Carbon Capture and Utilisation Technologies

For Prelims: CCUS Technologies, Paris Agreement.

For Mains: CCUSTechnologies, Applications, Net Zero emissions by 2050, Environment Degradation, Conservation.

Why in News?

According to a study conducted by **Radboud University**, most **Carbon Capture and Utilisation and Storage (CCUS) technologies,** which **suck carbon dioxide (CO_2) from the atmosphere and convert it into fuel or other valuable products,** might fail to help the world reach **Net Zero emissions by 2050.**

- The study noted that a majority of these systems are **energy intensive and the resultant product can also release CO_2 into the atmosphere.**
- 'Net zero emissions' refers to achieving an overall balance between greenhouse gas emissions produced and greenhouse gas emissions taken out of the atmosphere.

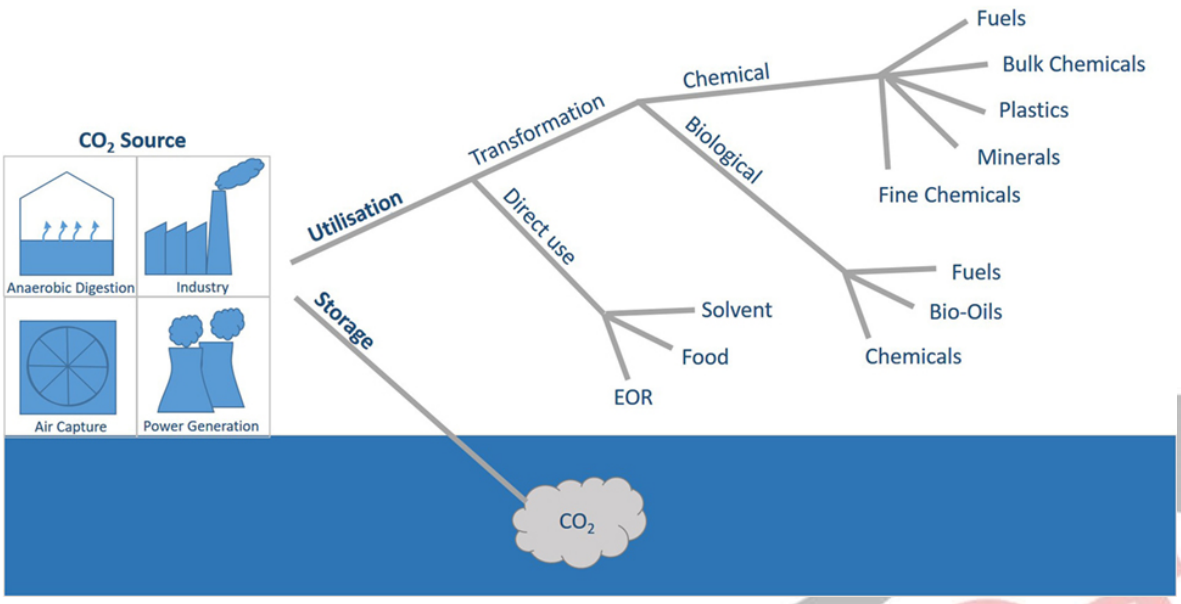
What are CCUS?

- **Carbon Capture, Utilization, and Storage (CCUS)** encompasses **methods and technologies to remove CO_2 from the flue gas and from the atmosphere**, followed by **recycling the CO_2 for utilization** and **determining safe and permanent storage options.**
- CO_2 captured using CCUS technologies is **converted into fuel** (methane and methanol), refrigerants and building materials.
    - The captured gas **is used directly** in fire extinguishers, pharma, food and beverage industries as well as the agricultural sector.
- CCUS technologies can play an important role in **meeting net zero targets**, including as one of few solutions to tackle emissions from heavy industry and to remove carbon from the atmosphere.
- CCUS is considered an important tool to help countries halve their emissions by 2030 and reach net-zero by 2050.
    - These goals are crucial to meet the **Paris Agreement targets** for restricting global warming to **2 degrees Celsius (°C), and preferable to 1.5°C, over pre-industrial levels.**

What are Applications of CCUS?

- **Mitigating Climate Change**: Despite the adoption of alternative energy sources and energy efficient systems to reduce the rate of CO_2 emissions, the cumulative amount of CO_2 in the atmosphere needs to be reduced to limit the detrimental impacts of climate change.
- **Agriculture:** Capturing CO_2 from biogenic sources such as plants and soil to boost crop growth in a greenhouse could work.
- **Industrial Use:** Combining CO_2 with steel slag - an industrial byproduct of the steel manufacturing process — to make construction materials compatible with the Paris Agreement goals.

- **Enhanced Oil Recovery:** CCU is already making inroads into India. For instance, Oil and Natural Gas Corporation signed a MoU with Indian Oil Corporation Limited (IOCL) for Enhanced Oil Recovery (EOR) by injecting CO_2.



What are the Challenges associated with CCUS?

- **Expensive:** Carbon capture involves the development of sorbents that can effectively bind to the CO_2 present in flue gas or the atmosphere, which is expensive.
- **Lesser Demand for Recycled CO_2:** Converting CO_2 into useful chemicals of commercial importance, or utilizing CO_2 for oil extraction or remediation of alkaline industrial wastes, would add economic value to this greenhouse gas.
    - However, the demand for CO_2 is limited compared to the vast amount of CO_2 that needs to be removed from the atmosphere, to reduce the detrimental environmental impacts of climate change.

Way Forward

- Any viable system for storing carbon must be effective and cost competitive, stable as long-term storage, and environmentally benign.
- Countries should narrow down on the handful of technologies that show more promise and channel investment in them.
- Replacing a conventional fuel with a synthetic fuel like methanol produced via CCU is likely to be a successful mitigation strategy only if clean energy is used to capture CO_2 and convert it into synthetic fuel.

Source: DTE

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