

15.031 Recitation 5 Solutions
Derived Demand and Capital vs. Current Cost Considerations

1. Derived Demand:

$T = 100 - 0.5C$ where C = cost of heat in $\$/^\circ\text{F}$

$T = G/4$ where G = amount of gas burned per month in MCF

P = price of gas in $\$/\text{MCF}$

a. Derived demand for gas as a function of price.

$T = 100 - 0.5C = G/4 \rightarrow$ demand for temperature

$G = 400 - 2C \rightarrow$ demand for gas as a function of the cost of heat

$$G^* = 4T$$

$$C^* = (PG)/T = 4P \text{ } \$/^\circ\text{F}$$

$$G = 400 - 2(PG/T)$$

$$G = 400 - 2(PG)/(G/4)$$

$$\underline{G = 400 - 8P} \rightarrow \text{demand for gas as a function of the price of gas}$$

b. If $P = \$12/\text{MCF}$, how much does he burn and how warm is his house?

$$G = 400 - 8P = 400 - 8(12) = \underline{304 \text{ MCF/month}}$$

$$T = 100 - 2P = 100 - 24 = \underline{76^\circ\text{F}}$$

c. Elasticity of demand for heat with respect to its price at this point.

$$P = 12 \text{ } \$/\text{MCF}, T = 76^\circ\text{F}$$

$$C = 4P = 48 \text{ } \$/^\circ\text{F}$$

$$T = 100 - 0.5C \Rightarrow dT/dC = -0.5$$

$$(dT/T)/(dC/C) = (C/T)*(dT/dC) = (48/76)*(-0.5) = \underline{-0.3158}$$

d. Elasticity of demand for gas with respect to its cost at this point.

$$P = 12 \text{ } \$/\text{MCF}, G = 304 \text{ MCF/month}$$

$$G = 400 - 8P \Rightarrow dG/dP = -8$$

$$(dG/G)/(dP/P) = (P/G)*(dG/dP) = (12/304)*(-8) = \underline{-0.3158}$$

2. Capital vs. Current Cost Considerations:

a. Total cost of each option and which option would the CFO of UtilityCo choose?

The table below shows the resulting present value costs of each type of plant. See the Excel spreadsheet for the details of the costs incurred each year for each of the options. Assuming that the Citizens of Energyville refuse to pay more for clean energy, the CFO of UtilityCo should choose the cheapest one to construct and operate, meaning the coal power plant as shown by the numbers below.

Plant Type	Coal	Natural Gas	Wind	Solar
Total Cost	\$314,070,129.66	\$362,256,873.95	\$451,360,920.80	\$463,202,566.80

b. Carbon tax = \$20M per year, Natural gas tax = \$10M per year. Benefit of \$5M per year for Wind and Solar plants. Taxes and Benefits will rise with inflation. Does the answer for part a change? Discuss operating assumptions or potential risks that may affect the residents of Energyville.

Adding the taxes and benefits, changes the answer to part a (see the Excel spreadsheet). In fact, the taxes on coal and natural gas plants lead to very high total costs for those two options. Instead, the benefits for wind and solar plants, make these options the cheapest. In this case, the CFO should choose the wind power plant seeing as it has the lowest total cost of construction and operation.

Plant Type	Coal	Natural Gas	Wind	Solar
Total Cost	\$554,546,455.66	\$482,495,036.95	\$391,241,839.30	\$403,083,485.30

It is important to note that the benefit received for the wind and solar plants is a “potential” benefit. Thus there is a risk that this benefit will not actually be received or that it might not last for the entire lifecycle of the plant, making the wind and solar power plants as expensive as they were in part a. In addition, we must keep in mind that the newly elected mayor is the one to have imposed the taxes on coal and natural gas. The mayor however, will most likely not be in office for the entire 30 years of the plant’s operation, meaning that a new mayor could lower or even remove these taxes. As a result, the cost of the coal and natural gas plants might go down to a cost similar to the original cost in part a. Finally, the current calculations do not take into account anything going wrong in any of the plants. Some problem or incident might greatly increase the maintenance costs, further affecting the differences in total cost of the plants.

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