Bioenergy with carbon capture and storage or BECCS, is the production of bioenergy using biomass, coupled with the harvesting and subsequent storing of carbon dioxide. This storing of carbon dioxide can be underground, in oceans, or in forests.

**BECCS Process:** The concept behind these technologies have been employed by the oil industry to enhance oil recovery by injecting the CO₂ into the oil field. But new designs are being developed to facilitate the processing of biomass residue in the agriculture, forestry, and industrial sectors. The BECCS technology is a three-step process:

1. Cultivating feedstock
2. Burning biomass feedstock to generate electricity
3. Capturing and storing the carbon emitted

Currently there is an underutilization of biomass as an energy source because of cost considerations, but with new designs, and when carbon capture is assigned economic value, the production of energy from biomass is likely to increase and a significant level of carbon sequestration can emerge.

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U.S. CONSUMPTION OF BIOENERGY WITH CARBON CAPTURE AND STORAGE

Efficiency of carbon capture and storage: There are three main methods of CCS:

1. Pre-combustion capture – Fuel is exposed to oxygen or air which emits a “fuel gas” composed mainly of carbon monoxide and hydrogen. The byproducts are then altered by a shift converter to produce CO₂ and additional hydrogen; the CO₂ is extracted, leaving a zero-carbon hydrogen-enriched fuel.

2. Post-combustion capture – Emissions from industrial processes may be dissolved in a chemical solvent; the CO₂ is then extracted from the liquid. CO₂ may also be separated using methods such as adsorption, separation with membranes, or cryogenic separation. Post-combustion capture is used to capture CO₂ from already existing emissions.

3. Oxyfuel combustion – Fuel is exposed to oxygen which results in a compound mainly made up of CO₂ and water; the CO₂ is then stored in a compression unit. (Gopalakrishnan, Hochman 2017)¹

4. Capture efficiency of pre-combustion capture stands at about 85% and oxyfuel combustion stands at about 87.5%. Meanwhile, post-combustion capture CO₂ at an efficient rate of 95%. The International Energy Agency found that by 2050, CCS could decrease CO₂ emissions by 14%.²

What are the climate-related advantages of BECCS? The main fascination with BECCS is the technology’s capability to “mop” up carbon; this capture and storage method effectively removes carbon dioxide from the atmosphere. Reversing the effects of climate change may only be successful with the implementation of bioenergy with carbon capture and storage. At the national level, manufacturing, agriculture, and energy sectors would benefit from the adoption of this new practice, whilst benefitting the public with cleaner air and cleaner water.

- In pursuing BECCS, many individual energy production facilities are likely to be transitioning from use of a nonrenewable fuel source.
- There is a 66% likelihood of reaching the 2 degrees Celsius goal; 87% of these scenarios include large-scale BECCS deployment, as produced in connection with the Representative Concentration Pathway (RCP) of the International Panel on Climate Change³
- BECCS energy crops improve water quality.⁴
- Bioenergy carbon storage content is net neutral for BECCS in forestry, while storage content with offsets is carbon negative.
- Photosynthesis, in this case, is the key to carbon negativity because it influences how fast a tree grows.⁵
- United Nations Framework Convention on Climate Change (UNFCCC) believes the promise of net negative in BECCS outweighs any negative associations attributed to BECCS as a geoengineering effort.

³ Gopalakrishnan, Harahsa & Hochman, Gal. “Carbon capture and Storage Technologies: A survey of the literature.” Presented at the Annual Aresty Meetings at Rutgers University, May 2017
Energy Security and BECCS
This creation of energy by biomass is rooted scientifically in the hydrocarbon content of biomass. Breaking down these hydrocarbons produces a considerable amount of energy that can be harnessed to maintain energy security, while minimizing pollution damages caused by fossil fuels.

BECCS generates electricity with a net carbon negative balance. Fridahl (2017)\(^6\) argued that BECCS produces energy at optimal levels, but only under the following conditions:
1. BECCS produced at a large-scale
2. Biomass sources and storage sites are co-located
3. Transportation infrastructure is well-developed
4. Competition for biomass is low

Problems with BECCS: BECCS climate benefits can be undermined by indirect emissions from deforestation and challenged by insurance issues from earthquakes associated with \(\text{CO}_2\) injections.\(^2\)
- Some challenges associated with BECCS, in relation to energy security, are its variability based on several factors. Energy produced from BECCS can vary with availability of biomass.
- Some environmental NGOs argue that more BECCS bioenergy crops use can result in deforestation.\(^2\) Some researchers additionally argue that it may take decades to millennia to recover the \(\text{CO}_2\) lost due to inefficient use of wood from the forest during bioenergy production. To this end, the use of agricultural and forestry residues is a promising avenue to pursue, which does not result in deforestation.
- BECCS is threatened by a negative public and UFCCC delegate preference for carbon capture and storage as well as not-in-my-backyard sentiments from the public and environmentalists, due to worries about possible leakage. \(^2\)

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Public perception and preference can have an indirect effect of the climate.

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