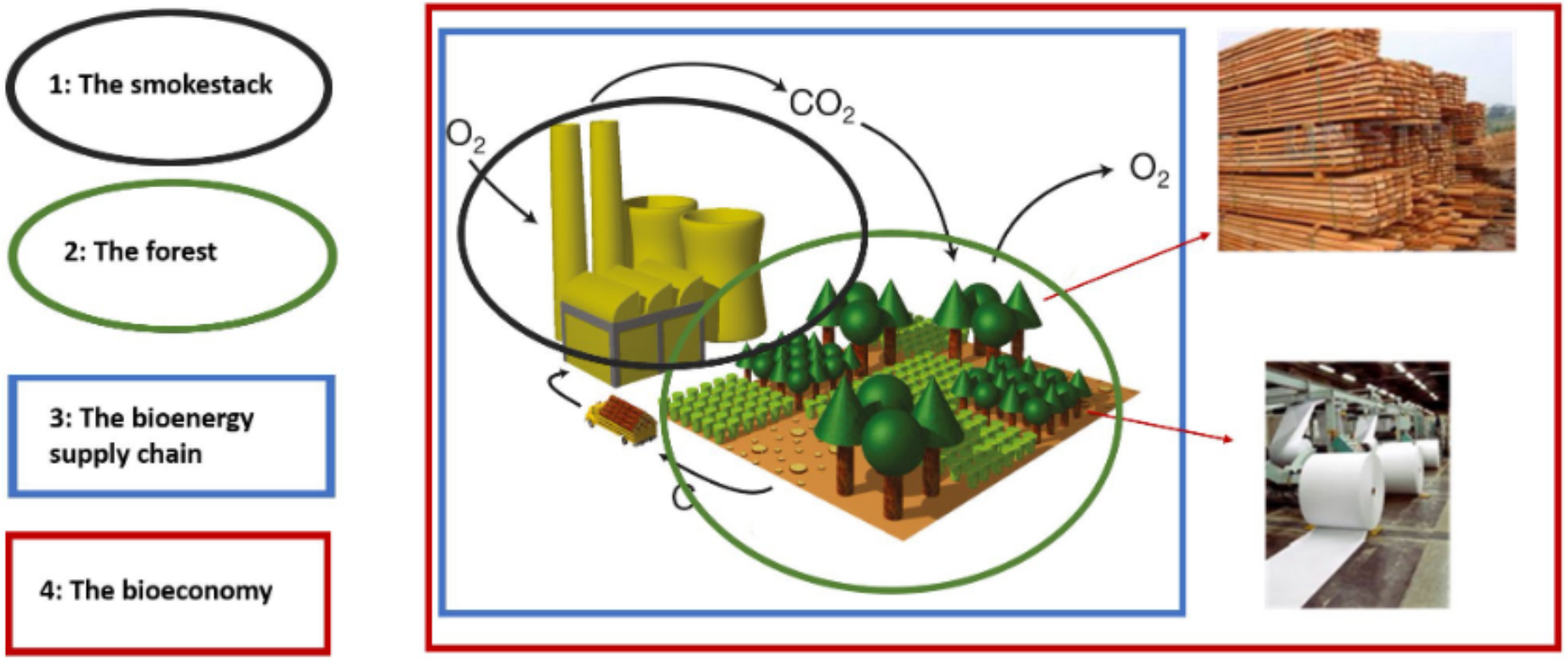


FIGURE 3 Alternative system boundaries that have been applied in studies assessing climate effects of forest-based bioenergy. Option 1 (black) considers only the stack emissions; Option 2 (green) considers only the forest carbon stock; Option 3 (blue) considers the bioenergy supply chain; Option 4 (red) covers the whole bioeconomy, including wood products in addition to biomass

At the stack – assumptions v real data

5.10 Plant loads, demand and efficiency

Major power producers (1)

Digest of UK Energy Statistics DUKES. Plant Loads, Demand and Efficiency DUKES 5.10, 2021

	Unit	2013	2014	2015	2016	2017	2018	2019	2020
Thermal efficiency *(10)*									
(gross calorific value basis)									
Combined cycle gas turbine stations	%	47.7	47.2	48.0	48.9	48.7	48.9	48.8	48.3
Coal fired stations	%	35.8	35.9	35.6	35.0	34.9	34.1	32.2r	32.1
Nuclear stations	%	39.3	39.6	39.1	40.0	40.0	39.8	40.0r	40.3

Drax efficiency using biomass c. 38%- 39%

Drax using coal v Drax using Biomass – c 3% more CO2/MWh – cf statutory annual reporting
Drax using biomass v general fleet of UK coal generation – likely equal or less CO2/MWh.

Compare: Sterman et al[1]: 'Typical combustion efficiencies for wood are approximately 25%, compared to 35% for coal'
Manomet[2] – biomass plants on full lifecycle 20% - 25% efficiency, Coal at 32% efficiency (Biomass emits 31% more CO2 at stack)

1. John Sterman *et al* 2018 *Environ. Res. Lett.* in press https://doi.org/10.1088/1748-9326/aaa512, licensed through Creative Commons
2. Manomet Center for Conservation Sciences. 2010. Massachusetts Biomass Sustainability and Carbon Policy Study: Report to the Commonwealth of Massachusetts Department of Energy Resources. Walker, T. (Ed.).
https://www.mass.gov/doc/manometbiomassreportfullhirezpdf/download

Story so far on Carbon..

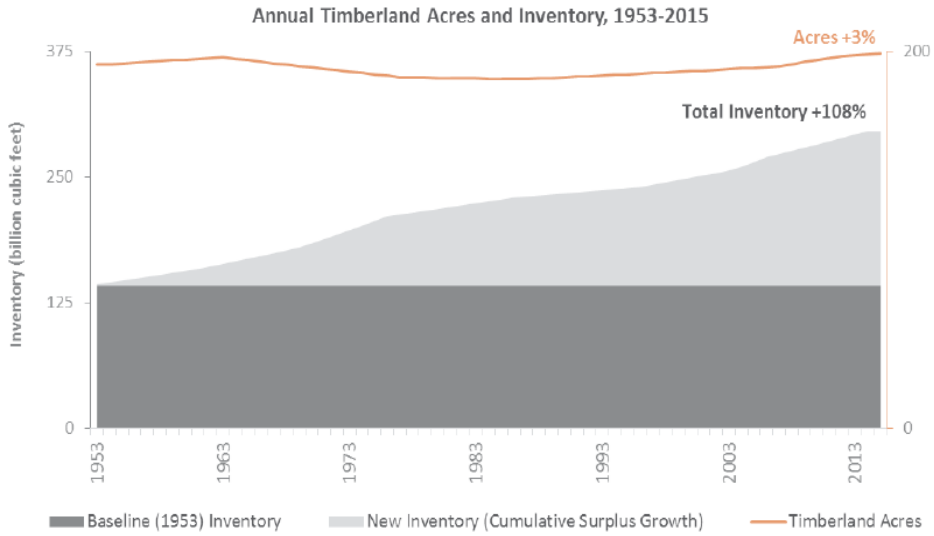
- Assumption that there is a ‘pulse’ is not necessarily correct
- Size of ‘pulse’ if present is important for next step
- Assumptions are important, and a key choice is how modellers characterise the effects of extra demand on the forest.
- Extra demand might have neutral, positive or negative impact on forest carbon.
- Kim Dubois (Enviva) talked about how in the US South where c, 80% of forests are privately owned, increased demand leads to more forest, and in Seminar 2 Alice Favero talked about the same effect – more demand meant more forest.

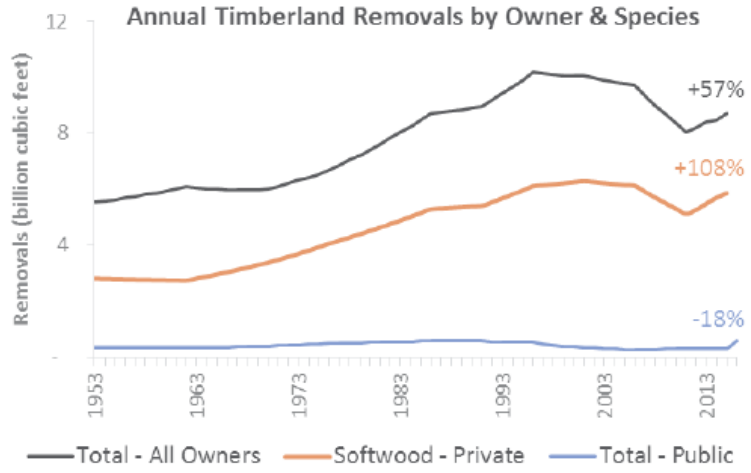
For US South, lots of evidence of positive response, i.e. more demand = more forest

The evidence is that in the US South the primary driver has been, and remains, sawtimber production

[Historical Perspective on the Relationship between Demand and Forest Productivity in the US South]

Forest2Market, 2017

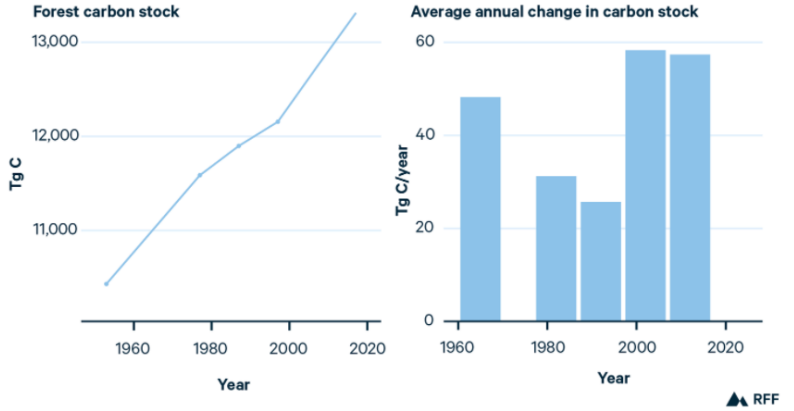




[Forest Carbon 201: Land Use Effects of Wood Product Markets]

Resources for the Future 2021

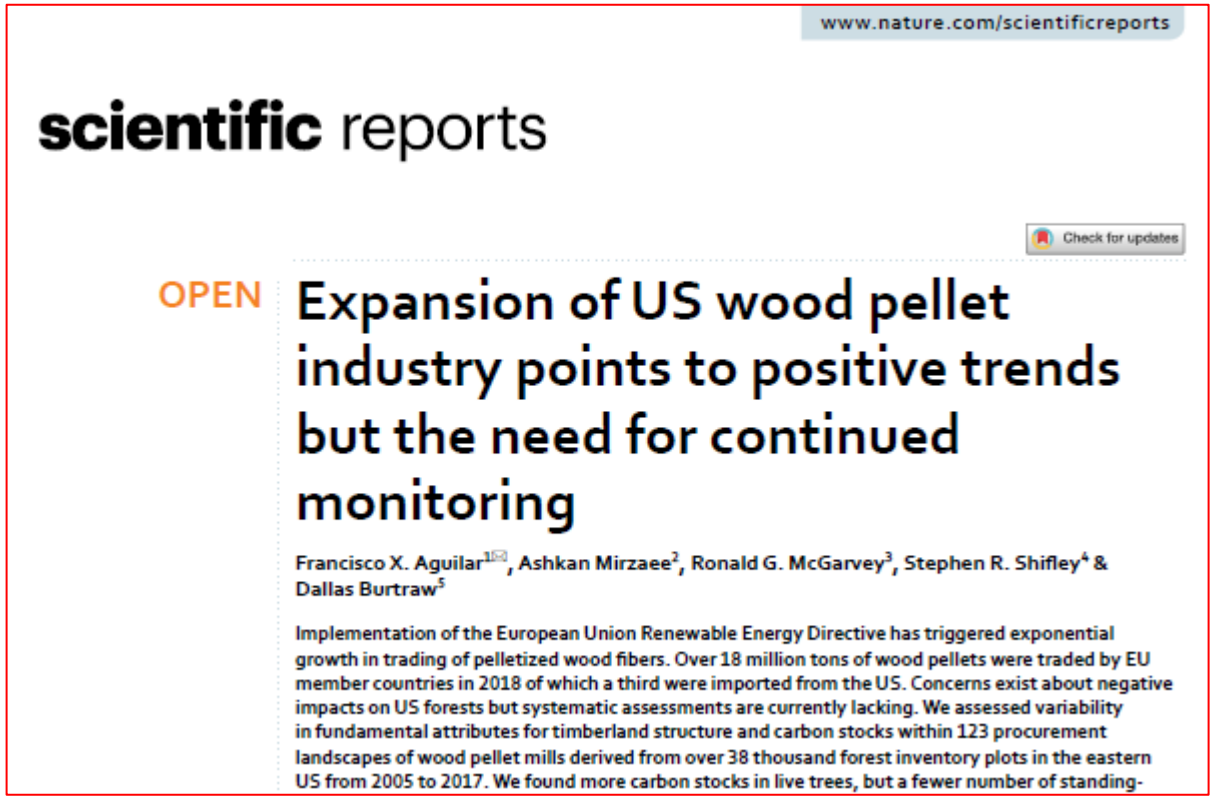
Figure 12. Total carbon contained in southeastern forests, 1953–2017



Sources: Domke et al. from 1990–2017, earlier estimates are based on a regression model of carbon as a function of tree biomass and forest area

Recent research by Aguilar et al confirms this response

Researchers compared US landscapes with pellet demand, to US landscapes without pellet demand



www.nature.com/scientificreports

scientific reports

Check for updates

OPEN

Expansion of US wood pellet industry points to positive trends but the need for continued monitoring

Francisco X. Aguilar[1✉], Ashkan Mirzaee[2], Ronald G. McGarvey[3], Stephen R. Shifley[4] & Dallas Burtraw[5]

Implementation of the European Union Renewable Energy Directive has triggered exponential growth in trading of pelletized wood fibers. Over 18 million tons of wood pellets were traded by EU member countries in 2018 of which a third were imported from the US. Concerns exist about negative impacts on US forests but systematic assessments are currently lacking. We assessed variability in fundamental attributes for timberland structure and carbon stocks within 123 procurement landscapes of wood pellet mills derived from over 38 thousand forest inventory plots in the eastern US from 2005 to 2017. We found more carbon stocks in live trees, but a fewer number of standing-

We found discernible trends on timberland conditions within procurement landscapes that overlapped with other pellet mills as well as with other industries competing for wood fibers (Fig. 4b). A one percentage-point increase in overlap of wood pellet mill procurement areas, denoting greater competition, was associated with larger C stocks in above and belowground live (2.07 tons C/ha; $p = 0.00$) and standing-dead (0.06 tons C/ha; $p = 0.00$) trees pools, and in soils (1.32 tons C/ha; $p = 0.02$).

On the balance, there has been a net contemporaneous positive effect.

Aguilar, F.X., Mirzaee, A., McGarvey, R.G. *et al.* Expansion of US wood pellet industry points to positive trends but the need for continued monitoring. *Sci Rep* **10,** 18607 (2020). https://doi.org/10.1038/s41598-020-75403-z

Drax Catchment Area Analysis – focussed on understanding impact on carbon dynamics

https://www.drax.com/sustainability/sustainable-bioenergy/catchment-area-analyses/

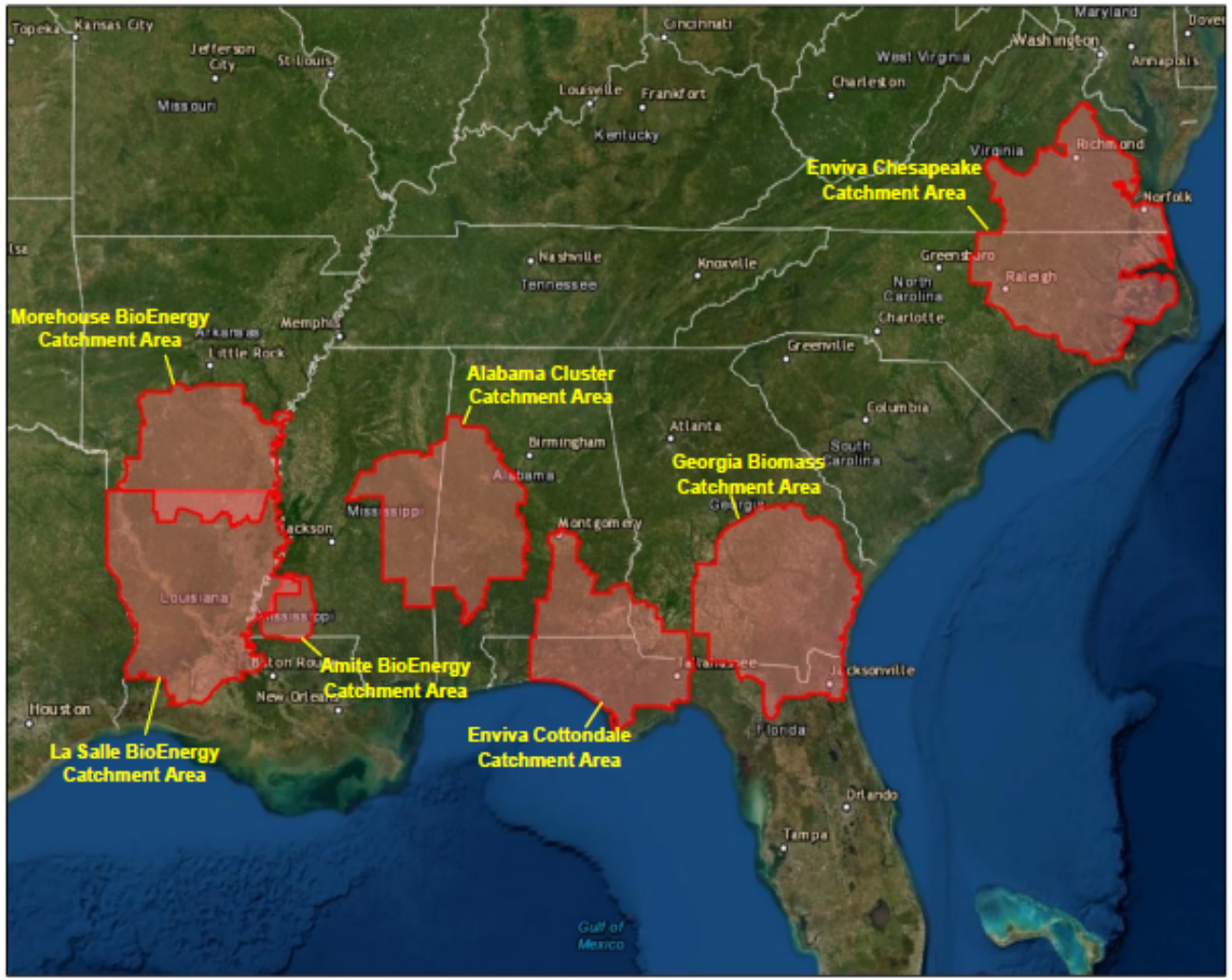
Seeking to understand local effects of our demand on:

- Forest area (Stable)
- Forest Inventory (Increasing, bioenergy demand assistive)
- Risk of displacement due to demand (Low – supply exceeds demand, sometimes significantly)
- Sequestration rate (neutral/positive)
- Changes in forest structure & forest management (no new trends attributable to bioenergy)

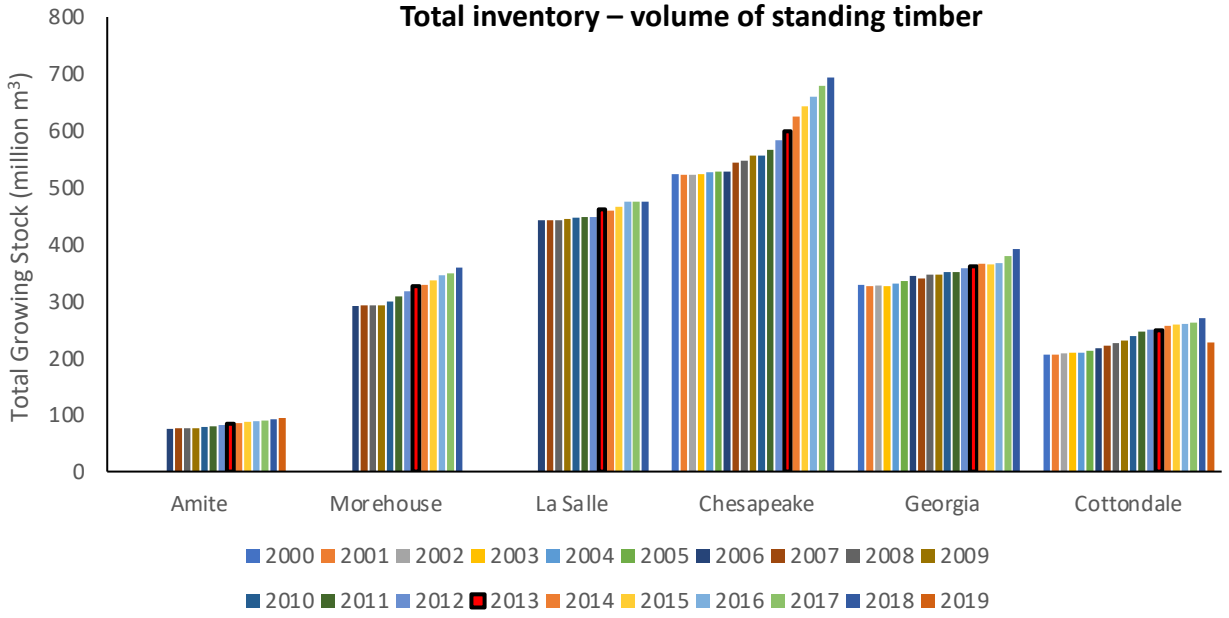
Also reports on Latvia, Estonia, Central BC.

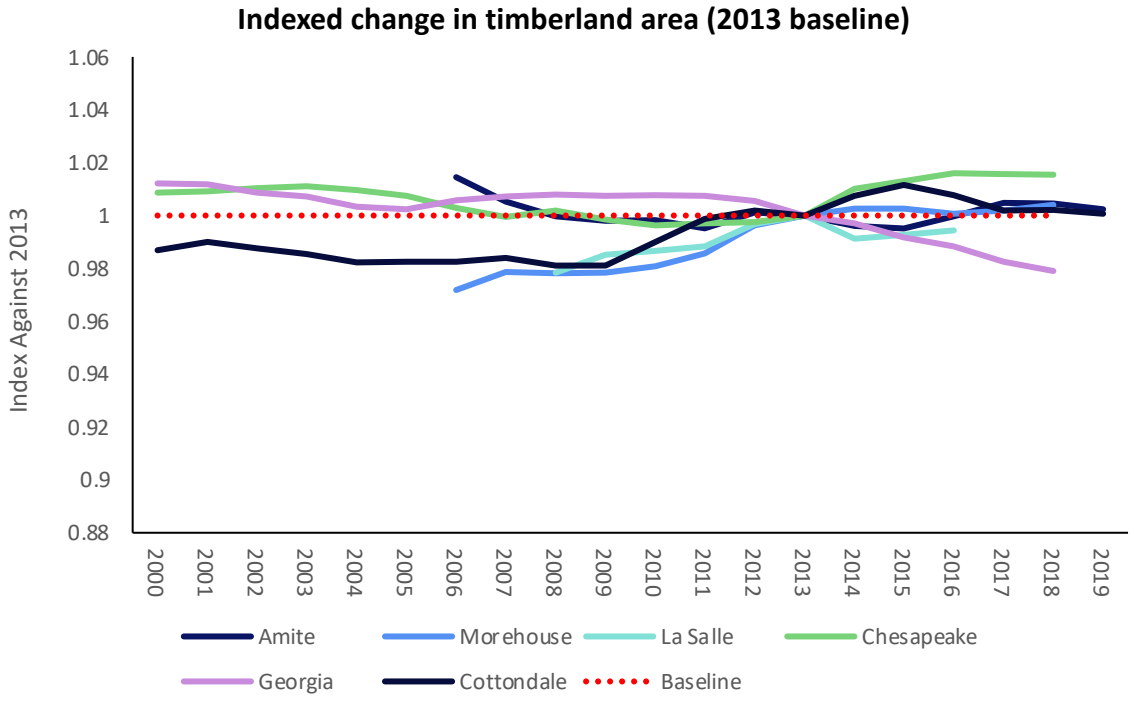
Will cover (almost) all supply chain over next 2 years.

Separately, we have methodologies to monitor risks for biodiversity, and our impact on people.



Summary of two data sets from Catchment Area Analysis





So far:

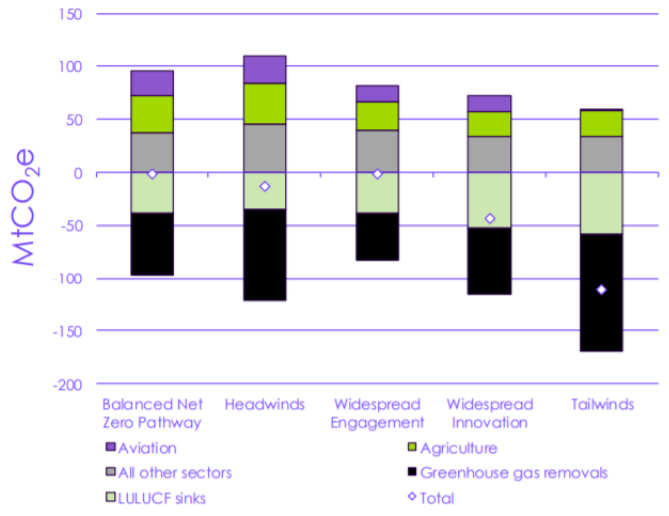
- We've seen how biomass generation fits into a low carbon grid
- We've looked at the assumptions about a 'pulse' of carbon that leads to carbon debt – that pulse is either non-existent or in event far smaller than oppositional voces claim
- We've looked at the assumption that more demand must equal less forest. Not true in US South – or Sweden, Finland, EU overall and many other examples
- This is strong evidence that the use of this biomass is already climate beneficial – there is not a long wait.
- **'Healthy Markets' are not a feature of all geographies (e.g. may not be prevalent where forests are publicly owned). They require a combination of biological capacity to respond, and the cultural, financial, institutional and social components that lead to better forests. Forest Schools such as this (and UGA, LSU, MSU, Laval etc etc) play a critical role!**

Bioenergy with Carbon Capture and Storage – IPCC say it's needed & we are involved

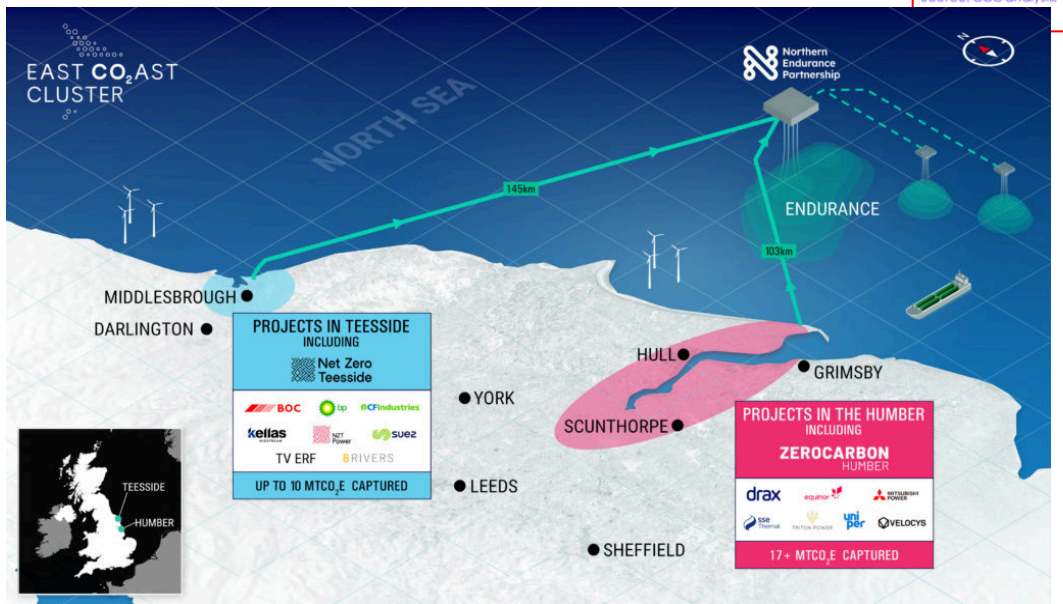
https://www.drax.com/about-us/our-projects/bioenergy-carbon-capture-use-and-storage-beccs/

- **2019:** Drax BECCS pilot (with C-Capture) started capturing CO_2 in world first with 100% biomass feedstock
- **2020:** Second Drax pilot (with MHI) to capture CO_2 from biomass feedstock installed in the autumn
- **2021:** Environmental scoping and two rounds of public consultation
- **2022:** Submission of development consent order (DCO) application
- **2024:** Construction of first two BECCS units underway at Drax Power Station
- **2027:** BECCS technology installed on at least one biomass generating unit at Drax
- **2030:** BECCS installed on two biomass units and Drax Group becomes a carbon negative company
- **2040:** Humber industrial cluster achieves zero carbon status

Figure 2.13 Emissions scenarios for 2050 are most sensitive to the balance of action across aviation, agriculture, LULUCF and greenhouse gas removals



Source: CCC analysis.



Conclusions

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- Using real world evidence we see:
  - Biomass generation integrates well into a low carbon grid
  - The assumption that there is a pulse of carbon is not borne out by evidence
  - Using whole system LCA it's important to include what happens in the forest
  - Our sourcing is **Climate Positive**.

- **Bioenergy is keeping fossil fuels in the ground today as part of a low carbon grid, and can remove carbon through BECCS.**

- Not covered in the talk – but I hope we can pick up in the questions:
  - **Nature Positive** - Monitoring & measuring effects on biodiversity (Healthy Forest Landscapes with Earthworm Foundation)
  - **People positive** - Monitoring social impact (HFL)
  - Future growth of the sector.

Earthworm

Thank
you