Ricardo Energy & Environment

CCC Bioenergy Call for Evidence

Summary of evidence submitted, final report

Report for Committee on Climate Change
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1 Introduction

This report summarises the responses to the CCC Bioenergy Review (2018) - Call for Evidence, which closed for submission on 5th February 2018. This is provided in Appendix 1.

As part of this summary we have discussed the quality of evidence submitted as part of the response. Figure 1 shows how this was assessed.

Figure 1 Criteria for assessing quality of evidence

Type of publication	Rating	Justification
Peer reviewed journal	High	Subjected to independent expert review
Published research from EC/ International Research Programmes	High	Likely to be peer reviewed
Government funded	High	Some review
Privately funded (Trade association, NGO)	Medium	Limited review. Scope may be strongly directed.
Information from individual companies or individuals.	Medium	Limited or no review. Scope may be strongly directed.
Information from websites, blogs etc.	Low	Traceability and reliability of information is difficult to ascertain.

In general, this means that high quality evidence included peer reviewed articles, well researched and cited Government funded work and Government statistics; medium quality evidence included reports where the derivation of the conclusions was not clear, but the research was based on credible studies, or NGO research that had not been peer reviewed. Low quality evidence included work that was not supported by high quality references or where references were not included.

2 GHG emissions and sustainability of bioenergy imports

2.1 Summary of responses to Q1

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.						
21 Respondents: 12 from UK; 8 from USA; 1 from Canada						
Trade Associations 8	Energy 3	Biomass 1	NGO 5	Government Agency 2	Research 2	Certification 0
Sectors						
Academic, Agriculture, Bioenergy, Conservation, Electricity generation, Forestry, Gas, Minerals, Non-bioenergy, Pellet, Renewable Energy						
Over 70 sources of evidence were provided.						

2.1.1 Summary of responses

Lifecycle GHG emissions

Responses were mainly focused on wood pellets and chips with only a couple of responses on biogas and biofuels. For wood pellets and chips, responses were generally split along two lines:

1. Those who felt the use of wood pellets offered substantial GHG savings compared to fossil fuels and would not cause land-use change.
2. Those who thought the use of wood pellets would not offer substantial GHG savings and could lead to an overall increase in GHG due to changes in forest and carbon stocks.

Over 70 sources of evidence were provided to support these views.

2.1.1.1 Areas where respondents agree

The following represents the range of respondents' views:

- GHG emissions vary greatly, dependant on the feedstock, conversion pathway and counterfactual / baseline used; these are all very specific to the individual supply chain being considered.
- In the case of bioenergy from energy crops, energy crop yield and the carbon intensity of local electricity generation can be as influential as transport distance to the UK in determining lifecycle GHG emissions.
- Identifying the correct counterfactual is critical to an accurate assessment of GHG emissions
- It is important to use the proper spatial and time scales to understand GHG emissions from forestry and pellet production.
- Reporting of lifecycle emissions under the RHI and RO legislation has provided information on GHG emissions from imported and domestic biomass fuels, albeit as calculated using the specified methodology.
- Use of woody biomass should only be allowed if it reduces carbon emissions and supply chains are sustainable and carefully managed.

2.1.1.2 Areas where there is uncertainty or disagreement in interpretation of the evidence

The following are particular issues raised by respondents or areas where there were clear differences in the interpretation of evidence:

- The correct counterfactual for wood used for pellet production. On the one hand, evidence was presented to support the argument that the economics that drive forestry management practice must be considered when considering the correct counterfactual, and that scenarios where the counterfactual is an unharvested forest are unrealistic. Several responses state that *biomass for bioenergy is at the bottom of the value chain; its utilisation offers increased return to foresters but is not of sufficient value to alter management decisions, which are driven by timber demand for the construction industry*. These respondents believed pellet production is unlikely to use whole trees, as these can be used for higher value products. As the biomass is produced as a by-product of other industries, they argue that only the direct emissions during production and transportation of pellets should be included in GHG calculations and that land use changes and changes in carbon stock do not need to be taken account of as they are not driven by pellet production.
- These respondents also suggested that without the bioenergy market, residues may in many cases be piled to decay in the forest or burned.
- On the other hand, some respondents provided low quality evidence that unsustainable logging practices are used and pellets are sourced from whole trees, that the industry degrades highly diverse natural forest and that natural forest could be converted to plantations as a result of pellet demand, and this should not be allowed to happen. They suggest that forests should be used as a means of carbon sequestration, and generally reference the Chatham house report, which uses unharvested forests as its counterfactual. Evidence on forest materials used in pellet production is provided for Question 3. They also reference work that suggests that explicit dynamic lifecycle models should be used to assess the climate impacts of using forest biomass for bioenergy.
- Some respondents agree that changes in forest carbon be accounted for in the country of origin's forestry sector carbon accounting (i.e. under LULUCF in their national GHG inventory), rather than be accounted for in bioenergy production emissions calculations. They say that biomass should then only be sourced from countries with mandatory carbon accounting for land related emissions. Any biomass sourced from non-LULUCF accounting countries should be required to prove there is no over-harvesting associated with its use.
- Some respondents question whether compliance with the ISO standards on lifecycle assessment methodologies prevents the proper assessment of emissions resulting from indirect land use change.
- Some respondents question whether the existing lifecycle methodologies adequately account for non-CO_2 GHG emissions, in particular methane emissions from biomass stockpiles and stores.

In the case of biofuels, respondents noted that evidence suggested GHG emissions associated with indirect land use change (ILUC) were uncertain, but could be high. They suggested that for biofuels it is useful to carry out consequential life cycle analysis of biofuels in addition to attributional life cycle analysis.

Impact on GHG emissions of scaling up supply

Far fewer respondents gave a view on the impact of scaling up supply on GHG emissions.

For pellets it was suggested that there is much additional residual material that could be used for pellets under current forestry management, so there would be no additional impacts on carbon stocks and hence emissions. One respondent suggested that growing recognition of the environmental benefits of using wood in construction could result in a greater use of wood in construction, increasing the sawmill waste available for pellet production. It was also suggested that increased supplies could bring about improvements in lifecycle emissions due to streamlining in the supply chain, e.g. development of more efficient pellet plants and use of larger capacity (more fuel-efficient) ships for transport to the UK. One respondent noted new uses for mill and harvest residues may also emerge for the production of bioproducts (e.g. biochemicals, biomaterials), decreasing residues available for pellet production.

With respect to energy crops, one respondent pointed to modelling that suggests that if increases in supply were large enough they could result in energy crops being grown on non-marginal land, which would result in direct and/or indirect land use effects, and increased emissions.

In the case of biofuels, one respondent suggested that until E10 is introduced, the proportion of biodiesel used to meet the RTFO is likely to increase. While no imported biodiesel to the UK is

currently made from food crops, the supply of wastes and residues is limited. Consequently, food crop derived biodiesel, which has higher GHG emissions, may enter the market in the future.

2.2 Summary of responses to Q2

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?						
15 Respondents: 9 from UK; 5 from USA; 1 from Canada; 0 from Europe						
Trade Associations	Energy	Biomass	NGO	Government Agency	Research	Certification
5	2	1	5	1	1	0
Sectors						
Academic, Agriculture, Bioenergy, Conservation, Electricity generation, Forestry, Minerals, Pellet, Renewable Energy						
37 pieces of evidence were submitted with responses. 30 of these were high quality, five were medium quality and 2 were low quality.						

2.2.1 Summary of responses

GHG emissions savings

Responses were generally split along the two lines they were for question 1, as this question is on a similar subject, and several respondents simply referred to their question 1 answer when responding to this question. As with question 1 responses are mainly focused on woody biomass, in particular imported wood pellets from North America. This is not surprising given its current dominance in biomass imports to the UK.

The split in respondents is as follows:

1. Those who felt the use of wood pellets offered substantial GHG savings compared to fossil fuels and would not cause land-use change.
2. Those who thought the use of wood pellets would not offer substantial GHG savings and could lead to an overall increase in GHG due to changes in forest and carbon stocks.

2.2.1.1 Areas where respondents agree

Overall respondents agree fuels that cause land use changes may not result in GHG savings, whereas fuels from wastes, residuals and by-products are more likely to offer GHG savings. It was thought that bioenergy products need to be harvested in a sustainable manner that does not decrease carbon stocks.

Responses generally agree on the following points for ensuring GHG savings are made for biomass:

- Biomass should be sourced from sustainably certified managed forests that will be replanted/regenerated after harvest where the material removed is below the rate of annual increment.
- Biomass should be sourced from forestry residues and processing residues.
- Pellets produced from forest residues that would have otherwise been burnt are likely to offer GHG savings, whereas those produced from forest residues that would have otherwise been left on the forest floor are offer lower savings.
- Biomass should not be sourced from primary or virgin forests, sites identified as having high biodiversity value or protected sites (*but the challenge will be providing an accepted definition for these terms*).
- Whether feedstocks are imported or domestic is a secondary factor for dictating GHG savings compared to feedstocks.
- Biomass should be sourced in accordance with best management guidelines and regulations (these responses included reference to specific guidelines); should not encourage high carbon harvest scenarios; and should encourage the efficient use of biomass (preferably for heat or cogenerating heat alongside power). If the demand for biomass results in new forest

being planted then there will be a net carbon benefit. One respondent stated the biomass demand had already increased forest growth (high quality statistical evidence was provided to support this).
- Sourcing standards should be adequately enforced.

Evidence provided in support of these statements was generally of high quality (mainly peer-reviewed scientific articles, government publications and EU commission reports). Some low quality references were also used (own data, web sites etc). There were a range of good scientific papers suggested as evidence. Hanssen et al (2017) and Jonker et al (2014) both discuss the GHG parity / Carbon payback for different feedstocks. The Royal Academy of Engineering have published a thorough report on the sustainability of biofuels. The BEIS reports on BEAC and North American pellets provide comprehensive evidence of forest practice and harvest drivers. The Forest Research source is universally acknowledged and referenced as good quality evidence. The NRCan references were of high quality and support the Forest Research work. What these references show is that the assumptions around the drivers for harvest and the use of the wood impact the carbon outcomes modelled. Results to carbon analysis can be very different depending on these assumptions (good quality evidence will provide a range of results), so any literature used should justify its choice of these assumptions and show that they are based on real forest management practice. One key assumption that influences results is whether the main driver for harvest is pellet production.

For **anaerobic digestion (AD) and biofuels** the following recommendations are made by respondents:
- Preference should be for feedstocks from local sources and feedstocks that would otherwise become waste.
- Digestates produced should be used to reduce the need for other fertilisers.
- For food waste one respondent suggested that AD extracts more energy than incineration, so incentives should encourage this waste to go to AD. (High quality evidence was provided on the energy balance).

2.2.1.2 Areas where there is uncertainty or disagreement in interpretation of the evidence

- The timespan of offering the GHG savings is often represented by a wide range.
- Some respondents said pellet production should not use healthy standing trees, whereas others argued it is acceptable to use whole trees, so long as they are harvested at a rate below the annual increment.

  One respondent suggested using biomass in cement kilns offers an important carbon solution and the RHI should not divert this biomass to heat without consideration of the carbon impacts. The arguments over the use of whole trees relate to how harvest is done and what would happen to these trees if they are not used for pellet production. In some cases, they may be left standing, but in most cases, they will be harvested anyway. What matters then is what happens to the harvested wood. In some cases it may be burnt to clear the land for regeneration; in others it may be left to rot naturally (the real threat of fire, pests and disease will probably determine this). One way to understand this could be to compare harvest practice in areas where there is no pellet production with that in areas where there is.

  There is also an argument that bioenergy sustainability requirements will not resolve the issue of deforestation. What is needed is good, local conservation practice for specific types of woodland that are under threat and that represent important ecosystems and that can represent carbon sinks. RSPB evidence indicates that “one of the best ways to reduce emissions is to protect and restore natural stores and sinks of greenhouse gas emissions… i.e. to leave these ecosystems intact”. Canada has introduced such requirements over a period of 20+ years. This type of negotiation is beyond the remit of pellet production; and probably very difficult to introduce in areas of high small scale ownership, such as southeastern USA.

One thing that came out of the BEAC analysis is the importance of economics/market return in dictating forest harvesting practice (whether for plantations or naturally regenerating forest). In other words, a high carbon option is probably not likely to happen if it makes no economic sense.

2.3 Summary of responses to Q3

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?
   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)
   c. What are the most likely alternative/counterfactual uses of forestry products used for wood pellet production?
   d. How are these wider market impacts (sub-questions a-c) likely to change over time if demand for wood pellets significantly increases?

18 Respondents: 8 from UK; 9 from USA; 1 from Canada; 0 from Europe

Trade Associations	Energy	Biomass	NGO	Government Agency	Research	Certification
7	3	1	3	3	1	0

Sectors

Academic, Agriculture, Bioenergy, Conservation, Electricity generation, Forestry, Gas, Non-bioenergy, Pellet, Renewable Energy

39 pieces of evidence were submitted with responses. Much of the evidence was of high quality, but some evidence was of medium or low quality

2.3.1 Summary of responses

Responses were split along two lines:

1. Responses that evaluated the impact of pellet production in general and concluded that the impacts of pellet demand in North America were not significant across the region
2. Those that highlighted specific concerns and concluded that impacts from increased pellet production are significant for these concerns.

Over 100 sources of evidence were provided to support these views. Some of these sources include letters that refer to further sources.

2.3.1.1 Areas where respondents agree

All respondents agree that there has been substantial increase in pellet production over the past eight years in southeastern USA and that this is likely to continue to expand at least until 2020. Good evidence from many sources (academic, market and Government) is provided to support this.

The potential competing markets for the raw material used by pellet production is pulp and paper or oriented strand board (OSB). Evidence is supplied to support this from market, industry and Government sources. Respondents did not agree on the impact of pellets on these competing markets.

There is good evidence that forests are not grown for pellets but that pellet production is an additional product that can use unused residues. This does not change forest management practice.

There is good evidence that pellet production is a small proportion of the overall market[1] and the ability to pay for raw material is low compared to saw log prices (reference was made to evidence from Pöyry and the European Commission's findings on their State Aid investigation).

[1] Provided variably as 0.1% of inventory, 4 and 6% of roundwood softwoods and hardwoods used (3% total fibre removals), or <7% of exported products.

2.3.1.2 Areas where there is uncertainty or disagreement in interpretation of the evidence

- The raw material used for pellet production.
- The impact of pellet production on competing markets for the wood.
- The impact of pellet production on the stumpage.
- The impact of pellet production on forests (biodiversity, loss of naturally regenerated forest and increase in plantations).

Respondents differed in their interpretation of the evidence in these areas and used different sources to support their views.

2.4 Summary of responses to Q4

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)?						
17 Respondents: 9 from UK; 7 from USA; 1 from Canada; 0 from Europe						
Trade Associations	Energy	Biomass	NGO	Government Agency	Research	Certification
4	3	2	5	2	1	0
Sectors						
Academic, Agriculture, Bioenergy, Conservation, Electricity generation, Forestry, Gas, Minerals, Non-bioenergy, Pellet, Renewable Energy						
55 pieces of evidence were submitted with responses. 25 of these were high quality, 17 were medium quality and 13 were low quality.						

2.4.1 Summary of responses

Sustainability Impacts

Responses focused on wood pellets and chips. There were few responses on biogas and biofuels. Responses were generally split along two lines:

1. Those who thought the production of biomass and other biofuels has a negligible or positive sustainable impact.
2. Those who thought the production of biomass and other biofuels has a negative sustainable impact.

Over 50 sources of evidence were provided to support these views of mixed medium – high quality.

2.4.1.1 Areas where respondents agree

- Sustainability is important to both domestic and imported fuels.
- Impacts on land, water and energy from biomass production should all be considered. One respondent said that the water footprint is strongly dependent on regional climate, precipitation, biomass type and yield, and that regions with low carbon footprint do not necessarily coincide with low water footprint areas. They referred to the MONET tool for calculating water footprints.
- Land use change can have negative sustainability impacts.
- It is important that the right assumptions/data is used in tools and models used to assess sustainability and other benefits (high quality evidence provided).
- There is a need for studies to provide specific evidence (supported by high quality evidence).

2.4.1.2 Areas where there is uncertainty or disagreement in interpretation of the evidence

Those who felt production of biomass had a negligible or positive sustainable impact generally made the following comments:

General comments on biomass

- European and UK requirements and North American regulations ensure harm to ecosystems is minimised.
- One respondent said that biomass that can improve biodiversity, habitat, water quality, soil carbon sequestration, soil quality, and wildfire prevention and gave the example of the clearance of invasive species (high quality evidence provided). Another suggested that the market for biomass could create development benefits in some exporting countries, e.g. markets for old rubber trees in West Africa which would otherwise be burned on site as waste wood. (No evidence provided).
- One respondent said that energy crops for anaerobic digestion have provided a profitable use for drought prone, low productivity land. They required very low pesticide levels, so were better for biodiversity than other crops. This respondent recorded an increase in grey partridge and brown hare since converting the land to growing energy crops. (Evidence based on empirical evidence).
- Integrating energy crops into agricultural systems or feedstock sourcing along other conventional agri and forest products can also provide environmental and emissions benefits (high quality evidence provided).

North American pellet supply

- High quality evidence was used to show that US biomass pellet production comes from working forest lands or underutilised mill residues; Canadian pellet production is predominantly from mill residues or pine beetle kill wood.
- One respondent said that Canadian studies have demonstrated the amount of harvest residues potential available and that harvest residues are under-utilised. This respondent said there have been studies on the impact of harvest removals on forest ecosystems, demonstrating few, if any, effects of forest harvesting on soil and site productivity. (High quality evidence). Respondents said a decline in the pulp paper market has resulted in a surplus of low-grade harvesting residuals (referenced to Pöyry analysis).
- A number of respondents used a range of medium to high quality evidence to support the view that demand for biomass provides long term security to forest owners, allowing them to invest in forest management that improves forest health, biodiversity and water quality; and that this market also encourages forest regeneration and retention. These respondents questioned whether removal of forest residues drives impacts, as forest harvesting is driven by other, higher return products.
- There are no biodiversity impacts associated with current practices, although longer term studies are needed (Scientific articles - Riffel et al. 2011a, Riffel et al. 2011b, Verschuyl et al. 2011, Work et al. 2013, Kline et al. 2015 and Venier et al. 2017).
- One respondent said that demand for pellets has led to an increase in the transparency of forest operations, providing evidence that the supply chain did not access wood from high conservation value regions or forests that would be converted to plantations (reference to a track and trace tool).

Those who thought the production of biomass and other biofuels had a negative sustainable impact considered that:

General biomass

- One respondent raised concerns about how potential impacts from land use for energy crops could be monitored/understand and controlled. The same respondent was concerned that the production of biofuels in the EU might have indirect impacts resulting in increased planting of oil palm elsewhere. (Low to medium quality evidence supplied).
- Some respondents were concerned about potential impacts in South American and African tropical regions, where poor governance and institutional factors may make it hard to control negative impacts such as deforestation and socio-economic impacts (A study conducted by the US National wildlife federation was referenced, the EU report on the environmental implications of increased reliance of the EU on biomass from the south east US and the EU study space for energy crops). One respondent said it is hard to check the sustainability of imports.

- Air emissions were mentioned by some respondents, particularly harvest emissions (dust) and combustion emissions (soot and NOx). (Quality of evidence supplied: low for harvest emissions; high for combustion emissions).

North American forest impacts

- Some respondents drew attention to the impacts of large scale biomass production for bioenergy in Southeastern USA, saying that pellet demand can result additional pressures for conversion of naturally regenerating forest to monoculture plantations and to decreases in biodiversity (specifically through habitat loss/degradation). In addition, removal of forest residues can impact soil quality. Medium to high quality evidence was provided to support this.
- These respondents were concerned about socio-economic pressures resulting in negative impacts. Low to medium quality evidence was provided to support this.

2.5 Summary of responses to Q5

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?						
15 Respondents: 7 from UK; 7 from USA; 1 from Canada; 0 from Europe						
Trade Associations	Energy	Biomass	NGO	Government Agency	Research	Certification
5	3	1	3	2	1	0
Sectors						
Academic, Bioenergy, Conservation, Electricity generation, Forestry, Gas, Minerals, Non-bioenergy, Pellet						
26 pieces of evidence were submitted with responses. Ten of these were high quality, three were medium quality and 13 were low quality.						

2.5.1 Summary of responses

The respondents fall into similar groups as questions 1 to 4 and had already raised several benefits or concerns over imports in their previous responses. The responses focus almost exclusively on woody biomass. There was little overall agreement, so responses are summarised as general evidence and evidence on benefits and negative impacts.

2.5.1.1 General comments

One respondent drew on high quality evidence, saying “If bioenergy is done right there are a range of benefits, including environmental and socio-economic. However, in terms of development benefits it is important to consider the livelihood and energy supply situation of the region biomass is sourced from and the question has to be ask if it is ethical to possibly source biomass for UK imports from regions with significant energy insecurity and limited energy access”.

Another respondent pointed to challenges in understanding life cycle impacts (using consequential LCA, getting the counterfactuals right and particularly to the challenges in understanding indirect consequences such as indirect land use change). (High quality evidence submitted).

Other respondents pointed to multiple benefits: market value to forestry sector, socio-economic benefits (jobs) and investment in local infrastructure development, but provided little evidence to support this.

A number of respondents mention the UK’s sustainability framework. Although many thought this was a good framework, some thought questions remain on its ability to deliver high sustainability standards. (No evidence provided to support this).

Respondents suggested the following conditions could help realise the benefits of imported biomass.

- Require developments to obtain the free, prior and informed consent of any communities living in or around the proposed biomass sourcing area and to guarantee secure land tenure to local communities.

- Encourage the harvesting of invasive species to restore native habitat or cultivating native grasses on marginal or degraded land.

2.5.1.2 Benefits from importing biomass

Benefits for the producing country

- A number of respondents said that the use of forest residues for pellet production has had local benefits, increasing the funds available to improve management of woodland with good environmental and local socio-economic outcomes. This market also strengthens the use of forestry and means land is less likely to be converted from forest to other uses. (Supported by a range from no evidence to high quality evidence).
- One respondent said that biomass provides a potential market for low grade wood fibre that otherwise would not be fully utilised e.g. in British Columbia the wood pellet producers are utilising sawmill residues that were previously burned as waste; in the Baltic region there have historically been limited markets for low grade wood and thinnings which has resulted in much of this material being left in the forest to rot. (Low quality evidence supplied to support this).

Benefits for the UK

- Increased energy security through diversification of fuel supplies.
- One respondent said that imports enable the development of a competitive market for biomass in the UK, allowing bioenergy to be developed. Large markets enable efficiency improvements and market stability and are one way to access cheaper biomass. (No supplementary evidence was provided).
- One respondent said the UK wood basket is limited and in places demand is exceeding supply. Importing biomass fuels can help to mitigate the risks of displacement of industries who are reliant upon using UK domestic wood for material purposes but whose supply base is under threat by subsidized energy companies. (No supporting evidence provided).
- One respondent noted that as all UK biomass imports must comply with criteria on sustainability and legality there is an opportunity for the UK to 'export' its standards to other countries, improving international sustainability (no supporting evidence provided).

2.5.1.3 Negative impacts of importing biomass

Respondents (mainly NGOs) raise the following negative impacts of biomass imports.

- Some respondents pointed to negative impacts from pellet production, primarily increased noise and dust pollution, threats to clean drinking water and health impacts such as asthma and allergies (using low quality evidence).
- Medium quality evidence was provided to support the view that large-scale forest plantations increase 'land grabs', resulting in important socio-economic impacts for the local community; and local water flow impacts.

3 Sustainability policy and certification

3.1 Summary of responses to Q6

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?						
19 Respondents: 10 from UK; 8 from USA; 1 from Canada; 0 from Europe						
Trade Associations	Energy	Biomass	NGO	Government Agency	Research	Certification
7	3	1	5	2	1	0
Sectors						
Academic, Agriculture, Bioenergy, Conservation, Electricity generation, Forestry, Gas, Minerals, Pellet, Renewable Energy						
30 pieces of evidence were submitted with the responses. 24 pieces of evidence were high quality; two were medium quality; and four were low quality.						

3.1.1 Summary of responses

Current sustainability framework

Respondents pointed out that the UK sustainability framework is implemented through the incentive schemes for bioenergy and renewables (i.e. the RTFO, RO, CfD and RHI) and although the principles are similar across the schemes they are implemented slightly differently.

The schemes comply with the requirements of the Renewable Energy Directive (RED), as amended by the Indirect Land Use Change Directive. They set sustainability criteria for crops and residues used to produce fuels or electricity and all set out methods of calculating the GHG emissions associated with land use, cultivation, transport and generation or production. These are acknowledged to provide the most stringent sustainability framework in the world and have to be implemented in all supply chains. High quality evidence supported this[2] such as

Strengths

- A number of respondents agree that the current systems laid out in the Ofgem and BEIS guidance are adequate if audited correctly. Some respondents went further and said that it is a strong sustainability framework (providing details as to why, but no additional supporting evidence).
- Respondents found it helpful that the framework recognises certification and management schemes, which enables producers to manage their whole supply chains, without having to comply with different schemes just for biomass.
- Some respondents thought it was an advantage to not include prohibitions on sourcing biomass from ‘primary forests’ because this terminology is difficult to interpret.
- Respondents liked the fact that it allows for either forest level certification compliance or a risk-based approach to sustainability. One respondent said the benefits of the risk based approach are that areas of weakness can be identified in a region making it feasible to ensure that suppliers mitigate those risks.
- The BSL certification scheme requires that suppliers submit a GHG life-cycle analysis for each fuel they register and evidence that the fuel complies with the land criteria and UK forestry legislation. Increased auditing of imported fuel on the BSL would also be beneficial to verify the GHG life-cycle and land-use compliance evidence.

[2] For example: Indufys (2016) ‘International Comparison of Forest Management Legal Frameworks and Certification Standards’; CCC (2018) An independent assessment of the UK’s Clean Growth Strategy From ambition to action.

- Independent auditing of fuel suppliers on a routine basis. Data submitted to the independent regulator (Ofgem), who determines compliance with UK regulations.
- Little evidence was submitted in support of these strengths, but respondents provided examples from their own experience.

Weaknesses

- General: some respondents were concerned that the framework is piecemeal and does not incentivise best performance or recognise the potential for trade-offs between different impacts. It has led to a disjointed approach to use of biomass in energy in the UK and inefficiencies in the way the valuable bioenergy feedstocks are being utilised. (High quality evidence is provided to support this[3])
- One respondent felt that the sustainability framework was not strong enough to guarantee that large scale biomass use does not harm the environment.
- Under the Renewables Obligation only 70% of feedstock must be both legal and sustainable; the remaining 30% can be legal alone (but does not have to meet the sustainability standards), referred to as the '70:30 threshold'. This also applies to the RHI and CfD

Specific weaknesses

- There are important differences between schemes. An example given is that transport biofuels made from waste are required to demonstrate that their GHG emissions are significantly lower than fossil fuels while electricity generated from waste does not have to carry out any GHG assessment.
- The RED includes a set of defaults based on a best practise that may not be employed in an actual facility. GHG calculations do not look at the actual counterfactual for the feedstocks used in a facility.
- The land criteria in the UK focusses only on sustainable forest management and does not cover sustainability throughout the supply chain (e.g. health and safety requirements in the processing plant). The land criteria are based on principles and procedures rather than outcomes.
- There is inherent sustainability in using mill residuals which are a by-product of manufacturing and might otherwise go to waste. Requirements for residual fibre to meet the same sustainability standards as fibre direct from the forest provides little additional sustainability assurances and may result in the exclusion of fibre that could provide a very positive carbon outcome.
- Only some activities can access the RHI and therefore biomass is switching from one consumer to another with a net detriment to the environment. For example, biomass that was used very efficiently to heat cement kilns is now being used in RHI incentivised combustion and digestion, which is less efficient.
- Biofuels (RTFO). The science behind ILUC is uncertain, , and on this basis, the European Biodiesel Board have argued that the crop cap should not be any lower than 7%. The new RTFO has a crop cap starting at 4% and going down to 2%. This is likely to put a strain on the UK's ability to fulfil the Obligation level in the future, and the regulations may need to be revisited to rectify the problem. (Medium quality evidence supplied).

From those who believe biomass will increase emissions:

- These criteria provide only limited protection for certain high biodiversity and high carbon stock areas from conversion for bioenergy. There are no restrictions on sourcing woody biomass from primary forests (including old growth forests), nature protection or highly biodiverse areas, peatlands, former wetlands or former continuously-forested areas. No definition of primary forests was provided. These respondents also called for restrictions on the use of whole trees and large diameter wood (definitions not provided). (Low to medium quality evidence submitted in support of this).

[3] Including Indufys (2016) 'International Comparison of Forest Management Legal Frameworks and Certification Standards'; CCC (2018) An independent assessment of the UK's Clean Growth Strategy From ambition to action; 'ABDA (2017) Anaerobic Digestion Market & Policy Report.

- A regional risk approach is used for assessing the potential sustainability risks of biomass. This approach is too coarse a scale to be able to identify potential on-the-ground impacts to the environment.
- One respondent considered that only FSC certified wood provides sufficient protection for the natural environment and wildlife.

Gaps

- Current policy does not address key biodiversity concerns.
- A number of respondents said that the main gap in the existing sustainability framework is that there is no agreed methodology for assessing Indirect Land Use Change (ILUC) and so these are not included (high quality evidence provided).
- There was a call to recognise the existence of waste and residues that are not listed in Annex IX of the Revised Renewable Energy Directive. Biofuels produced from feedstocks listed in Annex IX of the ILUC Directive are 'double counted' when assessing their contribution so e.g. in the UK receive double RTFCs. There was concern that the Annex IX list is not comprehensive and there are some wastes and residues which are not listed, that could be used as biofuels feedstocks, but the biofuels produced would not be eligible for double counting. The RTFO guidance needs to cover such material properly
- Policies suggested as plugging policy gaps on sustainability in the agricultural sector going forward were renewable biofertilizer credits to encourage the use of digestate, an agricultural greenhouse gas abatement fund to provide support for emissions reductions projects, and a favourable tax system to support AD.

Improvements

- GHG calculations should consider previous use of feedstocks and estimate the GHG impact of diverting them.
- There was a call for policy to recognise the important role of wastes and to encourage collection of wastes that cannot be recycled (particularly food waste) for use in bioenergy.

3.2 Summary of responses to Q7

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?						
13 Respondents: 6 from UK; 6 from USA; 1 from Canada; 0 from Europe						
Trade Associations	Energy	Biomass	NGO	Government Agency	Research	Certification
5	2	1	3	1	0	1
Sectors						
Agriculture, Bioenergy, Certification, Conservation, Electricity generation, Forestry, Pellet, Renewable Energy						
Seven pieces of evidence were submitted with the responses: two of high quality; three of medium quality and two of low quality.						

3.2.1 Summary of responses

3.2.1.1 Certification schemes

Responses that thought existing certification schemes are adequate, raised the following points:

- The outcome of the Ofgem 2015 benchmarking of voluntary schemes against the land criteria for woody biomass was considered by a number of respondents to be sufficient to demonstrate the adequacy of those schemes reviewed. One respondent thought that the SBP is particularly valuable because it captures and recognizes existing standards and takes a supply-based approach to evaluating sustainability. FSC and PEFC are established,

internationally-recognized, third-party schemes with 25 years of experience in designing systems to evaluate and encourage progress toward sustainable forest management.

- The current system offers a flexible approach by recognizing compliance with the land criteria through 'Category A' evidence (certification), or through bespoke 'Category B' evidence. This is useful as not all forest owners are certified.
- Standards that can be applied at the supply base level, such as Sustainable Biomass Program (SBP) are more suitable for small scale forest owners, removing the financial and administrative burden and placing it on the biomass producer instead.
- Use of a common certification system by operators in the woody biomass to energy sector brings efficiency benefits and facilitates consistency across the supply chain, replacing the need for individual end-users to implement their own verification systems.

Little evidence was provided in support of these points.

Responses that thought existing certification schemes are inadequate, raised the following points**:**

- The current systems rely on regional data, which may not adequately capture management trends and problems in forests and may become out of date.
- None of the schemes require producers to calculate the carbon emissions associated with carbon stock changes resulting from biomass harvests.
- On forest sustainability and legality, many of the standards (with the exception of the Forest Stewardship Council (FSC) standard) typically fail to provide robust, performance-based thresholds and protections.
- Risk assessments can be conducted with a fundamental lack of objectivity (often carried out by the biomass producers themselves), consistency, and connection to the management of actual source forests, and they rarely require on-the-ground verification.
- Critical flaws were highlighted in the SBP standard, raising questions about the SBP's ability to provide credible assurances of biomass sustainability and carbon emissions intensity. (Medium quality evidence was provided to support this point[4]). In general low to medium quality evidence was provided to support these points.

One respondent raised the point that setting standards for imported biomass is unlikely to change forestry practices, as most of the forest value (e.g. timber products) might not require compliance with certification schemes, which makes it difficult for fuel suppliers to require it for the low-value by-product.

Scheme improvements

One respondent raised the point it is important that sustainability standards also support landscape level, risk-assessments that ensure that across a landscape, not just on an individual property, forests are sustainably managed. Such landscape level assessments can help identify risks in wood baskets and can help focus certification in areas where it is needed to address sustainability issues. This respondent is currently building a new tool, Forest in Focus, designed to provide a transparent tool to assess sustainability of forests in wood baskets.

[4] •The Sustainable Biomass Program (2017), Smokescreen for Forest Destruction and Corporate Non-Accountability.

3.3 Summary of responses to Q8

8. What certification schemes currently represent 'best practice'? Why?						
15 Respondents: 7 from UK; 7 from USA; 1 from Canada; 0 from Europe						
Trade Associations	Energy	Biomass	NGO	Government Agency	Research	Certification
5	2	1	4	2	0	1
Sectors						
Agriculture, Bioenergy, Certification, Conservation, Electricity generation, Forestry, Pellet, Renewable Energy						
14 pieces of evidence were submitted with the responses: three were of high quality and 11 were of medium quality						

3.3.1 Summary of responses

General

Respondents note several internationally-recognized, independent third-party forestry certification schemes, such as FSC, SFI, SBP, and PEFC are used by pellet producers, having been used by forest products industries for decades to demonstrate sustainability and as being revised on a routine basis.

The respondents state these schemes assess sustainability using risk-based assessments of the supply chain and wood-basket or sourcing region, which allows a complete picture of forest growth and carbon stocks within the region. This approach has been endorsed by both the EU Parliament and the EU Council as they head into final negotiations on the Renewable Energy Directive for 2021-2030.

One respondent suggested that 'best practice' in the bioenergy context will come from adding of biomass-specific criteria into, or layering them onto, these well-established schemes, due to their extensive experience and understanding of the complexities and multi-dimensional nature of sustainable forest management.

The points raised by respondents on specific schemes are given below, in order of most cited to least cited.

Forest Stewardship Council (FSC) standard

- Developed and are governed by multi-stakeholder bodies.
- Requires production of national forest management standards and their audit at site level, combined with transparent and rigorous 'chain of custody' for product traceability.
- Covers social, environmental as well as economic representation at all levels of policy making, standard development and auditing, as well as having robust complaints procedures.
- Facilitates opportunities for small landowners to participate through group certificates.
- Precludes biomass from recently converted plantations and from clear cuts that are excessively damaging to wildlife. This is done though safeguards to protect rare, threatened and endangered species and their habitats, which require identification and protection of key species and ecosystems and that representative samples of the existing ecosystem are protected in their natural state. The safeguards also require that forest conversion to non-forest land uses shall not occur unless:
    - the area is limited in size to 1% of forest area (US standards) or 40 acres (other countries),
    - the area is not on high conservation value forests,
    - the conversion enables long-term conservation benefits)
- One respondent commented, however, that the FSC scheme does not adequately account for carbon stock changes resulting from biomass harvests

SFI certification

- Developed mandatory logger training programs in partnership with state forestry agencies.

- Requires suppliers to maintain up-to-date training status to deliver wood.
- SFI Procurement Standard, has created sufficient protections for water quality.

The Sustainable Biomass Programme

- Only certification scheme which is specifically designed to address the sustainability of bioenergy and which covers both the land criteria and the greenhouse gas criteria.
- 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.
- Evidence meets and often exceeds UK requirements and SBP is considered a Category A compliance mechanism for UK sustainability regulations.
- Greatest requirement for stakeholder consultation of the major certification schemes.
- 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.
- However, SBP can be applied only in combination with one of the existing forest certification schemes – it does not replace them.

American Forest Foundation (AFF)'s American Tree Farm System (ATFS) forest certification

- AFF's eight Standards of Sustainability that ATFS certifies to, which are updated and improved upon every 5 years, reflect best forestry practices for family woodland management.
- Engages an expert panel to review the Standards, accepts public comment, and works to continuously improve the Standards.
- Provides education, outreach, and support to help family woodland owners manage their land, while also certifying their land to 8 Standards of Sustainability.
- Promotes continuous improvement on the land, through regular monitoring, verification and third-party auditing of forests certified to ATFS.
- The largest woodlands system in the world aimed at family forest owners.

Biofuels and AD

Substantially fewer respondents commented on other areas, but the following were raised as best practice.

AD Certification Scheme (ADCS)

- Industry-led initiative which aims to support the AD industry in the UK to improve operational, environmental and health & safety performance created with extensive stakeholder input.
- Raises awareness of existing regulation, guidance and standards for delivering a high performing plant.
- Independent audit and certification process.

The Biomethane Certification Scheme (BMCS)

- Credible process for certifying biomethane and a trading platform to facilitate the trading of certificates.
- The biomethane certificates issued under the scheme can be traded separately from the physical commodity gas, allowing the certificate owner to transact the gas at the market price whilst seeking the highest economic value for the Biomethane Certificate.
- Independent certification.
- First accreditation against ISO 14065 for verification of claims (reference to UKAS announcement).

Renewable transport fuel obligation

- One respondent thought these represent best practice at present, because the legislation they are based on is being updated to comply with the ILUC directive.

3.4 Summary of responses to Q9

Question 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?						
12 Respondents: 8 from UK; 4 from USA; 0 from Canada; 0 from Europe						
Trade Associations	Energy	Biomass	NGO	Government Agency	Research	Certification
5	2	1	3	0	0	1
Sectors						
Agriculture, Bioenergy, Certification, Conservation, Electricity generation, Forestry, Pellet, Renewable Energy						
Five pieces of evidence were submitted by respondents: tow of high, two of medium and one of low quality.						

3.4.1 Summary of responses

GHG criteria and emission calculations

Responses were generally split along the two lines they were for question 1, as this question is on a similar subject, with those who think land use changes and carbon stock changes need not be included, as biomass is a low value product from other industries; and those who think these should be included. The former say the current approach is adequate, with some suggested improvements, the latter tend to think they are not.

One respondent noted that as emissions reduction thresholds become stricter, biomass producers will be paying closer attention to ensuring that GHG calculations accurately represent the energy use they report from their supply chains. Another suggested that to ensure fairness across the UK energy mix the same reporting should be required of all fuels.

One respondent commented that while the Renewables Obligation (RO) methodology is sound, most new plants will now be developed under Contracts for Difference (CfDs) and the recent consultation on setting new values for GHG criteria in the CfD Scheme represents a real challenge to new-projects' viability as they are so far below those previously achieved. The proposed criteria for projects commissioning between 2022-2026 are either 25 or 40 kg $C0_2$/MWh[5] compared to the most stringent criteria currently (from 2025 to 2030) of 180 kg $C0_2$/MWh.

Adequacy of the methodology

- The current framework is the result of considerable consultation and analysis and is viewed as the most stringent in the world, developed after many months of consultations and stakeholder input. The methodology is clear and easy to understand.
- It provides a robust and well-established method of accounting for emissions, covering these on a comprehensive basis, including transport and handling, therefore, providing a holistic account of emissions associated with particular plants' operations.
- The methodology requires third-party auditing of the data provided by plant operators.

Inadequacy of the methodology

- The methodology excludes emissions from changes in the carbon stock of a forest, foregone carbon sequestration of forests or indirect impacts on carbon stocks in other areas of land (all together 'land-use changes'), and from combustion (reference to BEAC report).
- There is little transparency of the GHG emission data reported to Ofgem by producers registered under the Feed-in Tariffs and the Renewable Heat Incentive schemes.

Suggested improvements

[5] The consultation document suggests two options:40 kg CO2e per MWh is the mean emissions intensity of plants reporting since 2011/12 and 25 kg CO2e per MWh, based on the lowest 30% of emissions intensities reported by existing plants since 2011/12.

The following improvements were raised by respondents

- The methodology could be improved to include greater flexibility, transparency and accuracy in calculations including by enabling users to enter more site-specific data and explanations / justifications for differences in emission factors and application of conservative factors.
- The methodology must be kept up to date with the best data. The current B2C2 model has several areas where updates are necessary, including default values which are based on out of date data.
- EU methodology advises that a 1.4 conservative factor[6] should be placed on any transportation or processing modules, compared to the UK model which uses 1.4, applied on the processing modules only.
- GHG savings goals for bioenergy power generation will need to be adjusted as grid carbon intensity declines with decarbonisation of the generating fleet.
- The GHG criteria would be strengthened by accounting for emissions from: the combustion of biomass; changes in the carbon stock of a forest; foregone carbon sequestration of forest land; or indirect impacts on carbon stocks in other areas of land, resulting from re-directing biomass from other uses, such as using wood to make paper, furniture and construction materials.
- GHG criteria that contribute to climate solutions should either a) have a lifecycle analysis framework that can differentiate the timeframe of emissions benefits, or b) provide a list of allowable climate-friendly feedstocks that can be verified.

Evidence
Often no evidence was provided in support of these views, but where it was provided the evidence was of medium to high quality.

3.5 Summary of responses to Q10

Question 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?						
15 Respondents: 11 from UK; 4 from USA; 0 from Canada; 0 from Europe						
Trade Associations	Energy	Biomass	NGO	Government Agency	Research	Certification
7	3	0	3	0	2	0
Sectors						
Academic, Bioenergy, Conservation, Electricity generation, Forestry, Gas, Minerals, Non-bioenergy, Pellet, Renewable Energy.						
29 pieces of evidence were submitted in support of these responses: 20 of high, five of medium and four of low quality.						

3.5.1 Summary of responses

Sustainability of bioenergy feedstocks

The respondents suggested the following additional measures for improving the sustainability of bioenergy feedstocks.

Woody biomass

- There should be a suite of biosecurity measures appropriate to the risk posed by different timber products: from pellets and pulp at the least threat, through chip and sawn timber, to timber packaging and firewood at the greatest threat.

[6] In the existing RED and in the RED recast for emissions from liquid biofuels, the methodology applies a conservative factor of 1.4 to the processing step only. In the RED recast, solid and gaseous biomass fuels have been added as well, and for this proposed new set of values a conservative value of 1.2 is applied to both the processing and transport related emissions. In both cases the conservative factor is applied to the typical emissions to get the default emissions.

- Apply robust sustainability standards to 100% of feedstock (as opposed to the current 70%).

Other Bioenergy

- Any assessment of the use of bioenergy feedstocks should take into consideration the end to end use of the feedstock, efficiencies and intended use. Priority should be given to the conversion of the feedstock into fuels that help to decarbonise sectors that have limited other options.
- Encourage incorporation into the farming landscape of the second-generation bioenergy crops Miscanthus and Willow SRC as these generally have positive impacts on farmland biodiversity (Scientific studies including Bourke et al., 2013, Petrovan et al., 2007, Rowe et al., 2009, 2011, 2013).

GHG savings

The respondents suggested the following additional measures for delivering GHG savings.

General

- For the Government to facilitate a working group on adjustments of GHG emission calculators used under RO/CfD/RHI to include the latest research and updated default values. This would help to deliver better and more accurate reporting across the industry.

Biomass

Similar points are raised as in previous questions from respondents who think land use changes and carbon stock changes are applicable to the biomass supply chain and should be included.

- Any assessment should look at carbon impacts for the whole system, including indirect impacts such as ILUC, where appropriate, and any changes to carbon stores. Consideration of changes in carbon stock resulting from biomass removal should be included in calculations even if these are separately treated under relevant accounting frameworks.
- High carbon feedstocks should be ruled out, particularly the use of stumps and roundwood.
- Policy needs to include emissions at the stack.
- Calculations should incorporate direct land-use change impacts on soil carbon stocks into GHG calculations and protecting high carbon mineral soils, in addition to the current protections for high carbon peat soils.
- Perennial energy crops should only be planted onto low carbon soils where they minimize soil carbon losses in the short-term and promote soil carbon sequestration in the long-term. (high quality evidence was provided to support this). Criteria must encourage the longevity of plantation while they remain productive (15-20 yrs.) and adopting best practices in management.

Other measures raised by respondents include:

- Biomass should only be used in the most efficient applications, preferably with co-generation.
- The cement and dolomitic lime sectors use a number of waste fuels that are 100% or part biomass. The cement and dolomitic lime manufacturing process offers a very energy efficient method of utilising this waste biomass because the heat from the combustion of these fuels is used directly, rather than to heat an intermediary substance. They would like this to be recognised.
- The UK must ensure a ‘cascading use’ of wood products, based on the waste hierarchy. In other words, wood products destined for recycling or reuse must not go to energy uses instead.
- There should be one set of sustainability regulations for all kinds of imported forest products. This will ensure consistency in how this material delivers GHG benefits and impacts on forests.

3.6 Summary of responses to Q11

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?						
12 Respondents: 6 from UK; 5 from USA; 1 from Canada; 0 from Europe						
Trade Associations	Energy	Biomass	NGO	Government Agency	Research	Certification
4	2	1	3	1	0	1
Sectors						
Bioenergy, Certification, Conservation, Electricity generation, Forestry, Pellet, Renewable Energy.						
Two pieces of evidence were submitted in support of the responses, one medium and one low quality.						

3.6.1 Summary of responses

Many of the responses listed below were not supported by evidence, rather the responses were based on the experience of the respondents in this area.

In favour of a risk based approach

The respondents state the key role for a risk based approach is to enable a bioenergy market to make use of residue material where there are low levels of certification. This includes areas such as:

- Sawmills where only a proportion of the material is purchased with a certified claim. In these circumstances, the sawmill would not be able to sell these residues to the pellet industry, which means the material may go unused.
- Countries which are well regulated, but do not have high levels of certified land (for example the US where there are many small private land owners). The lack of certification does not mean that the material is not sustainable, or the land has not been managed properly; it simply means that the purchaser of the material must do their own assessment to verify that the raw material came from sustainable sources. There are reasons why forest owners do not opt to become certified by certification bodies such as the FSC and PEFC, such as cost, forest size, rotation frequency, and overall consumer demand.

The respondents raise the following benefits of using a risk based approach.

- Risk assessments allow for robust and comprehensive sustainability assurances while also working within the private landownership framework and complex forest market that exists in some regions, including the USA.
- It allows suppliers to procure timber from forests that are not certified through certification schemes, if they can provide credible evidence showing low-risk of non-compliance with the woodfuel land criteria on a regional level. These forests are still governed by national and regional legislation which ensures the legality and sustainability of the forests.
- It allows a complete picture of forest growth and carbon stocks within the region. The pellet producer then has a complete view of their supply chain and the wood basket in which they operate and can demonstrate low-risk of non-compliance or mitigate any potential risks.
- With the diversity of governance reliability around the world, it makes sense to employ risk-based approaches to focus resources where most needed. Once the national assessment identifies a low level of risk, an assessment approach allows the producers to maintain a supply from diverse sources without imposing costly verification requirements while monitoring the overall sustainability of the wood basket.
- Allows importers to focus risk management efforts, such as in-depth investigations, site visits and document collection, on imports from higher-risk jurisdictions or higher-risk suppliers.
- With their position at the bottom of the value chain, pellet producers cannot provide enough financial incentive for private forest owners to obtain costly certifications annually. Instead, the pellet producers hold the certification.

The respondents raise the following points of note on risk based assessments.

- Several respondents support using risk-based approaches combined with the promotion of certification of individual forest parcels.
- The use of a risk-based approach is permitted in any jurisdiction. However in a high-risk region, this approach may become more onerous due to the high levels of FSC Forest Management certification and signification documentation of risk mitigation processes which is required
- Risk assessments should also take into account the use of voluntary forest certification schemes and chain-of-custody measures.

Against the use of risk based approach

Some respondents were against the use of risk based approach. The points they raise include:

- Risk assessments undertaken on a regional level do not necessarily demonstrate the risk at individual forest stand level and can miss significant on-the-ground impacts on the natural environment.
- Regional risk assessments place strong reliance on national and state laws. In the U.S. Southeast, such laws do not restrict clearcutting in sensitive forests, wetlands (reference to 2014 NRDC fact sheet).
- The SBP approach allows producers to choose their own evidence. There is no requirement for the assessment to be conducted by objective third parties. Rather, they can be conducted by the biomass producers themselves.
- Risk-based approaches should be replaced by evidence gathered at the supply-base or stand level in order to ensure the assessment accurately reflects what is occurring in the specific supply chain being assessed.

Low to medium quality evidence was provided in support of these points.

4 Supply of bioenergy feedstocks

4.1 Summary of responses to Q12

Question 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)						
15 Respondents: 8 from UK; 6 from USA; 0 from Canada; 1 from Europe						
Trade Associations	Energy	Biomass	NGO	Government Agency	Research	Certification
5	3	1	4	1	1	0
Sectors						
Academic, Agriculture, Bioenergy, Conservation, Forestry, Gas, Non-bioenergy, Pellet, Renewable Energy.						
15 sources of evidence were submitted by respondents. These were all of high quality. Two sources of evidence were recommended by four respondents. One source was recommended by two respondents.						

4.1.1 Summary of responses

There are limited sources of information on global resource potential, which is why a number of respondents submitted common evidence. Some of the evidence submitted is for one country (UK or USA). Five sources examined global sources.

4.1.1.1 Areas where there is agreement

- Estimations of global resource potential are sensitive to the assumptions that underlie the estimates: that is assumptions about land use and yields for energy crops, assumptions about fibre availability and competition for this fibre, assumptions about waste arisings and the competing uses for waste, and the general impacts and benefits of bioenergy.
- As a result of the point above, resource estimates tend to use scenario analysis to understand sensitivity to factors that might influence availability of biomass, such as policy, sustainability, socio-economic factors, etc.
- Most of the UK estimates use current data as a starting point to develop an unconstrained potential. This is then used to develop constrained potentials now (e.g. by subtracting competing uses) and then use assumptions to develop future estimates of availability.
- Estimates of resources tend to be done in a similar manner for each study, so differences in the outcome are a result of different fundamental assumptions around availability, competition and market, technical and environmental constraints.
- Respondents believe that there are “limited prospects for commercially competitive production of algal bioenergy feedstocks (in the UK), due to both capital and operating costs.”

4.1.1.2 Areas where there is uncertainty or disagreement in interpretation of the evidence

- Key areas where there is disagreement in interpretation of the evidence relate to land use estimates; competing uses (particularly future food requirements); land types and assumed current land uses; and environmental impacts and their mitigation.
- Conflicting evidence is provided on whether bioenergy demand increases deforestation or results in higher reforestation. The latter is based on the potential for bioenergy to increase income from forests and retain land in forestry (based on good quality economic analysis and experience of forest sector stakeholders).

- Some respondents present good quality evidence from scientific literature that there is potential to increase cropping intensity to simultaneously increase food and bioenergy provision whilst increasing soil fertility and improving ecosystem services; other respondents point to uncertainties in these analyses.
- Respondents present evidence that increased fibre take from forests should be accompanied by guidance to prevent negative impacts, such as erosion and loss of biodiversity. Mitigation options to prevent poor practice and environmental consequences are put forward by the US Forest Service Southern Forest Futures project, based on high quality scientific evidence.
- Some respondents thought insufficient account is taken of future fibre requirements for all wood products in the estimates of fibre available for wood fuels. One ns expressed concern that that the use of fibre for bioenergy may increase fibre prices[7],

4.1.1.3 Areas where there are gaps

One respondent summarised gaps as follows: estimates "are fraught with uncertainty and variability, most often in relation to related systems e.g. how land bioenergy production is affected by population, dietary trends (affecting both agri-residue availability and land availability)".

4.2 Summary of responses to Q13

4.2.1 Summary of responses

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?						
8 Respondents: 6 from UK; 1 from USA; 0 from Canada; 1 from Europe						
Trade Associations	Energy	Biomass	NGO	Government Agency	Research	Certification
2	1	0	3	0	2	0
Sectors						
Academic, Bioenergy, Conservation, Forestry						
23 sources of evidence were provided, including scientific peer reviewed literature, NGO reports and reports written by consultancies. 10 pieces of this evidence were of high quality, 9 medium quality and 2 low quality. Two pieces of evidence could not be accessed.						

4.2.1.1 Areas where there is agreement

- The data on land use is not adequate to judge the availability of marginal land. (For example, "data on spare land was not of a high enough quality and even the small area of spare land available may still result in an adverse environmental impact"). A number of high quality references discussed this issue, including work by JRC.
- Marginal land needs to be better defined so that land of high conservation value is not included. (E.g. "Great care needs to be taken in assessment of marginal land as GIS, satellite and other data sets may identify land as "unused" which is actually used on a rotational or partial basis").
- Understanding current land use is important, to ensure that land of high conservation value (high conservation value areas, HCVA), including land with important ecosystems is not included as marginal land; and that local community use is included in considerations (one submission discusses land grabs in Africa).

[7] The respondent suggested (based on Abt et al (2014) who completed modelling work for the US Forest Service) that between 2010 and 2025 the price of non-sawtimber over the US Coastal South will more than double, due largely to supply constraints in pulpwood and high prolonged demand by pellet export mills.

- Limiting energy crops to marginal or abandoned land reduces competition with food production, but a greater land area is required due to potentially decreased yields.
- Environmental impacts from biofuels crops depends on where the crops are planted and the crops or other land use displaced. Some biofuels crops require high water inputs (e.g. see high quality evidence submitted by ETI submission, the ADAS (2016) report, and the papers Petovan et al 2017 and Rowe et al, 2011).

4.2.1.2 Areas where there is uncertainty or disagreement in interpretation of the evidence

- There was disagreement about the amount of marginal land (see, e.g. IEEP, 2015) and the best use of marginal land.
- There was disagreement about the best use of abandoned agricultural land e.g. use of sustainable forestry to regenerate degraded land; allowing the land to regenerate naturally etc. (high quality evidence supported this[8]).
- The value of growing energy crops on marginal land, considered against other potential uses of this land.
- Options to integrate bioenergy crops into agriculture and their impact on biodiversity and other environmental issues. Some respondents provided high quality evidence that integrating energy crops into arable cropping systems would improve biodiversity, whilst enabling use of marginal land on farms[9]. Other respondents did not consider this option at all, but felt that it would be more beneficial (in carbon terms) to grow 'vegetation' that stored CO_2 (an example of using eucalyptus to do this was provided, but no consideration of other benefits/impacts of growing eucalyptus in this manner were considered and the evidence was low quality).

4.2.1.3 Areas where there are gaps

- Good data sets to define the land area that is potentially available to energy crops.
- Guidelines on the value of using energy crops within current farming systems.

4.3 Summary of responses to Q14

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.

14 Respondents: 14 from UK; 0 from USA; 0 from Canada; 0 from Europe

Trade Associations	Energy	Biomass	NGO	Government Agency	Research	Certification
7	4	0	1	0	3	0

Sectors

Academic, Agriculture, Bioenergy, Forestry, Gas, Minerals, R&D&D, Renewable Energy.

13 pieces of supporting evidence were provided: 10 were ranked as high quality and 2 medium. One piece of evidence could not be accessed.

4.3.1 Summary of responses

4.3.1.1 Areas where there is agreement

- A range of updated estimates have become available since the CCC 2011 analysis. These take recycling levels into account and assume all biogenic biomass in residual waste is potentially available to bioenergy.

[8] For example. 'Land abandonment, biodiversity and the CAP; outcome of an international seminar in Sigulda, Latvia,7-8 October,2004); JRC (2011) Critical issues in estimating ILUC emissions: outcomes of an Expert Consultation.'

[9] Four scientific studies in the UK were cited to support this.

- These estimates include potential for BioSNG[10] and BioLPG[11] as well as biomethane. Most analysis assumes that wet waste would be converted using anaerobic digestion (AD) and dry wastes through thermochemical conversion.
- The estimates provided are summarised in the box below.
- Submitted figures are generally based on high quality reports.

Estimates for energy potential from UK wastes

- Nine respondents cited the work by E4 Tech and Anthesis. This provides an estimate of the energy potential of wastes in the UK as between 64 TWh/y and 77 TWh/y in 2050, depending on scenarios that vary in the amount and influence of recycling. The Central scenario gave an estimate of 73 TWh/y. The report converts this (section 4.2) into a renewable gas potential of 47-56 TWh/a, with 83% coming directly from BioSNG using gasification and 17% from biomethane via AD.
- Note: this study compares its results to CCC (2011): they are 5.6 TWh/y higher due to an assumption that all residual waste is available for bioenergy generation and none to landfill (as was assumed in CCC 2011).
- Other resource estimates were:
    - Welfle: household wastes (>115 TWh by 2050), energy crops (>100 TWh by 2050) and agricultural residues (>80 TWh by 2050) – broadly similar to CCC 2011 analysis.
    - 75 TWh/y from anaerobic digestion.
    - 16.6 TWh from waste wood.
    - BioLPG: 75 -146 TWh/y between 2020 and 2050, although this includes imports of sustainable biogenic biomass.
    - 15TWh of low carbon fossil waste.
- Note: the Supergen Bioenergy Hub is undertaking a project that will address the question of availability and suitability of UK wastes and residues for bioenergy - outputs will be available by the end of June 2018.

4.3.1.2 Areas where there is uncertainty or disagreement in interpretation of the evidence

- Some respondents provided evidence that the waste wood resource in the UK is almost fully committed to current and planned energy plants. These respondents are concerned about the impact on competing uses of this resource.
- Some respondents emphasise that the waste hierarchy should be observed, i.e. recycling of waste should be considered a high priority than bioenergy.

4.3.1.3 Areas where there are gaps

There were no gaps identified.

[10] Substitute natural gas made using feedstock of biogenic origin.

[11] Liquid petroleum gas produced using feedstock of biogenic origin

4.4 Summary of responses to Q15

Question 15. What factors (opportunities, constraints, assumptions) should the CCC reflect in its bioenergy resource scenarios through to 2050?						
11 Respondents: 9 from UK; 2 from USA; 0 from Canada; 0 from Europe						
Trade Associations	Energy	Biomass	NGO	Government Agency	Research	Certification
6	2	0	2	0	1	0
Sectors						
Academic, Bioenergy, Conservation, Forestry						
28 sources of supporting evidence were provided by respondents, of which 17 were ranked of high quality, 6 medium, 4 low and 1 was not ranked as it could not be accessed.						

4.4.1 Summary of responses

4.4.1.1 Areas where there is agreement

The following areas were highlighted by more than one respondent as being important to reflect in the bioenergy resource scenarios:

- The respective contribution of different biomass options needs to be considered, in terms of carbon emissions, the value chain, cost-benefit analysis and socio-economic impacts and opportunities. (The various uses of AD and biomethane are both highlighted; it is suggested that the Biomass Value Chain Model is a useful tool to untangle choices within the UK). One respondent said that bioenergy carbon analyses should include appropriate details on energy pathways, including accurate end use energy conversion technologies and efficiencies.
- The respective contribution of alternatives to bioenergy for the UK's energy mix should be considered.
- The potential use of agricultural land, including the impact of bioenergy on productivity and the environment (positive and negative). Evidence included a wealth of research that has been done in the UK on bioenergy value chains, particularly the ELUM project and modelling.
- Bioenergy from forestry should be reflected within the context of forestry practice across the whole forest and integrated forestry value chains: impacts on other forestry products should be considered. Important evidence is provided by Matthews et al (2015) for European Forestry; and Miner et al (2014) for US forestry.
- In considering end of life materials, consider the alternatives for disposal, reuse and recycling as well as bioenergy.
- A mix of domestic and imported fuels will be necessary to achieve 10% final energy demand from biomass.

4.4.1.2 Areas where there is uncertainty or disagreement in interpretation of the evidence

There is disagreement on the carbon impacts of bioenergy, including the role of BECCS. This is also dealt with in Q1, Q2 and Q24.

There was disagreement over whether the evidence shows that bioenergy and a strong wood products industry keeps land in forest by triggering investment in forestry and maintaining forest areas. This is also discussed in Q3.

Another respondent said that wind and solar will soon be cheaper that electricity from biomass and therefore costs should be included in considering the renewables mix. Other respondents were keen that the CCC considers all uses of biomass, including heat and transport.

One respondent called for the impact of Brexit on agricultural subsidies and resultant potential afforestation on marginal land, although they acknowledged significant obstacles including bureaucracy and lack of political interest.

4.5 Summary of responses to Q16

Question 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)?						
8 Respondents: 6 from UK; 1 from USA; 1 from Canada; 0 from Europe						
Trade Associations	Energy	Biomass	NGO	Government Agency	Research	Certification
3	1	0	1	1	2	0
Sectors						
Academic, Bioenergy, Conservation, Forestry, Minerals, R, D&D, Renewable Energy.						
14 pieces of evidence were submitted with these responses. 12 of these are ranked as high-quality evidence and 2 of medium quality.						

4.5.1 Summary of responses

4.5.1.1 Areas where there is agreement

A number of respondents point to evidence that suggests we should prioritise policy that optimises UK supply prior to import.

4.5.1.2 Areas where there is uncertainty or disagreement in interpretation of the evidence

There are mixed responses to the approach to the assumptions of international resource that can be accessed by the UK

- Some respondents suggest that it should be assessed per capita.
- Some respondents refer to reports with global estimates, but on examination these reports do not apply a factor that represents the likely access the UK will have to biomass resources.
- Some respondents point out that the supply regions must have the necessary capacity (skills, equipment) to supply into the UK's market, particularly for complying with sustainability requirements; if these are not developed then the biomass supply chain cannot develop economically – in other words it might be sensible to tier supply according to the likelihood that a viable export supply can be developed in a region.
- It is pointed out that the UK is the second highest importer of wood products at present (behind China). This means it has considerable track record, networks and influence in this sector. This provides us with advantages in understanding key players in the market and continuing to be an important player in the global biomass market.
- Other respondents point out that economics and willingness to pay compared to competing markets is important. This will be dictated by the value placed on the carbon credit associated with that fuel, and to the values placed on this by other nations. As more countries develop renewables mandates the UK may find it is part of a more competitive market. (For example, the resources on the West coast of USA and Canada could be shipped to Asian markets). Supporting this some respondents point to biomass becoming a commodity like any other and being subject to the rules of supply and demand.

4.5.1.3 Areas where there are gaps

One respondent suggested identification of those issues that present barriers to supply and an understanding of how the UK could support supply chains in overcoming these barriers is also important in understanding availability of biomass and UK access to specific markets.

4.6 Summary of responses to Q17

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?						
Respondents 6: all from UK						
Trade Associations 0	Energy 0	Biomass 1	NGO 0	Government Agency 1	Research 0	Certification 4
Sectors						
Agriculture, bioenergy, Minerals, Renewable Energy						
5 pieces of evidence were submitted with these responses; all were ranked as high quality.						

4.6.1 Summary of responses

4.6.1.1 Areas where there is agreement

- Algal biomass has considerable potential globally.
- Macro-Algal biomass (sea weed) can be used in anaerobic digestion to generate biomethane.
- There are limited prospects for commercially competitive production of algal bioenergy feedstocks, due to both capital and operating costs. Evidence provided supports this and indicates that potential for supply to the UK by 2050 is low.
- These high capital and operating costs mean that future production of algal biomass within the emerging global bioeconomy is more likely to be directed towards higher value uses within the fine chemicals and pharmaceuticals sectors

4.6.1.2 Areas where there is uncertainty or disagreement in interpretation of the evidence

None

4.6.1.3 Gaps identified

Respondents comments and accompanying evidence shows that production of energy from algae is not commercialised. Use of macro-algae in the North Sea shows promise, but requires much more investment to decrease cost barriers. Private companies are funding research that is not included in the responses to the Call for Evidence.

5 Scaling up UK sustainable supply

5.1 Summary of responses to Q18

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						
16 Respondents: 14 from UK; 2 from USA; 0 from Canada; 0 from Europe						
Trade Associations	Energy	Biomass	NGO	Government Agency	Research	Certification
6	2	2	3	1	3	0
Sectors						
Academic, Agriculture, Bioenergy, Conservation, Forestry, Minerals, Non-bioenergy, R&D&D, Renewable Energy, Energy						
13 pieces of evidence were provided to support this question. There were 10 pieces of high quality evidence, 2 medium quality and 1 low quality.						

5.1.1 Summary of responses

The responses to Q18 can be split into two main groups:

1. Those who identified specific crops or types of crops on the UK should focus on
2. Those who looked at the policies that could support the scale up of supply

Overview of responses in group 1: specific crops or types of crops

A number of respondents agreed that planting second generation energy crops represents a significant opportunity to scale up domestic biomass supply. Furthermore, these respondents agree that the planting of second generation energy crops could provide additional environmental benefits such as improving biodiversity. There was high quality evidence to support this, particularly around the potential for land use and the factors that will influence scale up of energy crops. One respondent referred to the modelling of land for energy crops in the ETI's Bioenergy Value Chain Model.

Three responses agreed that biomass produced as a by-product from maintaining areas of conservation should be prioritised (and assistance provided for infrastructure development). This was supported by high quality evidence on the scale of the opportunity.

One respondent indicated that waste should be prioritised before scaling up virgin biomass supply and another stated that the use of waste as a feedstock for anaerobic digestion should be increased. These views were not supported by evidence.

One response highlighted creating new forests as the most effective way of scaling up bioenergy supply. The view of a different respondent was that there is little potential for increasing the supply of domestically sourced waste wood, but that short rotation forestry presents a good opportunity to scale up biomass supply. Evidence was not provided to support these responses.

Overview of responses in group 2: policies that could support scale up of supply

Respondents stated that the policy framework that supports the scale up of sustainably-produced domestic bioenergy supply should:

- Clearly identify situations where biomass for energy would be the preferred land use. No evidence was provided to support this.
- Link levels of supply with demand to ensure long term market stability and improved availability of finance to establish crops. High quality evidence was provided to support this.

5.2 Summary of responses to Q19

19. What risks are associated with scaling-up domestic supply and how can these risks be managed?						
18 Respondents: 8 from UK; 9 from USA; 1 from Canada; 0 from Europe						
Trade Associations	Energy	Biomass	NGO	Government Agency	Research	Certification
3	1	0	2	1	3	0
Sectors						
Academic, Agriculture, Bioenergy, Conservation, Forestry, Minerals, R&D&D, Energy						
9 pieces of evidence were provided of which 7 were high quality and 2 were low quality.						

5.2.1 Summary of responses

The responses to this question highlighted a range of risks, but few common points were made. Below is an overview of the views expressed:

GHG emissions

Several responses focussed on risks related to GHG emissions. One response said that to ensure the maximum possible GHG savings, perennial crops need to be in the ground for their maximum productive lifetime (approximately 15 years). The respondent suggested that to manage this risk, government support should require a minimum lifetime for crops and could incorporate staged payments throughout the crop's life. Good evidence was provided to support this.

Land use/land transitions

Respondents were clear that land transitions to energy crops need to be carefully managed because delivering a 'substantial area of planting is only possible without impacting on UK food production, if land use productivity is increased elsewhere in the agricultural sector and if there is a reduction in food waste.'

One response discussed the risk of inappropriate land transitions. The example given was growing second generation energy crops on arable and temporary grassland, which could lead to increased levels of carbon in the soil. Good evidence was supplied in support of this.

Another respondent suggested that large deployment of energy crops or afforestation could result in indirect land use change in natural habitats. No evidence was provided to support this.

Market risks

A number of responses discussed the need for landowners and farmers to have confidence in the market for energy crops and the failure of previous incentive mechanisms. As much of the investment is up front in establishing the crops, they need to be able to enter long term contracts to have certainty about payback. There was good evidence to support this. One idea put forward is to develop additional uses for energy crops to provide more market security, e.g. the use of Miscanthus as a building insulator.

One respondent was concerned about skills gaps for establishing and growing energy crops, which might impact the productivity of the crop over a 20-year life span.

One respondent was concerned about the use of wood for bioenergy 'skewing' the market from other wood products and wood in construction. High quality evidence was provided to support the carbon storage benefits of wood in construction[12], but no evidence was provided that clearly shows that wood for bioenergy impacts the market for wood in construction.

[12] The respondent referred to the report 'Combating Climate Change – A role for UK Forests (Read, 2009), to support the view that long term storage of carbon in timber products was the most significant climate change mitigation measure that the forestry sector could contribute.

Biomass from management of conservation areas

Two respondents were concerned that using areas of conservation to grow biomass feedstocks risks negative impacts on biodiversity. To manage this risk the respondents, suggest that the primary reason for harvesting in these areas should be to improve biodiversity, rather than to obtain biomass supply. It was suggested that the introduction of a five-year nature conservation plan would address this issue, providing it is approved and audited by a relevant governing body. High quality evidence was provided by one of these respondents.

General

One respondent expressed the view that the increased use of biomass for energy does not have to compromise food security, biodiversity or landscape. Little evidence was provided in support of this, although the respondent is familiar with trends in agriculture.

One respondent suggested that the use of solar PV is more beneficial in terms of carbon savings, referring to work by Searchinger et al (2017) to support this.

5.3 Summary of responses to Q20

Question 20. What 'low-regrets' measures should be taken now (e.g. planting strategies) to increase sustainably-produced domestic bioenergy supply?						
11 Respondents: 10 from UK; 1 from USA; 0 from Canada; 0 from Europe						
Trade Associations	Energy	Biomass	NGO	Government Agency	Research	Certification
4	2	1	2	1	2	0
Sectors						
Academic, Agriculture, Bioenergy, Conservation, Forestry, Minerals, R&D&D, Energy.						
5 pieces of supporting evidence: 4 ranked high and 1 medium.						

5.3.1 Summary of responses

There were a wide range of suggestions in response to this question. Respondents were keen to ensure sustainable use of UK biomass (prioritising the needs of local ecosystems and socio-economic benefits to agriculture).

A number suggested prioritising the use of biogenic waste for energy, particularly over landfill; and encouraging AD of on farm wastes.

Other suggestions were to ensure the policy environment provided support for overcoming the technical challenge of contaminants in residual and waste biomass resources:

Wastes and residues

- Incentivisation or legislation for wastes suitable for AD or gasification to be diverted from landfill to energy production.
- Incentivise the use of waste biomass over the use of virgin biomass.

Support Growth of on farm AD

- Support for the proposed virtual Centre for Anaerobic Biotechnology and Bioresources Research (CABB) hub as a centre of global excellence.

Land use

- Clarity on where land is suitable for bioenergy crops, identifying the type of land, limits to use and clearly demonstrating how we balance food, energy and amenity.
- Clarity on where the planting of energy crops confers farm economics and ecosystem benefits, including improvement in soil carbon and fertility, biodiversity, phyto remediation, flood protection and extreme weather event resilience.

- Support for a steady increase in the area of second generation energy crops, based on the principles above, to allow the industry to learn by doing and monitor the impacts on the wider agricultural sector. Respondents proposed increases along the lines of 5000ha/y in the near term, ramping up to 25,000ha/y to 35,000ha/y in the future.

Miscellaneous

- Tariff support and stability aimed at driving investment.
- Protection of the UK's existing forests and regeneration of disturbed forests.
- Prioritising support for UK sourced biofuel feedstocks and biofuels, prioritising the use of renewable gas in HGV vehicles.
- Investing in low-cost pre-processing technologies to improve biomass quality that could make UK-grown energy crops (and potentially waste wood) a more attractive fuel for buyers.
- Regulation/guidance on the utilisation of biomass for bioenergy from land managed for nature conservation to ensure that the areas are harvested for biodiversity benefit rather than the generation of biomass. This respondent suggested the introduction of five-year nature conservation management plans, approved by the relevant governing body and detailing reasons for habitat management and the amounts and type to be carried out.

5.4 Summary of responses to Q 21

21. What international examples of best-practice should the UK should look to when considering approaches to scaling-up domestic supply?						
Respondents 6: 5 from UK; 1 from USA; 0 from Canada; 0 from Europe						
Trade Associations	Energy	Biomass	NGO	Government Agency	Research	Certification
2	1	0	1	1	1	0
Sectors						
Bioenergy, Conservation, Forestry, R&D&D, Energy.						
4 pieces of evidence submitted, two of medium quality and two of low quality.						

5.4.1 Summary of responses

Respondents suggested the following examples:

- International AD experience can provide a wealth of experience and technical approaches for bioenergy. Examples were provided for Germany, South Korea and the USA. Further examples of work are provided in the accompanying evidence submitted by respondents.
- Bioenergy policies set by the U.S. State of Massachusetts were suggested as an example of the kinds of regulatory platforms that may optimise carbon benefits.
- Examples were provided on landscape restoration using bioenergy crops on degraded lands e.g. Ethiopian afforestation to supply local fuel, supported by DfID and Chinese plans to afforest large areas.
- One respondent suggested that the Brazilian practice of designated zoning areas suitable for different land uses (in this case sugar cane and eucalyptus cultivation) provides guidance on where energy crops can be planted.
- One respondent referred to ongoing IEA Bioenergy work to collate information on perennial biomass crop research and production worldwide.

5.5 Summary of responses to Q 22

22. What policy measures should be considered by Government to help scale-up domestic supply?						
9 Respondents: all from UK						
Trade Associations	Energy	Biomass	NGO	Government Agency	Research	Certification
5	2	0	0	0	2	0
Sectors						
Academic, Agriculture, Bioenergy, Forestry, Minerals, Non-bioenergy, RD&D						
18 pieces of evidence were provided: 12 high quality pieces of evidence, 4 medium quality and 2 low quality.						

5.5.1 Summary of responses

The responses to Q 22 can be broadly split into 2 main groups:

1. Those which gave specific policy ideas and recommendations.
2. Those which speak more broadly about what the policy framework should consider, what it could include and what areas it should focus on.

5.5.1.1 Policy recommendations made in group 1: policy ideas and recommendations

- Introduce support for on-farm AD plants e.g. in the form of renewable bio-fertiliser credits, an agricultural GHG abatement fund or favourable tax credits.
- Introduce a floor price for Renewable Transport Fuel Certificates (RTFC) in the Renewable Transport Fuel Obligation (RTFO).
- Extend the fuel duty differential between gas HGVs and conventional HGVs beyond 2023.
- Create a level playing field in the RHI and CfD across all sectors to prevent bioenergy being diverted from sectors that quality for incentives and those that do not.

5.5.1.2 Overview of responses in group 2: What a policy framework should consider

On farm policy

One response suggested that one aim of the policy measures should be to reduce the risk farmers experience when investing in bioenergy crops. This was supported by good evidence.

A different response suggested that the support payments should be designed to reward farmers for any decisions that offer GHG benefits, and for the benefits provided by ecosystem services that are generated through growing energy crops. However, the respondent accepted that work needs to be done to quantify the value of these ecosystem services.

Another response said that policy designed to support farmers in producing bioenergy feedstocks should include tailoring based on region, sustainability criteria, monitoring and a long-term approach.

Woodland

Some respondents indicated that policy support should focus the creation of woodland. Evidence provided to support this was medium quality.

Land use options

One respondent said government policy needs to identify in what circumstances biomass for energy would be preferred as a land use option. This was not supported by evidence.

6 Best-use of bioenergy resources

6.1 Summary of responses to Q 23

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?

9 Respondents: all from UK

Trade Associations	Energy	Biomass	NGO	Government Agency	Research	Certification
2	6	0	0	0	1	0

Sectors

Agriculture, Bioenergy, Gas, R&D, Renewable Energy

9 pieces of evidence were provided: 8 of these were of high quality and 1 was medium quality.

6.1.1 Summary of responses

The responses cover gasification as a stage in a range of processes including power generation, conversion to fuels and production of fuel cells.

6.1.1.1 Areas of agreement between respondents:

Commercial deployment

There was general agreement that while the gasification step (to produce crude syngas) is ready for commercial development, other technologies that are required to enable deployment - in particular tar removal technology for syngas clean up – are behind in terms of development and present a barrier. Several respondents suggest this will be overcome and commercial deployment possible in the 2020s. There is good evidence to support this.

Respondents also point out that the application of biomass gasification at high efficiency and large scales in the UK is not easily economically viable because of the lack of district heating load[13]. One respondent said, “development of the technology at high efficiency and smaller scale with treatment of the syngas to allow generation of electricity or production of fuels such as aviation fuels and chemicals is challenging and only now emerging.” Another said, “for gasification to offer any real advantages over incineration it is necessary to reform tars to allow the syngas to be used in higher value applications”.

Many respondents state that support for gasification should focus on the production of renewable gas for heating and transport rather than electricity generation. No evidence was provided in support of this point.

Respondents agree that the Renewable Heat Incentive scheme ending in 2021 presents an issue and that a replacement is needed.

[13] The UK does not have a long heat season in the same way that some of the central European and Nordic countries have, which means that opportunities for district heating are limited.

Risks and barriers

There is general agreement that a long-term overarching support mechanism is required for gasification. No evidence was provided in support of this point. One respondent however, believes that there is enough support currently in place to ensure commercial deployment in coming years.

There is general agreement that the major risks are economic (fuel costs and development costs), political (support is split with no overarching strategy), technical (early stage of development, perceived risks and tar removal, lack of reliable data for investors) and the perception that poor quality/failed gasification projects discourage investment and skew public perception.

There was disagreement in the role of Contracts for Difference (CfD) in supporting gasification. Some respondents stated that CfD should not be used to support gasification, but one respondent said that insufficient CfD funding has been available for gasification projects. No evidence was provided to support these points.

Conversion efficiencies

Evidence was provided (see box below) but one respondent summarised the situation by saying that efficiencies are at best 50-60% of the heating value in the feedstock.

Cost reductions

See box below. Due to the current status of gasification most respondents agreed there is scope for cost reduction.

The efficiency of the syngas to product conversion step varies as follows:

- Entrained flow systems have high efficiencies (90%) but require a significant amount of feedstock preparation which can reduce overall efficiency to 60%.
- Fluidised beds have high efficiencies 85% and require minimal feedstock preparation.
- Indirect gasifiers have efficiencies of 80% but require feedstock pelletisation, which reduces overall efficiency to 72%.
- Syngas gas engines have efficiencies of around 40% in combined cycle. Turbine performance is worse than engines at biomass scales. This gives an overall gross efficiency of 20-34%.
- Catalytic conversion efficiencies depend on the product. For simple chemicals such as hydrogen, methane and methanol efficiencies are around 80% but for ethanol and liquid fuels efficiencies are around 40%, with large amount of energy ending up in co-products. This gives overall gross efficiencies of around 60% for simple products and 30% of complex products.
- Fuel cell efficiency is reported at 50% or higher. This would give gross efficiencies of 25-43%.
- One respondent summarised by saying that efficiencies are at best 50-60% of the heating value in the feedstock.

Cost reductions

Detailed costs are provided by some respondents. Cost reduction opportunities are:

- Cost reductions can be achieved through tar removal; catalytic conversion equipment, optimised for small scale; project design and delivery costs that will fall as engineering contractors learn how to deliver gasification facilities.
- Larger savings can be achieved through increases in plant size.

Overall these changes will result in 25% reductions over time (overall capex reduction of 10%) for the former and capex reduction of 15% for the later. Another respondent estimated cost reductions of 20% between first of a kind and increased scale development, by the late 2020s.

6.1.1.2 Areas where there is uncertainty or disagreement in interpretation of the evidence

Areas of uncertainty

Several respondents presented the economic pros and cons related to using either biomass or waste for gasification. Most of these do not state which of these feedstocks would be preferable, but two respondents suggest waste is currently the best commercial option. This is not supported with evidence.

6.2 Summary of responses to Q24

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)?
        i. What are the main barriers and uncertainties associated with the development, deployment and use of BECCS?
        ii. 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

12 Respondents: 10 from UK; 2 from USA; 0 from Canada; 0 from Europe

Trade Associations	Energy	Biomass	NGO	Government Agency	Research	Certification
4	3	0	2	0	3	0

Sectors

Academic, Agriculture, Bioenergy, Conservation, Electricity generation, Minerals, Pellet, R&D&D, Renewable Energy

33 pieces of evidence were provided by the respondents of which 20 were of high quality and 13 medium quality.

6.2.1 Summary of responses

The responses can be broadly split into two main groups:

1) Responses that focussed on the technical aspects of BECCS development and deployment
2) Responses that focussed on the potential risks association with BECCS deployment

Most responses fall into category 1 and these generally expressed similar views.

6.2.1.1 Areas of agreement in group 1: technical aspects of BECCS

Most respondents stated that the main barrier to BECCS deployment is the current lack of financial incentives for achieving “negative emissions”.

A secondary barrier put forward is the need to develop transport and storage infrastructure to enable the deployment of BECCS.

Potential timescales to commercial deployment

Respondents generally suggested commercial deployment of BECCS is feasible by the 2030s and supported this with high quality evidence. Two respondents said small scale BECCS is happening

now; One was referring to the capture of CO_2 (where it occurs in a relatively concentrated stream) from a bioethanol production plant in the US, and the other to AD plant producing biomethane where the CO_2 which is already separated out from the biogas is being captured and reused. One of the respondents though that the latte could be realistically deployed in the 2020s in biomethane production.. Evidence was provided on this.

There was general agreement that delays to deployment will not be due to technological barriers. In general, the respondents did not provide evidence to support this point. However, one respondent said that there are 37 large Carbon Capture Utilisation and Storage (CCUS) facilities in operation or development globally. Although these are on fossil fuel plant, they could be applied to bioenergy sources. Another respondent discussed the deployment of BECCS in the USA.

A number of responses suggested that BECCS likely to be deployed at scale and be situated near a coastal hub for carbon dioxide storage, which would make its use to support biomass import supply chains likely.

Efficiencies and costs

One respondent presented data on this, showing that BECCS reduces the efficiency of a biomass fired electricity generation plant by 6-15 %. Figures were also presented for opportunities to improve the efficiencies of BECCS plants, but the respondent said that there are trade-offs with economic performance. Good evidence was provided to support this.

Areas of uncertainty in Group 1

- Optimal use for BECCSS – respondents were generally not certain what the best use is, although the 'hard to decarbonise sectors' were mentioned by a number of respondents. One respondent thought it was best with electricity generation or hydrogen production and supported this with good evidence. Another said we need to understand where its best value is in relation to the whole bioenergy supply chain.
- Optimal feedstock – respondents generally thought that no one feedstock would give best performance, but no evidence was provided in support of this point. There was some concern that BECCSS might enable the use of higher carbon feedstocks.

Gaps

- There is no current clear indication of the optimum use of BECCS.
- There is no clear understanding of what feedstocks would best benefit from BECCS.

Risks identified by this group

Respondents generally thought the key risks were political and financial, not technical. One respondent called for Government funding to kick start this industry (and supported this with evidence from a Parliament Advisory Group).

Social acceptability was also highlighted as important.

One respondent said a lot of work had been done to de-risk BECCS technically in the UK and supported this with high quality evidence.

6.2.1.2 Responses from Group 2: Identified Risks

Respondents in this group were concerned that BECCS allows the impression that 'we can continue as normal'. Other risks they identified were:

1. Potential environmental issues caused by potential large-scale land use change from production of biomass. Good evidence was provided to support this.
2. Economic impacts and a significant change to the Earth's albedo. The evidence to support this was of high quality[14].
3. Diversion of biomass from use in other sectors. This was not supported by good evidence for this question, but it is a general concern, and discussed in Question 3.

One respondent commented that, depending on the conditions of BECCS deployment, it can lead to scenarios that are both carbon negative and positive. This has been shown in modelling. It will be

[14] For example, the respondent referenced Smith P *et al*, Biophysical and economic limits to negative CO_2 emissions, Nature Climate Change 6 (1): 42-50. DOI:10.1038/nclimate2870.

important to understand this to avoid unintended consequences. High quality evidence was provided to support this.

6.3 Summary of responses to Q25

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?						
6 Respondents: 5 from UK; 1 from USA; 0 from Canada; 0 from Europe						
Trade Associations	Energy	Biomass	NGO	Government Agency	Research	Certification
1	2	0	1	0	2	0
Sectors						
Academic, Bioenergy, Conservation, Electricity generation, Minerals						
There were 16 pieces of evidence submitted, some of which we were not able to access. Those we did access were high quality, but not relevant to the international situation. The other evidence provided originated from CCC. This was high quality and relevant to the respondent's answer						

6.3.1 Summary of responses

The responses could be categorised into two main categories:

1. Those who stated involvement in any international BECCS scheme should not count towards domestic emissions targets
2. Those who looked at the prospect of an international BECCS scheme being developed

6.3.1.1 Areas of agreement in group 1: International BECCS should not count towards domestic emission targets

Respondents in group 1 focussed on the view that domestic emissions targets should be met through domestic action and not involvement in any international schemes.

6.3.1.2 Areas of agreement in group 2: Prospect of an international BECCS scheme

There was agreement in group 2 that the UK would be well placed to store carbon dioxide as part of any international BECCS scheme that may develop, due to the storage potential the country possesses.

Respondents in group 2 shared the view that if an international BECCS scheme was to be developed, a more flexible global framework would be needed in which it could operate.

6.4 Summary of responses to Q26

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?

9 Respondents: 7 from UK; 1 from USA; 0 from Canada; 1 from Europe

Trade Associations	Energy	Biomass	NGO	Government Agency	Research	Certification
3	4	0	2	0	0	0

Sectors

Agriculture, Bioenergy, Conservation, Gas, Renewable Energy

There were 30 pieces of evidence provided to support responses. 16 sources were high quality and 14 medium quality.

6.4.1 Summary of responses

The responses to Q 26 can be broadly split into two groups:

1. Responses that focussed on the most promising technologies, fuels and uses
2. Responses that focussed on the barriers and risks associated with advanced conversion technologies

6.4.1.1 Areas of agreement in group 1: Promising technologies, fuels and uses

There was general agreement between respondents in group 1 that low carbon gases are suitable fuels for the heavy-duty transport and heating sectors (several respondents specified off grid heating) and that low carbon gases can/should play a key role in decarbonising these sectors. The level of evidence provided to support these views was mixed (medium to high).

Responses highlighted biomethane, BioSNG, biohydrogen or biopropane as the most promising advanced biofuels, and either gasification or pyrolysis as the most promising advanced conversion technologies, providing good evidence to support this. One respondent provided results to scenario analysis for BioLPG production of 2.7 – 6 million tonnes/y.

One respondent said that gasification and pyrolysis are the only technologies that can use all biomass sources, providing high quality evidence. Another spoke about the flexibility offered by the gasification process and the option to produce biohydrogen. These respondents tended to favour the use of advanced conversion fuels as biofuels for transport, drawing from DfT (F4C) and ETI evidence.

One respondent mentioned aviation fuels in a previous question, saying that there are three projects ongoing to produce aviation fuels (from municipal waste).

Efficiencies and costs

Good efficiencies for conversion were quoted, drawing from the GoGreenGas project. Fewer respondents discussed price. One respondent said that no significant price decrease is foreseeable,

because feedstock and logistics costs are not likely to decrease by much. However, capital costs of plants should decrease.

Optimal end use

Most respondents agreed that advanced biofuels should be channelled to hard to electrify transport sectors.

Barriers:

The key barrier mentioned was uncertainty around Government policy making.

Policy:

Respondents thought that the RTFO provides good support for advanced biofuels. Areas where there is uncertainty or disagreement in interpretation of the evidence in Group 1

Group 1 responses to question 26 generally did not agree on one optimal end use, often referring to "heating and transport". Individual respondents suggested that for heavy duty transport BioSNG or biomethane present practical and viable decarbonisation options.

6.4.1.2 Areas of agreement in group 2: Barriers and Risks associated with advanced conversion.

Group 2 respondents were concerned about sustainability of certain feedstocks, and competition for their use. They thought this should be included in policy. Recent DfT supported work was used to support this. Evidence was mixed quality (medium to high). Sustainability is a repeated concern for these respondents.

The majority of Group 2 responses indicated that wastes and biomass residue feedstocks that should be used for producing advanced biofuels. Where evidence was provided the quality was medium to high.

One respondent said that 'advanced biofuels' is poorly defined, citing processes that could be referred to as advanced, and pointing out that some of these processes rely on first generation crops, such as palm oil.

6.4.1.3 Key gaps:

- Although there was information on potential efficiencies, it was not clear if these were measured or theoretical. Little information was provided on costs for advanced biofuels.
- Respondents did not provide specific timescales for commercial deployment for different fuels and technologies.
- There was little comment on development of aviation fuels.

6.5 Summary of responses to Q27

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.

6 Respondents: 5 from UK; 1 from USA; 0 from Canada; 0 from Europe

Trade Associations	Energy	Biomass	NGO	Government Agency	Research	Certification
2	2	0	2	0	0	0

Sectors

Bioenergy, Conservation, Electricity generation, Minerals, Non-bioenergy

The evidence provided was not comprehensive and much of it did not directly relate to the question itself. In total 7 pieces of evidence were provided - 4 of these were medium quality and 3 were high quality. The medium quality evidence was predominantly reports produced by private companies whereas the high quality evidence was government funded reports and peer reviewed scientific papers.

6.5.1 Summary of responses

Many responses to this question did not directly address the question.

There was agreement from some respondents that the 2050 Roadmaps do not appropriately account for sustainable biomass feedstock availability. No evidence was provided in support of this point.

A potential change suggested by one respondent was updating the assumptions related to biomass feedstocks and CCS potential.

One respondent pointed to the potential use of biomethane and biohydrogen in industry, providing good supporting evidence.

6.5.1.1 Key gaps:

The responses did not contain details of specific changes that should be made to the 2050 Roadmap estimates.

6.6 Summary of responses to Q28

28. In our 2011 review we identified wood in construction (WIC) 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?

7 Respondents: 6 from UK; 0 from USA; 1 from Canada; 0 from Europe

Trade Associations	Energy	Biomass	NGO	Government Agency	Research	Certification
4	1	0	0	1	1	0

Sectors

Academic, Agriculture, Bioenergy, Forestry, Minerals, Renewable Energy

The evidence provided for this question was not comprehensive, but supported some parts of the question. The evidence was relevant to the question. 23 pieces of evidence were provided. Of these 9 were high quality, 13 were medium and 1 was low quality.

6.6.1 Summary of responses

6.6.1.1 Areas of agreement between respondents

Most respondents broadly favoured the use of wood in construction and thought it represented an effective means of storing carbon and reducing emissions. Most, including those in favour of WIC, identified key barriers that must be overcome. High quality evidence was provided to support this.

6.6.1.2 Areas of disagreement between respondents

The views expressed in the responses can be split into two main groups:

1. Those that focussed on the risk and barriers associated with the use of wood in construction
2. Those that focussed on the suitability of wood for construction and its performance in terms of sustainability

Overview of responses in group 1:

The major barrier was seen to be lack of forest resource and lack of land to create wood resource. Two respondents identified a lack of available forest resource in the UK as a key barrier to using wood in construction. This was not supported by evidence. Another respondent stated that land availability would not be an issue and this was supported by high quality evidence. A related point expressed in a different response was that there is very limited land available for energy crops in the UK. The evidence used to support this was high quality.

One respondent suggested that most of timber grown in the UK is unsuitable for construction purposes and drew on Forestry Commission sources to support this.

Other secondary barriers suggested were: competition from other materials; lack of experience; perceived risks such as fire and rot; perceived costs; and lack of performance based data. No evidence was submitted in support of this.

A number of respondents talked about the issue of disposing of wood used in construction at the end of its lifetime. There were concerns that if wood is treated with chemicals, disposing of it would be more difficult and may result in an increase of GHG emissions. No evidence was provided in support of this point.

Overview of responses in group 2:

One respondent claimed that the wood offers significant benefits over comparable materials in terms of full life cycle sustainability, and that houses made from wood have better energy performance and lower emissions compared with concrete/steel alternatives. This was supported by a mix of high and medium quality evidence.

Another response disagreed with the above, and stated that there are no significant differences in between other materials and timber construction in terms of overall CO_2 emissions, particularly given the investment from cement manufacture in decarbonising the production of this building material. This response was supported by medium quality evidence.

Several responses highlighted the importance of considering the whole lifetime of the construction material and buildings when assessing the benefits of one material versus another.

Only one response detailed the end of life options for wood used in construction (where chemical treatment of the wood is not an issue). This identified feedstock for chipboard, garden products, animal bedding products and energy recovery.

6.6.1.3 Key Gaps

Responses provided little information on different wood products and their respective lifetimes.

Specific figures were not provided in relation to GHG emissions and savings.

6.7 Summary of responses to Q29

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?

11 Respondents: 6 from UK; 4 from USA; 1 from Canada; 0 from Europe

Trade Associations	Energy	Biomass	NGO	Government Agency	Research	Certification
5	0	1	2	2	1	0

Sectors

Academic, Bioenergy, Conservation, Forestry, Non-bioenergy, Pellet, Renewable Energy

Around half of the responses to this question provided evidence. In total there was 12 pieces of evidence and 7 of these were relevant to the question. This evidence was not comprehensive and evidence was lacking for specific parts of the question. Of the relevant evidence 3 were high quality and 4 were medium quality.

6.7.1 Summary of responses

Responses focussed on bio-plastics, bio-chemicals and applications (e.g. vehicle parts, food additives, cosmetics, detergent etc.). A number of research networks were mentioned. Overall respondents called for investment in research on non-energy uses, integration with bio-refineries and an understanding of the costs, benefits and impacts.

Responses to Q29 can be categorised into 2 main groups:

1. Those that focussed on the potential non-energy uses of bio-feedstocks.
2. Those that focussed on the risks and barriers associated with non-energy uses of bio-feedstocks.

6.7.1.1 Areas of agreement in group 1: Non-energy use of bio-feedstocks

Respondents in group 1 were broadly in favour of non-energy uses of bio-feedstocks and wanted to encourage their development and use. This group see them as a solution to issues with fossil plastics and a means for decarbonisation. The respondents thought there is real potential for growth and that the UK has important skills and expertise in this area.

Respondents thought bioplastics were the key non-energy use of biomass feedstocks. Several highlighted plastic packaging as an important application, specifically food packaging, although supporting evidence was not provided.

Other anticipated applications include textiles, construction materials, coating materials (such as paints), pesticides, lubricants, medical applications, vehicle parts and cosmetics. Several examples of how industry is developing and taking such applications on board were provided.

Two sources of funding were identified that have contributed to development in the UK: the BBSRC Networks in Biotechnology and Bioenergy (NIBBs) initiatives and European networks, in which the UK is involved in several. There was some concern that loss of our central role in these European networks would leave a funding and influence gap. These networks have identified bio-refinery work in Europe, supported bio-based industries and developed the use of waste feedstock to develop bioplastics.

The potential to integrate energy with production of biomaterials was also highlighted, specifically: anaerobic digestion and BioSNG production as versatile technologies that could be used for multiple bio-purposes (biorefining); and production of biomaterials from wood with the use of residues for low grade heat (also biorefining).

This group suggested that the Government has a role in mandating use of bio-plastics materials to help the development of the market; and to provide funds for the development of bio-materials, whether fundamental research or assisting transfer to industrial scale commercialisation.

The BBSRC's Biotechnology landscape report highlights the potential for industrial biotechnology in the UK. Respondents also cited work ongoing elsewhere (in Europe and North America).

6.7.2 Areas of agreement in group 2: Risks and barriers

Environmental, land and marine risks

Several respondents were concerned that non-energy uses of biomass feedstocks may result in land use change and that more evidence on this is needed. These respondents want use of land considered, taking ecosystem services and biodiversity into account. Evidence to support was ranked medium quality, but this reflects the need for clarity of these issues. These respondents were also concerned about the marine impacts, i.e. biodegradability under marine conditions.

Commercialisation

Respondents identified market barriers: bio-materials have to be established in a market place where there are already established market leaders and there are competing industries. These respondents suggested government mandates and/or obligations on industries to use bio materials.

Another concern was that the focus of policy on energy uses acts as a barrier to the increases of non-energy uses. Bio-materials and bio-refining could be complimentary to bioenergy and respondents thought this should be encouraged.

Research funding

Respondents were concerned that the loss of European funding and networking would leave a funding gap for developers in the UK

6.7.2.1 Key gaps:

A number of data and research gaps were highlighted.

- Technology gaps include: identification of viable markets, biotechnology research on waste/residue materials aimed at reducing waste generation, understanding the properties of bio-materials developed and consumer acceptability.
- Sustainability: understanding of life cycle emissions, land use and ecosystem impacts/benefits.
- General: data on economics/costs, timescales and market sizes.

7 GHG emissions reporting and accounting

7.1 Summary of responses to Q30

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?						
Respondents 12: 9 from UK; 3 from USA; 0 from Canada; 0 from Europe *Note: responses from the two NGOS were identical*						
Trade Associations	Energy	Biomass	NGO	Government Agency	Research	Certification
7	1	0	2	0	2	0
Sectors						
Academic, Agriculture, Bioenergy, Conservation, Forestry, Gas, Minerals, Non-bioenergy, Pellet						
24 pieces of evidence were submitted of which 12 were of high quality (mostly peer reviewed journal papers), 10 were of medium quality (reports from institutions or organisations, or non-peer reviewed material) and 2 were of low quality (press releases).						

7.1.1 Summary of responses

There were two distinct views on whether the current approach is adequate.

Trade associations representing forestry and pellet production in the US considered that the current approach focussing on supply chain emissions and the monitoring of land use were sufficient. Some pointed out that a robust carbon tracking system is required to ensure sustainability of wood from forests and that in the USA this is provided by the USDA Forest Services Forestry Inventory Analysis. Others indicated that all pellet producers supplying to the US are certified to the Sustainable Biomass Programme Standard, which is accepted as a Category A compliance mechanism for UK sustainability standards. Some respondents did not answer the question directly, reiterating responses made to earlier questions, highlighting the need to evaluate emissions from forestry over an appropriate scale (forest wide rather than stand) and long-time scale (to account for long rotation times). They suggested that on this basis, as long as forests across the landscape are managed sustainably and forest carbon stocks remain stable (or increase) over time, biomass energy and other parts of the forest products sector do not increase net atmospheric GHG concentrations.

Other respondents pointed out weaknesses in the current approach:

- One respondent suggested that there is a lack of clarity on the definition of residues and products in the GHG accounting methodology adopted in Europe and that Member States have differing interpretations. They suggested that this lack of clarity extends to the methodology used to calculate the fossil fuel comparators, with refinery outputs such as bitumen treated as products rather than residues, leading to lower GHG emissions being attributed to petrol and diesel.
- The same respondent also suggested that the main gap in land use accounting is in carbon stock, and, to accurately assess this, a counterfactual baseline should always be assessed.
- Some respondents questioned the perception that bioenergy is carbon neutral and called for methods that include accounting for all emissions from the biomass supply chain. These respondents drew attention to weakness in the reporting guidelines for LULUCF and that some countries exporting biomass may not be signatories to the Kyoto Protocol and so not reporting LULUCF emissions.
- The impacts of ILUC for crop based transport fuels was highlighted as an area for attention.
- A research body identified the need for an improved approach to soil N_2O emissions from fertiliser application, particularly for perennial grassy crops. They also suggested that emissions caused during establishment could be mitigated by using cover crops, implicitly suggesting that the methodology would need to be adjusted to take account of this.

- One respondent called for consistency in carbon accounting across sectors, pointing out that emissions associated with imported manufactured good are not accounted for in the UK, and the UK needs to be consistent in its approach about the accounting of emissions in the country of origin.

7.2 Summary of responses to Q31

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?						
9 Respondents: 3 from UK; 6 from USA; 0 from Canada; 0 from Europe *Note: responses from two NGOS were identical*						
Trade Associations	Energy	Biomass	NGO	Government Agency	Research	Certification
4	0	1	3	1	0	0
Sectors						
Conservation, Forestry, Pellet, Renewable Energy						
Five pieces of evidence were submitted, 1 of high quality (Data on Government website) 3 of medium quality (reports from organisations) and 1 of low quality (newspaper article).						

7.2.1 Summary of responses

There was no overall agreement in the responses on this question.

7.2.1.1 Areas where there is uncertainty or disagreement in interpretation of the evidence

Trade Associations for forestry and pellet production in the US, and a pellet producer did not acknowledge any risks for supply from the US, making the points that regardless of whether the US is committed to the Kyoto Protocol or Paris Agreement,

- US forests will continue to be managed sustainably.
- The USDA Forest Services Forest Inventory Analysis monitors and will continue to monitor carbon stocks in US forests.
- The US will continue to publish national GHG inventories which will include emissions from LULUCF.
- US Pellet producers supplying to the UK all comply with the **Sustainable Biomass Programme Standard which is accepted** as a Category A compliance mechanism for current UK sustainability standards.

One respondent made the same point as in the response to Q30, i.e. that there is a risk that emissions may not be accounted for completely. They suggested risks could be managed by amending the GHG accounting rules to use a historical base year instead of projected reference level baselines, and by ensuring comprehensive coverage of countries. If this is not feasible then they suggest managing risks by using 'proxy accounting', i.e. ruling out use of biomass feedstocks associated with high carbon emission such as whole trees and stumps.

7.3 Summary of responses to Q32

32. What alternative method(s) for bioenergy emissions accounting should be considered? What would the implications of these alternative method(s) be?						
Respondents 8: 4 from UK; 4 from USA; 0 from Canada; 0 from Europe *Note: responses from the two NGOS were identical*						
Trade Associations	Energy	Biomass	NGO	Government Agency	Research	Certification
3	1	0	2	1	1	0
Sectors						
Academic, Conservation, Forestry, Gas, Pellet, Renewable Energy						
Eight pieces of evidence of which 7 were of high quality (peer reviewed papers, Government commissioned reports, and Government data) and 1 of medium quality.						

7.4 Summary of responses

There was a general agreement that changes in carbon stock should be included in the assessment of bioenergy supply chain GHG emissions.

Beyond this point, respondents mainly reiterated positions given in response to questions 31 and 32, and earlier in the consultation. For example, those involved in forestry and pellet production in the US, reiterated that sustainable management of forests in the US means that carbon stocks remain stable or increase. They also pointed out the need to have a realistic counterfactual or baseline scenario when assessing changes in carbon stock. As earlier in the consultation, they suggest this counterfactual needs to recognise that there are many drivers in forest management not just bioenergy production.

The NGOs (who submitted very similar evidence) pointed out that if the improvements to accounting for carbon stock changes in LULUCF emissions reporting identified in Q31 were not achieved, then alternative emissions could be accounted for in the energy sector. However, this would be complex, and it might be better to introduce 'proxy accounting' to rule out feedstocks not meeting certain level of emissions reduction (based on full accounting) within a given climate-relevant timeframe.

8 Indicators

8.1 Summary of responses to Q33

33. What key areas should be reflected in these indicators?						
Respondents 10: 6 from UK; 4 from USA; 0 from Canada; 0 from Europe						
Trade Associations	Energy	Biomass	NGO	Government Agency	Research	Certification
6	0	1	2	0	1	0
Sectors						
Academic, Bioenergy, Conservation, Forestry, Minerals, Pellet, Renewable Energy						
No evidence was provided to support the responses to this question						

8.1.1 Summary of responses

The respondents were all broadly in favour of introducing indicators.

Responses could be split into two main groups:

1. Those that gave specific examples of indicators that could be introduced
2. Those that discussed what should be considered when producing the indicators

Overview of responses in group 1:

Some respondents gave a list of potential indicators. These covered areas such as biodiversity, emission reductions and the prioritisation of biomass supply.

Another respondent suggested that an area which should be reflected by the indicators is increase in biomass supply.

Overview of responses in group 2:

Responses indicated that before determining what the indicators should be, it is important to understand exactly what the desired bioenergy outcomes are.

Some respondents stated that indicators should be based on reliable peer-reviewed data and research.

8.2 Summary of responses to Q34

34. Please provide details of any examples of international best-practice in the area of bioenergy indicators.						
Respondents 2: 0 from UK; 2 from USA; 0 from Canada; 0 from Europe						
Trade Associations	Energy	Biomass	NGO	Government Agency	Research	Certification
2	0	0	0	0	0	0
Sectors						
Forestry, Pellet						
Summary of evidence: No evidence was provided to support responses to this question.						

8.2.1 Summary of responses

There were only two responses to this question. They did not directly state examples of international best-practice in the area of bioenergy indicators, but both highlighted the success the UK has had in importing sustainable biomass.

9 Other

9.1 Summary of responses to Q35

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

Trade Associations	Energy	Biomass	NGO	Government Agency	Research	Certification
4	4	2	2	0	0	0

Sectors

Agriculture, Bioenergy, Conservation, Electricity generation, Forestry, Gas, Pellet, Renewable Energy

9.1.1 Summary of responses

Respondents submitted a range of additional issues they would like CCC to consider, broadly in the following categories:

- *Cost effective energy*: Respondents were keen to ensure that energy is cost effective and that the cost of biomass should be a prime consideration in its use.
- *UK biomass sources*: Respondents were also keen to prioritise UK biomass sources, particularly waste, and the woodfuel strategy was submitted as evidence of UK wood fuel potential. Related to this, one respondent discussed the difference bioenergy had made to managing his farm, with production of wood chip for biomass boilers on the farm ensuring that woodland which had fallen into neglect was now properly managed. Another respondent said that there should be greater consideration of UK resources and that Government policy should recognise the versatility and flexibility of UK biomass fuel options. (Low to high quality evidence was provided to support this).
- *Renewable gas*: A few respondents, keen to support renewable gas sources provided additional evidence on this. One respondent provided references for the Freedom project[15], which looks at efficient ways of using renewable gas in the gas grid; another provided evidence in support of bioLPG. High quality evidence was submitted to support this.
- *Sustainability*: One NGO emphasised the importance of ILUC and carbon debt in sustainability. No additional evidence submitted.
- *IEA Roadmap*: One respondent suggested that the IEA Technology Roadmap provides good guidance for near term priorities and key steps to accelerating technology and deployment, whilst also identifying opportunities and obstacles that need to be resolved.

[15] The Freedom project is run by Wales and West utilities with Network Innovation Allowance funding in collaboration with Western Power Distribution and PassivSystems

Appendix 1 Bioenergy Review (2018) - Call for Evidence

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.

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.

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?
    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)
    c) What are the most likely alternative/counterfactual uses of forestry products used for wood pellet production?
    d) How are these wider market impacts (sub-questions a-c) likely to change over time if demand for wood pellets significantly increases?

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)?

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?

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?

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?

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)

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.

24. Gasification has been identified as a potentially important technology for unlocking the full potential of bioenergy to support economy-wide decarbonisation.
    f) What are the likely timescales for commercial deployment of gasification technologies?
    g) 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.
    h) What are the main barriers and uncertainties associated with the development, deployment and use of gasification technologies?
    i) What risks are associated with gasification technologies and how can these be managed?
    j) What policies and incentives are required to facilitate commercial deployment?

25. 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.
    e) What are the potential timescales for commercial deployment of BECCS technologies?
    f) What are likely to be the optimal uses of BECCS (e.g. electricity generation, hydrogen production)?
    g) What efficiencies and costs are possible?
    h) 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.
    h) 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.
    i) 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.
    j) What are likely to be the optimal feedstock types for advanced biofuel technologies?
    k) What are likely to be the optimal end-uses of advanced biofuel technologies?
    l) What are the main barriers and uncertainties associated with the development, deployment and use of advanced biofuel technologies?
    m) What risks are associated with the pursuit of advanced biofuel technologies and how can these be managed?

n) 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.
    f. 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.
    g. 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?
    h. What is the potential for using UK-produced timber in construction rather than imports? What are the barriers and how can they be overcome?
    i. What is the expected lifetime of different wood products in construction (e.g. cross-laminated timber)?
    j. 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.
    d. 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?
    e. What are the barriers to increasing these non-energy uses and how can these barriers be overcome?
    f. What risks are associated with the pursuit of other non-energy uses of bio-feedstocks and how can these be managed?

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?

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

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

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

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