Energy Investment Options

for the Smith and Jones Residence**[[1]](#footnote-1)ß**

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# Overview

This is an Energy Investment Options Report for the Smith and Jones Residence, they own a 1500 ft2 home built in the 1950s in Harrisonburg, Virginia. They asked us to analyze 7 possible strategies for decarbonizing their energy footprint and lowering expenses. The family has $20,000 to spend and does not want to borrow money to spend more than that. They asked us to analyze 7 strategies including an Electric Vehicle, a new furnace, a new air conditioner, a heat pump to replace the furnace and air conditioner, then new insulation, a new water heater, and a solar pv system. The life cycle for all of these was 15 years, except for the solar pv system the life cycle is 20 years for that option. A couple things about this analysis are the furnace is 22 years old and will need a major repair soon and the air conditioner is also 12 years old and needs replacement soon. They will also likely need a new car in the next 5 years.

# Analysis

For this Energy Investment Options Report, we evaluated the economic viability of seven strategies using a 15-year life cycle analysis, which aligns with the typical lifespan of major home energy systems and provides a reasonable horizon for assessing long-term value. Our analysis incorporated three key metrics: life-cycle cost (LCC), net savings or cost, and simple payback period, allowing for a clear comparison of upfront investments and ongoing operating expenses. We also identified and included relevant federal tax incentives and local rebates where applicable to reflect realistic out-of-pocket costs.

Options that involved varying levels of energy efficiency—such as the heat pump, air conditioner, water heater, and solar PV system—were assessed using current efficiency standards and high-efficiency alternatives to capture potential trade-offs between cost and performance. Energy prices used in the analysis were based on local utility rates in Harrisonburg, Virginia: $0.11 per kWh for electricity and $1.4815 per therm for natural gas. Equipment and installation costs were estimated using realistic, regionally appropriate figures, though actual contractor pricing may vary. This approach ensures a practical comparison of each investment’s potential impact on energy use, carbon footprint, and household expenses.

# Recommended Equipment Choices

Based on our benefit-cost analysis, we recommend the equipment shown in Table 1 as the choice to be considered for each investment option. The recommended choices were used to calculate the investment purchase and installation costs and the annual cost savings compared to the existing systems in the home. Appendix A provides the supporting Life Cycle Cost table for each option.

| **Table 1. Equipment choices that best optimize cost and energy efficiency** | | |
| --- | --- | --- |
| **Investment Option** | **Recommended Equipment Choice/Efficiency/Size** | **Explanation** |
| **Electric Vehicle** | Nissan Leaf S (2022) | The Nissan Leaf S is the best choice for this family, especially if they are driving it as their secondary vehicle doing only 8,000 rather than 18,000 Miles. The Nissan Leaf is much cheaper than the other options upfront to buy and auto insurance is lower, with the LCC being $4,000 cheaper than Tesla and $19,400 cheaper than the Bolt, as the primary vehicle. If driven at 8,000 it needs less battery replacements and the LCC is $13,000 cheaper than Tesla. |
| **Furnace** | Furnace with AFUE 95 | The minimum furnace efficiency begins in 2028, and the highest efficiency is cost effective for this climate. Its total life cycle cost was about $170 more than an AFUE 90 furnace. However, because this is a current dollar analysis, realistically, any increase in the cost of energy will make the AFUE 95 the most cost effective. |
| **Air conditioner** | EnergyStar SEER2 16.0 | We recommend the EnergyStar SEER2 16.0 as it has a lower upfront cost but is still eligible for a tax rebate of $600 while also cheaper energy costs than the 14.2 but more than the 18.0. The LCC of the SEER2 16.0 is $134 cheaper than the SEER 14.2 and $1600 cheaper than the SEER2 18.0 |
| **Heat pump** | RHEEM RP18AZ | The RHEEM RP18AZ would replace the furnace and air conditioner, it has a LCC of $26,913. |
| **Attic insulation** | Add R38 batt insulation | Meets current Virginia Energy Code recommendations. |
| **Hot water heater** | 50 Gallon Heat-Pump | We recommend the 50-gallon heat pump, while a much higher upfront cost than the water tank the energy saving, which will only increase as time goes on and energy prices increase. |
| **Solar PV system** | 5250-Watt PV System | The size required to achieve net-zero emissions for the current level of electricity consumption in the home (8,300 kWh per year). |

# Investment Options:

# Purchase Costs and Immediate Annual Savings

The investment budget of $20,000 needs to be optimized among the seven major options for affordability, long term energy savings, and home comfort. The age of the Honda Civic and some of the energy equipment also indicate that these systems will need to be replaced within the next few years. Table 2 provides key information about each energy investment option, including the age of the existing equipment and estimates about its remaining life. Table 2 also shows the net purchase and installation costs for each of the recommended equipment choices shown in Table 1, as well as the net annual cost savings that they create compared to the current equipment. This will allow you to evaluate (a) what combinations of options can be purchased with the available $20,000, (b) which options might be higher priorities, and (c) the value of annual savings that are created that can be set aside for future needs.

The topic of EV’s was a big part of this report for the family, the Nissan Leaf S (2022) had the best savings from the other two options, however there were many factors that were a part of this. For one it could be the primary or secondary car, if it is the primary the savings are a lot less only about $5,000 cheaper than the Tesla but while it is the secondary car it saves about $13,000 because the Leaf won’t need 2 battery replacements compared to driving 18,000 miles annually. Another factor in the EV’s is the cost of insurance, Tesla has a very high annual insurance rate which adds up, but if they could find new insurance or lower theirs it would save them consistently, especially if driving 18,000 annually. as well as Tesla being the most energy efficient option.

The Smith and Jones family only has $20,000 to spend, many of the options listed could be bundled together. The best scenario here would be to replace the Furnace and Air Conditioner units; both are aging systems that will need major repairs and only last another 5-8 years additionally. The heat pump could also just replace both options instead of bundling them, as the energy savings are slightly more annually, but it is also a much higher upfront cost instead of say buying the furnace now and waiting a few years until it is needed to buy the air conditioner. In time this could be bundled with the Insulation as a more efficient furnace will add to the savings provided by insulation and provide high annual cost savings. The PV System is not a likely choice as it is a very high upfront cost, does not replace anything, and is only used for electricity so the implementation of this strategy is unrealistic.

Other combinations could be purchasing the EV and then using some of those savings as they come to replace technologies as they get to the end of their life. For example, the Nissan Leaf S could be bought and then used as the secondary car going 8,000 miles for it is not running up the battery, but then as the annual cost savings come in they can use the money to replace the furnace once it reaches the end of its life cycle and do the same for the air conditioner once it gets there.

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| **Table 2. Summary of Investment Option Purchase Costs and Annual Savings** | | | | | |
|  | | | **Costs and Benefits of the Recommended Equipment Shown in Table 1** | | |
| **Investment Option** | **Age of existing equipment (years)** | **Estimated remaining life of existing equipment (years)** | **Net Purchase and Installation Costs** | **Payback Year compared to current system** | **Immediate Annual Cost Savings Compared to the Current System**  **(includes energy and other costs)** |
| **EV – Nissan Leaf S** | 15 | 5 | $6,600 | Not Applicable\* | N/A |
| **Furnace – 95 AFUE** | 22 | 3-8 with a major repair likely soon | $4,850 | Not Applicable\* | N/A |
| **Air Conditioner – Energy Star SEER2 16.2** | 12 | 3-8 with a major repair likely within 8 years | $8,900 | Not Applicable\* | N/A |
| **Heat Pump -** | NA replaces above | Replaces existing furnace and air conditioner, so 3-8 years | $15,340 | 15 | $901 |
| **Insulation** | 75 | Does not apply to insulation | $2,640 | 15 | $189 |
| **Water Heater** | 10 | 10 | $2,275 | 11 | $210 |
| **PV System** | NA | Does not apply to PV system | $10,732 | 17 | $913 |

\*Not applicable because the age of the existing equipment suggests that it will need to be replaced soon.

1. ß Disclaimer: This investment analysis is a simple cost analysis. The time value of money has not been considered; dollar values reflect current dollars. [↑](#footnote-ref-1)