Course Proposal

For Inception of Post Graduate Diploma (PGD)

in

ENERGY MANAGEMENT

Madhya Pradesh Bhoj (Open) University, Bhopal

About Post Graduate Diploma in Energy Management

Energy Management and Climate action are two pillars of sustainable and competitive economy. Effective energy management and climate actions are the essential tools in helping to reduce carbon emissions, improve efficiency and cost savings.

The Indian Power Sector with approx. 417.1 GW (as on 15/05/2023) installed capacity alongwith modernization of Indian Power Sector also with technological advancements and sophistication during last few decades has, in turn, been demanding trained man power. Coal, natural gas and oil reserves are finite and hidden. An unknown and limited amount of each resource is buried deep underground or under the ocean. As more is harvested, finding new sources becomes more difficult and more expensive, and exploiting them becomes more challenging and sometimes dangerous as well. Marginal reserves, such as oil sands, require the burning of huge amounts of natural gas to refine them into usable oil. The Overall generation (Including generation from grid connected renewable sources) in the country has been increased from 1110.458 BU during 2014-15 to 1624.465 BU during 2022-23.

Renewable energy is reliable and plentiful and will potentially be very cheap once technology and infrastructure improve. Strong consensus in the scientific community states that climate change and global warming are occurring and are caused by human production of carbon dioxide and other greenhouse gases. Climate change may also damage agriculture, cause widespread extinctions, imperil clean water supplies and aid the spread of tropical diseases. Renewable energy produces only minute levels of carbon emissions and therefore helps to combat climate change caused by fossil fuel usage.

The renewable energy sector is growing at an exponential rate creation new job opportunities across the globe. This program aims to develop competency in the areas of energy policy making, financing, energy management, auditing and infrastructure provisioning. Newer renewable electricity sources are targeted to grow massively by the end of decade, including more than 19 fold increase in solar power from April 2023 levels.

Post Graduate Diploma in Energy Management brilliantly brings together the understandings of energy generation, management and sustainability. The course is constructed with an objective to impart fundamental and in-depth expertise of the subject for you to get absorbed in the renewable energy generation & utilization industry. With an upgraded curriculum that matches the present industry requirements, the course shall give you insights in energy management issues and prepare you for handling challenges of the changing global world.

The technical knowledge acquired from Engineering Colleges provides the basic foundation, which needs to be supplemented with the Applied Engineering skills so as to groom the engineersfor efficient functioning at every

stage of planning, designing, engineering, procurement, construction, commissioning, operation, maintenance, transmission and distribution of power supply industry. This course would enable the graduates to make a meaningful participation in accelerating India's economy by gaining appropriate employment, becoming entrepreneurs and creating appropriate knowledge. Already, industry experts and academicians are hailing the move, calling it an opportunity for vertical mobility.

Business & Job Prospects in Energy Management: As per the Bureau of Energy Efficiency's UNNATEE Report, The energy saving investment potential of the country is estimated to be 840,852 INR Cr. by the year 2031 under the moderate savings scenario, with the industrial sector constituting highest energy saving investment potential of 307137 INR Cr. This offers a great opportunity to drive business in energy efficiency, technology and services and also would offer lucrative job prospects in order to drive this business potential. On the other side Climate Action is a must for all: There is no country that is not experiencing the drastic effects of climate change. Greenhouse gas emissions are more than 50 percent higher than in 1990. Global warming is causing long-lasting changes to our climate system, which threatens irreversible consequences as per the UN study, it is expected to mobilize around US$100 billion annually by 2020 to address the needs of developing countries to both adapt to climate change and invest in low-carbon development. To achieve the energy efficiency potential targets as well as climate action goals, it becomes necessary to structure a robust implementation strategy that paves the way for energy security and sufficiency. In order to scale up efforts on energy & climate action, it is also proposed to have Mandatory energy management cell with qualified and competent professionals in Industry. This would call for need of competent and qualified professionals in energy management & climate action.

With the objective of competence development and enhancing job prospects in energy management and climate action and to create world class leaders into the domain, Madhya Pradesh Bhoj Open University, Bhopal have designed the online "Post Graduate Professional Development Program in Energy Management". The course aims at creating world class leaders in Energy and Climate Action Domain by facilitating industry oriented education program for working professionals, recent graduates and for those who wish to build their career in energy management and climate action field Post Graduate Diploma in Energy Management brilliantly brings together the understandings of energy generation, management and sustainability. The course is constructed to impart fundamental and in-depth expertise of the subject for you to get absorbed in the energy management industry. With an upgraded curriculum that matches the present industry requirements, the course shall give you insights into energy management issues and prepare you for handling the challenges of the changing global world.

Eligibility Criteria

There may be three types of learners getting admission to the first semester of skill-based coursesunder NSQF:

Category – 1: Students who have already acquired NSQF certification Level 7 in a particular industrial sector and opted for admission in the skill based courses under NSQF in the institutions recognized under Community Colleges/B.Voc. Degree program/DDU KAUSHAL Kendras in same trade with job role for which he/she was previously certified.

Category – 2: Students who have acquired NSQF certification Level 7 but may like to change their trade and may enter into skill-based courses in a different trade.

Category – 3: Students who have passed Bachelor degree examination with at least secondclass from a recognized University.

Candidates who have passed an equivalent examination from any other University orexamining body and are seeking admission to the Post Graduate Diploma course, will be required to provide necessary eligibility certificate.

WRITTEN TEST: The Test will be of two hour duration and will have questions that will be of the level of Graduation or NSQF level 7 on the subject concerned. Questions will include topics on Renewable Energy. Candidates will have one compulsory paper on General Knowledge & Current affairs and other on subject.

Who should join

- Working professionals from PSUs/Industry/Consulting Firms etc
- Practicing energy, environment and climate professionals
- Production/Maintenance/Design/Project /EHS/Quality Engineers/Managers/Green building professionals
- Recent Engineering Graduates/Post Graduates in Science Streams
- Academic Professionals from Higher Educational Institutes

Minimum Qualification

B.Voc. in relevant Branch or
B.E./B.Tech or equivalent in any branch orB.Sc. with Physics or
Electronics or B.Sc.(Ag) or B.Tech (Ag.Engg) or
M.Sc. in Physics/Chemistry orM.Tech. in relevant
field or
Acquired above NSQF-7 Certification

Course Fee:

Rs 8,000 per year for Post Graduate Diploma

Security Deposit

Rs. 2,000 for Post Graduate Diploma

Admission Fee

As per university rules

Course Structure

The PG Diploma Programme in Energy Management consist of

a) Course on energy environment interaction, renewable energy sources and energy management
b) Specialized courses on solar energy, biomass energy, wind and hydro energy to expose the learner on these courses about the principles, conversion systems, and applications
c) Specialized courses on energy management and energy efficiency in thermal and electrical utilities to enhance the domain knowledge
d) Project work, where special emphasis is placed on the application of the knowledge gain in the theory courses in areas of renewable energy and energy management depending on the choice of learner.

Program Structure:

The program structure will comprise of virtual classroom, assignments and Project work (to conducted in evening/weekend – 3 days a week). Recordings of all the lectures/classes would be available for the reference. Course would mainly focus on practical case studies, analysis of energy & climate action initiatives, practical project work and assignment based on actual energy consumption profile of industry, energy audits etc. focus of the course would be to develop understanding of energy management and climate action initiatives at global level, country level, industry level and as professionals with an aim to create leadership.

Program Objectives

a) To prepare the learners for successful career in energy industry, energy service companies, energy utilities and consultancy agency.
b) To produce specialized manpower strong in understanding, designing on technologies and systems, energy efficiency in utilities, and capable in technological solutions required for industry, entrepreneurship development.
c) To enhance the knowledge and understanding of the working professional on energy conversion process, energy efficiency and make use of the enhanced knowledge in their domain of work.
d) To produce energy professional who are sensitive to and well aware of, the energy issues and concerns, and who can apply their specialized knowledge for the sustainable development.

Tentative Syllabus

YEAR-1					
MODULE CODE	**NAME**	**CREDIT**	**INTERNAL**	**EXTERNAL**	**TOTAL MARKS**
PGDRE-101	Energy Resources and Environment	4	30	70	100
PGDRE-102	Solar Energy	4	30	70	100
PGDRE-103	Wind and Hydro Energy	4	30	70	100
PGDRE-104	New Renewable Sources of Energy	4	30	70	100
TOTAL		**16**	**400**		
YEAR-2					
PGDRE-201	General Aspects of Energy Management and Energy Audit	4	30	70	100
PGDRE-202	Energy Efficiency in Electrical Utilities	4	30	70	100
PGDRE-203	Energy Efficiency in Thermal Utilities	4	30	70	100
PGDRE-204	Major Project & Dissertation	8	0	200	200
TOTAL		**20**	**500**		

After PG Diploma?

Demand for the energy sectors is increasing day by day. There is also a sustainable and growing interest in the renewable energy technologies worldwide. In a recent report from the European Commission and World Energy Council indicated that the limited contribution towards electricity generation made at present by renewable will increase substantially over the coming decades. Factors driving this increase are the environmentally benign nature of renewable, and their increasing cost effectiveness due to the recent technological advances.

The development and effective integration of energy systems into electricity supply networks of industrial or developing countries poses new challenges, which will require expert knowledge. As a consequence subject of energy science & technology is of increasing interest to the mature students and employment opportunities are expanding day by day. There is now huge demand for graduates with expertise in this area; hence this course can bridge the

demand gap with personnel possessing subject expertise.

- Trained in the field of Renewable Energy, to assess the commercial viability of updatingthe existing non-conventional Power Plants, business opportunities in Power Projects.
- Have the knowledge, skills and elements of analysis and judgement, necessary toconsider a pre-feasibility study for new smart power plants.
- Know the main lines of research in the field of Renewable Energy Utilization.
- Trained & equipped with knowledge and understanding to start their career in SkillUniversities and Colleges as a Teaching faculty as well as Researchers.
- Have the ability to analyze the behavior of a system in operation and make a diagnosison the operating system.
- Students have better opportunities to get the job in State Nodal Agencies for RenewableEnergy Development, State Electricity Board and their R&D sector.

Career Prospects

- Power sector skills represent over 25% of all available jobs. In India, 30% of all government jobs are from Electrical skills.
- The country would need skilled people in large numbers to meet the requirement related to installation and maintenance of the Renewable Energy Technology.
- A person with Renewable Energy skills have opportunities to get employed in manufacturing and service sectors.
- An energy auditor is one of the profiles high in demand these days as the number of people who are looking for the effective ways that can make their homes energy efficient. The course is designed in a way that student can appear in prestigious exam for Certified Energy Manager & Auditor conducted by Bureau of Energy Efficiency.
- Other than conventional jobs like power generation, distribution, transmission, manufacturing and utility sectors, skilled electrical persons are well positioned to succeed in competitive examinations.

Opportunity to pursue and upgrade career as

- Energy/ Climate Action Manager
- Highly Job Oriented Course for Engineering
- Graduates to pursue career as Energy
- Engineer/Energy Analyst/ Energy Strategist/
- Energy Auditor in India & abroad
- Wide future prospects for Academics and R & D
- Professionals to Build Proficiency in Energy and Climate Sector
- Opportunities for Entrepreneurs to learn and start-up in emerging field of energy efficiency and Climate action

Syllabus (Session 2023-24)

PGDRE 101 Energy Resources and Environment

Unit 1 Ecological principles and energy flow
1.1 Ecological principle of nature
1.2 Concept of ecosystems
1.3 Different types of ecosystems; ecosystem theories
1.4 Energy flow in the ecosystems; biodiversity

Unit 2 Energy scenario and development
2.1 Overview of world energy scenario
2.2 Overview of India's energy scenario
2.3 Overview of Energy Scenario of India
2.4 Energy and development linkage
2.5 Energy Sources: classification of energy sources
2.6 Quality and concentration of energy sources

Unit 3 Major energy resources
3.1 Units of various Energy sources, Conversion, calorific value
3.2 Coal-sources, formation, important properties & conversion
3.3 Petroleum-sources, genesis, important properties & uses
3.4 Natural gas- sources, genesis, important properties & uses

Unit 4 Environment concerns of energy extraction
4.1 Environment effects of energy extraction, conversion and use
4.2 Sources of pollution; primary and secondary pollutants.
4.3 Consequences of pollution growth; air, water, soil, thermal, noise pollution-cause and effect
4.4 Pollution control methods
4.5 Environmental laws on pollution control

Unit 5 Energy use & climate change
5.1 Global warming
5.2 Green house gas emission, impacts, mitigation.
5.3 Causes of global, regional and local climate change

Unit 6 Sustainability issues of energy use
6.1 Externalities
6.2 Future Energy Systems
6.3 Clean Energy Technologies

Unit 7Socio-Economical aspects of Energy resources
7.1 General concepts
7.2 Socio-economical impacts
7.2.1 Rural development, Poverty alleviation, Employment; Security of supply and use
7.2.2 Environmental and ethical concerns
7.3 Economical aspects of renewable energy systems vs large hydro and thermal power projects

Unit 8 International treaties & convention on environmental mitigation
8.1 United Nations Frameworks Convention on climate change (UNFCC)
8.2 Various convention and treaties at international level aiming at CO2 mitigation

Suggested reading references
1. Ristinen RA. Kraushaar JJ. Energy and the Environment, 2nd edition, John Willey & Sons, 2006
2. Banerjee BP. Handbook of Energy and Environment in India, Oxford University Press, 2005, India
3. MC Dass, Fundamentals of Ecology, Tata McGraw Hill, 1994
4. Kaushik ND. Kaushik K. Energy, Ecology & Environment, Capital Publishing, 2004
5. De AK. Environmental Chemistry, New Age International Publishers, 2005

PGDRE 102 Solar Energy

Unit 1 Solar Radiation
1.1 Solar radiation: extra-terrestrial and terrestrial
1.2 Radiation measuring instruments
1.3 Radiation measurements and predictions
Unit 2 Basics of Solar Thermal Conversion
2.1 Solar thermal conversion: basics
2.2 Flat plate collectors-liquid and air type, Theory of flat plate collectors
2.3 Selective coatings

Unit 3 Solar thermal systems and applications
3.1 Advanced collectors: ETC, Solar Pond
3.2 Concentrators: optical design of concentrators
3.3 Solar water heaters, Solar dryers, Solar stills
3.4 Economics of solar thermal conversion systems

Unit 4 Solar thermal Energy conversion
4.1 Solar cooling and refrigeration

4.2 Thermal storage
4.3 Conversion of heat into mechanical energy
4.4 Active and passive heating of buildings
4.5 Solar thermal power generation

Unit 5 Basics of Solar Photovoltaics
5.1 Principle of photovoltaic conversion
5.2 Technology for fabrication of photovoltaic devices

Unit 6 Solar Photovoltaic energy conversion and utilization
6.1 Photovoltaic power generation systems.
6.1.1 Off-grid systems
6.1.2 Grid connected systems
6.2 Organic solar cells
6.3 Electrochemical energy storage: Batteries
6.4 Economics of solar photovoltaic systems

Unit 7 Power electronics for Photovoltaic systems
7.1 Off-grid power control and management systems
7.2 Grid-connected power control and management systems

Unit 8 Solar Photo-catalysis
8.1 Solar photocatalysis: mechanism, Kinetics
8.2 Nano-catalysts: system design, Performance parameters
8.3 Applications of solar photo-catalysis

Suggested reading references
1. Goswami DY. Kreith F. Kreider JF. Principles of Solar Engineering, Taylor & Francis, 1999
2. Tiwari GN. Solar Energy, Fundamentals design, modeling and Applications. Narosa, 2002
3. Duffie JA. Beckman WA. Solar Engineering of Thermal Processes, John Wiley, 2006
4. Kishore VVN. Renewable Energy Engineering and Technologies, TERI, 2009

PGDRE 103 Biomass Energy

Unit 1 Introduction
1.1 Overview of biomass as energy source; Biomass availability in North Eastern States of India
1.2 Production of biomass, Photosynthesis, efficiency of C3 & C4 plants on biomass production.
1.3 Classification of biomass.

Unit 2 Biomass as fuel
2.1 Physicochemical characteristics of biomass as fuel

2.2 Thermal characteristics of biomass as fuel
2.3 Biomass conversion routes: biochemical, chemical and thermo-chemical

Unit 3 Biochemical conversion of biomass for energy production
3.1 Anaerobic digestion, biogas production mechanism
3.2 Types of digesters, installation, operation and maintenance of biogas plants
3.3 Biogas plants manure-utilization and manure values.
3.4 Biogas utilization and storage
3.5 Biogas for motive power generation etc.

Unit 4 Liquid biofuel
4.1 Biodiesel – the mechanism of transesterification, fuel characteristics of biodiesel, technical
aspects of biodiesel engine utilization
4.2 Alcohol production from biomass- types of materials of alcohol production-process description, utilization

Unit 5 Chemical conversion of biomass for energy production
5.1 Chemical conversion processes
5.2 Hydrolysis and hydrogenation

Unit 6 Synthesis biofuel
6.1 Modern biofuel synthesis
6.2 Bio- refinery

Unit 7 Thermo-chemical conversion of biomass
7.1 Combustion in excess oxygen and oxygen deficient atmosphere
7.2 Pyrolysis, Carbonization, Charcoal production
7.3 Biomass gasification--different types--power generation from gasification
7.4 Biomass based power generation

Unit 8 Energy plantation
8.1 Overview on energy plantation
8.2 Basis of selecting the plants for energy plantation
8.3 Waste land utilization through energy plantation
Suggested reading references
1. Mukunda HS. Understanding Clean Energy and fuels from biomass. Wiley-India Pvt. Ltd, 2011
2. Pandey A. Hand book of plant-based bio-fuel. CRC Press, Taylor & Francis, 2008
3. Mital KM. Biogas Systems, Principle and Applications. New Age International Ltd. 1996
4. Rai GD. Non-conventional energy sources. Khanna Publication, 2001
5. Ravindranath NH. Hall DO. Biomass, Energy and Environment, A developing country perspective from India. Oxford University Press, 1995

PGDRE 104 Wind and Hydro Energy

Unit 1 Wind resource assessment
1.1 History of wind energy, Current status and future prospects, Wind Energy in India.
1.2 Power available in the wind, Wind Turbine power and torque characteristics, Types of rotors: Horizontal and Vertical axis wind turbine, Characteristics of wind rotor.
1.3 Analysis of wind regimes
1.3.1 Local effects, wind shear, Turbulence and acceleration effects
1.3.2 Measurement of wind: Ecological indicator, Anemometers and wind directions.
1.3.3 Wind speed statistics: Time and Frequency distribution, Mean wind speed and distribution of wind velocity.
1.3.4 Statistical model for wind data analysis : Weibull distribution
1.3.5 Energy estimation of wind regimes, capacity factor.

Unit 2 Aerodynamics of wind turbine
2.1 Airfoil, lift and drag characteristics
2.2 Aerodynamic theories
2.2.1 Axial momentum theory
2.2.2 Blade element theory
2.2.3 Strip theory
2.3 Power coefficient and tip speed ratio characteristics, Rotor design and Performance analysis

Unit 3 Wind energy conversion systems
3.1 Wind electric generators
3.1.1 Tower, rotor, gearbox, power regulation, safety mechanisms
3.1.2 Generator: Induction and synchronous generator
3.1.3 Grid integration
3.2 Wind pumps
3.2.1 Wind driven piston pumps, limitations and performance analysis

Unit 4 Wind energy systems: Environment and Economics
4.1 Environmental benefits and problems of wind energy
4.2 Economics of wind energy
4.21 Factors influence the cost of energy generation: Site specific parameters, machine parameters
4.2.2 Life cycle cost analysis

Unit 5 Hydro-power
5.1 Introduction to Hydropower, Classification of Hydropower Plants, Small Hydropower Systems: Overview of micro, mini and small hydro systems, Status of Hydropower Worldwide, Advantages and Disadvantages of Hydropower

5.2 Selection of site for hydroelectric plant, Hydrological cycle
5.3 Essential elements of a hydroelectric power plant

Unit 6 Basics of Fluid Mechanics
6.1 Classification of Fluids, Characteristic of Water, units of Pressure, Pascal's law, applications of Pascal's law, Hydraulic press, Pressure measurement
6.2 Types of fluid flow, stream line and turbulent flow
6.3 Velocity Equation, Bernoulli's Equation, Power Equation, Continuity Equation, Cavitations, venturi meter, orifice meter, Pitot tube

Unit 7 Components of Hydropower Plants
7.1 Components of hydropower plants
7.2 Hydraulic Turbines: Types and Operational Aspects
7.2.1 Classification of Hydraulic Turbines, Theory of Hydroturbines; Francis, Pelton, Kaplan and Propeller Turbine; differences between impulse and reaction turbines; Operational Aspects of Turbines
7.2.3 Efficiency and selection of turbines
7.3 Types of generators - synchronous and induction, transformers, protection & control, transmission and distribution system.
7.3 Dam and Spillway, Surge Chambers, Penstock, Tailrace

Unit 8 Hydropower plant development
8.1 Site selection, environmental aspect, run-of-the-river and storage schemes; diversion structures, power channels, desilting arrangements, forebay tank and balancing reservoir, penstock and power house; transmission and distribution system.
8.2 Economics: cost structure, Initial and operation cost. Environmental issues related to small and large hydropower plants
8.3 Potential of hydro power in North East India

Suggested reading references

1. Johnson GL. Wind Energy Systems, (Electronic Edition), Prentice Hall Inc, 2006
2. Mathew S. Wind Energy: Fundamentals, Resource Analysis and Economics. Springer, 2006
3. Burton T. Sharpe D. Jenkins N. Bossanyi E. Wind Energy Handbook. John Wiley, 2001
4. Jha AR. Wind Turbine Technology, CRC Press, Taylor & Francis, 2011
5. Jain P. Wind Energy Engineering. McGraw-Hill 2011
6. Nag P K. Power Plant Engineering, 3rd Edition, Tata McGraw Hill, 2008.
7. Bansal RK. A textbook of fluid mechanics and hydraulic machines. Laxmi Publications, 2005, New Delhi
8. Hussian Z. Abdullah MZ. Alimuddin Z. Basic Fluid Mechanics and Hydraulic Machines. CRC Press, 2009.
9. Jiandong T. Mini hydropower. John Wiley, 1997
10. Wagner H. Mathur J. Introduction to Hydro energy Systems : Basics, Technology and Operation, Springer, 2011

PGDRE 105 New Energy Resources

Unit 1 Background
1.1 Need of energy systems and materials
1.2 Application to supplement and expedite energy conservation efforts
1.3 Addressing environmental concern
1.4 Suitability as CDM

Unit 2 Hydrogen Energy
2.1 Basics of Hydrogen Energy
2.3 Production methods
2.4 Storage and transportation
2.5 Applications

Unit 3 Fuel Cell
3.1 Principle of working
3.2 Basic thermodynamic and electrochemical principles
3.3 Classifications
3.4 Applications for power generations

Unit 4 Ocean Energy
4.1 Ocean energy resources
4.2 Ocean energy routes
4.3 Ocean thermal energy conversion
4.4 Wave energy conversion
4.5 Tidal energy conversion

Unit 5 Geothermal Energy
5.1 Origin
5.2 Types of geothermal energy sites
5.3 Geothermal Power plants

Unit 6 Magneto-hydro-dynamic (MHD) energy conversion
6.1 Principle of operation
6.2 Classifications
6.3 Features of MHD Systems

Unit 7 Electrochemical Energy Storage System
7.1 Batteries
7.2 Types
7.3 Working principles
7.4 Role of carbon nanotubes in electrode

Unit 8 Magnetic and Electric Storage System
8.1 Super conducting magnetic energy storage (SMES) systems
8.2 Capacitor and super capacitor

Suggested reading references

1. Narayan R. Biswanathan B. Chemical and Electrochemical Energy Systems, University Press (India) Ltd. 1998.
2. J W Twidell & A D Weir, Renewable Energy Resources, ELBS, 2006
3. Tiwari GN. Ghoshal MK. Fundamental of Renewable Energy Sources, Narosa, 2007.

PGDRE 201 General Aspects of Energy Management and Energy Audit

Unit 1 Energy and its various forms
1.1 Commercial and Non-commercial energy, primary energy resources, commercial energy production
1.2 Energy pricing, energy security, energy conservation and its importance
1.3 Electricity tariff, load management and maximum demand control
1.4 Thermal energy contents of fuel, heat capacity, sensible and latent heat, heat transfer
1.5 Stochiometric air-fuel ratio, Flue gas analysis

Unit 2 Energy management and auditing
2.1 Concept of energy management programme , Energy auditing services; basic components of an Energy audit, types of energy audit, Industrial, commercial and residential audit planning
2.2 Understanding energy costs, bench marking, energy performance index
2.3 Understanding energy used pattern, system efficiencies, input energy requirements optimization
2.4 Fuel & energy substitution
2.5 Energy conservation act and its features
2.6 Duties and responsibilities of energy managers and auditors
2.7 Energy audit instruments/ tools

Unit 3 Material and Energy Balance
3.1 Basic Principles, Sankey diagrams
3.2 Material balances for different processes
3.3 Energy balances, heat balances
3.4 Methods for preparing process flow chart
3.5 Procedure to carry out the material and energy balance in different processes

Unit 4 Energy Action Planning
4.1 Energy management systems, Management commitment and energy conservation policy
4.2 Energy performance assessment: Data collection and management, analysis of data,

baseline and benchmarking, Estimation of energy savings potential
4.3 Action planning, training planning.

Unit 5 Monitoring and Targeting
5.1 Defining monitoring & targeting, elements of monitoring & targeting,
5.2 Data and information-analysis, various techniques
5.3 Energy consumption, production, cumulative sum of differences (CUSUM), case studies.

Unit 6 Electrical Energy Management
6.1 Reactive power management
6.2 Energy conservation in domestic and industrial sectors
6.3 Energy conservation in lighting, motors, pumps and fan systems

Unit 7 Thermal Energy Management
7.1 Energy conservation in boilers and Furnaces
7.2 Waste heat recovery
7.3 Thermal insulation
7.4 Energy conservation in buildings, Building heating and cooling load management, Buildings code, solar passive and green building concepts

Unit 8 Financial and Project Management
5.1 Financial analysis techniques : simple payback period, return on investment, net present value, internal rate of return, cash flows and sensitivity analysis
5.2 Financing options, energy performance contracts and role of ESCOs.
5.3 Project definition and scope, Technical design and Financing
5.4 Project planning techniques; CPM and PERT, case studies

PGDRE 202 Energy Efficiency in Thermal Utilities
Unit 1 Fuels and Combustion
1.1 Introduction to Fuels
1.2 Properties of Fuel oil, Coal and Gas, Storage, handling and preparation of fuels
1.3 Principles of Combustion, Combustion of Oil, Coal, and Gas
1.4 Stoichiometric air fuel ratio, Theoretical and excess air

Unit 2 Energy conservation in boilers
2.1 Boiler systems, Types of boilers
2.2 Combustion in boilers
2.3 Performances evaluation; Analysis of losses
2.4 Feed water treatment, Blow down
2.5 Energy conservation opportunities

Unit 3 Steam Systems
3.1 Steam Properties

3.2 Steam distribution
3.3 Steam pipe sizing and designing
3.4 Steam traps: Operation and maintenance, Performance assessments
3.5 Energy conservation opportunities

Unit 4 Furnaces
4.1 Types and classifications of different furnaces
4.2 Performance analysis of furnaces; Analysis of losses
4.3 General fuel economy measures in furnaces; Case study
4.3 Energy conservation opportunities

Unit 5 Cogeneration
5.1 Principle and need for cogeneration
5.2 Technical options of cogeneration; Classifications of cogenerations
5.3 Factors influences cogeneration cycle
5.4 Cogeneration performance parameters, Case study

Unit 6 Waste Heat Recovery
6.1 Classifications and Applications
6.2 Benefits of waste heat recovery
6.3 Commercial waste recovery systems, Case study

Unit 7 Insulations and Refractories
7.1 Purpose of insulations, Types and applications
7.2 Calculation of insulation Thickness; Economic thickness of insulations
7.3 Types and properties of refractories; Industrial use of refractories
7.4 Heat losses from furnace walls

Unit 8 Energy Performance assessment of heat exchangers
8.1 Performance terms and Methodology of performance assessment;
8.2 Case study

PGDRE 203 Energy Efficiency in Electrical Utilities

Unit 1 Electrical systems
1.1 Introduction of Electrical systems, Tariff and economic considerations; T & D losses
1.2 Electrical load management; Maximum demand management
1.3 Role of Power factor and its improvement
1.4 Electric Power systems analysis
1.5 Energy Efficient Technologies in Electrical Systems

Unit 2 Electric Motors
2.1 Motor Types, Characteristics, Efficiency

2.2 Energy Efficient Motors
2.3 Factors affecting Energy efficiency of a motor
2.4 Soft starters, Variable speed drives

Unit 3 Compressed Air systems
3.1 Introduction, Compressor types and performance; Compressed air systems components;
3.2 Efficient operation of compressed air systems, Systems capacity assessment
3.3 Energy conservation opportunities

Unit 4 HVAC and Refrigeration systems
4.1 Introduction: Types of Refrigeration systems; Common Refrigerant and Properties
4.2 Compressor types and applications
4.3 Performance assessment of Refrigeration plants
4.4 Energy conservation opportunities

Unit 5 Fans and blowers
5.1 Types, Performance evaluation, efficient system operation, Capacity selections
5.2 Performance assessment of fans and blowers
5.3 Energy conservation opportunities

Unit 6 Pumping systems and cooling towers
6.1 Types, Performance evaluation, efficient system operation
6.2 Energy conservation opportunities in pumping systems
6.3 Introduction to cooling towers; cooling tower performance, efficient system operation
6.4 Energy conservation opportunities in cooling towers

Unit 7 Lighting systems
7.1 Basic terms of lighting systems; Lamp and Luminaries types, recommended illumination level
7.2 Methodology of lighting systems energy efficiency study
7.3 Cast study, Energy conservation opportunities

Unit 8 DG Set systems
8.1 Introduction, Selection and capacity factor, Operational parameters
8.2 Performance assessment of DG Systems
8.3 Energy conservation opportunities

Suggested reading references (PGDRE 201, 202 and 203)

[1]. General Aspect of Energy Management and Energy Audit, 2010, BEE Guide book
[2]. Energy Efficiency in Thermal Utilities, 2010, BEE guide book
[3]. Energy Efficiency in Electrical Utilities, 2010, BEE guide book
[4]. Turner WC. Energy Management Handbook, 5th Edition, The Fairmont Press, 2005
[5]. Capehart, Turner, Kennedy. Guide to Energy Management. Fifth Ed. The Fairmount Press,

2006.
[6]. Thumann, Younger. Handbook of Energy Audit. Sixth Ed. The Fairmount Press, 2003.
[7]. Thumann, Mehta. Handbook of Energy Engineering. Fifth Ed. The Fairmount Press, 2001

Project Work
Students are required to submit the hard copy of the project by the end of the semester