

## **Response to Energy and Climate Change Committee Call for Evidence on Bioenergy**

### **Summary**

1. The Energy Technologies Institute (ETI), a public-private partnership between global energy and engineering firms and the UK Government, believes the UK can have an affordable, secure and sustainable energy system in the future and that domestically grown biomass can be an important part of that mix. However, it is important that the right steps are taken to ensure the cost of carbon reductions are affordable in the context of sustaining UK economic growth and industrial development.
2. The ETI carries out two key activities – (1) modelling and analysis of the UK energy system to identify the key challenges and potential solutions to meeting the UK's 2020 and 2050 targets at the lowest cost to the UK, and (2) investing in major engineering and technology demonstration projects which address these challenges with the aim of de-risking solutions – both in technology and in supply-chain development – for subsequent commercial investors.
3. ETI has over £7.5m of bioenergy projects either completed or ongoing including: development of soil carbon stock models for a range of potential crops using data acquisition from 110 UK field trials, development of value chain models to facilitate business and government investment strategies, design and demonstration projects for improved performance waste gasification plants.
4. ETI's work to model both the UK energy system and its bioenergy potential suggests clearly that developing a UK domestic biomass supply base offers major economic benefits. It enables the UK to meet carbon targets at a substantially lower cost.
5. Development of a domestic supply base offers the opportunity to develop bioenergy in a way which clearly addresses concerns around sustainability and broader impact on emissions. This can be achieved through building the scientific evidence base, careful design of policy and geographic focusing of uptake in areas where benefits are greatest.
6. Policy should aim to create a stable and coherent enabling environment for the development of a domestic biomass supply base, focusing on promoting the uptake of perennial energy crops.
7. There is a need to align the full range of policies which impact on farmers, project developers and investors decision making – including the support for energy crop establishment, energy policies and incentives and broader agricultural and land use policies and subsidies.

## Specific questions raised in the consultation

### What contribution can biomass make on the UK's energy mix?

8. ETI analysis of the UK energy system out to 2050 is focused through our in-house and internationally peer-reviewed Energy System Modelling Environment (ESME), a national energy system design tool, integrating power, heat, transport and the infrastructure that connects them. Through this analysis the ETI can give a sound view on the potential impact of a specific technology – based on underpinning economic and engineering evidence.
9. We outline six key priorities to ensure the UK's future energy system is affordable, secure and sustainable. These are:
  - Improving efficiency – demand reduction and smarter use of energy in vehicles, businesses and homes to minimise the overall requirement for new infrastructure and energy delivery growth in line with rising population and demand.
  - Bioenergy – (not just biomass) offering energy security and climate change benefits with the potential to provide around 10% of the UK's energy needs by 2050 if sufficient sustainable supplies can be sourced (onshore in the UK and globally). [see para 13 below]
  - Carbon capture and storage – a critical technology in delivering energy security whilst meeting climate change targets, allowing the continued UK use of global supplies of fossil fuels.
  - Progressing new nuclear build – ETI modelling shows that it is possible to create a future energy system capable of meeting our 2050 emissions targets without new nuclear build but the system wide cost is increased by up to £8bn p.a. as alternative (higher cost) low carbon energy technologies are used instead.
  - Offshore renewables provide an important low carbon opportunity which acts as a hedging option for the country should the introduction of the highlighted technologies (above) be significantly delayed.
  - Gas for power, heat and potentially transport– the ETI expects gas, whether from fossil sources or alternatives such as bio-crop feedstocks, to remain a critical element of the UK energy system. Delivering UK climate change targets whilst still using gas is achievable through the use of bio-crops as a feedstock, application of CCS and substitution of lower carbon alternatives in some heating systems.
10. These all have technology risks which need to be understood and managed if they are to attract investors and an industrial supply chain.
11. The current risks and uncertainties around UK sourced bioenergy are principally around land use change issues and value chain development, hence our investments in our Bioenergy Technology programme have focussed on these issues.
12. Bioenergy is a very flexible primary energy source with the optimum end use depending on the rest of the national energy system operation (eg operating with or without CCS).
13. Bioenergy should be considered as being delivered from animal, domestic and industrial wastes as well as dedicated biomass crops.

## **Can genuine carbon reductions be achieved and is support for bioenergy maximising the overall benefit to the economy?**

14. The ETI provided data to the Government's UK Bioenergy Strategy which stated that excluding biomass from the energy mix would significantly increase the cost of decarbonising our energy system. Without bioenergy as part of the mix in 2050, our modelling suggests that the annual cost of meeting our national energy needs would be around £42 billion higher. Bioenergy has one of the highest impacts of any of the technologies in the ETI's ESME analysis.
15. To put this into perspective this figure would be an economic saving worth around 1% of expected GDP in 2050 and compares with UK agriculture's current share of GDP at around 0.7%. Much of this economic benefit could be delivered by applying CCS technology to bioenergy, as the carbon is captured first by the growing plants and then again as carbon dioxide is released from conversion of the biomass (probably from burning in large power plants). The key limit to the amount of bioenergy in the UK system is based on the availability of suitable land for production of biomass - without impacting upon food and fibre requirements.
16. Across the UK energy system it is cheaper to reduce carbon emissions in some sectors than others so it is not economic for all sectors to have the same reduction targets. It is more difficult to find a low carbon solution for power dense applications such as aviation and heavy duty vehicles. However, using bioenergy in sectors such as power generation combined with CCS can create a "carbon credit" by delivering a net reduction in atmospheric CO<sub>2</sub>. The reduction in atmospheric CO<sub>2</sub> associated with biomass growth and capture of any emissions arising from its conversion into energy, gives the potential to buy headroom for other sectors by providing a national 'carbon credit'. With widespread implementation at a national scale this may be the single, most cost effective lever for reducing UK greenhouse gas emissions.
17. Bioenergy is a flexible energy source capable of delivering heat, power, gas and liquid fuels. Using biomass to generate energy, however, is only effective with proper management of the greenhouse gas lifecycle. This involves careful attention to the agricultural processes employed, and the planting and growth of lignocellulosic crops (large and woody biomass such as trees and miscanthus), without the use of fertilisers. The best type of cycle is likely to be one which produces woody biomass on low grade land, therefore not displacing food production, and with ready access to a power station with CCS, thus minimising transport requirements and allowing the maximum capture of emissions. Without careful management, it is possible to produce bioenergy cycles which are worse than fossil fuel ones.
18. Sustainable global production of biomass provides a route to enhance stored 'carbon stock' but poor crop management practices could lead to a significant decrease. If agriculture also employs the use of fertilisers, there are resulting NO<sub>x</sub> emissions which have a significant effect on greenhouse gases, but this element is not covered here.

## **Is sufficient attention being given to potential impacts in other areas such as food security and biodiversity?**

19. Land availability in the UK constrains the quantity of energy crops that can be sustainably grown and therefore the resulting energy production from biomass and the potential for carbon capture. Currently only 0.45% of UK land is used for the production of biomass. However, only 0.04% or 11,000 hectares is dedicated to so called 'second generation' bioenergy crops such as miscanthus and short rotation coppice. ETI analysis and prior work from the TSEC-BIOSYS Consortium shows there is the potential to increase this to around 15% which equates to approximately 3.5 million hectares. In our analysis the ETI assumes that a more conservative 2 million hectares is a more likely level. Change on this scale would undoubtedly be a major challenge to deliver, but our work to model the energy system suggests that scale of potential economic benefits (as set out above) justify focus on promoting the development of a major UK biomass supply base.
20. Through work conducted jointly by the ETI with government and sector experts, the consensus view is that good results with biomass can be achieved by:
  - Increasing the stock of carbon in growing plants and the soil by changing land use.
  - Increasing the carbon capture rate in new and well managed forests and using the timber in structures with a long life cycle.
  - Increasing the carbon capture rate in growing plants, conversion of the plant mass into energy, and capturing and storing the CO<sub>2</sub>.
21. Small changes in land use and crop management practices can have positive or negative effects. If managed poorly, the production and consumption of bioenergy can emit more greenhouse gases than extracting and burning fossil fuel. The benefit arises through effective management to maximise carbon capture during the growth phase whilst minimising losses from the soil and root stock during harvesting and re-planting.
22. Understanding of the lifecycle of greenhouse gas emissions linked to agricultural practices and their impact on bioenergy crops is being captured in the ETI's Eco-systems Land Use Modelling study (ELUM). The project involves the Centre for Ecology & Hydrology, Aberystwyth University, Forest Research, the University of Aberdeen, the University of Edinburgh, the University of Southampton and the University of York.
23. Currently two years into a three year project ELUM is building an understanding of which land use transitions could be acceptable and which should be avoided. Targeting land use change which would have the greatest impact on emissions it is building a vital evidence base for the UK and one which can be shared with the committee effectively as it completes from mid 2014.
24. The ETI Value Chain Model project has created a powerful planning tool to help optimise the use of bioenergy in the UK taking into account a number of parameters such as the quality of the land, the biomass varieties available and the conversion technologies available. It involved Agra CEAS, EDF Energy, EIFER, E4tech, Forest Research, Imperial College London, Rothamsted Research and the University of Southampton

25. The ETI Value Chain Model project was completed in December 2012 and is now undergoing data validation. The results should help to identify how much biomass could be sustainably grown in the UK to help meet domestic energy demands.
26. Energy from waste technology is extremely important as it avoids the production of methane through decomposition. Although its main value is in mitigating against greenhouse gases, producing energy from waste could contribute up to 4% of the energy supply by 2050. Gasification is likely to be the most cost effective route to energy from waste. As the process is very similar technology to that for gasification of biomass, this is another very important reason for pursuing energy from waste technology.
27. The ETI is supporting three companies in a competition to design an economically and commercially viable, improved efficiency energy from waste demonstrator plant. The chosen plant could be designed, built, tested and in operation by 2016.

**What challenges are there to scaling up the use of biomass in the UK (i.e. regulation, feedstocks, sustainability, supply chain and financing)?**

28. There are significant challenges to scaling up the role of biomass in the UK. The bioenergy strategy published in 2012 was a useful first step to putting a coherent framework in place, but we believe there would be significant benefits in aligning policy more clearly to address the market failures and barriers to the development of the UK biomass supply base.
29. Key challenges include:
  - **Ensuring that the UK biomass production base reduces net emissions:** changes in land use can impact on greenhouse gas emissions directly in terms of the direct release of carbon stored in soil or existing vegetation and indirectly when activity is displaced onto other land with resulting impacts. There are emissions which arise during cultivation, harvesting and transportation which also need to be taken into account. ETI's work on the ELUM project aims to build current understanding about soil and biomass changes arising from land change in the UK. This will help ensure that any future decisions about UK biomass cultivation can be informed by sound understanding of the emissions impacts. For example, future policy and incentives could be shaped to promote biomass production in regions and land categories where it can deliver the greatest net impact on UK emissions.
  - **Careful management of sustainability impacts:** ETI's energy system modelling suggests that bio-energy has a crucial role to play in an affordable transition to a low carbon future, potentially providing up to 10% of the UK's primary energy resource. Careful design of policy and regulation can ensure that domestic biomass is sustainably produced, and on land and in ways which are acceptable to the public with positive impacts on the broader rural environment and bio-diversity. ETI's work suggests this volume of biomass can be produced by devoting around 12%-15% of UK land area to the production of biomass by 2050. More work needs to be done to fully understand the likely constraints on land availability for biomass production, with

a focus on ensuring that biomass production is concentrated on lower grade agricultural land.

- **Clear economic incentives:** the current market environment is challenging for the adoption of perennial energy crops by farmers. The decision to plant a perennial energy crop depends upon competitive returns against other land uses. These in turn are influenced by broader policies such as the Common Agricultural Policy and agri-environment funding. Our work points to the potential benefits for the UK in aligning the full range of economic incentives impacting upon farmers' decisions to promote an uptake of energy crops.
- **Stable policy environment:** the adoption of perennial energy crops involves a long term investment by farmers and entails a fundamental change in business model. Assistance with this is currently available, but greater certainty and visibility over medium term policy intentions would increase confidence and help promote the development of the supporting supply chain and logistics. Policy intentions around the future of the energy crops scheme remain unclear at present. ETI's initial work to understand the market, policy and regulatory issues around the development of the UK supply base have highlighted this as an area of concern.
- **Developing the supply chain:** this is perhaps one of the most difficult issues to address. There is a need to promote the simultaneous development of entire new supply chains. Farmer uptake of perennial energy crops requires a long term commitment and farmers are therefore reluctant to make major change without being assured of an outlet for crops at prices capable of delivering reasonable returns. Likewise investments in biomass based energy schemes require assurance of a supply of biomass. Due to the weight to value ratio of biomass for energy, markets may develop on a local or regional basis. There is a need therefore to carefully tailor policy support to promote a sustainable trajectory of upscaling biomass production. Much of this can be delivered by private sector players, but only within a broader policy environment that is stable and supportive. The conversion of major energy generators such as Drax to the use of biomass offers opportunities to further develop the UK biomass supply base, but consideration should also be given to other developing biomass production and energy conversion at other scales.
- **Financing:** finance for the development of UK bio-energy projects will be dependent on a clear and consistent policy framework which allows investors to understand risks and display clear visibility on returns. The specific challenges of developing the inter-dependent biomass/bioenergy value chain in UK is likely to present particular financial challenges and new business models may need to be financed which in turn stimulate and promote uptake of energy crops by farmers. For farmers the adoption of perennial energy crops presents particular financial challenges due to the longer period between investment outlays in crop establishment and their first returns. This is an area which should be explored further in building a better understanding of the barriers to uptake of energy crops which will need to be overcome.

**To what extent will UK be able to provide its own biomass and how much is likely to be imported?**

30. In the short term it appears that most of the UK biomass needs will need to be imported. For example, the planned conversion of major users such as Drax or Tilbury power stations will create volumes of demand that the UK supply base is currently unable to meet. However, this also presents an opportunity for the UK to build its supply base and learn lessons about how best to promote the uptake of energy crop production in circumstances where it is most sustainable, acceptable and delivers the greatest benefit in emissions reductions.
31. In the longer term, there is a major opportunity for sustainable production of biomass in the UK. Development of a clearly sustainable domestic biomass supply base will enable the UK to develop bioenergy with CCS as a route to deliver 'negative emissions'. This requires high confidence about its impacts on sustainability, food production and biodiversity and demonstration of where maximum value-added is retained within the UK economy. This would unlock major economic benefits by enabling the UK to reduce emissions while continuing to use some fossil fuels in applications (such as transport) where they are most difficult and expensive to replace.