

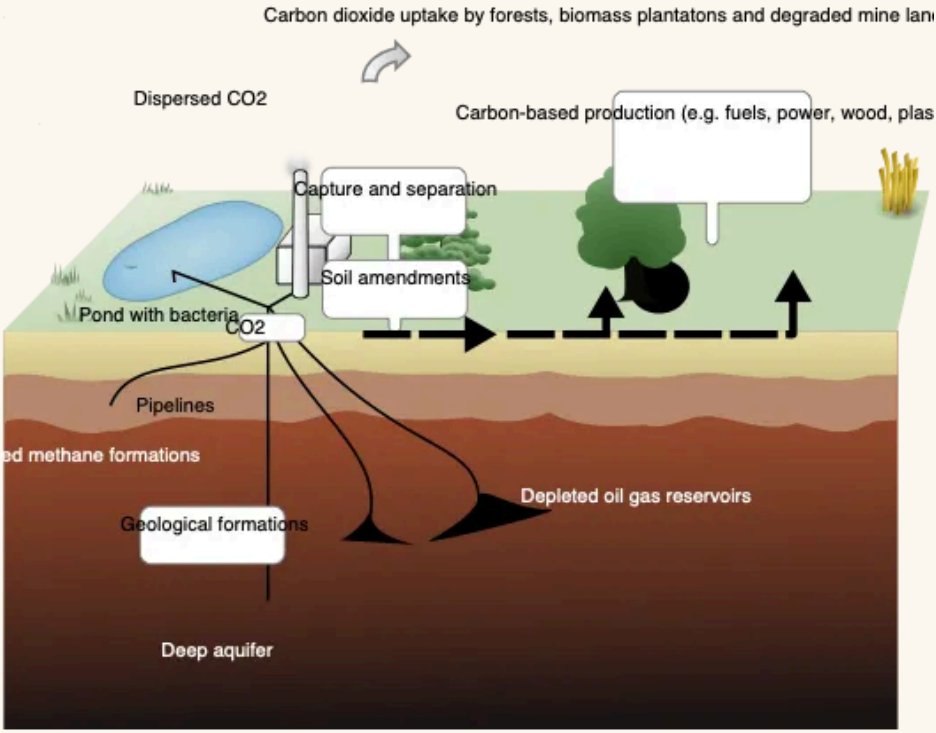
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Carbon Sequestration Sites

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Carbon Sequestration Sites

Carbon sequestration means keeping carbon out of the air in a lasting store. **This lesson focuses on geological sites. A site is not automatically safe. Its rock, wells, water and monitoring must be checked.**



Terrestrial and geological carbon sequestration routes for CO2 from a coal-fired power plant. Original by LeJean Hardin and Jamie Payne, SVG version by Jarl Arntzen, CC BY-SA 3.0, via Wikimedia Commons.

At a Glance

Four facts to hold on to.

01
Three sites

Coal seams, oil and gas reservoirs, saline formations.

02
Largest capacity

Deep saline formations.

03
Needs

Porous reservoir rock plus a sealing cap rock.

04
Limit

CCS is not yet at scale.

SequestrationMoving carbon into a store and keeping it there for a meaningful time.
CCSCarbon capture and storage.
Cap rock An impermeable layer above a storage reservoir.
Supercritical CO2A dense, liquid-like state used for injection.

Three Recognised Carbon Sequestration Sites

Must Know

Coal seams, oil and gas reservoirs, saline formations

- **Coal seams:** abandoned, uneconomic seams can store injected CO2. Coal surfaces naturally adsorb the gas.
- **Depleted oil and gas reservoirs:** strong candidates. Their rock trapped hydrocarbons for millions of years.
- **Deep saline formations:** porous rock filled with salty water. They offer the **largest total capacity**.
- All three are genuine sites. None is a distractor.

Capture, storage and sequestration

- **Capture:** separate CO2 from a plant's exhaust or from air.
- **Storage:** keep that CO2 in a chosen place, such as deep rock.
- **Sequestration:** move carbon into a store and keep it for a meaningful time.
- CCS joins capture, transport and geological storage.
- CCUS also includes uses for captured CO2.
- Storing fossil CO2 from a cement plant prevents a release. It is not automatically removal of CO2 already in the air.
- Forests and soils are natural sinks, not injection sites.
- Sources: IEA CCUS overview and IPCC land chapter.

Natural sinks versus engineered stores

Store	How it works	Main caution
Forests and soils	Plants absorb CO2. Some carbon moves into wood and soil.	Fire, clearing and decay can release it.

Store	How it works	Main caution
Wetlands and coastal mud	Wet soils can bury organic carbon.	Drainage and land conversion disturb the store.
Ocean	Water absorbs CO2. Ocean life moves some carbon deeper.	Uptake changes seawater chemistry.
Deep rock	Wells inject captured CO2 into rock pores.	Site, wells, pressure and monitoring matter.
Minerals	CO2 reacts with suitable rock to form carbonate.	Depends on rock and process.

- These pathways have different timescales.
- Geological storage needs evidence that injected CO2 stays contained.
- Source: IPCC carbon-cycle assessment.

> **Quick check 1.** Coal seams, depleted oil and gas reservoirs, and deep saline formations are all genuine carbon sequestration sites. *(True or False?)* See answer ↓

How the Storage Actually Works

Good to Know

Supercritical injection, and a sealing cap rock

- CO2 is compressed into a dense, liquid-like **supercritical** state before injection.
- A safe site needs a porous reservoir rock to hold the CO2.
- It also needs an impermeable **cap rock** on top to stop the gas rising.

One cement plant to the rock

- This is a teaching example, not a named Indian plant.

1. **Capture.** Equipment separates some CO2 from the exhaust. The plant still measures what it releases.
2. **Prepare.** The CO2 is dried and compressed.
3. **Transport.** A pipeline or other system takes it to the site.
4. **Choose a site.** Scientists study porous rock, the seal, faults, old wells and nearby water.
5. **Inject.** A well sends CO2 deep. Operators control pressure and track the plume.
6. **Monitor.** Tests check the well and underground movement. Checks continue after injection stops.

- Count capture energy, transport, leakage and remaining plant emissions.
- Capture alone does not prove a net climate benefit.
- Sources: IEA on how CCUS works and IPCC on geological storage.

Saline formations dominate capacity

- Deep saline aquifers underlie huge areas.
- Most commercial-scale storage is expected there, not in coal seams.
- A saline aquifer holds salty water, not drinking water.

What makes each site different?

- **Deep saline aquifer:** large potential. The seal, pressure and water movement need study.
- **Depleted oil or gas field:** existing records help. Old wells may be leakage paths.

- **Unmineable coal seam:** CO2 sticks to coal surfaces. Capacity depends on the seam.
- **Basalt:** CO2 may react with minerals and become solid carbonate. It needs the right rock and water.
- Dissolving in salty water and forming minerals add other traps over time.
- Sources: IPCC geological storage and US NETL storage FAQ.
- Compare basalt, ocean alkalinity and mine injection.

> **Quick check 2.** A safe carbon storage site needs only a porous reservoir rock, without any need for a sealing cap rock on top. *(True or False?)* See answer ↓

Exam Edge

Previous Year Questions

UPSC 2017 asked about storage sites.

> **Quick check 3.** Coal seams store CO2 mainly by adsorbing it onto the coal surface, not by filling open pore space. *(True or False?)*
>
> See answer ↓

Why This Matters for Climate Policy

Great to Know

Part of CCS, and not yet at scale

- These sites are the storage step of Carbon Capture and Storage.
- CCS aims to cut emissions from coal and gas plants.
- Few commercial CO2 projects in coal beds exist today.
- Coal seams hold less capacity than oil, gas or saline sites.

When is a climate claim credible?

- **Permanence:** will the carbon stay stored for the claimed time?
- **Additionality:** would the storage have happened anyway?
- **Leakage:** does carbon escape, or does the project push emissions elsewhere?
- **MRV:** measure, report and let others verify.
- Forest carbon can be lost through fire or clearing. Soil gains may slow, called saturation.
- Underground projects must watch pressure, wells and the CO2 plume.
- Energy used for capture also changes the net result.

- Sources: IPCC land report and IPCC geological storage.

India: potential is not proven storage

- India’s Department of Science and Technology (DST) reported a 2022–23 study of possible stores.
- It looked at saline aquifers, basalt, coal beds and oil-recovery routes.
- It described a planned pilot linked to the Gandhar field in Gujarat. A planned pilot is not proof of commercial storage.
- DST launched a CCUS research roadmap in December 2025, including cement and steel.
- India also has natural stores in forests, soils and coastal wetlands.
- Sources: DST annual report 2022–23 and DST roadmap announcement.

Exam traps

- Capture is the separation step. Storage is the place that keeps CO2.
- Fossil-source CCS avoids emissions. It does not remove old CO2 from air.
- A saline aquifer is not an underground lake of usable water.
- Any site needs testing. A rock type alone proves little.
- Carbon use is not always long-term storage.
- See also stratospheric aerosol injection in the wider climate toolkit.

Think it through: why do saline formations dominate capacity when coal seams and depleted reservoirs also work?

All three pass the basic test: porous rock under a cap rock. But capacity scales with area. Saline aquifers underlie far more land than coal seams or old oil and gas fields. Coal seams also rely on slower adsorption. So saline formations carry most commercial-scale storage.

Quick check 4. Geological carbon sequestration is the storage step of Carbon Capture and Storage technology. *(True or False?)*

See answer ↓

Quick check 5. Coal seams currently hold most of the world's commercial-scale CO2 storage, ahead of saline formations. *(True or False?)* See answer ↓

Quick Q&A

Which three sites count?

Coal seams, oil and gas reservoirs, saline formations.

Which has most capacity?

Deep saline formations.

What stops leakage upward?

An impermeable cap rock.

What state is CO2 injected in?

Supercritical.

Is capture the same as storage?

No.

Practice: Carbon Sequestration Sites

5 verified questions from this topic.

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Practice MCQs

1. In what physical state is CO2 typically injected underground for storage?

A. Gaseous

B. Supercritical fluid

C. Solid dry ice

D. Plasma

See answer ↓

2. The IPCC gives a range for biochar removal or avoided emissions at costs below 100 US dollars a tonne of CO2. What is the upper end of that range each year, in CO2-equivalent?

A. 1.8 billion tonnes of CO2-equivalent

B. 6.6 billion tonnes of CO2-equivalent

C. 20 billion tonnes of CO2-equivalent

D. 0.1 billion tonnes of CO2-equivalent

See answer ↓

3. What is Terra Preta?

A. A fertiliser made from nitrogen gas

B. A rock layer that stores CO2 underground

C. A pesticide made from neem oil

D. A dark, charcoal-rich soil made by Amazonian communities long ago

See answer ↓

4. Why is converting crop stubble to biochar better for the climate than burning it in the open?

A. Burning in the open locks away more carbon

B. Open burning adds oxygen to the soil

C. Biochar making creates no gas at all

D. Pyrolysis keeps about half of the carbon as a stable solid, per the European Biochar Certificate

See answer ↓

5. What does the IPCC say about biochar's effects on soil?

A. They vary with the feedstock, production conditions and soil

B. They appear only in tropical soils

C. They never include any yield gain

D. They are the same for every feedstock and soil

See answer ↓

6. What must sit above a CO2 storage reservoir to prevent the gas escaping upward?

A. A salt dome only

B. An impermeable cap rock

C. An active fault line

D. A coal seam

See answer ↓

7. Which type of geological formation offers the largest total CO2 storage capacity?

A. Depleted oil and gas reservoirs

B. Coal seams

C. River deltas

D. Deep saline formations

See answer ↓

8. Why do coal seams see fewer commercial CO2 storage projects than oil and gas reservoirs?

A. Coal seams hold less storage capacity

B. Coal seams cannot adsorb CO2 at all

C. Coal seams are too deep to reach

D. No coal seams exist near power plants

See answer ↓

9. Which of the following is NOT a recognized carbon sequestration site?

A. Ozone layer

B. Deep saline formations

C. Abandoned coal seams

D. Depleted oil and gas reservoirs

See answer ↓

Answer Key

1. **B.** Below about 800 metres, pressure and heat make CO2 a supercritical fluid. It is dense like a liquid and flows like a gas. Much more CO2 fits in rock pores in this state. ↑ Q1
2. **A.** The IPCC range at costs below 100 US dollars a tonne is 0.3 to 1.8 billion tonnes of CO2-equivalent a year. The wider technical range for 2050 is 0.2 to 6.6 billion tonnes. ↑ Q2
3. **D.** Terra Preta means dark earth. Amazonian communities added charcoal and waste to poor soil. These soils still hold far more black carbon than the soils around them. ↑ Q3
4. **D.** Open burning sends the stubble's carbon back to the air as CO2. Pyrolysis keeps about half of the carbon as stable biochar, per the European Biochar Certificate. The rest leaves as gas. ↑ Q4
5. **A.** The IPCC says effects vary with the biochar and the soil. Gains are most likely in sandy and acidic soils with low nutrient-holding power. ↑ Q5
6. **B.** A safe storage site needs a porous reservoir rock to hold the CO2, sealed by an impermeable cap rock on top. ↑ Q6
7. **D.** Deep saline aquifers underlie huge areas, giving them by far the largest total CO2 storage capacity of the three site types. ↑ Q7
8. **A.** Unmineable coal seams can adsorb CO2, but they hold less capacity than oil, gas, or saline sites, limiting commercial-scale projects. ↑ Q8
9. **A.** The ozone layer is not a carbon sequestration site. Coal seams, oil and gas reservoirs, and saline formations are the three recognized sites. ↑ Q9

Quick-check answers

1. **True.** ↑ 1
2. **False.** ↑ 2
3. **True.** ↑ 3
4. **True.** ↑ 4
5. **False.** ↑ 5

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