Flagstaff Homes: Energy Saving Alternatives Analysis

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Introduction

The goal of this research was to investigate a range of energy saving methods that could be employed in Flagstaff, Arizona. As the community becomes increasingly green oriented, it is important for residence to understand the different options that are available that help to ensure decreases in fossil-fuel-derived energy consumption. Part of this understanding includes consideration of the fiscal responsibility of these measures. This study examines the effects of the installation of residential a wind turbine, the installation of a solar thermal water heater, and improvements to insulation in an average Flagstaff home. Much of this was accomplished through the use of industry standard software, "eQuest." Following this examination, a comparison is made between the options by calculating the Net Present Value (NPV) for each possible change. The NPV demonstrates the actual return of a project, taking into account the initial cost, annual cost, and annual savings of the project. Also, the variability of the value of money over time is taken into account through the Minimum Attractive Rate of Return (MARR). The MARR can be thought of as the rate of return that could be achieved through placing the potential project money into a no-risk investment. This calculation is performed using a MATLAB program written by the researcher.

Methods

I.Wind Turbine – In order to determine the fiscal viability of installing a residential wind turbine in Flagstaff, it was first necessary to determine how much power could be derived from such a system. The SkyStream 3.7 wind turbine from Southwest Wind Power was selected for this study. Annual wind speed averages from meteorological (met) tower data as well as average cost of electricity from Arizona Public Service (APS) were then estimated. From the SkyStream specifications, annual power output by the turbine generator was calculated in kilowatt-hours (kWh). Using the average cost per kWh from APS, annual savings were found for the project. It should be noted that the NPV calculation used this savings value and an annual cost of $0.00 for varying MARR values for different project lifetimes. Also, rebates exist for wind turbine installations in residential areas from the state of Arizona, the federal government, as well as APS. These were taken into account when finding the initial cost of the system.

II.Solar Thermal Water Heater – A similar process was followed for determining the NPV of installing a solar thermal water heater. An active, closed-loop system with 2 flat collectors and an 80 gallon tank was selected from Solar Direct. A four (4) person household in a 1,600 square foot home was assumed in order to estimate average annual hot water usage using eQuest. Annual savings from the use of thermal energy to heat 80% of a households hot water were found, and the remaining 20% was considered to be operating costs of the electric heating within the tank. Again, in calculating the NPV, a federal and state tax credits for initial costs was used, as well as varying MARR values for different lifetimes.

III.Insulation Improvements – The effects of insulation improvements were also determined with the use of eQuest. Initial data were gathered with R-11 fiberglass insulation batts being used for the attic floor and ceiling. Higher quality batts, R-38 and R-30, were then placed at the attic floor and ceiling, respectively. The difference in annual heating costs were then found from eQuest simulations and average APS cost per kWh. As there is no maintenance expected for insulation replacement, there is only the initial cost to take into consideration when calculating the NPV. For insulation improvements in residential areas, only a federal tax credit exists, and this was also taken into account when determining initial costs.

Results

Figure 1, presented at right, demonstrates the NPV for wind installing a residential wind turbine in Flagstaff. Note that almost every MARR value results in a negative NPV for each project lifetime. The only way to yield a positive NPV from the implementation of a residential wind turbine would be to have very low expectations for the rate of return, that is an MARR less than or equal to about 3.5%. Also, the project lifetime would have to be greater than 15 years, as no positive results are seen for the 15 year lifetime.

Figure 2

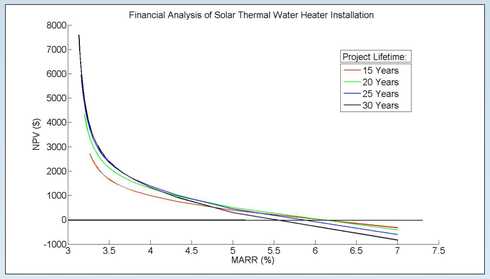


Figure 3, at right, shows the insulation options' NPV over varying project lifetimes. Here, it can be seen that positive NPV's are found at MARR values up to 6.5%. Again, the implication is that the insulation investment is well worth it unless MARR values greater than 6.5% can be found.

Figure 1

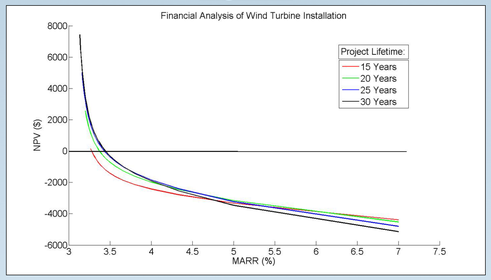
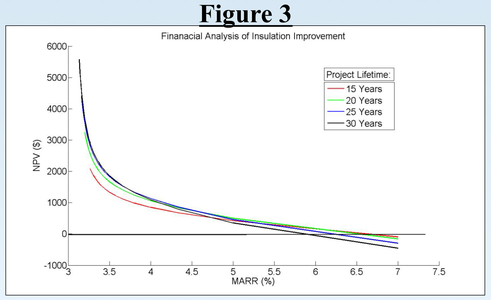


Figure 2, at left, shows the NPV vs. MARR for the installation of the selected solar thermal water heater, similar to Figure 1. Here, positive NPV's are yielded for MARR's less than about 5.75%. This demonstrates that if large MARR's cannot be achieved at a particular time, it is actually in a home owners best interest to invest the money in the solar thermal water heater, as higher returns will result.

Figure 3



Discussion and Conclusion

From the NPV results found using the MATLAB program, it is clear that the most likely investment to be fiscally responsible is the improved fiberglass insulation in the attic of a home. Also, this option happens to be the least expensive concerning the initial purchase of materials, as well as the simplest to install for a home owner. The insulation improvement is also the least likely change to require maintenance.

The solar thermal water heater is also a fiscally responsible investment given the appropriate MARR values are available at the time of investment. The study assumed a four (4) person household, however, a two (2) person household requires a significantly smaller amount of hot water, which decreases the needed collector size. This was the main driving cost of the system and would be greatly decreased under these circumstances. This change may make the solar thermal water heater yield higher returns than the insulation improvement and should be further investigated.

The residential wind turbine is the only option examined that was not a fiscally responsible investment. The rate of return can easily be increased by investing in bonds or other risk free investments. This is also the most expensive system to purchase, initially, making it more difficult for a large number of families to seriously consider.

Each of these options makes use of a 30% federal tax credit that is currently set to expire in 2014. It should be well-noted that these NPV graphs can greatly differ when the initial cost of materials is increased by such a large factor.

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