



- Rai GD. 1998. *Nonconventional Sources of Energy*. Khanna Publication, New Delhi.
- Twindal JW and Wier AD. 1986. *Renewable Energy Sources*. E & F N Spon, New York.
- Verma SR, Mittal JP and Singh S. 1994. *Energy Management and Conservation in Agricultural Production and Food Processing*. USG Publication, Chicago.

**I. Course Title : Renewable Energy for Industrial Application**

**II. Course Code : REE 610**

**III. Credit Hours : 2+1**

**IV. Aim of the course**

To provide the knowledge regarding the energy consumption pattern in agro based industries, quantification techniques and identification of opportunities for renewable energy sources.

**V. Theory**

**Unit I**

Elucidation of unit operations in industry. Energy quantification techniques, system boundary, estimation of productivity, plant capacity utilization, energy density ratio and energy consumption pattern. Energy flow diagram conservation opportunities identification.

**Unit II**

Solar energy for industrial application: Solar water heating, steam solar cooking system, industrial solar dryer and solar process heat, solar cooling system (refrigeration, air conditioning and solar architecture technology), solar furnace and solar green house technology for high-tech cultivation. Solar photovoltaic technology for industrial power.

**Unit III**

Bio energy for industrial application: Quantification of industrial bio-waste, characterization, power generation through bio-methanation, gasification and dendro thermal power plant.

**Unit IV**

Wind energy: Aero generator of new era and national and international state of art in wind power generation. Other renewable energy sources: Magneto hydro dynamics, fuel cells technology and micro-hydro energy technology.

**VI. Practical**

Elucidation and energy consumption for unit operations in industry. Study of energy quantification and identification of opportunities for RET's. Design of solar dryers. Design of solar photovoltaic system. Design of gasifiers for thermal energy and power generation. Design of combustor (gasifier stove). Study of solar greenhouse. Study of biogas engine generator set. Case study of agro-industrial energy estimation and visit to RSE power generation site.

**VII. Learning outcome**

Students will be acquainted with energy quantification techniques, design of system, economic evaluation and utilization of renewable energy sources for agro-industrial applications.



### VIII. Lecture Schedule

S.No.	Topic	No. of Lectures
1.	Elucidation of unit operations in industry.	1
2.	Energy quantification techniques, system boundary,	2
3.	Estimation of productivity, plant capacity utilization,	2
4.	Energy density ratio and energy consumption pattern.	2
5.	Energy flow diagram conservation opportunities identification.	1
6.	Solar energy for industrial application.	1
7.	Solar water heating.	1
8.	Steam solar cooking system.	1
9.	Industrial solar dryer and solar process heat.	2
10.	Solar cooling system (refrigeration, air conditioning and solar architecture technology).	2
11.	Solar furnace.	1
12.	Solar greenhouse technology for high-tech cultivation.	2
13.	Solar photovoltaic technology for industrial power.	1
14.	Bio energy for industrial application	1
15.	Quantification of industrial bio-waste, its characterization	2
16.	Power generation through bio-methanation,	2
17.	Gasification and dendro thermal power plant.	2
18.	Wind energy: Aero generator of new era.	1
19.	National and international state of art in wind power generation.	2
20.	Other renewable energy sources: Magneto hydro dynamics, fuel cells technology and micro-hydro energy technology.	3
	<b>Total</b>	<b>32</b>

### IX. List of Practicals

S.No.	Topic	No. of Practicals
1.	Elucidation and energy consumption for unit operations in industry.	1
2.	Study of energy quantification and identification of opportunities for RET's	1
3.	Design of solar dryers.	2
4.	Design of solar photovoltaic system.	2
5.	Design of gasifiers for thermal energy and power generation.	2
6.	Design of combustor (gasifier stove).	2
7.	Study of solar greenhouse.	1
8.	Study of biogas engine generator set.	1
9.	Case study of agro-industrial energy estimation	2
10.	Visit to RSE power generation site.	1
	<b>Total</b>	<b>15</b>

### X. Suggested Reading

- Duffie JA and Beakman WA. 2006. *Solar Energy Thermal Process*. John Wiley and Sons, New York.
- Kumar S. 2011. *Energy Conservation Building User Code Guide*. Bureau of Energy Efficiency, New Delhi.
- Rathore NS, Kurchania AK and Panwar NL. 2007. *Non Conventional Energy Sources*. Himanshu Publications, Udaipur, Rajasthan.
- Sayigh AAM. 2012. *Solar Energy Engineering*. Academic Press, New York.
- Singh P, Kurchania AK, Rathore NS and Mathur AN. 2005. *Sustainable Development through Renewable Energy Sources*. Yash Publications, Bikaner, Rajasthan.