Renewable Energy Technologies I

Exercise 10

Prof. A Wokaun
Assistant: Brian Cox (brian.cox@psi.ch)

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Instructions

- Please give the results in the units provided
- Round your results to a reasonable precision
- Formulae that are provided in the exercise will also be provided in the exam. If the formula is not given in the exercise it will also not be given in the exam.
- Exercises do NOT have to be submitted for correction
- Exercise solutions will be posted November 29.
- If you have questions, please email: brian.cox@psi.ch

1. Briefly describe pathways that can be used to convert waste into electrical energy using the following four initial processes: Incineration, Pyrolysis, Gasification, Digestion.

2. Briefly describe three other uses for waste that can offset primary energy consumption.

3. List several sources of waste that can be used for energetic purposes in Switzerland.

4. In Switzerland roughly 700 kg of municipal solid waste (MSW) is produced annually per person. Of this, approximately 50% is incinerated in order to produce electricity. The calorific value of MSW can be taken to be 10 MJ/kg.

    a) Assuming 10% efficiency in converting MSW into electricity, what is the annual amount of electricity (in kWh) that could be generated from MSW in Switzerland?
    b) If the average, per capita, electricity demand in Switzerland is 850 W, what is the percentage of electricity demand could be covered by electricity from waste incineration?

5. Lead acid car batteries consist mostly of lead and plastic. Both of these materials can be recycled, allowing manufacturers to select either primary or recycled materials with no impact on quality or the rest of the manufacturing process. The manufacturing energy to produce batteries, regardless of material input is 10 MJ/kg of battery. Batteries can be assumed to weight 10 kg each. The energy to produce the materials lead and plastic, along with their share in batteries is listed below:

		Material Production Energy (MJ/kg battery)	
	% of dry battery weight	Primary	Recycled
Lead	85%	30	5
Plastic	15%	75	15

a) Calculate the potential energy savings (in MJ/battery) of using recycled materials instead of primary materials for lead acid battery production.

b) If there are 300 000 new cars sold each year in Switzerland (each with one 10 kg battery), what are the potential energy savings per year (in million liters of gasoline equivalent) of equipping all new cars with a battery made from recycled instead of primary materials? (The energy content of gasoline may be assumed to be 42 MJ/kg, with a density of 0.75 kg/l)

c) If the average fuel economy of a new car in Switzerland is assumed to be 5 L of gasoline per 100 km, how far how far could a new car travel using the energy saved by using recycled lead instead of primary lead in its battery?