LECTURE NOTE

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Module-I : Global Warming and its effect:- Introduction and physical definition of global warming, the New Carbon Problem: Accumulation, Long Half-Life, Heating Potential, Carbon Emission Factors, Carbon Absorption in Nature, The Global Emission Situation and its effect in India, The Kyoto and Other Protocols and its view in India, Effect of climate change and its impact. Planning for the Future to reduce global warming:- Steps taken to Control Carbon Emissions universally, Use of Promotional and Punitive Mechanisms for Reducing Carbon in Atmosphere, The General Approach in Planning for the Future, Developing Countrywide Adaptive Measures for Safety of Local People, Developing Mitigative Measures for Global Reduction of Carbon, India's National Action Plan on Climate Change (NAPCC) till date, National Mission for a Green India, The MRV Debate. Global Warming and its effect:- Introduction and physical definition of global warming, the New Carbon Problem: Accumulation, Long Half-Life, Heating Potential, Carbon Emission Factors, Carbon Absorption in Nature, The Global Emission Situation and its effect in India, The Kyoto and Other Protocols and its view in India, Effect of climate change and its impact. Planning for the Future to reduce global warming:- Steps taken to Control Carbon Emissions universally, Use of Promotional and Punitive Mechanisms for Reducing Carbon in Atmosphere, The General Approach in Planning for the Future, Developing Countrywide Adaptive Measures for Safety of Local People, Developing Mitigative Measures for Global Reduction of Carbon, India's National Action Plan on Climate Change (NAPCC) till date, National Mission for a Green India, The MRV Debate.

Module-II Opportunities in Control of Carbon Emissions and Accumulation:- Essential Steps for Control of Carbon Emissions and Accumulation, Procedure to develop own Priorities and Business Opportunities in India for control of carbon emissions and accumulation, Needs a Mix of Green and Traditional Power Sources in India, A Logical Approach for Carbon Reduction, Need in India —More Forests, Less Deforestation and payment rates procedure for controlling carbon emissions and its Promotional Mechanisms at India. Green Technologies for Energy Production: - Various Technologies Available for Energy Production, Cost Comparison of a Few Typical Systems for Power Generation, Sources of Energy Production Already in Use, Alternative Methods Ready for Use, Green Technologies Needing some Prior R&D Work.

Module-III Green Technologies for Personal and Citywide Application: - Measures to be taken for Green city, Carbon Emission Reduction at Personal Level, Carbon Emission Reduction at Local Authority and Citywide Level, Carbon Emissions from Imports. Green Technologies for Specific Applications:- Promotion of 'Green' Buildings, Guidelines, The Energy Conservation Building Code (ECBC), Green Hotels and Hospitals, Green Technologies for Transport, Green Roads, Ports and Harbours, Industries, Carbon, Carbon Emissions from a Few Selected Industries in India, The Changing Scenario in Cities, Need for Wider Application to Town Planning and Area Re-Development Projects, 'Green' Infrastructure for Municipal Services, Bringing up Indian Villages, Green Services for Crematoria, Spreading Message to all Stakeholders.

Module IV: Some High-tech Measures for Reducing Carbon Emissions: - Use of Solar Power with Satellite-Based Systems, Use of Carbon Capture and Storage (Sequestration), Microorganisms, A Quick SWOT Analysis.Recommended Plan of Action: - India's National Action Plan Take Us to a Low-Carbon Path, The Missions Help Develop Awareness, few case studies on Projects undertakenby Various Countries, Adaptive Measures Essential for Indian People to Cope with Climate Change.

Books : [1] Green Technologies, Soli J. Arceivala, McGraw Hill Education
[2] Green Technologies and Environmental Sustainability edited by Ritu Singh, Sanjeev Kumar

Module-I

Global Warming and Its Effects :- Introduction and Physical Definition of Global Warming

Global Warming: The long-term rise in the average temperature of the Earth's climate system due to human activities, primarily the emission of greenhouse gases.
Physical Definition: An increase in the Earth's atmospheric and oceanic temperatures due to an enhanced greenhouse effect.
The New Carbon Problem Accumulation: Carbon dioxide (CO_2) and other greenhouse gases accumulate in the atmosphere, increasing their concentration over time.Long Half-Life: CO_2 has a long atmospheric lifetime, persisting for centuries. Heating Potential: Greenhouse gases trap heat, leading to a warming effect known as radiative forcing.
Carbon Emission Factors Sources: Fossil fuel combustion, deforestation, industrial processes, and agriculture.Quantification: Measured in terms of CO_2 equivalents (CO_2e) to standardize the impact of different greenhouse gases.
Carbon Absorption in Nature : Carbon Sinks: Forests, oceans, and soil that absorb more CO_2 than they emit. Biological Processes: Photosynthesis in plants, oceanic carbon sequestration, and soil carbon storage.
The Global Emission Situation and Its Effect in India Global Emissions: Major contributors include China, the USA, and the European Union.India's Contribution: India is the third-largest emitter of CO_2, mainly due to coal dependence. Local Effects: Increased frequency of heatwaves, changing monsoon patterns, and rising sea levels affecting coastal areas.

The Kyoto and Other Protocols and Their View in India Kyoto Protocol: An international treaty committing industrialized countries to reduce greenhouse gas emissions. Paris Agreement: A global accord to limit global warming to well below 2°C above pre-industrial levels. India's Stance: Actively participates in international agreements, committed to reducing emission intensity and increasing renewable energy capacity.

Effect of Climate Change and Its Impact Temperature Rise:

Increased average temperatures lead to heat stress and health issues.Sea Level Rise: Coastal erosion, saline water intrusion, and displacement of communities.Agricultural Impact: Altered rainfall patterns affect crop yields and food security.Biodiversity Loss: Habitat changes threaten species survival.

Planning for the Future to Reduce Global Warming :-

Steps Taken to Control Carbon Emissions Universally International Agreements: Binding commitments like the Paris Agreement.National Policies: Emission reduction targets and renewable energy incentives.Corporate Actions: Carbon neutrality pledges and green investments by businesses.

Use of Promotional and Punitive Mechanisms for Reducing Carbon in Atmosphere Promotional Mechanisms:

Subsidies for renewable energy, tax credits for green technologies, and public awareness campaigns.Punitive Mechanisms: Carbon taxes, cap-and-trade systems, and penalties for exceeding emission limits.

The General Approach in Planning for the Future Assessment:

Continuous monitoring of emissions and climate impacts.Target Setting: Defining clear and measurable emission reduction goals.Implementation: Enforcing policies and measures to achieve targets.Adaptation and Mitigation: Developing strategies to adapt to climate impacts and mitigate further emissions.

Developing Countrywide Adaptive Measures for Safety of Local People Disaster Management:

Strengthening infrastructure to withstand extreme weather events.Water Resource Management: Ensuring water availability through efficient use and conservation.Agricultural Adaptation: Promoting climate-resilient crops and farming practices.Health Measures: Enhancing healthcare systems to address climate-related health issues.

Developing Mitigative Measures for Global Reduction of Carbon Renewable Energy Expansion:

Investing in solar, wind, and other renewable sources.Energy Efficiency: Implementing energy-saving technologies and practices.Afforestation and Reforestation: Increasing forest cover to act as carbon sinks.Carbon Capture and Storage: Developing technologies to capture and store CO2 emissions.

India's National Action Plan on Climate Change (NAPCC) to DateMissions:

Eight missions focusing on solar energy, enhanced energy efficiency, sustainable agriculture, and more. Goals: Reducing emission intensity, increasing renewable energy capacity, and promoting sustainable development. National Mission for a Green India Objectives: Increasing forest/tree cover, restoring degraded ecosystems, and enhancing biodiversity. Implementation: Community participation, afforestation, and conservation initiatives.The MRV DebateMeasurement, Reporting, and Verification (MRV): Ensuring accurate tracking of emissions and the effectiveness of mitigation efforts.Challenges: Establishing reliable MRV systems, especially in developing countries with limited resources.By addressing these aspects comprehensively, India and the global community can work towards mitigating the effects of global warming and ensuring a sustainable future.

MODULE-II

Opportunities in Control of Carbon Emissions and Accumulation

Essential Steps for Control of Carbon Emissions and Accumulation Policy Implementation:
Enforce strict regulations on industrial emissions and incentivize green practices. Technological Innovation: Invest in R&D for carbon capture and storage technologies. Renewable Energy Adoption: Increase the share of renewable energy in the national energy mix. Energy Efficiency:
Promote energy-efficient appliances and practices in both industrial and domestic sectors.
Public Awareness: Educate the public on the importance of reducing carbon footprints. International Collaboration: Engage in global partnerships to share knowledge and resources. Procedure to Develop Own Priorities and Business Opportunities in India Market Analysis: Identify high-emission industries and potential markets for green technologies. Stakeholder Engagement: Collaborate with government bodies, private sector, and NGOs.
Feasibility Studies: Conduct technical and financial feasibility studies for proposed solutions. Pilot Projects: Implement small-scale pilot projects to test the viability of solutions.
Scaling Up: Develop strategies for scaling up successful pilots. Funding and Incentives: Explore funding opportunities and government incentives for green initiatives. Needs a Mix of Green and Traditional Power Sources in India Green Sources: Solar, wind, hydro, and biomass energy. Traditional Sources: Coal, natural gas, and nuclear power. Balanced Approach: Utilize green sources to reduce dependence on fossil fuels while ensuring energy security through traditional sources .
A Logical Approach for Carbon Reduction Assessment: Conduct a thorough assessment of current carbon emissions .
Target Setting: Set realistic and achievable carbon reduction targets. Action Plan: Develop a comprehensive action plan detailing specific measures and timelines.

Monitoring and Reporting: Establish monitoring systems to track progress and report outcomes. Continuous Improvement: Regularly review and update strategies based on performance data. Need in India: More Forests, Less Deforestation Afforestation Programs: Implement large-scale afforestation and reforestation projects. Deforestation Control: Strengthen laws and enforcement against illegal logging and land conversion. Community Involvement: Engage local communities in forest conservation efforts. Economic Incentives: Provide financial incentives for preserving and expanding forests. Payment Rates Procedure for Controlling Carbon Emissions and Promotional Mechanisms in India Carbon Pricing: Implement carbon pricing mechanisms such as carbon tax or cap-and-trade systems. Subsidies and Grants: Offer subsidies and grants for adopting green technologies and practices.

Credits and Offsets:

Develop a system for carbon credits and offsets to encourage emission reductions:-

Public-Private Partnerships: Foster partnerships between government and private sector for funding and implementing green projects.

Green Technologies for Energy Production Various Technologies Available for Energy Production Solar Photovoltaic (PV)Wind Turbines Hydroelectric Power Biomass Energy Geothermal Energy Tidal and Wave Energy Cost Comparison of a Few Typical Systems for Power Generation Solar PV: Moderate initial investment, low operational costs.

Wind Energy: High initial investment, low operational costs.

Hydropower: High initial investment, variable operational costs depending on maintenance.

Biomass Energy: Moderate to high initial investment, moderate operational costs. Sources of Energy Production Already in Use Coal: Predominant but highly polluting.

Natural Gas: Cleaner than coal but still emits carbon.

Nuclear: Low emissions but concerns about safety and waste disposal .

Hydro electric: Widely used, renewable but with ecological impacts. Alternative Methods Ready for Use Solar Thermal Energy Small-scale Wind Turbines Waste-to-Energy Systems Advanced Battery Storage for Renewable Energy Green Technologies Needing Some Prior R&D Work Hydrogen Fuel Cells Next-Generation Solar Cells (e.g., perovskite solar cells)Carbon Capture and Storage

(CCS)Algae-based Biofuels By strategically implementing these steps and leveraging available technologies, India can significantly reduce carbon emissions while fostering economic growth through new business opportunities in the green sector.

MODULE-III

Green technologies for city wide applications

In city green technologies are introduced to reduce carbon emission which leads to stability of atmosphere. This can be done at personal level, local authority and city wide level .

Carbon emission reduction @ personal level:

• Use public transport instead of using personal vehicles
• Use low emission fuels for usage of cars
• Avoid usage of vehicles for short distance
• Prefer video conference for business meeting in other countries
• Avoid stand by mode for electronic devices and turn off devices after usage.
• Prefer to buy local products(buy local concept) Carbon emission reduction @ local authority and city wide level: Electric consumption in city is much affected by Industries: Local authority need to set benchmarks for the carbon emission for every industry in the community Residential consumption: Electricity consumption is depend on the lifestyle of people ,financial status, location etc. To decrease the

consumption of electricity introduce CER’s, carbon credits. Ex: ujala scheme
Genral Lighting:

• Replace street lights CFL bulbs in place of incandescent bulbs.
• Provide solar panels to street lights to decrease the electricity consumption
• Use BEE certified electric products for energy efficiency. punjab is first state to use LED with street light.
• Use timer switches to lights. Misallaneous:
• Adopt solar water heaters in hotels, hostels and guest houses.
• Use solar cookers to prepare food.
• For economic air conditioning use cavity walls, sun breakers and double gazed window panes.
• Use thermostats or sensors to save the electricity. • Use LED display instead of LCD,CRT monitors.

PROMOTION OF GREEN BUILDING:

• Green building is one which uses less water consumption, optimizes energy efficiency measures, generates less waste compared to other building.
• It conserve the energy by retaining warm in winter and losing heat during summer.
• It can save carbon foot print ,water etc.
• It can be evaluated by using GRIHA ,LEEDS
• Green building is second generation building when water ,energy consumption reduced by 40%-60% and second generation building are reduced energy consumption also generates power.
• Green buildings are 4-6% expensive than traditional buildings but less in operating cost Green technology for specific approach LEEDS rating system
• The LEED system is Leadership in Energy and Environmental Design is found to be one of the most popular green building certification.
• The LEED system is developed by the U.S. Green Building Council (USGBC). The LEED rating system have a series of rating system for the design, operation, construction and the maintenance of the green buildings.
• The main objective is the development of a structure that make the building owner and the operator to be environmentally responsible and utilizes the resources efficiently.
• All new green building are required to comply with guidelines suggested with following aspect 1) building construction site 2) environmental concerns in

architectural planning 3) energy conservation 4)water conservation 5)waste management 6) socila relevance IGBC Green Homes ratings are awarded according to the following scale: Certified 32-39 Silver 40-47 Gold 48-59 Platinum 60-80

ADVANTAGES AND DISADVANTAGES OF LEED RATING SYSTEM IN INDIA:

¬ LEED India certified projects blend enhanced environmental, economic, and occupant-oriented performance. ¬ They cost less to operate and maintain; are energy- and water-efficient; have higher lease-up rates than conventional buildings in their markets and are healthier and safer for occupants. ¬ Often when a LEED rating is pursued in India, it increase the cost of initial design and construction. ¬ One reason for the higher cost is that sustainable construction principles may not be well understood by the design professionals undertaking the project ¬ Some of the finer points of LEED certification in India could possibly lead to misunderstandings between the design team, construction team, and client, which could result in delays. ¬ Also, there may be a lack of abundant availability of manufactured building components which meet LEED standards. ¬

ITC GREEN CENTER is a hotels division Headquarter located in sector-32, Gurgoan. ¬ It is a LEED PLATINUM certified building with 56 points. At 170,000 sq feet, ITC Green Centre is the world's largest 0% water discharge, noncommercial Green building, and compared to similar buildings, ITC Green Centre has a 30% smaller carbon footprint with the use of sensible technologies. ¬ One of the strongest aspects of ITC Green Centre is its design. All our systems are integrated in a way so that they can function as naturally as possible. ¬ For example, the L-shaped architecture of the building serves more than one function in more than one area of the immediate environment. The central atrium allows natural light to form in the heart of the building, thereby reducing the use of artificial light. It also ensures that one part of the façade is always in the shade, preventing too much heat from entering the structure, and the cooling effect is supported moreover by the discreet bodies of water placed in front of the building

ITC

GREEN CENTER WATER CONSERVATION :

• ITC harvests 100% of the rain that falls on the building and recycle 100% of all the water used in the building. • Along with the rainwater harvesting at ITC Green Centre, there are interlocking tiles placed across the landscape of our building to harvest rain water through the grass that grows between the tiles while ensuring 0% surface run-off.

ENERGY SAVING TECHNIQUES :

• The high albedo roof coating reduces the amount of heat absorbed by reflecting over 90% of visible and infra red radiations away from the building. This reduces the roof surface temperature by 30 degrees and brings down the use of energy for air conditioning in the top floor by 10- 15%.

• The building design has ensured that it uses as little energy as possible in terms of basic lighting. The architecture of ITC Green Centre allows enough natural light to penetrate throughout the building during daytime, so it needed very little energy to light the building at night.

GRIHA RATING SYSTEM:

• GRIHA (Green Rating for Integrated Habitat Assessment) GRIHA - Sanskrit word meaning – 'Abode'

• An innovative tool for sustainable development by the United Nations. • A tool for implementing renewable energy in the building sector by 'The Climate Reality project'- an organization founded by Mr. Al Gore

OBJECTIVES OF GRIHA :

• minimize a building's resource consumption, waste generation, and overall ecological impact

• evaluates the environmental performance of a building holistically over its entire life cycle, thereby providing a definitive standard for what constitutes a 'green building'

• Reduced energy consumption without sacrificing the comfort levels

• Reduced destruction of natural areas, habitats, and biodiversity, and reduced soil loss from erosion etc

GRIHA PROCEDURE:

• GRIHA assesses a building out of 34 criteria

• Awards points on a scale of 100

• To qualify for GRIHA certification, a project must achieve at least 50 points

Eligibility Except for industrial complexes, all buildings – offices, retail malls, institutions, hotels, hospitals, health-care facilities, residences, and multi-family high-rise buildings – in the pre-design/design stage are eligible for certification under GRIHA

• ADaRSH (Association for Development and Research of Sustainable Habitats) examine project documents to help project eligible for GRIHA rating and render requisite assistance for registration.

Energy Conservation Building Code(ECBC)

• Launched by ministry of power, government of India in may 2007 as a first step towards promotional energy efficiency in building sector.

• It was developed by expert committee set by bureau of energy efficiency with the support and guidance of from united states agency for international development The ECBC provides design norms for: ¬ Building envelope, including thermal performance requirements for walls, roofs, and windows; ¬ Lighting system, including day lighting, and lamps and luminaire performance requirements; ¬ HVAC system, including energy performance of chillers and air distribution systems; ¬ Electrical system; and ¬ Water heating and pumping systems, including requirements for solar hotwater systems. Carbon emission from Industries

Direct carbon emissions

• Emissions that are directly emitted from the site of the process or service. (industry would be the emissions related to burning a fuel on site)

• Emissions are the other emissions related to purchased electricity, heat, and/or steam used on site.

Indirect carbon emissions

• Transportation of materials/fuels
• Any energy used outside of the production facility
• Wastes produced outside of the production facility
• Iron and steel production (4%)
• Aluminium and non-ferrous metals production (1.2%)
• Machinery production (1%)
• Pulp, paper and printing (1.1%)
• Food and tobacco industries (1.0%)
• Chemicals production (4.1%)
• Cement production (5.0%)

• Other industry (7.0%)

GREEN HOTELS:

Green hotel, is an environmentally sustainable hotel or accommodation that has made important environmental improvements to its structure in order to minimize its impact on the natural environment.

• It is beneficial for these hotels to get certain certifications in order to be environmentally compliant. One beneficial certification specifically for hotels is the LEED certification.

• A LEED-certified hotel provides benefits to the environment through energy efficient practices.

GREEN HOTELS

• Renewable energy sources like solar or wind energy
• Bulk organic soap and amenities instead of individual packages to reduce waste
• Guest room and hotel lobby recycling bins
• Energy-efficient lighting
• On-site transportation with green vehicles
• Serve organic and local-grown food
• Non-disposable dishes
• Offers a fresh-air exchange system
• Grey water recycling, which is the reuse of kitchen, bath and laundry water for garden and landscaping
• Newspaper recycling program
• Housekeeping uses non-toxic cleaning agents and laundry detergent
• 100% organic cotton sheets, towels and mattresses.

GREEN TRANSPORTATION

Green Transportation comprises of those modes of transportation that do not depend on diminishing natural resources like fossil fuels. These transportation modes rely on renewable energy sources. They also have very low impact on the environment as these modes produce minimal or no greenhouse gas emission.

MODULE-IV

High Tech Measures

• Solar power with Satellite Based Systems • Sequestration • Genetic modifications of microorganisms • Electric vehicles • Energy from uranium and thorium Solar power with Satellite Based Systems • Space-based solar power (SBSP) is the concept of collecting solar power in outer space and distributing it to

Earth. • Potential advantages of collecting solar energy in space include a higher collection rate and a longer collection period due to the lack of a diffusing atmosphere, and the possibility of placing a solar collector in an orbiting location where there is no night. • Space-based solar power systems convert sunlight to microwaves outside the atmosphere

• History ¬ Originally known as satellite solar-power system (SSPS), was first described in November 1968. ¬ In 1973 Peter Glaser was granted U.S. patent for his method of transmitting power over long distances using microwaves from a very large antenna (up to one square kilometer) on the satellite to a much larger one, now known as a rectenna, on the ground. ¬ Between 1978 and 1981, the US Congress authorized the Department of Energy (DoE) and NASA to jointly investigate the concept. ¬ In 1997 NASA conducted its "Fresh Look" study to examine the modern state of SBSP feasibility. ¬ In 2008, Japan passed its Basic Space Law which established Space Solar Power as a national goal and JAXA (The Japan Aerospace Exploration Agency) has a roadmap to commercial SBSP. ¬ In 2015, the China Academy for Space Technology (CAST) showcased their roadmap at the International Space Development Conference.

• Requirements for Space Solar Power

• Low-cost, environmentally-friendly launch vehicles.

• Large scale in-orbit construction and operations: To gather massive quantities of energy, solar power satellites must be large, far larger than the International Space Station (ISS).

• Power transmission: To transmit power from satellites to the Earth's surface with minimal environmental impact.

• Design Space-based solar power essentially consists of three elements:

• Collecting solar power in space, for example via solar concentrators, solar cells or a heat engine.

• Transmitting power to earth, for example via microwave or laser.

• Receiving power on earth, for example via a microwave antenna (rectenna).

Advantages

• It is always solar noon in space and full sun.

• Collecting surfaces could receive much more intense sunlight, owing to the lack

of obstructions such as atmospheric gasses, clouds, dust and other weather events.
• Orbiting satellites can be exposed to a consistently high degree of solar radiation, generally for 24 hours per day, whereas earth surface solar panels currently collect power for an average of 29% of the day.
• Power could be relatively quickly redirected directly to areas that need it most. A collecting satellite could possibly direct power on demand to different surface locations based on geographical baseload or peak load power needs.
• Elimination of plant and wildlife interference.
• With very large scale implementations, especially at lower altitudes, it potentially can reduce incoming solar radiation reaching earth's surface. This would be desirable for counteracting the effects of global warming .

Disadvantages

• The large cost of launching a satellite into space. For 6.5 kg/kW, the cost to place a power satellite in GEO cannot exceed $200/kg if the power cost is to be competitive.
• Inaccessibility: Maintenance of an earth-based solar panel is relatively simple, but construction and maintenance on a solar panel in space would typically be done telerobotically.
• In addition to cost, astronauts working in GEO (geosynchronous Earth orbit) are exposed to unacceptably high radiation dangers and risk and cost about one thousand times more than the same task done telerobotically.
• The space environment is hostile; PV panels suffer about 8 times the degradation they would on Earth
• Space debris is a major hazard to large objects in space, particularly for large structures such as SBSP systems in transit through the debris below 2000 km. Collision risk is much reduced in GEO since all the satellites are moving in the same direction at very close to the same speed.
• The broadcast frequency of the microwave downlink would require isolating the SBSP systems away from other satellites. GEO space is already well used and it is considered unlikely the ITU would allow an SPS to be launched.
• The large size and corresponding cost of the receiving station on the ground. The cost has been estimated at a billion dollars for 5 GW by SBSP researcher Keith Henson.

• Energy losses during several phases of conversion.
• Waste heat disposal in space power systems is difficult

Carbon Capture and Storage

• Carbon dioxide (CO_2) capture and sequestration (CCS) is a set of technologies that can greatly reduce CO_2 emissions from new and existing coal- and gas-fired power plants and large industrial sources.
CCS is a three-step process that includes:
• Capture of CO_2 from power plants or industrial processes
• Transport of the captured and compressed CO_2 (usually in pipelines). • Underground injection and geologic sequestration (also referred to as storage) of the CO_2 into deep underground rock formations. These formations are often a mile or more beneath the surface and consist of porous rock that holds the CO_2 . Overlying these formations are impermeable, non-porous layers of rock that trap the CO_2 and prevent it from migrating upward.

Why is it important?

• Carbon dioxide (CO_2) capture and sequestration (CCS) could play an important role in reducing greenhouse gas emissions, while enabling low-carbon electricity generation from power plants.
• As estimated in the U.S. Inventory of Greenhouse Gas Emissions and Sinks, more than 40% of CO_2 emissions in the United States are from electric power generation.
• CCS technologies are currently available and can reduce (by 80- 90%) CO_2 emissions from power plants that burn fossil fuels.
• Applied to a 500 MW coal-fired power plant, which emits roughly 3 million tons of CO_2 per year, the amount of GHG emissions avoided would be equivalent to: – Planting more than 62 million trees, and waiting at least 10 years for them to grow. – Avoiding annual electricity-related emissions from more than 300,000 homes.

Where can captured carbon dioxide be stored?

• Storage basins in the form of deep, sedimentary basins have been found suitable for CO_2 storage.

• Use of space related by depleted oil and gas reserves underground.

• Use of CO_2 to increase oil and gas outputs from deposits

• Use of deep saline formations for storage • Use of CO_2 to improve coal-bed methane recovery Issues Involved in Planning CCS Projects

• Limited fundamental knowledge of storage and leakage mechanisms

• Storage engineering

• Safe operation and maintenance of project

• Financial responsibility

• Increase significantly the emissions of acid gas pollutants.

• In ocean storage carbon dioxide reacts with water to form acid, so the oceans could become significantly more acidic .

• In addition to the global climate change impact of CO_2 returning to the atmosphere, leakages pose local risks to health and ecosystems.

Genetic Modification of Microorganisms

In the carbon cycle methanogens convert carbon dioxide to methane in a process called methanogenesis

• In the nitrogen cycle nitrogen-fixing bacteria such as Rhizobium fix nitrogen, which means they convert nitrogen in the atmosphere into biological nitrogen that can be used by plants to build plant proteins.

• Photosynthetic algae and cyanobacteria form a major component of marine plankton. They play a key role in the carbon cycle as they carry out photosynthesis and form the basis of food chains in the oceans.

The Sahara CSP Project

• Located in North Africa

• To develop a concentrated solar power plant to generate enough electric power to meet the energy needs of Europe

• Use for desalination of sea water for growing crops in green houses located in Sahara

• Distribution of energy from desert to the European countries would pose problems and involve large cost.

Ujala Yojana

Free LED Bulb Scheme

- Earlier Ujala Scheme was launched with a different name – Domestic Efficient Lighting Programme (DELP).
- Now with the new name the programme has been relaunched.
- It has also been revived by providing a lot more benefits to the consumers than it was providing before. • The main aim of the Yojana is to switch the usage of over 200 million incandescent light bulbs into LED light bulbs. This will save a power of 10.5 billion kWh as a whole.

Ujala Yojana Key Features

- It is offering subsidized and affordable LED light bulbs to all.
- It is one of the first and the strongest measures taken by the central government to promote the usage of efficient light bulbs.
- The aim of the scheme is to preserve the environment.
- Under this scheme the applicant will be given the LED light bulbs at subsidized prices. The prices are going to be slashed down by 60%. So the reduced price will be 40% less than the market price.
- The Ujala Yojana has brought both the state and the central government to work hand in hand. Earlier a similar scheme was launched but now it has been revived with the Ujala Yojana. It comprises of both the central and the state governments to work together towards achieving the goal.
- The market rate of a common household LED bulb is around Rs. 160. Under this scheme you will get the same LED bulb for Rs. 85 and 3 year replacement warranty.

Pradhan Mantri Ujjwala Yojana

- Pradhan Mantri Ujjwala Yojana is a scheme of the Ministry of Petroleum & Natural Gas for providing LPG connections to women from Below Poverty Line (BPL) households.
- Under the scheme, five crore LPG connections are to be provided to BPL households. The Scheme provides a financial support of Rs 1600 for each LPG

connection to the BPL households, interest free loan to purchase stove and refill by Oil Marketing Companies.

• The administrative cost of Rs. 1600 per connection, which includes a cylinder, pressure regulator, booklet, safety hose, etc. would be borne by the Government.

Atal Jyoti Yojana

• The Ministry of New and Renewable Energy (MNRE)

• to illuminate dark regions through establishment of solar street lights.

• It is a sub scheme under off –grid and decentralized solar application scheme of Ministry of New and Renewable Energy (MNRE), Govt. of India. hed the Atal Jyoti Yojana (AJAY)

• The Phase I was implemented during September 2016- March 2018. The Phase II is being implemented during 2018-19 and 2019-20.

• Implementation agency Energy Efficiency Services Limited (EESL) has been entrusted to implement the scheme.

States covered • Phase I : The rural, semi-urban and urban areas that face less than 50% grid connectivity in Uttar Pradesh, Assam, Bihar, Jharkhand, and Odisha will be illuminated with 7 W solar LED street lights. These solar lights were installed on major roads, markets and public conveniences in remote areas to sustainably enhance the citizens' quality of life. • Phase II – States covered during Phase I - Uttar Pradesh, Assam, Bihar, Jharkhand, and Odisha – Hilly states of Jammu and Kashmir, Himachal Pradesh and Uttarakhand. – North-eastern states including Sikkim – Islands of Andaman Nicobar and Lakshadweep – Parliamentary constituencies covering 48 Aspirational districts of states other than those covered above. • Funding allocation • The total cost of the scheme is Rs 583 crore. MNRE will provide 75% of the cost of street lights and remaining 25% will come from Member of Parliament Local Area Development funds (MPLADS).

National Wind-Solar Hybrid Policy

• India has set an ambitious target of reaching 175 GW of installed capacity from renewable energy sources by the year 2022, which includes 100 GW of solar and

60 GW of wind power capacity.

Aims and Objective

• The main objective of the Policy is to provide a framework for promotion of large grid connected wind - solar PV hybrid system for optima l and efficient utilization of transmission infrastructure and land, reducing the variability in renewable power generation and achieving better grid stability.

• Policy also aims to encourage new technologies, methods and wayouts involving combined operation of wind and solar PV plants.

• Period of enforcement

• This policy will remain in force unless withdrawn, modified or superseded by the Government. The Government will undertake a review of this Policy as and when required.

National Biogas and Manure Management

• National Biogas and Manure Management programme (NBMMP)

• The programme was started in 1981-82 as the National Project on Biogas Development.

Objectives

• To provide fuel for cooking purposes and organic manure to rural households through family type biogas plants

• To mitigate drudgery of rural women, reduce pressure on forests and accentuate social benefits

• To improve sanitation in villages by linking sanitary toilets with biogas plants