BECCS DONE WELL

Conditions for Success for Bioenergy with Carbon Capture and Storage

Supplementary Materials

November 2022

SUPPLEMENTARY MATERIALS

1: DRAX SUBMISSION AND SOCIAL SUPPLEMENT

2: EXPERT WITNESS TESTIMONY: ORAL AND WRITTEN EVIDENCE SUBMISSIONS

1: DRAX SUBMISSION AND SOCIAL SUPPLEMENT

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Forum for the Future High-Level Panel Drax Submission

July 2022

Cover note

The need to tackle climate change by reducing fossil fuel use and restoring nature on a global scale cannot be understated. We believe that biomass sourced to strict sustainability standards combined with CCS (BECCS) will make a meaningful contribution to both these outcomes. We welcome this high-level inquiry into establishing the conditions which are needed to ensure that BECCS does, and only does, provide these positive outcomes to the satisfaction of a wide spectrum of stakeholders and interested parties.

Opinions and perceptions on biomass and BECCS nonetheless vary. We believe it is important to combine science, experience from best practice, feedback from stakeholders and evidence to establish these conditions. We also accept that growth of the sector to a level that these conditions cannot be met needs to be avoided, but not at the expense of growth that can occur within the conditions.

1. What conditions are required to ensure the sourcing and use of biomass from any region delivers positive outcomes for nature, climate and people?

Context:

The use of wood for construction/house building is set to grow further and many see this departure away from materials such as steel/etc as one means by which the construction sector will reduce its carbon emissions. That wood is primarily supplied by well-established sustainable harvesting practices in already highly regulated well-managed working forests around the world – notably in Europe, the US and Canada. Strict regulations, therefore, already exist to prevent deforestation and ensure the forests deliver and enhance positive climate, nature and people outcomes.

The primary source of biomass is sawdust, chips and shavings and other residues from sawmills and wood processing sites. The other source is forest material that is unsuitable for lumber. This includes forest residuals such as slash and tops left over after harvesting, low grade roundwood including thinnings, and diseased or fire-damaged trees. Often forest management requires the removal of this material to maximise the growth of new trees and protect the health of the forest which in turn supports healthy ecosystems. Importantly in some regions (including the US South), extra revenue incentivises forest owners to keep forest intact, and to invest further in forestry. In the past the pulp and paper industry would have used some of this fibre, but in the west specifically some of that sector is shrinking. Using these feedstocks to make pellets for renewable energy and BECCS creates a market for material which in some cases would otherwise be landfilled or burned at the roadside. In some cases, forest owners will manage their land specifically for thinnings because they know there is a market for the material. It is worth noting that, because of climate change there is an increased risk of wildfires as well as the spread of pests and disease. This is turn impacts the health of the forests. Due to this, there is an increasing need for the removal of more of this material, rather than less for community safety and for healthy ecosystems.

The biomass sector is therefore a critical component of the broader timber and forest products industry. This stimulates investment in reforestation, sustaining and creating jobs on a local and regional level, while delivering environmental and climate benefits including healthy growing forests as well as raw materials for renewable energy and negative emissions from BECCS

Forest harvest statistics clearly show that woody biomass for pellet production is not the economic driver for the forest sector. For example, in Drax's two primary sourcing areas, the south east US and British Columbia, 40% by volume goes to sawtimber, 40% pulp, 5% is veneer and the remaining 15% is pellets (south east US), and 65% timber, 10% exported as whole logs, 10% to veneer, 10% to chip mills and 5% to pellets (British Columbia).

Conditions for the right biomass:

To ensure that Drax – and the wider biomass industry - only produces what we refer to as the "right biomass" the criteria defining that must have widespread consensus. This can be achieved by creating an agreement that consolidates all the key activities required to guarantee that the woody fibre sourced, sold, and used originates from well-managed working forests and that the carbon aspects of the entire value chain are factored in. Voluntary standards and regulations make a powerful combination. The regulatory standards are useful because they apply to all players, whilst voluntary standards can test and drive higher standards. The best outcomes in forestry are achieved when both models work in parallel. For instance, when the voluntary SBP (Sustainable Biomass Programme) is in place alongside FSC certification and regulated, geographically specific regulations.

Whilst these standards must be in place prior to any transaction in biomass, we can also review the areas we source from to provide reassurance that the standards we use are delivering the outcomes we claim with biomass. Drax has undertaken its own studies to show that carbon stocks and sensitive habitats are protected or enhanced in the regions we source from, that forest cover is stable or growing, and that biomass contributes to neutral or positive outcomes in the landscape. These include fire prevention and restoration from disease and pest damage. These outcomes support the established view of low-carbon renewable power, and, when CCS is in place, of carbon removal. However, Drax would welcome the widespread use of these studies across the whole sector and would invite NGOs and academics to help, to comment on, and to look into the methodology to ensure there is widespread consensus on the validity of this the research.

How is a tree defined?

It is also crucial that we reach consensus on what different stakeholders mean by the concept of a tree. This is important because Drax, like other players is frequently challenged for using "whole trees" to make pellets. Use of this phrase "whole trees" is ambiguous, because whilst at face value, the definition of a whole tree is not open to interpretation if we accept that a whole tree includes the roots, it is reasonable to say Drax never uses a whole tree. If we say a sapling is a whole tree, then perhaps we do use a whole tree, but that tree is tiny and has no other commercial use. Where we use what people see as a whole tree, i.e. the trunk and branches, it is because it has no other value.

This is not to overlook the ecological need to ensure that there remains some brush on forest floors as a valuable habitat and food source for invertebrates and small mammals. This is very much dependent on forest type and risk assessment. In the south-east US for instance, this is common practise, and we work with forest owners to keep this practise intact. In British Columbia there are strong regulations in place for coarse and fine woody debris that is required to be left on site. Over and above these limits is what creates a higher fire risk, so the aim is to manage fire mitigation and nature's need.

As we have stated above and elsewhere, when a high-value tree is harvested for lumber for the construction or furniture industries, we take the remaining fibre that the lumber industry cannot use. This includes limbs, tops and damaged, misshapen and diseased wood. We also take the residues from lumber processing at a sawmill – these include sawdust, wood shavings and chips. In these cases, therefore, we do not take the whole tree. But we also take low-grade roundwood from thinning operations from the forest management process. This will include logs, but these are logs that are unfit for timber use. Indeed, there are some instances – in British Columbia particularly – where what might be called the 'by-catch' of commercial harvesting yields trees with no other commercial use. Aspen for instance. Selectively, these will be included for biomass. It is the image of these logs that gives the impression that whole trees are used but the reality is far more nuanced. What we also do not harvest whole forests. Not only does that corrupt the promise of biomass, but the economics of forestry would also never give us that choice. Raw timber prices in BC were recently $280 a tonne, pulp about $50 whilst material for pellets secured $37.

Regional variations:

The regional context is very important to take into account as forestry types, practices and ownership differ widely depending on geography and jurisdiction.

In some regions, such as British Columbia in Canada, wildfires are becoming more frequent and more intense. Land managers are required by law to dispose of the waste wood left behind after a harvest that could fuel and intensify a fire that could spread further and do more damage. In BC, the pellet industry has strong support from the First Nations and the provincial government to use this waste wood, which is typically burned at the roadside or landfilled. This therefore also provides local employment and other benefits.

In the tropical forests of Southeast Asia and South America the story is different. The area is complex to govern and police, concerns over corruption are higher and ownership can also be unclear. One way of reducing this challenge has been the introduction of voluntary standards from the buyers of forest products. FSC is the classic model as it has created a competitive advantage for suppliers – and buyers – of good forestry. Given the link between biomass and timber, biomass can also help provide additional incentives to good forest management and this will be an essential element that needs to be accepted across the region.

The conditions that must be met to answer this question are:

Woody biomass:

- Forest or woodland should not be grown or harvested in order to supply a feedstock for woody biomass that is used for pellets. Woody biomass from forests must come from forests that are strictly regulated and/or are managed under strong voluntary certification standards such as FSC, SFI and SBP. Woody biomass for energy use can only be sourced from the by-products of sawmills and existing commercial forest harvesting processes where the primary purpose is the extraction of timber for high-value purposes such as construction or furniture manufacture.
- The remainder should come only from thinning forests harvested for other commercial purposes, the otherwise unusable material resulting from forest harvesting, and trees which are damaged, misshapen or diseased and would not achieve a higher value, or are rejected by competing sectors, such as pulp and paper.

- There must be independent evidence that either the forests are expanding or stable at landscape scale, that biodiversity is kept at an independently adjudicated acceptable balance, and that overall carbon stocks are stable or rising, or that the biomass is making a neutral or positive contribution to this trend. Or, as in the case of BC, the sector can prove a positive contribution to helping forests recover from trauma like fire and disease.
- Externally, there must be use of existing, or creation of new, multi-stakeholder standards for on-going management of these forests in place, including certification, and that all relevant laws and regulations by jurisdiction are complied with.
- All standards, whether applied as part of a pellet users' sourcing standards, or by external certifications, or both, must reflect regional variations in terms of geography, ownership, forest type, climate and community practice, so long as none of these undermine the top-line definitions of the 'right biomass' and sustainable forest management processes.
- There must be widely acceptable instruments to enforce law, regulation, certification and biomass users' own sourcing standards.

Other energy crops:

- Other types of biomass that Drax could source from in the future, e.g. agricultural crops such as energy crops grown in the UK, will require a slightly different set of criteria.
- The use of agricultural waste (and even construction waste, where possible) in many cases will be benign, but we have to ensure there are no unintended consequences. For instance, if demand for straw from cereal harvesting is too high in one sector, then it prices livestock farmers out of the market for bedding material. So, while a reduction in meat-based protein is positive for the climate, one sector should not inflict accidental economic damage on another. Pricing and availability across all demand sectors is key here.
- In the case of specifically cultivated energy crops, there must be a set of land use change, and biodiversity metrics, as well as consensus on carbon indicators to show clear upsides for all three in the planting, growth and harvesting process. Regarding land use, the potential tension between land for food and land for fuel must be addressed. For example, miscanthus could be a UK energy crop, but we agree that its growth must not lead to losses in food production and/or losses of land for nature. The challenge is how to prove that to be the case.

To summarise, to qualify as 'the right biomass' the material can only be sourced as a by-product of an existing, well managed, stable or expanding commercial forestry operation subject to complete transparency of operation, and verifiable carbon accounting.

2. What conditions are required to demonstrate that energy from biomass makes a positive contribution to decarbonisation, energy security, affordability and a just transition as countries reduce fossil fuel use?

There is a fundamental difference between biogenic carbon (produced by living organisms) and fossil carbon (formed from the decomposition of buried carbon-based organisms) and the impact they have on the climate.

Carbon from biomass is biogenic carbon. Unlike fossil carbon, biogenic carbon, when harvested to sustainability standards, operates within natural carbon cycles. It relies only on carbon that is being drawn down from the sky and released through the death of that tree, only for that carbon to be reabsorbed with new growth. Since we source at landscape level, the notion of carbon debt does not prevail.

Coal, gas and crude oil emit fossil carbon that has been stored underground for millions of years and then combusted in a few decades, adding new carbon to the atmosphere and contributing to climate change. The prime goal of the energy transition is to eliminate reliance on fossil fuels and increase production of renewable, stable and secure sources of energy. Biomass is the only energy form which can do all these things.

Adding CCS to biomass removes carbon from that natural cycle and can deliver negative emissions that will help compensate for emissions from other sectors that are harder to abate.

Drax believes that all biomass businesses must comply with the regulations governing the sector and demonstrate carbon accounting measures through the entire value chain. This relies on collaboration to determine the carbon footprint of forestry and how to account for the counterfactuals.

The conditions for biomass's positive contribution to energy systems already exist and can be seen by analysing electricity generation by type over the last few years.

Biomass is a low-carbon technology that can provide reliable, dispatchable renewable power, enabling more intermittent renewables, such as wind and solar, to come on-line.

Nuclear is often presented as an important low-carbon source of energy. But it can only deliver baseload generation – it is not flexible, like biomass generation. This means it cannot be turned on and off to meet supply and demand fluctuations. Furthermore, it can take a long time to build and is extremely costly.

Hydrogen is another much-discussed option. But the technology is not ready to be deployed at scale and there are emissions associated with its generation that need to be accounted for. Large-scale battery storage will almost certainly be needed, and is being developed, but again the technology is currently at an early stage. The best existing technology at scale for energy storage is pumped storage hydro, which Drax has already invested in and is seeking to expand at its Cruachan hydro site in Scotland.

Some say that biomass is better deployed at community level, and indeed there are many small-scale biomass power stations around the country. However, these smaller power plants cannot deliver instant energy into the UK power grid when intermittent renewables such as wind and solar aren't producing enough power or aren't generating at all.

Biomass also enables BECCS, which can provide the carbon removals needed to get to net zero.

Another issue is around the question of ensuring that the energy transition we need to make to achieve our climate targets is a just transition. This means that people should not lose their jobs and opportunities for new jobs and the creation of new industries and supply chains should grow instead of decline. The conversion of coal-fired power plants to biomass – technology which Drax has already proved at its Yorkshire power station – demonstrates that when biomass is 'done right,' it can deliver a just transition which continues to provide dispatchable power while safeguarding jobs and skills and creating opportunities in new supply chains.

There are also the issues of energy affordability and security. Domestic energy costs are pushing millions into fuel poverty. Global energy and food insecurity over the war in Ukraine and the consequent impacts of sanctions on Russia are exacerbating both high cost and security of supply. Drax is based in politically stable countries with well established and reliable infrastructure. Headquartered in the UK, with operations across North America and Europe, we can be assured of the sustainability of our biomass pellet supply from both a political and financial perspective.

The argument is that if the first question (above) is answered, and the concept of the 'right biomass' is accepted and adopted universally, then the answer to the second question is that it is a viable option to support the delivery of a just transition as well as dispatchable, renewable power and negative emissions from BECCS will be needed to meet net zero.

The conditions that must be met to answer this question are:

- Acceptance of the difference between biogenic and fossil carbon and the accurate measurement of the carbon emission/sequestration cycle at landscape level.
- Understanding therefore that adding CCS can deliver negative emissions.
- All biomass must be sourced in compliance with all regulations and must demonstrate that its carbon accounting covers the entire value chain. This is already embedded in Drax's sourcing policies.
- Acceptance that this biomass is a complementary technology to allow the wider introduction of other renewables, along with the development of technologies that have yet to reach maturity.
- That biomass enables a just transition through the conversion of existing fossil fuel plants and therefore promotes the retention of labour and skills.
- That biomass contributes significantly to countering the negative impacts of energy cost inflation and energy supply insecurity.

3. What conditions are required for BECCS to make a material, ongoing contribution towards Net Zero targets?

Global, country and (most) company targets are aiming for net zero by 2050, not absolute zero by 2050. Therefore, there will be offsets, removals and other mitigating technologies included in the calculation mix to determine 'net'. While in theory removals could be used to balance existing emissions, there is clear international consensus that removals should not be used as an excuse to defer or avoid carrying out deep emissions reductions. Removals should be considered as an additional tool to other decarbonisation efforts. Many countries have legally binding decarbonisation targets (such as the UK's target for energy sector decarbonisation by 2035) that will help ensure that removals have an additive contribution towards the country's Net Zero goals. Companies should deploy the same approach when considering the balance between reductions and removals in their decarbonisation strategies.

Policymakers in the UK and elsewhere have already indicated their broad support for carbon removal technologies to be deployed in order to achieve net zero. BECCS features in their plans because the zero rating of biomass CO2 emissions when used in the energy sector, combined with the capture and storage of stack emissions, can result in negative emissions, even including the supply chain (the emissions of which must still be netted off). In addition to the rules, Drax also supports biomass sources undergoing a thorough carbon stock analysis.

Companies too have adopted a parallel path to net zero although with varying target dates, in some cases sooner than 2050. But in common with government, their focus is on net zero and not absolute zero, therefore indicating a universal need for a variable but reliable source of offsets and removals to meet the needs of both public and private sectors.

Bioenergy is also already in use in the UK and throughout the EU, as a key renewable technology supporting energy sector decarbonisation. Coal to biomass conversions also represent an important route for countries looking to remove coal from their energy mix. Going one step further by adding CCS allows counties to deliver negative emissions through existing biomass energy infrastructure. This is an appealing and efficient way to deliver carbon removals quickly, alongside renewable energy, while also supporting a just transition (as discussed in Q2), particularly in countries where coal is still a big employer.

Similarly, CCS is a core component of the UK and EU's Net Zero plans as it can support power and industrial emitters to reduce emissions where alternative decarbonisation options are not yet available, and CCS enables the delivery of engineered removals such as BECCS and DACS. It is therefore critical that the necessary legislative, commercial and monitoring systems for CCS are in place in order to support the delivery of BECCS. Helpfully, both the UK and EU have existing rules and regulations that govern the operation and monitoring of current CCS sites, such as those operated by Equinor in Norway. This ensures that geological CO2 storage is carried out in a safe and sustainable way and that any impacts on the environment and the integrity of the storage site are thoroughly assessed and minimised or mitigated. The UK is also actively progressing with business models to support CCS and BECCS deployment in the UK in the 2020s.

To ensure there is integrity in the nexus between commercial interests, forest and biodiversity health and biogenic carbon stability, BECCS needs to be understood and relied on for its contribution to net zero goals in a transparent and scientifically proven way. There is a risk of unintended consequences –that could undermine the credibility of the negative emissions from BECCS. There must be a clear and transparent trail showing the journey – and the carbon footprint - of the biomass from source to power station to capture and then safe and permanent storage. Equally there is a need to consider the indirect impacts of sourcing to ensure there are no undesirable consequences of scaling up BECCS.

From a macro point of view, if the world has decided that we need net zero and not absolute zero then we need a portfolio of carbon removal choices, and we need to continue the debate about what offsets and technologies are acceptable and why. Drax believes you can have carbon removals that are environmentally, socially and economically friendly. Ultimately, all technologies (including all removals, whether nature-based or engineered) will be needed to reach climate targets. Because BECCS will generate revenue from power, the technology offers removals at a lower cost than other competing removal technologies, whilst ensuring balanced nature and biodiversity outcomes.

The zero rating of biomass CO2 emissions in the energy sector stems from the IPCC international carbon accounting guidelines that factor in all removals and emissions associated with agricultural and forest commodities in the land sector. Often, the application of these rules results in biomass being classed as 'carbon neutral', when in fact, as we are touching on in this paper, it is much more nuanced than that. So, the primary condition in this question must be to understand the biogenic carbon argument in such a way that the majority of scientific and stakeholder opinion is aligned behind it.

To achieve that, the challenge this panel has is to examine the evidence put forward by proponents of both sides of the argument and then make a determination. This determination might be nuanced – i.e., along the lines of 'a zero rating of woody biomass can only be deemed widely acceptable if the following criteria are met….' This would need to be re-tested with the contributors. While the IPCC's views on the contribution of BECCS are clear there needs to be wider consensus and clarity on conditionality.

On the subject of rules around BECCS, there is presently no business model which supports the commercial operation of carbon removals. Although there is much discussion of corporate interest in buying carbon removals on the voluntary carbon market, the current volumes that are purchased are extremely small (<<10ktpa), and as such are not sufficient to give investors' confidence in projects or in the likely return on investment. To support the development of the carbon removal market, some form of policy incentive or government support is required to enable project development in the near term as happened in the wind and solar markets. For BECCS power projects, there is growing consensus that a suitable commercial mechanism could reward power generation via a power CfD (as is already common in the renewable sector) and that negative emissions should be awarded by a separate carbon payment (which could be at a similar level to the ETS price). Over time, as investor confidence grows and more BECCS projects are deployed, government support should be replaced by cap-and-trade systems (such as by including negative emissions in the ETS) and/or by demand in the voluntary carbon market. For BECCS (or indeed any carbon removal project) to be deployed at sufficient scale, it is essential that policies are brought forwards which place a value on negative emissions and support the deployment of these FOAK technologies. The sooner early support mechanisms are deployed, the sooner the market can develop and mature, removing the need for long term government support.

However, for a BECCS project to be remunerated for delivering negative emissions, there must be robust monitoring, reporting and verification mechanisms that ensure that the reported carbon removals are truly delivered and are accounted for appropriately at the corporate and national level.

The first step here is to see it in the context of 'do no harm', as the EU biomass taxonomy states. So, any credible summation must consider many impacts and the wider sustainability issues.

The conditions that must be met to answer this question are:

- Consider and calculate emissions alongside removals in the forest/land sector (as per IPCC guidelines) and ensure that sourcing has a neutral or positive impact on forest/ land carbon stocks (compared to the biomass sector not being active in that region)
- Measure at landscape scale to factor in both direct and indirect impacts– i.e. are carbon stocks above and below ground in source areas at least stable or better, expanding? This will be challenging because the status of soil carbon science, while broadly clear, is not yet sufficiently detailed to allow for accuracy across multiple land types. This is a part of carbon science that Drax is already supporting and is willing to continue to back, ideally alongside others in the industry.
- Determine if the analysis is to be quantitative, qualitative, or risk based. Drax's position is that there is value for all three approaches, with each having its own merits and drawbacks.
- Standards and verification for the commercialisation of carbon removals in both the voluntary and regulatory sectors.
- Alignment of frameworks – there are various accounting frameworks under which carbon is counted (e.g. corporate inventories, national inventories, compliance LCA thresholds, voluntary carbon markets, etc), many of which will need to become aligned in the future. Accounting rules for BECCS will inevitably be complicated and so present an increased risk of misalignment of frameworks.
- In LCA, be clear as to whether an attributional or contributional approach is most relevant for the context in which it is being used.
- Understand context – think of the carbon accounting exercise in the same way as a commercial supply chain – upstream is carbon, forest, processing, logistics. Mid-stream is combustion. Downstream is capture and storage
- Understand positional context too – Drax is connected to multiple different sectors (forestry, energy) and is part of a broader segment of carbon removal technologies. Connected here are end users (consumers and business users), regions (for instance the Humber cluster), and 'beyond country' – i.e. benefits do not stop at the UK border

- Consider also the need to ensure consensus about how BECCS is counted and claimed for. There must be clarity about the allocation of negative emissions and a need to avoid double counting of credits within each applicable accounting framework.
- Finally, it must also be cost-effective - not just to protect the commercial interests of Drax or any other user, but to protect end-user interests.

4. What are the implications of this for Drax and the wider biomass industry in policy and governance terms? How will verification work in an authoritative and transparent way, that all the conditions referenced in the three previous points have been met?

Drax believes – and the industry could follow suit – that this is best answered through:

- Regulatory enforcement
- Consensus-led standard setting, verification and transparency
- Cross-sector collaboration to achieve universally high standards

In each of these, the opportunities to apply benchmarks, standards, metrics and science are key. We also believe that separate interventions can be applicable in the three phases of the entire pellet transaction – before, during and after.

Before:

- The economics of biomass combined with procurement policy mean we draw from forests that are already working forests, usually being managed for lumber, meaning that in most cases the forest management is already tightly regulated.
- Drax is contributing towards an independently formed set of multi-stakeholder agreed global sourcing principles through the very process which will be informed in part by this submission. These principles will consider views of the industry as well as those of critics.
- From these, there will need to be versions of these principles with regional interpretations based on local conditions, practices and forest types. For instance, British Columbia standards informed by British Columbia stakeholders/ industry within the overarching global framework; US standards similarly; and so on by main sourcing geography.
- Application of industry and wider stakeholder collaboration. The Glasgow Declaration (https://sustainablebioenergy.org/wp-content/uploads/Glasgow-Declaration-on-Sustainable-Bioenergy.pdf) could be the first step towards this. Currently it does not have enough independence from the sector, but this could a foundation to build on since it has delivered a key step which is an agreement across many players in the sector for sustainability principles and a suggestion of what should be. However, for true independence to be achieved it will require other parties to come to the table and lend their names and time to the process.
- Work with customer markets with fewer or lower (or zero) standards to raise their regulatory and buyer/user standards to acceptable levels (Japan, South Korea for instance).
- Link standards for BECCS to standards for sourcing to avoid over duplication but to ensure sufficient clarity and reassurance is front and centre.

During:

- The imposition of stronger standards will have impacts on procurement. It is essential that the procurement processes are robust enough to buy to only those standards. Not only do the sources need to be audited, the buying companies' processes need auditing too. And as the market gets bigger so will the need for stronger standards rise.

- As referenced earlier, Drax believes a global overarching set of 'gold principles' is essential, but that are applied with an appreciation of and sensitivity to regional variations and geographies/forest types. But there will also need to be a process to understand how to apply standards to an acceptable level of consistency where it is known there are challenging issues and variances of regional practise and legislation – in, for instance, Canada, and Vietnam. Drax's intent is to pilot one country first to level set then roll out to others.
- Nothing stays the same, so everything will need constant review, and a major part of this is to understand what Drax's peer set is doing, and where Drax can learn – or teach.

After:

- Enhancing standards at the front end of a process is one thing. Ensuring what was imposed has had the desired effect is entirely another. Hence a major implication for Drax and the wider industry will be to have processes that demonstrate that the desired people, nature and climate outcomes have in fact been achieved.
- The task here is the comprehensive codification of what Drax calls 'Healthy Forest Landscapes', alongside the company's Catchment Area Analyses. Drax's intent is to review existing measurement processes and then commission an independent analysis of long-term systems that Drax, and any other company, can put in place to measure outcomes.
- This will include the understanding and adoption of technology, as it evolves. For instance, remote imagery is moving apace, as is LIDAR, techniques for measuring carbon sequestration rates, and storage across landscapes, and many others.
- These implications apply to the whole sector so one further objective would be to explore the industry-wide adoption of post-harvest studies via the Glasgow Declaration group.
- These studies – or the process for them - could then usefully be institutionalised under the umbrella of an appropriate not-for-profit so that they become the accepted independent standard for the entire industry.

Summary:

We have set out above the conditions under which biomass and BECCS could be considered sustainable.

Opinions and perceptions on biomass and BECCS will continue to vary. But we believe it's important to agree general principles under which biomass and BECCS can be considered sustainable and beneficial to the climate, nature and people. In the process of reaching that understanding of these conditions, it is possible a consensus may be found on the benefits that biomass and BECCS offer us in the race to reach net zero.

Importantly, we continue to believe in and support an evidence-based approach which sets out what these conditions are and how BECCS can meet such standards. We have sought to do this here and look forward to exploring these conditions in more detail as part of this project.

Focus on Social Issues
August 2022

Forests all over the world are home to many cultures and communities, and provide livelihoods for many. Employment in commercial forestry and related industries makes a large contribution to the economy of forested regions. For energy crops, there must always be a positive, sensitive and well-managed approach to local communities, cognisant of regional and national variations, practices, beliefs and economic or welfare needs.

In the south-east US, where almost all forest area is privately owned and managed commercially, Drax is indirectly responsible for 1,200 jobs and directly employs 300 people, generating US$45m in additional household income. Best practice in these regions will involve partnerships with local stakeholders and aligning our activities with their needs and expectations.

With that in mind, we have agreed a partnership with the Federation of Southern Cooperatives, an association of African American farmers, landowners and cooperatives, to drive equity in the US south forestry sector. This is designed to help owners of small plots to access markets, which in turn is providing historically underserved landowners with new opportunities. The extended benefits help stimulate sustainable forest management and prevent deforestation.

In British Columbia, where we entered the market in 2021 with the acquisition of Pinnacle, we are wholly supportive of the British Columbia government's multi-year review of old growth forestry practices, including protection of some of the most sensitive areas. Critical to this, and to our future thinking, is the increasing role of the First Nations as decision-makers in forestry which we support and respect.

We already work with some First Nations partners, such as the Witset Nation in Houston BC. and we are building capacity in the business to ensure that we can work with more First Nations as they become more involved in the planning in their region. It is worth noting that the First Nations communities we do work with welcome our contribution, partly because we provide an economic route for material that they would have piled or burned, and that the material we remove is now having to be removed out of necessity to reduce the risk of forest fires.

As regards to our pellet manufacturing plants, it is crucial that the right environmental controls are in place to avoid issues such as dust and storm water run-off. In the context of "biomass done right", it is paramount that pellet making complies with all local and federal environmental regulations, and that site managers have open and constructive relationships with local affected communities. An investment programme is now under way across the areas from which we source our biomass to ensure that all our plants meet all permitted levels. We are simultaneously investing in bringing our community engagement up to the required levels of two-way engagement and trust.

Here in the UK, we are looking at the opportunities of UK energy crops, and for us this has started with extensive stakeholder consultation on research to identify if this is viable given the conditionalities.

Another area to consider is "Just Transition". The conversion of coal-fired power plants to biomass is a prime example of "just transition in practice". We continue to deliver reliable, dispatchable power without coal and have safeguarded jobs and skills in the Humberside whilst creating opportunities in new supply chains.

2: EXPERT WITNESS TESTIMONY: ORAL AND WRITTEN EVIDENCE SUBMISSIONS

Written Submission: Kevin Anderson, 16.08.22

Professor of Energy and Climate Change in the School of Mechanical, Aerospace and Civil Engineering at the University of Manchester.

- on the following pages -

Professor Kevin Anderson
School of Engineering
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Tyndall°Centre
for Climate Change Research

Re: Evidence session on BECCS

Inquiry into current plans for a Biomass Energy, Carbon Capture & Storage (BECCS) plant at Drax.

Inquiry Question 3: ***What conditions are required for BECCS from woody biomass to make a material, ongoing contribution towards Net Zero targets?***

Response provided by Professor Kevin Anderson August 2022

Kevin Anderson is professor of Energy and Climate Change at the Universities of Manchester (UK), Uppsala (Sweden) and Bergen (Norway). Formerly director of the Tyndall Centre, he engages widely with governments and remains research active with publications in Climate policy, Nature and Science. Kevin has a decade's industrial experience in the petrochemical industry, is a chartered engineer and fellow of the Institution of Mechanical Engineers.

All views contained within this response are attributable solely to the author and do not necessarily reflect the conclusions of those within the wider Tyndall Centre or other affiliated institutions.

HEADLINE CONTEXT: This submission is premised on the assumption that the Drax CEO's expressed concern over his company's responsibility in terms of climate change is guided by the UK's signatory to the Paris Agreement, and more recently the Glasgow Climate Pact. In this regard, I take the Agreement's framing of *"well below 2°C"* and *"pursuing … 1.5°C"*, alongside the associated IPCC carbon budgets, as key parameters in assessing the potential of proposed technical responses to climate change.

A. Establishing an explicit context for judging responses to climate change

The UK Government is a signatory to the UNFCCC (1992) and to all subsequent Conference of the Parties (COP) protocols, including the Paris Agreement and the Glasgow Climate Pact. The Paris Agreement commits the UK to cut emissions in line with "*holding the increase in global average temperature to well below 2°C above pre-industrial levels, and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels"* – informed by equity (i.e. the concept of 'common but differentiated responsibilities and respective capabilities'; CBDR-RC; see Article 3 of UNFCCC 1992) and on the basis of science.

In May 2021, the UK chaired a meeting of G7 ministers responsible for Climate and Environment. Within the concluding communique, G7 nations committed to *"make ambitious and accelerated efforts to reduce emissions to keep a limit of 1.5°C temperature rise within reach"*.

In November of 2021, the UK hosted the Glasgow COP and subsequently presided over the drafting of the Glasgow Climate Pact. The Pact explicitly notes that *"the impacts of climate change will be much lower at the temperature increase of 1.5°C compared with 2°C and resolves to pursue efforts to limit the temperature increase to 1.5 °C",* recognizing that this *"requires rapid, deep and sustained reductions in global greenhouse gas emissions."*

Translating this shift of emphasis towards more stringent temperature objectives into the quantitative language of the IPCC, suggests a minimum commitment of a 50% chance of not exceeding 1.5°C.

It is this form of probabilities that the IPCC use (Table TS.3, p.98) in communicating their estimates of the total amount carbon dioxide emissions (i.e., the carbon budgets) that must not be exceeded if nations are, collectively, to abide by their commitments.

Updating the IPCC's headline 1.5°C budget to the start of 2022, gives a global carbon budget for a 50% chance of not exceeding 1.5°C of around 400 billion tonnes of carbon dioxide. To put this into context, current global emissions are approximately 42 billion tonnes each year. So, at the present rate of emissions, the total global carbon budget for 1.5°C will be consumed in under a decade. Put another way, each month we consume almost 1% of the remaining budget, i.e., since the start of this year (2022) we have emitted over 7% of the total carbon dioxide that, for all practical purposes, we can ever emit.

If a precautionary perspective is to be further weakened, or even abandoned, then a framing of *"well below 2°C"* (interpreted in the IPCC language of an 83% chance of not exceeding 2°C), would see, approximately, the budgets described above double in size. However, even this increase still would require profound and immediate cuts in emissions within wealthier nations of well over 10% pa. [3]

Based on Anderson et al (2020), downscaling these AR6-based global budgets to the UK, including the UNFCCC principle of CBDR-RC, gives the following budgets (from January 2022):

Headline carbon budgets and mitigation rates
(these values remain provisional and subject to refinement)

Interpretation of Paris Agreement	Carbon budget $GtCO_2$	Approx. Years of current emissions	Annual emission reductions with exponential decline	Real Zero CO_2 date with linear CO_2 reductions
83% chance 2°C	3.5	~9	10+%	~2039
50% chance 1.5°C	1.70	~4	19+%	~2031

Table 1: UK's Paris-compliant carbon budgets starting January 1, 2022. These values are for energy-only territorial CO_2 emissions, including international bunkers (aviation & shipping) and excluding cement process emissions.

Between January and the end of August of this year, the UK will have used a little under 20% of its remaining 50% of 1.5°C budget, and almost 9% of its 2°C budget.

It is within this scientifically and quantitively robust translation of the UK Government's commitments (and indeed those of all the COP signatories) that the role of BECCS needs to be considered. In the absence of such an explicit and quantitative framing, conclusions on the appropriateness or otherwise of BECCS (or indeed any other 'response' to climate change) are little more than nebulous arm waving hidden behind eloquent language and spurious quantification. In my judgment, it is exactly this framing that has and continues to dominate the mitigation agenda. Net Zero (2050) is the latest and now ubiquitous ruse for sidestepping the fundamental political, social and economic questions emerging from the 1.5 and 2°C commitments.

B. Why is this so removed from what is typically assumed?

The two heuristic mitigation pathways proposed here for the UK, and the zero emission dates for *"well below 2°C"* and *"pursuing … 1.5°C"*, are all far removed from the advice of the CCC and indeed many of the high-level global scenarios. For the CCC, as they specifically noted in their sixth carbon budget report [7], they no-longer consider it appropriate to downscale from global carbon budgets to provide national carbon budgets, choosing instead to be guided by what they judge to be *"highest possible ambition"*[i]. By contrast, the approach here very specifically downscales to the UK, premised on clear sequential reasoning and transparent assumptions.

In comparing the 1.5°C and 2°C budgets presented in this submission with those of the CCC specifically, and high-level global scenarios more generally, two key differences arise.

The first relates to the treatment of equity between nations, as defined in the UNFCCC concept of 'common but differentiated responsibilities and respective capabilities' (CBDR-RC)[8]. This concept remains embedded as a key criterion in both Paris and Glasgow.

Within Anderson et al [3] we detail how the CCC approach essentially ignores the CBDR-RC framing of equity, choosing instead a very weak interpretation of 'fairness'. Understanding this is important in appreciating just how tight the mitigation timeframe is, and hence the role of BECCS.

Second, and further differentiating the UK's *"net-zero 2050"* framing, arises from the assumption that future generations will develop and deploy technologies to remove many hundreds of billions of tonnes of this generations carbon dioxide directly from the atmosphere. This is assumed by the CCC (and most high-level scenarios) to begin in earnest by around 2035, increasing through 2050 and out to and beyond the end of the century. This reliance on future generations to deploy what are still highly speculative technologies (at scale) at an unprecedented planetary level has the expedient effect of increasing the carbon budget space, and thereby the timeline within which CCS, BECCS and wider CDR can be usefully deployed.

C. Why NETs (inc. BECCS) should not form part of the mitigation strategy for 1.5-2°C

NETs: too speculative for inclusion

As of today, NETs are either in the form of small pilot demonstrators capturing just a few thousand tonnes of carbon dioxide[ii] or remain in the imagination of modelers and engineers. Despite this, virtually all high-level mitigation analyses assume that in coming decades NETs will be deployed at huge, planetary scale, increasing significantly post-2050 and extending well beyond the end of the century. Certainly, there is merit in a well-funded research and development programme on NETs.

Moreover, provided any promising designs meet stringent ecological and social sustainability criteria, a rapid process of large-scale testing and subsequent deployment should commence.

Such deployment of NETs in a small suite of more exotic scenarios would add an important family of model outputs to complement those using existing technologies and understood processes of social change. However, and despite the fledgling state of NETs, their ‘unproblematic’ use to remove many hundreds of billions of tonnes of carbon dioxide across the century is now pervasive.

D. A focus on BECCS:

Within existing models and scenarios, the approach that dominates the NETs assumption is bioenergy with carbon capture and storage (BECCS). In essence, high-level scenarios assume a return to a global economy powered, in significant part, by the combustion of plants with the emissions subsequently captured and buried. The scale of the assumed role for BECCS is hard to exaggerate, yet there remain some very real concerns as to its delivery (at the scales assumed). In addition, the prospect and overselling of BECCS specifically, and CDR more generally, has and continues to have insidious impacts in weakening the political resolve for early and deep mitigation.

The ubiquitous promise & overselling of BECCs has consequences

The allure of BECCS, and other NETs, is that they substitute immense political, social and economic challenges of mitigation today for highly speculative (at scale) removal of CO2 from the atmosphere tomorrow. This proposed transfer of responsibility between generations has been one factor in weakening the pressure on policy makers to face mitigation challenges head on. A consequence of this is that emissions and temperatures have continued to rise at rates greater than those had the opportunity to shift the burden across time not ‘existed’. In this regard, the misused prospect of BECCS (and CCS) have already resulted in additional climate impacts, suffering and death.

Ecological and sustainability implications

Ostensibly BECCS confers considerable advantages to models seeking to cost-optimise their responses to climate change, as it substitutes for other mitigation options deemed to have higher marginal costs.

However, the scale of biomass (with limited biodiversity) necessary to deliver the hundreds of billions of tonnes of removal through BECCs, imposes considerable ecological as well as and societal and political risks. In important respects, the cure could be as bad if not worse than the disease. One estimate puts the *"loss of terrestrial species* (from high levels of BECCS) *perhaps worse than the losses resulting from a temperature increase of about 2.8°C above pre-industrial levels."* [14]. Another estimate puts the land take associated with the levels of BECCS in many models at between 380 and 700 million hectares [15], equivalent to one-and-a-half times the combined area of the EU's twenty-seven countries, or up to twice the area of India. Further to such high-profile impacts, BECCS at scale also has major implications for water use, land-rights, global shipping and wider transport demands, as well as those associated with the integrity of carbon dioxide storage.

BECCS is reliant on CCS, a technology that has consistently failed to deliver

The prospect of CCS has, since the late 1970s [22], been proposed as a potential means for reducing the emissions per kilowatt hour of fossil-fuel-fired power generation. For over a decade CCS has also been a key component of high-level scenarios embedding planetary scale BECCS. More recently, it has also been offered as a technology with the potential to unlock the production of 'blue hydrogen'. However, while CCS has remained central to most orthodox system-level mitigation scenarios, in practice the fossil fuels industries have demonstrated very little belief in its long-term prospects, having constructed just a few small pilot schemes over the past two decades.

In 2010 the IEA's CCS Roadmap (as part of its low carbon 'Blue' scenario) [23] envisaged sixty large scale CCS projects by 2020, rising to around 500 by 2030 and over 1800 by 2050. In its 2021 report, the Global CCS Institute noted there were twenty-seven plants operational, with four more currently under construction [24]. Total capture was estimated at a little under 37 $MtCO_2$, or less than 0.1% of total fossil-fuel CO_2 emissions. If those future plants designated by the Global CCS Institute as in a stage of "advanced development" were all to proceed to construction and then full operation, capture rates could rise by an additional 47 $MtCO_2$, bringing the total to a little over 0.2% of current annual fossil fuel emissions.

Importantly, these values include both geological storage and the use of captured CO_2 for 'enhanced oil recovery'. Considering only CO_2 actually stored geologically reduces the 37 $MtCO_2$ to a little over 7 $MtCO_2$, or under 0.02% of energy-related CO_2 emitted in 2021. As for the future projects, and again assuming they all proceed to full operation, then in terms of storage, by 2030 the total is set to rise to around 45 $MtCO_2$, or a little over 0.1% of current emissions [25].

All of this is far-removed from the long-standing enthusiasm for CCS as a cornerstone of the decarbonisation agenda – either for extending the use of fossil fuels directly, or, via BECCS, indirectly. Yet, and despite the long history of over-promising and under-delivering [26], this enthusiasm remains unchecked.

Parochial responses to 1.5-2°C are misleading … i.e. there's no scope for biomass imports

As demonstrated earlier, the mitigation rates for delivering on 1.5-2°C are both immense and without precedent; just to recall, for 1.5°C, mitigation rates for wealthy nations are in the region of 20% p.a. and starting now. Every nation and every sector will be absolutely pushing at the limits of what is possible. Under these circumstances, there will be little to no scope for transferring valuable low carbon materials between nations, or probably even regions.

Given climate change is a global issue, it makes no sense (for 1.5-2°C mitigation) to move large quantities of (theoretically) low carbon biomass via high-carbon shipping. If we are serious about 1.5-2°C, and believe bioenergy has an important role to play, then biomass needs to be used locally, and not shipped vast distances to satisfy some abstract and national carbon-accounting scheme.

Burning imported plant material & burying CO2 - thermodynamic madness when alternatives exist?

Power generation is the one area of energy supply where very low or zero carbon alternatives exist at scale and at prices that are already very competitive.

Shipping scarce and low energy-dense biomass over vast distances, to then be transported to powerstations to be subsequently combusted in an inherently inefficient process of electricity generation, before bolting on an energy-intensive capture and storage system to remove the CO2, demonstrates just how locked in to 'business as usual' we remain.

From any reasoned system perspective expending limited capital, labour and expertise on such a deeply inefficient process is 'madness' given the huge challenges we face – challenges where such resources could deliver far more progressive and sustainable levels of change.

Too little too late

The primary remit of this submission is reducing emissions in line with not exceeding 1.5 -2°C. This entails rapid decarbonisation, beginning now and being all but complete within one to two decades. Such a tight timeframe is inconsistent with any realistic interpretation of the roll-out of BECCS, roadmaps of CCS-based power generation or blue hydrogen production.

Ultimately, bolting on what is in effect an inefficient and expensive filter to an energy process that burns plants is very much an 'end-of-pipe' approach, more reminiscent of the last century than the system-level considerations of this century.

Professor Kevin Anderson
School of Engineering
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E. Degree of confidence in this submission

It is certainly possible to 'fine tune' some of the assumptions that underpin the quantitative analysis within this a submission. However, within the tight IPCC AR6 carbon budgets for 1.5–2°C, and with serious attention paid to the UN framing of equity, the key messages outlined here are sufficiently robust to provide a strong guide to mitigation policy. A potential exception to this is whether it is considered appropriate or not to expand the IPCC's carbon budgets through future 'carbon dioxide removal', deployed at planetary scale and principally in the second half of the century. Whilst CDR is now ubiquitous in mitigation analyses, the IPCC's estimates of additional feedbacks, potentially reducing carbon budgets, are seldom if ever included. For this submission, a conservative approach is adopted, neither easing the mitigation burden through CDR nor increasing it through additional feedbacks.

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[i] For example, see [7] p.428.

[ii] For example, the new (Sept 2021) Orca power plant in Iceland, which captures around 4000 tonnes of CO_2, or the equivalent of around 0.00001% of global CO_2 emissions from fossil fuels. Ostensibly higher levels of actual removal occur at the ADM bioethanol plant in Illinois in the USA. Here in the region of 0.5MtCO_2/yr have been successfully captured and stored, with the operational capacity to increase to 1MtCO_2/yr [60]. However, there is little full life-cycle information available to determine the net levels of CO_2 removal, with the plant's total CO_2 emissions actually rising in recent years (to over 4MtCO_2/yr), likely due in part to the wider activities it undertakes, but also the energy required for the capture and storage. The ADM plant certainly demonstrates how, when rich CO_2 streams exist from biomass processing, it is possible to capture and store the CO_2. However, the application of CCS on the *combustion* of biomass (or indeed fossil fuels) presents a very different engineering challenge (with much lower concentrations of CO_2 and more contaminants), yet it is this approach that dominates the high-level mitigation models.

Oral Evidence Summary: Kevin Anderson, 16.08.22

Professor of Energy and Climate Change in the School of Mechanical, Aerospace and Civil Engineering at the University of Manchester.

Timeframe

Kevin began the session with a useful reminder of the timeframes available for maintaining global temperature rise to within 1.5ºC or 2ºC. This is the broader context we need to keep in mind as we assess the relative merits and limitations of BECCS. Under these timescales, Kevin argues that the distinction between biogenic and fossil carbon is largely irrelevant from the perspective of the carbon budget. For a bit of context, updating the IPCC AR6 carbon budgets to now, leaves around 380 billion tonnes of CO2 (GtCO2) for a "pursuing … 1.5°C" and 780GtCO for "well below 2°C"; respectively, that is around 9 and 19 years of current global emissions. Factor in the issues of equity embedded in the Paris Agreement, and every international climate treaty since the 1992 UNFCCC (namely CBDR-RC) sees the timeframe to reach real zero emissions for the UK shrink to between 2030 and 2035.

Issues with the framing of Net Zero

The majority of Kevin's evidence focussed on issues surrounding the framing of the global goal of achieving 'net-zero' greenhouse gas emissions - arguing that this term has been normalised to the point of obscuring inherent assumptions and limitations of the concept.

Substitutability

Kevin argued the framing of net-zero allows for inappropriate substitution as the concept relies on a standard unit of carbon dioxide equivalent. However, different greenhouse gases behave very differently in the atmosphere, and natural carbon sinks are extremely context specific. In addition, there are considerable differences between the certainty of emissions today and the deep uncertainty of biological sinks tomorrow, particularly in a changing climate. A tonne of CO2 emitted now is not the same as a tonne of CO2 potentially sequestered at some date in the future.

Equity & Decision-making

Drax argues that "the world has decided that we need net zero and not absolute zero" and every model scenario is based on this assumption. Kevin argues this is a normative decision which enables the scenarios to conform to western lifestyles. Climate modellers are almost exclusively western, older, white, male academics who have an inherent bias towards model scenarios which don't challenge their lifestyle and consumption patterns. Yet citizens in areas of the world most threatened by climate impacts may have different opinions on the risks and rewards of absolute vs. net-zero emission goals. Greater diversity among climate modellers may produce more radical scenarios around absolute zero.

Consensus

Kevin argues that the merit of the net-zero framing was that it helped achieve consensus among countries and companies, uniting the world around a single goal. However, this consensus includes oil majors and petro-states who have proven incapable of transitioning away from fossil fuel investment, which undermines the value of this consensus. This is evidenced by most oil and gas companies publicly adopting net-zero 2050 targets, but quietly excluding their responsibility for scope 3 emissions (i.e. those from burning the fossil fuels they produce). Similarly, most of the major oil and gas producing nations, also have net-zero targets, yet are still seeking new oil and gas fields, in complete opposition to advice from the IEA, the UN Secretary General António Guterres, amongst others.

Absolute Zero vs. Net-Zero Emissions (NETs)

Kevin is in favour of deploying Carbon Dioxide Removal/NETs with strict social and environmental conditions in place. However, he argues we should assume they will not work at scale, which would imply we need to aim for absolute zero carbon emissions from energy as the global target. In part this is because whatever CDR can be achieved will be needed urgently to compensate for unavoidable GHG residuals from food production (probably 6-10GtCO_2e p.a.), principally CH_4 and N_2O.

Economics of BECCS

Kevin argued the scale of BECCS implied by IPCC modelling suggests that demand for sustainably sourced wood pellets is going to increase dramatically if countries are to hit their carbon budgets. The price of wood pellets for bioenergy could feasibly exceed the price of timber under this scenario, implying that wood pellets would no longer be a by-product of the timber industry.

This has implications for the global trade of biomass pellets: first, it may not be ethical for countries to import biomass from other countries who will need it to achieve their own targets. Second, countries may begin to view biomass as a strategic asset, and price volatility could end up being similar to that of fossil fuels today. This undermines the argument that BECCS is a source of energy security. For these reasons, Kevin argues we should not invest and commit to a BECCS plant which is dependent on imports of foreign biomass.

Scalability of CCS technology

While Kevin agreed the likelihood of Drax being able to scale CCS operations by 2027 is low under normal conditions, technological advances of this rate are not beyond the realm of imagination under conditions such as those of the Marshall Plan or the Apollo programme. That said, Kevin has concerns that the deep inefficiencies of burning plant material, with its very low energy density, and burying the CO_2, is far more reminiscent of the fledgling days of the industrial revolution, than the pinnacle of engineering prowess in 2022.

Opportunity Cost

If we assume BECCS is a) scalable, b) divorced from mitigation efforts and c) under strict social and environmental conditions, Kevin argues the question still remains whether it is a good use of limited financial and human resources. In other words, we need to account for the opportunity cost of deploying BECCS in the decision.

This is true of BECCS from woody biomass vs alternative conversion, capture & storage technologies, and vs alternative means of mitigating emissions in the short-term. Kevin argued this is particularly difficult given the low energy density of biomass.

System implications

Kevin argued that if Drax is going to advocate for BECCS technology, they must account for the systemic implications of the decision and the lock-in effects this may create, such as stimulating further demand and capacity for international trade in biomass.

Conditionality

The conditions we can infer from the discussion, that might satisfy Kevin of BECCS done well can be summarised as follows.

To ensure BECCS done well, it is necessary that:

1. There is no large-scale importation of foreign biomass.
2. Carbon removals do not contribute to mitigation targets in carbon accounting frameworks.

3. BECCS is not included in any climate modelling scenarios until demonstrated at scale, and even then full lifecycle emissions need to be considered
4. The resource and labour opportunity costs of BECCS is included in any economic or financial analysis and wider decision making.

Oral Evidence Summary: Richard Donovan, 19.08.22

Independent Senior Forest Advisor

Engaging with Campaign Groups

A great deal of Richard's evidence revolved around the relationship between the private sector and civil society. He argued that too often the debate is polarised, with neither side willing to appreciate that the other has any valid claim whatsoever. The result is binary solutions that fail to account for the nuances in situations.

Richard argues that the dismissive way in which the Sustainable Biomass Programme engaged with Dogwood Alliance is a significant reason why it has failed to gain traction or credibility with the Environmental Movement.

While the private sector has taken steps to address the issues raised, they have not acknowledged them publicly or been transparent about the measures taken to address them. Too often companies are driven by defensive PR departments rather than a desire to show real leadership.

Unjustifiable claims

Richard argued that Drax contributes to this problem by making claims that are very difficult to justify, for example that they do not harvest whole trees, or that they do not clear-cut forests - although as was pointed out to Richard, this is no longer Drax's official position.

Nonetheless, Richard argues that bickering over the question of whether Drax is or isn't using whole trees is not the right question to ask. The question they should be asking is what kind of forest are they leaving behind when they harvest? Drax needs a vision of forests which acknowledges the various values they provide (economic, environmental, recreational, cultural, spiritual etc) and states how they are working towards this vision, acknowledging that this may require harvesting whole trees in specific cases.

Richard pointed towards exciting work done by the University of Vermont looking at how to use harvesting and forest management to foster late successional old growth forest.

Data & Verification

Richard argued the data on sawmill residues is insufficient to be able to make independently verifiable claims about the proportion of Drax's supply from this sawmill residue. If they could provide this information, then Richard believes that many NGOs would not take issue. However, the data is either confusing, unavailable or not consistent enough.

Richard argues that companies hide behind anit-trust regulation as a means to avoid providing data to independent 3rd parties.

Richard believes that depending on the systems in place, it is possible to achieve solid accountability mechanisms without relying on independent auditors, but third party verification systems are preferable.

Poor Regulation & Perverse Incentives
Richard argues that companies should not rely on or wait for improvements in regulation, because in many parts of the world, regulation is either too lax or creates perverse incentives. For example, diameter-limited cutting is patently unsustainable, as it ignores old growth forest and for some species it is counterproductive.

Regional / Landscape Carbon Stocks
Richard questioned the timeframe over which companies measure regional carbon stocks in order to claim they have made a positive contribution at the regional or landscape level. This is because from a historical perspective, many areas of the United States have extremely degraded forests and therefore from this perspective, any improvement is at best a restoration.

Acknowledging Old Growth Forest
Richard argues that the failure of Drax or SBP to recognise the importance of protecting old growth forests is an issue. He also argues that PEFC should aggressively address issues around old growth forests and areas of high conservation value.

Social Impacts
Richard acknowledged the strength of Drax's supplementary submission on the social impacts of their pelleting operations.

Richard warned against SBPs plans to soften its stance on Free Prior and Informed Consent with local indigenous communities.

Zero Peat
Richard argues there shouldn't be any harvesting from regions with significant amounts of peat.

Conditions:
- SBP should adopt full FMU certification under FSC[1] when sourcing from high risk regions, particularly in developing countries or regions of the world with high risk situations such as the Northern Boreal.
- Zero sourcing from regions with high levels of peat

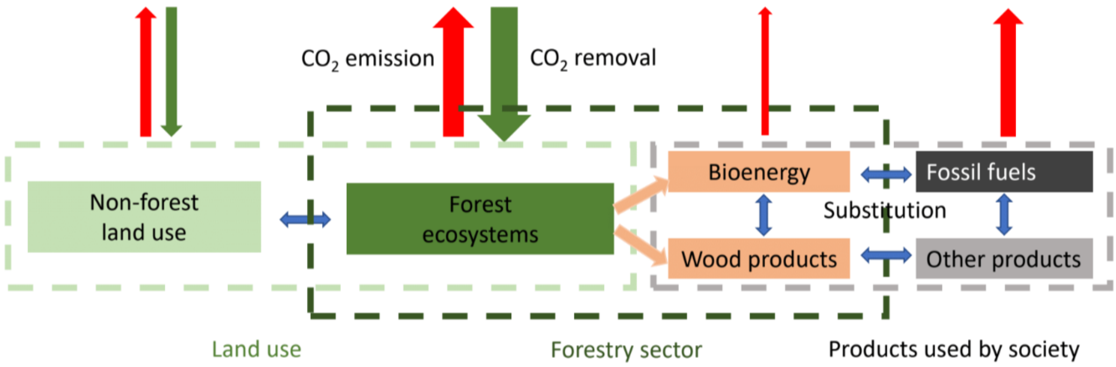
Oral Evidence Summary: Annette Cowie, 23.08.22
Technical Specialist climate policy (Principal research scientist), Climate Research and Development at New South Wales Government, Department of Primary Industries

Benefits of Carbon Dioxide Removals (CDR)
Annette opened the discussion by outlining that CDR will be needed to help to get us to net zero, to balance unavoidable emissions, to maintain net-zero, and achieve net negative emissions to manage overshoot. CDR is 'unavoidable', according to the IPCC.

Systems Model
Annette put forward the case for expanding the scope of analysis to the whole bioeconomy. Of course, we need to look beyond the smokestack to the forestry system, as looking only at the smokestack can suggest that biomass could produce more carbon emissions than coal per unit of energy, but this ignores the fact that sustainably-harvested biomass carbon is part of the short-term carbon cycle, whereas fossil carbon is part of the long cycle that is essentially

[1] https://fsc.org/en/document-centre/documents/resource/374

non-renewable. Also, if you only look at the forest system you miss avoided emissions from production of dispatchable energy for which we currently have few non-fossil fuel alternatives. If you only look at bioenergy systems, then you miss carbon sequestration and avoided emissions from the use of wood products over carbon intensive alternatives. Therefore, we need to look at the whole bioeconomy to understand the climate effects of incentives for bioenergy.



Reference Case

Annette emphasised the importance of selecting a credible, realistic reference scenario against which to assess the emissions reduction potential of different scenarios.

There are four relevant aspects of the reference scenario:

> **Land use -** In the case of bioenergy from managed forests it is often most realistic to assume that the land would continue to be used for commercial purposes, rather than conservation of standing forest.
>
> **Fate of biomass** - Options include being burnt in the field to reduce fire risk, decomposition in the field, landfill, or use as wood products.
>
> **Alternative products to sawlogs** - Alternatives to wood are usually materials with high CO_2 footprints such as concrete, steel or plastics, as for example in construction.
>
> **Energy system** – displacing coal gives greater climate benefit than displacing gas. Bioenergy can play a strategic role in stabilising the grid to enable faster expansion of the intermittent renewables.

Her conclusion was that modelling evidence suggests that managed forest for timber alongside bioenergy can provide greater carbon mitigation potential than conservation alone. This position is supported by the IPCC in several key statements including the Special Report on Climate change and Land.

Investing the Remaining Carbon Budget

Annette proposed reframing the issue of 'carbon debt', pointing out that we are happy to accept the carbon debts incurred in the creation of solar and wind farms, EV batteries and railway infrastructure, so why not bioenergy supply chains?

Certification

Annette argued that certification from the Sustainable Biomass Programme is currently the best means to ensure that bioenergy provides climate benefits, and trade-offs are managed.

To Cut or Not to Cut?

Annette responded that anyone who argues there is more value (economic, recreational, cultural, spiritual) in converting commercially managed forests to conservation forests needs to have an answer for what we will use instead of wood products, and how we will supply the energy we need.

This is because many alternatives have a higher carbon footprint and we will continue to need wood products in the future. Reducing harvesting in Australia has meant more imports of unsustainable timber from Indonesia. Similarly, limited capacity of other renewable energy generation means we are building new coal plants.

Furthermore, once we stop consuming oil-based materials, demand for bio-based materials will rise.

Annette noted that deploying bioenergy can allow us to keep fossil fuel in the ground, which is the most important climate change mitigation measure. For example, co-firing or fuel-switching can reduce the amount of coal burned while utilising existing GHG investments in infrastructure. Use of bioenergy can avoid the decisions to re-open or build new coal-fired plants.

Permanence

When asked about issues concerning the permanence of managed vs conserved forests in relation to carbon investments, Annette responded that there is evidence to suggest that reforestation projects are more vulnerable to forest fires due to climate change than commercially managed forests, as plantation managers take efforts to minimise risk, and are well-equipped to fight fire. Mitigation through carbon sequestered in plantations that is then stored in wood products or used to displace fossil fuels is more secure than carbon stored in conservation forests.

Future Demand for Biomass

Annette argued that demand for biomass will rise as we phase out petroleum-based products and increase our demand for bio-based alternatives, thereby making biomass crops more financially viable. Given this growing demand, there is therefore a need for a strong land governance regime to prevent the destruction of existing forests and unsustainable forest management. Sweden is a good example of how sustainable forest management can be achieved.

Annette argued the risk that it could be done badly should not be a reason to shift away from biomass. We have the same problem for wind farms and solar farms: these technologies also need good land governance and regulation.

Engaging with Stakeholders

Annette reflected on the fact that conveying scientific facts alone is not sufficient. However, Annette has had some success in dialogues with a limited number of participants, hosted by an independent chair where the aim was trying to understand where the other side is coming from.

Embedded Emissions

Annette referenced studies that show the GHG emissions from the BECCS lifecycle associated with transport reduce the mitigation benefits by around 5% if the biomass is used locally and 10% if transported long distances. Drax's supply chain is very efficient, once you get pellets on the ship it doesn't make much difference how far it has to travel.

This does not include the carbon emissions embedded in the machinery used to harvest the trees, since biomass is a by- product where the reference case is commercial forest for timber production; harvest would have occurred whether or not biomass is extracted for energy. So these studies only measured additional emissions caused by the bioenergy supply chain.

Sawmill Residues

Annette corroborated Drax's claim that 80% of their feedstock for some of their pellet plants is waste residues from sawmills as being broadly consistent with the figures she had seen.

Residue vs. Roundwood
Annette is uncomfortable with suggestions to ban the use of roundwood for biomass because there are already economic incentives not to use high-value saw logs, while biomass can be a sustainable use of thinnings, or twisted or diseased logs which are not suitable for timber. Removing this source of revenue may actually remove an incentive to manage forests more sustainably.

Sequestration Forgone
Annette argued that the case for considering the "sequestration forgone" from thinning forests is weak, because in the counterfactual, the growth of these trees would have been limited by competition, which is why they are thinned. To say that the carbon stock has reduced by the precise amount by which that tree would have grown misunderstands the competitive dynamics between trees.

In the case of commercial forests managed for timber production, they would likely have been "thinned to waste" (ie thinnings decomposed on forest floor). Quantifying sequestration foregone using a no-thinning, no-harvest reference is unrealistic; this sequestration would not have occurred in the no-bioenergy scenario. You need to model the carbon stock in the reference scenario without thinning, and then compare this to the scenario with thinning.

Feasibility of Capturing Data
Annette argued that foresters already have good models of growth and sequestration rates for all commercially grown species, and have good data on growth of commercial forests, as they regularly measure their trees. It is becoming easier to do this using LIDAR etc. Annette does not think data is an insurmountable problem and that it is a reasonable requirement to require forestry operations to have the means in place to measure the forest carbon stock using a combination of forest growth plots and modelling.

However, Brad Gentry argued that smaller landowners may not have the same means to capture this data.

Conditions
Annette summarised by arguing that the conditions under which bioenergy delivers benefits to nature, climate and people is where you can demonstrate that the net emission of the bioenergy system is lower than the relevant reference scenario without the bioenergy, which includes supply chain emissions, changes in the forest carbon stock and positive or negative leakage associated with land use, the energy system or indirect impacts on wood products.

This is subject to ensuring there are environmental and social safeguards in place.

Annette argued that the Sustainable Biomass Programme is reasonably effective at ensuring and verifying that biomass is obtained from sustainably managed forests (SFM certification).

Oral Evidence Summary: Dr Steve Smith, 25.08.22
Executive Director of Oxford Net Zero and CO2RE

Key Arguments
Steve set out some key foundations in his opening statement, arguing that both the IPCC and CCC argue that Carbon Dioxide Removals (CDRs) have a role to play in most scenarios to limit the effects of climate breakdown. In these scenarios, BECCS plays the largest part in the CDR

portfolio in terms of volume of CO_2 removed. Steve argues the evidence suggests that bioenergy, carbon capture and storage from forest biomass can be net-negative over the lifecycle of the process. Good guidance on best practice already exists, but it is extremely situationally specific. A compliance regime must therefore be in place to guarantee best practices are followed in those specific situations. However, there are still real challenges in monitoring and verification of the process.

Evidence Supporting Negative Emissions
Steve acknowledged that most of the evidence supporting BECCS is currently modelling evidence, however under very credible assumptions. This is because there are few real-world BECCS facilities, and none using Drax's model of bioenergy from imported forestry biomass, so evidence is necessarily based on modelling at this stage.

However, there have been a lot of studies on Drax's supply chain without the CCS. Again, these show that under credible assumptions the evidence is reasonably robust that adding CCS and ensuring the quality of the supply chain would make it a net-negative process.

Carbon Storage
There is robust evidence from existing storage sites (such as Sleipner in the North Sea, and other enhanced oil recovery projects) to suggest there is no leakage of carbon. This still needs careful site selection to ensure the storage sites are secure. Again, Steve argues we clearly need a robust regulatory and monitoring system to ensure the carbon storage works.

Biomass Sourcing - Landscapes vs Residues
Robert Matthews has developed fifteen criteria for forest management and wood feedstock supply, one of which is to focus primarily on sawmill residues[2]. Independent modelling evidence shows that using sawmill residues from existing, sustainably managed forests would lead to the Drax BECCS process being net-negative[3]. Steve argued you could require that Drax focus purely on these feedstocks, however this would still require risk management to ensure the tail isn't wagging the dog - i.e. that the installation of biomass pellet plants isn't locking-in or propping up a failing timber industry. This could involve requiring pellet plants to conduct a risk assessment which includes a market analysis to see how the broader forest management context is evolving.

Steve agrees that even the use of whole trees may be sustainable in specific situations, particularly where you are dealing with disease or fire risk. However, he believes it is inherently challenging to establish a watertight process for dealing with those cases because whenever we deal with counterfactuals we run into difficulties with verifying whether the counterfactual would have otherwise taken place.

Pros and Cons of Utilising Legacy Infrastructure
There was significant debate over the pros and cons of utilising the legacy of Drax versus developing new, more efficient plants in more optimal locations.

While Steve didn't fall on either side of this argument, he pointed out that in any case we would still need robust sustainability requirements and incentive structures to ensure a race to the top to encourage continual improvements.

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2 https://europeanclimate.org/wp-content/uploads/2018/05/CIB-Summary-report-for-ECF-v10.5-May-20181.pdf
3 https://www.sciencedirect.com/science/article/pii/S0961953421002002

Alternative Scenarios
Steve pointed to the fact that there are alternative, radical scenarios out there which do not depend on any CCS, by implementing drastic emissions reduction strategies. However, he raised the question of which we think is most reasonable.

Steve argued that we have to recognise that the CCC pathways are already incredibly stretching and there is not a huge amount of room to manoeuvre on either the emissions or removal side. However, a good way to think about it is to ask what is the portfolio of options we need to pursue to ensure there are enough arrows in our quiver, while recognising that we will learn as we go about what is and isn't working.

Steve pointed toward real options theory in finance to highlight the value of ensuring maximum flexibility and quick decision-making in a complex environment. Steve argues that developing carbon removal as an option *as well as* doing everything we can to cut emissions is a sensible portfolio approach.

The CCC Scenario Development Process
Many NGOs argue that radical scenarios which avoid CCS have brought forward the ambitious targets for carbon removals because there is an assumption among the modelling and policy making community that dramatic abatement is politically unacceptable. So, there is an argument that scenarios follow the political viability rather than policy making following bona fide scenarios. NGOs are very sceptical of how the CCC arrived at these scenarios.

Steve responded there is a lot of work that goes into creating these scenarios by some very dedicated and very capable expert analysts. The scenario process inevitably goes through a political process because the CCC needs to walk a tightrope between delivering high quality advice which is by some measure deliverable and realistic. Steve stated that he has never witnessed any evidence of nefarious watering down or hiding anything to try and make the scenarios more palatable to policy makers.

Steve argued that the CCC has not been afraid of developing ambitious scenarios and policy proposals in the past, pointing to the CCCs recommendation to ban sales of internal combustion engines by the early 2030s, when at the time of the recommendation the most advanced electric vehicle available on the market was the G-Wiz.

The Likelihood of Scaling CCS
Steve acknowledged that scaling CCS to the level required in the CCC scenarios is extremely challenging. Therefore, Steve welcomes any opportunities to further reduce emissions which would help close the removals gap.

On the question of whether the rate of increase in CDR in the CCC's scenarios is unusually high, Steve believed that the rate of emissions reductions is equally ambitious.

Risk of Delays
There is a real risk that either Drax is late to scale CCS technology, and/or the East Coast Cluster is delayed so we don't have the pipeline infrastructure to store the captured CO2. Steve acknowledged there is limited value in Drax power station without CCS, and that to his knowledge all the CCC's scenarios are dependent on Drax successfully deploying CCS at scale.

Steve also argued that a lot of the risk to date has come from government reversing policies at late notice. If CCS is an existential issue for Drax, then there should already be a good incentive to ensure Drax does their best to uphold their side of the bargain. We also need to ensure there are robust incentives facing government to uphold their side of the bargain.

The Mitigation Deterrent
Steve argued there is a risk that carbon removals deter mitigation efforts, but this is not unique to carbon removals. For example, an over-reliance on nuclear power can also be a mitigation deterrent. Many of the processes involved in BECCS are also involved in emissions reductions. So, when you dig down into the concerns, they often also apply to emissions reductions as well.

Who Else Does This Well
Steve pointed to the example set by Sweden who are planning a reverse auction to fund BECCS projects. The Scandinavians have a long history of relatively carefully managing their forests.

Steve noted that the USA seems to be more interested in Direct Air Capture than BECCS, which is a quandary given their large biomass resource. Steve argued that a lot of the risks associated with monitoring, verification and international carbon accounting stem from importing foreign biomass, which could be mitigated if Drax Group or the US government were to focus on establishing a BECCS plant in the USA.

Conditions
One suggestion put forward by Steve was that Drax could focus primarily on sawmill residue as the primary feedstock for BECCS, but he didn't go as far as suggesting that this should be the exclusive feedstock. During the discussion, Steve also referenced his comment piece in Communications Earth & Environment[4] which ends with the following three "elements":

- *Set targets consistent with achieving climate goals without overshoot*. Importantly this will include ambitious near-term action, as this is a distinguishing feature of pathways with lower peak temperatures.
- *Set out the mix of measures planned to achieve the target*. Publish a clear plan detailing the ER and CDR measures to achieve the targets. This ensures accountability and means that responsibilities and policies required to deliver them can be identified. Any traded offsets used, be they from ER or CDR measures, must have high environmental integrity.
- *Set out the carbon storage involved, and have plans to monitor and manage it*. This includes CO2 stored from ER measures, and should be differentiated by type (e.g. biological and geological). The greater the sink, the greater the need for monitoring and for plans to reduce and deal with possible leakage.

Oral Evidence Summary: Mirjam Röder, 05.09.22

Mirjam Roeder, Associate Professorial Research Fellow (Reader) at the Energy and Bioproducts Research Institute (EBRI) at Aston University

Note: This summary is pending approval by the Expert Witness. An updated version of this document will be available to download once approval is granted. For more information, please contact the Secretariat: c.thorneycroft@forumforthefuture.org

[4] https://www.nature.com/articles/s43247-021-00095-w

Oral Evidence Summary: Toby Webb, 12.09.22

Founder of the Innovation Forum

Challenge

Toby opened his evidence by laying out the narrative challenge that Drax is facing, given that the BECCS value chain feels intuitively unsustainable to most people and therefore it is quite easy to form a very negative story about the worst instances of BECCS. Drax then gets associated with these worst examples.

Toby argues that Drax needs to develop a new narrative, based on a fresh concept and terminology, to break free from the controversy that surrounds them. This must be driven by leadership rather than PR departments or external agencies.

Narrative Framing

Toby suggested that Drax develop a narrative that links their operations to the Circular Economy and Nature. Toby referred to the example set by APRIL (see below) in which they are using plantations to protect high conservation value forest, while using waste forestry residue to power a state-of-the-art pulp, paper and viscose mill. This is framed in the context of circularity and nature.

Transparency

Toby argues that Drax needs a comprehensive approach to transparency and an open-door policy to criticism. Some critics may never be convinced and will extrapolate from mistakes without paying any attention to the evidence. However, if the objective is to convince "reasonable people", then Toby argues transparency is the answer.

Toby recommends establishing a transparency dashboard. However, this requires Drax to be willing to admit to mistakes and share bad news before anybody else, which involves a significant shift in corporate culture.

Still, many companies that are very committed to transparency fail to adequately respond to their own transparency.

Best Practice Examples

Asia Pacific Resources International Holdings Limited, or **APRIL**, is a developer of fibre plantations and the owner of one of the world's largest pulp and paper mills with operations mainly in Indonesia and China. They have a strong commitment to transparency, including a transparency dashboard[5] detailing each of their fibre suppliers, and a public grievance procedure.[6]

Wilmar International and particularly **Golden Agri Resources** are good examples of transparency in the palm oil industry.

Nestle has been on a journey in the last 12 years, and has pioneered innovative responses to serious issues.

Patagonia were the early pioneers in transparency and disclosure.

Barry Callebaut has a strong commitment to transparency and collaboration. x

Independence vs Collaboration

Toby argues that a company's instinct is often to focus on multi-stakeholder certifications that drive credibility and move the market with you. However, these schemes are often

[5] https://sustainability.aprilasia.com/en/

[6] https://www.aprildialog.com/en/

dragged down by the lowest common denominator. Patagonia decided to take a different approach by focusing on their own supply chain within their sphere of influence.

Toby implied this is not an either/or but a both/and decision, and that companies need to divide their resources between investing in the quality and transparency of their own supply chain, whilst also investing time and resources into developing and reforming market institutions.

Certification bodies must, in turn, be led by their most progressive members rather than seeking consensus with laggard companies – if they are to gain credibility with civil society. However, often their own governance mechanisms prevent them from doing this, such as the RSPO which has been hamstrung by the Malaysian state-owned palm oil company.

Vertical Integration
Toby argued that many companies would prefer to vertically integrate their supply chain, given the complexities around proving the chain of custody and mass balance systems. He pointed to Ferrero as an example of a company buying up their hazelnut suppliers to secure the supply, with the additional benefits that come from transparency.

Nuanced Communication
Toby recommends against trying to adhere to definitive position statements such as "we do not burn whole trees", "we use 90% sawmill residues" or "no deforestation" etc. Instead, he advocated for an approach that lays out your proposition, the challenges and the trade-offs clearly and transparently.

Critical stakeholders
Toby warned against giving disproportionate airtime to a vocal minority of critical stakeholders and focusing on the more neutral stakeholders. You still need to treat them with respect and acknowledge their concerns while recognising they are not the only voice.

Toby referred to the PVC industry as an example of an industry effectively dealing with campaign organisations, when Greenpeace criticised them over the lead content of their PVC. They effectively removed the lead and sat down with Greenpeace to explain what they'd done. Greenpeace appear to have been satisfied and moved on to the next challenge.

The sustainable biomass programme should be prepared to change its governance structure to accommodate the critics, so long as those critics are genuinely open to negotiation. The offer needs to be sincere. A good negotiation is one in which nobody is happy, but everyone can live with the deal.

Neste is an example of a company which manages to do effective stakeholder engagement despite the hostility from many NGOs, over the use of palm oil in biofuels.

Social & Environmental Justice
Toby argued that the solution to many environmental justice issues associated with pelleting mills is quite simply to invest in the best technology to ensure pollutants don't enter the environment, which should be technically feasible.

The challenges with social justice are more complicated, but the efforts Drax has made towards engaging with co-operatives and first nations representatives shows a strong commitment. It involves paying living wages and investing in local communities. This is well documented in the sustainability field and shouldn't be too difficult either.

Oral Evidence Summary: Francis Sullivan, 12.09.22

Independent Non-Executive Chair of the Sustainable Biomass Program

The Case for BECCS

Francis started by outlining the case for biomass and BECCS as one solution to the need for baseload and dispatchable, low-carbon power in the UK. He argued there is a fundamental need for that low-carbon power, and for it to both baseload and dispatchable.

Technological Risk

Francis continued that while it is a new technology, all the components from forests to underground storage have been tried and some degree tested, but not have not been proven at commercial scale.

Certified Sustainable Forestry

Francis stated that certified sustainable forestry occurs in many countries, and he is confident that much of the forestry in Europe and North America is certified and shown to be "sustainable". He continued that timber is the primary product given its value, with residues and small dimension wood used for pulp, paper and biomass feedstock, in a cascading process.

Definition of "Sustainable"

Francis put forward a definition for "sustainable" as ensuring that managed forest can continue to supply the goods and services which they are intended to in perpetuity – regardless of the type of species grown. Furthermore, in key producer areas the forest area, the standing volume of timber and the carbon stock must all be either constant or growing.

Domestic vs. International consumption

Francis highlighted the fact that Scandinavian countries have very little import or export of biomass, given they consume most of their domestic production in CHP plants for district heating. So, the current international trade in wood pellets is coming from countries in areas such as the Baltics and North America, which have a large forest industry where there are currently no local commercial uses for forestry residues to compete with biomass. Francis also highlighted that that this may change in the future.

The Case for Certification

While not perfect, Francis argued that certification can reduce the risk of negative environmental and social outcomes by requiring field audits to agreed multi-stakeholder standards.

Risk Based Approach

Francis advocates for a risk-based approach to setting conditionality, rather than looking at detailed outcome and impact evidence due to the inherent complexity in dealing with biological and human systems.

Standards Review Process

Standards are updated every 5 years. Francis stated that the second edition of the standard has been delayed to early 2023 due to the lack of face-to-face meetings, resulting from Covid restrictions. However, the majority of the revised Standards have been approved with the exception of issues associated with monitoring the carbon stock. Francis claimed this is standards working at their best, with a revised and improved standard that responds to feedback from across the spectrum of stakeholders.

The standard will be aligned with REDII (EU Renewable Energy Directive) regulatory requirements of the UK, Netherlands and Belgium, which Jonathon pointed out is important for helping to create a hybrid voluntary and regulated set of outcomes.

Traceability & Data Transfer System

The SBP is funded via a fee charged on every tonne of wood pellets sold under the certification. SBP have established a Data Transfer System which allows for full traceability back to each pellet-producing mill and through to each power-producing plant.

This Data Transfer System is based on the same logic as blockchain and is ready for blockchain applications when it makes sense to do so. While the specific data is commercially sensitive, the meta data can also be made publicly available, and this is something SBP could explore further in the next 5 years.

Perceptions of Biomass in Civil Society

Francis argued that concerns around biomass stem from issues associated with liquid biofuels and the risk of deforestation. Most NGOs are not particularly concerned with current practices in biomass industry, but by the potential risk of scaling the biomass industry to unsustainable levels.

In his experience, Francis has found that NGOs who manage land are far more likely to see the benefits of removing residues due to the fire risk than those who don't, because they understand forestry very well.

Constraints on unsustainable biomass

Francis argued that there will be regulatory, market and finance constraints on growth of biomass industry to unsustainable levels, although he acknowledged this is a significant risk in South-South trade or trade within Asia in the absence of certification schemes like SBP.
Francis argued that the biomass market, like any renewable resource, should be "supply driven" based on the maximum sustainable yield rather than be driven by the demand for biomass products.

Under current market conditions, significant biomass expansion would require either harvesting uncertified forest which therefore would not have access to key markets or would be competing with the timber industry for more of the tree itself. Francis argued it is very unlikely that the price of biomass would ever compete with the price of timber and that while not impossible, the incentive regime to make that happen would be extreme.

Francis argued we need to view BECCS as one solution among many, where the right supply chains, assets and geology exist. Companies in the BECCS supply chain need to appreciate this fact.

Social Protections

Francis confirmed that the SBP standard addresses issues associated with workers, communities and traditional landowners, in the context of land ownership and health, safety and labour rights.

Francis argued that given biomass is a by-product of the timber industry and therefore not the primary driver of logging, it tends to operate in areas where forest industries are already well established and it therefore doesn't have as many issues associated with land-rights violations as the timber industry did in the 1980s & 1990s.

SBP has a public grievance process which allows communities to raise issues. SBP could then review and suspend a certificate if there was evidence the claim was valid.

Trends over the next 5 years

- **Data:** Francis expects there to be much better cradle to grave data, along the entire supply chain. The case for BECCS relies on the ability to calculate the net-carbon balance and therefore demonstrate the carbon removal is permanent
- **Non-energy uses:** some think that biomass will not be used for combustion as they will be more valuable non-energy uses of the carbon compounds.

SBP Value Proposition

Francis made it clear that SBP does not lobby on behalf of its members, although it does respond to policy consultations. The value SBP adds to members is the ability of its certificate to access markets and command a price premium over uncertified products.

SBP Theory of Change

Francis outlined the theory of change behind SBP which aims to eliminate so-called "bad biomass" by preventing it from accessing key markets, rather than advocating for a policy or regulatory means of eliminating unsustainable practices. Francis referred to examples in West Africa where SBP has refused to grant certificates on the basis of an independent audit.

Protection of Areas with High Conservation Value

Responding to a question regarding the risk of small, irreversible transgressions that might chip away at old-growth forests, Francis outlined a condition for certification is that auditors must be satisfied that operations have the means in place to identify areas of high conservation value and avoid them. Any transgressions would need to be known, investigated and if identified then the accreditation body would withdraw the certificate.

Restoration

Francis acknowledged that in some areas there is very little high value conservation forest left. Currently, the aim of the SBP is only to maintain ecosystem health, however it is a discussion in the standards review process as to whether SBP should make restoration of ecosystems a mandatory requirement for certificate holders going forward. Examples from other companies include a Conservation Easement Fund or requiring land to be set aside for conservation. SBP approves but currently has no role in delivering this.

Francis acknowledged that without efforts to restore ecosystems, individual irreversible transgressions will slowly erode ecosystems as an overall trend. However, there is evidence from British Columbia that despite logging, the average age of the forest and individual trees within the Province is getting older. So, there may be more room for data collection to demonstrate the positive impact of the forest industry beyond simply maintaining current logging levels.

Auditors & Accreditation Bodies

Francis acknowledged that SBP has outsourced the management of the accreditation bodies to a third party. However, SBP trains all the auditors in house to maintain the quality and consistency of the audit.

Francis believes the number of certification bodies is sufficient to deal with the current volume of biomass traded through the system, but this may need to grow in the future.

SBP review their accreditation of certification bodies on an annual basis.

Feedstock Classification

Francis defended the 'primary, secondary, tertiary' classification system on the basis that while high-grade roundwood is occasionally included under primary feedstock, this is typically due to mis-reporting or because there is no market for that timber. High-grade roundwood currently makes up 0.1% of the total SBP-certified volume traded.

Decarbonisation Incentive
Francis emphasised the point that if BECCS is established, the incentives available will depend on the amount of carbon removals the operators can claim. This will introduce a large incentive on the upstream supply chain such as the pellet mills to decarbonise their operations, many of which still use natural gas to power their plants. The role of SBP in this process is to provide the Data Transfer System to store and track this data.

Conditions
Francis advocated for an approach in which the Panel identifies clusters of risks associated with environmental, social and governance issues and then require as a condition of BECCS done well, that supply chain actors can demonstrate that those risks are being managed.

Francis pointed to risks such as indigenous rights, pollution, protecting high conservation value forests, measuring the carbon balance, forest area, forest density, genetic modification etc.

Francis recommended that companies have their own grievance processes in place, or perhaps a third-party ombudsman, where communities can raise their complaints.

Consistent arguments
Francis made the point that the UK is already 80% dependent on foreign imports of timber to support domestic demand. Therefore, if we are happy to import and rely on this timber, we should as a matter of consistency, be willing to import the residues from those activities so long as the right conditions are in place.

Written Submission, Duncan McLaren, 14.09.2022

Researcher at Lancaster University

Introduction
Before considering the question it is important to note that Net Zero embodies many ambiguities. Here I assume that Net Zero implies the minimising emissions of GHGs as quickly as possible, and balancing any unavoidable residual emissions with carbon removals. Net Zero is a global aim, and for the UK a just contribution would involve reaching Net Zero before 2050 (targeting 2040 might be appropriate), and subsequently delivering net negativity. This implies swifter and deeper action, both on emissions reductions, and on carbon removal than currently envisaged.

My working presumptions are that BECCS is technologically feasible, but that a balance will need to be struck between the desirability of scaling removals rapidly; and the inevitable negative social and environmental impacts of the provision and use of larger amounts of biomass. In principle the sustainable level of biomass supply for carbon removal should be first established, and allocated according to agreed principles of justice, before a detailed policy regime for BECCS is designed.

In this context, the question at hand raises two sets of issues, each generating distinct conditions. The first are those arising in replacing fossil power with bioenergy, relating primarily to how emissions are eliminated in the energy system. The second set are the implications of adding CCS to bioenergy to generate ‘negative emissions’, for the purposes of counter-balancing residual emissions, or reducing atmospheric concentrations of GHGs to safer levels. Many of the conditions I suggest or endorse here would be the responsibility of states or regulators to impose, not things that an operator could voluntarily adopt or establish. Moreover, I do not start from a presumption that the choices made need to be consistent with current market rationalities and drivers: policy should shape markets not the other way around.

Replacing fossil power

Some of the questions raised by the use of biomass for energy are covered in more detail by Inquiry questions 1&2: notably the critical issue of whether the biomass production and land-use involved is sustainable now, and in future climate conditions, at the scale envisaged, with full accounting of incidental and consequential emissions considered over time. And by sustainable I include issues of distributive justice as well as environment. Sustainability criteria should extend across the whole supply and transport chain. While international shipping of biomass might be justified on carbon grounds, it is unlikely to meet environmental justice criteria, and should be discouraged.

In addition this set of issues suggests the following conditions:
System balancing: The role of biomass electricity plants is understood as system balancing to complement intermittent generation or demand. The operating time of biomass electricity plants should, broadly, be minimised, so as to minimise both residual emissions and biomass demand. In system development and management, the appropriate aspiration is to maximise wind and solar, alongside power storage facilities of various duration.

Combined heat and power: Appropriate use of biomass for energy should maximise useful heat recovery. To my knowledge there is little research to indicate what an appropriate level of heat recovery would be, but I have no doubt that it is significantly above zero, and thus should be considered in any development of biomass use.

Adding CCS to bioenergy

This step turns bioenergy from a mitigation (emission reduction) tool into a potential carbon removal tool. It does so by imposing an energy penalty on the bioenergy plant, which means either less electricity (and heat) is produced for the grid, or more biomass is consumed to achieve the same output. This is critical to understand, and is typically ignored by BECCS advocates who claim misleadingly that the BECCS process ‘also generates energy’.

Separate targets

Like any potential carbon removal technique, BECCS requires a governance framework which ensures no erosion of mitigation. The key policy tool to achieve this is clear separate targets and accounting. There are multiple mechanisms through which promises of future carbon removal can undermine near-term mitigation. These closely resemble the effects of promises of CCS on fossil fuel use, which enabled serious delays in emissions reduction. In the absence of a policy framework to manage these risks, pursuit of uncertain removals via BECCs could prove counter-productive.

Acceptable energy penalty

The addition of CCS on BE imposes an energy penalty. Either more feedstock is required or less energy is exported from the plant to the grid. Typical capture processes require both heat and electrical power. Both should be taken into account. If a plant in poorly sited or configured in ways that currently waste useful heat, this is not reason to ignore the energy cost of the heat component. The economics of heat recovery and heat networks are changing with rising energy costs. A heat resource which appears stranded today may be next year’s strategic means to reduce dependence on imported and carbon intensive gas use.

Minimised residual (or consequential) emissions
Carbon capture processes are not 100% efficient in removing CO2 from a gas stream. Chemical removal from flue gases following combustion in air is perhaps the least efficient of methods currently proposed for CCS. Energy and financial costs escalate as capture levels increase. Typically a figure of 90% capture has been suggested, but not demonstrated at scale in any of the handful of f0ssil-CCS pilots so far. Precombustion approaches based on gasification, or combustion in pure oxygen, would seem to offer higher capture rates, but are even less well established, and still involve consequential emissions in supply chains that have not yet been (and may never be) fully decarbonized. Any deployment of post-combustion methods should be conditional on replacement with higher capture rate methods once demonstrated.

Any utilisation of captured carbon must be permanent
One of the main ways in which BECCS could fail to deliver removals is if the captured CO2 were diverted into an impermanent form of utilisation (making synthetic fuel, carbonating drinks, greenhouse fertilization etc) from which it would return quickly to the atmosphere. Utilisation should only be permitted where at least century scale, and ideally millennial scale retention can be demonstrated. Similarly captured CO2 must not be diverted to enhanced oil recovery (EOR) which can act as an emissions multiplier (with emissions from the recovered oil typically outweighing capture by 1.5 times). These increased oil production volumes do not merely offset production elsewhere, they serve also to put downward pressure on prices and increase consumption.

Adequate availability of storage
Current evidence suggests there is plenty of geological storage potential for CO2. But less work has been done to assess the commercially viable availability in specific regions. Early work by the CCC suggested reserving storage for genuinely hard-to-abate industrial residual emissions (from concrete or steel) rather than using it for CCS on fossil fuels. BECCS as a removal technology might legitimately make a priority claim for limited storage capacity, and is likely to be limited more tightly by sustainable biomass supply than by storage availability. Nonetheless this condition may be relevant in specific locations, and should be considered.

No selling of offsets
The other principal route through which BECCS might fail to deliver net removals is through the conversion of removals into carbon credits sold in offset markets to legitimate continued emissions from another (technically abatable) source. The complexities and debates over offsets and carbon trading are too great to document here. Suffice to say that unless there is a regulated market in which only legitimate, genuine residuals (that cannot otherwise be abated) are being traded for removals, then the removals are not contributing to net-zero or net negativity, while consuming valuable limited resources of biomass and storage.

Storage leakage limited to acceptable rates
In practice if we want millennial storage, then leakage rates need to be below 0.1% a year. The mechanics of CO2 behaviour in geologic stores suggests that leakage rates might decline over time as more the CO2 is mineralised, but in the face of uncertainties about behaviour in more saturated, higher pressure stores used over prolonged periods, the 0.1% level remains a sensible benchmark. Critically, the authorisation of BECCS at scale should be conditional on the deployment and financing of adequate monitoring of the ultimate stores.

Optimum use of biomass - assessed vs Sustainable Development Goals (SDGs)
Laying aside questions of food vs fuel (biomass crops, agroforestry etc), there are still important options for woody biomass that should not simply be determined by the market. The most significant is around what proportion should remain in the forest for biodiversity. Arguments such as those advanced for thinning for fire management are disingenuous, because they presume intervention in the first place. In many forests dead and dying woody

biomass is a critical resource for insect, and thus bird biodiversity. In general, managing forests for biomass productivity runs counter to managing (or not intervening) for biodiversity. Then we need to consider uses for woody biomass that can replace steel, concrete and other carbon-intensive materials. The source materials for pellets may not be a feedstock for construction grade materials, although advances in composites are making much more material useable. And the use of woody material for manufacture of insulation products is likely to be substantially better for the climate than burning it for energy. Finally, insofar as there is a residual of sustainably produced woody biomass suitable for carbon removal purposes we need a multi-criteria evaluation of the best methods to utilise this potential. It is not clear from the literature whether and in which circumstances BECCS is preferable to biochar, to biomass burial, to long-life utilisation, or even to natural forest accumulation of carbon in soils and biomass.

Conclusion
To contribute sustainably to Net Zero, therefore, bioenergy must use only (a fair share of) sustainable levels of biomass, account fully for incidental and consequential emissions, ensure utilisation of heat as well as power, and be kept to the minimum level needed for system balancing once other less damaging options have been fully utilized. And BECCS must be set within firm separate targets for emissions reduction and removals, achieve an acceptably low energy penalty, minimize residual and consequential emissions, ensure permanent storage or utilization of captured carbon, not be sold into offset markets, not exceed an appropriate rate of use of available storage, not exceed acceptable rates of leakage from storage, and be limited to that share of sustainable biomass for which it is the optimum choice for carbon removal.

Oral Evidence Summary: Michael Grubb, 15.09.22

Professor of International Energy and Climate Change Policy at University College London

Grid Balancing
Michael emphasised the point that as we begin to significantly increase the generation capacity of intermittent renewables, we will have significant fluctuating input into the power system which needs to be balanced in a way that is secure, plausibly economic and extremely low carbon.

Michael posed the question of what technology options can fill the bulk of the flexible energy demand, that is low, zero or even negative carbon, at a load factor of somewhere between 20 – 80% of the time?

Michael then outlined the following options for achieving this:

Gas-fired peaking
This system could involve a very small amount of gas-fired peaking plants which are used very infrequently, because the plants already exists and the capital expenditure has already been written off etc.

Battery Storage
Michael then argued that while the learning and cost curves of batteries is extremely promising, the storage potential of these batteries is still in the region of hours to a few days.

Electrolysers and Hydrogen
Michael argued that molecules, and therefore chemical potential energy, is likely to be the long-term solution to inter-seasonal energy storage. Therefore, if we look two or

three decades out, then electrolysers producing hydrogen fuel could be a solution. However, Michael considered there is substantial uncertainty about the volume of electrolysers, the load factor to make them economic or the transport infrastructure in place to make hydrogen viable and efficient in the medium-term.

Biomass vs Nuclear
Michael drew the conclusion that all this seems to leave biomass or nuclear as the most proven or likely viable medium-term solutions to the intermittency challenge.
Michael therefore believes that in the medium term, the energy system will involve competition between existing large and small-scale biomass, and the existing nuclear fleet with the potential for one more large nuclear facility or small modular reactors.

Path Dependency & Legacy
Michael recognised that Biomass and BECCS is by no means the cleanest source of energy we can think of. However, we should also recognise we have a big industrial facility, which could be converted to biomass, and which is located reasonably close to suitable geological storage sites. While we may have got here more by accident rather than design, that is how policy works. Economies are path dependent, and therefore we need to optimise our decision given the legacy of the system.

Baseload vs Balancing
Michael recognised that while his assumption is that BECCS and Drax should only be used to balance the grid rather than run as baseload, he anticipated that is probably not what the engineers at Drax would prefer.

His justification for this is that by 2030 onwards he expects we will have growing periods of surplus wind, and it would not make economic sense (from the system perspective) to generate biomass energy given the relative cost of wind & solar energy. However, until 2030, this may only happen at 5-10% of the time. Furthermore, unlike biomass, wind and solar energy has limited environmental impact in operation.

This would imply that BECCS is limited to the extent it delivers a function for the energy system, which would imply less demand for biomass which may then fall within the constraints of sustainable supply.
On the other hand, if the policy aim of BECCS is to maximise carbon dioxide removals, then this could justify running BECCS plants as baseload albeit at significantly increased cost to the system.

However, generally speaking, Michael agreed with the statement that renewables should take priority to supply the energy system, with dispatchable power plants acting as infill rather than primary load. The challenge Drax face is that this dispatchable energy will only be needed between 20 – 80% of the time.

Academic attitudes towards Biomass
Michael suggested that the academic community may have overcompensated for an initial position that relied too heavily on BECCS to fill gaps in their models, towards now taking a position against BECCS even in limited cases to test the practical implementation of the concept.

Counterfactual without Drax
Michael argued there are many reasons he could think of which mean shutting down Drax is not an obviously good decision. We need to consider what the counterfactual would be without Drax, which would require a mix of nuclear and gas regardless of how much demand-side mitigation we can achieve, the supply chains of which are subject to far less

scrutiny than biomass. Looking at the CCC's position, it seems clear that they believe it is difficult to deliver the fifth and sixth carbon budget without biomass.

Pricing Mechanism
Michael identified two justifications for creating a two-payment system that distinguishes payments for bioenergy and carbon stored, first because they have very different capital and risk profiles, and second because the government may want to learn how big the appetite is for CCS via auction, independently of the application - I.e. gas, coal, biomass etc.

Michael argued that the cost and risk profile for CCS somewhat resembles the cost and risk profiles of offshore wind fifteen years ago, where government-backed contracts for difference (CfDs) played a key role in scaling the technology. This would imply government could write a CfD on the carbon stored relative to the inclusion of CCS in the UK emissions trading scheme.

Michael recognised that this would mean Drax carry the risk that if the CCS capture rates are not as effective as designed and they therefore receive significantly less subsidy, however this isn't unreasonable since they are in the best position to mitigate that risk. It made sense to offer CfDs to offshore wind generators as they had no control over the wholesale electricity prices and were therefore exposed to significant revenue risk. On the other hand, achieving high capture rates is something the engineers running the CCS plant should be accountable for.

Innovation
On the other hand, Michael acknowledged this is FOAK technology, not second- or third- of a kind, and in these instances there is a role for government to front-load the investment to shoulder the innovation risk in the name of public benefit.
FOAK technologies also involve a great deal of cooperative coordination before competition can be introduced.

Offsets
Michael agreed that Drax would have to decide whether to secure funding through a carbon CfD from the government or via revenue from offset markets to avoid being paid twice for the same activity.

Lock-in
Michael agreed there is risk of both contractual or institutional lock-in to biomass supply chain once the justification for BECCS/biomass energy as a transition fuel is no longer valid. In response, long-term contracts need to be subject to regulatory constraints on sourcing sustainable biomass.

Michael pointed to the example of the French Nuclear Regulatory Authorities as a good example of avoiding institutional lock in, as they are capable of requiring nuclear plants to shut down for prolonged periods of maintenance despite the French Government's significant interest in keeping them running.

Best use of biomass
Michael observed that in several years' time there could be better uses of biomass than burning it in a power station, but that we would still have the intermittency problem, so we may still need to burn some kind of fuel unless there is some dramatic technological shift in inter-seasonal storage.

Energy Security
When asked whether Michael sees any energy security risks associated with biomass dependency, he responded by framing it as a commercial risk, rather than a security risk.

The gas crisis has revealed how global market prices can suddenly react to unforeseen events regardless of where you source the fuel. Furthermore, free market forces failed to invest sufficiently in storage capacity, which left us unprepared when the crisis hit. Michael raised the question of how easy, safe and expensive is it to store large volumes of wood pellets without degradation or combustion? Storage could tide Drax over a short-term crisis. However, it wouldn't protect them against a deep structural crisis of a bidding war for a limited supply of pellets. This would have to be mitigated via long-term contracts for pellet supply.

Oral Evidence Summary: Darren Miller & Angie Larsen-Gray, 23.09.2022

Vice President of Forestry Programs and Research Scientist

Misconceptions about biomass harvesting

Darren kicked off the session by reasoning that the available scientific literature does not support the claim that biomass harvesting creates any *additional* negative impact on biodiversity, or lead to *additional* forest change when compared to commercially managed forests for timber production – so long as this activity takes place within a framework for sustainable forest management and pays attention to species and communities that can be harmed by this type of activity.

Darren went further to argue that in some cases, biomass harvesting can be used to improve habitat conditions for a variety of species – referring to the example in which biomass harvesting provides an economic incentive to thin stands of dense pine trees which thereby enables greater light penetration to the ground. This opening of the canopy creates conditions for herbaceous vegetation to return to the forest floor. Some species also depend on young forests and biomass harvesting can be used to create young forests.

Landscape Level Analysis

Darren pointed out the fact that harvest rates in the SE USA are more than half the level of where they were before the 2008 Recession. Darren claimed that forest growth and drain models of the SE USA suggest that there is still more timber grown than harvested in this region. Therefore, the evidence does not support the claim that biomass harvesting is leading to large-scale deforestation in the SE USA.

Stand Level Analysis

Darren argued that there is no evidence to suggest that biomass harvesting has any *additional* negative impact on the structural conditions of a stand, compared to traditional harvest for timber production. The destination of biomass has no effect on species and communities on the ground, who adapt and respond to what is left after the harvest.

Down Woody Debris

Darren also argued the evidence from the SE USA does not support concerns that biomass harvesting could remove more downed woody debris than would otherwise have taken place under a "traditional" harvest.

While Darren cautioned there is limited research on this subject, he pointed toward a comprehensive study in North Carolina which didn't show adverse effects on biodiversity elements examined from clearing downed woody debris. Furthermore, the authors tried to observe effects of completely removing woody debris from the forest floor but were unable to do so due to practical difficulties.

Furthermore, the climatic conditions in the SE USA mean that material on the forest floor decomposes quickly and therefore many species that use the downed wood are not dependent on it for survival or are adapted to the ephemeral nature of that resource.

Darren argued that we do not know if there is a limit to the amount of woody debris required on the forest floor to maintain biodiversity, however, it is not a significant concern in the SE USA. This may be different in the Pacific Northwest; however, they have retention standards in place to mitigate this.

Conditions for Sustainable Biomass Harvesting
Darren summarised his opening statement arguing that biomass harvesting could qualify as sustainable from a biodiversity perspective so long as:

a) It is part of a sustainable forest management system
b) It is not negatively impacting sensitive communities or species, when they are identified, as being sensitive to forest disturbance (such as forest harvest), and mitigation factors are put in place
c) Forestry best management practices are followed to protect water quality

So long as these conditions are followed, there is no evidence to suggest that biomass harvesting will have *additional* impacts on biodiversity.

Scale of Analysis
Darren referred in his evidence to using 'coarse' and 'fine' filters of analysis, which roughly correlates to landscape vs stand (or smaller) spatial scales in forest management practices.

Darren argued that at a coarse scale you see plenty of diversity of forest management practices, which provides structural diversity and therefore is helpful to biodiversity. However, there are sensitive species which will struggle regardless of forest management practices. These species require a 'fine' management filter to establish specific biodiversity practices for each stand on a site-specific basis. Companies can use state-level Natural Heritage Program data, and the related NatureServe data, and other resources, to identify sensitive species and locate documented occurrences in forests they own and/or manage.

Landscape monitoring
While it is possible to monitor harvest rates over time across an entire landscape using remotely sensed data, Darren acknowledged that it would be very difficult to distinguish between trees harvested for biomass energy from trees harvested for traditional timber production using these data. However, this is currently the only means of collecting data due to the number and size of landowners in the SE USA which are not currently organised to produce this data at the landscape level.

Landscape harvest data is collected and published by the US Forest Service Resource Planning Act (RPA) every five years. The US Forest Service's Forest Inventory Analysis (FIA) data plots have smaller time increments but at a spatial scale of a plot approximately every 6,000 acres. Darren referred to ongoing work to improve the resolution of these data. However, Darren emphasised the point that none of the indicators currently suggest that biomass harvesting is increasing harvest rates.

Definitions of Landscape and Stand
Darren's definition of a forest landscape is simply an area composed of a collection of forest stands.

A forest stand refers to an area with a unique management unit, rather than an ecological function. Stand sizes depend on the area. In the SE USA they are typically between roughly 10 – 100 hectares.

Management Practices of Private Landowners
Darren argued that the management practices on private land depend on the size of the landowner, where smaller-sized owners are perhaps more likely to harvest their stands in one go than a much larger landowner. However, Darren argued that survey evidence suggests that income is not the primary motivation that determines management practices, with aesthetic value and biodiversity considerations also determining management practices.

Darren argued that for smaller landowners, management practices are largely at their discretion, whereas institutional landowners managing thousands of hectares tend to have more consistent sustainable management practices in place.

Economics of Timber vs Biomass
Darren argued there are many reasons why it is useful for there to be another revenue stream for residues from the timber industry. Currently, the economics guarantee that wood harvested for biomass is indeed residues, due to the relative price of sawtimber. However, Darren did refer to a short period after 2008 in which saw logs were sent to pulp and paper mills due to a collapse in demand for timber in construction.

While this is not an area of Darren's expertise, he recognised the fact that currently there do not appear to be any forest plantations grown specifically for biomass harvesting, which, in part, may be related to the much greater economic return from sawtimber. Darren is not aware of organisations planting large areas in fast-growing biomass feedstock (non-timber).

Darren reflected on the fact that the SE USA has moved away from high-density short-rotation pine plantations for the pulp and paper industry and moved towards a saw timber and thinning regime because of the higher value of this product.

Incentives to maintain forest cover
Darren argued that enabling landowners to make a return on their investment through a diversity of revenue streams is necessary to incentivise them to maintain forest cover.

Potential for Biodiversity Restoration
Darren made the point that species grown for timber production in the SE USA are native species, so local wildlife populations are already adapted to those species. There is a shift towards proactively managing for at-risk species that are sensitive to forest management on private forest lands.

Darren was sceptical that there is potential to restore the SE USA to its original ecosystem conditions before agriculture was introduced to the region, arguing there are keystone species such as the American Chestnut, which will never return.

Furthermore, in many cases, Darren argued you could manage shorter rotation pine forests to emulate the conditions of longleaf pine forests without having to create 200-year stands, with some exceptions.

Angie argued there is evidence that the legacy of agriculture on this land has impacted the forest understory composition, as it has proven extremely difficult to restore some understory plant species to these forests. This has implications for the potential to restore biodiversity in the region.

Statutory Requirements vs Voluntary Best Practice
Darren pointed out that protecting endangered species is mandatory, regardless of the land-ownership model, under the Endangered Species Act (ESA) and State endangered species rules. Looking beyond protecting endangered species, while it is true that many

biodiversity conservation practices are voluntary, they are de facto required because of their inclusion certification schemes which are currently essential for access to markets. Introducing mandatory regulation would increase costs. Darren argued that implementation rates of voluntary forestry best management practices are extremely high.

Pro-forestation
Darren pointed towards several trade-offs that must be considered when assessing the value of the 'pro-forestation' approach to land management, including the higher rate of carbon sequestration for young trees vs the high carbon storage of mature trees, the carbon footprint of alternatives to timber products such as concrete and steel, and the permanence of conserved vs managed forest stands due to risk of disease, fire, or extreme weather events.

Furthermore, from a biodiversity perspective, Darren argued there are some animal species that depend on young forests with open canopy conditions.

There is also evidence that native oak-hickory forests are being replaced by shade-dominant maple forests in public lands because there is not enough forest management to ensure light reaches the ground for the shade-intolerant oak trees to regenerate.

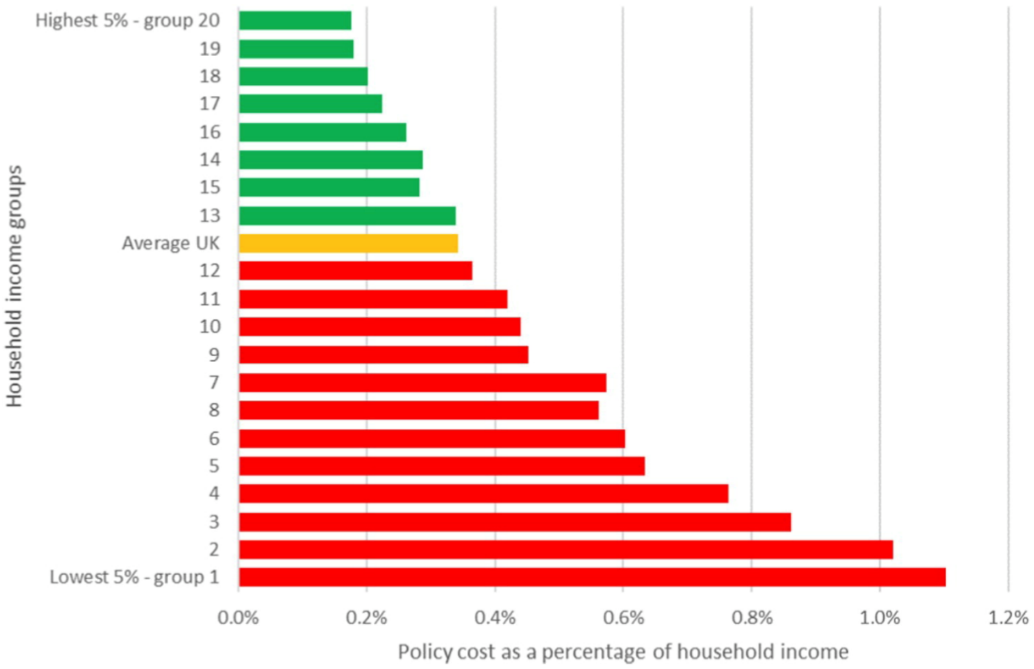
While it sits outside of Darren's expertise, he noted there has been some degree of active forest management by indigenous cultures in the region long before the arrival of Europeans.

Certification Schemes
Darren was not familiar with the Sustainable Biomass Program certification scheme. He did, however, reference the Sustainable Forestry Initiative, which is not dependent on the end-use of the fibre. The scheme involves rigorous third-party auditors who are free to determine which sites they inspect – results of the audits are publicly available.

Written Submission, Josh Burke, 26.09.2022

Senior Policy Fellow at the Grantham Research Institute on Climate Change and the Environment

BECCS - implications from a financial and governance perspective
Why is the funding envelope important?
The core governance question is not whether CDR (carbon dioxide removal) should be mobilised, but which CDR methods governments want to see deployed by whom, by when, at which volumes and in which ways. This reflects a more nuanced debate, reframing the question of whether we should use GGR, to how do we do it in sustainable and equitable manner.



This is particularly important as to date, low carbon policy costs disproportionately impact low-income households (Figure 1).

Figure 1: Low carbon policy costs disproportionately impact low income households: Source: Owen, A and Barrett, J (2020) 'Reducing inequality from UK low carbon policy

Despite the prevalence of GGR technology in Paris-consistent scenarios, and the UK's own net-zero technological pathway, there is limited analysis of how potential funding options for GGR could work in practice.

The focus on BECCS is particularly pertinent as evidence on public perceptions suggest this GGR technique is currently seen as controversial and incompatible with prevailing visions of decarbonization. Indeed, public support for BECCS and DACCS is currently low while afforestation and other land-based GGR processes are a priori popular. Research by Citizens Assembly UK suggests that nature-based GGRs have far higher support than engineered GGRs (BECCS or DACCS).

BECCS could therefore be susceptible to further public opposition if the policy for funding and deployment fails to account for undesirable distributional consequences. Choosing an equitable funding model from the outset can help to ensure public legitimacy of GGR technologies, including BECCS, and in turn, enhance the immediate political feasibility as well as the durability of GGR policy over time. The scale of the costs associated with engineered GGR necessitates an understanding of where costs might fall.

Policy funding option	Description	Operational mechanism	Operational approach	Strength of Government intervention
1, Polluter pays principle	Assumes that the cost of GGR deployment is allocated to sectors based on their proportion of residual emissions The cost falls on **UK households and the Government.**	• GGR obligation where producers are obliged to purchase GGR credits and must be able to demonstrate that a percentage of their emissions are offset by GGR. • Carbon markets provide a mechanism where polluters purchase GGR credit directly from producers.	Market-based	Low
2, Carbon CfD	Assumes that the cost of GGR deployment is allocated via a levy on consumer energy bills. The cost falls on **UK households only.**	• All GGR contracted via a carbon CfD or GGR service contract. • Both mechanisms are funded via a levy on consumer energy bills (covering both electricity and gas).	Contracted	
3, Multi sector gov contract	Assumes that the cost of GGR deployment is allocated to sectors based on end use application (for example BECCS power in the power sector, BECCS energy from waste (EfW) in the waste sector etc) The cost falls on **UK households and the Government.**	• GGRs are funded based on end use application. For example, BECCS power is contracted via power sector contracts, BECCS EfW through waste sector contracts and BECCS in industry via the industrial sector. • This could be operationalised using bilateral sector contracts that reward additional low carbon products.	Contracted	
4, Income tax	Assumes that household contributions to fund GGR's are weighted by the household's contribution to total UK income tax payments	• Household contributions to funding GGR are weighted by the household's contribution to total UK income tax payments.	Government interventions	High

Summary of policy funding options

How do different funding options compare?

Our research considered both the absolute annual costs and the proportion of the household's annual income when assessing the distributional impact of funding GGRs on different household income deciles. A levy on consumer bills is found to be the most severely regressive policy. This is happening because there is little difference in energy spends across income deciles so as a proportion it's much higher at lower income deciles. In contrast, income tax is the only progressive policy funding option in this study. Although funding GGR technologies through income tax avoids excessive costs for low-income households, socialising costs may have the unintended consequence of blunting the price signal polluters face. It is also important to remember that the different funding options are not mutually exclusive and the proposed contract-based business model for GGR can be designed to recover costs from a combination of areas that are known to mitigate regressive distributional impacts, including but not limited to, income tax.

Notably, the polluter pays option draws attention to aviation as an important point for intervention to reduce unfair distributional impacts. High-income households have larger aviation carbon footprints than low-income households, so passing on costs through air travel could help fund GGR technologies while having minimal impacts on social welfare.

Policies to incentivise BECCS – the role of carbon markets

The role of carbon pricing as policy mechanism to incentivise GGR is one area that has experienced more attention than others, including discussion about the future inclusion of GGR in carbon markets. Indeed, Government consultations suggest this is being considered as a future policy mechanism.

Specific problems with the EU ETS include: the potential of free allowance allocation to drive firms to emit more in the present to secure more allowances in the future, potentially leading to over-allocation and low prices; the lack of long-term incentives for mitigation if the permit price is too low; and sudden release of permit supply-demand information which can drive price volatility, including price collapses. Specific issues of linking mechanisms such as the Clean Development Mechanism (CDM) include most importantly the risk that it has removed incentives for developing country governments to enact climate policies, since they can now fund such policies via CDM payments, thereby making CDM projects not genuinely additional to what would have occurred anyway. From this and other critiques of carbon markets there are two risks relevant to BECCS – lack of fungibility, additionality and durability of linking new mechanisms and technologies into carbon markets and the lack of adequate price signal for investment in more expensive technologies.

With regards to the first risk, it can be argued that there is a lack of real fungibility between emissions reductions and removals, especially between "biotic" carbon (i.e. that which is part of the active carbon cycle, such as from land use) and "fossil" carbon (i.e. that which is locked away in fossil fuels). In the context of GGR, standardisation between nature based and engineered GGR techniques/components could mask differences in environmental durability and additionality. Consequently, poor substitutability between GGR and convention mitigation could be obscured under a policy framework that promotes carbon markets.

Secondly, there are several reasons to be sceptical about the ability of an emissions trading system to on its own drive the requisite innovation and cost reductions in such techniques in the coming decades. A moderate and steadily rising carbon price - which might in principle be delivered by a carbon market - could help provide a useful backdrop to the development of these technological GGR techniques, such that they can compete cost-effectively with other mitigation solutions in the future. However, there is a long list of market barriers to GGR deployment that needs addressing (including failures in capital markets and externalities related to low-carbon innovation). Such considerations are likely to reveal that many complementary mechanisms are needed in addition to a pure carbon price, and that inclusion in carbon markets alone would not drive the requisite innovation, learning and cost reduction in more expensive GGR techniques.

Oral Evidence Summary, Mike Hemsley, 26.09.2022

Deputy Director of the Energy Transitions Commission

The Global Energy Mix

Mike opened his evidence by outlining the ETC's position on the Energy Transition, arguing it is possible to fully decarbonise the economy at reasonable cost. They estimate that low-carbon sources can meet 100% of electricity demand, with wind and solar energy providing 75-90% of electricity demand. The options for the remaining 10-25% include hydrogen, bioenergy and fossil fuels with CCS.

Sustainable Bioenergy Supply
The ETC's conclusion is that the supply of sustainable bioenergy feedstock is likely to be constrained at ~50EJ. For reference, global energy consumption is currently 400EJ, which may rise to 500EJ in a net zero scenario without energy productivity.

When pressed, Mike reaffirmed the ETC's confidence in their estimate. Mike argued that other estimates differ from the ETC's due to their definition of biomass residues, and smaller expectations about the potential for biomass from waste collection. Another factor in other studies is additional energy crop potential involving land use change, which we don't consider in our base estimateThe ETC's estimate also does not consider additional crop potential involving land-use change.

Bioenergy Demand
Bioenergy is extremely versatile compared with other low-carbon energy vectors, given the relative ease with which it can be substituted with fossil fuels for electricity generation, surface transport, aviation, and hydrogen production. Total demand from these sectors could amount to 600EJ.[7]

Sector claims to bioenergy
Mike argued that surface transport can be justifiably excluded from limited supply of bioenergy feedstock due to progress in electric vehicles. Similarly, shipping has viable alternative in hydrogen as ammonia.

Most industrial heating can be met by either heat pumps or electrical resistance heating. The remaining industrial processes can be met by hydrogen. Industrial heat is therefore unlikely to require significant bioenergy feedstock.

In the Power Sector, wind and solar energy are cheaper alternatives, and are able to provide 75 – 90% of the world's annual electricity demand in the vast majority of countries. Bioenergy needs to compete with hydrogen and fossil fuels with CCS for the remaining 10 – 25% of electricity generation.

Aviation does require an energy dense drop-in fuel. This can be met either through biofuels or synthetic aviation fuels made from captured CO2 and hydrogen. While the potential for synthetic fuels is high, the cost is prohibitively expensive meaning there is significant demand for biofuels from this sector.

The chemical sector is likely to require some non-fossil carbon input from either biogenic carbon or Direct Air Capture. Given scaling restraints of DACCS, bioenergy is also likely to be needed in the chemicals sector.

Opportunities for BECCS
Of the sectors eligible for bioenergy, Mike then looked at which of them could provide the maximum carbon removal potential.

Baseload vs Dispatchable power
Mike highlighted the fact that in the context of our electricity system, the objective of maximising carbon removals is in direct tension with the objective of minimising cost, as this would require running BECCS power generation as baseload at a times when there is cheaper excess wind and solar. This points towards prioritising bioenergy feedstock in other energy vectors that do not experience this inherent trade-off.

[7] This figure is a hypothetical. See Exhibit 2.1 here: https://www.energy-transitions.org/wp-content/uploads/2021/07/ETC-bio-Report-v2.5-lo-res.pdf

Aviation Fuels & Hydrogen

Using bioenergy with CCS for the production of aviation fuels and hydrogen can maximise both carbon removal and energy potential due to the flexibility in being able to effectively store those outputs to smooth the discrepancy between supply and demand. Given the inherent synergies between energy use and negative emissions, Mike suggested we should be prioritising the limited supply of sustainable bioenergy feedstock for aviation fuels.

Mike emphasised that he is not ruling out BECCS for power generation, but highlighted the challenge of designing a mechanism that incentivises dispatchable energy from BECCS whilst maximising negative emissions as well.

Conditions that determine sustainability of bioenergy supply

Mike outlined the following conditions to ensure bioenergy feedstocks are sourced sustainably:

- Avoid sourcing from habitats with endangered species
- Avoid sourcing from areas with existing deforestation pressures
- Source from managed forests with a growing forest stock
- Source from managed forests with reasonable rotation periods
- Source only from residues or by-product that do not have a higher value alternative use.

Counterfactuals to Biomass Sourcing

Mike recognised the most difficult condition to verify is whether or not the feedstock is a residue, as this would require proving that a hypothetical counterfactual scenario would in fact have taken place. The reason this is so important is that it determines the size of the carbon benefit from utilising bioenergy. Mike referred to a graph in a BEAC report[8] by DECC which highlights the relative carbon intensity of bioenergy electricity compared to gas and coal, depending on which counterfactual you compare bioenergy to (see p.7-8).

While this is not Mike's area of expertise, he pointed towards effective satellite monitoring and robust third-party auditing against agreed definitions of what constitutes a "residue" as means of verifying this condition. Furthermore, it could be possible to monitor the level of biomass entering pelleting plants as a proportion of total forest harvesting to monitor whether the ratio of timber to residue is changing.

Counterfactuals to Bioenergy in Power Generation

One the one hand, Mike recognised the benefits of using the existing Drax infrastructure, networks and international supply chain to facilitate carbon removals and dispatchable power, rather than develop the counterfactual options to provide this. On the other hand, Mike argued that the relatively small size of this sunk cost investment should not by itself determine our policy decisions going forward.

Mike argued that a strategic way forward is to use the assets presented by Drax to demonstrate the feasibility of BECCS at scale, and drive down the overall cost of Drax in the future.

Counterfactuals to international transportation

Mike argued that the transportation of biomass pellets from North America forms a relatively small proportion of the carbon footprint of the BECCS supply chain.

8 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/349024/BEAC_Report_290814.pdf

Given the relatively low energy density of biomass, it would probably require more transportation emissions than an equivalent unit of energy in the form of fossil fuels. However, it is too small a proportion of the overall carbon footprint of both scenarios to make a material impact on the decision.

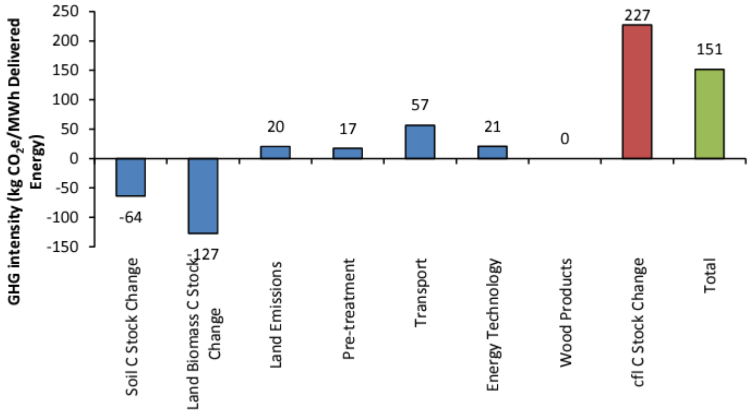


Figure 21. Example headline graph in BEAC (type 2), showing the GHG intensity of each stage of the life cycle for a biomass electricity scenario. cfl: counterfactual.

Technological Feasibility

Mike acknowledged there are currently no examples of carbon capture and storage applied to biomass combustion for energy generation at scale, for industrial heat or gasification for hydrogen production.

Mike argued that as capture rates tend toward 100%, the importance of proving the counterfactual use of biomass feedstock to demonstrate the carbon benefit is reduced. While there may still be important reasons to source biomass sustainably, it becomes less relevant to the overall carbon balance. However, Mike recognised we still haven't demonstrated high capture rates on this technology.

Land-use change & Food vs Fuel debates

Mike argued the only means of increasing the potential supply of sustainable bioenergy feedstock above 50EJ is a significant shift away from meat-based diets to free up land available for bioenergy production. However, he recognised that current trends in behaviour, demographics and policy do not point in this direction.

Mike acknowledged that given current diet patterns and demographic trends, the amount of land dedicated to agricultural production is predicted to rise by 400m ha by 2050. This implies that sources of biomass are constrained to waste resources or areas where land is already dedicated to biomass production.

Mike argued that the estimated 50EJ of sustainable biomass resource is approximately what is already produced today, and so this figure does not imply a general need for additional land-use change. However, this is land which could otherwise be used for agricultural production and so there is an inherent tension between the demands for zero-carbon energy and growing demand for food production, which needs to be navigated.

Mike pointed towards several ways to alleviate this tension, such as increasing the efficiency of biomass production, shifting diets away from land-intensive commodities, and maximising the use of non-bioenergy sources of electricity and carbon removals such as Direct Air Capture.

Mechanisms to allocate constrained sustainable biomass resource
The ETC argue that policy mechanisms must be in place to guide the allocation of biofuels into their optimum use from a whole systems perspective.

In some cases, policy will not be necessary where economic fundamentals are already driving the transition, in areas such as renewable energy generation and surface transport. That implies that existing incentives to use biofuels in these cases should be phased out and phased in for those sectors that need them – e.g. blending mandates for the aviation sector.
Mike argued that across key markets, there is a need for strong industry standards which acknowledge the constraint on bioenergy supply, which are backed by state regulation. Once these are in place, we can expect the price to accurately reflect the overall scarcity of the resource.

Lock-in Risks
While recognising the risks of lock-in, Mike reiterated the point that the ETC does view BECCS for power generation as a legitimate use of the constrained supply of sustainable biomass in the long-term, not simply as a transition fuel to another energy mix. This means the risk of lock-in is smaller than, for example, the risk associated with transitioning to bioenergy for surface transport fuels which could delay the necessary transition to electric vehicles.

Mike recognised there are still lock-in risks associated with demonstrating the technology at scale. In this case, Mike advocated for introducing clear phases into the investment.

International Framework
Mike acknowledged there is unlikely to be an international institution with the authority to monitor and constrain the supply of biomass to within sustainable limits. However, Mike argued that a bottom-up approach involving industry standards and national regulations across the key biomass producing and consuming states could get us close to a robust international framework.

Tropical Sourcing
Mike recognised that while forest residues from the tropics can be a low carbon form of bioenergy in theory, he advocated for an extremely high degree of caution regarding any sourcing from the tropics given this practice could exacerbate existing deforestation pressures in those regions. This deforestation pressure exists in large part because of high productive capacity of this land, which is true of both agriculture and biomass such as short-rotation eucalyptus. Companies must decide either to categorically avoid sourcing from these regions or remove the other drivers of deforestation pressure such as economic incentives or utilising genuinely marginal land.

Oral Evidence Summary: Michael Norton, 29.09.22

Environment Programme Director at the European Academies Science Advisory Council

Central Research Question
Michael opened his evidence by outlining the purpose of his research to examine the question of whether or not bioenergy using woody biomass from forests can contribute to climate change mitigation.

Comparing Lifecycle emissions
Michael outlined the lifecycle carbon emissions per kWh of electricity generated for Solar, Wind and Bioenergy – referencing Drax's own figures.

- **Solar energy** = 41 $gCO_2\ kWh^{-1}$

- **Wind energy** = 11 – 12 $gCO_2\ kWh^{-1}$
- **Forest Biomass**:
    - Supply chain = 124 $gCO_2\ kWh^{-1}$
    - Stack = 955 $gCO_2\ kWh^{-1}$
    - **Total** = 1079 $gCO_2\ kWh^{-1}$
- **Coal:**
    - Supply chain = ca. 50 $gCO_2\ kWh^{-1}$
    - Stack = 898 $gCO_2\ kWh^{-1}$
    - **Total** = 948 $gCO_2\ kWh^{-1}$

Michael acknowledged that Drax has done a good job of improving the efficiency of their operations and supply chain as far as they can within the regulatory framework in which they operate. However, despite this action, their stack emissions are still considerably larger than burning coal.

The implication for Michael is that from a policy perspective, incentivising bioenergy via public subsidy is ineffective at mitigating climate change, regardless of what Drax can do to improve the efficiency of their operations.

Carbon Accounting Rules
Michael outlined the reason bioenergy is classified as carbon neutral because it is presumed the biogenic stack emissions will be reabsorbed on regrowth.

Michael argued that the Kyoto Protocol reporting requirements were established at a time when biomass energy was a niche energy vector, and therefore the IPCC was more concerned with carbon emissions from land-use change. For simplification and to avoid double counting, carbon stored in biomass would be reported under national forestry statistics, rather than stack emissions.

Michael argued that Drax benefits from these accounting rules, because it allows them to make exaggerated claims about the reduction in carbon emissions from the conversion to biomass from coal, and exempts them from carbon taxes and emissions trading schemes.

Carbon Payback Periods
Michael moved to the issue of how long it takes for the carbon dioxide emitted during the combustion of biomass to be reabsorbed by regrowth. To answer this question, Michael referred to the Joint Research Council study on the Use of Forest Biomass for Bioenergy[9]. In it, the JRC plots the different types and sources of biomass against the likelihood of carbon emission mitigation and their impacts on biodiversity and ecosystem condition. They conclude that for forest biomass, the time taken to recover the initial pulse of CO2 from stack emissions is decades to centuries, or in some cases, never.

Michael acknowledged that some degree of investment of the available carbon budget is acceptable, as is the case with wind and solar albeit with shorter payback periods. Michael referenced EASAC's position which recommends a maximum carbon payback period of 20 years as a suitable guideline.

Policy Responses
Michael put forward a number of "policy responses" to the arguments above:
- Make public subsidy conditional on avoiding the harvest"new whole trees" or "stem wood"

[9] https://publications.jrc.ec.europa.eu/repository/bitstream/JRC122719/jrc-forest-bioenergy-study-2021-final_online.pdf

- Recognise the time dimension in sustainability criteria in allocation of public subsidy and exclude feedstocks that worsen climate change for more than 10 - 30 years
- Improve the transparency of reporting on real inputs to the atmosphere
- Apply carbon taxes to real emissions

Michael highlighted the fact that many governments are already heading in this direction, with the UK and Netherlands phasing out subsidies for bioenergy, and the EU Parliament voting to exclude "primary woody biomass" from the EU RED.

The Role of BECCS

Michael argued that IAMs contain inherent biases which favour BECCS and carbon removals in the future, over mitigation today, and therefore imply a significant role for BECCS in any net-zero scenario. However, there are three issues which severely limit the potential role that BECCS can play.

The first is that the supply of sustainable biomass is much smaller and constrained than is assumed by the IPCC reports and scenarios. Second, there is substantial 'parasitic' energy energy loss through the operation of the CCS technology meaning more biomass is needed to deliver the same energy to the grid as would be required for bioenergy. Finally, significant leakage along the supply chain may reduce any net CO2 sequestration, since CCS technology can only capture a percentage of the stack emissions.

Conditions

Michael summarised his evidence with the following suggested conditions:

- Require a reduction of atmospheric levels of CO2 within a short time period
- Require a full life cycle assessment using the DECC BEAC model, and open these assessments to independent verification.
- Base calculations on real emissions to the atmosphere, rather than arbitrary accounting rules determined by institutions
- Source biomass feedstocks that are local, sustainably grown and of short payback periods.
- Comply with the EU Parliament decision to exclude 'primary woody biomass'

BECCS vs. Nature Based Solutions

Michael argued that the distinction between BECCS and nature based solutions (NBS) is that the latter does not have to compensate for an initial pulse of CO2 emissions, but instead improve the natural carbon sink. There are, however, similar concerns associated with both BECCS and NBS, given the reduction in forest productivity and resilience associated with climate change - due to drought, fire and disease etc.

Scope of the JRC Report

Michael confirmed that the JRC report does not analyse supply chain emissions, given that its scope was to categorise all European feedstocks, and their analysis is bounded within Continental Europe. The report does quantify the various sources of feedstock such as sawmill and forestry residues, finding that almost half could not be classified and were thereby assumed to be primary woody biomass from countries such as Estonia and Romania where trees are often harvested directly for bioenergy.

Uniform feedstock

Michael argued there are strong incentives to procure uniform feedstock to ensure the ash content and gas emissions from biomass combustion fall within the design parameters of the biomass plants, which can therefore create an incentive to harvest primary forest over residues of varying composition.

EASAC's Terms of Reference
Michael confirmed that EASACs terms of reference are bounded to address scientific implications on policy decisions made by the EU Parliament, Commission and Council.

IPCC Carbon Accounting Rules
Michael highlighted that the IPCC acknowledges their accounting system makes it impossible to properly assess the climate impacts of international bioenergy transfers. However, many countries benefit from being able to zero rate emissions from bioenergy plants as a means of giving the appearance of reducing their national emissions. Michael argues that regardless of the IPCC accounting rules, countries should, at a minimum, publicly disclose their bioenergy emissions and preferably make those subject to carbon taxes. Michael also referred to a recent report which explores different mechanisms for adjusting the IPCC accounting framework.

Valid Exemptions
Michael acknowledged there are potential exemptions where harvesting for bioenergy may indeed make sense. This includes forest thinning in the case of disease, fire damage or fire prevention. These exemptions are included in the EU commission's decision to exclude primary woody biomass from subsidy. However, Michael cautioned against any exemption which might become a loophole to allow business as usual.

Inherent sustainability of the bioenergy business model
Speaking in a personal capacity, Michael raised concerns about the inherent limitations of any business model designed on the basis of a constrained supply of sustainable biomass, which is in direct tension with the growing demand for bioenergy. Michael feared that any conditions we suggest which do not resolve this tension may simply improve an inherently unsustainable business model rather than result in substantive change.

The Biomass Cascade
Michael argued that aviation fuel and biochemicals are higher value uses of sustainable biomass than bioenergy, and therefore should be prioritised. The EU commission has issued guidance to member states to consider the biomass cascade of uses in their own policy.