| Course Type | Course Code | Name of Course | L | T | P | Credit |
|---|---|---|---|---|---|---|
| DE | ESD403 | Waste to Energy | 3 | 0 | 0 | 9 |

**Course objectives**

This course is designed to provide a holistic approach to understanding the conversion of anthropogenic waste to energy. The focus has been on technological advancements, and the emerging variety of waste that can be utilized to provide energy in form of heat, solid/liquid/gaseous fuel, or direct electrical energy. Waste characterization for appropriate technology selection, waste management approach, utilization as an alternative energy source, and economics thereof will be discussed for developing a better understanding of the concepts. The case studies will be helpful to give a practical and on-ground understanding of the mechanics involved in waste to energy in the Indian context.

**Learning Outcomes**

- Develops the concept of zero waste by its efficient utilization.
- Develops management principles for the production of energy from waste.
- Updated technologies for more efficient conversion of waste to energy.
- Reconciliation of theoretical concepts with practical on-ground experiences.
- Provides opportunities for understanding possibilities of success and failures on a case-to-case basis.

| Unit No. | Topics to be Covered | Lecture Hours | Learning Outcome |
|---|---|---|---|
| I | **Introduction, Global dedication for waste to energy**<br>Waste sources & characterization, waste production in different sectors such as domestic, industrial, agriculture, postconsumer waste etc.<br>Classification of waste – agro-based, forest residues, domestic waste, plastic waste, industrial waste (hazardous and non-hazardous). Characterization of waste for energy utilization. Waste Selection criteria. Aspirational aims and international forums. | 8 | This unit will provide an overview of waste source, characterization, and energy conversion. |
| II | **Technologies for Waste to Energy**<br>Thermo-chemical Conversion – Combustion, Incineration and heat recovery, Pyrolysis, Gasification; Plasma Arc Technology, hydrothermal liquefaction, and other newer technologies.<br>Biochemical Conversion – Energy production from organic waste through anaerobic digestion and fermentation.<br>Hybrid Technology: Bio-electrochemical conversion – Microbial fuel cells, Electrolytic cells.<br>Source utilization-based classification of waste-to-energy technologies into the first, second, and third generation. | 9 | This unit develops an understanding of conventional technologies and the need for technological advancements and emerging technologies. |
| III | **Energy opportunities from urban waste**<br>Energy from Municipal solid waste and Sewage sludge.<br>Fuel from non-recyclable plastic waste and energy analysis<br>Landfill gas collection and recovery. Refuse Derived Fuel (RDF), briquettes, pellets. Alternate Fuel Resource (AFR), – production and use in various Industries. | 4 | This unit explores the waste-to-energy options from solid and liquid waste generated mostly from urban areas. |
| IV | **Energy opportunities in suburban and rural areas.**<br>Agriculture waste for the generation of liquid and gaseous fuel. Conversion of agroindustry and food processing industry waste to byproducts and fuel generation.<br>Domestic/Municipal wastewater for the cultivation of algal biomass -the next-generation fuel. | 4 | Reveals the vast opportunityof energy from the rural waste and economic development opportunities |
| V | **Centralized and Decentralized Waste to Energy Plants**<br>Waste activities – collection, segregation, transportation, and storage requirements. Location and Siting of 'Waste to Energy plants. Industry Specific Applications – In-house use – sugar, distillery, pharmaceuticals, Pulp and paper, refinery and petrochemical industry, Nuclear waste, Mining (shaly coal waste), and other industry.<br>Centralized and Decentralized Energy production, distribution, and use. Comparison of centralized and decentralized systems and their operations. | 6 | Reveals the advantages and disadvantages and suitability of the centralized or the decentralized waste-to-energy units. This will help in developing the feasibility of waste-to-energy plans. |

| | | | |
|---|---|---|---|
| VI | **Case Studies Indian and Global** –<br>Success/failures of waste to energy. Global Best Practices in waste to energy production distribution and use.<br>Indian/global scenario on waste to energy production distribution and use. Success and failures of waste to energy plants. Role of the Government in promoting 'Waste to Energy. | 6 | Provides a mechanism for insight into the feasibility of technology. |
| VII | **Waste To Energy & Environmental Implications**<br>Environmental standards for Waste to Energy Plant operations and gas clean-up. Savings on non-renewable fuel resources.<br>Carbon Credits: Carbon foot calculations and carbon credits transfer mechanisms. Life cycle assessment for studying environmental sustainability. Economic study. | 5 | Application aspects of the knowledge in planning and operations of Waste to Energy plants. |

**Text Books:**

1. Rogoff, M.J. and Screve, F., "Waste-to-Energy: Technologies and Project Implementation", 3rd edition, 2019. Elsevier Store.
2. Young G.C., "Municipal Solid Waste to Energy Conversion Processes: Economic, Technical, and Renewable Comparisons", John Wiley and Sons.

**Reference Book:**

1. Mukhopadhyay S.N. Fundamentals of waste and Environmental Engineering, , TERI Press.
2. Waste-to-Energy in Austria – White Book – Figures, Data Facts, 2nd edition, May 2010.
3. Harker, J.H. and Backhusrt, J.R., "Fuel and Energy", Academic Press Inc.