3.2) TRANSPORTATION ENERGY

Objective: This data gathering exercise utilizes raw data from the U.S. Department of Energy in order to evaluate the energy costs of electric cars and economic consequences of gas taxes. **Video instructions:** https://vimeo.com/476120803

Introduction: There is a growing interest in alternative fuel due to environmental concerns over fracking and vulnerability of shipping routes (*1*). One alternative that was widely promoted in recent years was the "flex-fuel" vehicle that uses ethanol as a substitute for gasoline. Unfortunately, ethanol contains only half the energy-to-mass ratio of gasoline and American agriculture is highly fossil fuel-dependent. Consequently, the widespread use of agricultural land to grow this biofuel would be disastrous in that it will accelerate deforestation while having little or no impact on oil consumption.

Electric vehicles are the ultimate flex-fuel vehicle because power plants have the widest range of fuel options, but they are limited by the large mass-to-energy ratio of the batteries and the severe environmental impact of lithium mining. Fuel-cell cars overcome the energy/mass ratio problem by using hydrogen to generate electricity. Unfortunately, hydrogen is a very difficult fuel to deliver and contain. All things considered, the technological breakthroughs that are most needed to reduce consumption of petroleum are lighter batteries and affordable fuel cells that run on energy carriers that are more practical.

Procedure 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 kWh?"
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)".
   Direct link: https://www.eia.gov/totalenergy/data/monthly/index.php#electricity
5) Click on the pdf file that corresponds to Table 7.2a.
   Direct link: https://www.eia.gov/totalenergy/data/monthly/pdf/sec7_5.pdf
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.
   Direct link: https://www.eia.gov/totalenergy/data/monthly/pdf/sec7_9.pdf
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 the spreadsheet. Since all the kWh number in the millions, you multiply these numbers by 10^6. For tons of coal and barrels of petroleum you multiply by 10^3. For natural gas you multiply this number by 10^9. If you do not have a spreadsheet, use these calculations:

   Coal: [(total kWh from coal) ÷ (total tons consumed)] ÷ 2000 lbs/ton = **total kWh/lb**

   Oil: [(total kWh from petroleum) ÷ (total bbl. consumed)] ÷ 42 gal/bbl **= total kWh/gal**.

   Gas: (total kWh from gas) ÷ (total ft^3 consumed) = **total kWh/ft^3**

Fuel used	Total kWh	Total fuel consumed	Original fuel unit	Unit conversion	kWh per converted unit	Converted unit
coal			per ton	2000 lbs/ton		per lb
oil			per barrel	42 gal/bbl		per gal.
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 fill the table:

Coal: (total kWh/lb) × (0.94 transmiss. effic.) × (0.81 charging effic.) × (3.1 mi./kWh) = **total mi./lb**
Oil: (total kWh/gal.) × (0.94 transmiss. effic.) × (0.81 charging effic.) × (3.1 mi./kWh) = **total mi./gal.**
Gas: (total kWh/ft^3) × (0.94 transmiss. effic.) × (0.81 charging effic.) × (3.1 mi./kWh) = **total mi./ft^3**

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Fuel used	kWh per converted unit	Transmission efficiency *(2)*	Charging efficiency*(3)*	Miles per kWh *(4)*	Miles per unit fuel	Converted unit
coal		0.94	0.8	3.1		per lb
oil		0.94	0.8	3.1		per gal.
gas		0.94	0.8	3.1		per ft^3

Procedure 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) Copy down the price per barrel:

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 decline = (% Cost increase ÷ 10) × 0.075

Sample calculation:

Tax per gal. ($)	Price per bbl. ($)	Tax per bbl. ($)	% Cost increase	% Econ. Decr. *(5)*
1	100	19	19	0.14

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

Tax per gal. ($)	Price per bbl. ($)	Tax per bbl. ($)	% Cost increase	% Econ. Decr. *(5)*
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 your spreadsheet. If the EIA does not readily provide this information, look it up somewhere else. 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)

Here is a sample calculation:

Mill. bbl. consumed by US per day	% reduct. in US consumption	Mill. bbl. conserved by US per day	Price per bbl. ($)	New price per bbl. *(5)*
20.00	10.00	2.00	100	92

This blank table is for inserting your values and calculations:

Mill. bbl. consumed by US per day	% reduct. in US consumption	Mill. bbl. conserved by US per day	Price per bbl. ($)	New price per bbl. *(5)*
	10.00			
	20.00			
	30.00			
	40.00			

Literature Cited:

1. US Department of Energy. 2012. *World Oil Transit Chokepoints*. Energy Information Administration (updated January 2012); Accessed on July 2, 2014 http://www.eia.gov/countries/analysisbriefs/World_Oil_Transit_Chokepoints/wotc.pdf
2. World Bank. 2011. *Electric power transmission and distribution loses (% output).* Accessed on July 2, 2014 http://data.worldbank.org/indicator/EG.ELC.LOSS.ZS
3. Home Power. 1997. *Batteries: What We Know About Them and How to Use Them*. April/May p. 66.
4. US Department of Energy. 2014. *Charging efficiency of and mileage of the 2014 electric Ford Focus*. Fuel Economy Guide. Accessed on June 28, 2014 www.fueleconomy.gov
5. Information on price based on world oil supply is currently available by request at the Energy Information Administration: InfoCtr@eia.gov

Questions:

1. What are two main disadvantages of electric cars? *Hint: Re-read the introduction.*

2. Based on your spreadsheet, what is the average miles per pound of coal for the electric Ford Focus when all the electricity is obtained entirely from coal?

3. Under what conditions does the widespread use of electric cars result in more air pollution than the widespread use of cars that use internal combustion engines?

4. 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?

5. A gasoline-powered 2012 Ford Focus gets an average of 33 miles per gallon of gasoline *(3)*. Is this significantly different (>10%) than the mpg of the electric Ford Focus?

6. 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?

7. 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 mpg of the electric Ford Focus?

8. Based on your spreadsheet, why do most economists oppose punitive taxes on fuel?

9. Based on your spreadsheet, what happens to the price per barrel when Americans consume less oil?

10. How might this change in price affect oil consumption? Explain:

11. 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?

12. Online discussion: Based on your answers to these questions, what policies would you implement in order to persuade the general public to consume less oil without damaging economic growth? (Be specific! You get no credit for describing changes in your personal behavior)

Assignment Checklist:

1. Did you completely answer all the questions?
2. Did you fill out the blank spreadsheet form by hand?
3. Did you post your answer to 12 to the online discussion?
4. Did you respond to someone else's post?