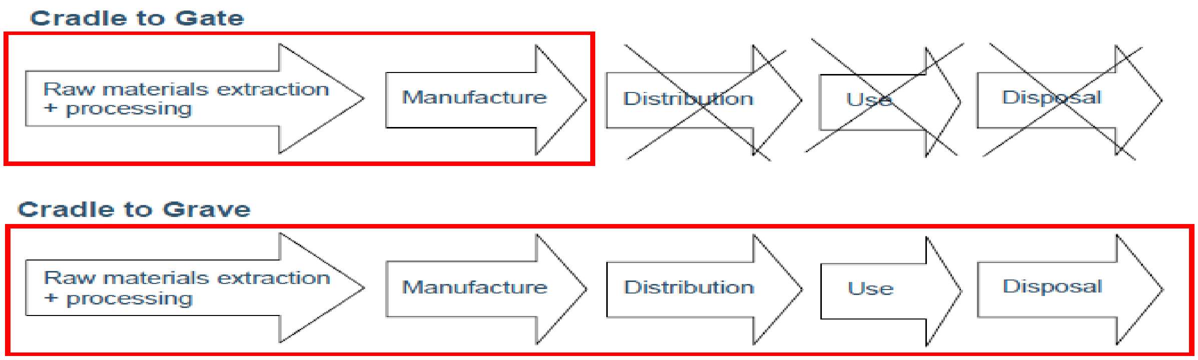


4.3 CARBON CREDIT

INTRODUCTION

Carbon credits are a tradable permit scheme. It is a simple, non-compulsory way to counteract the greenhouse gasses that contribute to climate change and global warming. Carbon credits create a market for reducing greenhouse emissions by giving a monetary value to the cost of polluting the air. The Carbon Credit is this new currency and each carbon credit represents one tonne of carbon dioxide either removed from the atmosphere or saved from being emitted. Carbon credits are also called emission permit. Carbon credit is in the Environment and Pollution Control subject. Carbon credits are certificates awarded to countries that are successful in reducing emissions of greenhouse gases.

GENERATIONOFCARBONCREDITS

Carbon credits are generated as the result of an additional carbon project. Carbon credits can be created in many ways but there are two broad types:

1. Sequestration (capturing or retaining carbon dioxide from the atmosphere) such as afforestation and reforestation activities.
2. Carbon Dioxide Saving Projects such as use of renewable energies

These credits need to be authentic, scientifically based and Verification is essential. Carbon credit trading is an innovative method of controlling emissions using the free market.

NEEDFORCARBONCREDITS

Over millions of years, our planet has managed to regulate concentrations of greenhouse gases through sources (emitters) and sinks (reservoirs). Carbon (in the form of CO_2 and methane) is emitted by volcanoes, by rotting vegetation, by burning of fossil fuels and other organic matter. But CO_2 is absorbed, by trees, forests or by some natural phenomenon like photosynthesis and also oceas to some extent.

TYPES OF CARBON CREDIT

There are two main markets for carbon credits:
A) Compliance Market credits
B) Verified Market credits (VERs)

VALUE OF CARBON CREDITS

Carbon credits create a market for reducing greenhouse gases emissions by giving a monetary value to the cost of polluting the air such as carbon emitted by burning of fossil fuels. This means that carbon becomes a cost of business and is seen like other inputs such as raw materials or labor.

Carbon credits are measured in tonnes of carbon dioxide.
1 credit = 1 tonne of CO2.
Each carbon credit represents one metric ton of C02 either removed from the atmosphere or saved from being emitted. The carbon credit market creates a monetary value for carbon credits and allows the credits to be traded.
For each tonne of carbon dioxide that is saved or sequestered carbon credit producers may sell one carbon credit.

4.4 CARBON SEQUESTRATION or CARBON CAPTURE AND STROAGE or SCRUBBING OF CO_2

Carbon sequestration is the capture of carbon dioxide (CO_2) and may refer specifically to:

- "The process of removing carbon from the atmosphere and depositing it in a reservoir." When carried out deliberately, this may also be referred to as carbon dioxide removal, which is a form of geoengineering.

- The process of carbon capture and storage, where carbon dioxide is removed from flue gases, such as on power stations, before being stored in underground reservoirs.

- Natural biogeochemical cycling of carbon between the atmosphere and reservoirs, such as by chemical weathering of rocks.

Carbon sequestration describes long-term storage of carbon dioxide or other forms of carbon to either mitigate or defer global warming and avoid dangerous climate change. It has been proposed as a way to slow the atmospheric and marine accumulation of greenhouse gases, which are released by burning fossil fuels.

Carbon dioxide is naturally captured from the atmosphere through biological, chemical or physical processes. Some anthropogenic sequestration techniques exploit these natural processes, while some use entirely artificial processes.

Carbon dioxide may be captured as a pure by-product in processes related to petroleum refining or from flue gases from power generation.CO_2 sequestration includes the storage part of carbon capture and storage, which refers to large-scale, permanent artificial capture and sequestration of industrially produced CO_2 using subsurface salineaquifers, reservoirs, ocean water, aging oil fields, or other carbon sinks.

STEPS :

A) **Capturing or Scrubbing**
B) **Transporation**
C) **Sequestration or Storage**

<u>A) CAPTURING or SCRUBBING OF CO_2:</u>

TECHNOLOGIES:

Broadly, three different types of technologies for scrubbing of CO_2 exist:

2. post-combustion,
3. pre-combustion, and
4. oxyfuel combustion
5. Chemical looping

1. **Post-Combustion:** In post combustion capture, the CO_2 is removed after combustion of the fossil fuel — this is the scheme that would be applied to fossil-fuel burning power plants. Here, carbon dioxide is captured from flue gases at power stations or other large point sources. The technology is well understood and is currently used in other industrial applications, although not at the same scale as might be required in a commercial scale power station.

2. **Pre-Combustion** : The technology for pre-combustion is widely applied in fertilizer, chemical, gaseous fuel (H_2, CH_4), and power production. In these cases, the fossil fuel is partially oxidized, for instance in a gasifier. The resulting syngas (CO and H_2O) is shifted into CO_2 and more H_2. The resulting CO_2 can be captured from a relatively pure exhaust stream. The H_2 can now be used as fuel; the carbon dioxide is removed before combustion takes place. There are several advantages and disadvantages when compared to conventional post combustion carbon dioxide capture. The CO_2 is removed after combustion of fossil fuels, but before the flue gas is expanded to atmospheric pressure. This scheme is applied to new fossil fuel burning power plants, or to existing plants where re-powering is an option. The capture before expansion, i.e. from pressurized gas, is standard in almost all industrial CO_2 capture processes, at the same scale as will be required for utility power plants.

3. **Oxy-Fuel Combustion:** In oxy-fuel combustion the fuel is burned in oxygen instead of air. To limit the resulting flame temperatures to levels common during conventional combustion, cooled flue gas is re-circulated and injected into the combustion chamber. The flue gas consists of mainly carbon dioxide and water vapor, the latter of which is condensed through cooling. The result is an almost pure carbon dioxide stream that can be transported to the sequestration site and stored. Power plant processes based on oxy fuel combustion are sometimes referred to as "zero emission" cycles, because the CO_2 stored is not a fraction removed from the flue gas stream (as in the cases of pre- and post-combustion capture) but the flue gas stream itself. A certain fraction of the CO_2 generated during combustion will inevitably end up in the condensed water. To warrant the label "zero emission" the water would thus have to be treated or disposed of appropriately. The technique is promising, but the initial air separation step demands a lot of energy.

4.**Chemical looping combustion (ClC):** Chemical looping uses a metal oxide as a solid oxygen carrier. Metal oxide particles react with a solid, liquid or gaseous fuel in a fluidized bed combustor, producing solid metal particles and a mixture of carbon dioxide and water vapor. The water vapor is condensed, leaving pure carbon dioxide which can then be sequestered. The solid metal particles are circulated to another fluidized bed where they react with air, producing heat and regenerating metal oxide particles that are re circulated to the fluidized bed combustor.

5. **Calcium looping:** A variant of chemical looping is calcium looping, which uses the alternating carbonation and then calcinations of a calcium oxide based carrier as a means of capturing CO_2.

B) TRANSPORT:

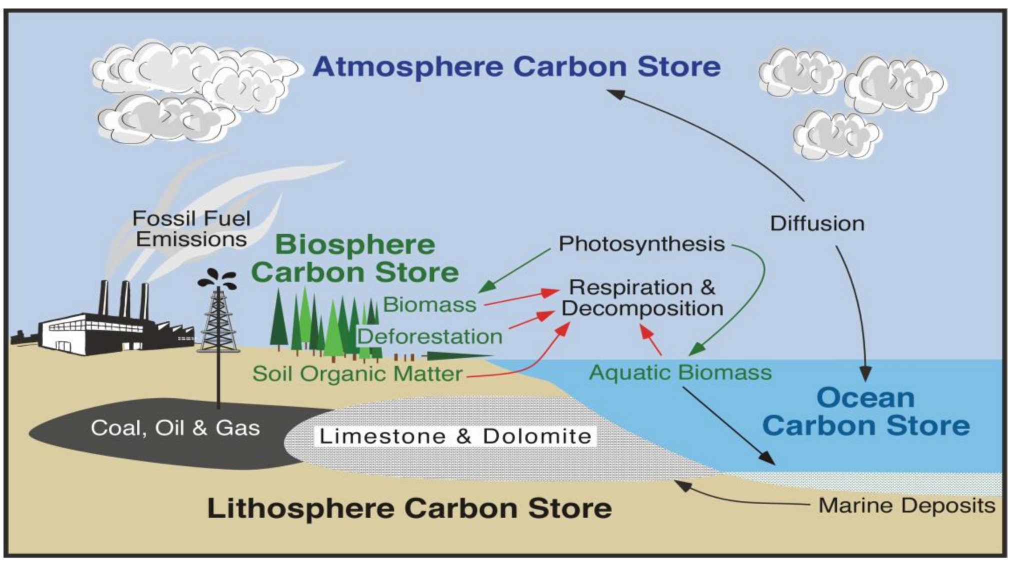
After capture, the CO_2 would have to be transported to suitable storage sites. This is done by pipeline, which is generally the cheapest form of transport. In 2008, there were approximately 5,800 km of CO_2 pipelines in the United States, used to transport CO_2 to oil production fields where it is then injected into older fields to extract oil. The injection of CO_2 to produce oil is generally called Enhanced Oil Recovery or EOR.

In addition, there are several pilot programs in various stages to test the long-term storage of CO_2 in non-oil producing geologic formations.

A COA conveyor belt system or ship could also be utilized for transport. These methods are currently used for transporting CO_2 for other applications.

C) SEQUESTRATION or STORAGE:

Various forms have been conceived for permanent storage of CO_2. These forms include gaseous storage in various deep geological formations (including saline formations and exhausted gas fields), liquid storage in the ocean, and solid storage by reaction of CO_2 with metal oxides to produce stable carbonates.



i) GEOLOGICAL STORAGE: Also known as geo-sequestration, this method involves injecting carbon dioxide, generally in supercritical form, directly into underground geological formations. Oil fields, gas fields, saline formations, unmineable coal seams, and saline-filled basalt formations have been suggested as storage sites. Various physical (e.g., highly impermeable cap rock) and geochemical trapping mechanisms would prevent the CO_2 from escaping to the surface.

Enhanced oil recovery:CO_2 is sometimes injected into declining oil fields to increase oil recovery. This option is attractive because the geology of hydrocarbon reservoirs is generally well understood and storage costs may be partly offset by the sale of additional oil that is recovered. Disadvantages of old oil fields are their geographic distribution and their limited capacity, as well as the fact that subsequent burning of the additional oil so recovered will offset much or all of the reduction in CO_2 emissions.

Unmineable coal seams can be used to store CO_2 because the CO_2 molecules attach to the surface of coal. The technical feasibility, however, depends on the permeability of the coal bed. In the process of absorption the coal releases previously absorbed methane, and the methane can be recovered (enhanced coal bed methane recovery). The sale of the methane can be used to offset a portion of the cost of the CO_2 storage. Burning the resultant methane, however, would produce CO_2, which would negate some of the benefit of sequestering the original CO_2.

II) OCEAN STORAGE:

Another proposed form of carbon storage is in the oceans. Several concepts have been proposed:

- 'Dissolution' injects CO_2 by ship or pipeline into the ocean water column at depths of 1000 – 3000 m, forming an upward-plume, and the CO_2 subsequently dissolves in seawater.
- Through 'lake' deposits, by injecting CO_2 directly into the sea at depths greater than 3000 m, where high-pressure liquefies CO_2, making it denser than water, and forms a downward-plume that may accumulate on the sea floor as a 'lake', and is expected to delay dissolution of CO_2 into the ocean and atmosphere, possibly for millennia.
- Use a chemical reaction to combine CO_2 with a carbonate mineral (such as limestone) to form bicarbonate(s), for example: $CO_2 + CaCO_3 + H_2O \rightarrow Ca(HCO_3)_2(aq)$. However, the aqueous bicarbonate solution must not be allowed to dry out, or else the reaction will reverse.
- Store the CO_2 in solid clathrate hydrates already existing on the ocean floor,[23][24] or growing more solid clathrate.

The environmental effects of oceanic storage are generally negative, and poorly understood. Large concentrations of CO_2 could kill ocean organisms, but another problem is that dissolved CO_2 would eventually equilibrate with the atmosphere, so the storage would not be permanent.In addition, as part of the CO_2 reacts with the water to form carbonic acid, H_2CO_3, the acidity of the ocean water increases.

The bicarbonate approach would reduce the pH effects and enhance the retention of CO_2 in the ocean, but this would also increase the costs and other environmental effects.

III) MINERAL STORAGE:

In this process, CO_2 is exothermically reacted with available metal oxides, which in turn produces stable carbonates. This process occurs naturally over many years and is responsible for a great amount of surface limestone. The reaction rate can be made faster, for example by

reacting at higher temperatures and/or pressures, or by pre-treatment of the minerals, although this method can require additional energy.
Carbon sequestration by reacting naturally occurring Mg and Ca containing minerals with CO_2 to form carbonates has many unique advantages. Most notable is the fact that carbonates have a lower energy state than CO_2, which is why mineral carbonation is thermodynamically favorable and occurs naturally (e.g., the weathering of rock over geologic time periods). Secondly, the raw materials such as magnesium based minerals are abundant. Finally, the produced carbonates are unarguably stable and thus re-release of CO_2 into the atmosphere is not an issue. However, conventional carbonation pathways are slow under ambient temperatures and pressures. The significant challenge being addressed by this effort is to identify an industrially and environmentally viable carbonation route that will allow mineral sequestration to be implemented with acceptable economics

4.5 POLLUTER PAYS PRINCIPLE

The polluter pays principle (PPP) is a basic economic idea that firms or consumers should pay for the cost of the negative externality they create. The polluter pays principle usually refers to environmental costs, but it could be extended to any external cost.

In a purely free market, you would only face your private costs. However, for goods with negative externalities, there are additional external costs, e.g. damage to the environment. This means the social cost of some goods are greater than the private cost.

The polluter pays principle is simply the idea that we should pay the total social cost including the environmental costs. This requires some authority or government agency to calculate our external costs and make sure that we pay the full social cost. A simple example, is a tax on petrol. When consuming petrol, we create pollution. The tax means the price we pay more closely reflects the social cost.

The polluter pays principle is a way of 'internalizing the externality'. It makes the firm / consumer pay the total social cost, rather than just the private cost. (Social cost = private cost+ external cost)

The polluter pays principle is an important basis of international law. In 1972, the OECD (Organisation for Economic Co-operation and Development)wrote Guiding Principles concerning International Economic Aspects of Environmental Policies, stating:

" The polluter should bear the expenses of carrying out the above-mentioned measures decided by public authorities to ensure that the environment is in an acceptable state."

The polluter pays principle was incorporated into the 1992 Rio summit the declaration stated:

"National authorities should endeavor to promote the internalization of environmental costs and the use of economic instruments, taking into account the approach that **the polluter should, in principle, bear the cost of pollution**, with due regard to the public interest and without distorting international trade and investment."

Difficulties of implementing polluter pays principle

- It can be difficult to measure how much pollution is produced, e.g. firms may try to hide the extent of their pollution.
- It can be difficult to impose regulations or tax on firms from other countries. For example, when we contribute to global warming, the problem effects everyone around the world, but it can be difficult to create international agreements to impose penalties on those polluting.
- Pollution havens. These are countries which have weaker environmental legislation and firms can escape taxes and regulations on pollution by shifting production to those countries.
- Some costs are unexpected and occur after the event. e.g. in building nuclear power plant.
- Administration costs of collecting information and implementing tax. For example, a few drunks late at night may make a lot of noise and disturb the neighbourhood, but it would be impractical to impose a tax on those who make noise after a hard-days night. Administration costs have prevented the extension of congestion charge to smaller cities like Manchester – even though in principle it would make economic sense to have a charge for those who cause the external cost of congestion.

4.6 GREEN BUILDING or GREEN CONSTRUCTION OR SUSTAINABLE BUILDING

"A green building is one which uses less water, optimizes energy efficiency, conserves natural resources, generates less waste and provides healthier spaces for occupants, as compared to a conventional building."

Green construction or **sustainable building** refers to a structure and using process that is environmentally responsible and resource-efficient throughout a building's life-cycle: from siting to design, construction, operation, maintenance, renovation, and demolition.

Objectives:
- Efficiently using energy, water, and other resources
- Protecting occupant health and improving employee productivity
- Reducing waste, pollution and environmental degradation

Buildings can be rated for their environmentally sustainable construction. One such rating system is the LEED (Leadership in Energy and Environmental Design).
This building rating system was developed by the U.S. Green Building Council (GBC)
The other rating systems are BREEAM (Building Research Establishment's Environmental Assessment method -United Kingdom)and CASBEE (Comprehensive Assessment System for Building Environmental Efficiency-Japan) help consumers determine a structure's level of environmental performance.

What is LEED?

Leadership in Energy and Environmental Design (LEED) is a rating system devised by the United States Green Building Council (USGBC) to evaluate the environmental performance of a building and encourage market transformation towards sustainable design.

The system is credit-based, allowing projects to earn points for environmentally friendly actions taken during construction and use of a building.

What types of buildings can use LEED?

LEED certification is available for all building types including new construction and major renovation; existing buildings; commercial interiors; core and shell; schools and homes. LEED systems for neighborhood development, retail and healthcare are currently pilot testing. To date, there is over 4.5 billion square feet of construction space involved with the LEED system.

How does LEED work?

LEED is a point based system where building projects earn LEED points for satisfying specific green building criteria. Within each of the seven LEED credit categories, projects must satisfy particular prerequisites and earn points.

The rating system addresses six major areas:
1. Sustainable sites;
2. Water efficiency;
3. Energy and atmosphere;
4. Materials and resources;
5. Indoor environmental quality; and
6. Innovation and design process.

LEED certification levels:
four progressive levels according to the following scale:
Certified 40–49 points
Silver 50–59 points
Gold 60–79 points
Platinum 80 points and above

In 2004, the European Commission initiated the Green Building Program (GBP). This program aims at improving the energy efficiency and expanding the integration of renewable energies in non-residential buildings in Europe on a voluntary basis.

Green building materials offer specific benefits to the building owner and building occupants:
- Reduced maintenance/replacement costs over the life of the building.
- Energy conservation.
- Improved occupant health and productivity.
- Lower costs associated with changing space configurations.
- Greater design flexibility.

Green building material/product selection criteria

1. Resource efficiency
2. Indoor air quality
3. Energy efficiency
4. Water conservation
5. Affordability

1. Resource Efficiency can be accomplished by utilizing materials that meet the following criteria:

- **Recycled Content**: Products with identifiable recycled content, including postindustrial content with a preference for postconsumer content.
- **Natural, plentiful or renewable**: Materials harvested from sustainably managed sources and preferably have an independent certification (e.g., certified wood) and are certified by an independent third party.
- **Resource efficient manufacturing process**: Products manufactured with resource-efficient processes including reducing energy consumption, minimizing waste (recycled, recyclable and or source reduced product packaging), and reducing greenhouse gases.
- **Locally available**: Building materials, components, and systems found locally or regionally saving energy and resources in transportation to the project site.
- **Reusable or recyclable**: Select materials that can be easily dismantled and reused or recycled at the end of their useful life.
- **Recycled or recyclable product packaging**: Products enclosed in recycled content or recyclable packaging.
- **Durable**: Materials that are longer lasting or are comparable to conventional products with long life expectancies.

2. Indoor Air Quality (IAQ) is enhanced by utilizing materials that meet the following criteria:

- **Low or non-toxic**: Materials that emit few or no carcinogens, reproductive toxicants, or irritants as demonstrated by the manufacturer through appropriate testing.
- **Minimal chemical emissions**: Products that have minimal emissions of Volatile Organic Compounds (VOCs). Products that also maximize resource and energy efficiency while reducing chemical emissions.
- **Low-VOC assembly**: Materials installed with minimal VOC-producing compounds, or no-VOC mechanical attachment methods and minimal hazards.
- **Moistureresistant**:Products and systems that resist moisture or inhibit the growth of biological contaminants in buildings.
- **Healthfully maintained**: Materials, components, and systems that require only simple, non-toxic, or low-VOC methods of cleaning.
- **Systems or equipment:** Products that promote healthy IAQ by identifying indoor air pollutants or enhancing the air quality.

3. Energy Efficiency can be maximized by utilizing materials and systems that meet the following criteria:

- Materials, components, and systems that help reduce energy consumption in buildings and facilities.

4. Water Conservation can be obtained by utilizing materials and systems that meet the following criteria: