ENERGY STAR vs. CONVENTIONAL APPLIANCES

Technology Comparison & Cost Analysis

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ENERGY STAR vs. Conventional Appliances (Refrigerators)

EXECUTIVE SUMMARY

Historically, advances in technology have made it possible for modern consumers to perform daily tasks more rapidly and efficiently. In the present technological age, innovation extends to energy conservation. As a typical consumer may be well aware, such innovation often means higher prices. However, in the case of appliances which run on minimal energy, advertisements claim that higher purchase prices will be justified by long-term monetary savings resulting from lower energy bills. This report investigates the veracity of this claim. Generally, the findings in this report are that *it depends*.

The ENERGY STAR program pioneered by the United State Environmental Protection Agency is a voluntary green-labeling program that helps consumers identify energy-saving appliances. Nevertheless, ENERGY STAR does not indicate to consumers whether a higher purchase price for the efficient appliance will be justified by subsequent energy savings.

There are several variables which may justify spending more for energy conserving appliances. It seems uncommon practice for a consumer to thoroughly evaluate factors which affect their purchase, making it possible to spend more money despite the mindset of saving money. The goal of this report is to identify and evaluate the variables, or varying scenarios, that potentially sway the smart purchase decision in the case of ENERGY STAR refrigerators. Thus, the decision can be tailored to a specific type of individual or household.

The ideal refrigerator for any given consumer depends on the habits and preferences of that consumer including: time value of money preferences, food storage habits, and energy prices. A cash flow diagram is a tool used to depict the monetary gains and losses involved in an investment and will be a practical means to showcase both the initial costs and long-term maintenance costs for either type of refrigerator as influenced by each of the three criteria introduced. This report will use cash flow diagrams to investigative the sensitivity of a refrigerator purchase option to these three parameters. Graphs are also included which will take the costs shown in the cash flow diagrams and display how many years it will take for the higher initial purchase price of the ENERGY STAR refrigerator to be justified by its lower maintenance costs, called the *break-even point*. The analysis also involves calculating the net present value, a term used largely in business, for both an ENERGY STAR appliance and a conventional appliance; and involves calculating this net present value, also, as influenced by the different circumstances mentioned.

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INTRODUCTION

The ENERGY STAR Program was created in 1992 by the US Environmental Protection Agency (EPA) to stimulate the development and sale of energy-efficient goods in hopes of minimizing greenhouse gas emissions. In addition to reducing greenhouse gas emissions, the program strives to provide the consumer with products that meet and/or exceed their conventional counterparts in terms of performance and standards of comfort. [1] ENERGY STAR appliances are rated on a 1 to 100 scale, 50 being an average rating. Typically, a rating of 75 or higher indicates a high performance appliance in terms of meeting a string of energy standards set by the U.S. government. [2]

Owning an appliance rated 50 or higher by ENERGY STAR may seem most useful when considering those household devices at the top of the list for energy consumption. According to the Energy Information Administration in 2001, conventional refrigerators consume the highest percentage of electricity, and thus energy, in comparison to other household appliances. Specifically, refrigerators are responsible for approximately 14% of electricity usage by appliances followed by lighting at about 9%. [3] ENERGY STAR refrigerators, a proposed solution to soaring energy consumption, utilize new technologies that provide better insulation, higher efficiency compressors, more accurate temperature control measures and better defrost mechanisms to reduce that energy usage by upwards of 50 percent.

INVESTIGATIVE METHOD

A comparison between an ENERGY STAR appliance and a conventional appliance with similar dimensions and functionality provides a baseline investigative method for a comparative net present value analysis. Two of Kenmore's popular refrigerator models, conventional model #68882 (sold at Sear's), and ENERGY STAR model #68892 are both 18 cubic feet, meeting the capacity needs of most households, and are both top-freezer refrigerators. The price for Kenmore's conventional model is approximately $80.00 cheaper than the ENERGY STAR model at market price $619.99 vs. $699.00. The choice between these specific two models allows us to highlight the effects of time preference, food storage habits, and energy costs on the analysis results, without having to consider other elements that are likely to be the same in each case, such as repair cost.

A first variable to consider when deciding to purchase an Energy Star or conventional refrigerator is a consumer's time preference. Time preference refers to the concept that each individual varies from another in the amount of time they are willing to wait before he or she enjoys or consumes the benefit of an investment. The theory is that a person with patience (low discount rate, or weak preference for the present compared with future benefits) is willing to wait longer for a return of their initial investment. [4] This greatly influences the buyer's decision on an ENERGY STAR vs. conventional refrigerator. A college student on a budget, an example of high discount rate, likely prefers present savings over future savings. They may be in the market for an inexpensive refrigerator knowing that in

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less than 4 years, he or she will be a successful graduate and can buy the tech savvy stainless steel refrigerator of his or her dreams. The issue here is that in the current year, the student has no significant income and is looking to spend the least amount of cash as immediately possible. The analysis for the time preference variable will evaluate the initial difference in purchase cost and the yearly operating costs to determine if and when the ENERGY STAR refrigerator begins to save the consumer money (i.e. break- even point) on their energy consumption expenditures. In the case that the break - even point ends up being later than a person's time preference period, perhaps an ENERGY STAR appliance is not the correct recommendation.

The second factor to be examined in this analysis is food storage habits. For owners with conventional refrigerators, storing less food actually increases the appliance's energy consumption due to the fact that the larger space causes the cooling system, which maintains the desired temperature, to stay on longer. [5] According to a study conducted by the National Institute of Standards and Technology, keeping a refrigerator at least 75% empty can raise monthly energy costs by about 20% [11]. ENERGY STAR appliances, as mentioned, have the insulation technology to counter-act the constant running of the cooling apparatus, whether or not the refrigerator is stocked or empty. The cost analysis for food storage habits, then, will involve using the increased price of running an empty conventional refrigerator in place of the average yearly operating costs previously used. The team's recommendation will be based on whether or not the outcome break-even point is close enough to the initial purchase time.

Along with variables focused on the consumer, are economic market based variables. The price of energy, for one, fluctuates with its supply and demand in the world market. The current 2012 price in the Phoenix Metro Area is $0.095 per kilo-Watt-hour (kWh) [6] and is an approximate increase of 1.7% from 2011 prices. [7] The team's analysis, similar to the previous two, will include initial purchase cost and yearly operating costs of an ENERGY STAR vs. conventional refrigerator, but with energy costs at 1.7% higher, and at energy costs 1.7% lower

Perhaps the most important tool which will be utilized in the following section of the report is Net Present Value (see Equations 1, 2, & 3 below) which indicates the future value of either refrigerator model in terms of "today's money." The annual discount rate will be plotted against this Net Present Value in order to illustrate which of the options is the best choice for any of the three variables/scenarios just discussed. Microsoft Excel® computes the net present value with an embedded formula, shown below. However, net present value calculations may also be performed manually as shown throughout the next section (pages 8 and 9).

$$PRESENT\ VALUE_{recurring\ payment} = A\left(\frac{(1+i)^N - 1}{i(1+i)^N}\right) \tag{1}$$

Where A = the amount of each recurring payment, i = the discount rate, and N = the total number of payments.

$$PRESENT\ VALUE_{OF\ ONE\ PAYMENT} = \frac{F}{(1+r)^N} \tag{2}$$

Where F = the cash flow per period, r = the rate of return, and N = the number of periods.

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$$NET\ PRESENT\ VALUE = \sum PV \qquad\qquad (3)$$

RESULTS & CALCULATION

Time Preference Variable

Figure 1 & 2 are the cash flow diagrams reflecting initial prices (excluding sales tax) and the first year energy cost of each refrigerator model in year 1, followed by the operating costs per year of each. As the diagrams show, the initial cost of the ENERGY STAR appliance is higher, but requires a lower maintenance amount per year throughout the 14 year projection. The estimated yearly operating cost for a conventional refrigerator is $45.51 [8] and the operating cost for an ENERGY STAR Refrigerator is approximately $36.39; both utilizing the $0.095 per kWh energy cost. [9]

Cash Flow (Conventional)

Cash Flow (Energy Star)
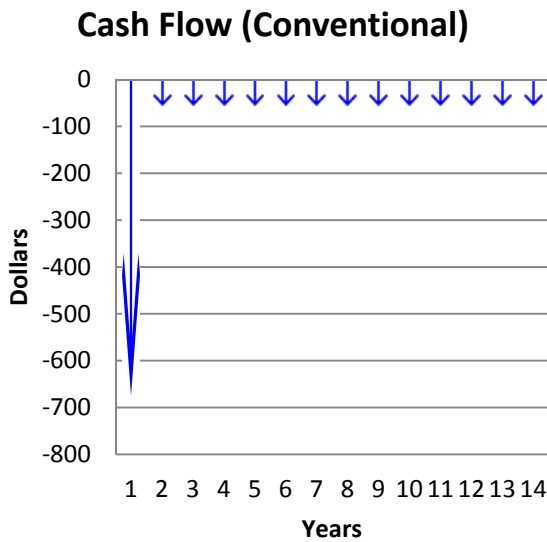
FIGURE 1 – *Refer to Table 1 in Appendix B for plotted data*
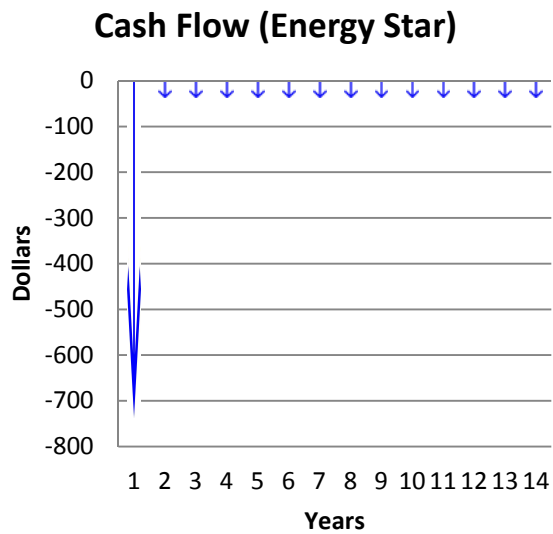
FIGURE 2 – *Refer to Table 2 in Appendix B for plotted data*

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Assuming that the typical life span of a refrigerator is 8 - 14 years without major repair [10], Figure 3 above shows the linearly compounded cost of both the ENERGY STAR and conventional refrigerator over a course of 14 years. The break - even point is estimated to be around 8.7 years (without discounting to present value). This gives us an overall view of costs over time. However, consumers are most likely interested in how these costs over time might look in terms of money today. The Net Present Value analysis to follow will show discounted costs.
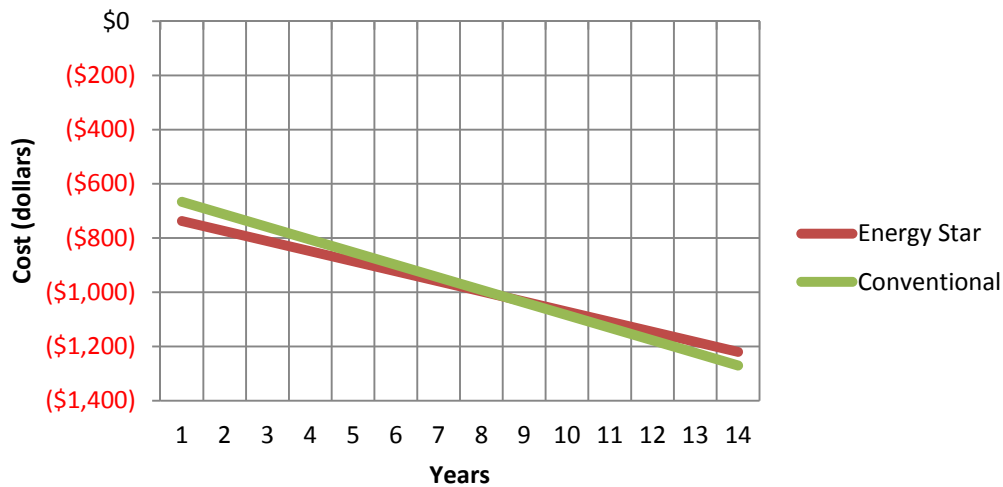
FIGURE 3 — *Refer to Table 3 in Appendix B for plotted data*

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NET PRESENT VALUE vs. ANNUAL RATE
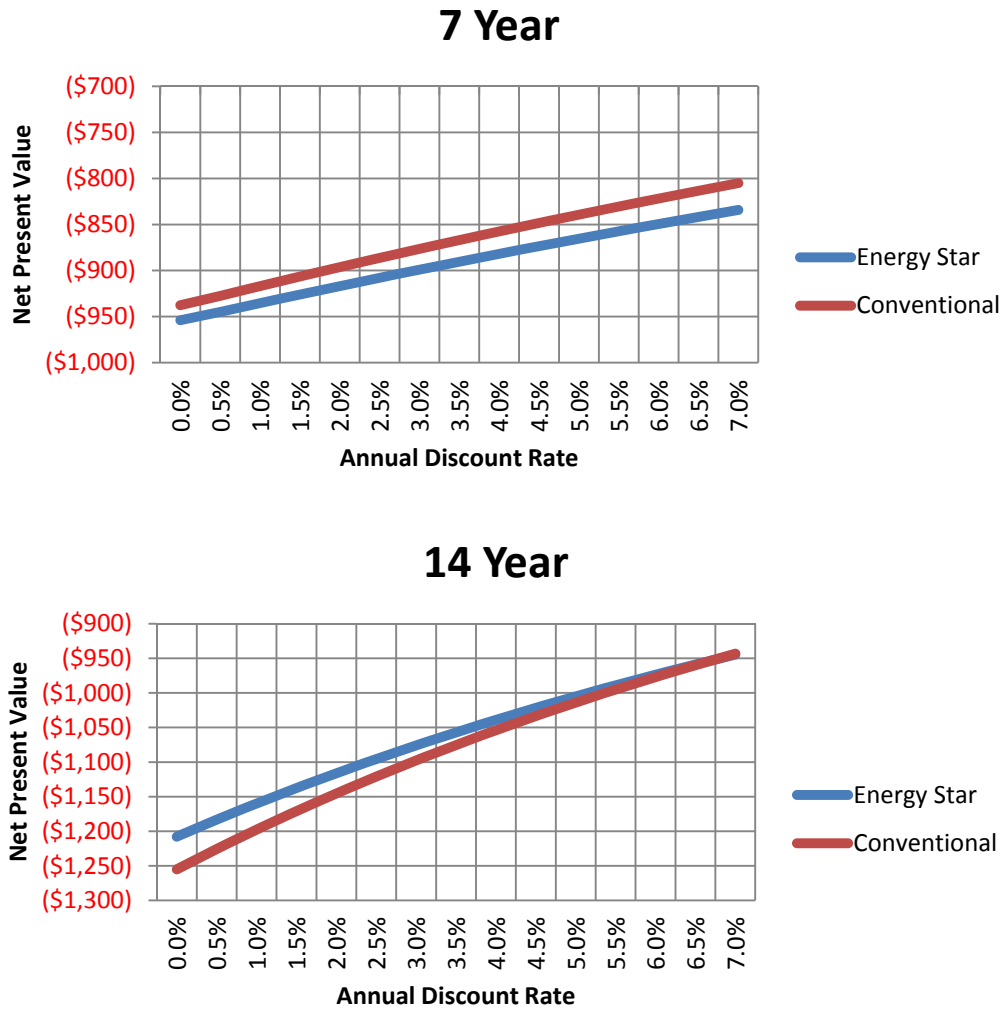
FIGURE 4,5 – *Refer to Tables 4,5 in Appendix B for plotted data*

Using annual discount rates of 0-7%, the Net Present Value plot in Figure 4 (top graph) the conventional refrigerator is always more cost efficient than the energy star refrigerator throughout the course of 7 years. The Effective discount rate shown in the 7 year projection table was calculated as follows:

$$EFFECTIVE\ DISCOUNT\ RATE = \left(1 + \frac{r}{m}\right)^m - 1 \qquad (4)$$

Where r = the annual rate, and m = the # of compound periods, which was 12 in this case, compounding monthly.

SAMPLE CALCULATION: $EFFECTIVE\ DISCOUNT\ RATE = \left(1 + \frac{0.025}{12}\right)^{12} - 1 = 0.0253$

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Using similar methods of calculating effective discount rate, the 14 year projection of Net Present Value shown in Figure 5 above is that the Energy Star refrigerator is actually more cost efficient, or, "cheaper in terms of today's money." Until, that is, the effective rate of 7.2%.

The following sample calculations demonstrate the method used to produce Figures 4 and 5.

<u>**SAMPLE CALCULATION**</u>**:**

The following calculations utilize Equations (1), (2), and (3) from the Investigative Method Section of this Report. The example chosen for display is the calculation of the ENERGY STAR APPLIANCE Net Present Value over the 14 year projection.

$$PRESENT\ VALUE_{recurring\ payment} = 36.39\left(\frac{(1 + 0.07229)^{14} - 1}{0.07229(1 + 0.07229)^{14}}\right)$$

$$PRESENT\ VALUE_{recurring\ payment} = \$313.92$$

$$PRESENT\ VALUE_{of\ one\ payment} = 0$$

**There is no one payment in the future that differs from the recurring payments of $36.39. The initial purchase cost is not to be discounted as it is already at present value.

$$INITIAL\ PAYMENT = \$699.99$$

$$NET\ PRESENT\ VALUE = \sum PV$$

$$= (\$313.92) + (\$0) + (\$699.00) = \boxed{\$1012.92}$$

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Food Storage Habits Variable

According to a study conducted by the National Institute of Standards and Technology, keeping a refrigerator at least 75% empty can raise monthly energy costs by about 20% [11]. Figure 6 above is similar to the cash flow diagrams in Figures 1 & 2, instead replacing the average yearly costs of a conventional refrigerator with yearly operating costs at a 20% increase; assuming that the ENERGY STAR technology is advanced enough to be immune to raising energy consumption via an empty fridge.

Cash Flow (Energy Star)

### Cash Flow (Conventional)
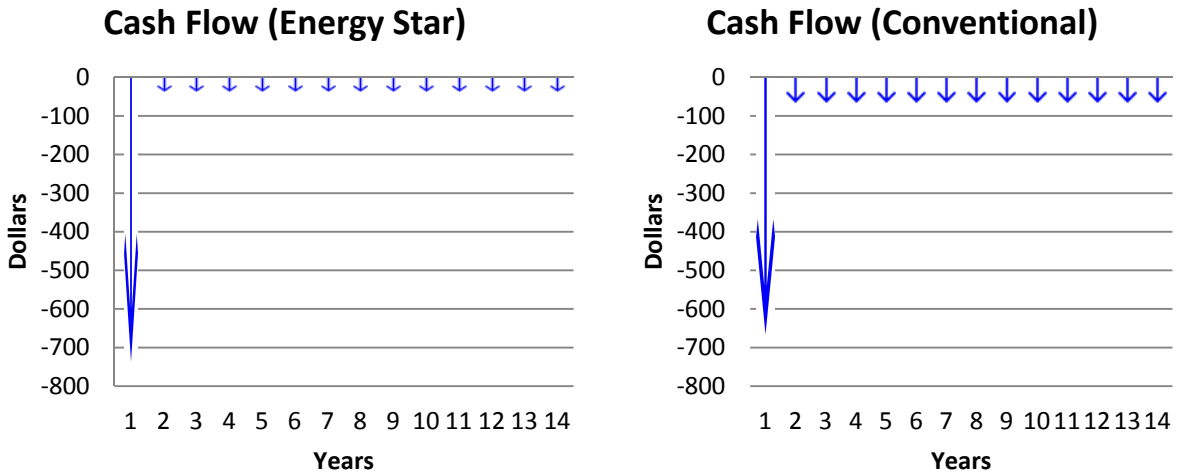
FIGURE 6 – *Refer to Table 6 in Appendix B for plotted data*
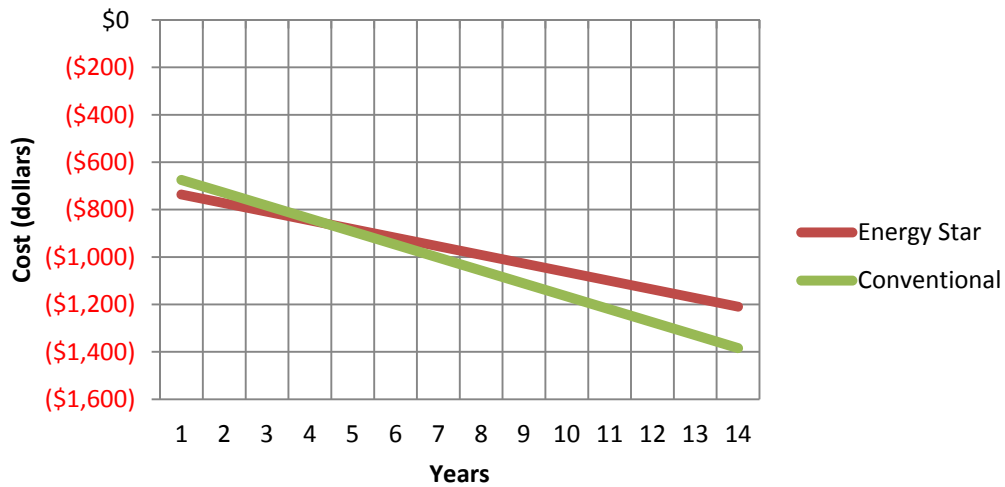
FIGURE 7 – *Refer to Table7 in Appendix B for plotted data*

With the 20% increase in costs to run a conventional refrigerator, the break - even point occurs sooner at approximately 4.5 years.

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In contrast with Figure 4 in the Time Preference Variable Section, this 7 year projection (Figure 8) shows ENERGY STAR being more cost-efficient. The increased 20% yearly operating costs consequent of leaving a refrigerator at least 75% empty is enough to change the recommendation to a consumer. ENERGY STAR now becomes a more suitable purchase. The 14 year projection would also show ENERGY STAR as more cost -efficient than a conventional refrigerator.

7 Year
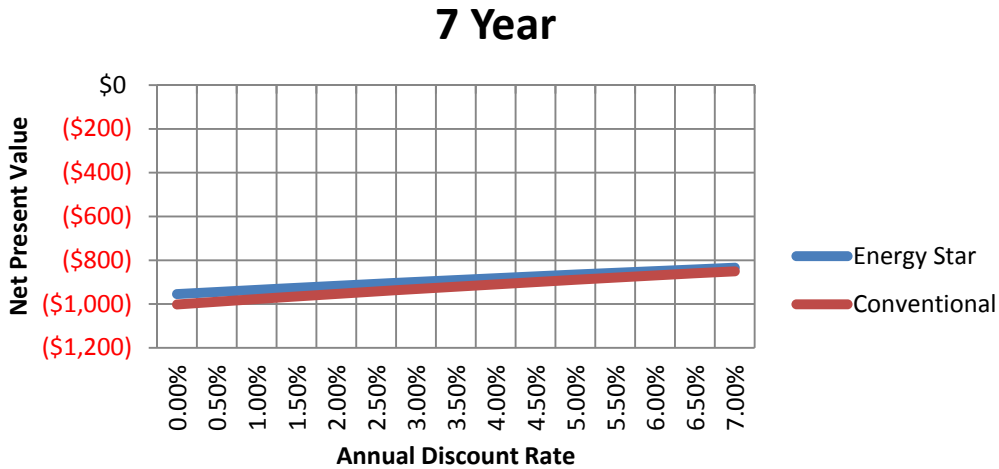
FIGURE 8 – *Refer to Table 8 in Appendix B for plotted data*

Cost of Energy Variable

Shown in Figure 9 are the cash flow diagrams for the Energy Star(top) and conventional refrigerator (bottom) using yearly operating costs when energy is priced at 9.7 cents per kWh versus the current 9.5 cents per kWh (a 1.7% increase in energy costs). As shown, the initial purchase prices remain the same and the yearly operating costs for the conventional refrigerator are still higher than those for the Energy Star refrigerator. It is the overall costs per year (for both) that increase. In the following Net Present Value analysis, we will see if these increased costs are significant or not.

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Cash Flow (Energy Star)

Cash Flow (Conventional)
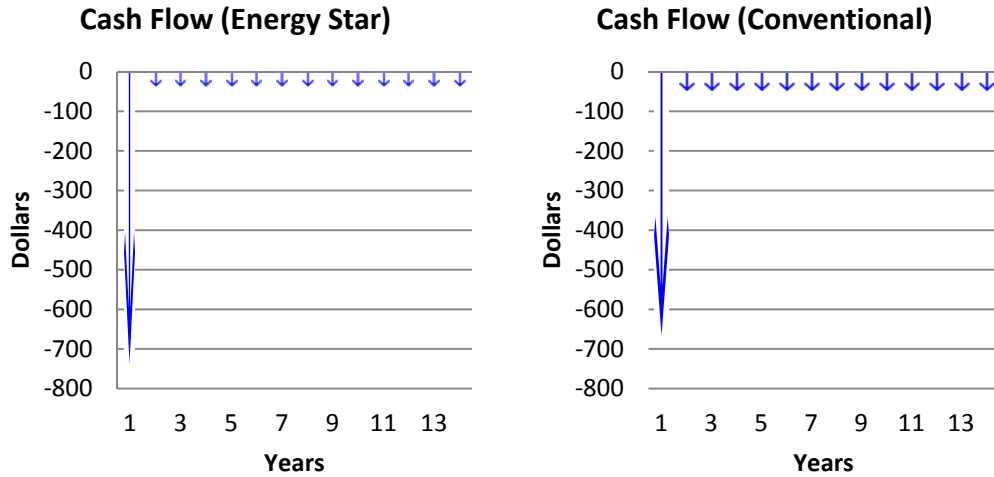
FIGURE 9 – *Refer to Table 9 in Appendix B for plotted data*

Figure 10 shows yearly operating costs which reflect the use of 9.3 cents per kWh versus the current 9.5 cents per kWh: a 1.7% decrease in energy costs. Again, we shall see with the Net Present Value analysis to follow, whether or not (this time) a DECREASE in energy costs is significant.

Cash Flow (Energy Star)

Cash Flow (Conventional)
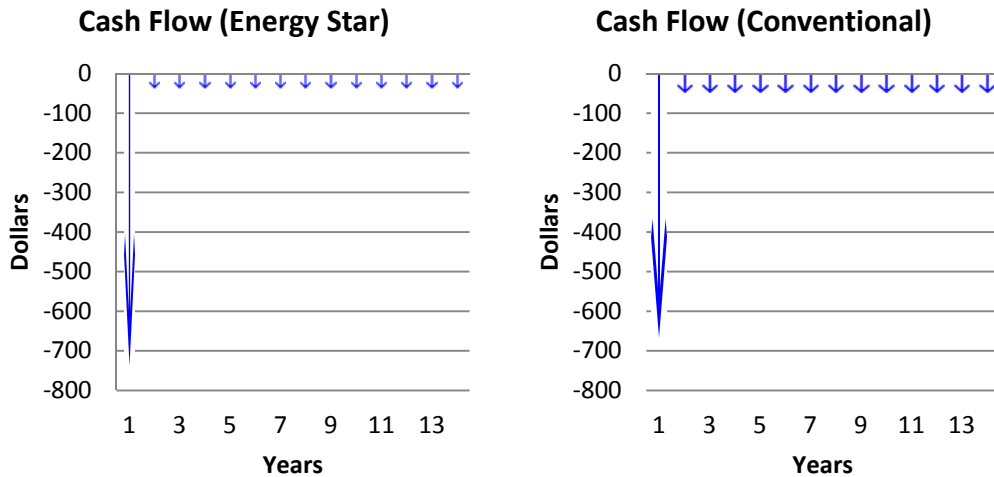
FIGURE 10 – *Refer to Table 10 in Appendix B for plotted data*

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When considering Energy Costs that are 1.7% HIGHER than the current costs, changes the break - even point from 8.7 years (Figure 3), to about 8.2 years (Figure 11).
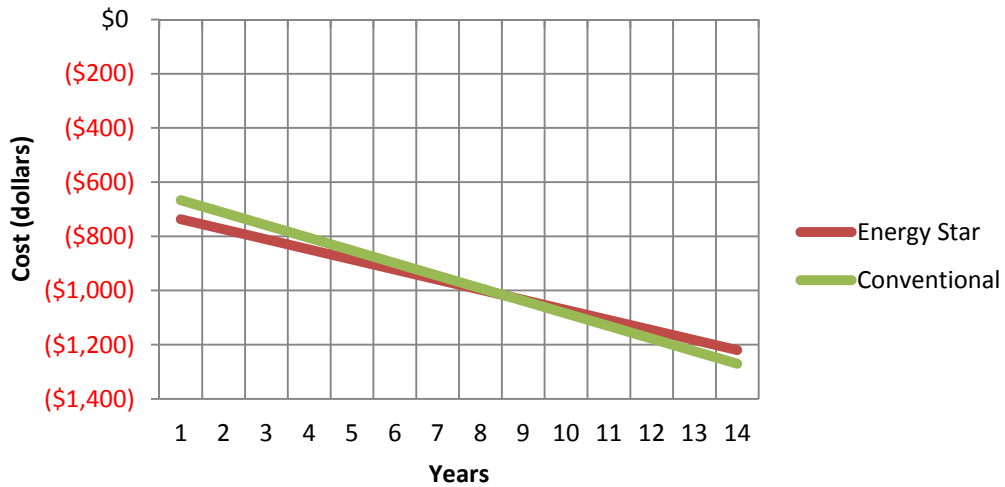
FIGURE 11 – *Refer to Table 11 in Appendix B for plotted data*

When considering Energy Costs that are 1.7% LOWER than the current costs, changes the break - even point from 8.7 years (Figure 3), to about 9.1 years (Figure 12).
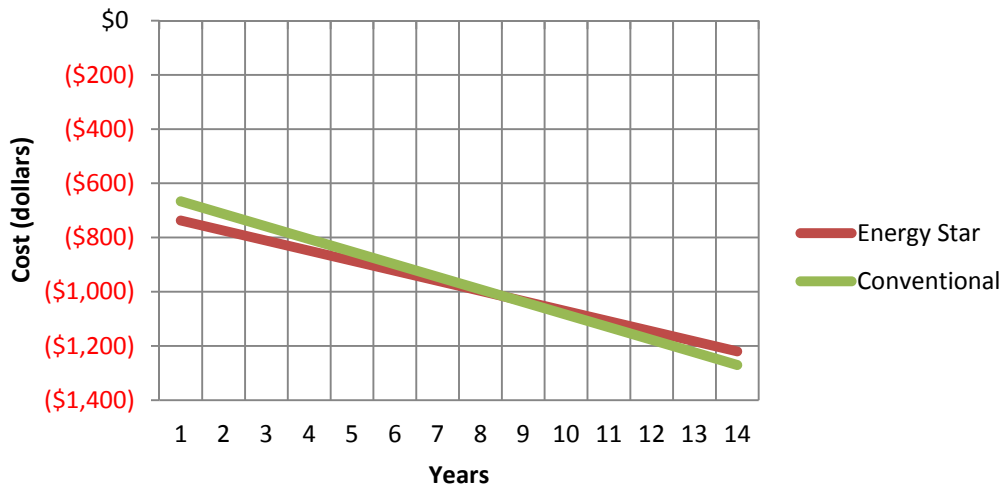
FIGURE 12 – *Refer to Table 12 in Appendix B for plotted data*

A quarter year difference in break - even point is not a very significant alteration to time preference projections. Thus, the team recommendation for the Energy Cost Variable will depend on the Net Present Value diagram. *Please see next page*.

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NET PRESENT VALUE vs. ANNUAL RATE
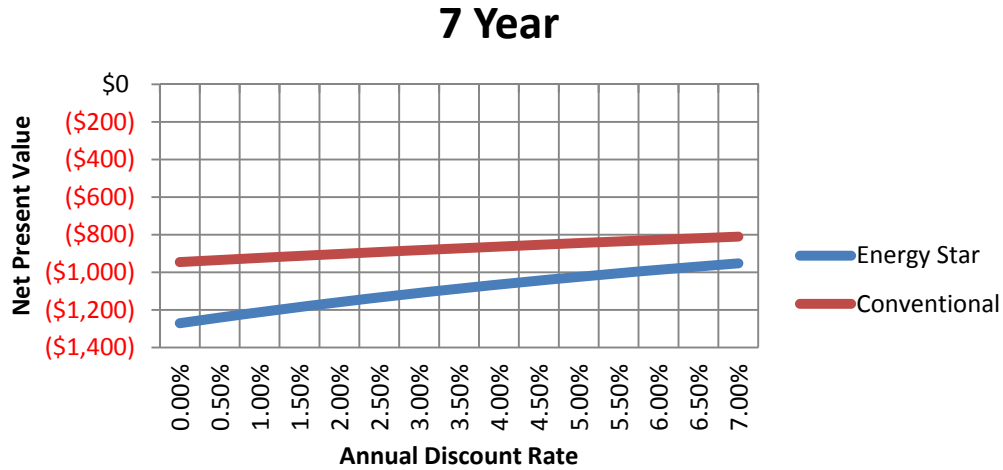
7 Year

FIGURE 13 – *Refer to Table 13 in Appendix B for plotted data*

When considering Energy Costs that are 1.7% HIGHER than the current costs, the 7 year projection once again becomes favorable for the conventional refrigerator
model as it was in Figure 4.
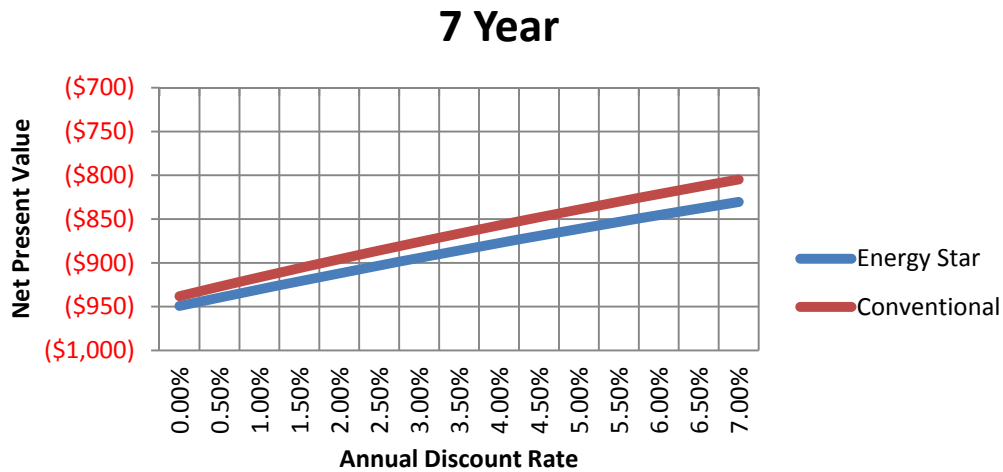
7 Year

**FIGURE 14 –** *Refer to Table 14 in Appendix B for plotted data*

When considering Energy Costs that are 1.7% LOWER than the current costs, the 7 year projection once again becomes favorable for the conventional refrigerator model as it was in Figure 4.

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The 14 projection models were ALWAYS favorable for ENERGY STAR (*refer to Appendix B for these*). What differed with each variable, were the 7 year projections. It seems from Figure 13 & 14, that considering different costs of energy (at least at the 1.7% change rate) finds the conventional model more cost-efficient. The cost efficiency when energy costs are more expensive, seems to be more immediate than if the energy costs were lower.

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FINAL RECOMMENDATIONS

TIME PREFERENCE	
Person with a low Discount Rate (willing to wait)	
Person with a high Discount Rate	CONVENTIONAL
Explanation: A person with a low discount rate would fare well to purchase an ENERGY STAR appliance. After 14 years, with good care, the refrigerator's yearly energy savings would justify its initial purchase cost making Net Present Value higher than the conventional model. A person with a high discount rate, however, may not want to wait the full 14 years in order to benefit from his/her purchase. In the example of the college student who is in the market for a budget friendly refrigerator needed for only 4 or so years, the conventional refrigerator is the recommendation. The break - even point, as shown in Figure 3, occurs at approximately 8.7 years - long after the future value projection of the student.	

FOOD STORAGE HABITS (assuming consumer has a high Time Preference)	
Person who keeps an average to fully stocked fridge	CONVENTIONAL
Person who dines out often, keeping Often keeping an empty fridge (approx. 75% empty)	
Explanation: A person with a high time preference and who keeps an averagely stocked refrigerator will have average yearly operating costs of approximately $45.51. (using the current 9.5 cent per kWh energy price). Even when considering the lower yearly operating costs of the ENERGY STAR refrigerator, a 7 year projection of the Net Present Value will show the conventional model as being more cost efficient. A person who dines out often and, thus, often keeps an empty fridge, is more likely to experience a 20% increase in energy consumption which will lead to a 20% increase in yearly operating costs (still using the current 9.5 cent per kWh energy price). This increase in yearly operating costs lowers the break - even point in a cost vs. time analysis (Figure 7) to about 4 years as opposed to 8.7 years. This means that the initial purchasing price of the ENERGY STAR refrigerator is justified much sooner when compared to the raised yearly operating costs of the conventional model. Furthermore, when considering the 20% increase in energy consumption of the conventional model, the Net Present Value of the ENERGY STAR model becomes higher, even in the 7 year projection. It is now more cost - efficient not only in the long run, but in the "short run."	

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ENERGY COST CHANGE	
1.7% increase in Energy Cost	See Time Preference Recommendation
1.7% decrease in Energy Cost	See Time Preference Recommendation

Explanation: *It was found that a fluctuation in energy prices of 1.7% (which was the case moving from 2011 to 2012) incurred no significant differences from the cost benefit analysis using Time Preference as the primary variable. The only changes were the actual yearly operating costs for both the ENERGY STAR and conventional appliance; it is obvious that because both models are subject to the energy price increase or decrease, their relation to one another remains linear. Similarly, a larger percent increase or decrease (for example, in 10 years) would affect the comparison between the two models in the same manner.*

In a seven year projection, the conventional model is more cost efficient. The Net Present Value graph shows a smaller slope when the prices are increased by 1.7% than when the prices are decreased by 1.7%, but the recommendation still remains favorable for the conventional model as the overall cost efficiency prices are lower throughout the projection.

Conclusively, it is the consumer's personal time preference and food storage habits which need to be considered as purchase decision factors. When in the market for purchasing a large appliance which is responsible for a major portion of the household energy consumption, it becomes important to evaluate how often it will be used, the capacity to which it will be used, and the time period it is intended to be kept.

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[9]   http://www.kenmore.com/kenmore-18.2-cu-ft-top-freezer-refrigerator/p-04668892000P?vName=Kitchen&cName=Refrigerators+%26+Freezers&sName=Top+freezer+Refrigerators&prdNo=2&blockNo=2&blockType=L2. [Accessed: September 23, 2012].

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[11]   Grimes, Mulroy, Shomaker. "Effect of Usage Conditions on Household Refrigerator-Freezer and Freezer Energy Consumption." *National Institute of Standards and Technology.* Available: http://fire.nist.gov/bfrlpubs/build77/PDF/b77002.pdf. [Accessed: October 6, 2012].

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APPENDIX A

THE FOLLOWING TIPS WERE SUGGESTED BY THE AMERICAN COUNCIL for an ENERGY EFFICIENT ECONOMY at the website: http://www.aceee.org/consumer/refrigeration

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To find the most efficient refrigerators , download a qualifying product list from the ENERGY STAR Web site. Sort by "Configuration," "Volume," and "Percent Better" to see which refrigerators meet our recommendations (below). For a quick search by manufacturer, here's a direct link to the list in html.

When buying a new refrigerator, consider the following:

1. **Low Annual Energy Use:**   ACEEE recommends that you consider models that use at least 20% less electricity than that required by federal law. Models that are 20%, 25% and 30% better than the federal standard may qualify for rebates — check with your local utility.

2. **Choose top-mounted freezer configuration over side-by-side:**   Side-by-side refrigerator/freezers use more energy than similarly sized models with the freezer on top, even if they both carry the ENERGY STAR. The government holds the two categories to different standards, allowing side-by-sides to use 10-30% more energy. Icemakers and through-the-door ice also add to energy consumption. To compare energy performance across different refrigerator types, look for the measured "kWh/year" either on the ENERGY STAR list above, or on the yellow EnergyGuide label posted on the refrigerator (and available on-line through many manufacturers and retailers websites).

3. **Size Matters:** Refrigerators under 25 cubic feet should meet the needs of most households. The models over 25 cubic feet use significantly more energy. If you are thinking about purchasing such a large unit, you may want to reconsider. A smaller unit may well meet your household's needs.

4. **Minimize multiple refrigerators:**   That said, if you need more refrigerator space, resist the temptation of moving your old refrigerator to the basement or garage for auxiliary purposes. Instead, have it recycled and think about other options if you need more refrigerator space. Depending on your situation, it is generally much more efficient to operate one big refrigerator rather than two smaller ones. If your big fridge is likely to be empty most of the year, maybe the better option would be to purchase an ENERGY STAR compact fridge. Compact refrigerators less than 7.75 ft3 must be 20% more efficient than the minimum federal standard to qualify for ENERGY STAR. They are listed alongside full-size refrigerators at the ENERGY STAR link above.
5. **Recycle your old fridge**: Be sure you dispose of your old refrigerator properly. You can usually have the utility or the city pick it up; they might even pay you to throw it out.

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APPENDIX B

Table 1

Year	Conventional refrigerator
1	-665.50
2	-45.51
3	-45.51
4	-45.51
5	-45.51
6	-45.51
7	-45.51
8	-45.51
9	-45.51
10	-45.51
11	-45.51
12	-45.51
13	-45.51
14	-45.51

Table 2

Year	ENERGY STAR Refrigerator
1	-736.38
2	-36.39
3	-36.39
4	-36.39
5	-36.39
6	-36.39
7	-36.39
8	-36.39
9	-36.39
10	-36.39
11	-36.39
12	-36.39
13	-36.39
14	-36.39

Table 3

Year	Conventional refrigerator	ENERGY STAR Refrigerator
1	(665.50)	(736.38)
2	(711.00)	(772.76)
3	(756.51)	(809.15)
4	(802.01)	(845.53)
5	(847.52)	(881.92)
6	(893.02)	(918.30)
7	(938.53)	(954.69)
8	(984.03)	(991.07)
9	(1029.54)	(1027.46)
10	(1075.04)	(1063.84)
11	(1120.55)	(1100.23)
12	(1166.05)	(1136.61)
13	(1211.56)	(1173.00)
14	(1257.06)	(1209.38)

Table 4

14 YEAR PROJECTION			
Annual Rate	Effective Rate	NPV Conventional refrigerator	NPV ENERGY STAR Refrigerator
0.00%	0.00%	($1,257.13)	($1,209.45)
0.50%	0.50%	($1,227.66)	($1,184.86)
1.00%	1.00%	($1,199.54)	($1,161.37)
1.50%	1.51%	($1,172.70)	($1,138.90)
2.00%	2.02%	($1,147.08)	($1,117.41)
2.50%	2.53%	($1,122.59)	($1,096.84)
3.00%	3.04%	($1,099.19)	($1,077.13)
3.50%	3.56%	($1,076.80)	($1,058.24)
4.00%	4.07%	($1,055.38)	($1,040.13)
4.50%	4.59%	($1,034.86)	($1,022.75)
5.00%	5.12%	($1,015.21)	($1,006.07)
5.50%	5.64%	($996.37)	($990.04)
6.00%	6.17%	($978.30)	($974.63)
6.50%	6.70%	($960.97)	($959.82)
7.00%	7.23%	($944.32)	($945.56)

Table 5

7 YEAR PROJECTION			
Annual Rate	Effective Rate	NPV Conventional refrigerator	NPV ENERGY STAR Refrigerator
0.00%	0.00%	($938.56)	($954.72)
0.50%	0.50%	($927.62)	($944.95)
1.00%	1.00%	($916.92)	($935.39)
1.50%	1.51%	($906.46)	($926.02)
2.00%	2.02%	($896.23)	($916.83)
2.50%	2.53%	($886.22)	($907.83)
3.00%	3.04%	($876.43)	($899.01)
3.50%	3.56%	($866.84)	($890.36)
4.00%	4.07%	($857.46)	($881.88)
4.50%	4.59%	($848.28)	($873.56)
5.00%	5.12%	($839.28)	($865.40)
5.50%	5.64%	($830.47)	($857.39)
6.00%	6.17%	($821.85)	($849.53)
6.50%	6.70%	($813.39)	($841.82)
7.00%	7.23%	($805.11)	($834.24)

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Table 6

Year	Conventional refrigerator	ENERGY STAR Refrigerator
1	-665.50	-736.38
2	-54.61	-36.39
3	-54.61	-36.39
4	-54.61	-36.39
5	-54.61	-36.39
6	-54.61	-36.39
7	-54.61	-36.39
8	-54.61	-36.39
9	-54.61	-36.39
10	-54.61	-36.39
11	-54.61	-36.39
12	-54.61	-36.39
13	-54.61	-36.39
14	-54.61	-36.39

Table 7

Year	Conventional refrigerator	ENERGY STAR Refrigerator
1	(674.60)	(736.38)
2	(729.20)	(772.76)
3	(783.81)	(809.15)
4	(838.41)	(845.53)
5	(893.02)	(881.92)
6	(947.63)	(918.30)
7	(1002.23)	(954.69)
8	(1056.84)	(991.07)
9	(1111.44)	(1027.46)
10	(1166.05)	(1063.84)
11	(1220.66)	(1100.23)
12	(1275.26)	(1136.61)
13	(1329.87)	(1173.00)
14	(1384.47)	(1209.38)

Table 8

	7 YEAR PROJECTION		
Annual Rate	Effective Rate	NPV Conventional refrigerator	NPV ENERGY STAR Refrigerator
0.00%	0.00%	($1,002.26)	($954.72)
0.50%	0.50%	($989.75)	($944.95)
1.00%	1.00%	($977.53)	($935.39)
1.50%	1.51%	($965.59)	($926.02)
2.00%	2.02%	($953.92)	($916.83)
2.50%	2.53%	($942.52)	($907.83)
3.00%	3.04%	($931.36)	($899.01)
3.50%	3.56%	($920.46)	($890.36)
4.00%	4.07%	($909.80)	($881.88)
4.50%	4.59%	($899.37)	($873.56)
5.00%	5.12%	($889.17)	($865.40)
5.50%	5.64%	($879.18)	($857.39)
6.00%	6.17%	($869.41)	($849.53)
6.50%	6.70%	($859.85)	($841.82)
7.00%	7.23%	($850.48)	($834.24)

Table 9

	1.7% higher Energy Cost	
Year	Conventional refrigerator	ENERGY STAR Refrigerator
1	-666.45	-737.14
2	-46.46	-37.15
3	-46.46	-37.15
4	-46.46	-37.15
5	-46.46	-37.15
6	-46.46	-37.15
7	-46.46	-37.15
8	-46.46	-37.15
9	-46.46	-37.15
10	-46.46	-37.15
11	-46.46	-37.15
12	-46.46	-37.15
13	-46.46	-37.15
14	-46.46	-37.15

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Table 10

	1.7% higher Energy Cost	
Year	Conventional refrigerator	ENERGY STAR Refrigerator
1	(666.45)	(737.14)
2	(712.92)	(774.29)
3	(759.38)	(811.44)
4	(805.84)	(848.59)
5	(852.31)	(885.75)
6	(898.77)	(922.90)
7	(945.23)	(960.05)
8	(991.69)	(997.20)
9	(1038.16)	(1034.35)
10	(1084.62)	(1071.50)
11	(1131.08)	(1108.65)
12	(1177.55)	(1145.80)
13	(1224.01)	(1182.95)
14	(1270.47)	(1220.10)

Table 11

	1.7% higher Energy Cost	
Year	Conventional refrigerator	ENERGY STAR Refrigerator
1	-664.54	-735.61
2	-44.55	-35.62
3	-44.55	-35.62
4	-44.55	-35.62
5	-44.55	-35.62
6	-44.55	-35.62
7	-44.55	-35.62
8	-44.55	-35.62
9	-44.55	-35.62
10	-44.55	-35.62
11	-44.55	-35.62
12	-44.55	-35.62
13	-44.55	-35.62
14	-44.55	-35.62

Table 12

	1.7% lower Energy Cost	
Year	Conventional refrigerator	ENERGY STAR Refrigerator
1	(664.54)	(735.61)
2	(709.08)	(771.23)
3	(753.63)	(806.85)
4	(798.18)	(842.47)
5	(842.73)	(878.09)
6	(887.27)	(913.70)
7	(931.82)	(949.32)
8	(976.37)	(984.94)
9	(1020.91)	(1020.56)
10	(1065.46)	(1056.18)
11	(1110.01)	(1091.80)
12	(1154.55)	(1127.42)
13	(1199.10)	(1163.04)
14	(1243.65)	(1198.66)

Table 13

		7 YEAR PROJECTION (1.7% higher Energy Costs)	
Annual Rate	Effective Rate	NPV Conventional refrigerator	NPV ENERGY STAR Refrigerator
0.00%	0.00%	($945.21)	($1,270.43)
0.50%	0.50%	($934.11)	($1,240.41)
1.00%	1.00%	($923.25)	($1,211.77)
1.50%	1.51%	($912.64)	($1,184.44)
2.00%	2.02%	($902.25)	($1,158.34)
2.50%	2.53%	($892.10)	($1,133.40)
3.00%	3.04%	($882.16)	($1,109.57)
3.50%	3.56%	($872.44)	($1,086.78)
4.00%	4.07%	($862.93)	($1,064.97)
4.50%	4.59%	($853.61)	($1,044.09)
5.00%	5.12%	($844.49)	($1,024.09)
5.50%	5.64%	($835.56)	($1,004.92)
6.00%	6.17%	($826.81)	($986.54)
6.50%	6.70%	($818.24)	($968.90)
7.00%	7.23%	($809.85)	($951.96)

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Table 14

		NPV	NPV
7 YEAR PROJECTION			
(1.7% lower Energy Costs)			
Annual Rate	**Effective Rate**	**Conventional refrigerator**	**ENERGY STAR Refrigerator**
0.00%	0.00%	($938.14)	($949.33)
0.50%	0.50%	($927.21)	($939.70)
1.00%	1.00%	($916.52)	($930.26)
1.50%	1.51%	($906.07)	($921.01)
2.00%	2.02%	($895.85)	($911.95)
2.50%	2.53%	($885.85)	($903.07)
3.00%	3.04%	($876.07)	($894.36)
3.50%	3.56%	($866.49)	($885.82)
4.00%	4.07%	($857.12)	($877.45)
4.50%	4.59%	($847.94)	($869.24)
5.00%	5.12%	($838.95)	($861.18)
5.50%	5.64%	($830.15)	($853.27)
6.00%	6.17%	($821.53)	($845.51)
6.50%	6.70%	($813.09)	($837.89)
7.00%	7.23%	($804.81)	($830.40)

Table 15

		NPV	NPV
14 YEAR PROJECTION			
(1.7% higher Energy Costs)			
Annual Rate	**Effective Rate**	**Conventional refrigerator**	**ENERGY STAR Refrigerator**
0.00%	0.00%	($1,259.03)	($1,210.97)
0.50%	0.50%	($1,229.48)	($1,186.32)
1.00%	1.00%	($1,201.29)	($1,162.77)
1.50%	1.51%	($1,174.39)	($1,140.25)
2.00%	2.02%	($1,148.69)	($1,118.70)
2.50%	2.53%	($1,124.15)	($1,098.08)
3.00%	3.04%	($1,100.69)	($1,078.33)
3.50%	3.56%	($1,078.25)	($1,059.40)
4.00%	4.07%	($1,056.77)	($1,041.25)
4.50%	4.59%	($1,036.21)	($1,023.83)
5.00%	5.12%	($1,016.52)	($1,007.12)
5.50%	5.64%	($997.64)	($991.06)
6.00%	6.17%	($979.53)	($975.62)
6.50%	6.70%	($962.16)	($960.77)
7.00%	7.23%	($945.48)	($946.49)

14 Year
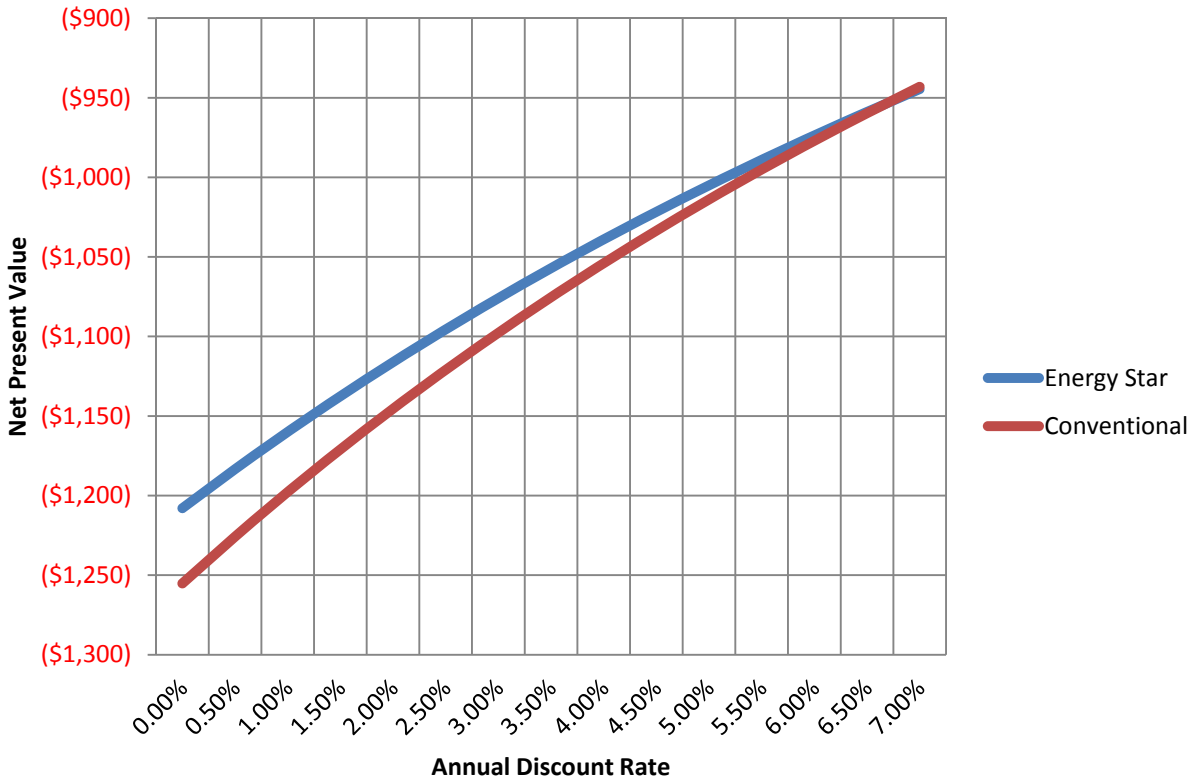
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Table 16

Annual Rate	Effective Rate	NPV Conventional refrigerator	NPV ENERGY STAR Refrigerator
14 YEAR PROJECTION (1.7% lower Energy Costs)			
0.00%	0.00%	($1,255.21)	($1,207.91)
0.50%	0.50%	($1,225.82)	($1,183.39)
1.00%	1.00%	($1,197.77)	($1,159.95)
1.50%	1.51%	($1,171.01)	($1,137.54)
2.00%	2.02%	($1,145.44)	($1,116.10)
2.50%	2.53%	($1,121.02)	($1,095.57)
3.00%	3.04%	($1,097.67)	($1,075.91)
3.50%	3.56%	($1,075.34)	($1,057.07)
4.00%	4.07%	($1,053.96)	($1,039.00)
4.50%	4.59%	($1,033.49)	($1,021.66)
5.00%	5.12%	($1,013.89)	($1,005.01)
5.50%	5.64%	($995.09)	($989.01)
6.00%	6.17%	($977.06)	($973.64)
6.50%	6.70%	($959.76)	($958.85)
7.00%	7.23%	($943.15)	($944.62)

14 Year

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