

# 16.682: Technology in Transportation

Problem Set #1 - Energy

Due: Thursday, February 10<sup>th</sup>, 2011

Note: Make sure to list all assumptions based on your background search.

## 1. Human energy:

a) I'm going to the store, which is 2 miles away. Is it more efficient for me to walk or to drive my Toyota Camry?

b) I'm travelling from Boston to Los Angeles. Is it more efficient for me to:

- i. carpool in a Toyota Camry with 4 total passengers
- ii. ride a half-full Amtrak (assume straight line), or
- iii. fly in a fully loaded 747.

## 2. Solar power:

a) How many square miles of the US have to be covered by photovoltaic solar panels to cover all of the electricity demand in 2011 and how much will it cost (for the PV panels only?)

b) How does this compare to the current cost of coal and when will the investment break even? Consider the optimum location for the installation in the US, average yearly irradiance, sun incidence angle and effective coverage area, etc...

c) How large of an area of solar panels would be necessary to power a mid-sized sedan?

## 3. Biofuels:

a) How many square miles of farmland need to be covered with corn to produce bioethanol to fuel all of the passenger cars in the United States, assuming they ran on 100% ethanol?

## 4. Electric Vehicles and Gas-Electric Hybrids:

Tesla Motors has claimed that the Roadster electric sports car is 2x more efficient than a Toyota Prius. Is this true? Is it always true? Under what conditions? One very good [resource](#) to get started.

## 5. Greenhouse Gas Emissions:

Compare the greenhouse gas emissions of operating an electric vehicle vs. an internal combustion engine (ICE) vehicle.

a) Assume grid electricity is generated using the following mix: 7% hydroelectric, 20% nuclear, 24% natural gas, 45% coal, 4% renewable.

b) Now, assume electricity is generated from only 2 sources: zero emissions renewables (or could be nuclear) and coal. Is there a breakeven point between the proportion of renewables to coal at which ICE vehicles become “cleaner” than electric vehicles in terms of carbon dioxide emissions? Where in the country might this make a difference?

Assume that the average electric vehicle consumes 350 Wh/mile and come up with reasonable values for all other numbers.

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