2-2) Transportation

Objective: This data gathering exercise utilizes raw data from the U.S. Department of Energy in order to evaluate the pros and cons of different energy policies as well as alternative forms of personal transportation.

Introduction: Even though petroleum is still the best fuel available for most forms of transportation, exclusive reliance on this fuel is a poor long-term energy strategy. In addition to environmental concerns about fracking, a large portion of the world's oil production is moved by tankers through chokepoints that can be easily disrupted (*1*). Furthermore, given that petroleum is usually the most cost-effective transportation fuel, it may not be enough to rely on the free market for options that do not disproportionately undermine our environment and our foreign policy.

One option that is being increasingly discredited is the "flex-fuel" vehicle whose engine is modified to run on ethanol, methanol, as well as gasoline. Unfortunately these alcohols contain only half the energy-to-mass ratio of gasoline. Ethanol is particularly problematic because American agriculture is highly fossil fuel-dependent. Worst of all, the consequences of using agricultural land to meet our all energy needs would be nothing short of disastrous in that it will greatly increase food prices and the adverse effect of agriculture on the natural environment.

Electric cars are the ultimate flex-fuel vehicles because power plants have the most fuel options. The biggest drawback of these vehicles is the relatively large mass-to-energy ratio of the batteries that usually limit their range between 60 and 100 miles per charge. Fuel-cell cars can provide a longer range because the cells that use hydrogen to produce electricity are much lighter. Unfortunately, hydrogen is a very difficult fuel to deliver and contain. All things considered, the near-term technological breakthroughs that are most needed to reduce dependence on petroleum are lighter batteries and fuel cells that run on an energy carrier that is more convenient than hydrogen.

Part A: The Fossil-Fuel Costs of Electric Cars

1. Go to the "Energy Information Administration" website: www.eia.gov
2. Type into the search box "how much is coal per kwh".
3. Click on the link that says "how much coal, natural gas, or petroleum is used to generate a kilowatt hour of electricity?"
4. Click on the link that says "Data on total U.S. electricity generation (Table(s) 7.2) and fuel consumption for electricity generation (Table(s) 7.3)".
5. Click on the pdf file that corresponds to Table 7.2a.
6. Scroll down and copy down the three totals for electricity generated from coal, petroleum liquids, and natural gas (usually expressed in millions kilowatt hours) for the most recent year.
7. Click on the pdf file that corresponds to Table 7.3a.
8. Scroll down and copy down for the most recent year the total coal (thousands of short tons), petroleum (thousands of barrels), gas (billions of cubic feet). Note that petroleum consumption is broken down in to four components (distillate, residual, other liquids, and petroleum coke). Do not use these values. Use the petroleum value labeled "total".
9. Copy these values into their corresponding boxes in the spreadsheet. Since all the kilowatt hours number in the millions, you need to multiply these numbers from the pdf file by

1,000,000. For tons of coal and barrels of petroleum you need to multiply by 1000. For natural gas you need to multiply this number by 1,000,000,000. If you do not have a spreadsheet, you can use the following calculations to complete the table below:

- ***Coal:*** *[(total kWh from coal) ÷ (total tons consumed)] ÷ 2000 lbs/ton = ____ kWh/lb*
- ***Oil:*** *[(total kWh from petroleum) ÷ (total bbl. consumed)] ÷ 42 gal/bbl = ____ kWh/gal.*
- ***Gas:*** *(total kWh from gas) ÷ (total ft^3 consumed) = ____ kWh/ft^3*

Fuel used	Total kWh	Total fuel consumed	Original fuel unit	Unit conversion	kWh per new fuel unit	New fuel unit
coal			per ton	2000 lbs/ton		per lb
oil			per barrel	42 gal/bbl		per gallon
gas			per ft^3	N/A		per ft^3

The second table is used to calculate the amount of fuel indirectly consumed by a 2014 electric Ford Focus. Since the second table on your spreadsheet template is already set up to incorporate the values from the first table, there should be no need to do anything other than plugging in the raw values. If you do not have a spreadsheet, you can use the following calculations to put into the table below:

- ***Coal:*** *(___kWh/lb) × (0.94 trns. eff.) × (0.81 chrg. eff.) × (3.1 mi./kWh) = ___ mi./lb*
- ***Oil:*** *(___kWh/gal.) × (0.94 trns. eff.) × (0.81 chrg. eff.) × (3.1 mi./kWh) = ___mi./gal.*
- ***Gas:*** *(___kWh/ft^3) × (0.94 trns. eff.) × (0.81 chrg. eff.) × (3.1 mi./kWh) = ___mi./ft^3*

Fuel used	kWh per new fuel unit	Transmission efficiency *(2)*	Charging efficiency*(3)*	Miles per kWh	Miles per unit fuel	Fuel unit
coal		0.94	0.81	3.1		per lb
oil		0.94	0.8	3.1		per gallon
gas		0.94	0.81	3.1		per ft^3

Questions:

1. What are the main disadvantages of electric cars? (See introduction for answer)
2. Based on your spreadsheet, what is the average miles per gallon for the electric Ford Focus when all the electricity is obtained entirely from oil?
3. A gasoline-powered 2012 Ford Focus gets a combined average of 33 miles per gallon of gasoline *(3)*. Is this significantly different (>10%) than the average mpg of the electric Ford Focus?
4. Based on your spreadsheet, what is the average miles per cubic foot for the electric Ford Focus when the electricity is obtained entirely from natural gas?
5. A 2013 Honda Civic that runs on compressed natural gas gets a combined average 0.25 miles per cubic foot of natural gas *(3)*. Is this significantly different (>10%) than the average mpg of the electric Ford Focus?

Part B) The Effect of U.S. Energy Policy on Economic Growth and World Oil Price

Spreadsheet B-1: Energy Taxes and the U.S. Economy

1. Go to the "Energy Information Administration" website: www.eia.gov
2. Type into the search box "price per barrel".
3. Click on the box that says "Today in Energy-Daily Prices…."
4. Copy down the price per barrel that corresponds to "WTI". This is the abbreviation for a type of crude oil known as "West Texas Intermediate". Type it into the corresponding boxes of your spreadsheet. If you do not have access to the spreadsheet, you need to use the following calculations:

- *Tax per barrel = Tax per gallon × 19 gallons of gasoline extracted per barrel of crude*
- *% Cost increase = 100% × (Tax per barrel ÷ WTI price per barrel)*
- *% Economic decrease = (% Cost increase ÷ 10) × 0.075*

Below is a sample calculation:

Tax per gallon ($)	WTI price per barrel ($)	Tax per barrel ($)	% Cost increase	% Economic decrease *(4)*
1	100	19	19	0.14

Below is a blank table:

Tax per gallon ($)	WTI price per barrel ($)	Tax per barrel ($)	% Cost increase	% Economic decrease *(4)*
1				
2				
3				
4				

Spreadsheet B-2: U.S. Oil Consumption and World Oil Price

1. Go to the "Energy Information Administration" website: www.eia.gov
2. Type into the search box "petroleum consumption per day".
3. Click on the link that says "How much oil is consumed in the United States".
4. Copy down the millions of barrels of oil consumed in the U.S. in the most recent year and copy it into the corresponding boxes of you spreadsheet. If you do not have access to the spreadsheet, you need to use the following calculations:

- *Millions bbl. conserved per day = (Millions bbl. consumed × % Reduction) ÷ 100%*
- *New price per bbl. = WTI price per bbl. – (Millions bbl. conserved per day × 4)*

Below is a sample calculation based on U.S. consumption of 20 million barrels of oil per day and a cost of $100 per barrel of oil:

Mill. bbl. consumed by US per day	% reduct. in US consumption	Mill. bbl. conserved by US per day	WTI price per bbl.	New price per bbl. *(4)*
20.00	10.00	2.00	100	92

Below is a blank table for inserting your values and calculations:

Mill. bbl. consumed by US per day	% reduct. in US consumption	Mill. bbl. conserved by US per day	WTI price per bbl.	New price per bbl. *(4)*
	10.00			
	20.00			
	30.00			
	40.00			

Questions:

6. Based on your spreadsheet, why do most economists oppose punitive taxes on fuel?
7. Based on your spreadsheet, what happens to the price per barrel when Americans consume less oil?
8. How might this change in price affect oil consumption?
9. Based on your spreadsheet, what is the meaning of a "negative price"? At what point does the new price of oil based on consumption from your spreadsheet become unrealistic?
10. Challenge question: Based on your answers to these questions, what policies would you propose in order to persuade Americans to consume less oil without hurting the economy?

Literature Cited:

1. "World Oil Transit Chokepoints", Energy Information Administration of the US Department of Energy (updated January 2012); Retrieved on July 2, 2014 from http://www.eia.gov/countries/analysisbriefs/World_Oil_Transit_Chokepoints/wotc.pdf
2. "Electric power transmission and distribution loses (% output)" World Bank (2011); Retrieved on July 2, 2014 from http://data.worldbank.org/indicator/EG.ELC.LOSS.ZS
3. Charging efficiency of and mileage of the 2014 electric Ford Focus; From *Fuel Economy Guide*; Retrieved on June 28, 2014 from www.fueleconomy.gov
4. This information is currently available by request at the Energy Information Administration: InfoCtr@eia.gov