Colorado CTE

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

Examine the classifications of solar power technology. RNEP.01.04

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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

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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

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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

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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

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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

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

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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

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

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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

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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

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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

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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

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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

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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

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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

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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