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Making efficient use of bioenergy feedstocks for cleaner, greener energy

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27 November 2017

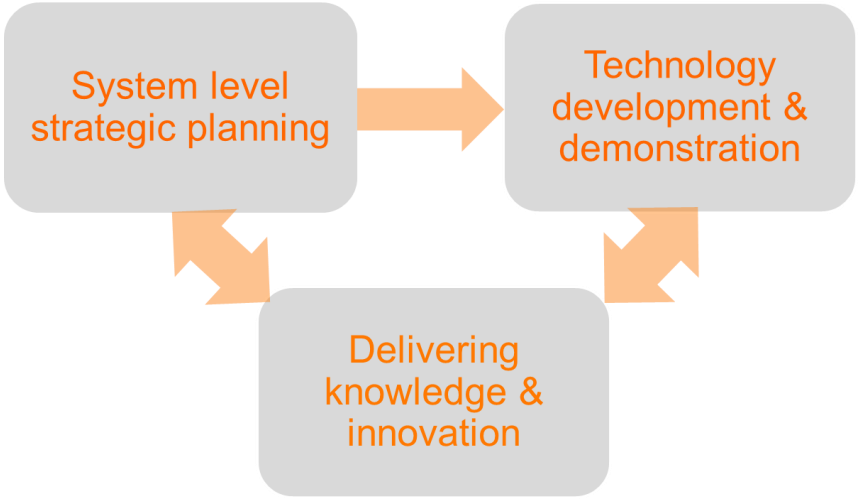
ETI10 TEN YEARS OF INNOVATION 2007 – 2017

Overview

- What is the ETI?
- Why do we think bioenergy is important?
- What research have we commissioned on feedstock properties and pre-processing?
    - Characterisation of Feedstocks
    - Techno-Economic Assessment of Biomass Pre-Processing
- Wider research into water washing of biomass
- The BioFIP Project – demonstrating water washing at a commercial scale
- Forward look – next steps for BioFIP and life beyond the ETI!

What is the ETI?

- 10-year public-private partnership
- Set up to identify and accelerate the development and demonstration of an integrated set of low carbon technologies needed to meet 2050 emissions reduction targets



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HITACHI Inspire the Next

A route to meeting - 80% CO2 for the UK

Power now, heat next, transport gradual – cost optimal

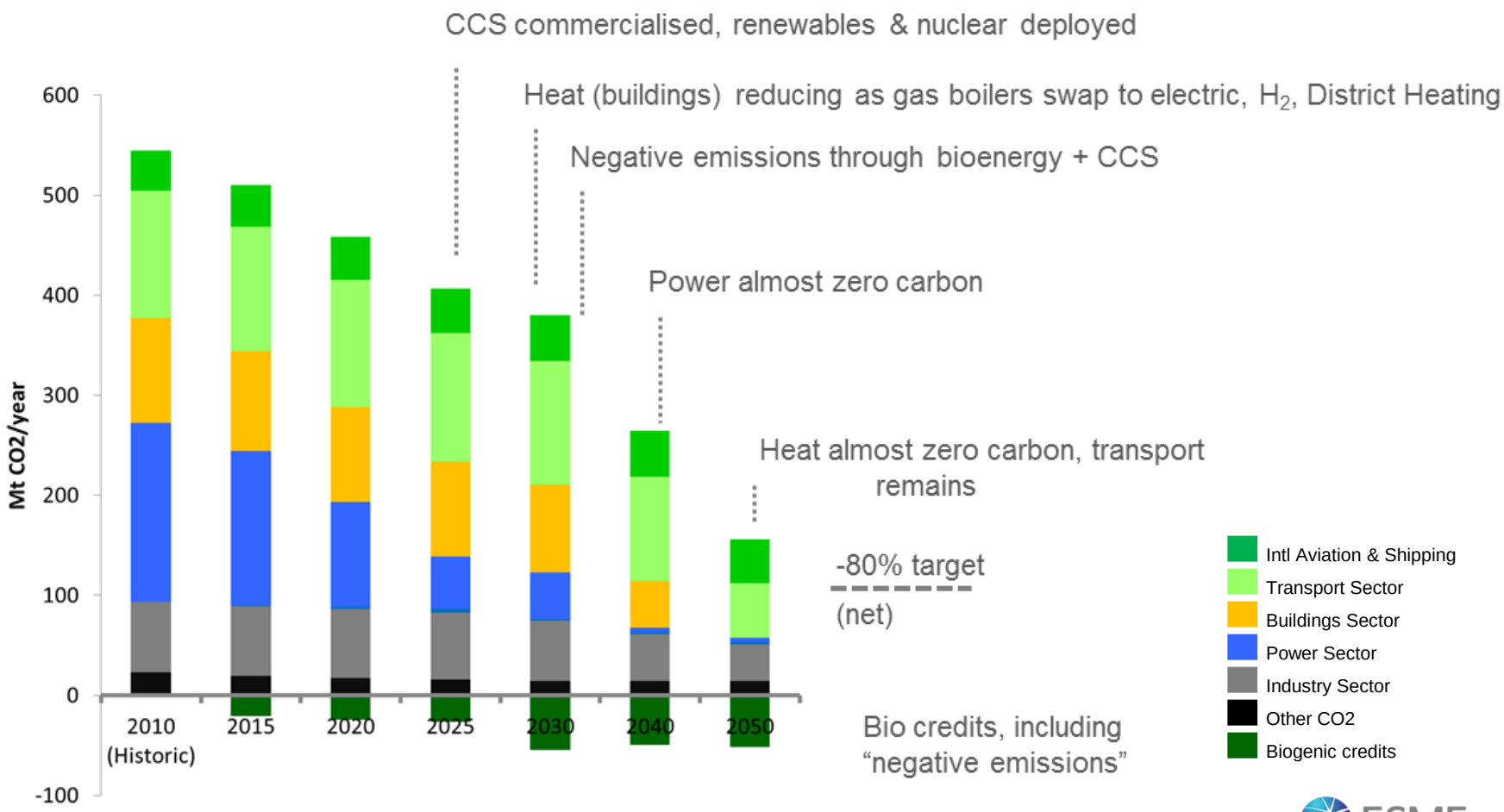
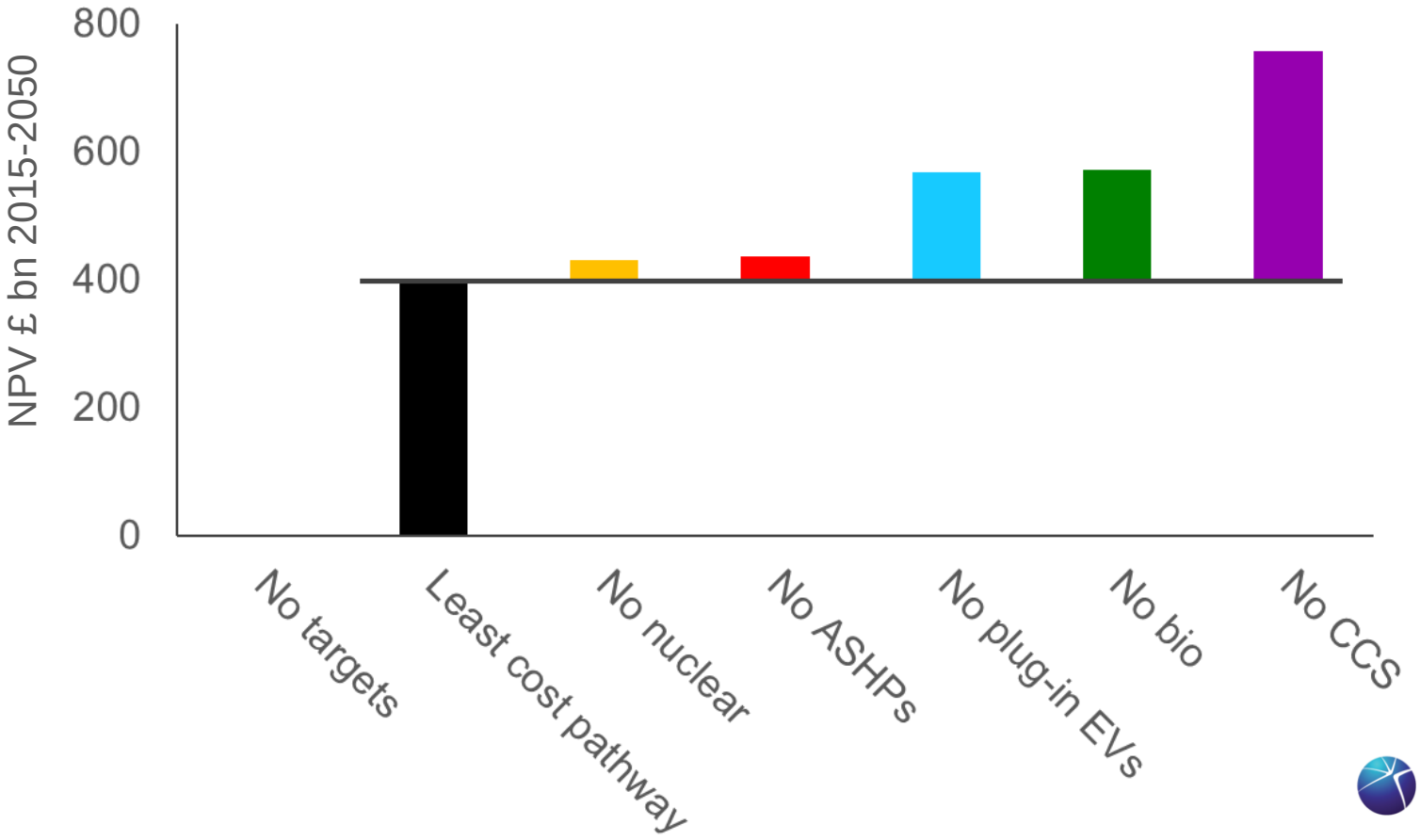


Chart data from base case v4.3

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

Additional cost of delivering 2050 -80% CO_2 energy system

NPV £(2015) bn 2015-2050



ESME Energy System Modelling Environment

Chart data from base case v4.3 (£(2015), DR: 3.5%)

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

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

TEAB

Techno-Economic Assessment of Biomass pre-processing

BioFIP

Biomass Feedstock Improvement Process

Biomass Resources

- For the UK to generate 10% of energy demand in 2050s, it will need to use a mixture of wastes, domestic biomass feedstocks and imported biomass (wood pellets)
- These resources have different characteristics which affect performance of conversion technologies
- Virgin woody biomass produced from forestry and sawmill activity is regarded as a clean biomass feedstock and its characteristics are well understood (ENPlus standards)
- Other forms of biomass such as miscanthus or waste wood have different characteristics which are often less optimal for use in current conversion technologies, and potentially more variable
- This can lead to issues of corrosion, fouling and slagging

Characterisation of Feedstocks

- Purpose – improve understanding of the variability in feedstock properties of UK-produced energy biomass types and investigate whether this could be linked to provenance
- Experiments tested whether variability in characteristics of Willow, Miscanthus and Short Rotation Forestry could be linked to location, soil type, harvest time and other factors
- Results found statistically significant variability both between and within biomass feedstock types
- Often, biomass properties could not be linked back to provenance data, and for some feedstock characteristics the variation within fields was much greater than between different sites
- None of the feedstocks sampled could meet the I3 pellet standard. SRF stemwood was close but Miscanthus was too high in Chlorine and Willow did not meet the limits for Cadmium or Nitrogen

CoF Characterisation of Feedstocks

Value of Pre-Processing Biomass

- When does it ‘pay’ to add a pre-processing step to your supply chain?
- Field washing, water washing, chemical washing, pelleting, torrefaction and pyrolysis
- Benefits of densification of biomass in reducing transport costs only outweigh cost at significant distances (800km +)
- Based on current costs, the TEAB modelling project suggested that pre-processing often adds more cost to the overall supply chain. However,
    - The project only looked at Miscanthus and woody feedstocks, not waste woods
    - The long term impact of operating with characteristics that exceed manufacturer recommendations are difficult to model, therefore results may underestimate benefits of pre-processing when they reduce contaminant levels
    - Commercially, pre-processing may be necessary to ensure operation within warranty and/or to improve handling properties
- Water washing of biomass was one of few technologies capable of removing sufficient contaminants

TEAB Techno-Economic Assessment of Biomass pre-processing

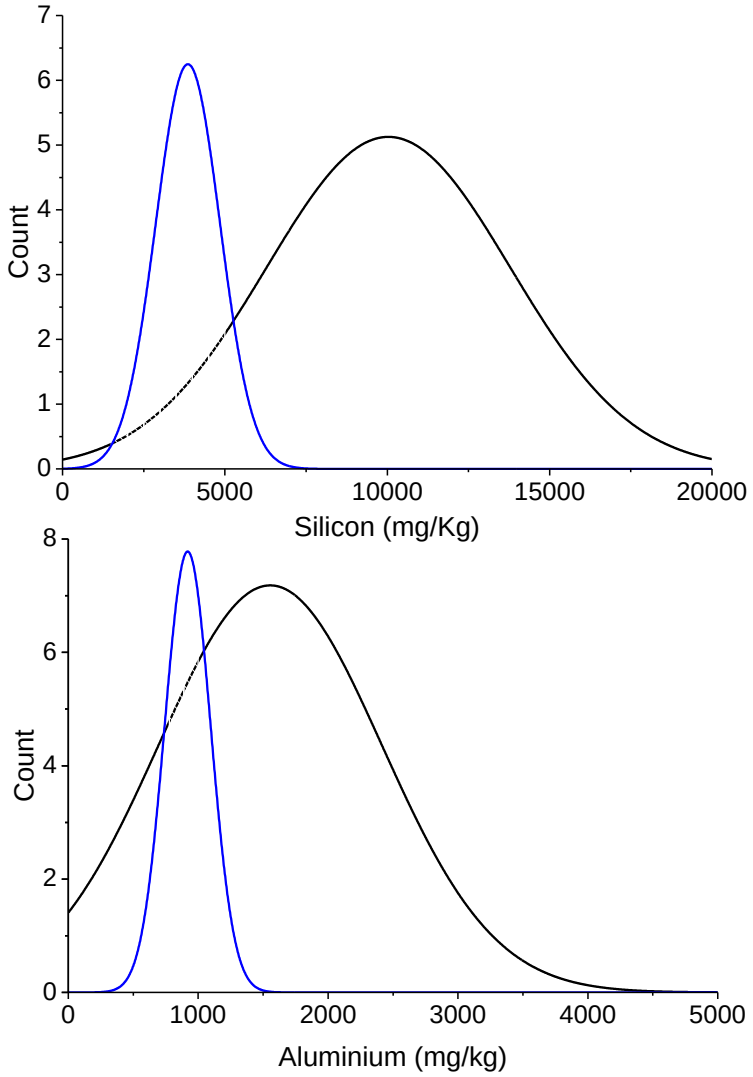
Water Washing Research

- Research conducted at Leeds University to investigate the impacts of water washing on biomass characteristics of waste woods
- Washing removes surface contaminants (e.g. soil) as well as promotes leaching of undesirable species within the biomass

UNIVERSITY OF LEEDS

Gudka. B, Jones. j, Pre-treatment of Waste Wood via Washing and the use of an additive to optimise fuel properties. [PowerPoint presentation], Available at https://irp-cdn.multiscreensite.com/57706d10/files/uploaded/B%20Gudka%2C%20Leeds%2C%20Leeds%2C%2027-06-17.pdf

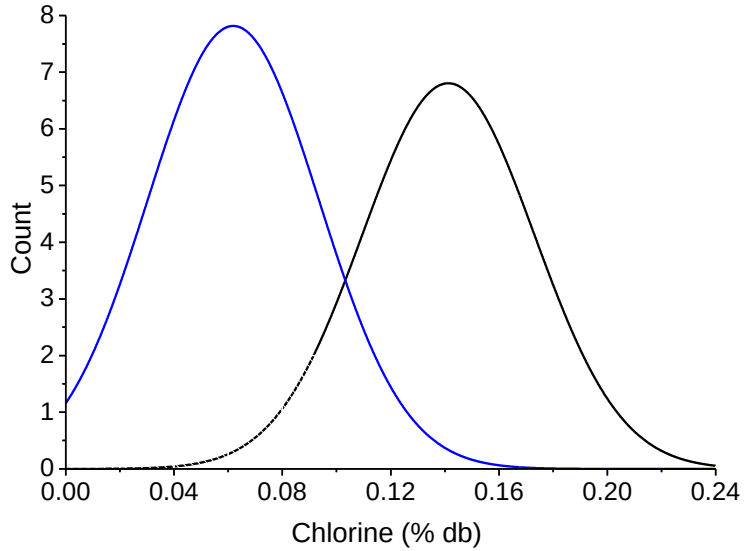
Water Washing Research

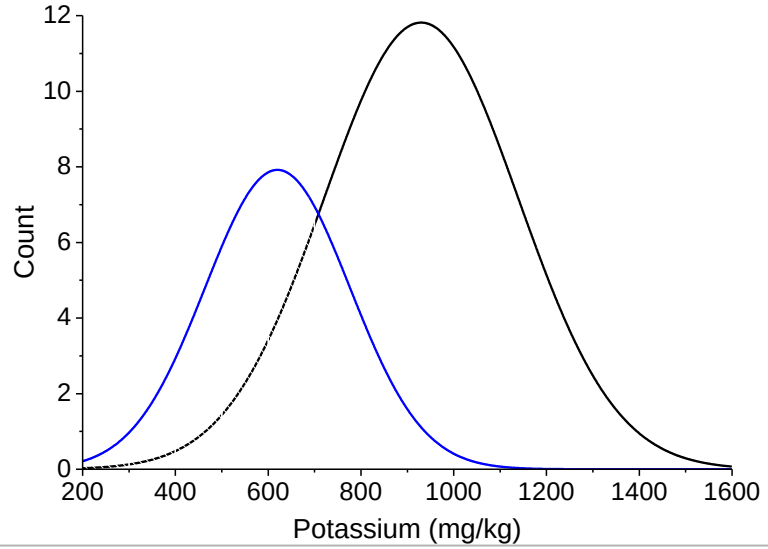


- Water washing of waste woods has been shown to reduce the potential of fouling, slagging and corrosion significantly
- Slagging caused by Fe, alkali and alkali earth metals reacting with Si and Al to form alkali silicates and aluminosiliscates which lower the ash melting temperature
- University of Leeds research shows that as well as reducing the average levels of Si and Al, the range of concentrations is also decreased
- This research also showed that water washing can slightly increase ash fusion temperatures

[2] Gudka. B, Jones. j, Pre-treatment of Waste Wood via Washing and the use of an additive to optimise fuel properties. [PowerPoint presentation], Available at https://irp-cdn.multiscreensite.com/57706d10/files/uploaded/B%20Gudka%2C%20Leeds%2C%20Leeds%2C%2027-06-17.pdf

Water Washing Research





- Water washing of waste woods has been shown to reduce the potential of fouling, slagging and corrosion significantly
- Corrosion and fouling caused by Na and K reacting with Cl and S to produce alkali chlorides and sulphates
- Similarly to previous slide, water washing reduces average level of contamination, but doesn't have as much impact on range of contamination
- Overall, research indicated potential for water washing to improve biomass properties

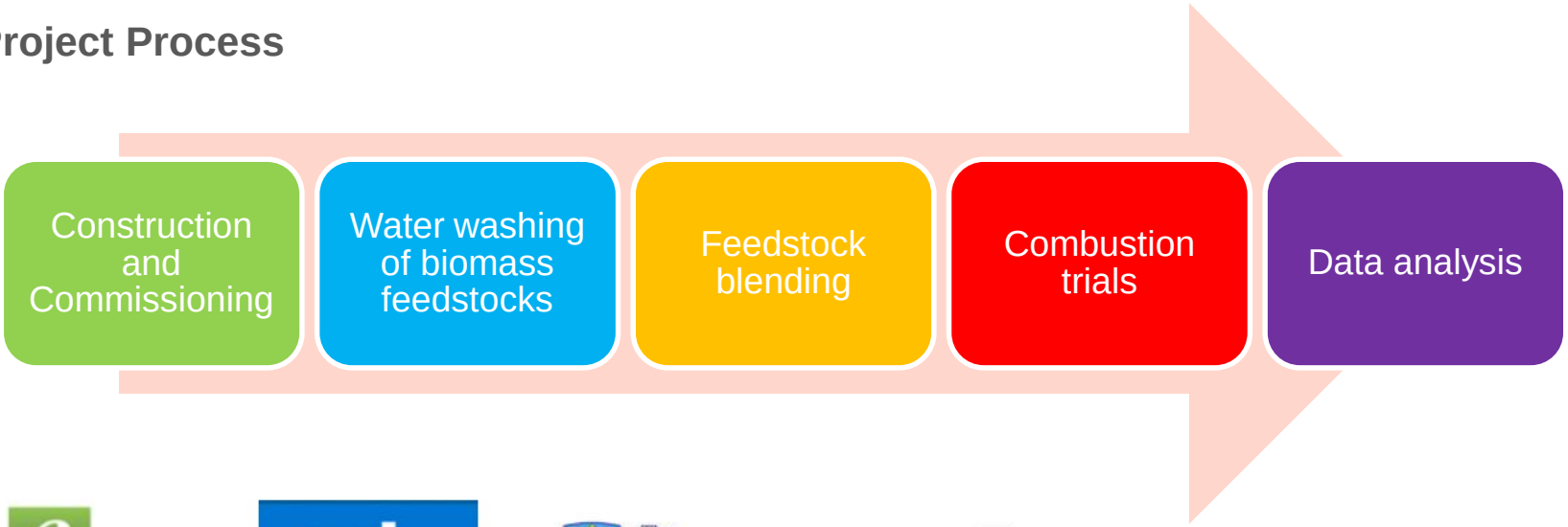
[2] Gudka. B, Jones. j, Pre-treatment of Waste Wood via Washing and the use of an additive to optimise fuel properties. [PowerPoint presentation], Available at https://irp-cdn.multiscreensite.com/57706d10/files/uploaded/B%20Gudka%2C%20Leeds%2C%20Leeds%2C%2027-06-17.pdf

The BioFIP Project

Aim

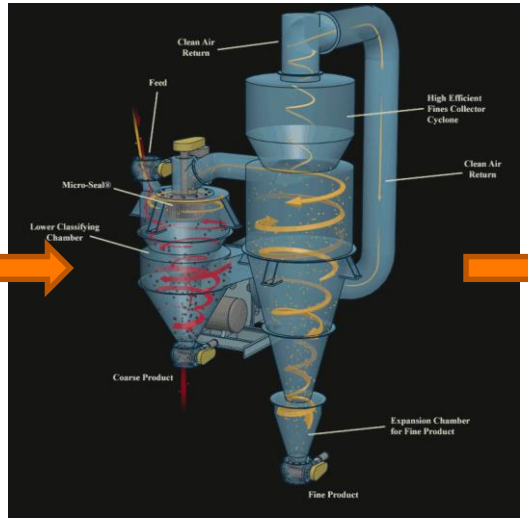
To demonstrate the technical and commercially viability of the BioFIP technology in order to facilitate the commercialisation of the technology

Project Process



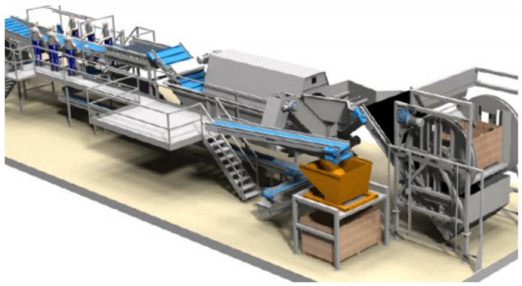
The Technology

Chipping



Air Classifier

Trommel

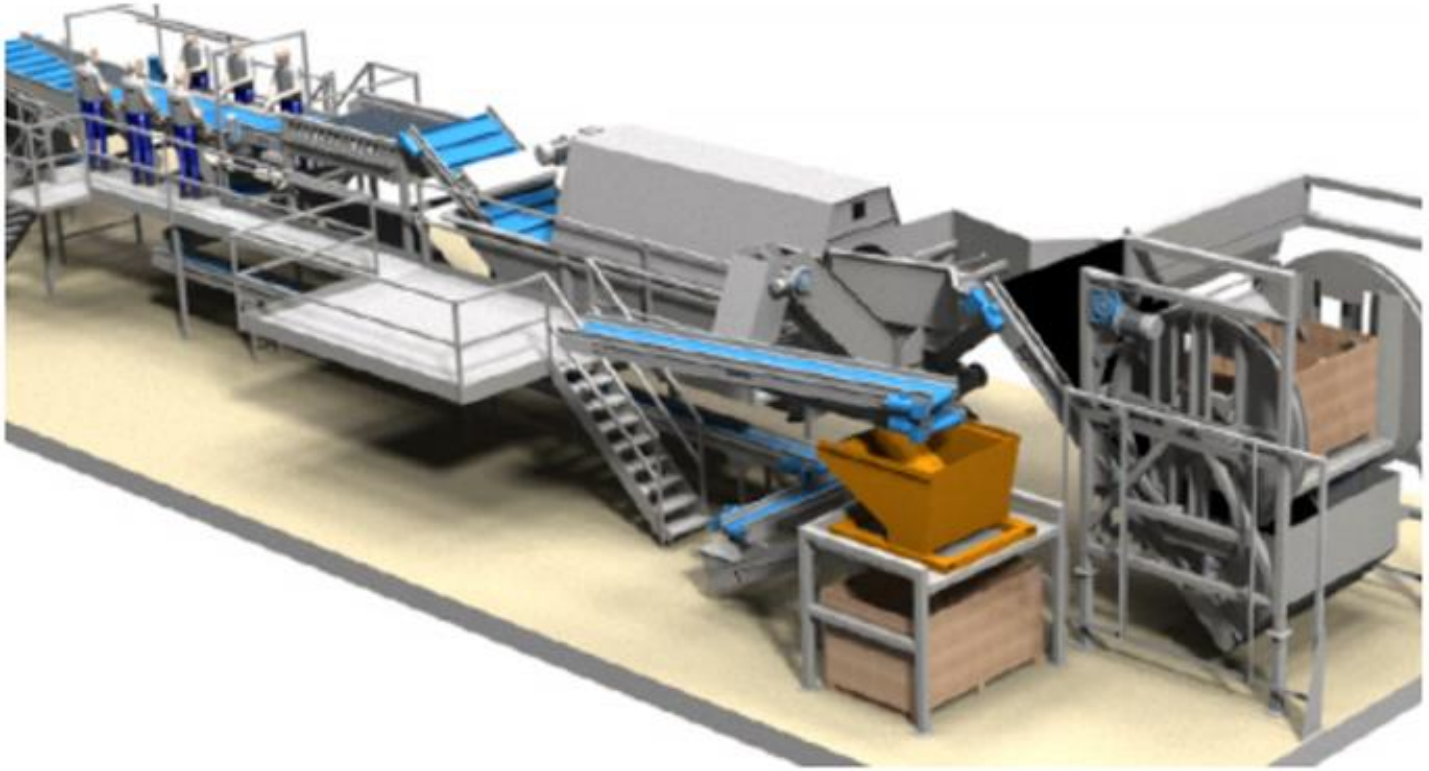


Water Washing

Drying

Blending

Construction and Commissioning



Haith manufacturer – modified from commercial vegetable washers

Construction and Commissioning

- Demonstration plant will be operated on site at Sutton cum Lound, nr Retford
- Water washing trials will be managed by Forest Fuels and Uniper
- Feedstock will be washed and dried on site using waste heat from an on-site AD plant

Map Data ©2017 Google

Feedstocks

SRC Willow

Compost Oversize

Arboricultural Arisings

Miscanthus

Straw

Grade A Waste Wood

Grade B Engineered Wood

Grade B Chipboard

Grade C Treated Wood

Feedstock Analysis

- 100t of each feedstock will be washed
- On-site monitoring of energy inputs and waste outputs will enable energy, mass and GHG balances to be produced
- Testing of biomass characteristics pre- and post- washing & drying will be carried out by Leeds University
- Project team will also identify any issues with scale up of process such as feedstock handling and impact of cold weather
- Washing trials will establish best operating procedure for different feedstocks, in terms of water temperature, retention time, agitation and feedstock handling
- Using results from washing trials, Uniper will use modelling software to identify which blends of feedstock to take forward to combustion trials based on cost and performance improvement

Feedstock Analysis

- Combustion testing of both washed blends and unwashed biomass will be carried out at Sheffield University's PACT facility
- Analysis of the combustion characteristics of the washed and unwashed feedstock:
  - Flue gas analysis
  - Ash emissions and distribution
  - Corrosion
  - Combustion chamber gas analysis

The University Of Sheffield.

UKCCSRC PACT FACILITIES

“TO WASH OR NOT TO WASH? THAT IS THE QUESTION”

- Establish if, and to what degree, the BioFIP Technology is technically and commercially viable for different waste wood and biomass feedstocks
- Establish to what extent the water washing processes adds or removes (through improved conversion efficiency) greenhouse gas emissions from the value chain
- For the project to proceed to commercialisation, the feedstock will need to meet the RHI threshold

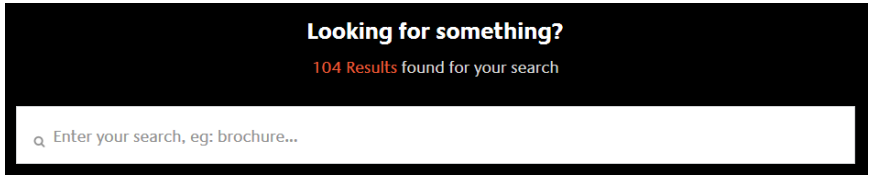
Future plans - BioFIP

- Construction of the washer at Sutton Grange farm will begin before Christmas
- Combustion testing of unwashed feedstocks at PACT facility will start in mid-December
- Expect to start water washing trials in the New Year
- Demonstration project will be completed towards the end of 2018
- If successful, Forest Fuels will have the opportunity to use arising IP from project in commercialisation

Future plans – ETI

ETI Knowledge Zone

http://www.eti.co.uk/programmes/bioenergy



ETI Insights & Reports

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ETI Demonstration Projects

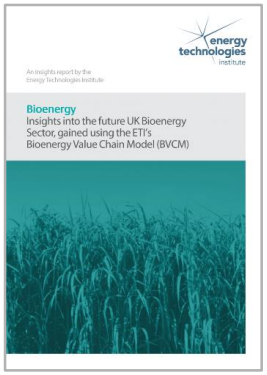
BioFIP
Biomass Feedstock Improvement Process

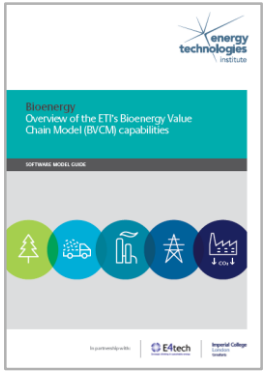
Waste Gasification

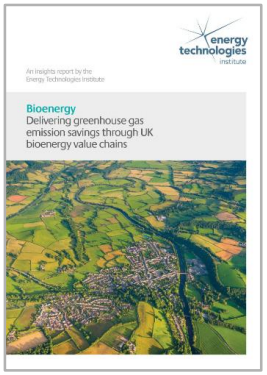
…new home for ETI's Strategy and Modelling function

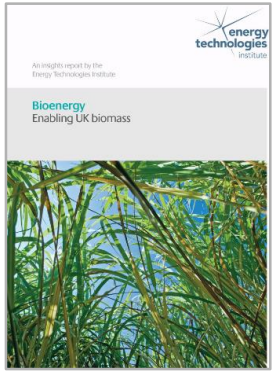
CATAPULT Energy Systems

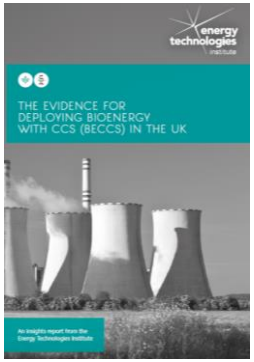
Thank you for listening

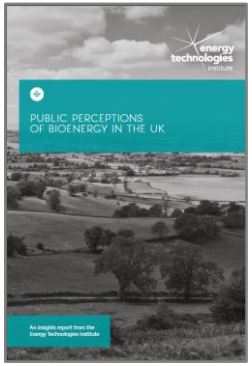


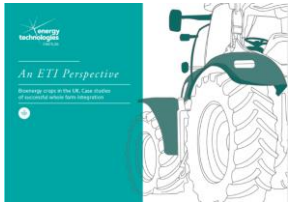


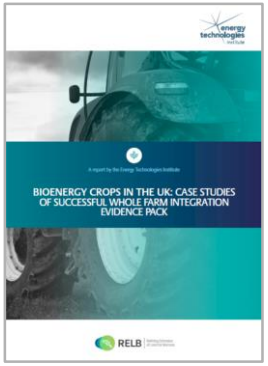












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