www.eti.co.uk

Driving the renewables industry with new technology developments and investment in Research and Development

Hannah Evans, Bioenergy Strategy Manager

ETI10 TEN YEARS OF INNOVATION 2007 — 2017

What is the ETI?

- The ETI is a public-private partnership between global energy and engineering companies and the UK Government
- The UK faces increasing energy demands and stringent GHG emission targets out to 2050 (> 500 $MtCO_2e$ to 105 $MtCO_2e$)
- This will require significant change to our energy system
- The ETI was set up to identify and accelerate the development and demonstration (and de-risking) of an integrated set of low carbon technologies to deliver this step change

ETI members

bp

CATERPILLAR®

EDF ENERGY

Rolls-Royce

Department for Business, Energy & Industrial Strategy

EPSRC Pioneering research and skills

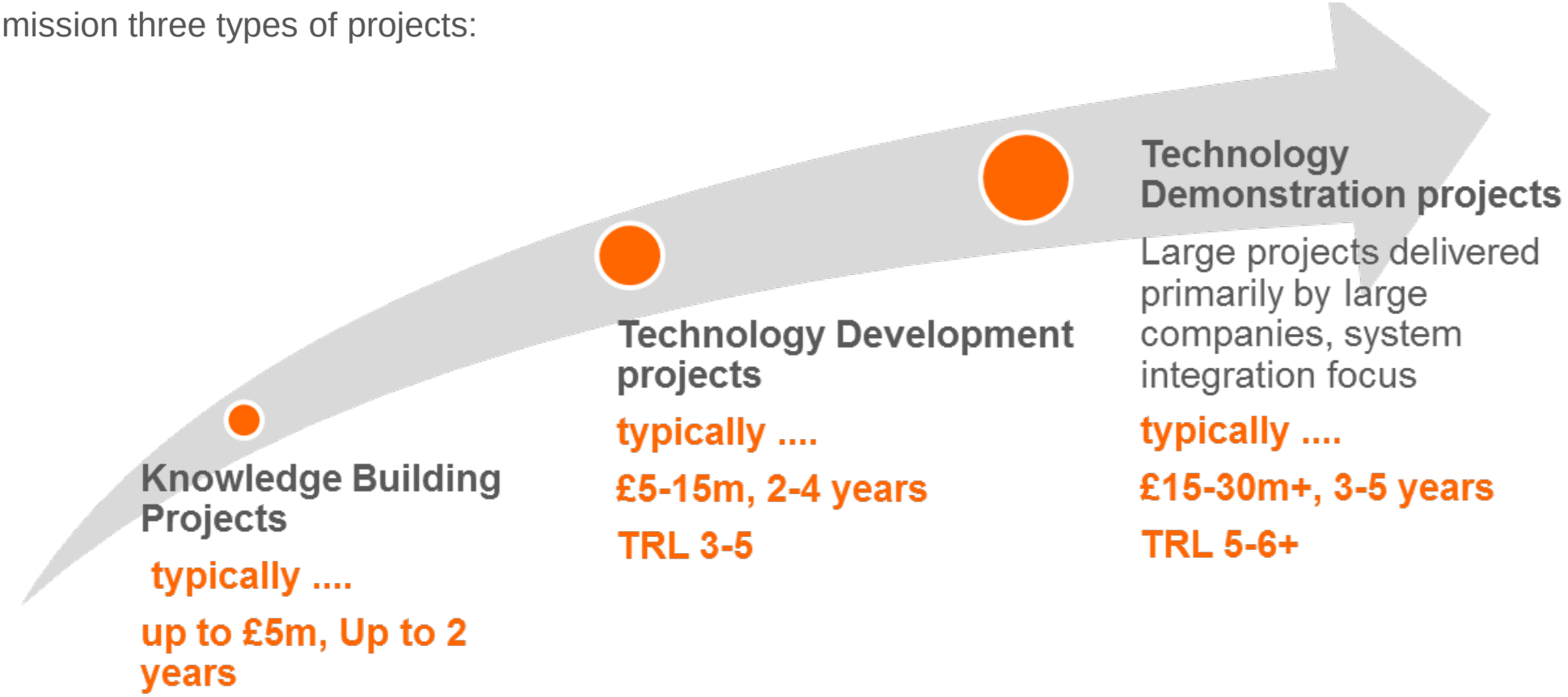
Innovate UK

ETI programme associate

HITACHI Inspire the Next

ETI Technology Programmes

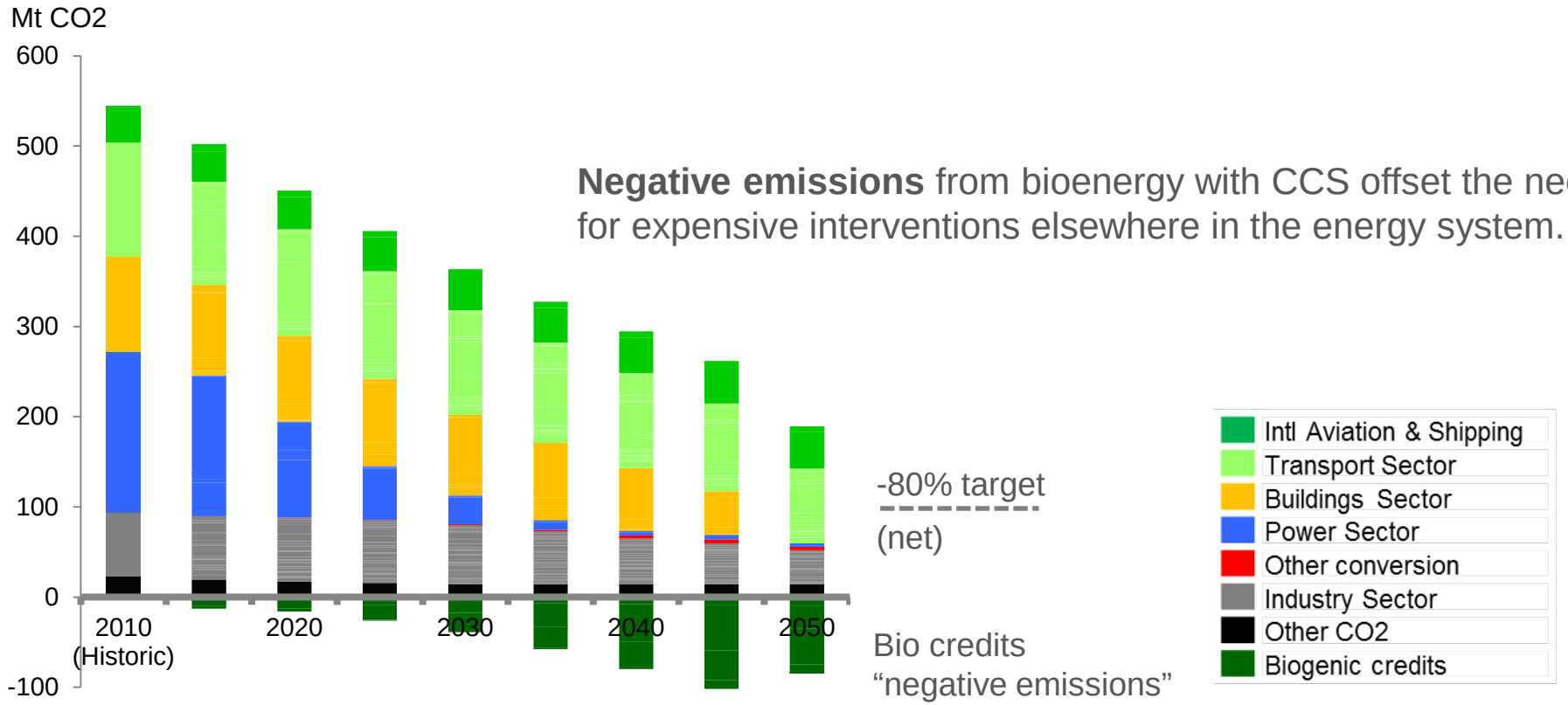
We commission three types of projects:



ETI's 'ESME' model indicates an important role for bioenergy in the UK

ESME
Energy System Modelling Environment

A national energy system design tool with sufficient spatial and temporal detail to understand system engineering challenges.



Negative emissions from bioenergy with CCS offset the need for expensive interventions elsewhere in the energy system.

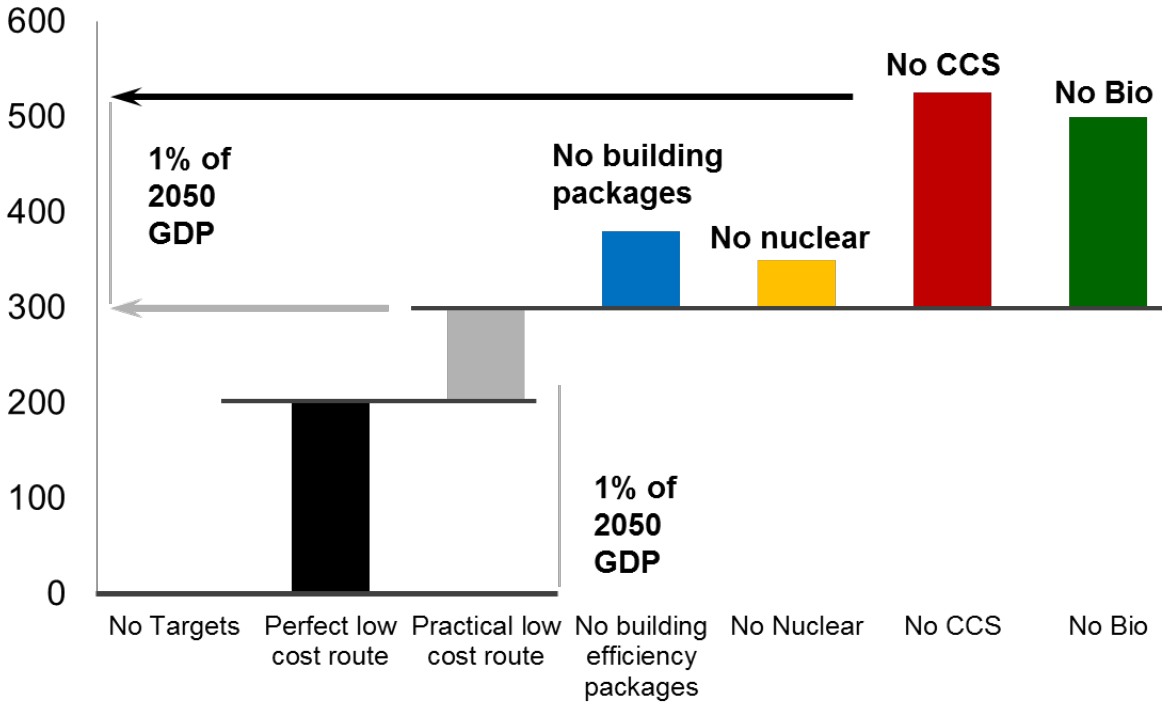
Chart data from case v41

ETI's 'ESME' model indicates an important role for bioenergy in the UK

ESME
Energy System Modelling Environment

A national energy system design tool with sufficient spatial and temporal detail to understand system engineering challenges.

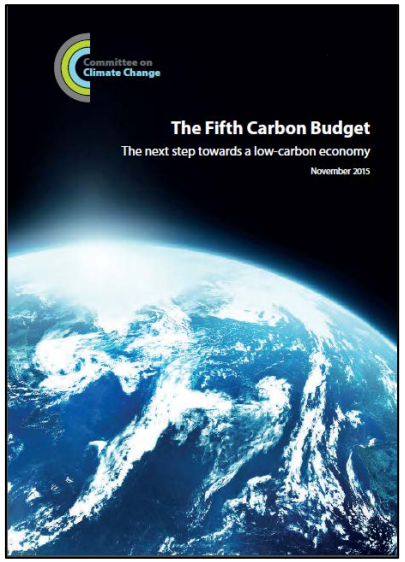
Additional cost of delivering 2050 -80% CO_2 energy system
NPV £ bn 2010-2050



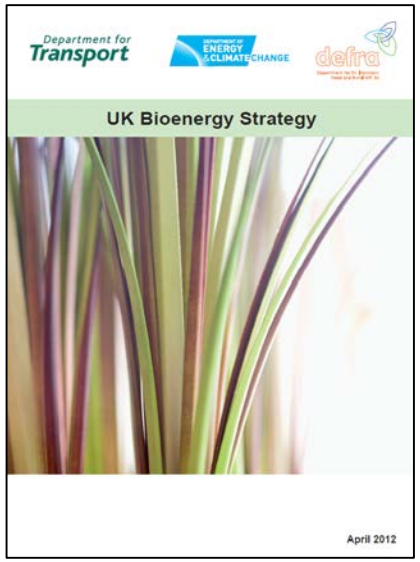
- It is likely to be very hard to deliver an *affordable* low carbon energy system without Bioenergy or CCS
- Without both, it becomes very hard to meet our 2050 GHG targets

Chart data from case dc14

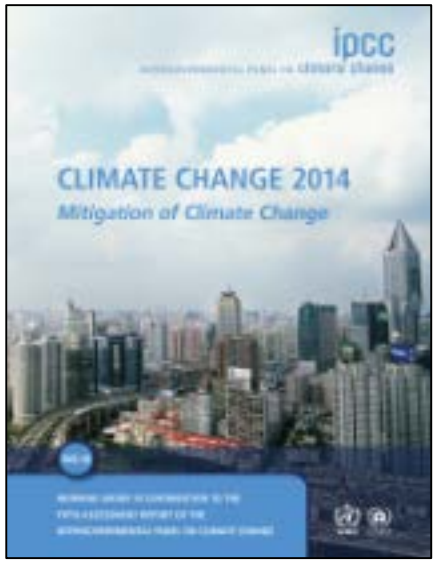
The importance of bioenergy is also recognised by others



"Sustainable bioenergy can play an important role. ...Bioenergy should be allocated to options where it has the largest impact on reducing emissions."



"It is widely recognised that bioenergy has an important role to play if the UK is to meet its low carbon objectives by 2050."



"Bioenergy has a significant mitigation potential, but there are issues to consider, such as the sustainability of practices and the efficiency of bioenergy systems"

ETI Bioenergy Programme – key questions

How much negative emissions could be realised through bioenergy deployment in the UK?

What would be the best ways to use this bioenergy in the future UK energy system?

What are the right combinations of feedstock, pre-processing, and conversion technologies?

Enabling policy, regulatory and market frameworks. Understanding public perception

ETI Bioenergy Programme – key questions

How much negative emissions could be realised through bioenergy deployment in the UK?

What would be the best ways to use this bioenergy in the future UK energy system?

What are the right combinations of feedstock, pre-processing, and conversion technologies?

elum
BIOENERGY DIRECT LAND-USE CHANGE

BVCM
Bioenergy Value Chain Model
Optimising Bioenergy

BioFIP
Biomass Feedstock Improvement Process

Advanced Waste Gasification

Enabling policy, regulatory and market frameworks. Understanding public perception

How much negative emissions could be realised through UK bioenergy deployment?

How much negative emissions could be realised through bioenergy deployment in the UK?

- Understanding the impact of whole chain emissions on delivering negative emissions – focusing on land use change emissions as a key area of uncertainty
- Bioenergy with CCS – apprising technology options and identifying and de-risking the barriers to deployment

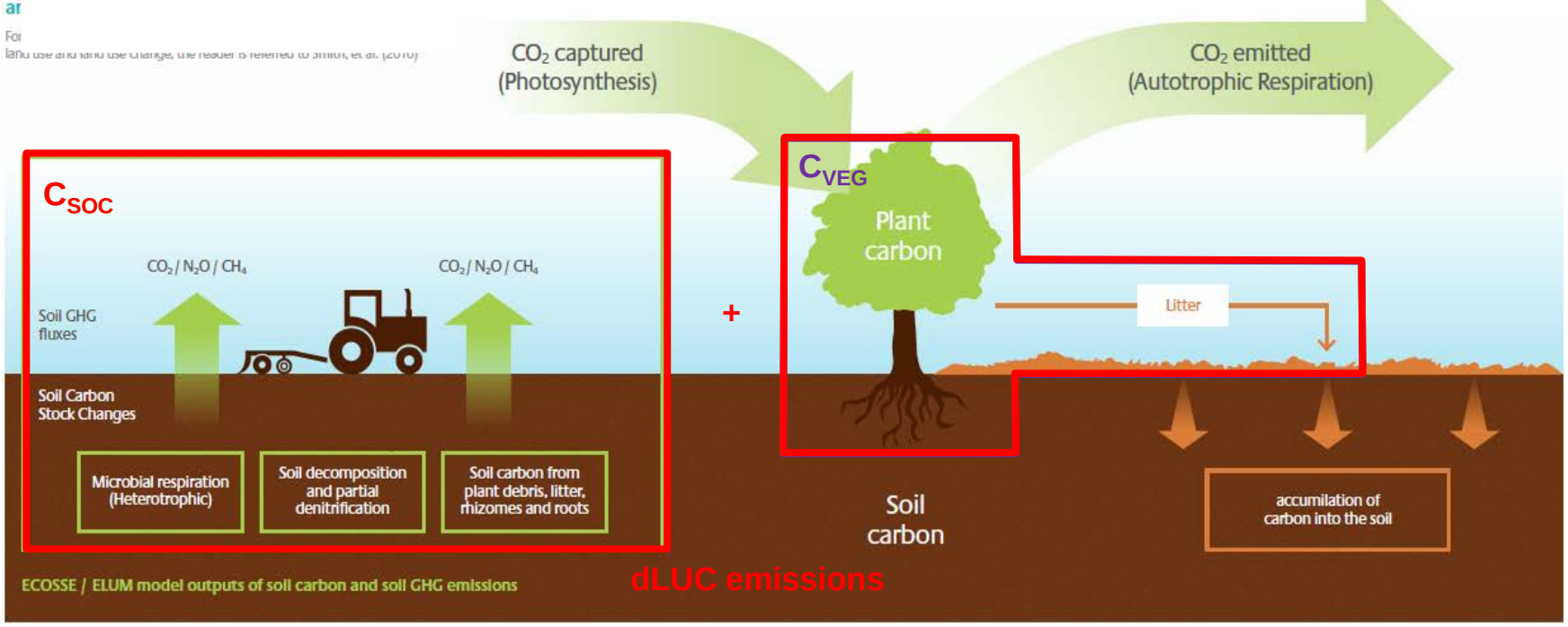
Ecosystem and Land Use Modelling and Soil GHG Flux Trial (ELUM) Project

"What are the dLUC emissions associated with growing bioenergy crops in the UK? Can they be predicted, and if so, what is best to grow and where?"

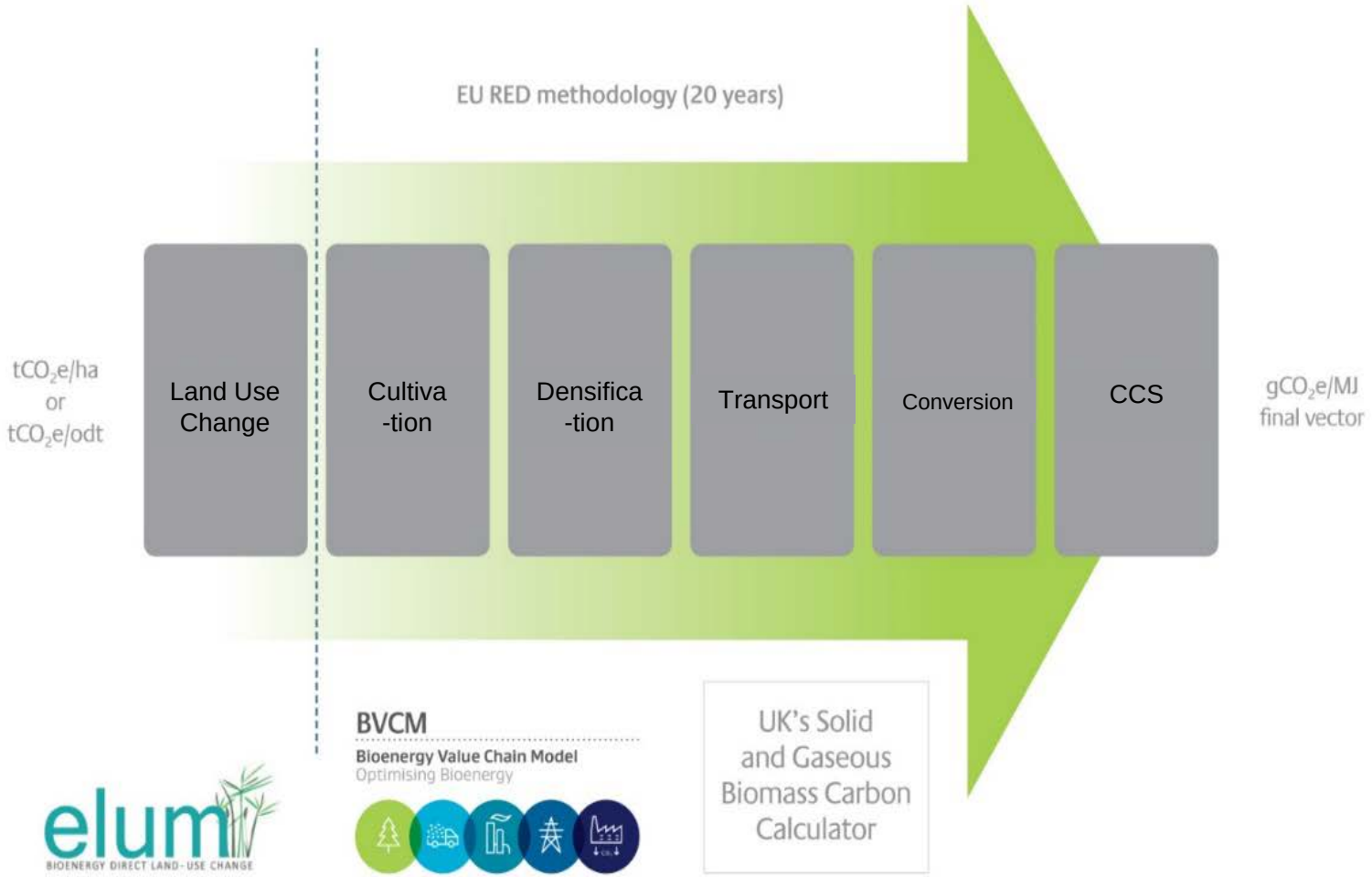
FIGURE 2

Schematic representation of components of soil carbon and soil GHG emission changes measured ar

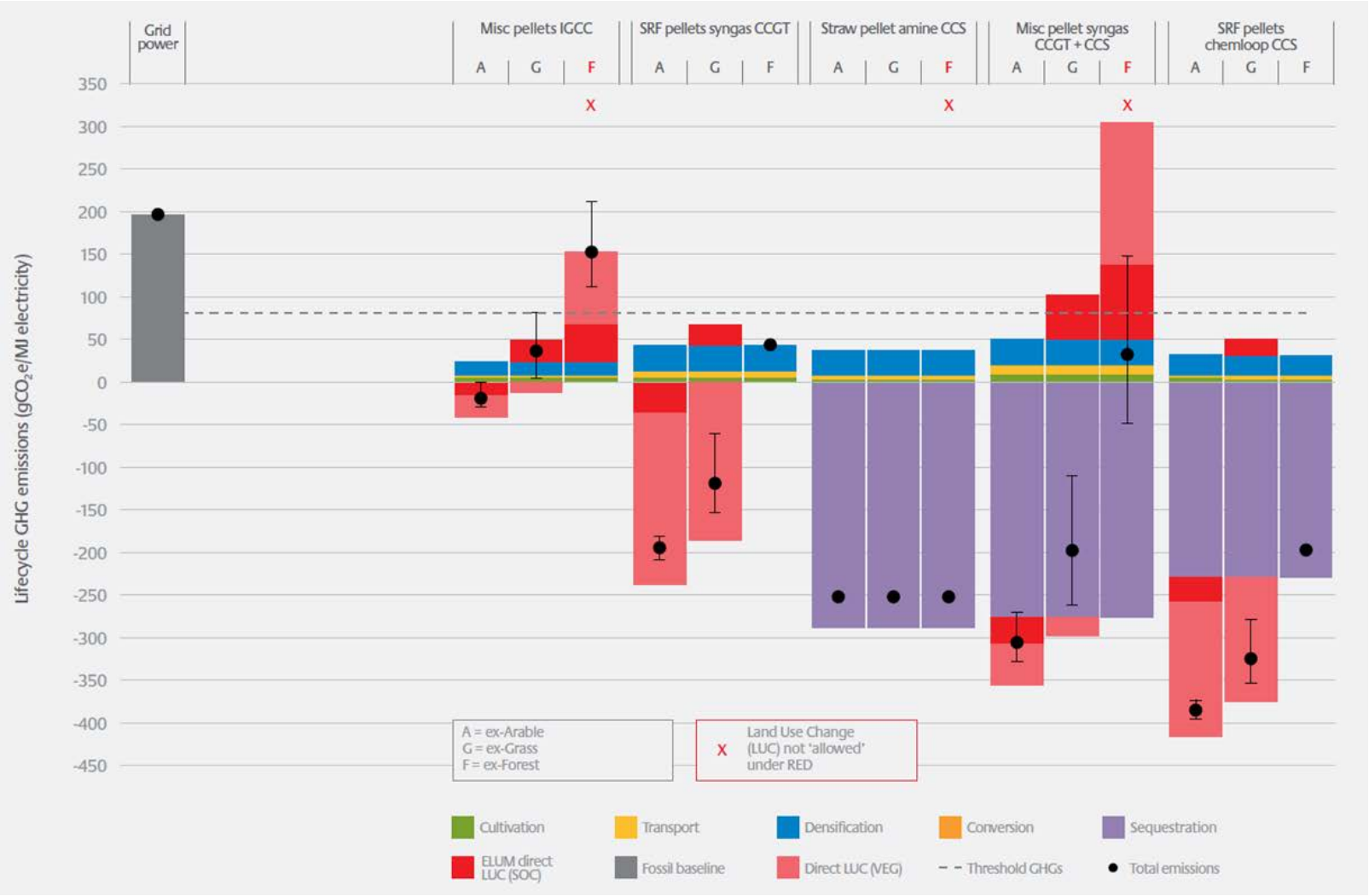
Note: harvested material was not measured in ELUM specifically



Soil carbon stock change has to be viewed in the context of whole chain emissions

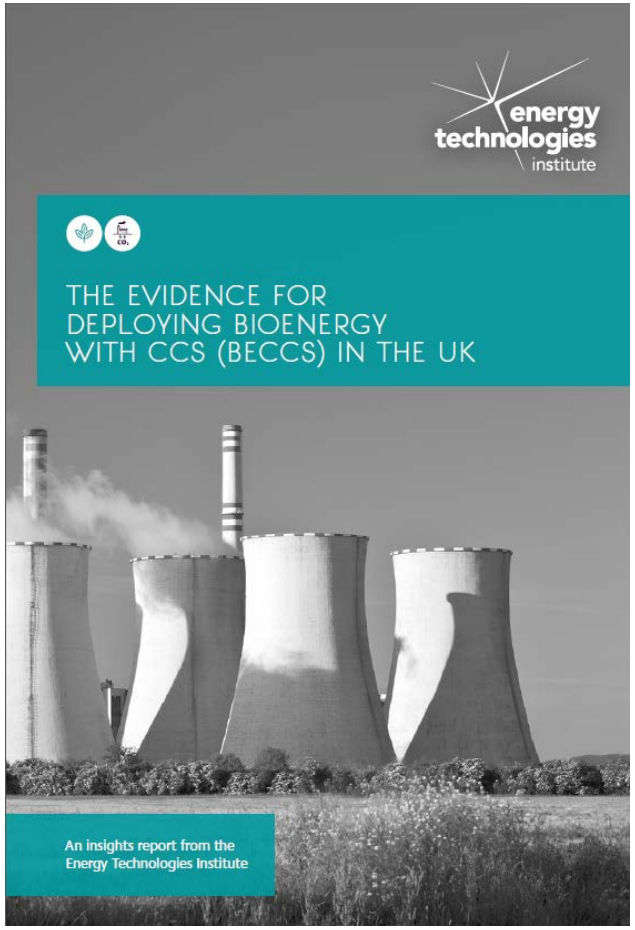


Bioenergy value chains can deliver genuine carbon savings



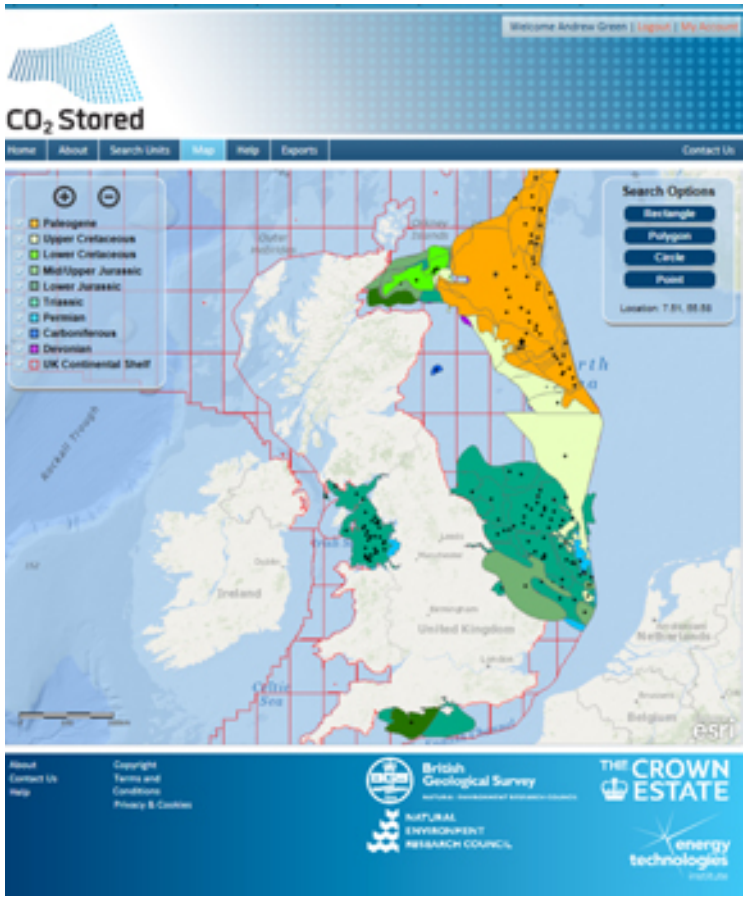
- dLUC emissions can be material, but are of second order importance in chains with CCS
- In grassland transitions, SOC change is somewhat offset by increased above ground biomass
- Existing sustainability criteria prevent the most damaging land use transitions

Significant advances have been made in de-risking BECCS deployment



- BECCS is critical to deploy in order for the UK to meet its 2050 emissions target cost effectively
- The evidence base suggests that BECCS value chains can deliver genuine sizeable negative emissions
- Over the last 10 years further advances have been made in:
  - The costs, efficiencies and challenges of biomass-fed combustion with carbon capture
  - Understanding the potential availability and sustainability of feedstocks relevant to the UK
  - Identifying and assessing high capacity, low cost, low risk stores for CO_2 around the UK and the infrastructure required to connect them
- The UK is well-placed to exploit the benefits of BECCS, given the vast storage opportunities offshore, our experience in bioenergy deployments and our strength in bioenergy and CCS research and development

UK Storage Appraisal Project UKSAP (CO_2 Stored)



- Produced the UK's first CO_2 storage appraisal database
- Allows for more informed decisions on the economics of storage opportunities
- Licensed to The Crown Estate and the British Geological Survey (BGS) and publically available under the brand of CO_2 Stored

Project Partners

senergy · HERIOT WATT · The University of Edinburgh · Ikon Science GeoPressure Technology · GRL · RPS Energy · elementenergy · British Geological Survey NATURAL ENVIRONMENT RESEARCH COUNCIL · Durham University · Imperial College London

Measurement, Modelling and Verification of CO_2 Storage

- £1m collaboration project to develop a marine monitoring system for underwater CCS sites
- Monitoring system will use marine robotics to provide assurance CCS sites are secure
- Project delivered by a consortium from academia and industry

Project Partners

What would be the best way to use bioenergy in the future UK energy system?

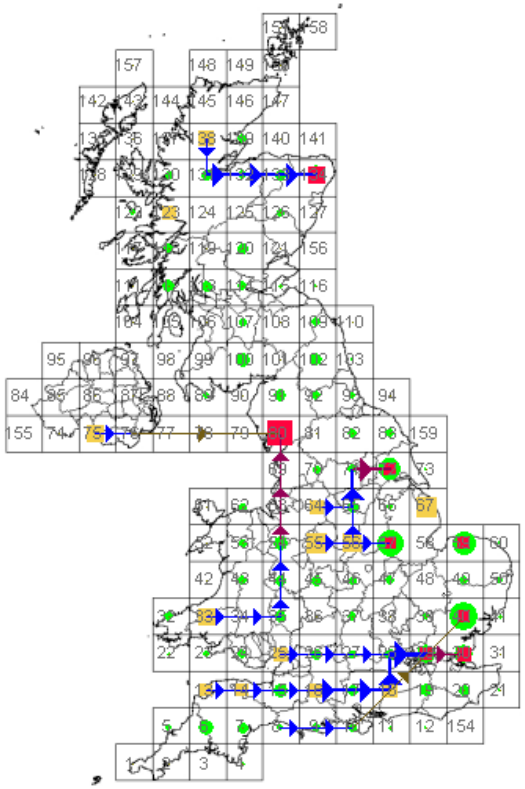
What would be the best ways to use this bioenergy in the future UK energy system?

- ESME – Analyses the role for bioenergy in the wider energy system under different scenarios. Explores how much more it would cost to meet the 2050 targets without bioenergy
- BVCM (Bioenergy Value Chain Model) – A more detailed model for whole system biomass value chain analysis and optimisation

ESME
Energy System Modelling Environment

BVCM
Bioenergy Value Chain Model
Optimising Bioenergy

The Bioenergy Value Chain Modelling (BVCM) Project



BVCM
Bioenergy Value Chain Model
Optimising Bioenergy

Problem definition:

What is the most effective way of delivering a particular bioenergy outcome in the UK, taking into account the available biomass resources, the geography of the UK, time, technology options and logistics networks?

Project commissioned:

Development of a comprehensive and flexible toolkit for whole system biomass value chain analysis and optimisation

- Pathways optimised based on: minimum cost, minimum GHG emissions, maximum energy, maximum profit or a combination

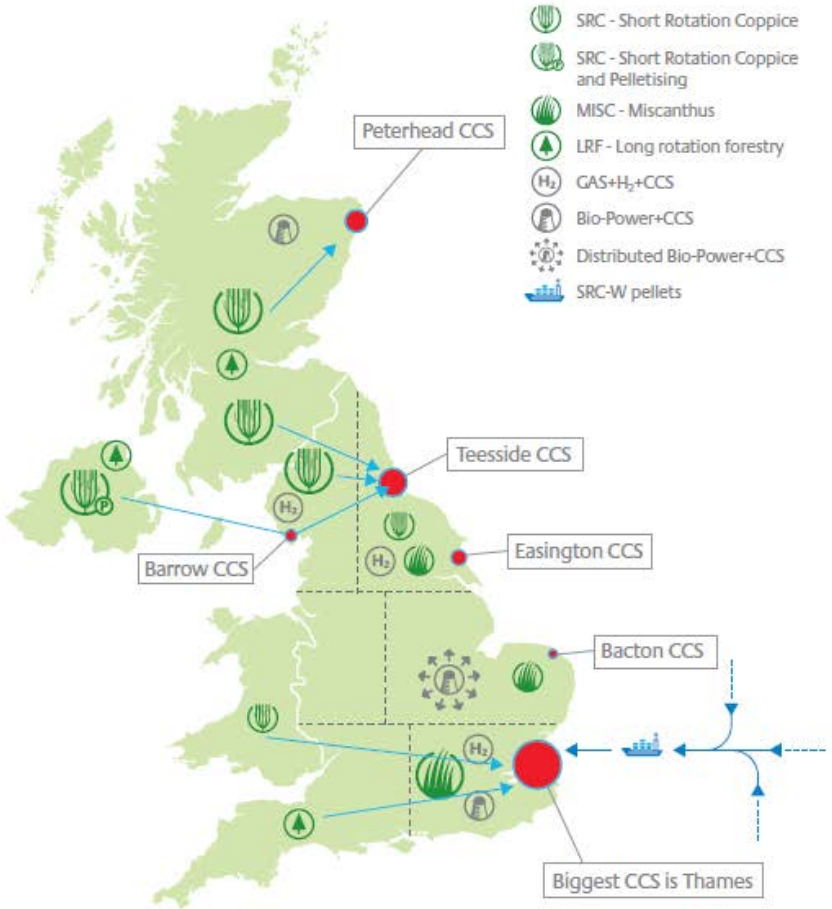
- 93 'Resources' and 69 distinct 'Technologies' at different scales and with multiple feedstocks. Includes UK production factors (land constraints; yields); imports; logistics

Project Partners

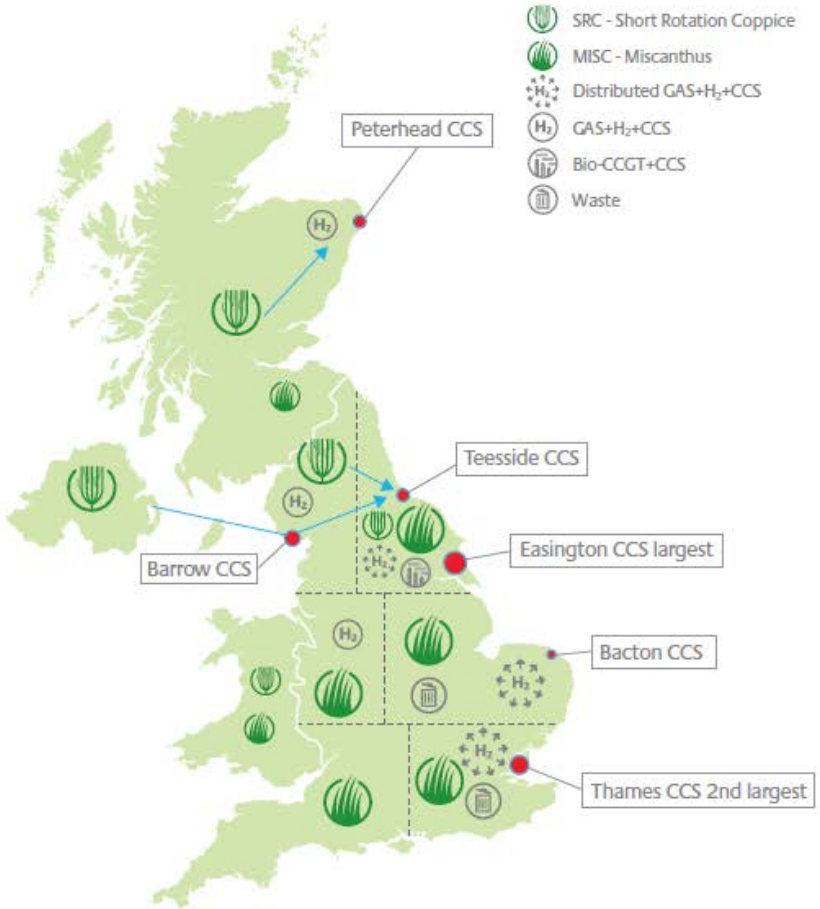
E4tech, Agra CEAS Consulting, EIFER, University of Southampton, Imperial College London, Forest Research, EDF Energy, Rothamsted Research

BVCM enables the bioenergy sector to be modelled under different conditions

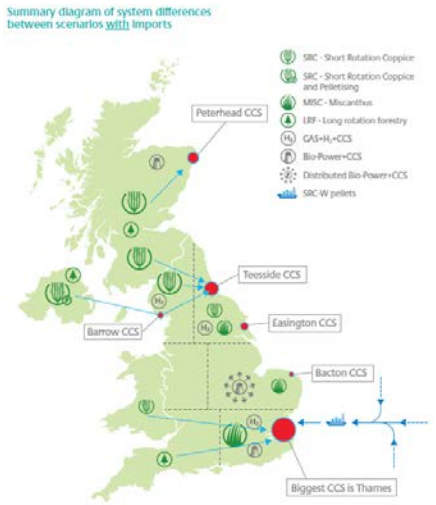
Summary diagram of system differences between scenarios with imports



Summary diagram of system differences between scenarios without imports



BVCM enables the bioenergy sector to be modelled under different conditions



Key insights from modelling the bioenergy sector under different scenarios out to 2050:

- Gasification technology is a key bioenergy enabler and resilient to a number of different scenarios
- Planting around 1.4 Mha of second generation bioenergy crops would make a significant contribution to the sector
- Deployment of BECCS makes a significant difference to the bioenergy sector:
  - With CCS, BECCS technologies dominate, clustered around key coastal hubs
  - Without CCS, more heat and biomethane are produced and the sector is more spatially distributed

What are the right combinations of technologies?

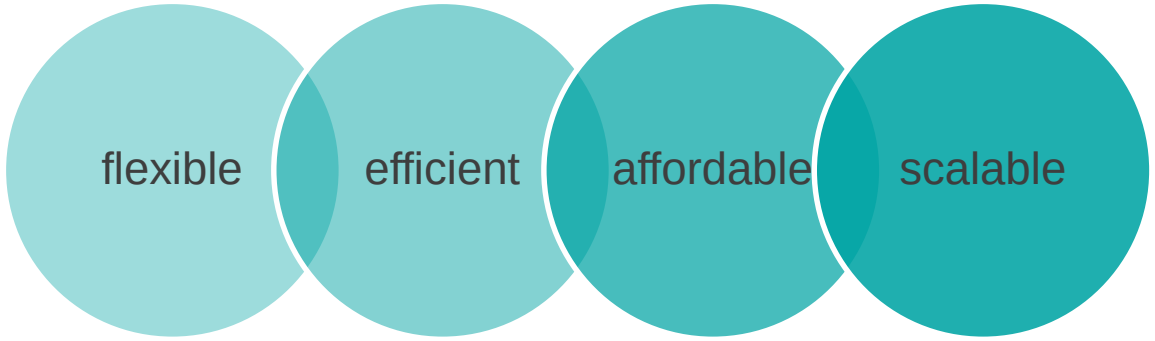
What are the right feedstocks, pre-processing, and conversion technologies?

- The sector will need a combination of feedstocks – wastes, UK-grown and imported biomass
- Waste Gasification with gas clean up – a technology with significant potential but not yet commercially proven
- Pre-processing technologies – when does it ‘pay’ to pre-process biomass? ETI funding demonstrator to assess the impact of water washing on waste wood feedstock quality

Advanced Waste Gasification

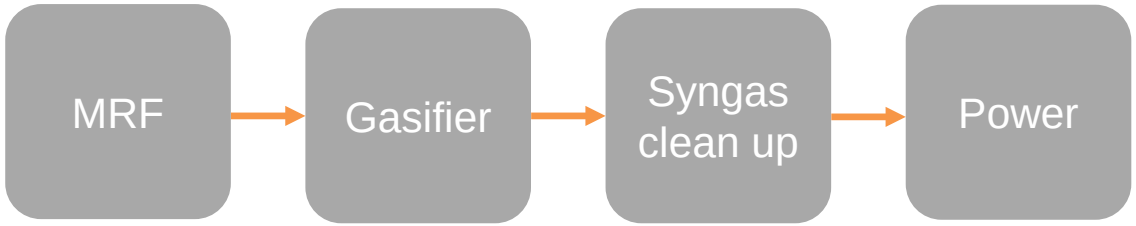
BioFIP
Biomass Feedstock Improvement Process

ETI analysis highlights gasification as a prominent, scenario resilient technology



- Energy from Waste project (2011-12) looked at waste arisings in the UK and the existing and developing technologies that could be best placed to generate energy from residual waste.
- Highlighted small scale (town) **waste gasification with syngas clean up** as a potentially important technology with near term deployment opportunities.

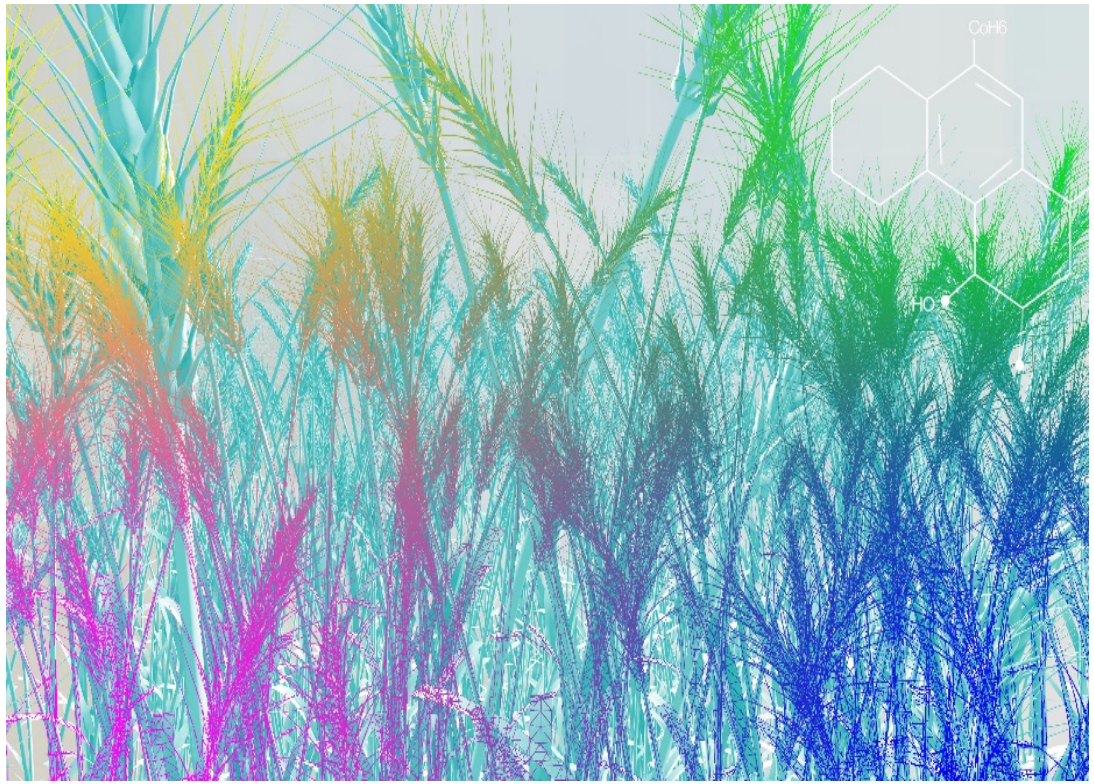
ETI has commissioned a 1.5MWe demonstrator



Advanced Waste Gasification

- Competition to design the most efficient, economical and commercially viable gasification demonstrator plant
- Advanced Plasma Power, Broadcrown and Royal Dahlman selected for the competition. Each design capable of providing a step change in efficiency compared to existing gasification projects in the UK
- Each of the plant designs will need to demonstrate ability to operate at a net electrical efficiency of at least 25% at 5-20MW scale
- ETI today announced a 1.5MWe demonstration project with Syntech, to be built in Wednesbury

A techno-economic assessment of pre-processing indicates potential value in water washing of biomass



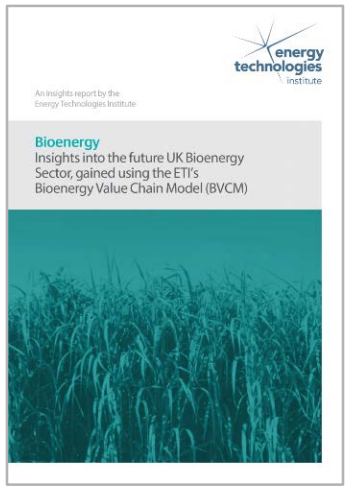
- ETI have commissioned a £2.2m Feedstock Improvement project which will be led by biomass specialists Forest Fuels
- Uniper Technologies, University of Sheffield's PACT Facilities and the University of Leeds will also work on the 18 month project
- A prototype plant which will pre-treat different forms of biomass to remove impurities using water-washing will be built at Widmerpool, Nottinghamshire

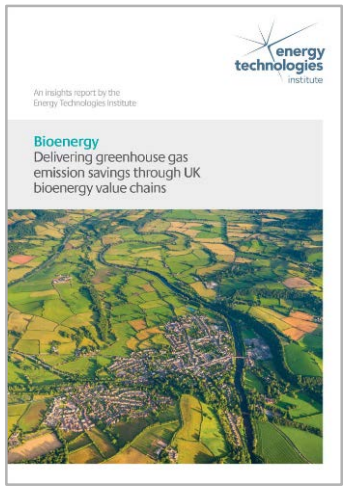
Project Partners

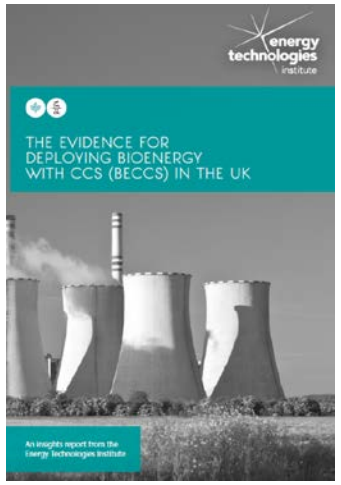
Summary

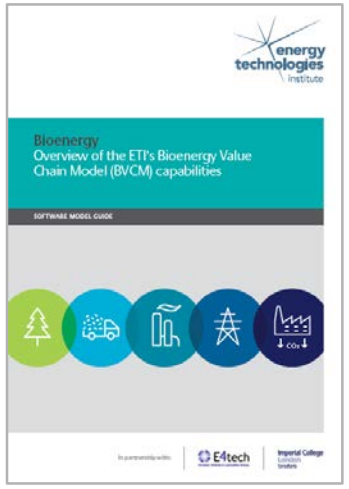
- ETI was established to identify and accelerate the development and demonstration (and de-risking) of an integrated set of low carbon technologies to deliver this step change
- ‘Whole systems’ analysis by the ETI and others enables us to identify those sectors and technologies which are key in delivering a cost-effective, low-carbon energy system.
- Analysis by the ETI and others indicates that Bioenergy, particularly in combination with CCS, is key to reaching our 2050 targets cost-effectively
- The ETI’s Bioenergy and CCS Programmes have focused on filling key knowledge gaps (such as direct land use change emissions and CO_2 storage opportunities) and identifying and accelerating key technologies (such as gasification).
- ‘Knowledge building’ projects have improved confidence in the sector to deliver genuine GHG emissions savings
- Demonstration projects requires identifying technologies which are important in meeting our 2050 targets, for which there are commercial opportunities in the near future.

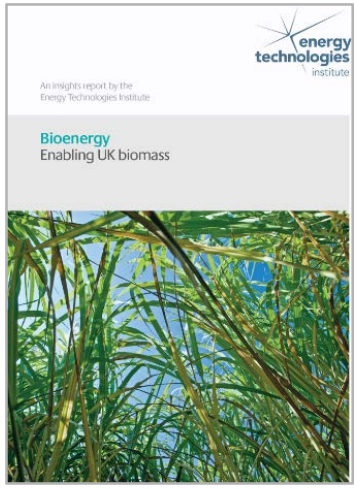
Thank you for listening – any questions?

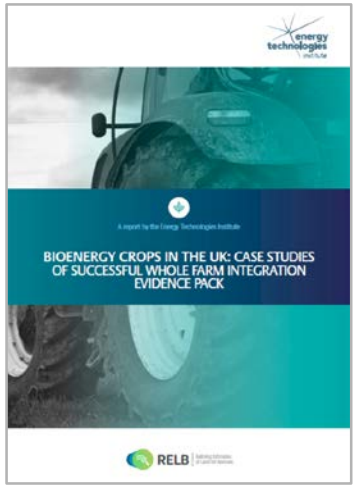


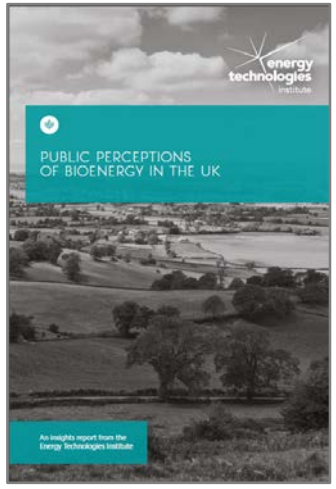












- ETI Stakeholder Event – 10 years of Innovation: **21st – 22nd November**, London
- ETI Publications: http://www.eti.co.uk/library
- ETI 'Knowledge Zone' – outputs from ETI funded projects: http://www.eti.co.uk/programmes

ANNEX – BACKGROUND INFORMATION

Links

ETI Overview Booklet http://www.eti.co.uk/library/eti-briefing-booklet

ETI publications library: http://www.eti.co.uk/library

ELUM website: http://www.elum.ac.uk/

UK Government, UK Bioenergy Strategy: https://www.gov.uk/government/publications/uk-bioenergy-strategy

CCC, 5th Carbon Budget: https://www.theccc.org.uk/publication/the-fifth-carbon-budget-the-next-step-towards-a-low-carbon-economy/

CCC, Bioenergy Review: https://www.theccc.org.uk/publication/bioenergy-review/

DECC, Digest of UK Energy Statistics (DUKES): https://www.gov.uk/government/collections/digest-of-uk-energy-statistics-dukes

Ofgem, Environmental Programmes: https://www.ofgem.gov.uk/environmental-programmes

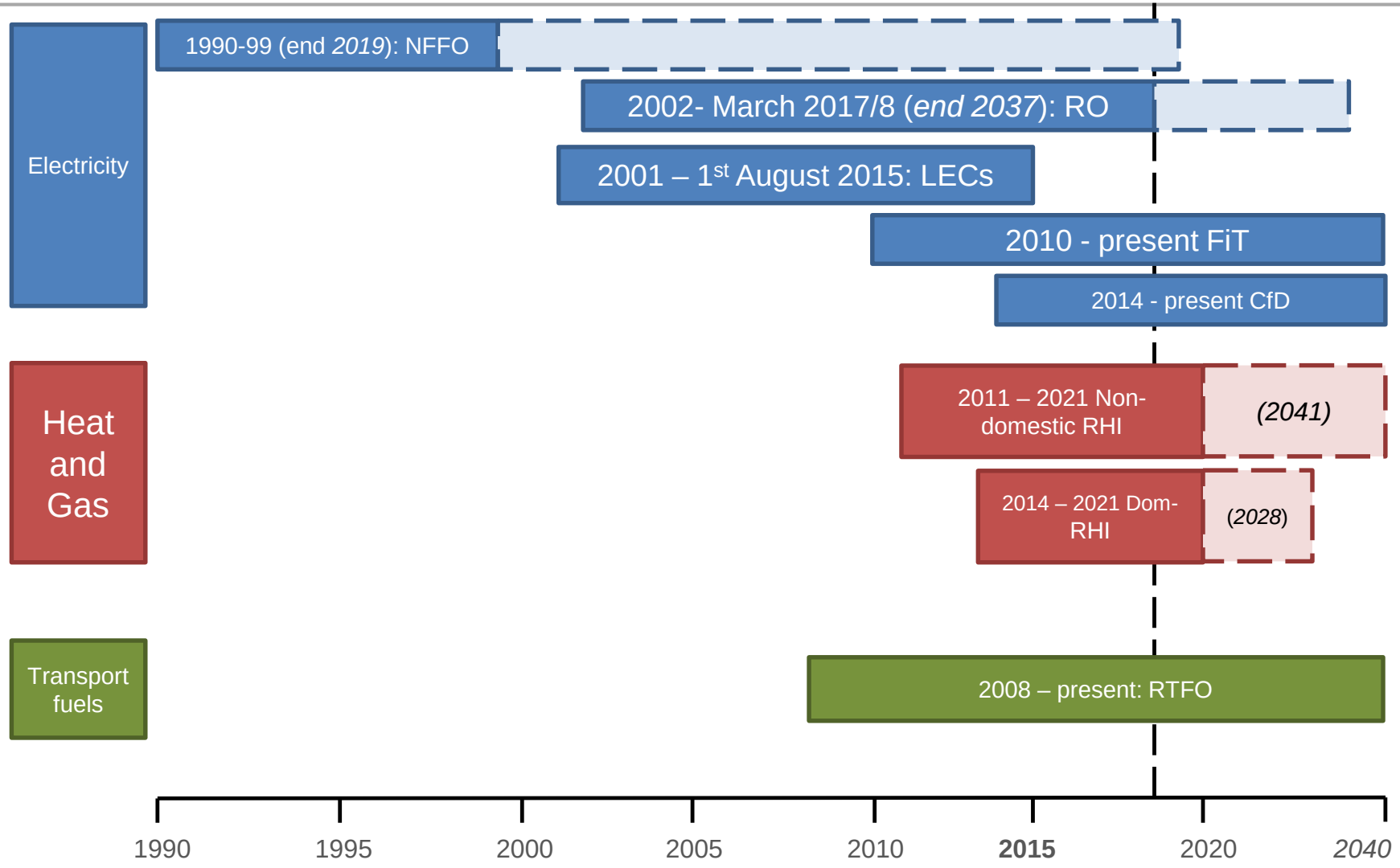
Defra (2016) Area of crops grown for bioenergy in England and the UK (2008-2015): https://www.gov.uk/government/statistics/area-of-crops-grown-for-bioenergy-in-england-and-the-uk-2008-2015

IPCC, 5th Assessment Report: https://www.ipcc.ch/report/ar5/

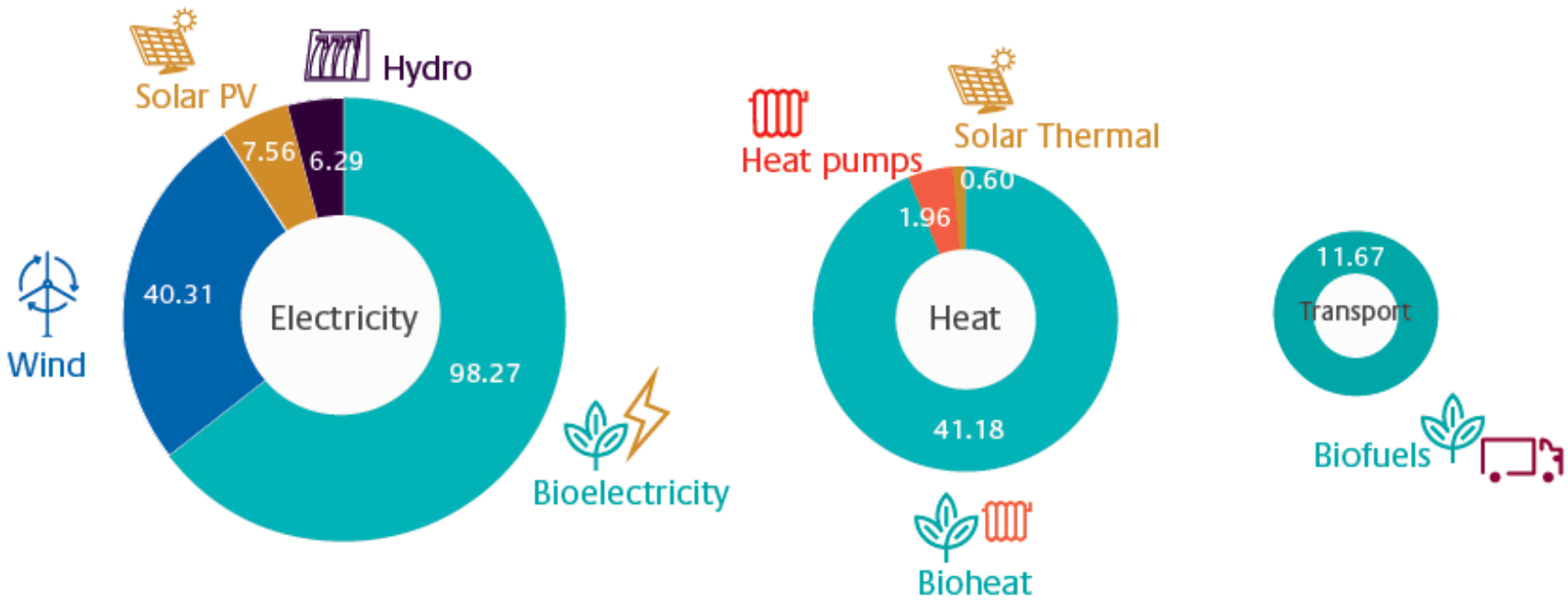
Bioenergy Crops in the UK - 2015

Defra (2016). Includes all food crops used in transport fuel production and anaerobic digestion, plus second generation crops (Miscanthus and SRC Willow). Excludes forestry.

Renewable Energy Policy Incentives



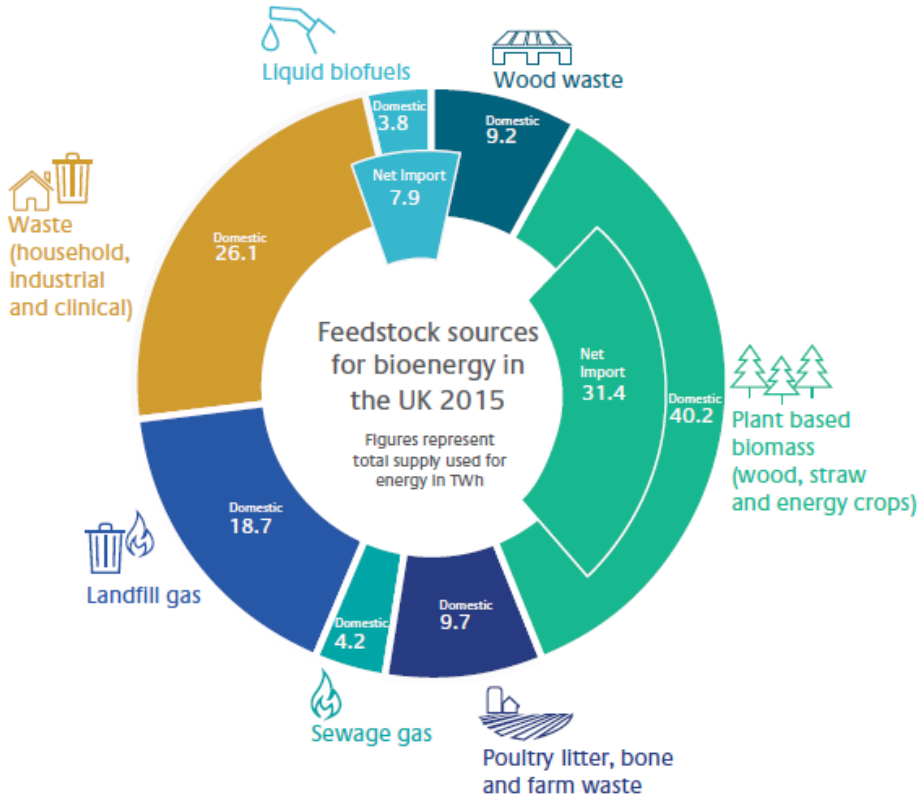
Bioenergy – the current picture



- Bioenergy feedstocks (biomass and waste) accounted for 73% of renewable fuel used in 2015
- Only renewable energy source used to produce electricity, heat and biofuels
- Bioenergy is currently supported under the Renewables Obligation (RO) and Contracts for Difference (CfD) (Electricity), the Renewable Heat Incentive (RHI) and the Renewable Transport Fuels Obligation (RTFO)

(DUKES, 2016). Table 6.1. Figures represent Total Supply (used for energy) in TWh

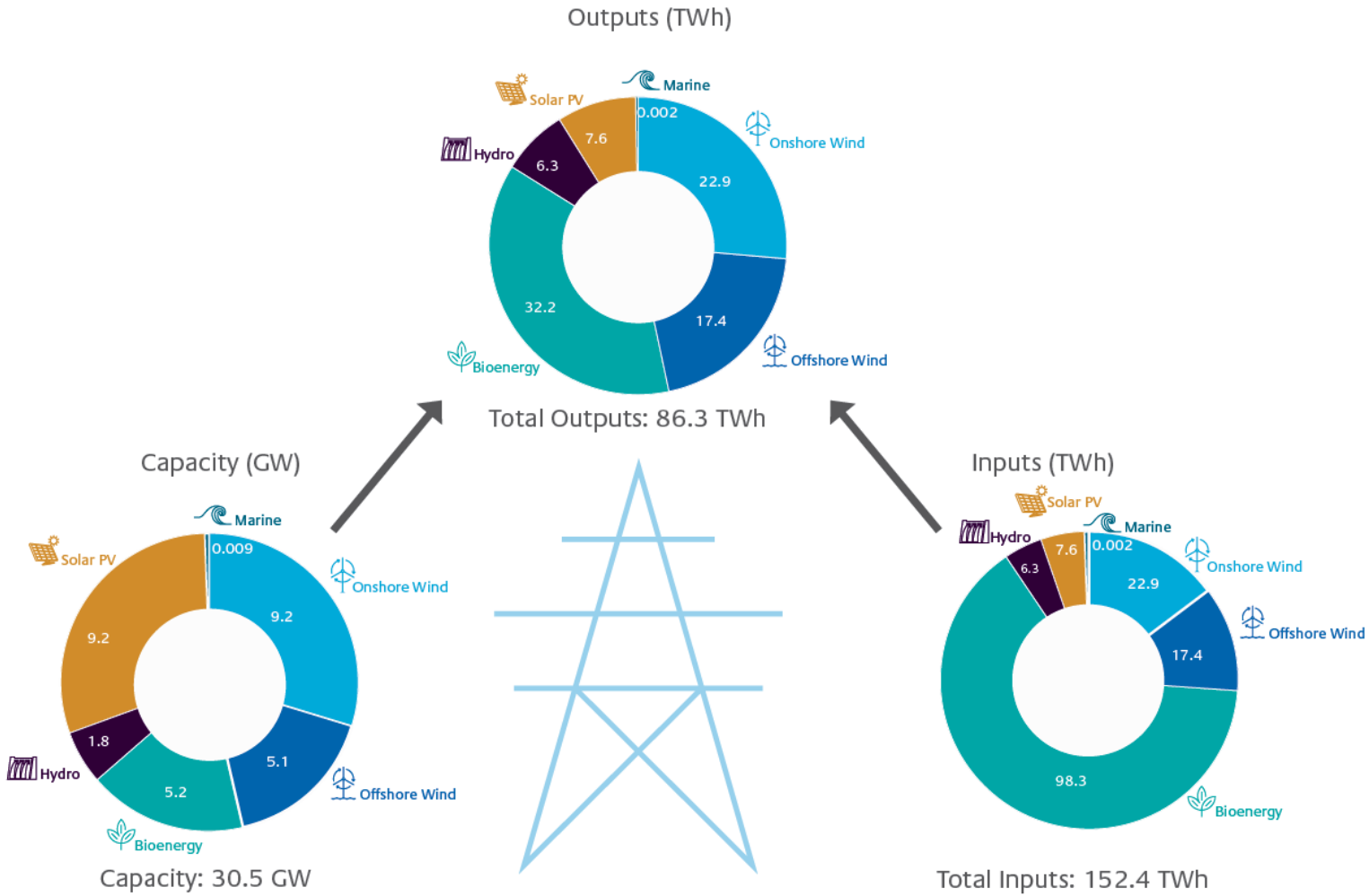
Current bioenergy feedstocks are a mixture of biomass and waste



- The mix of feedstocks for bioenergy is changing
- UK and imported biomass are main growth areas
- Waste feedstocks are becoming less dominant
- In 2015, 74% of bioenergy feedstocks were sourced in the UK
- The use of imported biomass has grown rapidly in recent years – in large part driven by demand from biomass power stations (e.g. Drax)

(DUKES, 2016). Table 6.1.

Renewable Electricity, 2015



(DUKES, 2016). Tables 6.1. and 6.4.

Registered Office
Energy Technologies Institute
Holywell Building
Holywell Park
Loughborough
LE11 3UZ

For all general enquiries telephone the ETI on 01509 202020.

For more information about the ETI visit www.eti.co.uk

For the latest ETI news and announcements email info@eti.co.uk

The ETI can also be followed on Twitter @the_ETI