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CHAPTER 1

INTRODUCTION

Project Title

Discussion and analysis of possible solutions of carbon capture and storage to reduce emission in heavy industries.

Project Overview

Indeed, even as countries expand their energy portfolios, petroleum derivatives are supposed to meet a greater part of the world's energy interest for a considerable length of time. Speeding up an arrangement of carbon capture innovation is fundamental to diminishing outflows from these power plants, and from modern plants like concrete and steel manufacturing. [1]

The greater part of the models referred to in the Intergovernmental Panel on Climate Change's Fifth Assessment Report [2] required carbon capture for an objective of remaining inside 2 degrees Celsius of warming from pre-modern days. For models without carbon capture, outflows decrease costs rose 135%.

For almost 52 years, in a training called upgraded oil recuperation, carbon dioxide has been utilized to remove extra oil from created oil fields in the United States. U.S. organizations are likewise putting resources into new advancements to re-utilize caught fossil fuel byproducts in imaginative ways, including plane fuel and auto seats.

As numerous specialists consider hydrogen to be a spotless fuel of things to come and anticipate that it should assume a significant part in decarbonizing the modern area, a cycle, for example, petroleum gas improving with carbon capture innovation introduces itself as the most reduced cost choice for delivering clean hydrogen. This cycle produces "blue hydrogen" by improving petroleum gas into hydrogen and carbon dioxide; the carbon dioxide result will be caught, moved, and put away in profound geologic developments. [3] The expansion of carbon capture makes the hydrogen creation process almost discharges free when clean power is utilized to control the carbon capture office.

Carbon capture and storage is the process of capturing carbon before it enters the atmosphere, transporting it, and storing it for centuries or millennia. Usually the carbon is captured from

large point sources, such as coal-fired power plant, a chemical plant or biomass power plant, and then stored in an underground geological formation.

Project aim

The aim of this report is to look for possible solutions to prevent the release of carbon dioxide from heavy industry with the intent of mitigating the effects of climate change. Although carbon dioxide has been injected into geological formations for several decades for various purposes, including enhanced oil recovery, the long-term storage of carbon dioxide is a relatively new concept.

Carbon capture and utilization (CCU) and CCS are sometimes discussed collectively as carbon capture, utilization, and sequestration (CCUS). This is because CCS is a relatively expensive process yielding a product with an intrinsic low value (i.e. CM). Hence, carbon capture makes economically more sense when being combined with a utilization process where the cheap carbon dioxide can be used to produce high-value chemicals to offset the high costs of capture operations.

About Carbon capture, utilization, and sequestration (CCUS)

Carbon capture, utilization, and sequestration (CCUS) is the method involved with capturing carbon dioxide and putting away it so it is not discharged into the environment. CCUS innovations can possibly diminish carbon dioxide emanations in energy frameworks. Offices with CCUS can capture practically all of the carbon dioxide they produce (some presently capture 95 or even 100%). [https://www.rff.org/publications/explainers/carbon-capture-and-storage-101] This report work gives an outline of CCUS innovation, including how it works, where it is as of now utilized in the World, obstructions to more inescapable use, and arrangements that might influence its turn of events and sending. It likewise incorporates a rundown of extra assets for additional perusing.

CHAPTER 2

LITERATURE REVIEW

Background

The seriousness of harming human-initiated environmental change relies upon the greatness of the change as well as on the potential for irreversibility. A paper published by Susan Solomon shows that the environmental change that happens because of expansions in carbon dioxide fixation is largely irreversible for quite some time after emanations stop. [4] Following end of emanations, expulsion of air carbon dioxide diminishes radiative compelling, however is generally repaid by more slow loss of hotness to the sea, with the goal that environmental temperatures do not decrease essentially for somewhere around 1,500 years. Among illustrative irreversible effects that ought not out of the ordinary assuming environmental carbon dioxide focuses increment from momentum levels almost 385 sections for each million by volume (ppmv) to a pinnacle of 500-650 ppmv over the approaching century are irreversible dry-season precipitation decreases in a few locales similar to those of the "dust bowl" time and unyielding ocean level ascent..

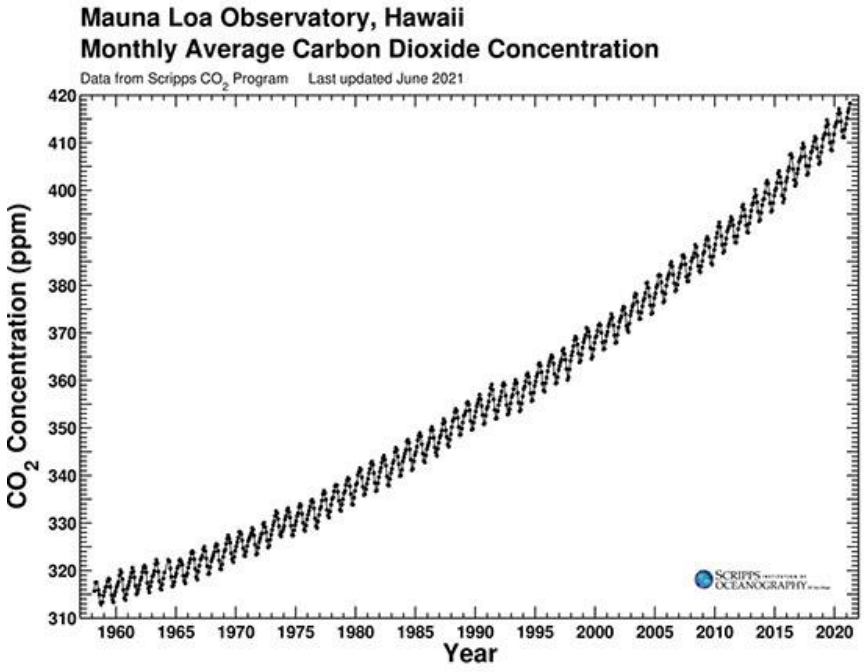


Figure 1 CARBON DI - OXIDE concentration exponentially increasing

Global discussion on carbon emissions

By 2010, new investigations had nailed down a few really upsetting numbers about times in the far off past when CARBON DI - OXIDE levels had been high - albeit no higher than we would reach by the late 21st century on the off chance that emanations kept on ascending without limitation. [5] In those times worldwide temperatures had been something like three degrees higher than as of now, and maybe however much six degrees higher, or at least, in the upper scope of what PC models viewed as conceivable, on the off chance that not even higher.

For the genuine planet, a climb in temperature had obviously not been restricted by expanded cloud reflection or something like that. The ascent had rather clearly been intensified by certain inputs, as ice and seas and vegetation answered over hundreds of years to the changing circumstances with hazier surfaces and their own gas outflows. The PC models didn't consider these sluggish input circles. Hansen and others contended that humankind took a chance with setting off a chain response that would ultimately bring a through and through disastrous planetary change.

Through this large number of disclosures and debates, Keeling and his associates had kept on discreetly checking and breaking down the continuous changes in environmental carbon dioxide levels. Since the 1980s, an agreeable worldwide program had been estimating the gas at land stations all over the planet and along transportation paths. The standard kept on rising forebodingly, however not easily. There had been years when the world's air had acquired one billion metric huge loads of the gas, while in different years it acquired as much as six billion. What amount did changes on the planet's enterprises and agrarian practices influence the pace of the ascent? Monetary insights permitted a decent retribution of how much gas humankind transmitted in consuming petroleum products - and furthermore of some importance, in the assembling of concrete - however the impacts of deforestation and other land use changes were not so natural to figure.

The 21st century brought an amazing development of investigations of the manner in which carbon dioxide was gathering in the environment, and where the carbon went in the land and seas. Here as somewhere else in environment research, the worldwide degree and intricacy of the issue called forward gigantic global activities. At large number of areas instruments estimated air, soils, trees, seawater, and that's only the tip of the iceberg, giving "ground truth" for satellites that checked the whole planet.

Carbon emission from big industries

A huge amount of outflows can be followed to a moderately modest number of non-renewable energy source makers. Heedels (2015) examined noteworthy creation records of the ninety biggest makers of coal, oil, and flammable gas, as well as concrete, from 1856 to 2012, working out the carbon content of their promoted energizes (deducting for non-energy utilizes), process carbon dioxide from concrete assembling, carbon dioxide from direct erupting, venting, and fuel use, and outlaw or vented methane.

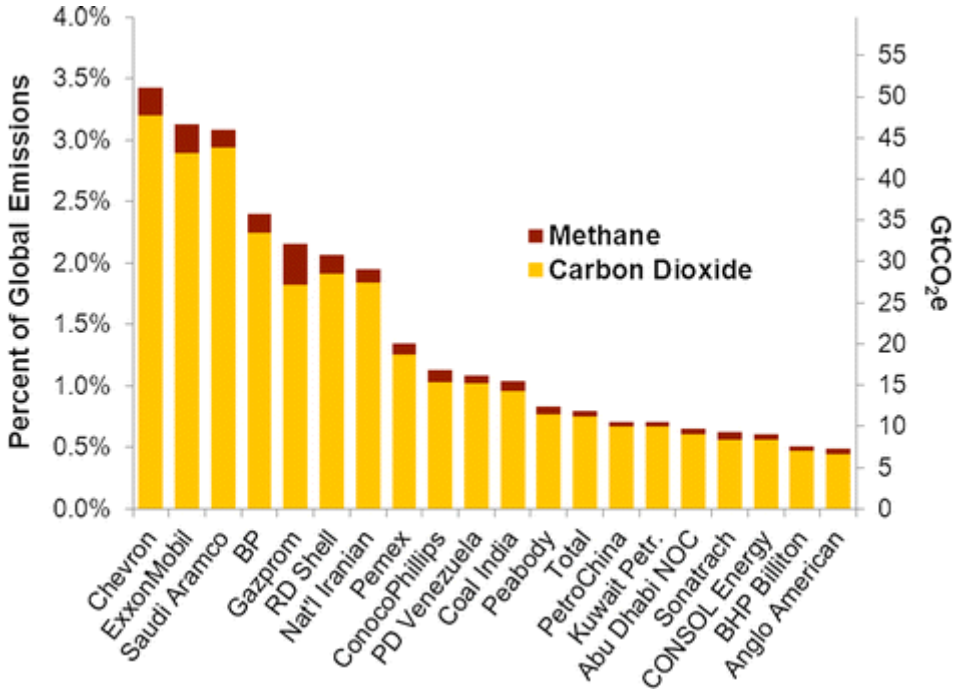


Figure 2 Percentage share in carbon emission from big industrial companies [Image credit:6]

Of complete outflows of modern carbon dioxide and methane from 1752 to 2011, 65 % were followed to 83 of the world's biggest makers of coal, oil and petroleum gas, and seven biggest makers of concrete. In other words, just 95 elements have delivered all the fossil energy and concrete liable for 64 % of the world's modern outflows of carbon dioxide and methane; 30 % of these emanations have been followed to only 20 financial backer and state-possessed organizations.[7]

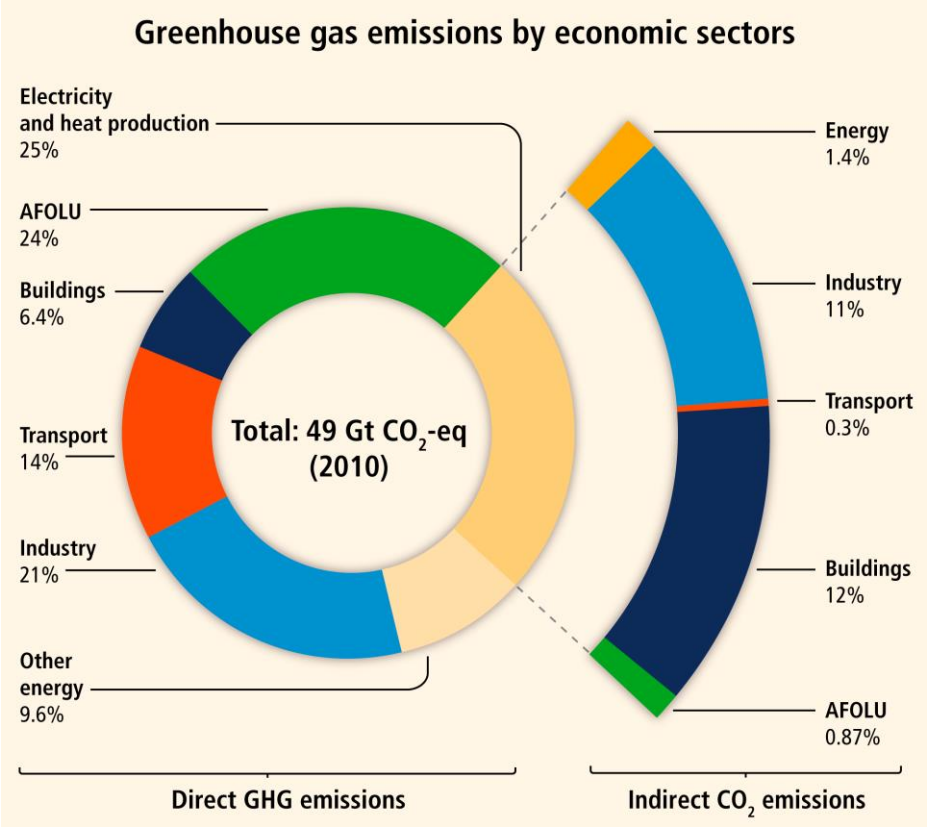


Figure 3 Sector wise green house gas emissions [8]

Carbon capture, utilization, and sequestration (CCUS)

Universally, power and industry represent around half of every single nursery ga (GHG) outflows. Carbon Capture, Utilization, and Storage program plans to decrease carbon emissionby either putting away or reusing it so that caught carbon dioxide doesn't enter the air. Various associations expects to sustain the area of Carbon Capture, Utilization, and Storage through accentuation on innovative work and limit working of both human asset as well as foundation, to advance advances and strategies that address issues connected with high capital expenses, security, planned operations and high helper power utilization.

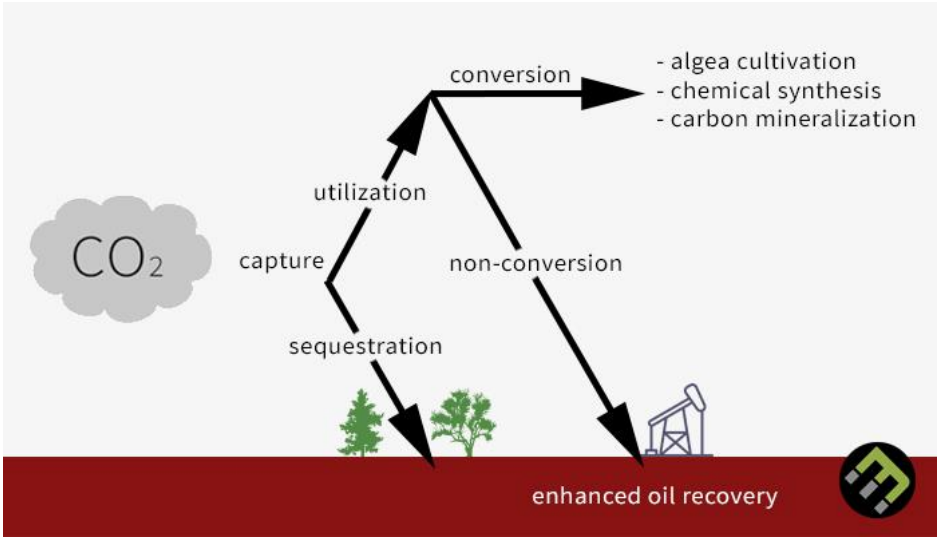


Figure 4 CCUS system [Image credit: 9]

The job of carbon catch, use, and capacity (CCUS) in environmental change relief has been a subject of discussion for more than twenty years. The Intergovernmental Panel on Climate Change's (IPCC) Special Report on Global Warming of 1.5°C and the new series of declarations by countries on net-zero have enthused the defenders of this innovation, given the potential job counterbalances are supposed to play in a net-zero world. In different nations, partners have to a great extent had a few some lingering doubts of the CCUS innovation due to the irrelevant advancement on the sending of this innovation over the most recent twenty years. The unreasonable motivation it presents to delay moderation activities, and the likely expansion in the expense of force age assuming that this innovation is sent. Interestingly, CCUS offers a rent of life to financial backers and enterprises in fossil-energy-subordinate organizations and could save them from huge interruptions expected to accomplish a low carbon future.

Method of CCUS

Among different utilizations of the innovation, CCUS in mix with petroleum gas powerplants can be utilized to give firm baseload power or could fill in as reinforcement for irregular inexhaustible power instead of multi-day power capacity. [10] Additionally, CCUS could be utilized to decarbonize hard-to-zap modern cycles and to give manufactured powers to decarbonizing nonelectric energy utilizes. [11]

CCUS innovation can catch carbon dioxide outflows from fixed sources like production lines and assembling plants. Tragically, versatile sources like vehicles can't be gathered for their fossil fuel byproducts. A few new and old advances can be utilized to catch carbon dioxide emanations from fixed sources, and the field is constantly growing new techniques.

carbon dioxide can be utilized for some applications, which is the use part of CCU. These applications make items that are financially reasonable, making them an engaging possibility for producers.

Green growth Cultivation

Microalgae is being considered as a genuine wellspring of sustainable power while additionally functioning as a carbon dioxide sink. Microalgae feed on a careful nutritional plan of carbon dioxide, which can be obtained through CCU. The biofuel generally involves 1.8 huge loads of carbon for each metric ton of dry green growth created. Notwithstanding, since microalgae is a biofuel, its use in the long run prompts the arrival of carbon. Fortunately this sum is lesser than the info expected for the development of the green growth. While this innovation is currently at an early stage, the conceivable outcomes of microalgae and its capacity to trap carbon dioxide are a large number.

Compound Synthesis

Carbon dioxide can be changed over to numerous different items through substance responses. This course of involving carbon dioxide in synthetic responses to make other helpful items is known as a substance feedstock.

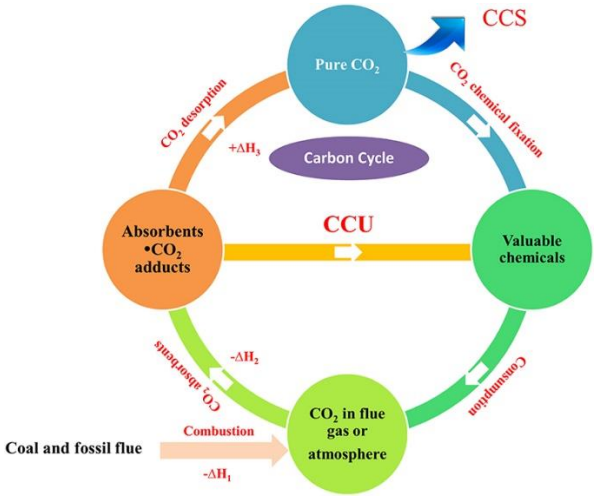


Figure 5 Compound synthesis in CCUS [Image credit:12]

A portion of the items created utilizing this system are polycarbonates and other natural mixtures like urea and acidic corrosive. Novomer, a compound organization, utilizes CCU to make and deliver an assorted arrangement of plastic items. The organization has gotten subsidizing to make this cycle business.

Carbon Mineralisation

Carbonates are shaped when carbon dioxide is made to respond with minerals like magnesium oxide and calcium oxide. These carbonates can then be utilized in the development business.

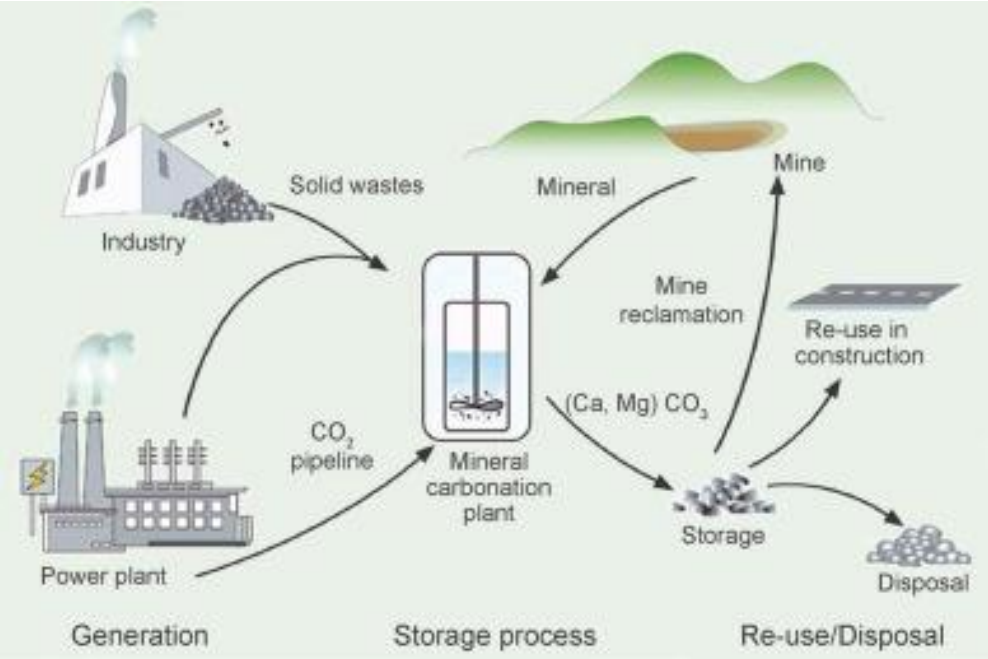


Figure 6 Carbon Mineralisation process [Image credit:13]

An organization named Calera made a mineralization interaction, which likewise delivers water as a side-effect. The greatest obstacle Calera and different organizations who are zeroing in on carbon mineralization is a huge opposition from the development business.

Essentially all philosophies will require carbon dioxide partition and catch at the discharge source as a basic piece of the carbon mineralization process. The ex situ approaches utilizing mafic/ultramafic rock types as well as modern side-effects as the cation source should likewise manage the sheer feed volume, and the expanded item volume, as carbonation brings about a weight and volume gain. An unsure element that necessities further examination is a definitive ecological solidness of the shaped carbonate material. While enormous surface stores of silicate minerals happen around the world, incredibly surpassing accessible amounts of petroleum products, the size of mining tasks could be risky. Saline infusion will require nearby carbon dioxide direct sources toward limit transportation costs, as well as long haul checking after the infusion time frame. As a part of saline infusion, mineral sequestration inside geologic developments (mineral catching) will have similar necessities. Mineralogy and design of chosen developments can incredibly improve sequestration achievement; for

instance, the ideal mineralogy and layered construction of flood basalts gives an infusion target high mineral catching potential and clearly all around detached zones of high porosity.

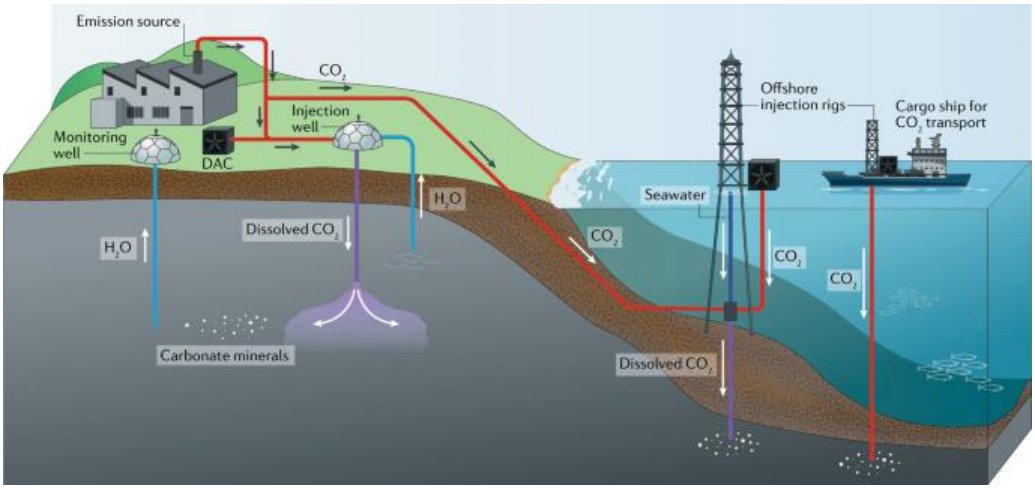


Figure 7 A schematic diagram of CARBON DIOXIDE mineraliation

Upgraded Oil Recovery (EOR)

This technique is utilized to extricate oil from oil handles that can't be separated by different strategies. There are a few distinct techniques with regards to EOR. The utilization of carbon dioxide is especially viable in supplies or fields that are more profound than 2000 feet. The fluid or gas carbon dioxide is utilized in a high-pressure structure, where it blends in with the oil and makes it swell and rise.

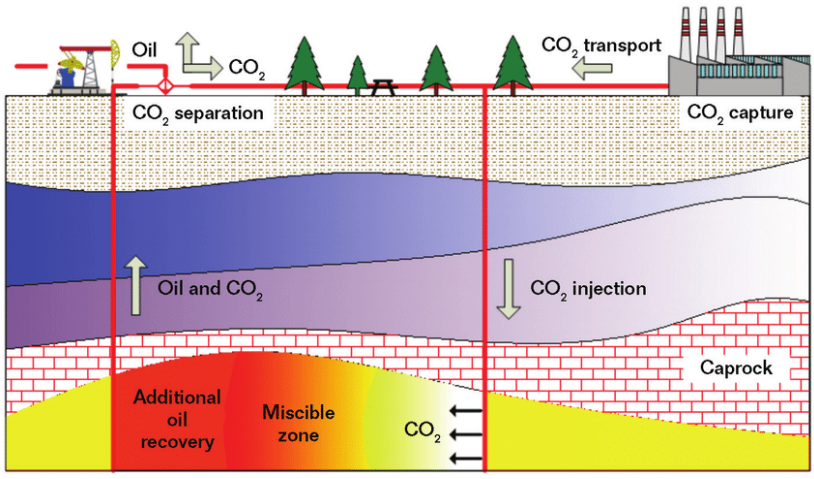


Figure 8 Schematic representation of upgraded oil recovery with CCUS [14.]

Barriers in application of CCUS

The vital obstruction to CCUS topping these different jobs and living off to its specialized potential is significant expenses comparative with current impetuses: regardless of current U.S. government support through charge strategy, CCUS isn't monetarily cutthroat today in

the vast majority of its applications. Except if and until it turns out to be so or is legally necessary, it won't accomplish inescapable arrangement.

There are presently just 26 working business CCUS offices around the world, twelve of which are in the United States. Of the offices in the United States, four are sent in flammable gas handling, three in ethanol creation, three in compost creation, one in syngas creation, and one in hydrogen creation. Everything except one utilize the caught carbon dioxide for improved oil recuperation (EOR), where caught carbon dioxide is infused into oil-containing geologic developments to ease extraction of difficult to-recuperate oil.

Difficulties in scaling of CCUS

From the factual information, it very well may be seen that the worldwide objective of carbon decrease and discharge decrease has driven the CCUS business into a quickly developing track, with the world's CCUS industry venture scale moving toward USD 3 billion of every 2020.

A complete investigation of the real circumstance shows that there is still a ton of opposition and difficulties to accomplish huge scope improvement in the CCUS business in world:

1. Economic viewpoints. A definitive objective of CCUS is to accomplish outflow decrease, however the failure to profit from discharge decrease subsequent to burning through colossal measures of cash will influence the excitement of undertakings to complete show projects. What's more, the significant expenses of big haulers, boats, and pipeline network sending during carbon dioxide transportation likewise breaking point somewhat the advancement of CCUS innovation.

2. Technical viewpoints. Albeit some test showing projects have been completed in World, they are little in scale, and the entire is in the R&D and trial stage. Enormous scope exhibit projects are deferred or dropped for different reasons, which genuinely thwarts the advancement and utilization of CCUS innovation.

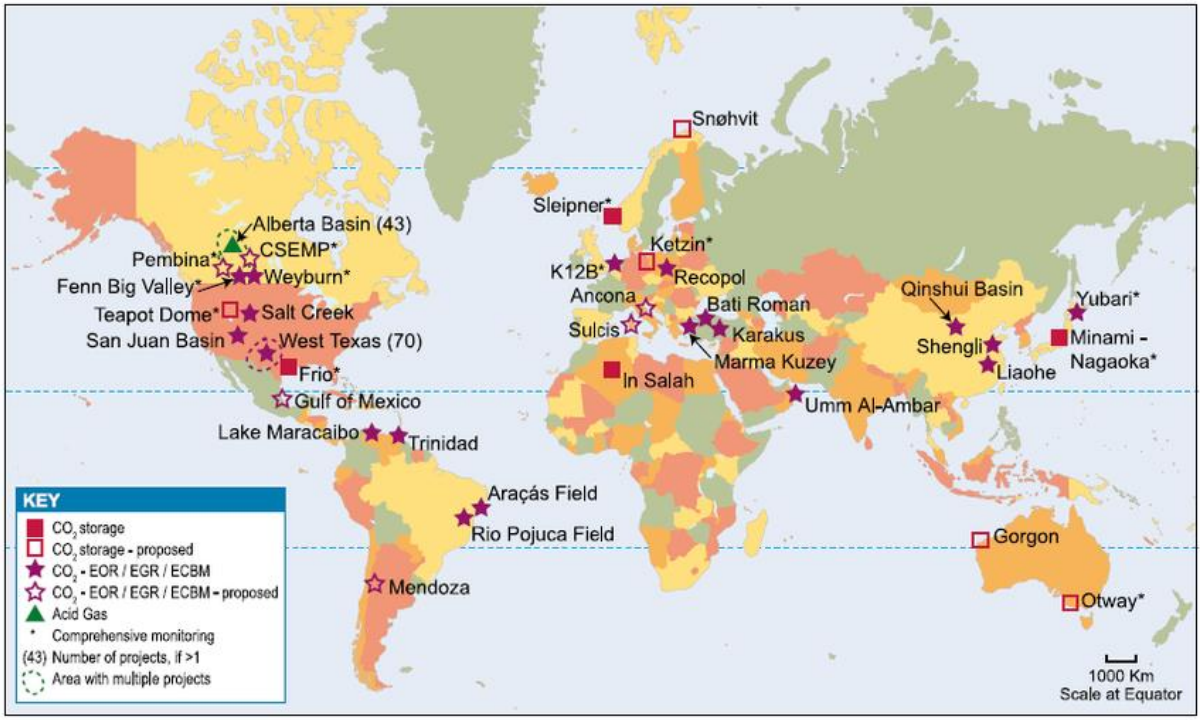


Figure 9 Major CCUS projects in the world [Image credit:15]

The ecological and security parts of CCUS catch and transportation are for the most part fluid carbon dioxide or supercritical carbon dioxide at high focus and tension, and any mishap. For example, spillage during catch, transportation and capacity will truly affect the climate and individual wellbeing, particularly the natural effect brought about by geographical intricacy genuinely confines the acknowledgment and acknowledgment of CCUS. This requires the advancement of an entire cycle and stage risk avoidance and control program for wellbeing issues all through the CCUS interaction.

Summary of literature review

In discussed literature review we have seen how global warming and carbon dioxide emissions are dangerous for the planet earth. We discussed the contribution of heavy industries towards carbon dioxide emissions throughout history. Carbon capture, utilization, and sequestration (CCUS) is the method involved with capturing carbon dioxide and putting away it so it is not discharged into the environment. We have seen four different methods (Green growth Cultivation, Compound Synthesis, Carbon Mineralisation and Upgraded Oil Recovery) used in the heavy industries for CCUS,

CHAPTER 3

PROJECT PLANNING

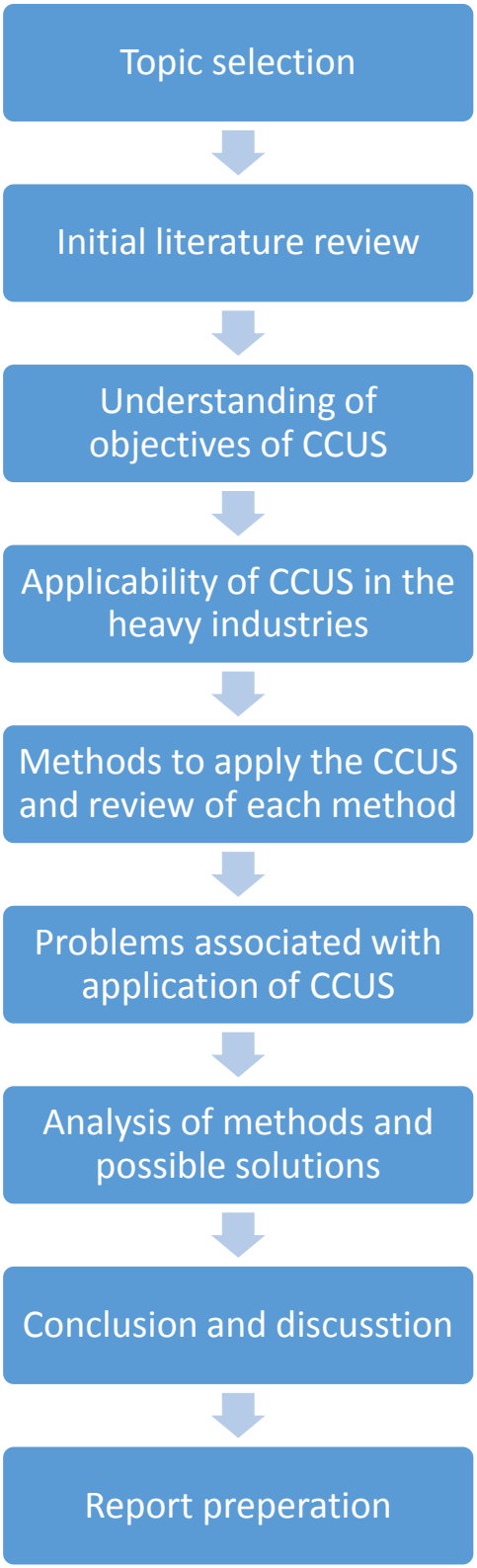
Gantt chart

Following gantt chart shows the list of detailed project activity with time frame.

Task	Week													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Briefing on final year project														
Selection of project topic with consultation of supervisor														
Initial study to get idea about topic														
Initial literature review of the topic														
Define the aim of the project														
Detailed literature review of the work														
Preparation of progress report 1														
Primary discussion on the possible solutions of the CCUS for heavy industries														
Preparation of progress report 2														
Collection of required data														
Detailed Analysis on the possible solutions of the CCUS for heavy industries														
Conclusion														
Final report & presentation preparation														

Work- flow chart

Following flow chart shows the important steps to complete the project work



Reference

1.Center for Climate and Energy Solutions (2018). Carbon Capture | Center for Climate and Energy Solutions. [online] Center for Climate and Energy Solutions. Available at: https://www.c2es.org/content/carbon-capture/.

2. Anon, (n.d.). Fifth Assessment Report — IPCC. [online] Available at: https://www.ipcc.ch/assessment-report/ar5 [Accessed 3 Apr. 2022].

3. Center for Climate and Energy Solutions (2018). Carbon Capture | Center for Climate and Energy Solutions. [online] Center for Climate and Energy Solutions. Available at: https://www.c2es.org/content/carbon-capture/.

4. Solomon, S., Plattner, G.-K., Knutti, R. and Friedlingstein, P. (2009). Irreversible climate change due to carbon dioxide emissions. Proceedings of the National Academy of Sciences, 106(6), pp.1704–1709.

5. https://history.aip.org/climate/carbon di - oxide.htm

6. Rdcu.be. (2022). The climate responsibilities of industrial carbon producers. [online] Available at: https://rdcu.be/cKuHY [Accessed 3 Apr. 2022].

7. https://www.ourenergypolicy.org/wp-content/uploads/2015/08/document_cw_02.pdf

8. Extinction Rebellion. (n.d.). A Guide to Carbon Capture and Storage. [online] Available at: https://rebellion.global/blog/2021/02/18/guide-to-ccs [Accessed 3 Apr. 2022].

9. EcoMatcher. (2020). Carbon Capture and Utilization (CCU). [online] Available at: https://www.ecomatcher.com/carbon-capture-and-utilization-ccu/.

10. Williams, J.H., B. Haley, F. Kahrl, J. Moore, A.D. Jones, M.S. Torn, and H. McJeon, "Pathways to Deep Decarbonization in the United States," The U.S. Report of the Deep Decarbonization Pathways Project of the Sustainable Development Solutions Network and the Institute for Sustainable Development and International Relations, modification with specialized supplement, November 16, 2015

11. Larson, E., C. Greig, J. Jenkins, E. Mayfield, A. Pascale, C. Zhang, J. Drossman, et al., Net-Zero America: Potential Pathways, Infrastructure, and Impacts, interval report, Princeton University, Princeton, NJ, December 15, 2020, https://netzeroamerica.princeton.edu/the-report.

12. Fu, H.-C., You, F., Li, H.-R. and He, L.-N. (2019). CO2 Capture and in situ Catalytic Transformation. Frontiers in Chemistry, 7.

13. Xie, H., Yue, H., Zhu, J., Liang, B., Li, C., Wang, Y., Xie, L. and Zhou, X. (2015). Scientific and Engineering Progress in CO 2 Mineralization Using Industrial Waste and Natural Minerals. Engineering, 1(1), pp.150–157.

14. Xiang, Yong. (2018). Corrosion issues of carbon capture, utilization, and storage. Materials Performance. 57. 32-35

15. ResearchGate. (n.d.). (PDF) International Carbon Capture and Storage Projects Overcoming Legal Barriers, DOE/NETL–2006/1236. [online] Available at: https://www.researchgate.net/publication/258629909_International_Carbon_Capture_and_Storage_Projects_Overcoming_Legal_Barriers_DOENETL-20061236 [Accessed 3 Apr. 2022].