Written evidence submitted by Professor Michael Norton, director of Environment Programme, European Academies Science Advisory Council (EASAC); Professor Lars Walløe, Chair of Environment Steering Panel, EASAC; Professor Alistair Jump, Dean of Faculty, Natural Science, University of Stirling; Professor Duncan McLaren, Research Fellow, University of Lancaster; Professor William Moomaw, Professor Emeritus of International Environmental Policy, Tufts University; Duncan Brack, Associate Fellow, Environment and Society Programme, Chatham House; Dr Daniel Quiggin, Senior Fellow, Environment and Society Programme, Chatham House; and Dr Mauricio Diazgranados, Research Leader, Royal Botanic Gardens, Kew

On the 22nd of October 2021, we wrote to the Prime Minister; the Chancellor of the Exchequer, the Secretary of State for Business, Energy and Industrial Strategy; the President of COP26 and the Secretary of State for Environment, Food and Rural Affairs, setting out what we consider should be four principles for guiding the UK's Biomass Strategy. This includes a principle (Principle 4) which specifically refers to understanding and reducing the risks associated with Bioenergy with Carbon Capture and Storage (BECCS).

As BECCS is one of the technologies, the Committee is investigating as part of its inquiry, and as the call for evidence specifically asks what should be included in the Government's Biomass Strategy, we enclose our recommendations here.

As we set out below, there is a particular need to understand and address the risks associated with biomass harvested from *forests*, both to climate and biodiversity targets, as forest biomass makes up a significant portion of the biomass being burned in the UK. This is, of course, highly relevant to the potential development of BECCS.

While capacity constraints have rendered us unable to provide a responses to each of the 12 questions the Committee poses, we hope these principles, relating to the UK Biomass Strategy, will be useful in considering how the UK should approach the question of negative emissions technologies. These should be considered in addition to the four principles which currently underpin the UK's Bioenergy Strategy (2012) [1] – but which are inadequate. Our suggested principles are as follows:

1. The UK's Biomass Strategy should be set with its global social and environmental implications in mind and the UK government should harness its COP26 presidency to close loopholes in international biomass accounting.
2. The UK's Biomass Strategy should take full advantage of the developing understanding on both the scale of wood harvesting in Europe and North America (both for bioenergy and for materials) and its impacts on climate and biodiversity.
3. The UK's Biomass Strategy should maximise 'no regrets' nature based solutions to climate change which pose less risk to biodiversity and to climate than industrial scale bioenergy.
4. The UK Biomass Strategy should *not* commit to large-scale BECCS projects unless they have been sufficiently demonstrated at smaller scale; and should not allow an emissions pathway with potential negative emissions to slow the acceleration of emissions mitigation in the 2020s. Any demonstration projects must prove their ability to deliver negative emissions within a few years, once lifecycle emissions are accounted for.

Signed:

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1 The UK's existing Bioenergy Strategy (published in 2012) is set out as a list of 4 principles, which on their face should prohibit the type of biomass currently being used: (1) ensure genuine carbon reductions; (2) support should be cost effective - bioenergy should only be supported when offers equivalent or lower emissions for each unit of expenditure; (3) max benefits and min costs across economy; and (4) policy should be adjusted as needed when demand increases, including consideration of other objectives re food security, biodiversity, etc.

Dr Mauricio Diazgranados, Research Leader, Royal Botanic Gardens, Kew

Four Guiding Principles for The UK Biomass Strategy

Principle 1

The UK's Biomass Strategy should be set with its global social and environmental implications in mind and the UK government should harness its COP26 presidency to close loopholes in international biomass accounting.

With regard to biomass feedstock and land use, the UK is not operating in a vacuum. In fact, the UK remains one of the largest importers of woody biomass in the world; so, the risks of unintended consequences are large, and the UK could become a model for poor practice or good practice.

At present, there is evidence that a large proportion of the wood pellets imported to the UK are coming from hardwood sourced from intensively logged natural forests[2] as well as softwood from intensively managed plantations.[3]

Indeed, in forthcoming peer-reviewed research for Chatham House Duncan Brack presents robust evidence of the GHG emissions directly linked to several specific wood pellet mills in

[2] Southern Environmental Law Center "Biomass Energy in the South"
[3] Spatial Informatics Group (2019): Results (found here and here) from this study found that over the course of the 40 future years modelled, carbon parity was not achieved for pellet mills compared to the fossil fuelled portions of the UK electricity grid. This means that, even over 40 years, wood pellets produced higher emissions than other likely or traditional energy sources, such as coal or other fossil fuels. This result also holds up when mixing NIPF softwood plantation feedstock with a large share (>40% of total) of a low-emission feedstock, such as sawmill residues.

the US Southeast. As noted below, peer-reviewed research is showing the short-term negative impacts on both GHG and biodiversity of using most forest-harvested wood for bioenergy.

Furthermore, for reasons given below, there is a significant risk that any scaling up of a forest biomass-intensive model could damage progress towards both climate and biodiversity targets under the Paris Agreement and the *Convention on Biological Diversity.*

We would welcome the chance to discuss the developing evidence here and the reasons why this model of biomass sourcing could come to damage the UK's standing as a climate leader.

It is to be noted that the Committee on Climate Change's 2018 report into "Biomass in a Low Carbon Economy" highlighted the need for 'strengthened governance…to manage the risks to sustainable low carbon production, as the global biomass market scales up'. Among other things, the CCC recommended[4]:

- Ensuring that changes in terrestrial carbon stocks in managed forests are fully accounted for in current sustainability criteria, enhancing monitoring and reporting and looking at new mechanisms for driving best practice.
- A broader approach to managing risks (beyond the current practice of setting sustainability criteria in subsidies) - for example, by extending the use of sustainability criteria across procurement and finance rules and through further strategic coordination of development and trade policy.
- In order to provide benefits at an aggregate level, policy needs to look beyond existing sustainable supply chains, and drive up standards more widely. This is to ensure that the UK is not simply sourcing existing sustainable feedstocks while pushing less sustainable stocks elsewhere.

Several additional suggestions have been made in the literature on how the UK and the EU can tighten the criteria against which all biomass may qualify for subsidy under GHG targets. There is not space to discuss specific ideas here, but the implications both of the EU Joint Research Centre's report, the UK Committee on Climate Change's report into Biomass and Land Use, and the work conducted by Chatham House on the Global Emissions relating to Biomass all point towards **a specific restriction of feedstocks from certain land use categories (e.g., monoculture plantations) coupled to a restriction based on feedstock**

[4] Committee on Climate Change (2018) *Biomass in a Low Carbon Economy* pp.10-11

type (e.g., stemwood). The case for including forest residues (a loose definition at the moment) is weakening[5].

But the key question remains to what extent biomass energy is actually contributing to climate mitigation where the fundamental weakness of its innate inefficiency in terms of CO2 emissions per kWh of electricity generated has to be a fundamental consideration when considering the best use of the resources available for emission reductions. The extensive literature that shows the length and uncertainties in the delay between initial increases in emissions to the atmosphere before they can be compensated by forest regrowth leads scientists (starting with the DECC's own Chief Scientific Adviser in 2014[6]) to point to this payback period as critical to biomass policy.

In a much-cited 2019 paper published in *Global Change Biology*, the *European Academies Science Advisory Council* (EASAC) recommended that:

> Forest biomass should not be regarded as a source of renewable energy under the EU's Renewable Energy Directive unless the replacement of fossil fuels by biomass leads to net reductions in atmospheric concentrations of CO2 within a decade or so.[7]

A similar criterion should be applied to the UK's supply of biomass – with the burden of proof being placed on the UK-based combustor of biomass to demonstrate genuine lifecycle carbon reductions within a short-term timeframe. *This crucial criterion is not covered by either UK or EU sustainability standards for forest biomass.*

There remain significant problems with international carbon accounting norms that mean that significant amounts of GHG emissions associated with imported biomass may continue to be "going missing" on the global scale. These have been detailed by Duncan Brack[8] – alongside an estimate of the amount of global carbon emissions that could be going unaccounted for each year. Needless to say, unaccounted for emissions on this scale threaten to undermine

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[5] See for example Booth https://iopscience.iop.org/article/10.1088/1748-9326/aaac88/pdf

[6] David McKay and Anna Stephenson (2014) Scenarios for Assessing the Greenhouse Gas Impacts and Energy Input Requirements of Using North American Woody Biomass for Electricity Generation in the UK – *Department of Energy and Climate Change (DECC)*

[7] Norton, M, Baldi, A, Buda, V, et al. Serious mismatches continue between science and policy in forest bioenergy. **GCB Bioenergy**. 2019; 11: 1256– 1263. https://doi.org/10.1111/gcbb.12643

[8] Duncan Brack, 'The Impacts of the Demand for Woody Biomass for Power and Heat on Climate and Forests' **Chatham House** (2017): https://bit.ly/2AnIq5s

the UK's credibility on climate policy as well as its ability to meet its own emissions reductions targets should the Paris rulebook be amended to close the loophole.

These concerns were originally highlighted by Tim Searchinger[9]. Michael Ter-Mikaelian's paper of 2014[10] remains a good explanation of the 'critical errors [that] exist in some methodologies applied to evaluate the effects of using forest biomass for bioenergy on atmospheric greenhouse gas emissions.' *To our knowledge, these errors remain embedded in current UK policy assumptions[11].*

The UK's Presidency of COP26 and the UK Emissions Trading System offer opportunities to close loopholes in the international carbon accounting rules that permit emissions from biomass to go missing, and to contribute to the debate around the proper methodology via which biomass's contribution to climate targets is assessed.

The case of second generation energy crops is distinct from forest biomass and is where the focus of the UK's Biomass Strategy should lie. Although the UK CCC's 2018 report recommended building up the domestic sources of bioenergy, there remain significant gaps in knowledge regarding both the viability of energy crops on UK degraded land and/or on farmland – as well as on their use for combustion in – for example – large scale BECCS facilities (see Principle 4). It is to be remembered that the CCC estimated that increasing domestic biomass production as recommended could "require over 1 million hectares of land to be used for energy crops (around 7% of current agricultural land) and increasing rates of tree planting (to 50,000 hectares every year by 2050)."[12]

Needless to say, the impacts on biodiversity and food security of growing energy crops on 1 million hectares of land are likely to be significant. [See Principle 2, below]

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[9] By Timothy D. Searchinger et al, 'Fixing a Critical Climate Accounting Error' ***Science*** 23 Oct 2009: 527-528 DOI: 10.1126/science.1178797

[10] Michael T. Ter-Mikaelian, Stephen J. Colombo, Jiaxin Chen, The Burning Question: Does Forest Bioenergy Reduce Carbon Emissions? A Review of Common Misconceptions about Forest Carbon Accounting, **Journal of Forestry**, Volume 113, Issue 1, January 2015, Pages 57–68, https://doi.org/10.5849/jof.14-016

[11] See forthcoming paper by Funk et al in GCB Bioenergy

[12] Committee on Climate Change (2018) Biomass in a Low Carbon Economy p.10

Principle 2

The UK's Biomass Strategy should take full advantage of developing knowledge regarding both the scale of wood harvesting in Europe and North America (both for bioenergy and for materials) and its impact on climate and biodiversity.

2021 has seen the publication of two synoptic reports assessing the interaction between climate and biodiversity targets. The first report, by the EU's Joint Research Centre (JRC)[13], examined the EU's bioenergy policy in the Renewable Energy Directive (2018/2001) in light of the aims of the EU's Biodiversity Strategy (2020). It was prompted in part by findings in the European State of Forests report (2020)[14] stating that the area of European forest 'undisturbed by humans' had fallen by 45% in five years, suggesting a large increase in harvesting – and the JRC noted both that 'an increase in wood fuel use [has been] reported between 2009 and 2013 as a major driver of the increase in roundwood uses in reporting countries'[15] and that between a third and half of all wood used for energy (37-51%) in the EU likely comes from *primary wood* (stemwood, treetops, branches, etc. harvested from forests). This chimes with the findings of a much commented on 2020 paper published in *Nature,* which:

> [Used] fine-scale satellite data to observe an increase in the harvested forest area (49 per cent) and an increase in biomass loss (69 per cent) over Europe for the period of 2016–2018 relative to 2011–2015, with large losses occurring on the Iberian Peninsula and in the Nordic and Baltic countries. Satellite imagery further reveals that the average patch size of harvested area increased by 34 per cent across Europe, with potential effects on biodiversity, soil erosion and water regulation. The increase in the rate of forest harvest is the result of the recent expansion of wood markets, as suggested by econometric indicators on forestry, wood-based bioenergy and international trade. If such a high rate of forest harvest continues, the post-2020 EU vision of forest-based climate mitigation may be hampered, and the additional carbon

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13 Camia A., Giuntoli, J., Jonsson, R., Robert, N., Cazzaniga, N.E., Jasinevičius, G., Avitabile, V., Grassi, G., Barredo, J.I., Mubareka, S., The use of woody biomass for energy purposes in the EU, EU Joint Research Centre (JRC) EUR 30548 EN, Publications Office of the European Union, Luxembourg, 2021, ISBN 978-92-76-27867-2, doi:10.2760/831621 JRC122719 p.9
14 FOREST EUROPE, 2020: State of Europe's Forests 2020.
15 Ibid JRC p.22

losses from forests would require extra emission reductions in other sectors in order to reach climate neutrality by 2050[16]. It is worth noting that the primary conclusions of this paper have stood up to direct challenges.

In the US, meanwhile, there is significant evidence that forest carbon stocks are negatively impacted as a direct result of biomass harvesting. As Duncan Brack (2021)[17] notes:

> In 2014, for example, the US Forest Service reported that while forest hardwood inventories were expected to continue increasing to 2020, even as bioenergy demand increased, ***the rate of growth of forest carbon stocks would be lower as a result of demand for biomass for energy***. It concluded: 'Even assuming full utilisation of mill residues and increased utilisation of logging residues, harvest of pine and hardwood non-sawtimber feedstock increases … hardwood inventories continue to increase although these end at lower levels' than without new bioenergy demand.[18] ***Subsequent projections by the US Forest Service indicated that increased demand for forest products (including bioenergy) would increase the area harvested***, and a recent independent study used a similar harvest response scenario based on macroeconomic modelling.[19] In 2018 a survey of forest professionals in the area of the three pellet mills in the US South that supply the Drax power station concluded that demand for pellets led to additional harvesting in privately owned pine plantations, mainly through thinning (though it was not leading to the overall expansion of plantations).[20] A further study of the same area in 2021 confirmed that forest management practices on the non-industrial private forest pine plantations included thinning harvest treatments in the presence of pellet demand, and that **thinnings were largely forgone in the absence of demand for wood pellets**.[21] [emphasis ours]

[16] Ceccherini, G., Duveiller, G., Grassi, G. et al. Abrupt increase in harvested forest area over Europe after 2015. **Nature** 583, 72–77 (2020). https://doi.org/10.1038/s41586-020-2438-y

[17] Duncan Brack, (Chatham House), Richard Birdsey and Wayne Walker (Woodwell Climate Research Center), Greenhouse gas emissions from burning US-sourced woody biomass in the EU and UK, October 2021

[18] Abt, K. L., et al. (2014), Effect of Policies on Pellet Production and Forests in the U.S. South: **A Technical Document Supporting the Forest Service Update of the 2010 RPA Assessment,** Washington, DC: US Department of Agriculture, https://www.srs.fs.usda.gov/pubs/gtr/gtr_srs202.pdf .

[19] US Forest Service. 2016. Future of America's Forests and Rangelands. Update to the Forest Service 2010 Resources Planning Act Assessment. General Technical Report WO-94. U.S. Forest Service; Favero A, Daigneault A, Sohngen B. Forests: Carbon sequestration, biomass energy, or both? **Sci Adv.** 2020 Mar 25;6(13):eaay6792. doi: 10.1126/sciadv.aay6792. PMID: 33052875.

[20] Thomas Buchholz, John Gunn and Brian Kittler, 'UK wood pellet derived electricity: Carbon emission estimates from trees, thinnings and residues sourced in mixed pine-hardwood forests and pine plantations in the south-eastern US' (**Spatial Informatics Group**, October 2018).

In this context, it is important to note that – according to its own figures[22] – Drax is deriving at around half of its wood pellets from tree harvest, and this rises to 61% in the US.

To reiterate, the 2021 Buchholz et al paper cited by Brack (2021) found that Drax demand resulted in thinning pine plantations that were previously being left to grow to maturity (and thereby store more carbon before harvest for sawtimber). The lifecycle analysis conducted by Buchholz et al indicates that adding this extra harvesting for pellet production **will increase atmospheric CO2 for more than four decades** (compared to a counterfactual of not thinning and using 2018 UK grid mix and projected 2025 grid).

> [the data show an] initial drop in forest stocks (baseline vs. bioenergy scenario) over the first 10 years after the thinnings. The delta in forest carbon stocks between the two scenarios continues to be noticeable throughout the analysed timeframe. Both scenarios show a long-term trend to increase forest carbon stocks over time. However, the bioenergy scenario continues to maintain lower forest carbon stocks than the baseline scenario because of the initial decrease in growing stock through thinning and a continued higher harvest rate under the bioenergy scenario.[23]

In addition to concerns around the carbon impacts of harvesting, there is emerging evidence that wood pellet production is having socially deleterious effects.[24]

Considered together, it is fair to say that there are grounds for very serious concerns that UK and EU bioenergy policy is driving an increase in harvesting of primary wood; the conversion of primary forest to monocultures and damaging biodiversity. Given these

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[21] Buchholz T, Gunn JS and Sharma B (2021) 'When Biomass Electricity Demand Prompts Thinnings in Southern US Pine Plantations: A Forest Sector Greenhouse Gas Emissions Case Study'. ***Front. For. Glob. Change*** 4:642569. doi: 10.3389/ffgc.2021.642569

[22] Drax Group Annual Report and Accounts (2020) – p.54

[23] Ibid p.7

[24] Majlie de Puy Kamp, (July 2021) **CNN**, How marginalized communities in the South are paying the price for 'green energy' in Europe: https://cnn.it/3xYehlw

concerns, it is fair to say that there is very limited scope for the UK to increase its imports of woody biomass from European forests (Question 7).

Furthermore, a situation in which both UK and EU demand for forest bioenergy is driving the intensification of harvesting for primary wood would be harmful both for climate and biodiversity targets and – indeed – the JRC found that, out of the 24 categories of forest intervention ('pathway archetypes') it considered, only one (the removal of fine woody debris) provided both short-term emissions reductions *and* short term biodiversity gains[25]. This implies that even the removal of most forest 'residues' is harmful both to short term climate and biodiversity targets. "Short-term", in this context, refers to benefits accruing over the period of 5-10 years; (the timeframe that is consistent with targets under the Paris Agreement and Convention on Biological Diversity).

The Joint Research Centre's findings chime with subsequent recommendations made in June 2021, in the first ever collaboration between the IPBES and the IPCC on *Tackling Biodiversity and Climate Crises Together*[26]*.* The recommendations from the workshop report contained the following observations relevant to the development of the UK Biomass Strategy:

- Eliminating subsidies that support local and national activities harmful to biodiversity – such as deforestation, over-fertilization and over-fishing, can also support climate change mitigation and adaptation, together with changing individual consumption patterns, reducing loss and waste, and shifting diets, especially in rich countries, toward more plant-based options.

- Some focused climate mitigation and adaptation measures identified by the report as *harmful* to biodiversity and nature's contributions to people include:
    - Planting bioenergy crops in monocultures over a very large share of land areas.
    - Planting trees in ecosystems that have not historically been forests and reforestation with monocultures – especially with exotic tree species. This can contribute to climate change mitigation but is often damaging to biodiversity, food production and other nature's contributions to people, has no clear

[25] Camia A., Giuntoli, J., Jonsson, R., Robert, N., Cazzaniga, N.E., Jasinevičius, G., Avitabile, V., Grassi, G., Barredo, J.I., Mubareka, S., The use of woody biomass for energy purposes in the EU, EUR 30548 EN, Publications Office of the European Union, Luxembourg, 2021, ISBN 978-92-76-27867-2, doi:10.2760/831621, JRC122719 p.9
[26] Suggested citation: Pörtner, et al 2021. IPBES-IPCC co-sponsored workshop report on biodiversity and climate change; **IPBES and IPCC**, DOI:10.5281/zenodo.4782538

benefits for climate adaptation, and may displace local people through competition for land.

- Conversely, dedicated bioenergy crops for electricity production or fuels may provide co-benefits for climate adaptation and biodiversity provided they are planted *at small scales*, alongside pronounced and rapid reductions in fossil-fuel emissions [emphasis own]

This went alongside a finding that:

> Any measures that focus too narrowly on climate change mitigation should be evaluated in terms of their overall benefits and risks, such as some renewable energies generating surges of mining activity or consuming large amounts of land. The same applies to some technical measures too narrowly focused on adaptation, such as building dams and sea walls. Although important options for mitigating and adapting to climate change exist, these can have large negative environmental and social impacts – such as interference with migratory species and habitat fragmentation.

All signatories underline these points in connection to the UK's Biomass Strategy and note the likelihood that there will be much greater political scrutiny – and therefore more available tools – for monitoring and assessing the impact of emissions mitigation policies on biodiversity.

Again, it is important to highlight a disconnect between the UK's current practice of importing wood pellets from intensively logged natural forests and plantations and the observation of both these major reports.

It is also worth noting that the CCC's own recommendations in 2018 foresaw the development of a UK supply of domestic bioenergy feedstock planted mainly on degraded or marginal land. There is no evidence of this in the UK to date – to our knowledge.

Principle 3

The UK's Biomass Strategy should maximise 'no regrets' nature based solutions to climate change which pose less risk to biodiversity and to climate than industrial scale bioenergy.

In connection to the points made under Principle 2, it should be noted that the scientific literature and the pathways yielded by Integrated Assessment Models are evolving, especially with respect to the negative emissions potential (and trade-offs) of various interventions.

This knowledge advance has implications for questions 5-6 in the consultation, which refer to the development of UK domestic biomass feedstocks – something which the Committee on Climate Change has also suggested the UK develop.

We highlight here **five** pieces of research which strongly suggest that the potential of forest plantations and energy crops (both of which are associated with Bioenergy and CCS) may be overstated as the best means to long term carbon storage and biodiversity protection. The emphasis in the reproduced passages below is ours.

Anna Harper et al (2018) find that:

> The effectiveness of BECCS strongly depends on several assumptions related to the choice of biomass, the fate of initial above ground biomass, and the fossil-fuel emissions offset in the energy system. Depending on these factors, **carbon removed from the atmosphere, through BECCS, could easily be offset by losses due to land-use change**. If BECCS involves replacing high-carbon content ecosystems with crops, then forest-based mitigation could be more efficient for atmospheric CO2 removal than BECCS.[27]

Likewise, Cécile Girardin et al (2021), find that:

> Nature-based solutions can have a powerful role in reducing temperatures in the long term. Land-use changes will continue to act long past the point at which net-zero emissions are achieved and global temperatures peak (known as peak warming) and will have an important role in planetary cooling in the second half of this century…**Restoration of forest cover is widely considered the most viable near-**

[27] Harper, A.B., Powell, T., Cox, P.M. et al. Land-use emissions play a critical role in land-based mitigation for Paris climate targets. **Nature Communications** 9, 2938 (2018). https://doi.org/10.1038/s41467-018-05340-z

term opportunity for carbon removal. Unfortunately, some of this enthusiasm has been used to promote plantation forestry — growing trees of a limited variety of ages and species (for example, in monoculture plantations) does not have the same carbon benefits as maintaining an intact forest ecosystem[28].

Meanwhile, Simon Lewis et al (2019) find that:

> **Natural-forest restoration is clearly the most effective approach for storing carbon.** But clashing priorities are sabotaging carbon storage potential. To illustrate, we calculated carbon uptake under a series of four restoration scenarios pledged by 43 countries under the Bonn Challenge and national schemes. In the first scenario, today's commitments are extended to 2100. In the second, these are retained to 2050, after which natural forest is converted to plantations for biofuels. In the third, the whole area (350 Mha) regenerates to natural forest. And in the fourth, everything becomes plantations.
>
> In short, if the entire 350 Mha is given over to natural forests, they would store an additional 42 Pg C by 2100. Giving the same area exclusively to plantations would sequester just 1 Pg C or, if used only for agroforestry, 7 Pg C. Furthermore, we find, on average, that **natural forests are 6 times better than agroforestry and 40 times better than plantations at storing carbon (sequestering 12, 1.9 and 0.3 Pg C per 100 Mha by 2100, respectively**[29];

Isabella Butnar et al (2020), after examining six of the most widely-cited Integrated Assessment Models which refer to negative emissions associated with BECCS, find, firstly, that:

> **All the IAMs we assessed assume that bioenergy is carbon neutral,** i.e., that the CO2 emissions linked to producing and using bioenergy in any form are equal to the CO2 that is sequestered by growing the biomass. Whilst there seems to be general agreement that sustainable biomass growth does re-capture the CO2 that results from

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[28] Girdardin et al Nature-based solutions can help cool the planet — if we act now **Nature** 593, 191-194 (2021) doi: https://doi.org/10.1038/d41586-021-01241-2 - see also - Anand M Osuri et al 2020 Greater stability of carbon capture in species-rich natural forests compared to species-poor plantations **Environ. Res. Lett**. 15 034011

[29] Lewis et al "Restoring natural forests is the best way to remove atmospheric carbon" Nature 568, 25-28 (2019): doi:10.1038/d41586-019-01026-8

> the combustion of biomass, the sequestration and emission rates might be in temporal imbalance[30]

And, secondly, that:

> When we dig into the detail of land rental rates per region and agricultural subsidies assumed for bioenergy production, the transparency of model assumptions decreases, with only some models detailing these costs.

Both of these points are important to bear in mind when considering biomass's potential contribution to a Net Zero UK, in terms of emissions pathways but also in terms of the likely costs of the transition, given the global pressures on land. **Pursuing large-scale BECCS as a policy option carries unacceptable risks**

Finally, Kew Science's work on the "Ten golden rules for reforestation to optimise carbon sequestration, biodiversity recovery and livelihood benefits" points towards a mix of species and forest restoration, rather than monocultures, as the means to maximise both carbon storage and biodiversity protection in forested areas.

> **When carbon capture and biodiversity enhancement are primary objectives, Natural Restoration can provide significant benefits over tree planting**…Tree planting is needed to restore forest when NR is insufficient (Rule 5)…
>
> In livelihood native forests, selecting a mix of species, rather than planting a monoculture, is crucial (Brancalion and Chazdon, 2017). A mixed-species forest, either with native species only or with a mix of native and non-native species, has a higher capacity to conserve biodiversity, create habitats for wildlife and attract seed dispersers and pollinators. Such forest can regenerate autonomously, especially if patches of native vegetation are maintained within the plantation matrix as habitat islands (Horák et al., 2019). It will also be more resilient to disease, fire and extreme weather events (Florentine et al., 2016; Verheyen et al., 2016). Monoculture plantations sequester little more carbon than the degraded lands on which they are planted, especially if they are

[30] Isabela Butnar et al 2020 Environ. Res. Lett. 15 084008 p.7

used for fuel or timber, in which case carbon is released back into the atmosphere within a few decades.[31]

Principle 4

The UK Biomass Strategy should not commit to large-scale BECCS projects unless they have been sufficiently demonstrated at smaller scale; and should not allow an emissions pathway with potential negative emissions to dampen the acceleration of emissions mitigation in the 2020s. Any demonstration projects must prove their ability to deliver negative emissions within a few years, once lifecycle emissions are accounted for.

There remain significant uncertainties around the potential for Bioenergy with Carbon Capture and Storage (BECCS) to contribute to the UK's Net Zero target. As Dan Quiggin points out in a report for Chatham House:

> The UK is leading efforts to develop policies and market frameworks to support BECCS. The UK must do so cognisant of the risks of BECCS under-performance and supply chain impacts, especially if such technologies are scaled internationally, else it risks undermining global efforts to decarbonise via proven low-carbon technologies.
>
> Based on the UK's Committee on Climate Change's (CCC) 2050 "further ambition" scenario for BECCS-to-power, if 100 per cent of the feedstock were provided by domestically grown wheat straw, an uplift of 57 to 83 per cent of current wheat production would be required, and 27 to 31 per cent of the UK's current agricultural land area, a substantial proportion that could have implications for food prices. Whilst this gives an indicator of the scale required under the CCC target, it should be noted that other agricultural residues could also be used alongside wheat straw, minimising or eliminating the need to increase wheat straw production.

[31] Alice Di Sacco and Kate A. Hardwick et al "Ten golden rules for reforestation to optimize carbon sequestration, biodiversity recovery and livelihood benefits" Global Change Biology Volume27, Issue7, April 2021 https://doi.org/10.1111/gcb.15498

> There are indications that first generation BECCS-to-power facilities will exhibit lower efficiencies than that envisaged by the CCC. Inefficient BECCS power plants would remove more CO2 for an equivalent generating capacity, but would likely require a greater carbon removal subsidy as power revenues would be relatively low compared to efficient equivalents.[32]

Two key questions around BECCS in the UK are which feedstocks will be available and what the capture rates and efficiencies of the facilities will be. For example, if facilities cannot use UK domestic energy crops because of how the facilities are designed, this may rule out a source of potential feedstock. We have already noted the huge pressures on European and US forests from bioenergy demand – so **it is hard to envision a carbon- beneficial scenario in which large-scale BECCS in the UK could rely on high levels of wood pellets.** *Furthermore, with the Paris Rulebook not yet complete – it is far from certain as to whether a tonne of 'negative emissions' based on the believed sequestration of an imported biomass feedstock would count towards the UK's net emissions reductions or those of an exporting country.*

There are also questions over the realistic technology-readiness of BECCS for a Net Zero policy aiming at 2050.

As a 2019 research programme led by Julian Allwood, for the UK FIRES programme[33] pointed out:

> Plans for "Bioenergy with CCS" or "BECCS" claim to be carbon negative – burning biomass and storing carbon permanently underground – are entirely implausible, due to the shortage of biomass, and should not be considered seriously.[34]

And both EASAC and another of our signatories, Duncan McLaren, have pointed out, there could be significant unintended negative effects of pursuing large- scale BECCS policies, in the shape of deterred action on mitigation in the 2020s and 2030s. A 2020 paper by Duncan McLaren examined a – global – worst case scenario in which 'imagined offsets' by BECCS and other Greenhouse Gas Removal technologies reduced global action to abate emissions by 17-27% - contributing to an additional temperature rise of 1.4 °C.[35]

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[32] Daniel Quiggin, BECCS Deployment, (Chatham House, 2021)

[33] UK Fires is a collaboration between the Universities of Cambridge, Oxford, Nottingham, Bath and Imperial College London

[34] Allwood et al (2019) 'Absolute Zero' p.33

It is also worth noting that the joint IPCC/IPBES workshop highlighted the following:

> Scenarios that achieve climate change targets with less need for terrestrial CDR measures generally rely on agricultural demand-side changes (diet change, waste reduction), and changes in agricultural production such as agricultural intensification (IPCC, 2019a; Section 2.7.2).
>
> Such pathways that minimize land use for bioenergy and bioenergy with carbon capture and storage (BECCS) are characterised by rapid and early reduction of GHG emissions in all sectors, as well as earlier carbon dioxide removal (CDR) through afforestation. In contrast, delayed mitigation action would increase reliance on land-based CDR.[36]

As noted, all this points to the huge risks associated with pursuing a large-scale BECCS policy.

October 2021

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[35] McLaren, D. (Oct. 2020), Quantifying the potential scale of mitigation deterrence from greenhouse gas removal techniques, Climatic Change, 162(4), doi:10.1007/s10584-020-02732-3. Springer Science and Business Media B.V.

[36] Ibid, IPBES/IPCC p.105