

# Carbon Capture and Storage – Emerging risk or Opportunity?

Understanding CCUS – Lu Meng



# CCUS (Carbon Capture, Utilization, and Storage)

Carbon capture, utilization and storage (CCUS) refers to a cluster of technologies that can play an important and diverse role in meeting global energy and climate goals.

CCUS involves the capture of CO2 from large point sources, or directly from the atmosphere. If not being used on-site, the captured CO2 is compressed and transported by pipeline, ship, rail or truck to be used in a range of applications, or injected into deep geological formations which trap the CO2 for permanent storage.



**Capture**  
Captures CO2 from point sources (power plants, industries, etc.) or directly from air.

**Transportation**  
Transports captured CO2 from the capture location to storage location by pipelines, ships, or trucks.

**Storage**  
Permanently stores CO2 in underground geological formations, onshore or offshore



**Capture**  
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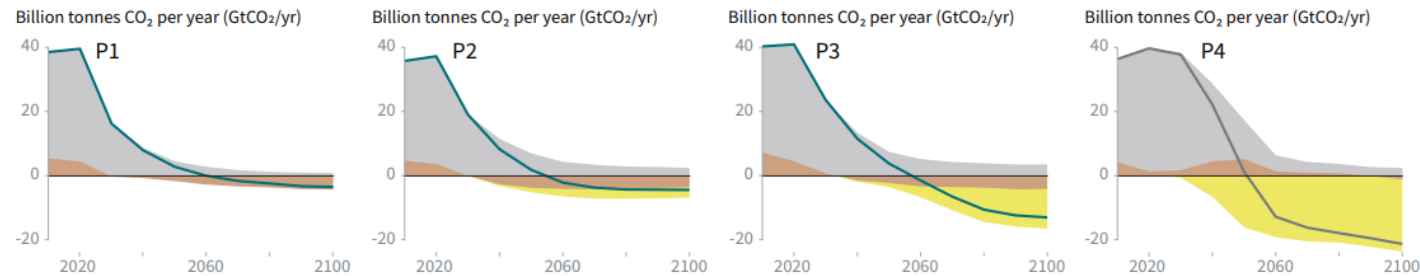
**Transportation**  
Transports captured CO2 from the capture location to utilization location by pipelines, ships, or trucks.

**Utilization**  
Utilizes CO2 as an input or feedstock to create products or services

# Why CCUS is important?

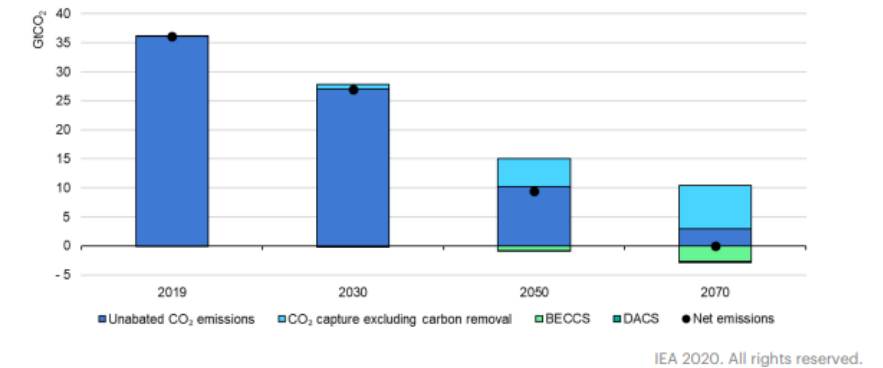
## Breakdown of contributions to global net CO<sub>2</sub> emissions in four illustrative model pathways

● Fossil fuel and industry ● AFOLU ● BECCS



Source: IPCC, <http://www.ipcc.ch/report/sr15/>

Figure 2.4 Global CO<sub>2</sub> emissions and capture across the energy system in the Sustainable Development Scenario, 2019-70



Note: CO<sub>2</sub> emissions include both energy-related and process emissions.

Source: IEA (2020), CCUS in Clean Energy Transitions, IEA, Paris <https://www.iea.org/reports/ccus-in-clean-energy-transitions>

**According to IPCC, it would not be possible to reach net zero without CCUS technologies**

# CCUS use case in net zero transitions



Mitigating emissions from existing energy infrastructure



A solution for hard-to-abate sectors, i.e. cement, steel.



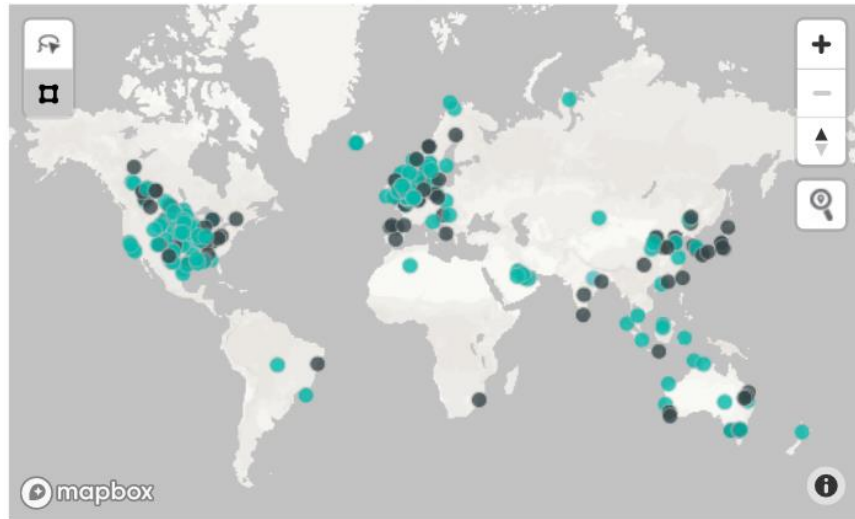
A cost-effective pathway for low-carbon hydrogen production



Removing carbon from the atmosphere - negative emissions

# Global CCS projects - 2022

Facility Category ● Commercial CCS ● Pilot/Demonstration



Source: Global CCS Institute, [Facilities - Global CCS Institute \(co2re.co\)](https://www.co2re.co/facilities)

	Operational	In construction	Advanced development	Early development	Operation suspended	Total
Number of facilities*	30	11	78	75	2	196
CO2 Capture capacity (Mt/year)	42.5	9.6	97.6	91.8	2.3	243.9

\*Including dedicated transport and storage projects

# Global milestones for CCUS capacity in Net Zero Scenario

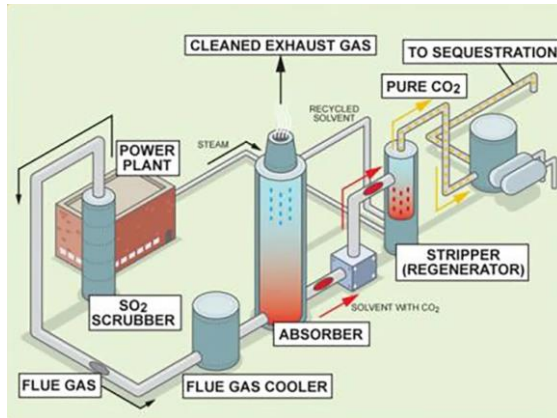
By 2050, 7.6 Gt of CO<sub>2</sub> will be required to be captured per year from a diverse range of sources.

Around 95% of total CO<sub>2</sub> captured in 2050 will be stored in permanent geological storage and 5% will be used to provide synthetic fuels. Estimates of global geological storage capacity are considerably above what is necessary to store the cumulative CO<sub>2</sub> captured and stored in the Net Zero Scenarios

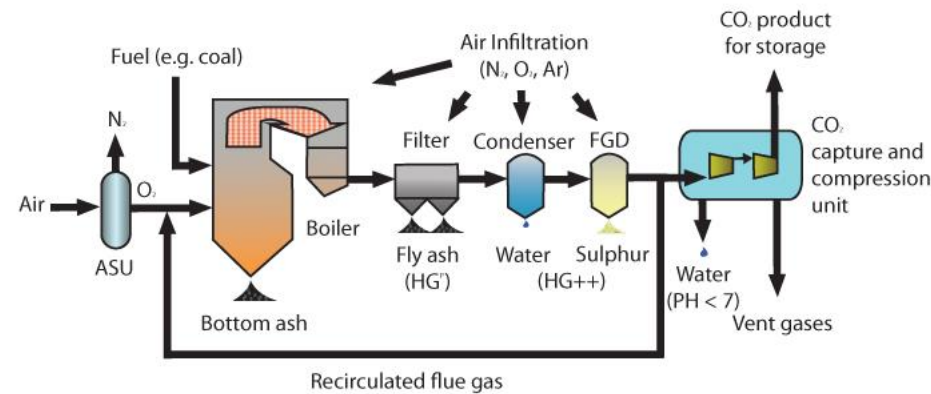
	2020	2030	2050
<b>Total CO<sub>2</sub> captured (Mt/year)</b>	<b>40</b>	<b>1670</b>	<b>7600</b>
<b>CO<sub>2</sub> captured from fossil fuels and processes</b>	<b>39</b>	<b>1325</b>	<b>5245</b>
Power	3	340	860
Industry	3	360	2620
Merchant hydrogen production	3	455	1355
No-biofuels production	30	170	410
<b>CO<sub>2</sub> captured from bioenergy</b>	<b>1</b>	<b>255</b>	<b>1380</b>
Power	0	90	570
Industry	0	15	180
Biofuels production	1	150	625
<b>Direct air capture</b>	<b>0</b>	<b>90</b>	<b>985</b>

Source: IEA (2021), Net Zero by 2050, IEA, Paris, <https://www.iea.org/reports/net-zero-by-2050>

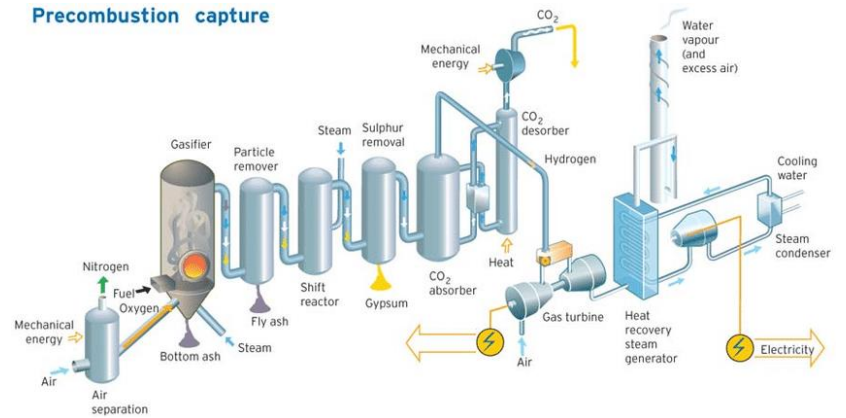
# CO2 capture technologies



Source: UKCCS, [UKCCSRC - Carbon Capture & Storage \(CCS\)](https://www.ukccs.gov.uk/) Carbon capture – UKCCSRC



Source: Natural Resources Canada, <https://www.nrcan.gc.ca/energy/coal/carbon-capture-storage/4307>



Source: Revcoo, <https://revcoo.fr/la-capture-du-co2-une-methode-indispensable-pour-contrer-le-rechauffement-climatique/>

## Post-combustion

- CO2 is separated from flue gas after burning the fuel
- Widely used in multiple sectors
- Mature experience (decades)
- Easy retrofitting

## Oxy-fuel combustion

- The fuel is burnt in oxygen, making flue gas purely CO2 and H2O
- High purity of CO2 output and less NOx emission
- Prototype/demonstration stage
- Less applicable for retrofitting

## Pre-combustion

- CO2 is separated from the fuel before combustion
- Typically used in IGCC and gas reforming plants
- Long application history in gas reforming
- Hydrogen production (water-gas shift)
- High cost and long start-up time

# CO2 transportation



## Pipelines

long distance  
large quantity  
wide implementation



## Shipping

long distance  
large quantity  
flexibility



## Mix

"hub" + destination



# CO2 geological storage

## Rationale:

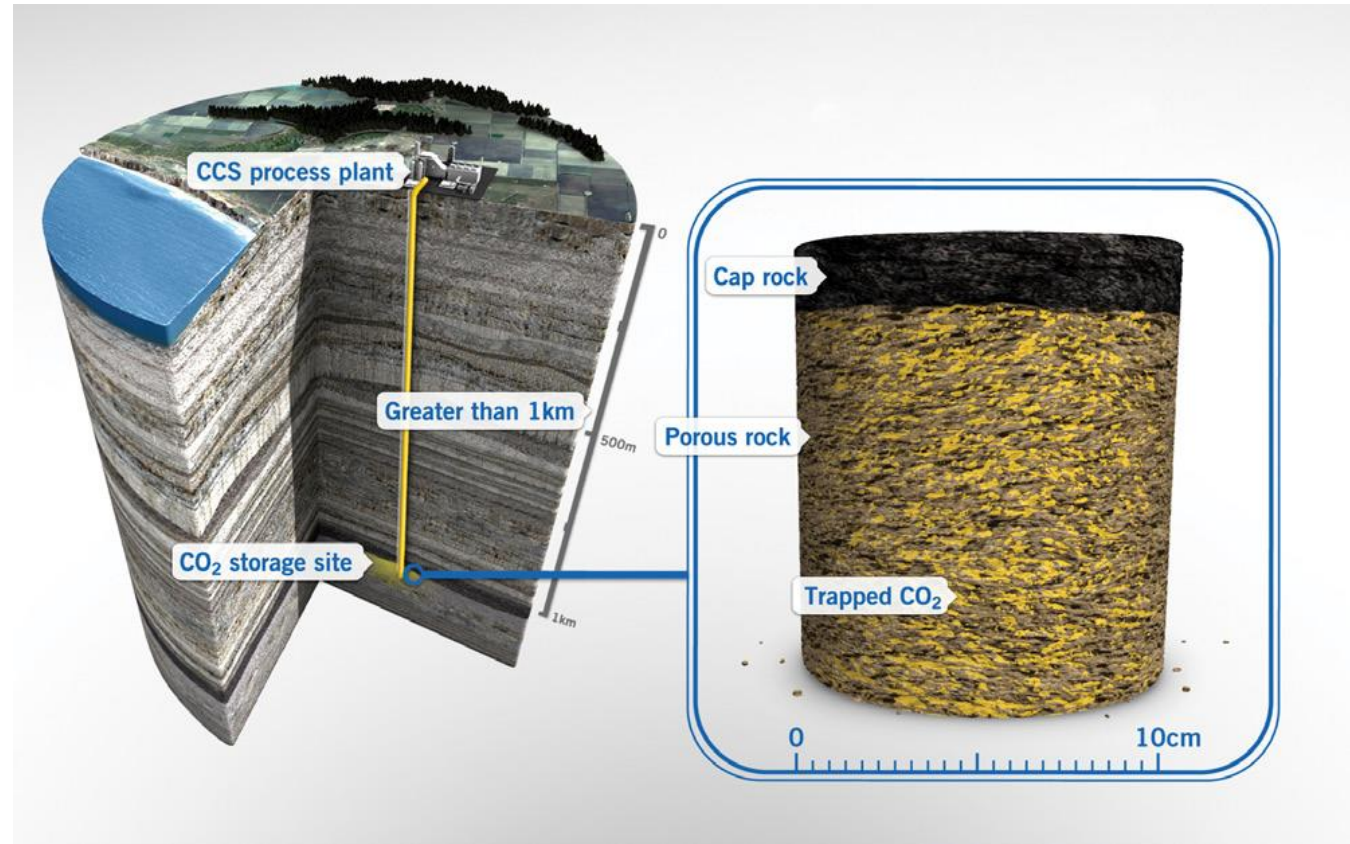
- Putting CO2 underground is better than putting the same amount of CO2 in the atmosphere
- CO2 is trapped in microscopic rock pores by the same process that has trapped natural gas for millions of years
- Decades of experience in oil&gas drilling as well as geological storage projects

## Challenges and concerns:

- Induced seismicity during drilling and operational phase
- CO2 leakage from storage sites
- Technical and human failures

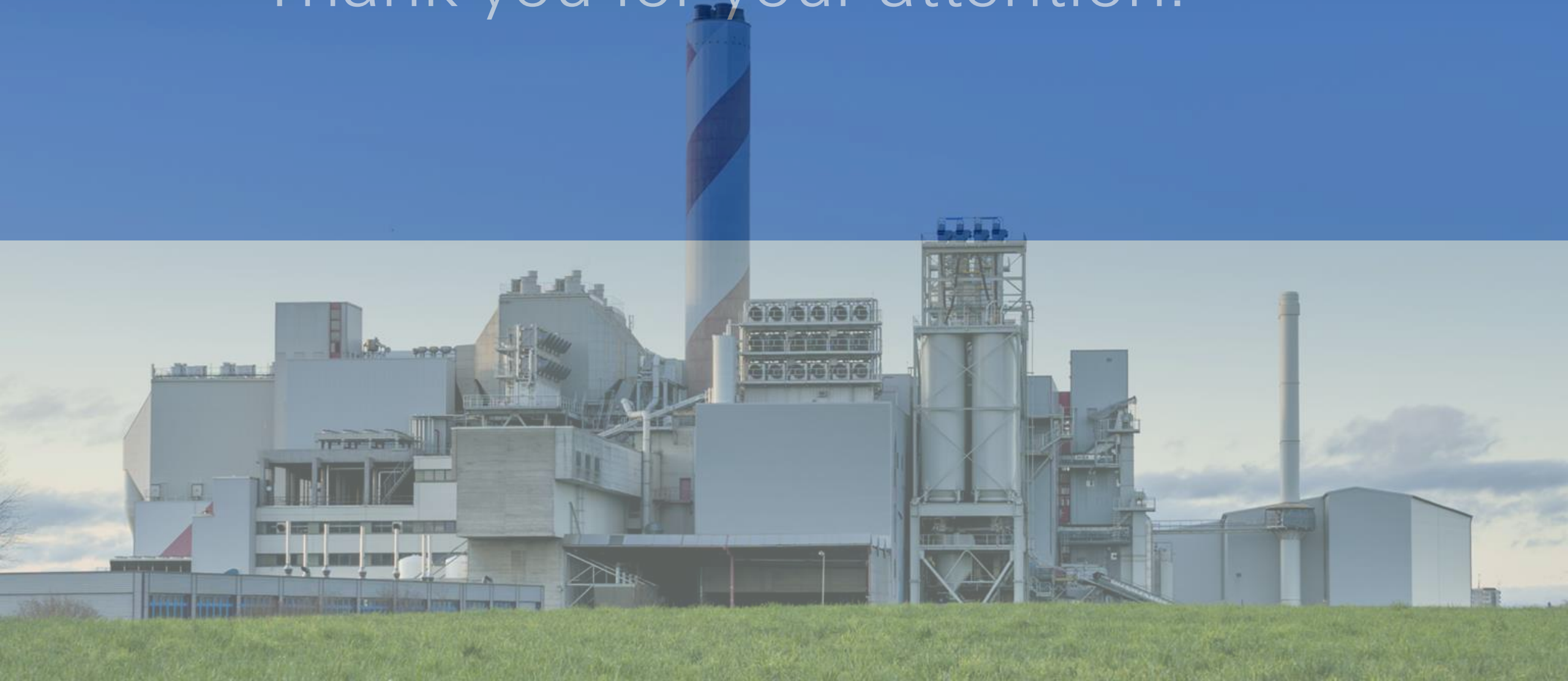
## Risk management:

- Regulations (i.e., EU storage directive)
- Detection, inspection, monitoring, remediation



Source: Global CCS Institute, Fact sheet: Geological storage of CO2: safe, permanent, and abundant

Thank you for your attention!





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