CLEAN COAL TECHNOLOGY - BIOENERGY WITH CARBON CAPTURE AND STORAGE (BECCS)

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BACKGROUND

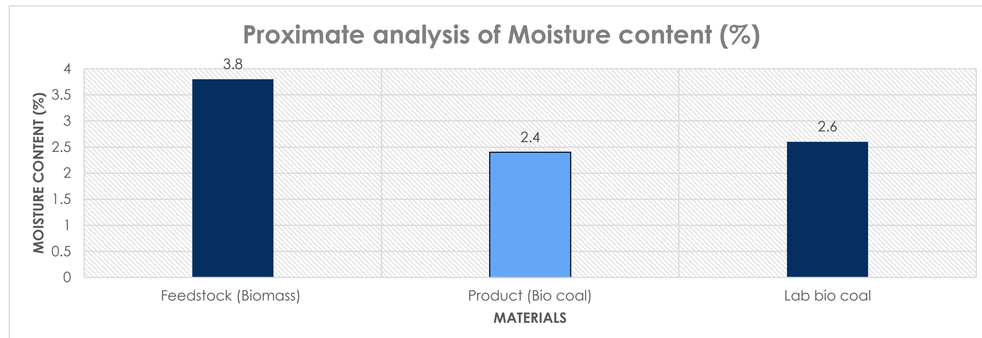
- For the first time since the industrial revolution, the United Kingdom has reduced its use of coal to generate power, with plans to phase out coal entirely by 2025.
- For over a century, coal was used to generate the majority of the electricity in the United Kingdom, but it is currently mainly utilised as a backup.
- Most of the energy in the UK is generated by natural gas, which is cleaner but still emits carbon dioxide.
- Due to the energy crisis, the UK may enhance oil and gas extraction to minimise imports. However, increasing UK oil and gas output is unlikely in the near future (1).
- Even a slight increase in UK oil and gas production would not significantly improve its energy security.
- Petroleum and nuclear energy supplies are limited to a few countries, generating concerns about national security.
- Alternative energy sources are thus being investigated in many nations in order to achieve energy security and environmental sustainability (2).
- Increasing renewable energy capacity would cut gas demand and imports. Over 600 wind and solar projects already have planning authorization in the UK (1).
- But, to achieve the current power generation demand with the net zero carbon emission, bio energy is introduced as a form of energy obtained from biological sources such as biomass which replaces the combustion of coal with bio coal or bio char.
- Bioenergy with carbon capture and storage technology is considered as an important technology to meet the current greenhouse gas stabilization targets as it achieves negative carbon emission.

SUMMARY OF PREVIOUS RESEARCH ON BIOCOAL

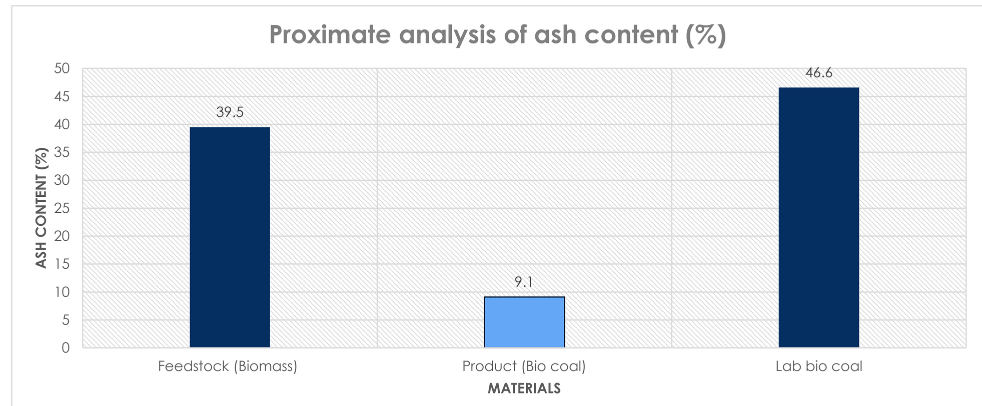
- Biomass as a source of renewable energy has the potential to supply the world's primary energy needs in the future (3).
- There are several methods that can convert biomass into usable energy fuel.
- Hydrothermal carbonisation is a new technique that is recognised as essential for the management of climate change and energy policy objectives, such as reducing air pollution and increasing energy access.
- Since it reduces pollutants like as trace metals, chlorine, and greenhouse gases, it is seen as a significant technique for achieving greenhouse gas stabilisation objectives.
- HTC's major purpose is to develop bio-coal with qualities similar to coal as a solid fuel. The objective of this research is to assess the quality and behaviour of bio-coal using thermogravimetric analysis.
- The moisture content, volatile matter, fixed carbon, ash content, high heating value, and calorific value obtained from the feedstock biomass (green waste), product bio coal, and lab bio coal are compared with the assumed feedstock characteristics in the initial design and the actual feedstock characteristics along with correlations (Figure: 1-3).
- The outcomes have been stated and partially addressed, which might either complement or replace the existing approach. This will raise the performance of the process, which will eventually improve the grade of bio coal.

INFOGRAPHIC RESULTS OF BIOCOAL

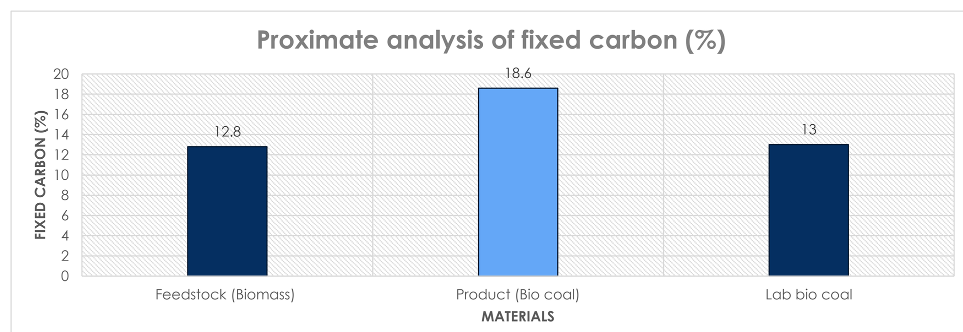
- **Figure 1: Moisture content (%) (result comparison):**



- **Figure 2: Ash content (%) (result comparison):**



- **Figure 3: Fixed carbon (%) (result comparison):**

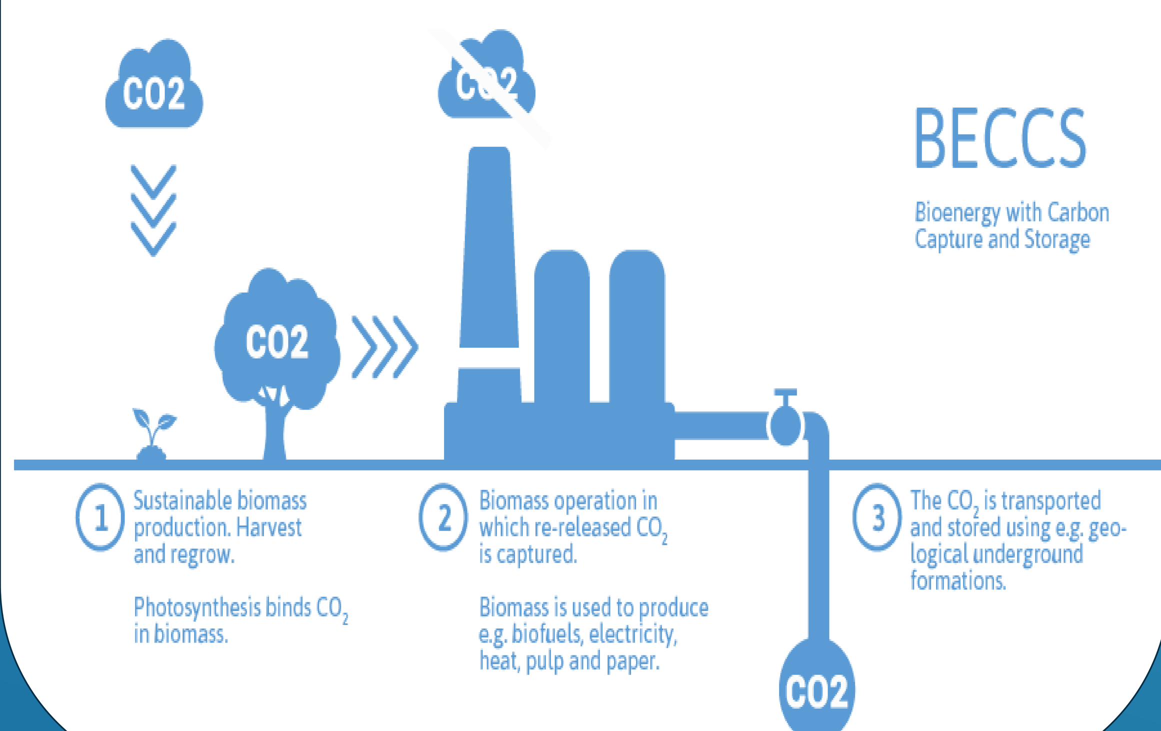


BECCS AS A NEGATIVE EMISSION TECHNOLOGY

- Negative Emissions Technologies (NETs) have been identified as a method for reducing co_2 levels and consequently limiting climate change.
- Several NETs, including afforestation, biochar, biomass with CCS (BECCS), direct air capture (DAC), marine and terrestrial improved weathering, and land use management, are cited in the literature (5). Among NETs, BECCS has received significant attention.
- According to research from (6), BECCS is a combination of two mitigation strategies: biomass combustion for energy generation and carbon capture and storage.
- This combination is considered one of the most efficient CO_2 reduction strategies.

CARBON CAPTURE AND STORAGE

- CCS can be applied to the major point emission sources of thermal power stations to mitigate environmental problems. By combining this with biomass, zero CO_2 emissions can be achieved.
- This can be accomplished using post-combustion, oxy-fuel, or pre-combustion arrangements (6).
- However, the technique may be implemented and modified to better satisfy the requirements of biomass extraction.
- There are three fundamental BECCS technologies and configurations: post combustion, oxy-fuel combustion, and before combustion capture.
- **Figure 4: BECCS infographic (4).**



BECCS ANALYSIS

ENVIRONMENTAL:

- Depending on the location and feedstock utilised, biofuel production strategies vary in terms of their yield.
- It is possible to maximise ecosystem services while minimising negative environmental consequences, so enhancing food, fuel, and economic security (7).
- Research and optimization of land suitability may aid in the development of sustainable biofuel production systems.

ECONOMIC:

- The carbon price is therefore an important factor in evaluating BECCS costs. A carbon price is the most effective policy strategy for increasing BECCS implementation.
- Numerous studies indicate that including CCS and BECCS into the mitigation portfolio reduces the price necessary to satisfy strict emission goals.
- Global Change Assessment Model (GCAM) was utilised by (7) to examine the global and regional economic effects of BECCS.

SOCIAL:

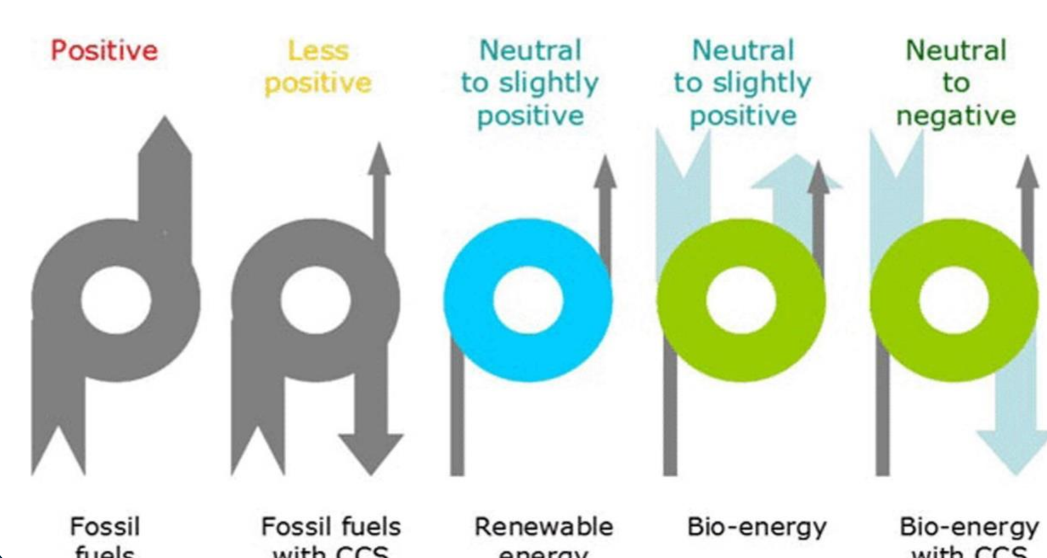
- According to social analyses, bioenergy is less favoured than other renewable energy sources, and CCS is less preferred than other mitigation strategies such as energy efficiency and renewable (7).
- According to this analysis, BECCS is more essential than CCS and nuclear. BECCS is given less weight than other climate mitigation technologies, such as solar and wind.
- BECCS is seen completely differently by the expert and popular sectors. Thus, increasing public understanding may help eliminate myths and educate activists and developers on the social, economic, and cultural aspects of the community.

POLICY:

- Lack of economic and regulatory support is more significant than lack of technological capability.
- BECCS legitimization delays are a political issue that will have an effect on future mitigation methods.
- BECCS is an expensive technology requiring regulations that recognise the value of negative co_2 emission.
- (7) analysed the political recognition of BECCS among major international mitigation strategies.

BECCS IN THE FUTURE

- The combination of renewable energy and conventional CCS would produce energy and generate negative emissions. BECCS is a zero-emission technology whose implementation is at best decades away.
- In some circumstances, bio sequestration is economical and has been implemented. In the future, like BECCS, will have to compete for land.
- However, unlike bio sequestration, BECCS carbon storage is permanent and can be performed with municipal waste or ethanol plants.
- Various researchers now feel that negative emissions through BECCS are the only means of preventing catastrophic climate change (3).
- **Figure 5: Carbon negative power generation (3).**



- **Figure 6: UN's SDGs (Affordable and clean energy) (5).**

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