

# ENERGY RESOURCES AND TECHNOLOGY

ENME 309

**Lecture** : 3  
**Tutorial** : 1  
**Practical** : 3/2

**Year : III**  
**Part : I**

## Course Objectives:

The objective of this course is to provide the key concepts of energy, including different energy resources and renewable energy technologies. Students will be able to design and evaluate energy systems, grasp the basics of energy storage and efficiency, and assess the environmental and economic impacts of energy solutions.

## 1 Introduction (6 hours)

- 1.1 Energy, laws governing energy flow, energy conversion efficiency and quality of energy
- 1.2 Importance of energy, energy demand and supply
- 1.3 Different forms of energy, primary and secondary energy in demand and supply side, Maslow's hierarchy of needs and its relation to energy
- 1.4 Current energy issues of the world and options for meeting world's energy need
- 1.5 Classification of energy resources with their advantages, dis-advantages and challenges
- 1.6 Classification of traditional fuels, refining of crude oil
- 1.7 Overview of energy trends, demand and supply of energy in the world and Nepal
- 1.8 Energy conservation and efficiency, energy mix for national energy security, overview of national and global energy policies on renewable energy
- 1.9 Global warming, climate change, and sustainability issues

## 2 Solar Energy (8 hours)

- 2.1 Basics of solar energy
  - 2.1.1 Solar radiation fundamentals and solar angles
  - 2.1.2 Measurement of solar radiation and measuring devices
  - 2.1.3 Solar resource assessment in a site
- 2.2 Solar thermal
  - 2.2.1 Solar collectors
  - 2.2.2 Solar water heating systems (Active and passive, flat plate and evacuated tube)
  - 2.2.3 Solar cooker (Concept, types and applications)
  - 2.2.4 Solar dryer and its applications

- 2.2.5 Solar space heating and cooling systems
- 2.2.6 Concentrating solar power (CSP) system
- 2.3 Solar photovoltaics
  - 2.3.1 Photovoltaic (PV) cell working principle
  - 2.3.2 Materials and types
  - 2.3.3 Current-Voltage (I-V) and Power-Voltage (P-V) characteristics for different temperature and radiations
  - 2.3.4 Solar modules and arrays: Standard test conditions (STC), nominal operating cell temperature (NOCT) and array losses
  - 2.3.5 Effects of partial and complete shadowing, PV tracking system and fixed installations, PV array location, distance between rows)
  - 2.3.6 PV system application: system components and design for non-pumping and pumping applications
  - 2.3.7 Off-grid and grid-integrated PV systems, rooftop and large-scale system

**3 Bio Energy (5 hours)**

- 3.1 Bio-energy and biomass resources
- 3.2 Biomass to energy conversion process
- 3.3 Energy from industrial waste
- 3.4 Biogas plant
  - 3.4.1 Working principle
  - 3.4.2 Components and construction
  - 3.4.3 Types of digesters
  - 3.4.4 Factors affecting bio digestion or generation of gas
- 3.5 Biomass pyrolysis and gasification process and their applications in industries

**4 Wind Energy (4 hours)**

- 4.1 Wind energy resources and measurements
- 4.2 Principles of wind energy conversion
- 4.3 Betz's limit, wind power density
- 4.4 Types and characteristics of horizontal and vertical axis wind turbines
- 4.5 Wind power control systems
- 4.6 Wind farming: Wind turbulence, locations (Offshore and onshore), concept of wind and solar hybrid power plants for mini-grid applications

**5 Micro and Small Hydro Power (7 hours)**

- 5.1 Principle of hydropower systems and components, types
- 5.2 Hydro turbines for micro and small hydro power plants
- 5.3 Micro and mini hydropower system
  - 5.3.1 Application in the context of Nepal
  - 5.3.2 Site investigation or feasibility study
  - 5.3.3 Determination of head and flow

- 5.3.4 Construction and operation overview
- 5.3.5 Electrical transmission and distribution system
- 5.4 System sizing and design considerations

**6 Non-Conventional Sources and Technologies (6 hours)**

- 6.1 Geothermal energy
- 6.2 Energy from co-generation (CHP) and its application in industries.
- 6.3 Hydrogen energy and fuel cell technology
  - 6.3.1 Fuel cells and hydrogen fuel system
  - 6.3.2 Hydrogen production processes
  - 6.3.3 Infrastructure requirement for hydrogen production, storage, transportation and utilization
- 6.4 Nuclear energy
  - 6.4.1 Nuclear reactions
  - 6.4.2 Nuclear fission and fusion technologies
  - 6.4.3 Nuclear power plant and working principle
  - 6.4.4 Health hazards, radiation protection and shielding
- 6.5 Urban and industrial waste to energy
- 6.6 Emerging renewable energy technologies

**7 Energy Storage System (4 hours)**

- 7.1 Different forms of energy storage
- 7.2 Battery fundamentals and different types of batteries
- 7.3 Super-capacitors (Construction and working, characteristics and applications)
- 7.4 Smart grids
- 7.5 EV integration (G2V, V2G) in commercial and industrial parks
- 7.6 Recent development on energy storage technology

**8 Energy Efficiency and Economics (5 hours)**

- 8.1 Energy conservation, energy efficiency and energy management
- 8.2 Energy saving measures in industry and other sectors
- 8.3 Energy star ratings and industrial efficiency standards
- 8.4 Energy audit concept, needs and types
- 8.5 Basic elements of audit and energy audit measurement devices
- 8.6 Energy pricing and tariff analysis
- 8.7 Financial analysis
- 8.8 Levelized cost of energy (LCOE)

**Tutorial (15 hours)**

- 1. Calculation for sizing solar thermal collector for industrial heating, drying, and process applications.
- 2. Calculation for system sizing in domestic and industrial use

3. System sizing and design for different components of micro and mini-hydropower system
4. Case study on renewable energy and energy efficiency projects
5. Review of energy audit reports

### Practical

**(22.5 hours)**

1. Measurement of solar radiation using pyranometer or reference cell and analyze solar angles at a specific site
2. Assemble a small PV system, measure I-V characteristics of solar panels under different conditions, and analyze the effects of shading and tilt angle
3. Determination of the performance of study of solar water heater
4. Study of bio gas plant and its principle of operation (Visit to nearby site)
5. Study the construction and operation of wind turbine (Visit to nearby site)
6. Study of micro/small hydro power systems (Visit to nearby site)
7. Conduct an energy audit in a small building/small industry, identifying areas of energy loss, and propose solutions for improving efficiency

### Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapters	Hours	Marks distribution*
1	6	10
2	8	10
3 and 4	9	10
5	7	10
6	6	10
7 and 8	9	10
<b>Total</b>	<b>45</b>	<b>60</b>

\* There may be minor deviation in marks distribution.

### References

1. Garg, H.P., Prakash, J. (2000). Solar energy: Fundamentals and applications (Latest Edition). McGraw-Hill Education.
2. Rai, G. D. (2010). Non-conventional sources of energy. Khanna Publishers.
3. Boyle, G. (2012). Renewable energy: Power for a sustainable future. Oxford University Press.
4. Bureau of Energy Efficiency. (2015). Energy efficiency in electrical utilities.