# RENEWABLE ENERGY AND CONVERSION DEVICES

**ENAE 251**

**Lecture : 3** **Year : II**
**Tutorial : 1** **Part : II**
**Practical : 2**

**Course Objectives:**
The objective of this course is to provide fundamental knowledge to detect potential renewable energy sources near to farm and development of skills on their conversion devices. After completion of this course, the students will be able to use locally available energy sources to fulfill the requirements of farm power devices using appropriate tools and methodology.

**1 Introduction (4 hours)**

1.1 Energy sources and their classification
1.2 Earth energy cycle and human interference
1.3 Energy consumption by fuel type and economic sectors in Nepal
1.4 Energy requirement in agricultural production system
1.5 Concept of energy audit and tools of energy analysis

**2 Solar Energy (18 hours)**

2.1 Availability and distribution of solar radiation
- 2.1.1 Spatial and temporal distribution
- 2.1.2 Measurement of solar radiation
- 2.1.3 Solar angle, angle of incidence and solar time
- 2.1.4 Incidence of solar radiation on horizontal and inclined surfaces
- 2.1.5 Solar energy potential and distribution in Nepal

2.2 Application of solar energy
- 2.2.1 Solar electricity
- 2.2.2 Solar thermal energy application

2.3 Solar plate collectors
- 2.3.1 Principle
- 2.3.2 Types of solar plate collectors: Flat and concentrating
- 2.3.3 Material of construction of solar plate collectors
- 2.3.4 Design considerations of solar plate collectors

2.4 Solar passive heating devices
- 2.4.1 Types and use
- 2.4.2 Thermal storage walls and attached green houses
- 2.4.3 Thermal storage roof

2.5 Solar crop dryers
- 2.5.1 Types of solar crop dryers
- 2.5.2 Natural convection solar dryers
- 2.5.3 Forced convection solar dryers
- 2.5.4 Mixed mode solar dryers
- 2.5.5 Design considerations
- 2.5.6 Performance evaluation

2.6 Photovoltaic conversion
- 2.6.1 Fundamentals of photovoltaic cell
- 2.6.2 Materials, manufacturing process and performance
- 2.6.3 Applications: Home/street lighting, water pumping, refrigeration and cold storage
- 2.6.4 Design procedures for solar PV system
- 2.6.5 Installation and maintenance

**3 Bioenergy Technologies (13 hours)**

3.1 Biomass
- 3.1.1 Definition and characteristics of biomass
- 3.1.2 Application of bioenergy
- 3.1.3 Collection and preconditioning of biomass
- 3.1.4 Briquetting and pelleting
- 3.1.5 Biomass conversion technologies
- 3.1.6 Biomass potential and application in Nepal

3.2 Thermochemical conversion technologies
- 3.2.1 Basic principles and process
- 3.2.2 Types of thermochemical conversion technologies: pyrolysis, gasification, combustion, and hydrothermal liquefaction
- 3.2.3 Design procedures for thermochemical conversion technologies
- 3.2.4 Factors affecting thermochemical conversion
- 3.2.5 Products and their application

3.3 Biochemical conversion technologies
- 3.3.1 Basic principles and process
- 3.3.2 Types of biochemical conversion technologies: Anaerobic digestion and fermentation
- 3.3.3 Design procedures for biochemical conversion technologies
- 3.3.4 Factors affecting biochemical conversion
- 3.3.5 Products and their application

3.4 Chemical conversion technologies
- 3.4.1 Basic principles and process
- 3.4.2 Types of chemical conversion technologies: Hydrolysis and transesterification
- 3.4.3 Design procedures for chemical conversion technologies
- 3.4.4 Factors affecting chemical conversion
- 3.4.5 Products and their application

**4 Wind Energy (5 hours)**

4.1 Basic wind data- speed and direction
4.2 Diurnal and seasonal variation in wind speed and direction
4.3 Types of wind energy converters
4.4 Performance and efficiency of windmill
4.5 Wind energy potential and application in Nepal
4.6 Design procedures for wind power for farm

**5 Micro and Small Hydroelectric Systems (5 hours)**

5.1 Classification of water wheels and turbines
5.2 Components of water wheels and turbines
5.3 Design considerations of hydropower
5.4 Power output and efficiency
5.5 Installation and operation management
5.6 Hydropower potential and distribution in Nepal
5.7 Applications of hydropower in agricultural and rural development

**Tutorial (15 hours)**

1. Energy audit of a campus building
2. Design of solar water heating system for a house
3. Design of solar crop dryer
4. Design of solar PV system for a house
5. Design of biogas plant for a house
6. Design of a wind pump for a farmland
7. Design of a micro-hydropower for a village

**Assignments**

Prepare a report on biogas plant/solar farm/micro/small hydropower plant.

**Practical (30 hours)**

1. Measurement of solar radiation using Pyranometer
2. Testing of solar thermal water heater
3. Efficiency testing of a flat plate solar collector
4. Performance analysis of a passive solar greenhouse
5. Efficiency evaluation of a solar cooker
6. Testing of a mixed model solar crop dryer
7. Proximate analysis of biomass
8. Operation and performance evaluation of a pyrolysis/gasification reactor
9. Fermentation of biomass to produce ethanol
10. Transesterification of vegetable oil to produce biodiesel

**Final Exam**

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

| Chapter | Hours | Marks distribution* |
|---|---|---|
| 1 | 4 | 4 |
| 2 | 18 | 24 |
| 3 | 13 | 20 |
| 4 | 5 | 6 |
| 5 | 5 | 6 |
| **Total** | **45** | **60** |

* There may be minor deviation in marks distribution.

**References**


1. Jenkins, N., Ekanayake, J. (2024). Renewable energy engineering. Cambridge University Press.
2. Sukahtme, S. P. (2009). Solar Energy: Principle of Thermal Collection and Storage. Tata McGraw Hill Publishing Co., New Delhi (latest edition)
3. Garg, H. P., Prakash, J. (2017). Solar Energy Fundamentals and Applications. Tata McGraw Hill Publishing Co., New Delhi (latest edition)
4. Mittal, K. M. (1916). Biomass Systems: Principle and Applications. New Age International Pvt. Ltd., New Delhi
5. Harvey, A., Brown, A., Hettiararchi, P., Inversin, A. (1993). Micro hydro design manual: a guide to small-scale water power schemes. Rugby, UK: Practical Action Publishing.
6. S Kafle, M Gyawali, S Adhikari, JP Kropp, P Pradhan. (2024). Possibilities and challenges for converting waste biomass into fuel, feed, and fertilizer in Nepal. Regional Environmental Change, Springer, 24, 133.
7. Neupane, D., Kafle, S., Pradhan, P., Karki, K.R., Kim, D.H. (2022). Solar and wind energy potential assessment at provincial level in Nepal: Geospatial and economic analysis. Renewable Energy, Elsevier, 181, 278-291.
8. Hydropower potential in Nepal. https://hydro.naxa.com.np/