Carbon Capture Has A Ways To Go

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Carbon capture and storage (CCS) has entered mainstream thinking, although the technologies have not yet been tested and established on any useful scale:

--Proposals include pumping carbon dioxide (CO_2) into a suitable geological reservoir--for example, depleted oil and gas reservoirs--or into the deep ocean or reactive rock formations.

--Alternatively, CO_2 could be reacted with crushed rock on the surface to be sequestered as carbonate minerals or injected into coal beds or methane-hydrate-bearing marine sediments below the sea floor, where it displaces methane (which can subsequently be captured and used for power production).

Underground storage. Storage underground in depleted oil and gas reservoirs or saline aquifiers is best understood. However, this approach still raises questions:

--Cost. Recent estimates suggest that separating and compressing CO_2 at the power plant would cost $25 to $150 per ton of CO_2 emission avoided. Transport and geological storage would add under $20 per ton. Full carbon dioxide sequestration for U.S. electricity production would increase costs between 50% and 100%.

--Safety. To mitigate climate impacts effectively, carbon would need to remain in storage for about 10,000 years. If CO_2 is injected with too high an overpressure it might fracture previously intact cap rock. A leak in a reservoir need not be disastrous; an old well could be re-drilled and sealed. The economics of recovery operations would depend on the carbon price, but relative to the economics of carbon capture, remediation of a limited number of failures would be affordable.

Injection of CO_2 with the objective of storage now is taking place at several sites. Oil companies already have considerable experience of injecting CO_2 into reservoirs--a technique they have been using to enhance oil recovery for more than 40 years. Coupled with geological evidence that CO_2 may remain trapped for millions of years, this demonstrates that geological storage can work.

Ocean storage. CO_2 could be stored in the deep ocean, injected at depth and dissolved in ocean waters, or deposited on the sea floor at depths of several kilometers where supercritical CO_2 is denser than water and should remain in place. However, this approach carries risks for the oceanic environment:

--Acidification of sea water in the immediate vicinity is likely to affect marine life.

--Ocean-mixing processes would bring back CO_2 to the surface on timescales associated with ocean circulation--hundreds of years.

If CO_2 were mixed uniformly throughout the whole ocean, impact on ocean acidity would be relatively small compared with the current situation where the increase in atmospheric CO_2 is predicted to decrease the pH of the surface ocean by as much as 0.5 pH units by the year 2100.

Policy. Because cumulative CO_2 emissions are an important consideration for climate change, a mandatory link has been proposed between carbon sequestration and fossil fuel extraction as an effective way of mitigating climate change:

--Costs would be passed on to fossil fuel consumers, but the policy decouples the direct link between consumption and climate policy, and hence could be more effective.

--This could bring about a carbon sequestration industry, which would also need to be responsible for compensating for any leakage from existing reservoirs.

Outlook. CCS can pull out CO_2 of the atmosphere at source for storage or production of useful products. The key is to overcome practical difficulties associated with large scale implementation and storage, and ensure policy is strong enough for this process to become commonplace.