

**Semester-I**

**Energy Resources- India and World**

**Unit-I**

Energy Units and Conversion- energy units- Mtoe, ktoe, BTU, kWh, GJ, calorie etc., comparison of heat of combustion and energy-mass density of different fuels-Crude Oil, coal, gasoline, diesel, natural gas (GJ/kg, GJ/m<sup>3</sup>, kg/GJ, m<sup>3</sup>/GJ)

**Unit-II**

Availability and potential of energy resources in India-crude oil, natural gas, coal, lignite, solar, wind, hydro, nuclear fuel, biomass etc. Sankey diagram for India- balance and sector wise consumption.

**Unit-III**

Comparison of land area, population and per capita energy consumption of United States, Germany, United Kingdom, China, Sweden, France, Nepal, Bangladesh, Sri Lanka, Pakistan, Africa and India, World's average per capita energy consumption.

**Unit-IV**

Interactive Sankey Diagram of world, regions (Africa, Asia, China, OECD, Non-OECD, Europe, Middle East) and India in million of tones of oil equivalent, production and imports, sector wise consumption, analysis on energy imports and exports for India.

**Unit-V**

Solar Radiation- comparison of World solar radiation map with India solar radiation map-global horizontal irradiation, direct normal radiation, photovoltaic electricity potential, daily totals and yearly totals.

**References**

1. International Energy Agency, Interactive Sankey Diagram, <https://www.iea.org/sankey/>
2. Energy Statistics 2019, Central Statistics Office, Ministry of Statistics and Programme Implementation, Government of India, [http://www.mospi.gov.in/sites/default/files/publication\\_reports/Energy%20Statistics%202019-finall.pdf](http://www.mospi.gov.in/sites/default/files/publication_reports/Energy%20Statistics%202019-finall.pdf)
3. Energy Statistics 2018, Central Statistics Office, Ministry of Statistics and Programme Implementation, Government of India, [http://mospi.nic.in/sites/default/files/publication\\_reports/Energy\\_Statistics\\_2018.pdf](http://mospi.nic.in/sites/default/files/publication_reports/Energy_Statistics_2018.pdf)
4. Ministry of New and Renewable Energy, <https://mnre.gov.in/>
5. Bureau of Energy Efficiency, Government of India, <https://beeindia.gov.in/sites/default/files/1Ch1.pdf>
6. Ministry of Power <https://powermin.nic.in/en/content/power-sector-glance-all-india>
7. NITI Aayog, Energising India, <https://niti.gov.in/writereaddata/files/Energising-India.pdf>

8. World Energy Outlook, International Energy Agency <https://www.iea.org/reports/world-energy-outlook-2019>
9. World Energy Statistics <https://yearbook.enerdata.net/>
10. Energy, Hannah Ritchie and Max Roser, Our World in Data, <https://ourworldindata.org/energy>
11. World Bank Energy Use per capita <https://data.worldbank.org/indicator/EG.USE.PCAP.KG.OE>
12. IEA Atlas of Energy <http://energyatlas.iea.org/#!/tellmap/-1118783123>
13. Our World in Data <https://ourworldindata.org/grapher/energy-use-per-capita>
14. U.S. Energy Information Administration <https://www.eia.gov/>
15. Eurostat, European Statistics <https://ec.europa.eu/eurostat/web/energy/data>
16. Solar radiation maps <https://solargis.com/maps-and-gis-data/overview>

## **Semester-II**

### **Electricity Access- India and World**

#### Unit-I

Electricity production, access and per capita electricity consumption in different regions and countries -Africa, Asia, China, Europe, Middle East, United States, Germany, Japan, Nepal, Bangladesh, Sri Lanka, Pakistan, and India, world overview.

#### Unit-II

Electric Power Production in India-Pre-independence, post independence, five year plans, present status, growth of power sector, installed capacity and generation since independence to present scenario, growth of renewable energy in power production, National Solar Mission.

#### Unit-III

Estimated benefits of universal access of electricity to households, comparison of electricity access in various states and Union Territories of India, rural and urban areas, different income groups.

#### Unit-IV

Barriers to household electricity access and adoption- availability, power reliability, affordability, transmission and distribution (AT&C) losses for different states, comparison of losses in India with United States, electricity theft.

#### Unit-V

Rural electrification-history, evolution of rural electrification in India, Rural Electrification corporation, Kutir Jyoti Yojna, Pradhan Mantri Gramodaya Yojana, Rajiv Gandhi Grameen Vidyutikaran Yojana, Deen Dayal Upadhyay Gram Jyoti Yojana.

### **References**

1. Power for All, Electricity access challenge in India, Sudeshna Ghosh Banerjee, Douglas Barnes, Bipul Singh, Kristy Mayer, and Hussain Samad, World Bank Group, 2015.
2. Garv Dashboard, <https://smartutilities.net.in/2017/03/16/garv-dashboard/>

3. Electrification Status, Saubhagya Dashboard, <https://saubhagya.gov.in/>
4. Rural Electrification in India <http://www.ddugjy.gov.in/>
5. Gram Swaraj Abhiyan <https://saubhagya.gov.in/dashboard/gsa>
6. Ministry of Power Uday Dashboard <https://www.uday.gov.in/home.php>
7. Energy Statistics 2019, Central Statistics Office, Ministry of Statistics and Programme Implementation, Government of India, [http://www.mospi.gov.in/sites/default/files/publication\\_reports/Energy%20Statistics%202019-final.pdf](http://www.mospi.gov.in/sites/default/files/publication_reports/Energy%20Statistics%202019-final.pdf)
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9. Ministry of New and Renewable Energy, <https://mnre.gov.in/>
10. Ministry of Power <https://powermin.nic.in/en/content/power-sector-glance-all-india>
11. NITI Aayog, Energising India, <https://niti.gov.in/writereaddata/files/Energising-India.pdf>
12. World Energy Outlook, International Energy Agency <https://www.iea.org/reports/world-energy-outlook-2019>
13. World Energy Statistics <https://yearbook.enerdata.net/>
14. World Bank Energy Use per capita <https://data.worldbank.org/indicator/EG.USE.PCAP.KG.OE>
15. IEA Atlas of Energy <http://energyatlas.iea.org/#!/tellmap/-1118783123>
16. Our World in Data <https://ourworldindata.org/grapher/energy-use-per-capita>
17. U.S. Energy Information Administration <https://www.eia.gov/>

## **Semester-III**

### **Energy and Environment**

#### Unit-I

Introduction to energy resources-oil, natural gas, gasoline, coal, solar, wind, hydro, nuclear, biomass etc., environmental impacts of power production by different energy sources, comparison of carbon emissions from different types of power plants.

#### Unit-II

Air pollution- definition, sources and causes of air pollution, impact of air pollution on human health, comparison of World Health Organisation data on death toll due to air pollution in low income, middle income and higher income countries.

#### Unit-III

Direct air pollutants- NO<sub>x</sub>, SO<sub>x</sub>, lead, CO, particulate matter, indirect air pollutants- ground level ozone or smog, particulate matter, health impact and welfare losses caused by pollution, measures to reduce these pollutants.

#### Unit-IV

Climate Change- definition, reason for climate change, observed changes in climate system-green house gas concentrations and CO<sub>2</sub> emissions, impacts of climate change on physical, biological and human managed systems.

## Unit-V

Future Climate Change- Introduction to Representative Concentration Pathways (RCPs), mitigation scenarios, (RCP2.6), intermediate scenarios (RCP4.5 and RCP6.0) and scenario with very high GHG emissions (RCP8.5), their impacts.

## References

1. Renewable Energy Engineering and Technology: Principles and Practice, Edited by V V N Kishore, The Energy and Resources Institute, New Delhi.
2. Energy Science: Principles, technologies and impacts – John Andrews & Nick Jelly (Oxford).
3. Renewable Energy: Power for sustainable future, Godfrey Boyle, Oxford University Press, 2004.
4. World Health Organization  
<https://www.who.int/airpollution/ambient/en/>  
<https://www.who.int/health-topics/air-pollution/>
5. IPCC Climate Change 2014, Synthesis Report, Summary for Policymakers
6. The Cost of Air Pollution: Strengthening the Economic Case for Action, World Bank and IHME report 2013
7. Climate Data Explorer  
[http://cait.wri.org/historical/Country%20GHG%20Emissions?indicator\[\]=Total%20GHG%20Emissions%20Excluding%20Land-Use%20Change%20and%20Forestry&indicator\[\]=Total%20GHG%20Emissions%20Including%20Land-Use%20Change%20and%20Forestry&year\[\]=2014&sortIdx=NaN&chartType=geo](http://cait.wri.org/historical/Country%20GHG%20Emissions?indicator[]=Total%20GHG%20Emissions%20Excluding%20Land-Use%20Change%20and%20Forestry&indicator[]=Total%20GHG%20Emissions%20Including%20Land-Use%20Change%20and%20Forestry&year[]=2014&sortIdx=NaN&chartType=geo)
8. Global Carbon atlas <http://www.globalcarbonatlas.org/en/CO2-emissions>
9. Carbon Emissions <https://www.co2.earth/>

## Semester-IV

### Sustainable Development and Clean Energy

#### Unit-I

Sustainable Development – definition of sustainable development, United Nations General Assembly resolution 2015, Agenda 2030, sustainable development goals (SDGs), brief introduction to seventeen SDGs.

#### Unit-II

Sustainable Development Goal 7- Affordable and clean energy, importance of energy from social, economic, health and environmental perspectives, need for clean energy for improvement in quality of life in developing countries-educational outcomes, social security, increasing earning potential, better health services, energy security.

### Unit-III

Clean energy for lighting- comparison of energy sources used for lighting applications in developed and developing countries, estimating and comparing carbon emissions from different lighting sources- kerosene lamp, incandescent bulbs and LEDs.

### Unit-IV

Clean energy for cooking- comparison of energy sources used for cooking applications in developed and developing countries, comparing carbon emissions from different cooking fuels- wood, kerosene, coal, LPG, electricity, solar cookers.

### Unit-V

Clean energy for transportation- comparison of energy sources used in transportation in developed and developing countries, comparing carbon emissions from different transportation fuels-diesel, gasoline, natural gas, electricity.

### References

1. Renewable Energy: Power for sustainable future, Godfrey Boyle, Oxford University Press, 2004.
2. World Health Organization  
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