Committee on Climate Change

Independent advice to government on building a low-carbon economy and preparing for climate change

Bioenergy Review (2018) - Call for Evidence

Please answer only those questions where you have particular expertise and are able to provide links to supporting evidence.

In 2011 the Committee on Climate Change (CCC) published a Bioenergy Review to provide an assessment of the potential role of bioenergy in meeting the UK's carbon budgets. The Bioenergy Review drew on the best available evidence to address questions relating to the sustainability of bioenergy, lifecycle emissions, resource availability and best-use across the economy. It highlighted the importance of bioenergy for meeting the UK's climate change targets and made recommendations for tightening the sustainability standards for bioenergy resources - recommendations that were subsequently adopted by the UK Government.

The CCC is now planning to update its work on bioenergy, culminating in a new Bioenergy Review to be published in Autumn 2018. This will consider the latest evidence to provide an updated view on the role of bioenergy in decarbonising the UK economy through to 2050. Key themes to be explored include sustainability and certification, GHG emissions accounting, developing sustainable supply, non-energy uses of bioenergy resources, and transitions to future best-uses of bioenergy resources. We will identify recommendations for further action and aim to develop indicators to allow the CCC to monitor progress over time.

Stakeholder engagement will underpin the 2018 Bioenergy Review. This Call for Evidence is the first formal step in the engagement process. It is intended to provide all stakeholders with the opportunity to input to the CCC's work and to enable the CCC to draw on the full range of up-to-date evidence relating to bioenergy production, sustainability and use.

The Call for Evidence will be followed by stakeholder workshops on specific key topics in 2018. In addition, we will be establishing an Expert Advisory Group to provide advice and support to the CCC throughout the review.

Responding to the Call for Evidence

We encourage responses that are brief and to the point (i.e. a maximum of 400 words per question, plus links to supporting evidence), answering only those questions where you have particular expertise. We may follow up for more detail where appropriate.

Please use the website form when responding, or if you prefer you can use this word form and e-mail your responses to: communications@theccc.gsi.gov.uk. Alternatively, if you would prefer to post your response to us, please send it to:

The Committee on Climate Change – 2018 Bioenergy Review Call for Evidence
7 Holbein Place
London SW1W 8NR

The deadline for responses is 9am on 5th February 2018.

Confidentiality and data protection

Responses will be published on the CCC website after the response deadline, along with a list of names or organisations that responded to the Call for Evidence.

If you want information that you provide to be treated as confidential (and not automatically published) please say so clearly in writing when you send your response to the consultation. It would be helpful if you could explain to us why you regard the information you have provided as confidential. If we receive a request for disclosure of the information we will take full account of your explanation, but we cannot give an assurance that confidentiality can be maintained in all circumstances. An automatic confidentiality disclaimer generated by your IT system will not, of itself, be regarded by us as a confidentiality request.

All information provided in response to this consultation, including personal information, may be subject to publication or disclosure in accordance with the access to information legislation (primarily the Freedom of Information Act 2000, the Data Protection Act 1998 and the Environmental Information Regulations 2004).

Information on organisation / individual submitting response

If you are responding on behalf of an organisation please provide a brief description of your organisation and your role within this organisation.

My name is Joe Fox, and I am the Chair of the Southern Group of State Foresters (SGSF), submitting these comments on behalf of SGSF. SGSF represents the interests of the state government forestry agencies which are led by State Foresters. State Foresters are responsible for managing state and private forests, from across a 13-State area of the southern United States. The vast majority of the wood pellets sourced from the US to the UK come from this region. The SGSF mission is to provide leadership in sustaining the economic, environmental, and social benefits of the South's forests.

We have answered the questions below which intersect with our area of expertise – sustainable forestry in the US South and forest products markets in our region. We have included citations where appropriate to support our comments.

We thank you for the opportunity to comment and share our expertise, and welcome any further dialogue you wish to have on these or other forestry topics.

If you are responding as an individual we would be grateful if you could provide a brief description of your background and interest in bioenergy.

GHG emissions and sustainability of bioenergy imports

Our 2011 Bioenergy Review concluded that UK and EU regulatory approaches should be strengthened to better reflect estimates of the full lifecycle emissions of bioenergy feedstocks, taking into account both direct and indirect land-use change impacts. Whilst changes have been made to these regulatory frameworks, both life-cycle emissions and the wider sustainability impacts of bioenergy remain highly contested issues, particularly in relation to bioenergy imports. Given the potential role for bioenergy in the UK's low-carbon transition, and the potential increase in bioenergy feedstock production in the future, it will be essential that policy is based on the latest available evidence and that bioenergy is genuinely sustainable.

The term 'sustainable' here is used to cover a wide-range of issues relating to GHG emissions, biodiversity, water use, land-use, land-rights, air-quality and other social and environmental issues.

1. What is the latest evidence on lifecycle GHG emissions of biomass and other biofuels imported into the UK? How could this change over time as a function of scaling up supply? We are particularly interested in evidence that considers the full range of relevant issues including changes to forest and land carbon stocks, direct and indirect land-use change and wider market effects.

   Any method for bioenergy emissions accounting must be based on science and recognize the natural cycling of carbon. In contrast to GHGs from fuels like coal, oil and gas which have been in the ground for millions of years, modelling forest carbon necessarily involves fluxes of carbon being both sequestered and released. Thus, it is important that any accounting is done using the proper spatial and time scales to understand the full impacts of any policy intervention. While cutting a tree may instantaneously stop that tree from sequestering carbon, it may also enable other trees to increase their sequestration rate and create room for new trees to be planted and start sequestering in the future, all while the carbon in that tree that was cut can be used for long-lived wood products or for energy to replace fuels that will never resequester their carbon, such as coal, gas and oil. Any emissions modelling or accounting from forests must also be done recognizing a realistic counterfactual or baseline scenario. In our region, an unfortunate realistic baseline or alternative fate is for forests to be converted to other uses, such as residential or commercial development. In addition, in many places in our region bioenergy markets provide an alternative use for lower-value wood fibre that is harvested during a sawtimber harvest or as part of sustainable forestry best management practices. Without such a bioenergy market, this fibre may in many cases be piled to decay in the forest or burned to clear the ground for replanting, both of which would release carbon. Bioenergy emissions accounting needs to recognize how the forest is changed from an alternative fate, which is based upon many factors other than simply whether or not there is a bioenergy market.

Forest carbon analysis and tracking needs to be wholistic in our part of the country where forests are impacted by many different drivers.

There are a number of peer-reviewed studies which show significant lifecycle GHG benefits from biomass as a renewable energy displacing coal and other fossil fuels using the above described approach. These studies provide the most holistic lifecycle assessment, as they take into account the ecological response which takes up additional carbon, as well as the economic response of landowners planting more trees to access forest products markets.

Dr. Madhu Khanna, former chair of the US EPA Scientific Advisory Board Panel on Biogenic Emissions, and colleagues specifically studied the carbon impacts of trans-Atlantic biomass trade and found significant reduction in carbon emissions when biomass from the US was used in place of coal to produce energy in Europe and found beneficial results.

Drs. Christopher Galik and Robert Abt, through analysis of market responses to changes in supply and demand and consideration of historical and projected wood fibre prices in the US South, find a positive impact from new markets for lower-value wood fibre on forest growth and carbon storage.

The Society of American Foresters, led by Dr. Reid Miner, analysed peer-reviewed research on biogenic carbon and found insights for developing bioenergy policies, including: As long as wood-producing land remains forested, wood products and bioenergy reduce fossil fuel use and its long-term carbon emission impacts; Increased demand for wood can trigger investments and increase forest area and forest productivity; and a100 year time-frame should be used to assess biogenic carbon.

- **Wang, W. et al., Carbon savings with transatlantic trade in pellets: accounting for market-driven effects, Environmental Research Letters, Volume 10, Number 11, http://iopscience.iop.org/article/10.1088/1748-9326/10/11/114019**

- **Galik, C., and Abt, R. and Wu, Y. 2016. Sustainability guidelines and forest market response: an assessment of European Union pellet demand in the southeastern United States, Global Change Biology, Volume 8, Issue 3 May 2016, Pages 658–669 (http://onlinelibrary.wiley.com/doi/10.1111/gcbb.12273/full)**

- **Miner, R.A, et al; Forest Carbon Accounting Considerations in US Bioenergy Policy, Journal of Forestry, Volume 112, Number 6, November 2014, pp. 591-606(16) http://www.ingentaconnect.com/content/saf/jof/2014/00000112/00000006/art00007**

2. Under what circumstances can imported biomass and other biofuels deliver real GHG emissions savings (considering full life-cycle emissions and indirect/wider market

effects)? Conversely, what evidence is there for ruling out certain sources on the grounds of lifecycle GHG emissions or sustainability risks?

3. Currently the UK imports a significant proportion of wood pellets for biomass electricity production from North America, particularly the south-east USA.

    a) What are the wider market impacts of demand for wood pellets on forestry management practices and carbon stocks at the landscape level in North America?

Markets for forest products of any type have been shown to have generally positive impacts on forest cover and forest management in the US South. The largest positive impact comes from the market incentive provided to private landowners, who own 86% of the forests in the South, to keep their forests as forests and not convert them to other potentially more profitable land uses such as agriculture and development. The positive impact of strong forest products markets on forest retention has been shown historically, as the acreage of forests in the US South has grown in the past 50 years despite a significant increase in wood harvest for a variety of products, and been modelled into the future with studies showing beneficial forest cover and carbon impacts from wood pellet market growth.

Additionally, there has been no research we are aware of documenting landscape level forest impacts from wood pellet markets. To the contrary, evidence suggests wood pellet markets are not impacting forests in the US South any differently than other markets. This is due to the fact that as the number and/or diversity of markets grow, the US South has an excellent system of monitoring combined with regulatory and voluntary programs that ensure sustainability and minimize impacts on the landscape. Forestry Best Management Practices (BMPs) exist in every southern state to minimize impacts to water quality and other resources from silvicultural activities for markets of all types. Categories of activities for which BMPs exist in most states include harvesting, site preparation, forest roads, stream crossings, and streamside management zones. State forestry agencies developed BMPs starting in the 1970s, and they have been actively evaluated, tested, revised, and adapted over time. The Clean Water Act recognizes BMPs as the most viable pathway to address nonpoint source pollution that originates from various land management activities. SGSF and its members track BMP implementation rates on a state-by-state basis, as well as at the regional level. The most recent synthesis report in 2012 indicates that BMP implementation across the South is very high at 92%, and that implementation has been steadily increasing over the past two decades.

In addition, logger training and forest and fibre sourcing certification programs have proven to be key elements in ensuring sustainability on the ground in US Southern forests. These programs all work in concert to ensure that forest product procurement activities associated with markets of any type, including wood pellets, do not negatively impact our region's forest resource.

- **Galik, C., and Abt, R. and Wu, Y. 2016. Sustainability guidelines and forest market response: an assessment of European Union pellet demand in the southeastern United States, Global Change Biology, Volume 8, Issue 3 May 2016, Pages 658–669 (http://onlinelibrary.wiley.com/doi/10.1111/gcbb.12273/full)**

- **Parish, E.S. et al; Dataset of timberland variables used to assess forest conditions in two Southeastern United States' fuelsheds, Forest Ecology and Management, Volume 396, 15 July 2017, Pages 143-149, https://doi.org/10.1016/j.dib.2017.05.048**

- **Southern Group of State Foresters (SGSF) – Water Resources Committee. 2012. Implementation of Forestry Best Management Practices: 2012 Southern Region Report. http://www.southernforests.org/resources/publications/SGSF%20BMP%20Report%202012.pdf**

b) What evidence is there that wood pellet production displaces other uses of forestry products in North America? (e.g. panel board or lumber production)

Currently, USDA Forest Service Forest Inventory and Analysis data clearly show that significantly more trees are growing in southern forests than are being harvested. Across the area where pellet mills have opened, forests are growing 60 percent more volume than is being removed through all causes including harvest, insects & disease, and wildfire. This figure is even higher when looking at only hardwoods. The same trends remain when examined at smaller scales, with individual states showing between 40 and 100 percent more growth than removal. Simply put, there is an abundance of wood on the landscape.

Some of this abundance can be attributed to the loss of paper production capacity in our region. There has been, and will continue to be a decline in the pulp and paper market as a result of the 2008 recession and waning global demand for printed materials. The wood pellet markets are helping to fill that market void on the landscape, even siting in some of the exact same woodbaskets that have lost paper mills. Where there are both paper/pulp mills and pellet mills procuring from the same woodbasket, there may be competition for resources, but we have seen no evidence of market displacement. We believe that market competition for resources is a good thing, as it positively impacts the prices landowners get for selling their timber, and incentivizes replanting and keeping their land in forests.

Relative to other higher-value markets such as lumber, the pellet industry does not compete for the same resource. The markets have a symbiotic relationship, where lumber mills can take the higher-value trees off a site while the pellet mill takes the lower-value trees which are misshapen or unfit for the lumber mill process.

- **Wood Supply and Market Trends in the US South 1995-2015, Forest2Market, https://www.forest2market.com/hubfs/2016_Website/Documents/20151119_Forest2Market_USSouthWoodSupplyTrends.pdf**

c) What are the most likely alternative/counterfactual uses of forestry products used for wood pellet production?

In many places in our region bioenergy markets provide an alternative use for lower-value wood fibre that is harvested during a sawtimber harvest or as part of sustainable forestry best management practices. As described above, in many regions paper and pulp mills have closed or reduced in size and there is no market for the lower-value fibre. Without a bioenergy or other market, this fibre would be piled to decay in the forest or burned to clear the ground for replanting, both of which would release carbon, and could also have negative impacts on air and water quality.

When thinking about alternative fates or counterfactuals for the forest as a whole absent pellet and other markets, it is important to remember that the greatest threat to southern forests is conversion to other uses, most notably development and agriculture. The current economic reality is that the majority of private forest owners have to constantly reassess the best value of their land. Forestry is competing with agriculture, development and other uses for that land. Research from the USDA Forest Service projects that the South will lose between 11 and 23 million acres of forest by 2060, primarily due to conversion to development. However, it finds that forest conversion is reduced under scenarios with strong forest products markets that incentivize replanting and keeping forests on the landscape.

Good forest policy must incentivize these private forest owners to keep their forests as forests, and support markets that return to them an investment for their land. Recent modelling has shown that sustainably managed pellet markets can do just that, with a resultant increase in forested acres across the South. Policy that instead creates financial and procedural hurdles for these owners to access markets and actively manage their lands can be counterproductive to the end goal of forest health and forest retention across the South.

- **Wear, David N.; Greis, John G., eds. 2013. The Southern Forest Futures Project: technical report. Gen. Tech. Rep. SRS-178. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station. 542 p.**

- **Galik, C., and Abt, R. and Wu, Y. 2016. Sustainability guidelines and forest market response: an assessment of European Union pellet demand in the southeastern United States, Global Change Biology, Volume 8, Issue 3 May 2016, Pages 658–669 (http://onlinelibrary.wiley.com/doi/10.1111/gcbb.12273/full)**

d) How are these wider market impacts (sub-questions a-c) likely to change over time if demand for wood pellets significantly increases?

Currently, USDA Forest Service Forest Inventory and Analysis data clearly show that significantly more trees are growing in southern forests than are being harvested. Across the area where pellet mills have opened, forests are growing 60 percent more volume than is being removed through all causes including harvest, insects & disease, and wildfire. This figure is even higher when looking at only hardwoods. The same trends remain when examined at smaller scales, with individual states showing between 40 and 100 percent more growth than removal. Simply put, there is an abundance of wood on the landscape.

As wood pellet sourcing is one of many markets accessing the fibre from forests in the US South (Wood pellet demand in 2014 made up only 3% of fibre removals, and less than 0.1% of overall forest inventory in the US South), we do not see any likelihood that even with significant scaling up of the industry that pellet production could negatively impact forest sustainability. If sustainability impacts do begin to arise from wood pellet sourcing or any other cause, the United States has a robust monitoring system in place, led by the Forest Inventory and Analysis Program, to detect and respond to those challenges.

- **Wood Supply and Market Trends in the US South 1995-2015, Forest2Market, https://www.forest2market.com/hubfs/2016_Website/Documents/20151119_Forest2Market_USSouthWoodSupplyTrends.pdf**

- **Dale, V.H. et al, Status and Prospects for renewable energy using wood pellets from the southeastern United States, GCB Bioenergy (2017), doi: 10.1111/gcbb.12445, http://onlinelibrary.wiley.com/doi/10.1111/gcbb.12445/full**

4. Aside from GHG emissions, what evidence is there of other sustainability impacts associated with imported biomass or other biofuels? What evidence is there for how these might change as a function of scaling up supply (from the US, and internationally)?

We are unaware of any sustainability issues associated with current procurement of biomass, or reasonable projections for future sourcing. Currently, USDA Forest Service Forest Inventory and Analysis data clearly show that significantly more trees are growing in southern forests than are being harvested. Across the area where pellet mills have opened, forests are growing 60 percent more volume than is being removed through all causes including harvest, insects & disease, and wildfire. This figure is even higher when looking at only hardwoods. The same trends remain when examined at smaller scales, with individual states showing between 40 and 100 percent more growth than removal. Simply put, there is an abundance of wood on the landscape.

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5. Are there any benefits resulting from importing biomass or other biofuels into the UK (e.g. development benefits)? How might these vary internationally? What are the conditions required for any benefits to be realised?

The development of a biomass industry in the US to provide fibre to the UK and other international markets has numerous benefits within the US. Markets for forest products of any type have been shown to lead to a positive response in landowner replanting. As the majority of forests in the US South are privately owned (86%), with each private forest owner having the decision whether to continue growing trees or convert their land to other uses, the greater the market potential of trees the more likely those landowners are to keep their land in forests and maintain all the benefits that forests provide such as wildlife habitat, clean air and water, recreation opportunities, and more. In addition, the existence of the biomass market creates more jobs in the logging, transportation and pellet mill sectors, much of which are located in rural areas where jobs are lacking.

- **Dale, V.H. et al, Status and Prospects for renewable energy using wood pellets from the southeastern United States, GCB Bioenergy (2017), doi: 10.1111/gcbb.12445, http://onlinelibrary.wiley.com/doi/10.1111/gcbb.12445/full**

Sustainability policy and certification

The sustainability framework for bioenergy in the UK has evolved significantly since 2011. Changes have included the tightening over time of lifecycle GHG emissions limits for bioenergy supported under Government incentive schemes, changes to EU rules on liquid biofuels and the development of certification schemes. Nonetheless questions remain regarding the current framework's capacity to guarantee high sustainability standards.

The term 'sustainability framework' refers here to the policies, regulations and incentives in place to promote bioenergy sustainability in the UK.

6. What are the strengths, weaknesses and gaps of the current sustainability framework for bioenergy in the UK? How could the current sustainability framework for bioenergy in the UK be improved to address these issues?

   To our knowledge, the current UK sustainability framework works well in allowing biomass sourced from the United States to be used in the UK while assuring that forests where biomass fibre comes from are sustainable. In particular, it allows for the option for either forest-level certification or a risk-based approach to showing sustainability, which is necessary for the landscape in the US South where 86% of the forests are owned by over 100,000 private landowners. Despite many efforts, the level of forest certification in the US South has remained relatively low (~20%) over the past 20 years for many reasons, including costs and time to the landowner, lack of market premium placed on certification, and privacy concerns. This, however, does not mean that the forests aren't being managed sustainably, and the current UK framework allows for that sustainability to be shown at the supply-base level, through the Sustainable Biomass Program certification or other methods, which are equally useful.

7. Ofgem has identified a number of certification schemes that it considers appropriate for demonstrating compliance with the 'Land Criteria' under the Renewable Obligation sustainability standards. Are these certification schemes adequate? Why/why not? How could they be improved?

8. What certification schemes currently represent 'best practice'? Why?

   SGSF supports and recognizes three forest certification schemes operating in the United States: American Tree Farm Standard (ATFS), Sustainable Forestry Initiative (SFI), and Forest Stewardship Council (FSC) certifications. Each of these systems is science-based and together they work to help document the sustainability of forest management in the United States. In addition, the Sustainable Biomass Program (SBP) certification has proven to be a best practice approach to meeting the needs of the growing industrial biomass sector in the US South. SBP recognizes the role of other forest certifications such as ATFS, SFI and FSC and also adds additional elements that are unique to the needs of the biomass industry. In addition, SBP includes a comprehensive risk-based methodology for evaluation of sustainability at the supply-base level for non-certified lands, which is the most practical approach to documenting sustainability on a landscape with hundreds of thousands of individual landowners who are unlikely to get individually certified.

9. Ofgem has set out approaches to calculating bioenergy GHG emissions for demonstrating compliance with the 'GHG Criteria' under the Renewable Obligation sustainability standards. Are these approaches adequate? Why/why not? How could they be improved?

10. Please highlight any further measures you feel are required to ensure bioenergy feedstocks used in the UK are sustainable and deliver significant life-cycle GHG emissions savings. Why are these measures needed?

11. Some large UK users of imported biomass use a risk-based approach to assess the sustainability risks associated with importing biomass from specific jurisdictions. What is the role for these approaches?

Supply of bioenergy feedstocks

In our 2011 Bioenergy Review we considered scenarios for the amount of sustainable bioenergy resource available to the UK over the coming decades. Our central 'Extended Land Use' scenario suggested that around 10% of the UK's primary energy demand could be met from bioenergy in 2050, with over half coming from domestic feedstocks. We are now looking to develop new supply scenarios through to 2050 to reflect the latest evidence on sustainability and different assumptions about the potential future availability of imported and domestically produced bioenergy resources.

To support the development of these scenarios and our wider work, the CCC is currently undertaking new analysis on how the use and management of land in the UK can deliver deeper emissions reduction and increased sequestration. This analysis will provide updated data on the potential supply of non-waste and non-food bioenergy resources from UK sources. For projections of international bioenergy resources and waste-based UK bioenergy resources we will review the latest evidence and publicly available literature. We are particularly interested in quantitative estimates of resource potential, broken down by feedstock type, that are underpinned by explicit assumptions relating to sustainability.

12. What are the most credible and up-to-date estimates for global bioenergy resource potential through to 2050, broken down by feedstock type? What key assumptions underpin these estimates?

    Please provide details of any assessments of global bioenergy resource explicitly tied to sustainability standards (covering GHG emissions, biodiversity, water use, land-use, land-rights, air-quality and other social and environmental issues)

    For the US, the US Department of Energy estimates that 1 billion tons of forest and agriculture resources per year are available for a variety of uses, including for energy, without any adverse environmental effects.

    - **2016 Billion Ton Report, US Department of Energy, https://energy.gov/eere/bioenergy/2016-billion-ton-report**

13. What is the latest evidence relating to the availability of 'marginal' and abandoned agricultural land for growing bioenergy crops (where possible, reflecting broader sustainability requirements e.g. water stress, biodiversity, social issues)? Is this evidence adequately reflected in global resource estimates?

14. What are the most credible and up-to-date estimates for the amount of bioenergy resource that could be produced from UK waste sources through to 2050? Where possible please state any assumptions relating the reduction, reuse and recycling of different future waste streams.

15. What factors (opportunities, constraints, assumptions) should the CCC reflect in its bioenergy resource scenarios through to 2050?

16. What should be the assumptions on the share of international resource which can be accessed by the UK (e.g. per capita, current or future energy demand)?

17. What are the prospects for the development and commercial production of 3rd generation bioenergy feedstocks (e.g. algae)? What are the timescales, costs, risks, opportunities and abatement potential of using algae to make biofuels?

Scaling up UK sustainable supply

An objective of our current work on bioenergy is to better understand and reflect the potential for scaling-up of the supply of sustainably produced domestic (UK) bioenergy resources through to 2050. We aim to identify and develop policy recommendations for 'low-regrets' measures/strategies that can be implemented in the near term.

18. What are the main opportunities to scale-up the supply of sustainably-produced domestic bioenergy supply in the UK? Where possible please provide details on the scale of opportunity.

19. What risks are associated with scaling-up domestic supply and how can these risks be managed?

20. What 'low-regrets' measures should be taken now (e.g. planting strategies) to increase sustainably-produced domestic bioenergy supply?

21. What international examples of best-practice should the UK should look to when considering approaches to scaling-up domestic supply?

22. What policy measures should be considered by Government to help scale-up domestic supply?

Best-use of bioenergy resources

Our 2011 review developed a hierarchy of appropriate uses for bioenergy feedstocks based on minimising costs and maximising abatement. We concluded that if CCS technology is available it is appropriate to use bioenergy in applications with CCS, making it possible to achieve negative emissions under the right circumstances. This could include power and/or heat generation, hydrogen production, and biofuels production for use in aviation and shipping. If CCS is not available, bioenergy use could be skewed towards heat generation in

energy-intensive industry, and to biofuels in aviation and shipping, with no appropriate role in power generation or surface transport. In either case, we concluded the use of woody biomass in construction should be a high priority given that this can potentially secure negative emissions through a very efficient form of carbon capture.

We are now looking to update this analysis to reflect the latest technological and market developments. We are particularly interested in technologies such as biomass gasification, CCS and advanced second and third generation biofuels as well as the potential role of hydrogen to support decarbonisation across the economy. To support our consideration of these areas, the CCC is currently undertaking analysis into the potential of the hydrogen economy and we are planning to undertake further investigation into non-energy uses of bioenergy resources.

23. Gasification has been identified as a potentially important technology for unlocking the full potential of bioenergy to support economy-wide decarbonisation.
    a) What are the likely timescales for commercial deployment of gasification technologies?
    b) What efficiencies and costs are likely to be achieved? What scope is there for improvement and/or cost reductions over time? Please differentiate between feedstocks where possible/necessary.
    c) What are the main barriers and uncertainties associated with the development, deployment and use of gasification technologies?
    d) What risks are associated with gasification technologies and how can these be managed?
    e) What policies and incentives are required to facilitate commercial deployment?

24. Bioenergy with Carbon Capture and Storage (BECCS) has been identified as a key potential mechanism for achieving the UK's 2050 carbon target due to the 'negative emissions' it could offer.
    a) What are the potential timescales for commercial deployment of BECCS technologies?
    b) What are likely to be the optimal uses of BECCS (e.g. electricity generation, hydrogen production)?
    c) What efficiencies and costs are possible?
    d) How will performance and cost differ according to feedstock type? What are likely to be the optimal feedstock types for BECCS? What are the implications for domestic supply vs imports (e.g. feasibility, considerations in scaling up over time)?
    a. What are the main barriers and uncertainties associated with the development, deployment and use of BECCS?
    b. What are the risks associated with the pursuit of BECCS that go beyond the risks that relate to supplying sustainable feedstocks and CCS more generally? How can these be managed?

25. Once developed BECCS is a technology that could be deployed in many different countries around the world. What principles and mechanisms should be used to

determine where BECCS is deployed and how any associated negative emissions are accounted for? Should any UK participation in any international BECCS scheme be counted as additional to efforts to meet domestic carbon budgets?

26. There is currently substantial interest in the development of 'advanced' biofuels for use in sectors such as aviation, shipping and/or heavy duty transport.
    a) What are the most promising technologies/processes for advanced biofuel production up to 2050? Please provide details on each technology/process including advantages/disadvantages, timescales for commercial deployment, feedstock type, fuel type and end-user.
    b) What efficiencies and costs are likely to be achieved? What scope is there for improvement and/or cost reductions over time? Please differentiate between technologies/processes.
    c) What are likely to be the optimal feedstock types for advanced biofuel technologies?
    d) What are likely to be the optimal end-uses of advanced biofuel technologies?
    e) What are the main barriers and uncertainties associated with the development, deployment and use of advanced biofuel technologies?
    f) What risks are associated with the pursuit of advanced biofuel technologies and how can these be managed?
    g) What policies and incentives are required to facilitate commercial deployment of advanced biofuels?

27. In 2015 the Government published the Industrial Decarbonisation and Energy Efficiency Roadmaps to 2050. These Roadmaps explored decarbonisation options across multiple industrial sectors and the estimated deployment potential, timescales, cost data and abatement for each option (including bioenergy). Are there any substantial changes from these estimates that the CCC should consider when assessing abatement options in industry? If so please provide your reasoning and details of any recent evidence that relates to these changes.

28. In our 2011 review we identified wood in construction as a potentially effective method of CCS and a high priority 'non-energy' use in our best-use hierarchy.
    a. What lifecycle GHG emissions savings can be achieved by using WIC? Under what circumstances does WIC fail to deliver GHG emissions savings? Please consider the full range of impacts associated with using WIC including substituted product emissions (e.g. cement), product equivalence (impacts on co-products), end-of-life options and biogenic carbon storage.
    b. What is the potential for increasing the amount of wood used in construction in the UK? What are the barriers and how can they be overcome?
    c. What is the potential for using UK-produced timber in construction rather than imports? What are the barriers and how can they be overcome?
    d. What is the expected lifetime of different wood products in construction (e.g. cross-laminated timber)?
    e. What currently happens to wood in construction at the end of its useful life? What other viable options should be developed?

29. There are also a number of other potential non-energy uses of bio-feedstocks including bio-based plastics and bio-based chemicals.
    a. What other non-energy uses of bio-feedstocks have the most potential through to 2050 in terms of GHG abatement, cost, timescales and market size?
    b. What are the barriers to increasing these non-energy uses and how can these barriers be overcome?
    c. What risks are associated with the pursuit of other non-energy uses of bio-feedstocks and how can these be managed?

From a forest fibre standpoint, increasing the number and diversity of markets and end uses has been shown to be a benefit and not a risk to southern forests. By and large, all end uses source wood fibre in the same ways, through the same loggers, and from the same landowners. As the majority of forests in the US South are privately owned (86%), with each private forest owner having the decision whether to continue growing trees or convert their land to other uses, the greater the market potential of trees the more likely those landowners are to keep their land in forests and maintain all the benefits that forests provide. Reducing the number of markets increases the risk of conversion to other uses like commercial and residential development.

- **Wear, D.N. and Greis, J.G. (2013) Southern Forest Futures Technical Report, http://www.srs.fs.fed.us/pubs/gtr/gtr_srs178.pdf**

- **Abt., K.L. et al (2014) Effect of Policies on Pellet Production and Forests in the US South https://www.srs.fs.usda.gov/pubs/gtr/gtr_srs202.pdf**

GHG emissions reporting and accounting

GHG emissions reporting rules for bioenergy are different to those for other forms of energy. Emissions relating to the use (combustion) of bioenergy resources are not reported in the country of use but rather in the country where bioenergy resources are produced. Only Annex 1 countries under the Kyoto Protocol currently account for land-use emissions as part of binding emission reduction targets. In addition under Paris Agreement rules emissions (as under the Kyoto Protocol) will be reported against land-use baselines that may already assume a degree of land-use change. For these reasons and others, bioenergy GHG accounting has been criticised for not properly reflecting the impacts of bioenergy.

30. What are the strengths and weaknesses of the current approach to GHG emissions accounting for bioenergy in the UK and internationally? Specifically, what are the main gaps in the current land use emissions accounting rules?

31. What are the risks, in terms of GHG emissions, associated with importing biomass or other biofuels from countries that have not committed to limiting or reducing emissions under the Kyoto Protocol or Paris Agreement? How can these risks be managed?

Whether a country is a signatory to the Paris Agreement or not, it is important from a risk standpoint for any wood fibre exporter to the UK to have a robust forest carbon tracking system. In the United States, forest carbon stocks and forest inventory are monitored on a regular basis, and reported at the national level by the USDA Forest Service through Forest Inventory and Analysis (FIA) data. Our state agencies in the South are responsible for inventorying forest data in our respective states and including that data in the FIA database. This monitoring, which was first initiated in 1930, occurs irrespective of any international treaties or agreements and provides the most comprehensive national system in the world for tracking forests and the carbon pool they represent. This data enables foresters and policymakers to know whether the forest carbon pool is a sink or a source for any given time period and any given region, and to analyse how the forest carbon pool responds to any number of policy interventions and market opportunities for forest products. Forest carbon and forest stocks are reported by FIA on an annual basis.

- **FIA and Carbon Homepage - https://www.fia.fs.fed.us/forestcarbon/**

- **2015 National Greenhouse Gas Report – LULUCF documentation https://www.fia.fs.fed.us/forestcarbon/docs/US-GHG-Inventory-2015-Chapter-6-Land-Use-Land-Use-Change-and-Forestry-opt.pdf**

32. What alternative method(s) for bioenergy emissions accounting should be considered? What would the implications of these alternative method(s) be?

Any method for bioenergy emissions accounting must be based on science and recognize the natural cycling of carbon. In contrast to GHGs from fuels like coal, oil and gas which have been in the ground for millions of years, modelling forest carbon necessarily involves fluxes of carbon being both sequestered and released. Thus, it is important that any accounting is done using the proper spatial and time scales to understand the full impacts of any policy intervention. While cutting a tree may instantaneously stop that tree from sequestering carbon, it may also enable other trees to increase their sequestration rate and create room for new trees to be planted and start sequestering in the future, all while the carbon in that tree that was cut can be used for long-lived wood products or for energy to replace fuels that will never resequester their carbon, such as coal, gas and oil. Any emissions modelling or accounting from forests must also be done recognizing a realistic counterfactual or baseline scenario. In our region, an unfortunate realistic baseline or alternative fate is for forests to be converted to other uses, such as residential or commercial development. In addition, in many places in our region bioenergy markets provide an alternative use for lower-value wood fibre that is harvested during a sawtimber harvest or as part of sustainable forestry best management practices. Without such a bioenergy market, this fibre may in many cases be piled to decay in the forest or burned to clear the ground for replanting, both of which would release carbon. Bioenergy emissions accounting needs to recognize how the forest is changed from an alternative fate, which is based upon many factors other than simply whether or not there is a bioenergy market. Forest carbon analysis and tracking needs to be wholistic in our part of the country where forests are impacted by many different drivers.

- **Miner, R.A, et al; Forest Carbon Accounting Considerations in US Bioenergy Policy, Journal of Forestry, Volume 112, Number 6, November 2014, pp. 591-606(16) http://www.ingentaconnect.com/content/saf/jof/2014/00000112/00000006/art00007**

- **Galik, C., and Abt, R. and Wu, Y. 2016. Sustainability guidelines and forest market response: an assessment of European Union pellet demand in the southeastern United States, Global Change Biology, Volume 8, Issue 3 May 2016, Pages 658–669 (http://onlinelibrary.wiley.com/doi/10.1111/gcbb.12273/full)**

Indicators

As part of the 2018 Bioenergy Review the CCC is planning to develop a set of indicators to track progress towards key bioenergy outcomes. We envisage these will cover key areas such as sustainability, policy development, supply and best-use.

33. What key areas should be reflected in these indicators?

34. Please provide details of any examples of international best-practice in the area of bioenergy indicators.

Other

35. Please submit any further evidence that you would like us to consider.