Walchand College of Engineering

(An Autonomous Institute)

DEPARTMENT OF ELECTRICAL ENGINEERING

Presentation on Project Phase -1

"Small Scale Direct CO2 Extraction From Air "

Presented By

SR.NO	STUDENT NAME	PRN
1.	Aditya Lalit Jha	2020BTEEL00003
2.	Sumedh Dhanaji Nalawade	2020BTEEL00050
3.	Mayur Vishwambar Kandalwad	2020BTEEL00068
4.	Manoj Mukundrao Shinde	21320001
5.	Sagar Sanjay Kamble	21320003

Under the Guidance of

Dr. Ramchandra. P. Hasabe

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INTRODUCTION

- Currently in 2023 looking back the globalization of industries and technological sectors had been advanced with an extreme speed. The whole credit goes to the inventions of electricity which plays a crucial role in our daily lives and became a necessary part of us.

- As great are the merits of the electricity greater the demerits. The world engulfing in the profits of electricity tries to neglect the by product produced while generating electricity.

- The main byproduct is CO2 which is crucial part which holds as well as destroys the ecosystem. Hence the proper removal of the co2 is necessary.

- There are various methods to overcome this problem such as forest enhancements, reduce of fossil fuels, reducing deforestation, direct air capture(DAC) system. Etc.

INTRODUCTION

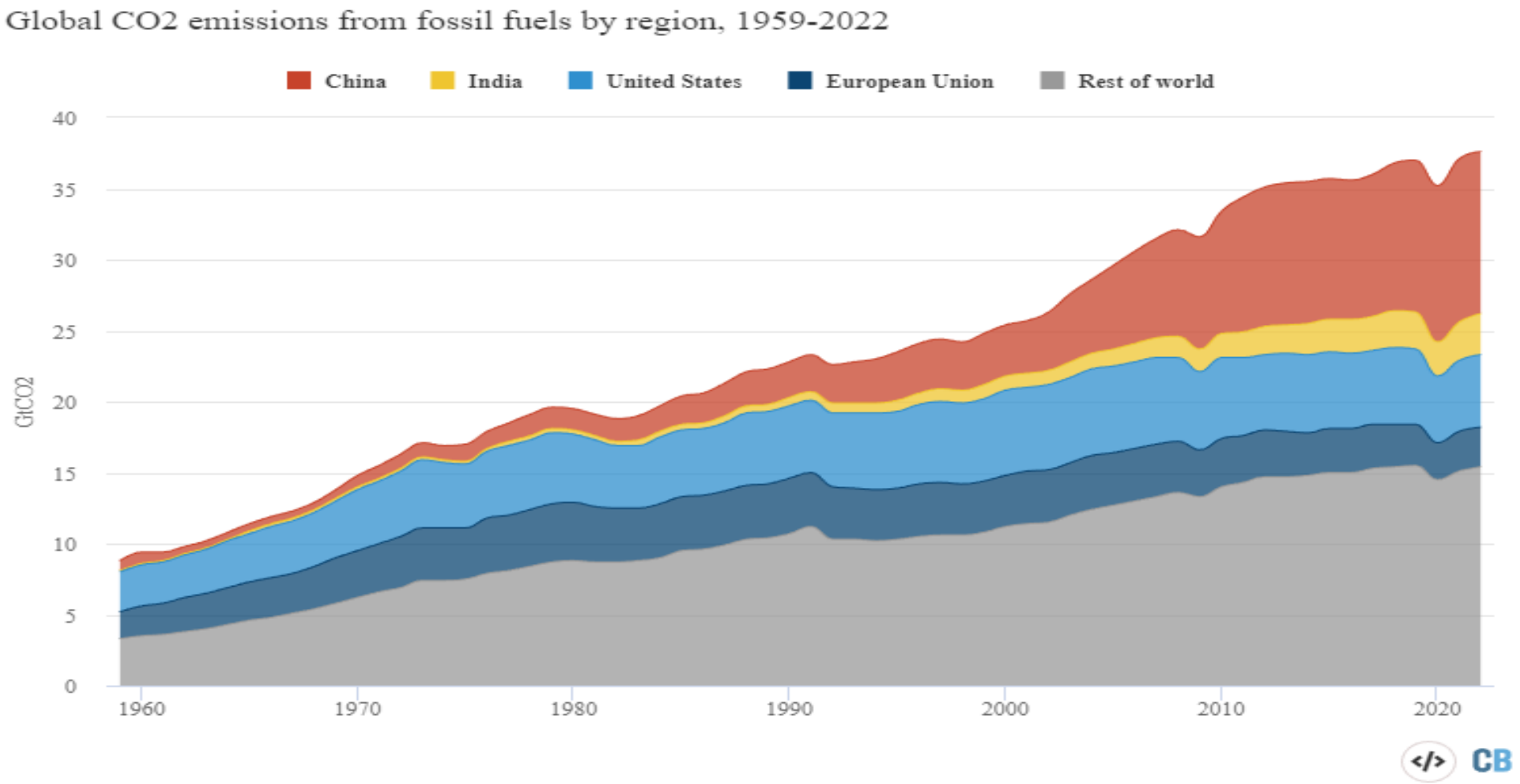
- Direct Air Capture (DAC) technology is a process that involves capturing carbon dioxide (CO2) directly from the air using specialized equipment.

- It has the potential to play a significant role in reducing emissions from hard-to decarbonize sectors, such as transportation and industry.

- DAC typically involves several steps, including air filtration, absorption of CO2, Separation of CO2 and Storage or utilization.

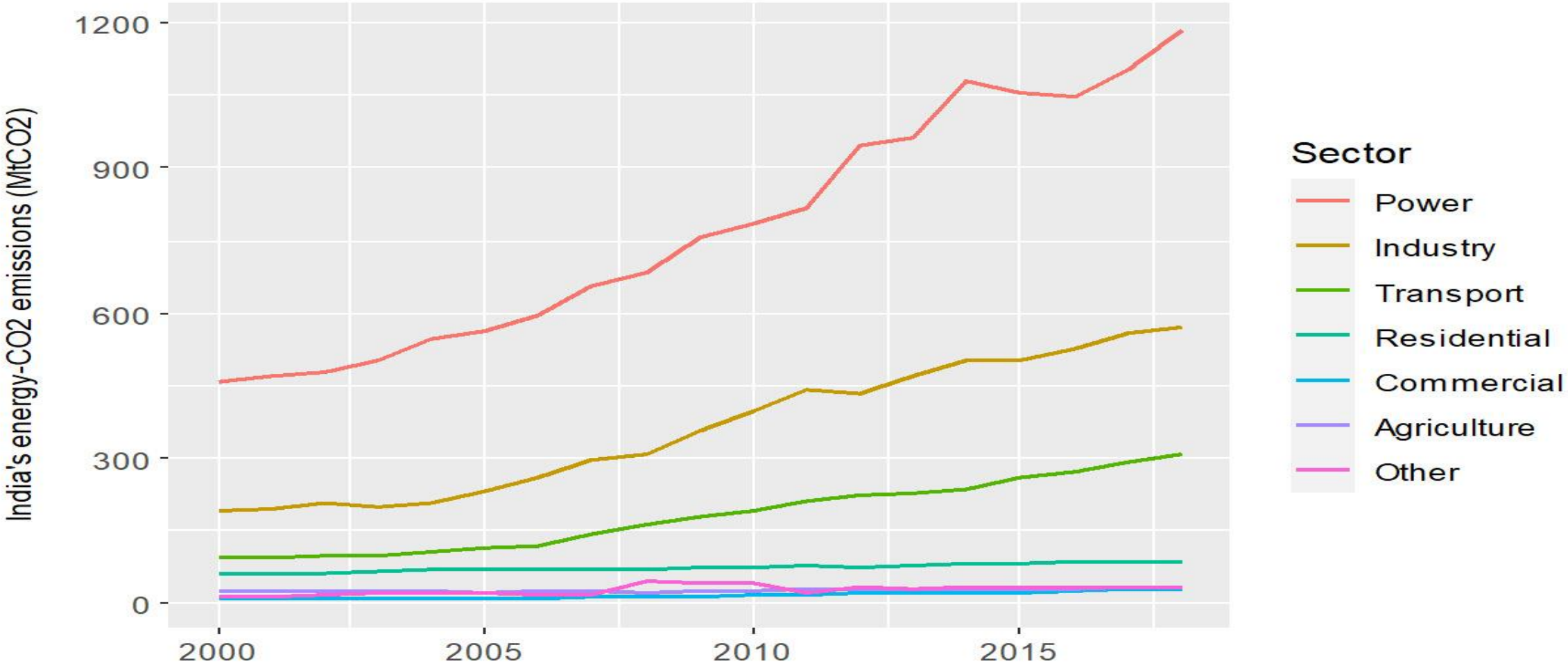
- The captured CO2 can then be stored or used in various applications, such as enhanced oil recovery, synthetic fuel production, and industrial processes.

CO2 EMISSIONS WORLDWIDE



CO2 Emissions from 1960 -2020

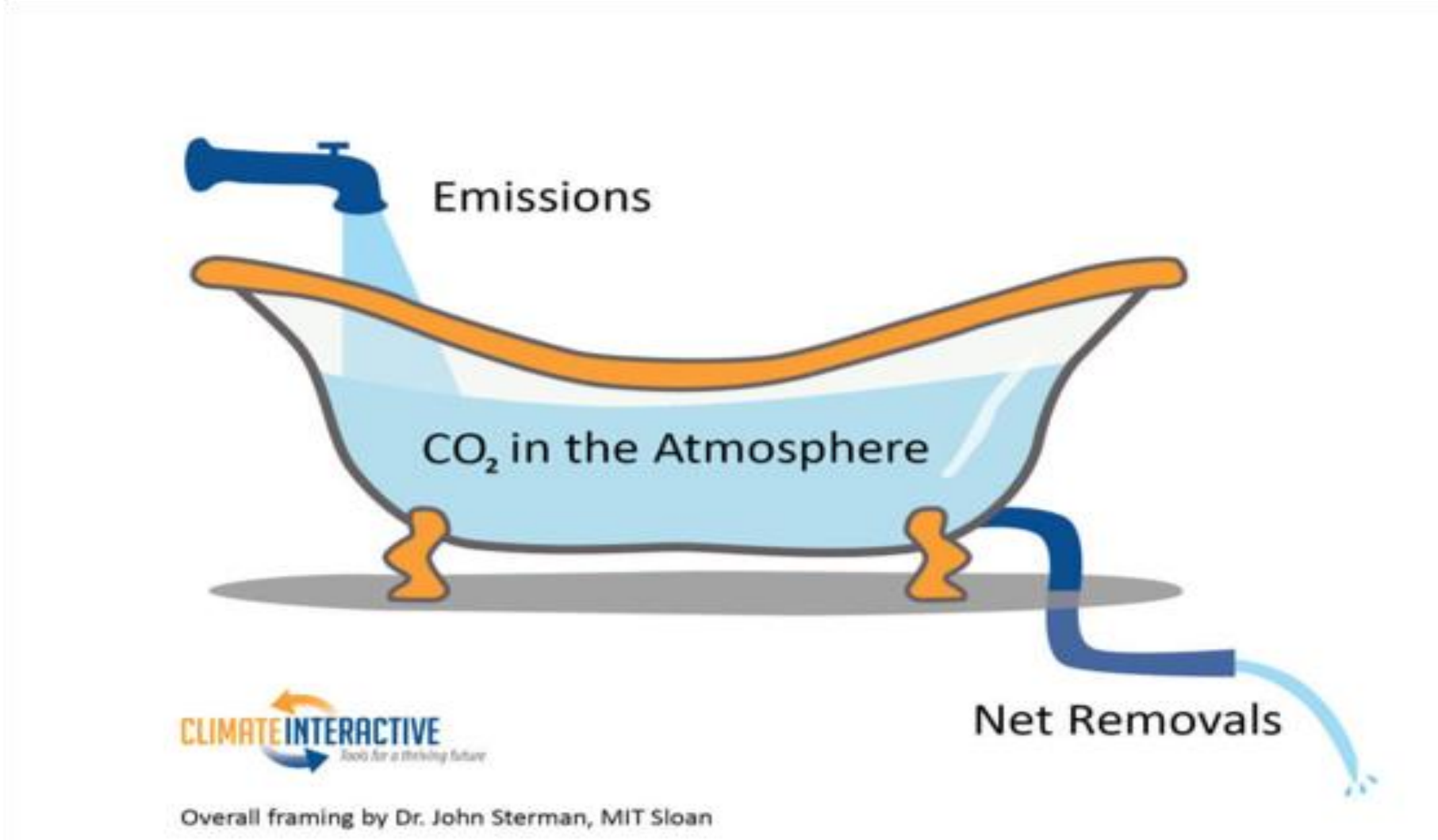
CO2 EMISSIONS IN INDIA



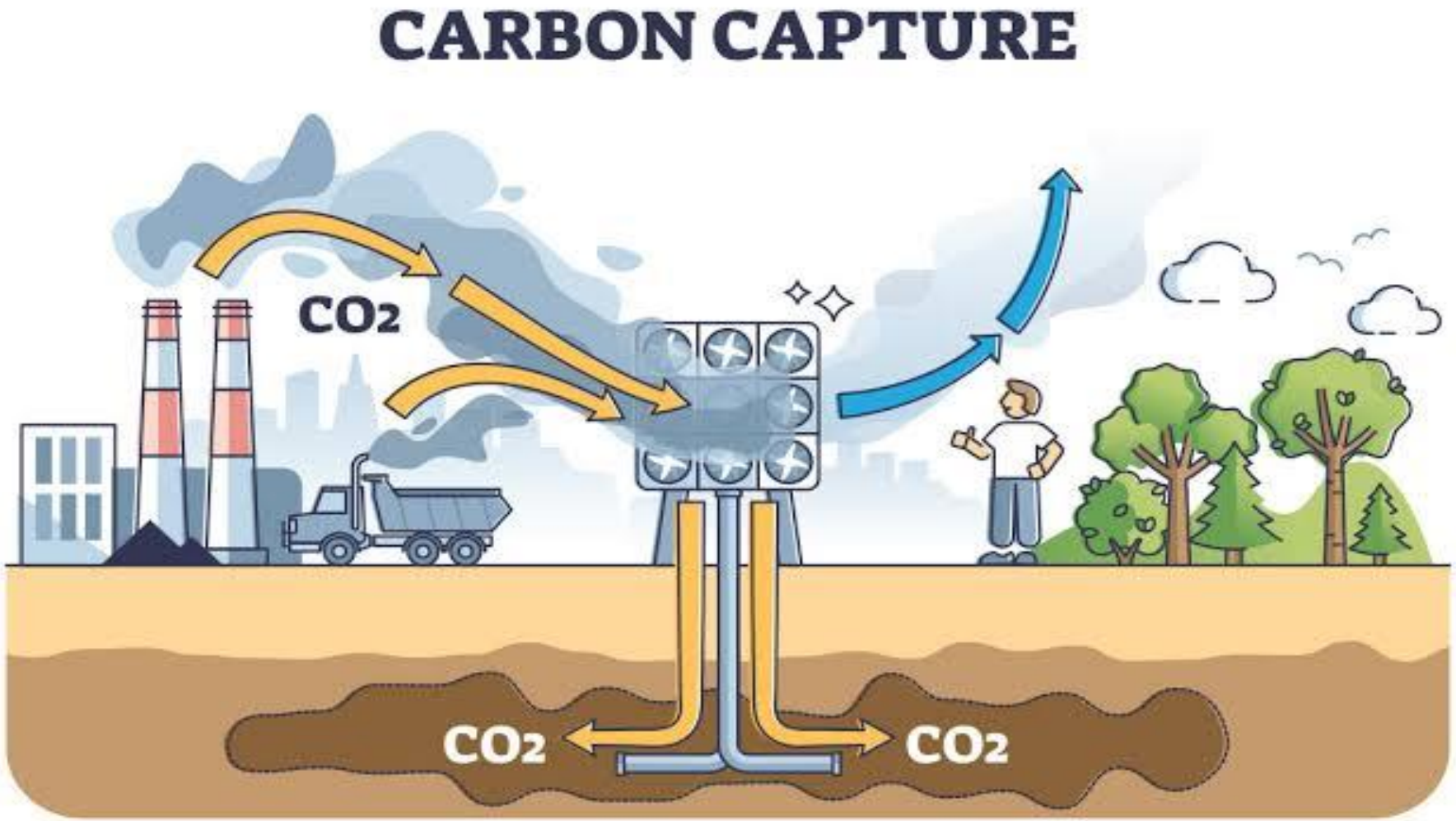
CO2 emissions in India (In metric tonnes)

EFFECTS OF CLIMATE CHANGE

- Hotter temperatures
- More severe storms
- Increased drought
- A warming, rising ocean
- Not enough food
- More health risks



Graphical Representation of CO2 Emissions and Removals



Graphical Concept of DAC Technology

Capture capacity

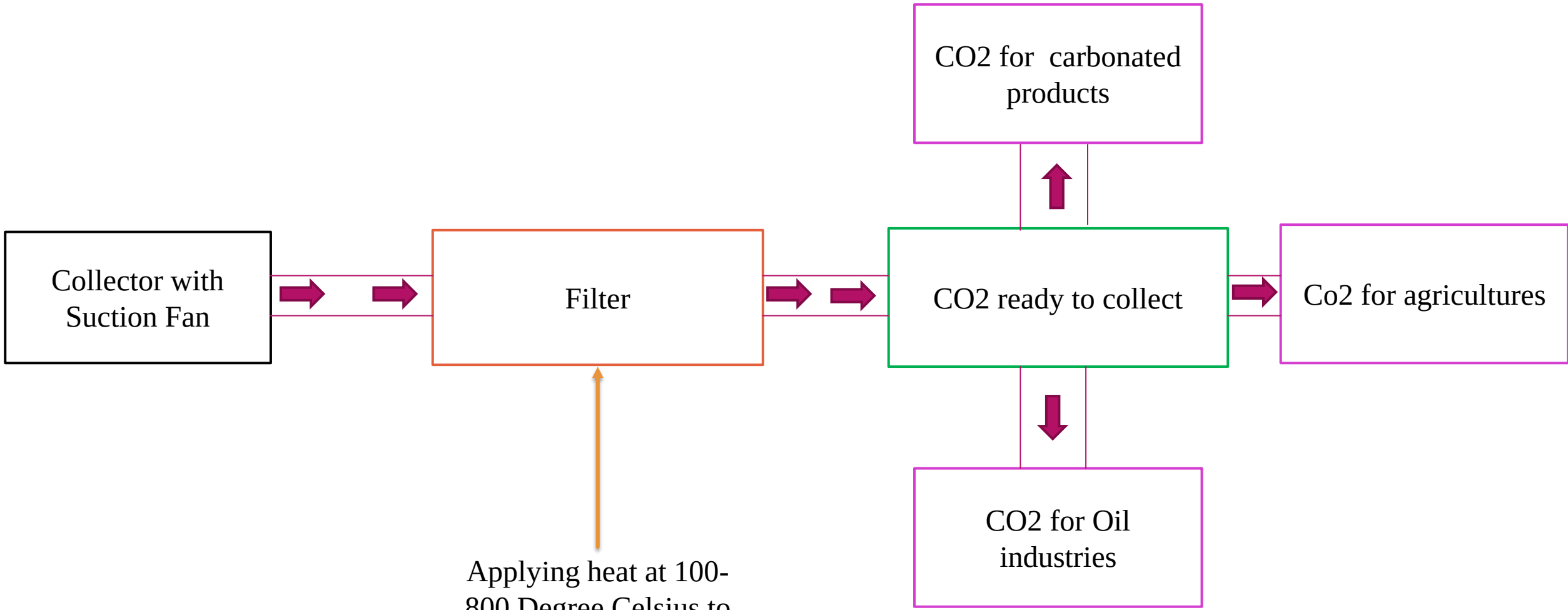
Up to 4'000 tons of CO_2 per year

Location

Hellisheidi, Iceland

Orca: The first large-scale plant by climeworks

BLOCK DIAGRAM



LITERATURE REVIEW

- Numerous studies have been conducted on DAC, covering various aspects of the technology, including its feasibility, cost-effectiveness, and scalability.
- One study by Wurzbacher (2019) :-
    1. Wurzbacher evaluated the potential of DAC technology for mitigating climate change, concluding that it could help achieve the targets of the Paris Agreement if deployed at large scale.
    2. The study also identified key challenges, such as high energy requirements and the need for significant infrastructure investment.
    3. Current markets will likely to allow DAC companies to grow to considerable size

A review by Lackner and Granger (2016):-

1. He summarized the current state of DAC technology and identified key challenges, including energy requirements, cost, and scalability.

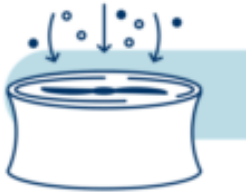
2. The review also highlighted ongoing research and development efforts aimed at improving the efficiency and cost-effectiveness of DAC.

3. Many small process changes in DAC processes will incrementally improve performance of the DAC

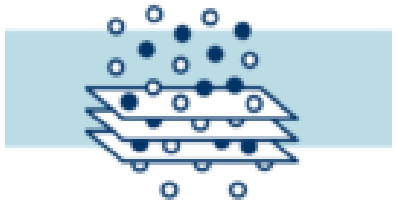
METHODOLOGY

DAC typically involves several steps such as:-

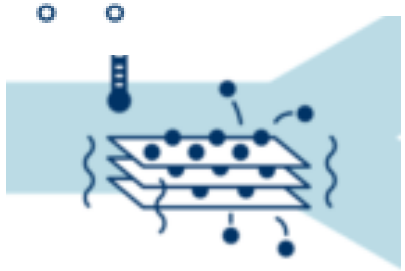
- AIR FILTRATION



- ABSORPTION OF CO2



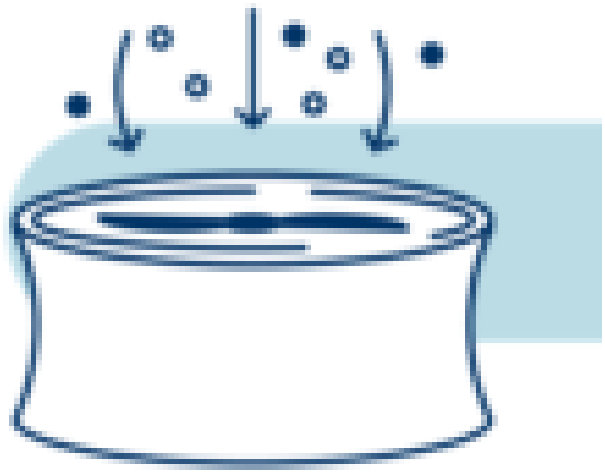
- SEPERATION OF THE CO2



- STORAGE OR UTILISATION OF CO2

AIR FILTRATION

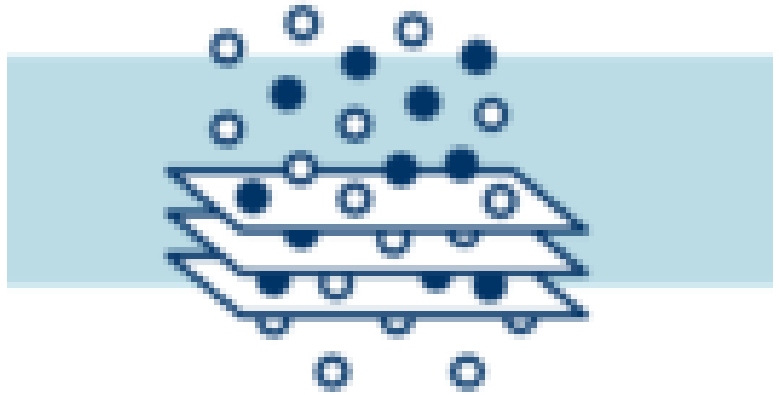
- The first step in the DAC process is to filter the air to remove particles and other contaminants. This is typically done using specialized filters or membranes that can remove small particles and dust from the air.



Air is intake by the suction fans

ABSORPTION OF CO2

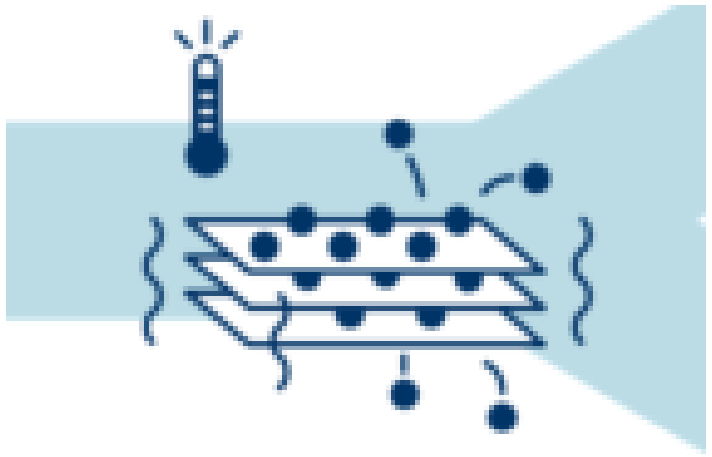
- After the air is filtered, the CO2 is captured using absorption techniques. Absorption involves using a liquid solvent, such as amine or water, to capture CO2 from the Collector sheets.



CO2 is captured in Honeycomb PVC Fills

SEPERATION OF THE CO2

- Once the CO2 is captured the filter is processed to release the CO2. This is typically done by applying heat to the captured solution, which releases the CO2 and can be reused again.



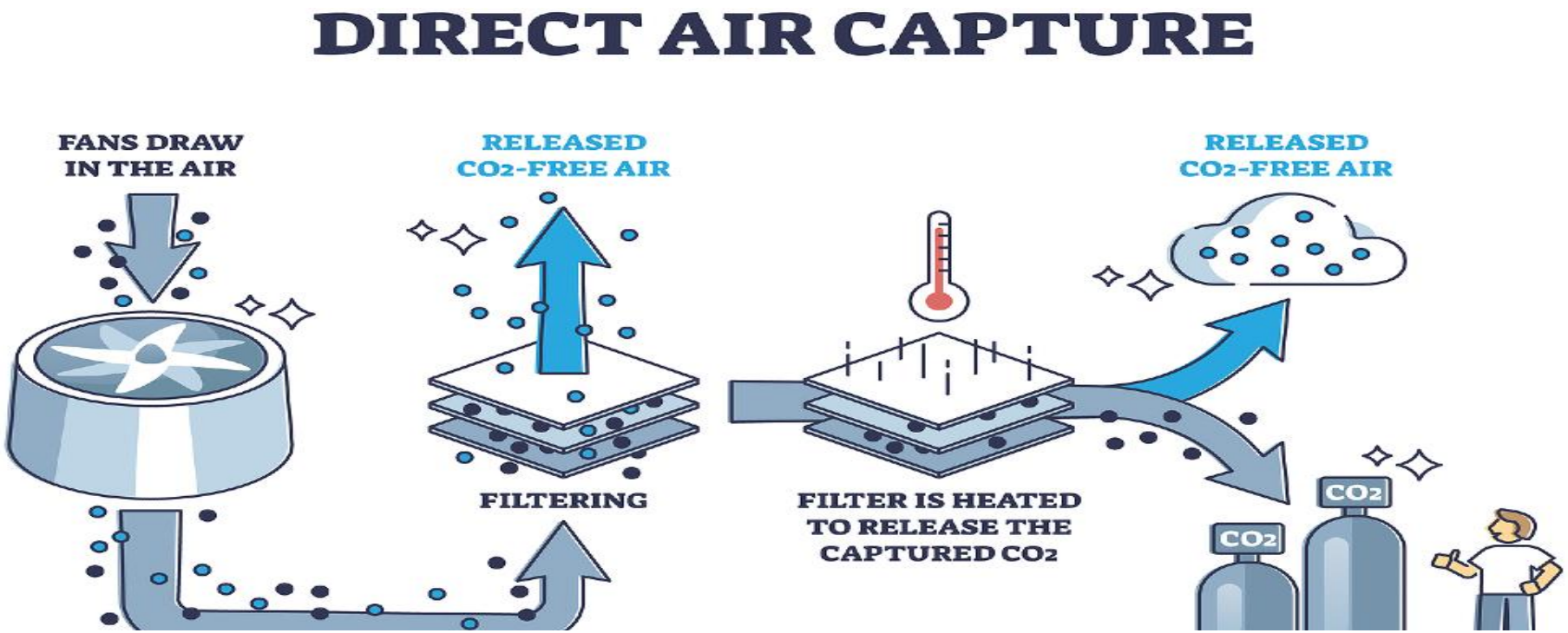
Separation of CO2

STORAGE OR UTILISATION OF CO2

- After the CO2 is captured, it can be either stored or used in various applications. CO2 can be stored underground in geological formations, such as depleted oil and gas reservoirs or saline aquifers, or it can be used for enhanced oil recovery or in industrial processes, such as the production of synthetic fuels.

Storing of captured CO2

Working Principle



Working process of project

CHEMICAL REACTION TAKING PLACE

REACTION OF POTASSIUM HYDROXIDE AND CARBON DIOXIDE

$$CO_2(g) + 2KOH\ (aq) \longrightarrow K_2CO_3\ (aq) + H_2O\ (l)$$

REACTION OF POTASSIUM CARBONATE AND CALCIUM HYDROXIDE

$$Ca(OH)2 + K2CO3 \rightarrow CaCO3 + 2KOH$$

OBJECTIVE

- The primary objective of Direct Air Capture (DAC) technology is to capture carbon dioxide (CO2) directly from the atmosphere and utilize it.

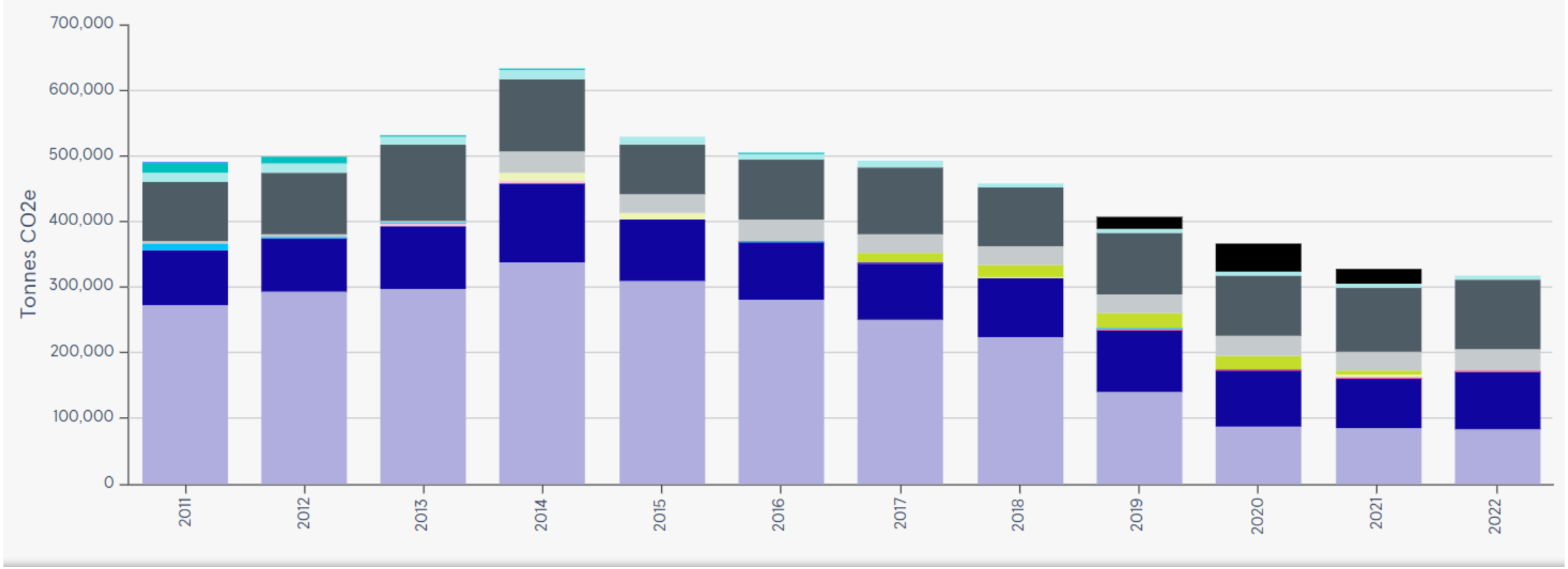
- The technology is a form of carbon capture, utilization, and storage (CCUS), which aims to reduce greenhouse gas emissions and mitigate climate change.

- Additionally, DAC can be used to remove CO2 that has already been emitted into the atmosphere, thus helping to reduce atmospheric CO2 concentrations.

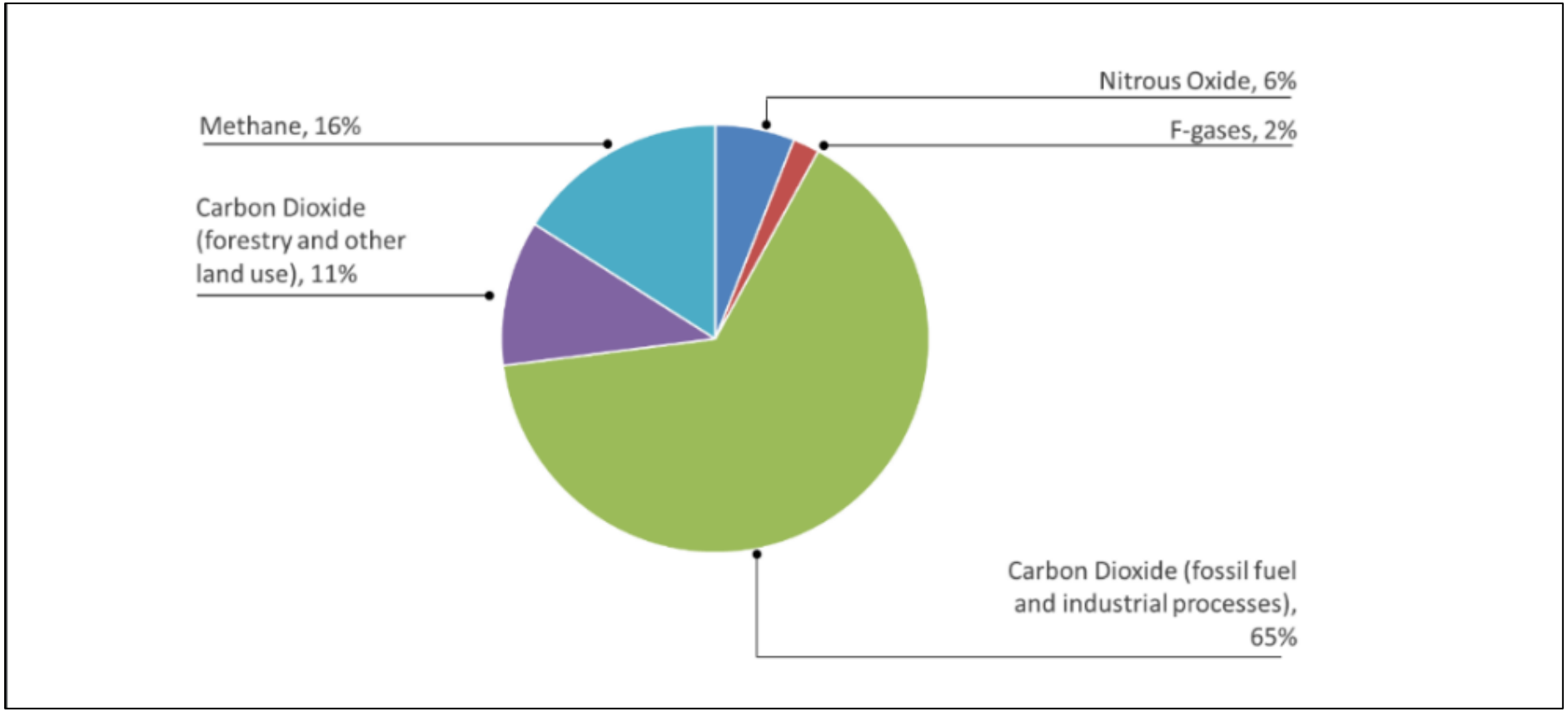
SCOPE

- Addressing hard-to-decarbonize sectors: DAC technology could be used to capture CO2 emissions from hard-to-decarbonize sectors.
- Carbon removal: DAC technology has the potential to remove CO2 that has already been emitted into the atmosphere, which could help to reduce atmospheric concentrations of greenhouse gases and limit the impacts of global warming.
- Economic opportunities: The development and deployment of DAC technology could create new economic opportunities in various sectors.
- We are designing a prototype of direct air capture technology which is very major project in scale and cost, hence our main aim is to design a project which has small scale, low cost and also reliable.

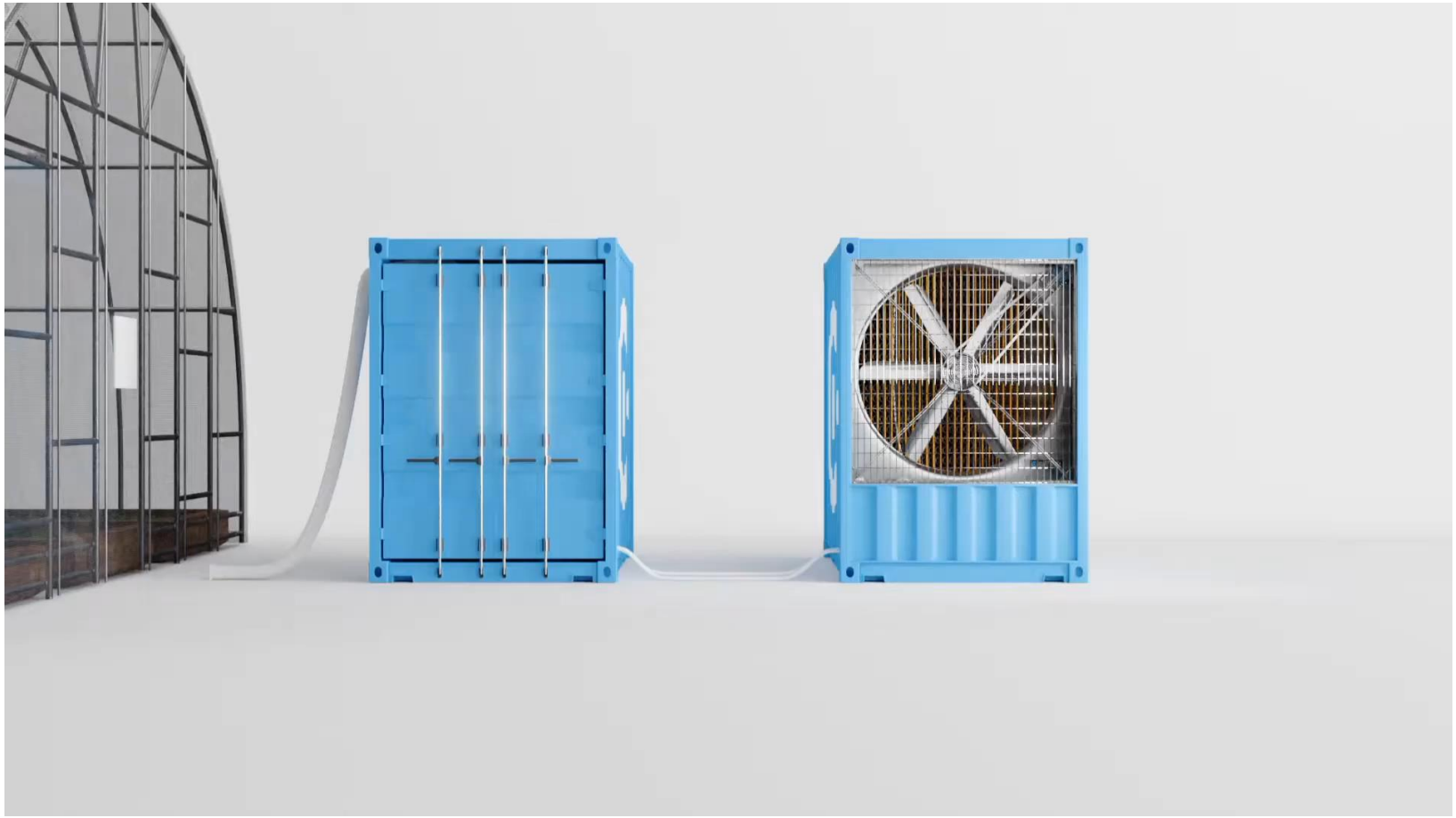
CARBON EMISSION BY INDUSTRIES



MAJOR GASES RELEASED BY INDIAN SUGAR INDUSTRIES



WORKING SIMULATION

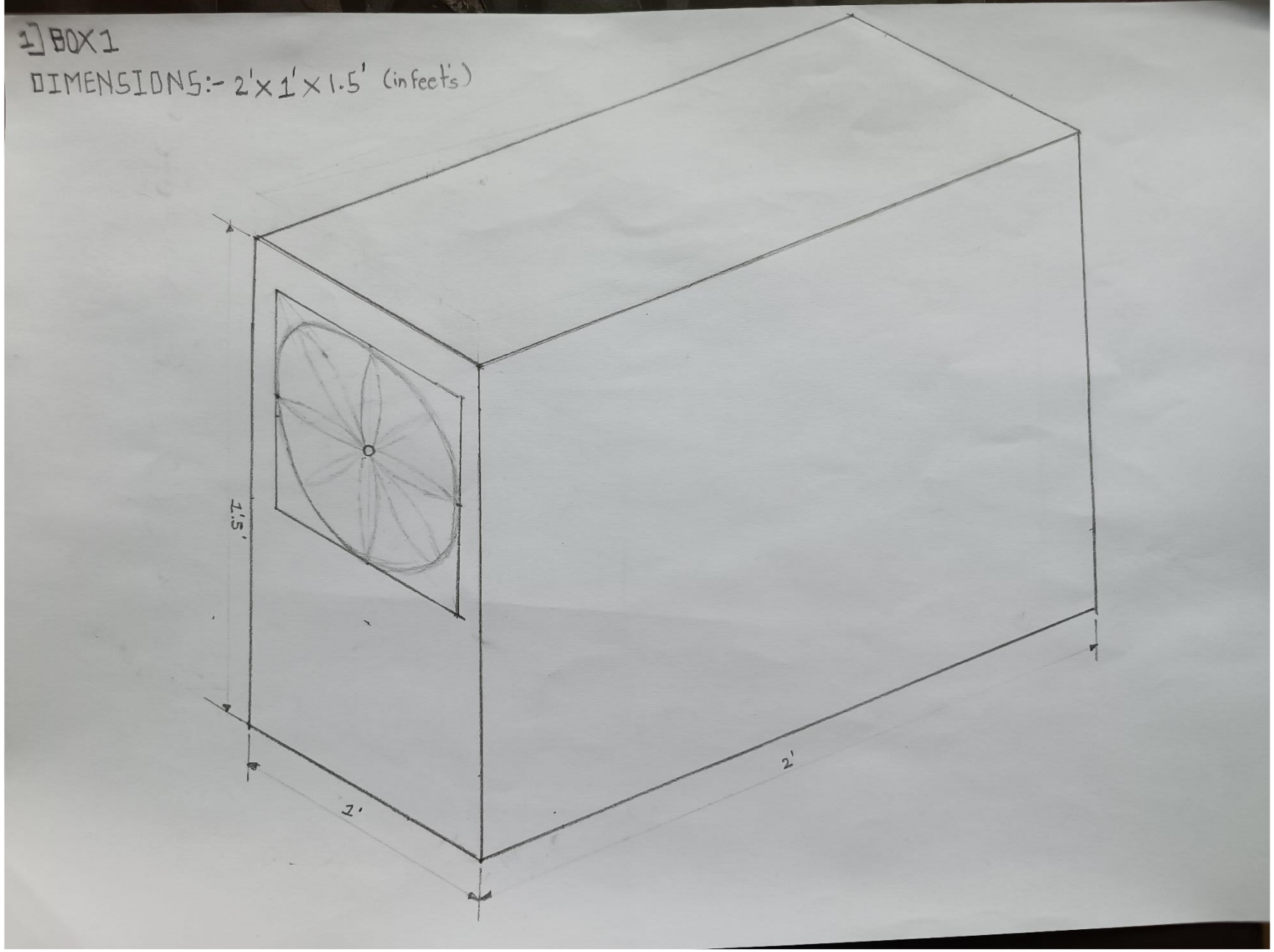


WORK COMPLITION TILL DATE

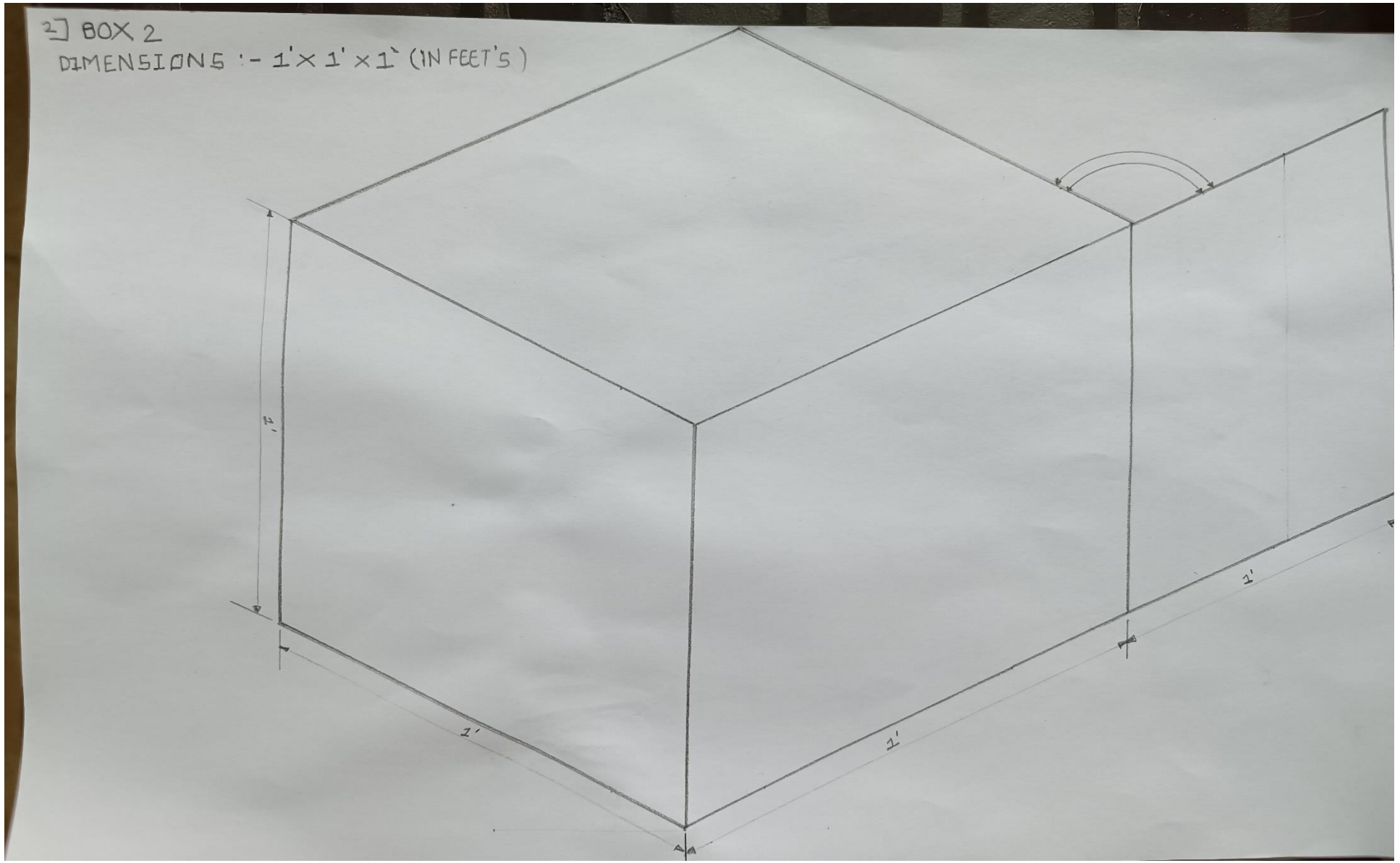
- With the help of our guide and the gathered information we were able to identify the most suitable components required to complete the project. Here we are willing to build a small scale direct air capture which is able to collect the carbon dioxide direct from the air.

SUCTION FAN

Apparatus	Rating	RPM	Cost in Rs
Suction fan	70 watts	1350	1200 Rs



Schematic Diagram of Box 1



Schematic Diagram of Box 2

ENCLOSED HARDWARE

Apparatus	Dimensions of component	Capacity in Ltrs.	Cost in Rs
Box 1	2’ * 1.5’ * 1’	84.95 Ltrs	2200 Rs
Box 2	1’ * 1’ * 1’	28.31 Ltrs	1800 Rs

FILTER :-

The filter used ere is made from the PVC(Polyvinylchloride) material, and can be available in various materials. The filter is main apparatus of project which works as absorber which olds the carbon dioxide CO2 which further mixed with Koh (Potassium Hydroxide) aqueous solution

Apparatus	Dimensions	Cost in Rs
Filter	2’ * 1’ * 1’	400 Rs

HEATING COIL:-

The heating coil is one of the key apparatus used for the heating process, where the solution formed K_2CO_3 can be heated up-to 650 degree Celsius to separate CO_2. The coil can Atten the temperature of 800 degree Celsius and above

HEATING COIL

Apparatus	Rating	Max Temperature	Cost
Heating Coil	2200 watts	800 Degree Celsius	900 Rs

CHALLENGES FACED

- There are various challenges we have faced during the project. But the most difficult part was to find a material which can hold the co2 in place for some time which then can be reacted with solution of koh and after researching for materials we came across the PVC fills which used as filter in our project.

- Another big challenge which we faced was whether to make a single infrastructure for the project or to separate the processes in two parts, hence as conclusion we decided to go for 2 boxes which carries out separate processes .

RISK FACTORS

There are several risk factors which should be properly considered

1. The solutions used in the project are very basic in nature hence proper safety should be followed while handling the project.
2. The prototype is made from steel hence it is surely corrode by time hence the proper maintenance is required.
3. The 2nd part of project works as heater and the temperature of that box can be high if the box is not properly insulated hence this should be also keep in mind when working or maintenance of project

CONCLUSION

- Direct Air Capture (DAC) technology has the potential to play a significant role in mitigating the effects of climate change by capturing carbon dioxide directly from the atmosphere. However, there are several challenges that need to be addressed to make the technology feasible and effective.
- On the technical side, improving the efficiency of the adsorbent material, developing more cost-effective and reliable thermal management systems, and improving carbon dioxide collection and storage techniques are key areas of research and development.

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1. Keith, D. W., Holmes, G., St. Angelo, D., Heidel, K., & Polak, A. (2018). A process for capturing CO2 from the atmosphere. Joule, 2(8), 1573-1594.

2. Wurzbacher, J. A., Wing, I. S., Johnson, K. E., & Keith, D. W. (2019). Large-scale direct air capture of CO2 using a clustered modular atmospheric processing system. Joule, 3(5), 1145-1164.

3. Lackner, K. S., & Granger, R. (2016). Carbon dioxide extraction from the air: Is it an option? Proceedings of the National Academy of Sciences, 113(21), 5847-5854.

4. These references provide a comprehensive overview of DAC technology, including its feasibility, cost-effectiveness, scalability, and potential applications

THANK YOU