Exercise 1: Electric Energy Consumption

1. What is your average monthly household electric bill? \$150/month ($/month)

2. How much do you pay for electric power? \$0.10/kWh ($/kWh)

3. Calculate the corresponding average monthly energy use for your household. ____________ (kWh/month)

4. How many people are there in your household? 4

5. Calculate the **per capita** monthly residential electric energy use for members of your household. ____________ (kWh/month/person)

6. Calculate the **annual** per capita residential electric energy use for members of your household. ____________ (kWh/year/person)

7. In the U.S., residential electric energy consumption is about one-third of overall electric energy consumption. Calculate the annual per capita **total** electric energy consumption by members of your household. ____________ (kWh/year/person)

8. Assuming this per capita energy use is average, calculate the **U.S. annual total** electric energy consumption. ____________ (trillion kWh/year)

9. The U.S. consumes about 25 percent of global electric power. Estimate **global annual** total electric energy consumption. ____________ (trillion kWh /year)

10. Calculate the global annual **per capita** total electric energy consumption. ____________ (kWh/year/person)

11. Compare your calculated global annual **per capita** total electric energy consumption value to your calculated U.S. annual **per capita** total electric energy consumption value.

Exercise 2: Windpower

Consider a wind turbine that is rated at 1.5 MW. This means that with sufficiently high winds, it will produce 1.5 MW or 1,500 kW of power. The installed cost of this turbine is $1.5 million.

1. If this turbine runs at its rated power 100 percent of the time for a full year, how much energy would it produce in a year? ______________________ (million kWh/year)

2. This wind turbine has a **capacity factor** equal to 0.38. This means that over a year, it will produce only 38 percent of its theoretical maximum energy production. How much energy does this turbine actually produce in a year? ______________________ ______________________ (million kWh/year)

3. Over the next 20 years, U.S. annual electric energy consumption is projected to increase by 1.5 trillion kWh/year. How many 1.5 MW wind turbines would be needed to supply 10 percent of this additional energy? ______________________

4. Calculate the cost of installing these wind turbines. ______________________ ______________________ ($)

5. Assuming the electric energy produced by these turbines is worth 5 cents per kilowatt-hour, these turbines would generate electric energy worth $7.5 billion per year. Calculate the simple payback period for these turbines. (Payback period is the time it takes for a system's net benefits to equal its cost.) ______________________ ______________________ (years)

Exercise 3: Photovoltaic Power

A grid-connected residential PV system is placed on the roof of a 2,000-square-foot suburban house. The PV array with an area equal to 50 square meters (about 500 square feet) covers half of the south-facing part of the roof. The power rating of this PV system is 5.0 kW, meaning that it will produce 5.0 kW under peak sunlight conditions. The installed cost of this system is $50,000.

1. The PV system is operating in a location where the annual average daily incident solar energy (the insolation) on the array equals 5.0 kWh/m²/day. Calculate the average amount of solar energy incident on the PV array each day. ______________ (kWh/day)

2. The efficiency of the PV system equals 10 percent (that is, 10 percent of the solar energy incident on the array is transformed into useful electric power). Calculate the daily average electric energy produced by this system. ______________ (kWh/day)

3. Calculate the average amount of electric energy produced by this system each year. ______________ (kWh/year)

4. Over the next 20 years, U.S. annual electric energy consumption is projected to increase by 1.5 trillion kWh/year. How many rooftop PV systems would be needed to supply 10 percent of this additional energy? ______________

5. Calculate the cost of installing these residential PV systems. ______________ ($)

6. Assuming the electric energy produced by these PV systems is worth 10 cents per kilowatt-hour, these residential systems would generate electric energy worth $15 billion/year. Calculate the simple payback period for these PV systems. (Payback period is the time it takes for a system's net benefits to equal its cost.) ______________ (years)