

Modeling Conventional and Energy Star Central Air Conditioners

Riley Hunt

Abstract

This study uses calculus to analyze the costs associated with a conventional central air conditioner and an Energy Star central air conditioner based on their seasonal energy efficiency ratio (SEER). Energy Star models have higher initial costs but promise long-run savings due to their more efficient use of energy compared to conventional models. This experiment displays the importance of analyzing all costs total associated with central air conditioning units and how they are interrelated in order to make educated decisions based not just on retail price.

Introduction

- With the formation of organizations such as Energy Star, the United States has moved toward a more organized way of keeping track of energy efficiency, especially among central air conditioners.
- However, the more efficient a central air conditioning unit is, the greater its retail price compared to conventional models. Yet the difference in price between a conventional and an Energy Star model is supposed to be alleviated over time with savings on energy bills.
- By looking at the initial costs, energy costs, and energy usage between the two models, over an average life expectancy of 14 years, I will determine if the Energy Star model will eventually save you money and when.

Methods and Results

- The study compares two different central air conditioning units. One was a conventional model with a SEER of 13 and the other was an entry-level Energy Star model with a SEER of 15 (Minimum SEER to be considered an Energy Star Appliance).
- **Note:** SEER is calculated by dividing the seasonal Btu (British thermal unit) of cooling by the seasonal watt-hours of electricity used. High Ratio=High Efficiency



	Initial Cost	Energy Cost	Energy Consumption (kWh)
Energy Star Model	\$3,413.00	\$486.00	4,465
Conventional Model	\$2,857.00	\$646.00	5,929



Cost Functions: $f(x) = \$486.00x + \3413.00
 $g(x) = \$646.00x + \2857.00
 (Where x is in years)

Setting the equations equal to each other will determine how many years of energy savings it will take to make up for the higher initial cost of the Energy Star central air conditioner and how many total dollars one would have spent over those years, including the purchase price (Figure-1).

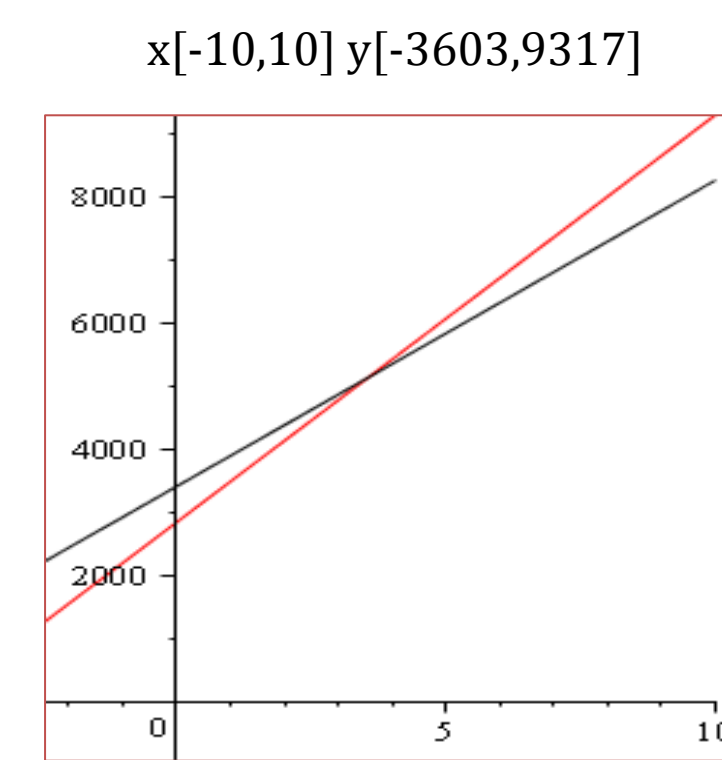


Figure-1

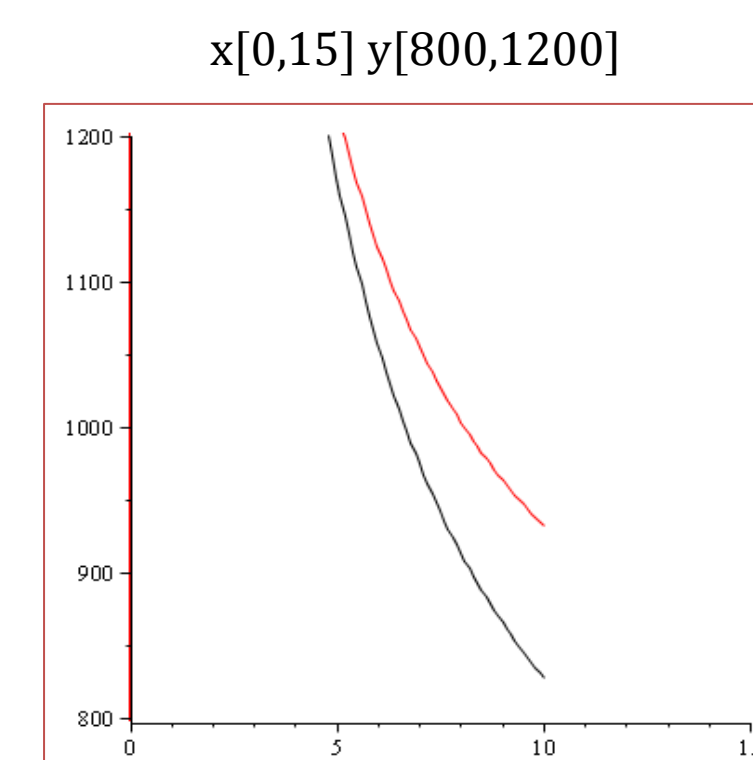


Figure-2

- In both figures the x-axis is in years and the y-axis is in dollars
- $f(x)$ is the Energy Star Model (black curve)
- $g(x)$ is the conventional model (red curve)

Average Cost Functions:

(Where x is in years)

$$\overline{f(x)} = \frac{\$3413.00}{x} + 486.00$$

$$\lim_{x \rightarrow \infty} \overline{f(x)} = \$486.00$$

$$\overline{g(x)} = \frac{\$2857.00}{x} + \$646.00$$

$$\lim_{x \rightarrow \infty} \overline{g(x)} = \$646.00$$

- The average cost function gives the average cost of owning and operating the central air conditioning unit per year.
- By taking the limit as 'x' approaches infinity, one can see that the Energy Star unit has a net savings of \$160 per year.
- The Energy Star model's average cost decreases lower over 'x' years than the conventional model (Figure-2).

Discussion

- The study shows that it will take 3 years and 5 months of energy savings to alleviate the higher initial cost of the Energy Star model.
- One would spend approximately \$5101.85 in initial and energy costs before the Energy Star model becomes a less-expensive investment.
- From the average cost functions I determined that the Energy Star model yields greater long-run savings.
- The study produced results as expected. Given enough time, lower variable costs eventually make-up for higher initial costs.
- While I compared only 2 models, there are numerous other Energy Star models with higher SEER and greater initial costs. Also, all costs are based on United States averages that could be greater in areas that require more cooling throughout the year.
- As the study shows, it is important to consider all the factors and not let a higher initial price alone deter you from purchasing a central air conditioning unit.

References

Stewart, J. (2007). *Calculus: Early Transcendentals* (6th ed.). N.p.: Cengage Learning.

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