**More Energy Conversion / Energy Source Math Problems**

1. Shown above is a graph of the gross domestic product (GDP) per capita versus the annual electrical energy consumption per capita for nine countries in 2009.

(a) Iceland’s position on the graph is due in part to its access to geothermal energy sources. Describe how electricity is generated from a geothermal source.

(b) Despite its low GDP per capita and low annual electrical energy consumption per capita, China has become the world’s largest emitter of CO2 . Explain this apparent contradiction.

(c) In addition to contributing to increased atmospheric CO2 concentrations, China is facing other air pollution issues related to the generation of electricity. Identify one such issue and describe the impact it has on human health.

(d) Two countries shown on the graph have developed domestic energy sources: sugarcane in Brazil and tar sands in western Canada.

(i) Choose EITHER sugarcane or tar sands, then briefly describe the process of fuel production from that energy source.

(ii) Describe TWO disadvantages of using the energy source that you chose in part (d)(i).

(iii) Which of the two energy sources is more sustainable? Justify your answer with an explanation.

1. Animal waste (primarily the methane from this waste) can be broken down into energy using the following combustion reaction:

**CH4 + 2O2 🡪 CO2 + 2H2O**

For a certain dairy farm with 500 cows, the cost of installing a methane energy convertor is approximately $400,000. Assume that, before the switch to methane, the farm uses 800,000 kilowatt-hours (kWh) of electricity each year at a cost of $0.10 per kWh. The waste from a single cow can produce 3.0 kWh of electricity each day.

1. Burning manure is a form of what type of renewable energy? Describe two advantages of using this source.
2. Identify the two starting materials and the two products given the chemical equation.
3. Name two sources of methane and why this gas could be dangerous for the environment.
4. Assuming that the cost of electricity remains constant and the farmer starts using the manure from the cows to produce electricity on the farm, calculate:

(i) The number of kWh of electricity that can be produced in one year using all of the cows.

(ii) The amount of money the farmer can save in one year, NOT counting the installation cost of the digester.

(iii) The amount of time, in years, that it will take to recover the cost of installing an anaerobic digester on the farm.

 (e) Calculate the minimum number of cows the farm would need to produce 800,000 kWh of electricity per year.

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| Gallons of Oil per Acre per Year |
| Corn | 20 |
| Sunflower | 102 |
| Microalgae | 10,000 |

1. Use the table below to help you in answering the questions:
	1. Calculate the number of acres required to produce 1,000 gallons of oil in one year from
		1. microalgae
		2. corn
	2. Burning microalgae is similar to what type of renewable energy source? Describe TWO environmental advantages that oil production from microalgae offers over fossil fuel sources.
2. The Cobb family of Fremont is looking for ways to decrease their home water and energy usage. Their current electric hot-water heater raises the water temperature to 140oF, which requires 0.20 kWh/gallon at a cost of $0.10/kWh. Each person in the family of four showers once a day for an average of 10 minutes per shower. The shower has a flow rate of 5.0 gallons per minute.
	1. Calculate the following. Be sure to show all your work and include units with your answers.
		1. The total amount of water that the family uses per year for taking showers
		2. The annual cost of electricity for the family showers, assuming that 2.5 gallons per minute of water used is from the hot-water heater
	2. The family is considering replacing their current hot-water heater with a new energy-efficient hot-water heater that costs $1,000 and uses half-the energy that their current hot water heater uses (0.10 kWh/gallon). How many days would it take for the new hot-water heater to recover the $1,000 initial cost?
	3. Describe two practical measures that the family could take that would reduce their overall water use at home.
3. West Fremont is a community consisting of 3,000 homes. A small coal-burning power plant currently suuplices electricity for the town. The capacity of the power plant is 12 megawatts (MW) and the average household consumes 8,000 kilowatt hours (kWh) of electrical energy each year. The price paid to the electric utility by the residents is $0.10 per kWh.

Town leaders are considering setting up wind turbines instead of relying on coal, this plan includes 10 wind turbines that each have the capacity of 1.2 MW and each would cost the town $3 million to purchase, finance and operate for the next 25 years.
	1. Assuming that the existing power plant can operate at full capacity for 8,000 hours per year, how many kWh of electricity can be produced by the plant in a year?
	2. At the current rate of electrical energy use per household, how many kWh of electrical energy does the community consume in one year?
	3. Assuming that the electrical energy needs of the community do not change in the 25-year lifetime of the wind turbines, what would the cost be to the community over those 25 years (express your answer in dollars/kWh)
	4. Identify two pros of switching to wind power and two cons of switching to wind power.