Cars, Trains, Planes

Physics and Mathematics of Sustainable Energy

College of the Atlantic

A few facts:

- Gasoline: 10 kWh per litre or 38 kWh per gallon
- Typical gas mileage for car: 30mph, but this ranges considerably.
- Carbon intensity of gasoline: 240g per kWh.
- Carbon intensity of electricity generation in the US: let's use 500 g per kWh. (This varies around the country and from day to day depending on the particular mix of electricity on the grid at any one time.)

1. Let's compare driving 1000 miles in conventional and electric vehicles.
   (a) In the conventional car, how much gas does this use?
   (b) How much does this gas cost?
   (c) How much CO_2 is emitted by the car?
   (d) How much of the thermal energy released when burning the gasoline goes into the kinetic energy of the car? Assume that the car's engine has an efficiency of 0.20.
   (e) How many kWh of electricity would be needed by an electric car to go 1000 miles. Assume that the efficiency of the electric car is 0.75.
   (f) How much would this electricity cost?
   (g) How much CO_2 would be emitted as a result of generating this amount of electricity, assuming the US average carbon intensity.
   (h) How much CO_2 would be emitted as a result of generating this amount of electricity if the electricity was generated in a coal-burning power plant with an intensity of 1 kg/kWh?
2. Suppose you fly from New York to California twice in a year.
   (a) Flying takes roughly 40 kWh per 100 person-kilometers. Estimate how much energy this takes. What is this in kWh/day? What is this in kW? Is this a lot or a little?
   (b) Very roughly, the direct emissions associated with a flight are 0.1kg or CO_2 per km per person. What are emissions associated with two NY to California flights. Is this a lot or a little?