BHARATHIDASAN UNIVERSITY

Tiruchirappalli- 620024, Tamil Nadu, India

Programme: M.Sc., Environmental Science

Course Title: Solid and Hazardous waste Management

Course code: CC07

Unit II

Carbon credits and Electricity Energy Recovery

Dr. M. Vasanthy

Professor

Department of Environmental Biotechnology

What is climate change and the Kyoto Protocol?

- Growing scientific evidence shows that human activity is increasing the earth's temperature; this is called global warming.
- Global warming is caused by rising concentrations of greenhouse gases in the atmosphere, and this is changing the earth's climate. This is called climate change.
- To address climate change, governments of the world adopted the United Nations Framework Convention on Climate Change (UNFCCC) in 1994.

- In 1997, governments adopted the Kyoto protocol that outlined a timetable of greenhouse gas reduction targets.
- The most important aspect of the Kyoto Protocol is its legally binding commitments for 39 developed countries to reduce their greenhouse gas emissions.

Carbon credits

- Carbon credits are certificates issued to countries that reduce their emission of GHG (greenhouse gases) which causes global warming.
- Carbon credits are measured in units of certified emission reductions (CERs).
- Each CER is equivalent to one tonne of carbon dioxide reduction.

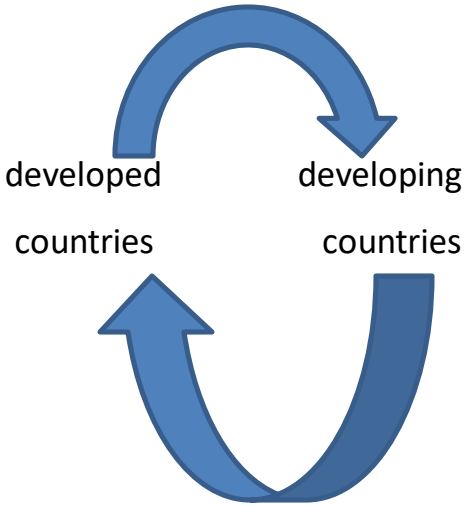
- Reducing emissions doesn’t automatically create carbon credits – they result from a formal process or “protocol” that quantifies, verifies, and certifies qualifying emission reductions from eligible projects.
- Credible carbon credits represent real, permanent, quantifiable, verifiable, and enforceable emission reductions.
- Carbon credits are usually quantified in units of metric tons of carbon dioxide equivalents.

- Organizations or projects that reduce emissions (such as planting trees, investing in renewable energy, or improving energy efficiency) can earn carbon credits.
- These projects are often verified by independent bodies to ensure that the emission reductions are real and measurable.
- The carbon credits can be bought and sold. Companies or countries that exceed their emissions targets can purchase these credits to offset their excess emissions.

- What is the Clean Development Mechanism (CDM)?
- It is a mechanism established under the Kyoto Protocol through which developed countries can contribute towards climate change mitigation and sustainable development in developing countries.
- CDM allows developed countries to achieve part of their reduction obligations through investment in emission reduction projects in developing countries.
- The projects can be implemented wherever the emission reduction can be achieved most efficiently. The aim is to improve the overall flexibility and economic efficiency of obtaining emission reduction.

Carbon financing and solid waste management

Flow of finance



Flow of credit

- Greenhouse gas reduction of any CDM project is measured according to internationally agreed methods and are quantified in standard units called Certified Emission Reductions (CERs).
- These are expressed in tons of carbon dioxide equivalents (CO2 e). The CERs can be traded and sold on international carbon markets.

Can improved solid waste management contribute to mitigating climate change?

- When biodegradable waste is deposited at a landfill, it produces methane. Methane can either be burned to produce energy from landfills or avoided through aerobic composting.
- Methane is a green house gas 20 times more potent than carbon dioxide. Through source-segregation of waste, followed by reusing and recycling of materials and composting of organic waste, greenhouse gas emissions from the solid waste management sector can be reduced significantly.

- Other feedstocks might be available to the compost facility that could also earn carbon credits.
- For example, dairy or swine manure stored in lagoons can produce significant amounts of methane.
- Table 1 shows some typical feedstocks and the carbon avoidance they may qualify for.

Feedstock and the estimated gas emission in lagoons

Feedstock	Yield		Time
	L CH4 kg-1	Mg CO2 /Mg waste	Days
Grass	144.4	2.37	50
Leaves	30.6	0.5	100
Branch	62.6	1.03	100
Food	300.7	4.94	120
Coated paper	84.4	1.39	150
Old newsprint	74.33	1.22	300
Corrugated containers	152.3	2.5	400
Office paper	217.3	3.57	500

Emissions from composting

- GHG emissions from the composting facility need to be calculated and subtracted from the emissions avoided calculated above.
- Emissions may come from the composting process.
- Carbon dioxide released during composting is considered biogenic, so does not count in GHG calculations.
- While it is theoretically possible for methane to be generated in a poorly managed compost pile, the EPA has concluded that there is little evidence that this actually happens, so considers any releases negligible (EPA 2002)

References

- USEPA, 2007, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2005, USEPA #430-R-07-002, US Environmental Protection Agency, Washington, DC
- Solid Waste Management and Greenhouse Gases, 3rd edition, USEPA, 2006, http://epa.gov/climatechange/wycd/waste/SWMGHGreport.html
- Pew Center for Global Climate Change, 2007, Legislation in the 110th Congress Related to Global Climate Change, http://www.pewclimate.org/what_s_being_done/in_the_congress/110thcongress.cfm
- Capoor, K and Ambrosi, P, 2007, State and Trends Of The Carbon Market, World Bank Institute, Washington, DC
- Visse, Dana, 2004, Food Waste Diversion Greenhouse Gas Analysis: Portland Oregon, prepared for City of Portland Office of Sustainable Development

Indian scenario

- India comes under the third category of signatories to UNFCCC. India signed and ratified the Protocol in August, 2002 and has emerged as a world leader in reduction of greenhouse gases by adopting Clean Development Mechanisms (CDMs) in the past few years.

- Other than Industries and transportation, the major sources of GHG's emission in India are as follows :

- Paddy fields
- Enteric fermentation from cattle and buffaloes
- Municipal Solid Waste

- Of the above three sources the emissions from the paddy fields can be reduced through special irrigation strategy and appropriate choice of cultivars; whereas enteric fermentation emission can also be reduced through proper feed management.

- In recent days the third source of emission i.e. Municipal Solid Waste Dumping Grounds are emerging as a potential activity despite being provided least attention till date.
- Various processes/technologies available to reduce the amount of Municipal Solid Waste are as follows.

1. Physical (a. Pelletisation)
2. Biochemical (a. Aerobic Composting b. Anaerobic Digestion)
3. Thermal (a. Incineration b. Gasification)

Electrical Energy Recovery

- Municipal Solid waste has a heating value ranging from 9300 to 12,800 kJ/kg.
- It is possible to recover this energy by using MSW to fire boilers in order to produce steam that can be used to drive steam turbine.
- The turbine then turns a generator producing electricity.
- Before electricity is produced, there are efficiencies and losses that must be accounted for.
- Heat losses include heat losses due to the sensible heat content of the ash and the unburnt carbon remaining in the ash, heat loss due to radiation, and water losses.
- Since the actual furnace combustion suspends all the combustion water in gaseous form, energy of vaporization is needed for this suspension.
- This wasted energy is the loss.
- Water losses include loss due to the moisture content, loss due to combined water, and loss due to net hydrogen water.
- The latent heat of vaporization of water is equal to 2420 kJ/kg.

- For the sensible heat of ash, the specific heat normally taken as 1047 J/kg-C°.
- The heating value of carbon is 32,851 kJ/kg.
- Radiation losses range from 0.003 to 0.005 kJ/kg of fuel.
- After all the losses are accounted for, these are subtracted from the higher heating value of MSW to obtain the sensible heat content of the stack gases.
- These gases are then passed through boiler tubes.
- As the gases travel through the tubes, the sensible heat contents are given up heating the water in the boiler to steam.
- It is the steam introduced to the steam turbine that drives the generator to produce electricity.

- In 2013, there were about 80 waste-to-energy plants in the United States that generated electricity or produced steam.
- These plants burned about 30 million tons of MSW in 2013, and generated nearly 14 billion kilowatthours of electricity, about the same amount used by 1.3 million U.S. households in 2013.

- The biogenic material in MSW contributed about 52% of the energy from MSW that was burned in electricity-generating waste-to-energy facilities.
- Many large landfills also generate electricity by using the methane gas that is produced as biomass decomposes in the landfill.

QUESTIONS

- 2 MARKS
- **What do you mean by CARBON CREDITS?**
- **What is the unit of carbon credit?**
- **1 carbon credit = -------tonne of CO2 redution**
- **What are the important sources of green house emissions in India ?**
- What is the Clean Development Mechanism (CDM)?

5 MARKS

- **Is it possible to recover electrical energy from solid waste ?Explain.**
- Can improved solid waste management contribute to mitigating climate change?

10 MARKS

- **What is the importance of carbon credit? Discuss.**