

Renewable Energy Production (2015): Grades 9, 10, 11, 12, Higher Education

Adopted 2015

Analyze the various types of renewable energy sources available & their feasibility as a commercial energy source. **RNEP.01**

- 01. Compare and contrast renewable and non renewable energy sources.** **RNEP.01.01**
 - a. Define renewable and non renewable in designation of energy sources. **RNEP.01.01.A**
 - b. Classify energy sources currently available into renewable or non-renewable. **RNEP.01.01.B**
 - c. Compare and contrast the advantages and disadvantages of using renewable vs. non-renewable energy sources. **RNEP.01.01.C**

- 02. Explain solar radiation as energy from the sun.** **RNEP.01.02**
 - a. Describe what happens to the sun's radiation as it passes through the earth's atmosphere and into contact with the earth's crust. **RNEP.01.02.A**
 - b. Determine the effect that atmospheric conditions have on the sun's radiation. **RNEP.01.02.B**
 - c. Explain global dimming and its predicted effect on future solar energy. **RNEP.01.02.C**
 - d. Discuss the capacity of the sun's radiation as a viable energy source. **RNEP.01.02.D**

- 03. Analyze solar as a renewable energy source.** **RNEP.01.03**
 - a. Define solar power. **RNEP.01.03.A**
 - b. Trace the evolution of the applications of solar energy. **RNEP.01.03.B**
 - c. Describe the primary applications for solar energy. **RNEP.01.03.C**
 - d. Differentiate plants' use from humans' use of solar energy. **RNEP.01.03.D**
 - e. Compare and contrast the advantages and disadvantages of solar power. **RNEP.01.03.E**

04. Examine the classifications of solar power technology. RNEP.01.04

- a. Analyze direct solar power as a transformation of sunlight into usable forms of energy (e.g., photovoltaic cells creating electricity, thermal mass heating, solar sail on a space craft, direct lighting). RNEP.01.04.A
- b. Describe and diagram indirect solar power as a multiple transformation of sunlight into usable forms of energy (e.g., photosynthesis, hydroelectric dams, wind turbines, ocean thermal energy production, fossil fuels derived from captured vegetation, reflected sunlight). RNEP.01.04.B
- c. Differentiate passive from active solar systems, primarily in building construction. RNEP.01.04.C
- d. Differentiate concentrating (e.g., lenses, mirrors) from non-concentrating (e.g., photovoltaic cells) solar systems. RNEP.01.04.D

05. Analyze the types of technologies developed to make use of solar radiation. RNEP.01.05

- a. Describe the current solar technologies used in architecture (e.g., heating, cooking, lighting, photovoltaic cells). RNEP.01.05.A
- b. Explore the function and operation of solar thermal electric power plants. RNEP.01.05.B
- c. Discuss the function and operation of solar ponds. RNEP.01.05.C
- d. Describe the solar chemical process. RNEP.01.05.D
- e. Compare the relationship between biofuels and solar power. RNEP.01.05.E

06. Explain the issues and trends affecting the distribution and storage of solar energy. RNEP.01.06

- a. Distinguish between the amount of solar radiation contacting the earth's surface, the amount of available power and the amount of delivered power. RNEP.01.06.A
- b. Identify current means for storing solar energy (e.g., thermal mass, batteries, pumped-storage hydroelectricity, hydraulic accumulator). RNEP.01.06.B
- c. Discuss transferring excess power to a grid and drawing it back when needed. RNEP.01.06.C
- d. Discuss consumption in terms of time of day, demand and peak power available. RNEP.01.06.D
- e. Explain the economic issues affecting storage and distribution. RNEP.01.06.E
- f. Analyze current government, international, national and state utility policies on application and financing of solar energy systems. RNEP.01.06.F

07. Explain how photovoltaic (PV) cells produce electrical energy. RNEP.01.07

- a. Describe the function of each PV cell. RNEP.01.07.A
- b. Trace the production of electricity through PV cells (i.e., from the sun's rays to electrical output). RNEP.01.07.B
- c. Compare and contrast the solar cell with the rechargeable battery. RNEP.01.07.C
- d. Compare and contrast different PV technologies. (e.g., crystalline, thin film, emerging technologies). RNEP.01.07.D
- e. Analyze PV cell performance and the effects of heat and sunlight spectrum. RNEP.01.07.E
- f. Compare and contrast PV cell manufacturing methods in terms of cost, environmental impact, embodied energy and materials. RNEP.01.07.F

08. Explain how solar thermal systems collect and transfer energy. RNEP.01.08

- a. Compare solar thermal technologies to solar electrical technologies. RNEP.01.08.A
- b. Describe different types of solar thermal systems (e.g., parabolic, flat plate, solar cooking, evacuated tubes, hot air). RNEP.01.08.B
- c. Identify different delivery methods for solar thermal systems (e.g., closed loop hydronic, open loop hydronic, mass, forced air). RNEP.01.08.C

09. Explain wind power as an energy source. RNEP.01.09

- a. Research the origin and natural sources of wind. RNEP.01.09.A
- b. Describe how wind is converted into mechanical and electrical energy. RNEP.01.09.B
- c. Identify and explain the function of the basic parts of a wind turbine. RNEP.01.09.C
- d. Correlate wind variability and turbine power. RNEP.01.09.D
- e. Discuss the capacity of wind as a viable energy source. RNEP.01.09.E

10. Analyze wind power as a renewable energy source. RNEP.01.10

- a. Trace the origins and technical development of wind energy. RNEP.01.10.A
- b. Describe the primary applications for wind energy. RNEP.01.10.B
- c. Compare and contrast the differences between small wind, small utility scale and large utility scale projects. RNEP.01.10.C
- d. Identify basic technical factors affecting wind energy (e.g., stand-alone systems, utility interconnection). RNEP.01.10.D
- e. Analyze basic economic factors affecting wind energy (e.g., installation, energy costs, operation, maintenance). RNEP.01.10.E
- f. Compare and contrast the advantages and disadvantages of wind power in relation to location, wildlife and performance. RNEP.01.10.F

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- 11. Examine the growth and development of small-scale, small utility scale and large utility scale wind turbine utilization.** RNEP.01.11
- a. Identify and describe different types of small-scale, small utility scale and large utility scale wind turbines for individual, institutional, industrial and community use. RNEP.01.11.A
 - b. Discuss the technological developments and capacities of small-scale, small utility scale and large utility scale wind turbines for individual, institutional, industrial and community use. RNEP.01.11.B
 - c. Identify and describe basic infrastructure requirements as well as hardware and software systems used to transport, distribute, store and utilize energy produced by small-scale, small utility scale and large utility scale wind turbines. RNEP.01.11.C
 - d. Compare and contrast among small-scale, small utility scale and large utility scale turbines other than size. RNEP.01.11.D
 - e. Analyze the advantages and disadvantages of each scale in relationship with each other. RNEP.01.11.E

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- 12. Analyze hydropower as a renewable energy source.** RNEP.01.12
- a. Explain the process of producing electricity from water flow. RNEP.01.12.A
 - b. Trace the historical development of hydropower. RNEP.01.12.B
 - c. Identify the different types of hydropower installations. RNEP.01.12.C
 - d. Describe the geological implications affecting the location of hydropower installations. RNEP.01.12.D
 - e. Distinguish potential energy from kinetic energy. RNEP.01.12.E
 - f. Calculate the amount of electricity generated in relation to height and speed of water flow. RNEP.01.12.F
 - g. Discuss the capability of producing and delivering hydropower for consumption. RNEP.01.12.G
 - h. Correlate the relationship between hydropower and thermal installations. RNEP.01.12.H

13. Explain the issues and trends affecting the production, distribution and storage of hydroelectricity. RNEP.01.13

- a. Describe the societal issues affecting the placement of hydropower facilities. RNEP.01.13.A
- b. Explain the state and federal laws and regulations affecting hydropower installations and production. RNEP.01.13.B
- c. Contrast the economics of installation versus operations and maintenance. RNEP.01.13.C
- d. Discuss the potential for future hydropower installations. RNEP.01.13.D
- e. Explain consumption in terms of time of day, demand and peak power available. RNEP.01.13.E
- f. Differentiate between the advantages and disadvantages of hydropower installations. RNEP.01.13.F

14. Analyze geothermal as a renewable energy source. RNEP.01.14

- a. Define geothermal as an energy source. RNEP.01.14.A
- b. Explain the systems and processes of producing energy from geothermal installations. RNEP.01.14.B
- c. Identify the best locations for geothermal power installations. RNEP.01.14.C
- d. Differentiate between the advantages and disadvantages of geothermal power as a viable energy source. RNEP.01.14.D
- e. Describe the primary applications of geothermal energy. RNEP.01.14.E
- f. Explain the economic factors in terms of installation cost versus operation and maintenance. RNEP.01.14.F
- g. Describe the environmental implications of geothermal power installations. RNEP.01.14.G

15. Explain biomass as a renewable energy source. RNEP.01.15

- a. Explain the process of producing electricity from biomass. RNEP.01.15.A
- b. Trace the historical development of biomass sources. RNEP.01.15.B
- c. Identify the different types of biomass installations. RNEP.01.15.C
- d. Describe the implications affecting the location of biomass installations. RNEP.01.15.D
- e. Distinguish potential energy from kinetic energy. RNEP.01.15.E
- f. Calculate the amount of electricity generated from different biomass fuel sources. RNEP.01.15.F
- g. Discuss the capability to produce and deliver biomass energy for consumption. RNEP.01.15.G
- h. Compare relationship between biomass and biodiesel fuels. RNEP.01.15.H
- i. Analyze the societal issues affecting the placement of biomass (e.g., sorghum, bagasse) facilities. RNEP.01.15.I
- j. Identify the state and federal laws and regulations affecting biomass installations and production. RNEP.01.15.J
- k. Discuss the potential for future biomass/fossil fuel installations. RNEP.01.15.K
- l. Differentiate the advantages of biomass/fossil fuel installations. RNEP.01.15.L
- m. Explain the disadvantages of biomass/fossil fuel installations (e.g., ecological, geographical, carbon dioxide). RNEP.01.15.M

16. Analyze biodiesel as an energy source. RNEP.01.16

- a. Trace the evolution of biodiesel from its origin. RNEP.01.16.A
- b. Justify biodiesel as an energy source. RNEP.01.16.B
- c. Explain the process of producing energy from biodiesel. RNEP.01.16.C
- d. Diagram the production process and raw materials used to produce biodiesel. RNEP.01.16.D
- e. Compare the efficiencies of raw materials used to produce biodiesel. RNEP.01.16.E
- f. Describe the co-products in the production of biodiesel. RNEP.01.16.F
- g. Identify the physical properties and technical standards of biodiesel as an energy source. RNEP.01.16.G
- h. Evaluate the primary applications of biodiesel energy. RNEP.01.16.H
- i. Identify engine modifications that are necessary to utilize biodiesel. RNEP.01.16.I
- j. Investigate improvements in engine design and denaturants for biodiesel use. RNEP.01.16.J
- k. Describe the concerns about gelling and water. RNEP.01.16.K

17. Explain the issues and trends affecting the production, storage and distribution of biodiesel. RNEP.01.17

- a. Compare and contrast the advantages and disadvantages of biodiesel as a viable energy source. RNEP.01.17.A
- b. Compare the economic factors of biodiesel to other fuels. RNEP.01.17.B
- c. Identify the environmental implications of biodiesel. RNEP.01.17.C
- d. Explain the current status for production, storage and distribution facilities. RNEP.01.17.D

18. Analyze ethanol as an energy source. RNEP.01.18

- a. Trace the evolution of ethanol from its origin. RNEP.01.18.A
- b. Explain the processes of producing energy from ethanol. RNEP.01.18.B
- c. Diagram the production processes and raw materials used to produce ethanol. RNEP.01.18.C
- d. Compare the efficiencies of raw materials used to produce ethanol. RNEP.01.18.D
- e. Describe the co-products in the production of ethanol. RNEP.01.18.E
- f. Identify the physical properties and technical standards of ethanol as an energy source. RNEP.01.18.F
- g. Hypothesize the different sources of ethanol. RNEP.01.18.G
- h. Describe the primary applications of ethanol energy. RNEP.01.18.H
- i. Identify engine modifications that are necessary to utilize ethanol. RNEP.01.18.I
- j. Investigate improvements in engine design and denaturants for ethanol use. RNEP.01.18.J

19. Explain the issues and trends affecting the production, storage and distribution of ethanol. RNEP.01.19

- a. Compare and contrast the advantages and disadvantages of ethanol as a viable energy source. RNEP.01.19.A
- b. Compare the economic factors of ethanol to other fuels. RNEP.01.19.B
- c. Describe the environmental implications of ethanol. RNEP.01.19.C
- d. Explain the current status for production, storage and distribution facilities. RNEP.01.19.D
- e. Describe ethanol logistics. (e.g., rail, blending, distribution). RNEP.01.19.E
- f. Identify and describe raw material logistics for ethanol. RNEP.01.19.F
- g. Explore the markets for different blends of ethanol and co-products. RNEP.01.19.G
- h. Diagram the political timeline of ethanol. RNEP.01.19.H