

## *Pushing Net Energy Consumption to Zero*

This report covers a suburban 2,060 ft<sup>2</sup> ranch-style home in Hightstown, New Jersey. It was originally constructed on a 0.7-acre lot in 1964 and has undergone 2 major renovations in the last 10 years.

Hightstown, being only about 4 square miles in area, offers plenty of services within walking distance. Home to shops, restaurants, and offices, downtown is about a half-a-mile north relative to the house. The local supermarket is only a mile away, and two elementary schools and the high school are easily walkable. Unfortunately, the middle school is in the next town over, and is not easily accessible by foot.

The front- and backyards are dotted with several large trees that offer substantial shade throughout much of the day. In tandem with bushes, the trees also offer a home for small critters such as squirrels and birds. The lawns are well taken care of throughout the year, and professional landscapers service it during the summer.

Several parts of the house contribute positively to energy efficiency. Throughout the house, including the attic, there is 8-inch-thick fiberglass insulation in the walls. Fiberglass is one of the most common types of insulation in modern homes, but the 8 inches used across the entire house allow for a much better heat storage. Specifically, this type of insulation allows for minimal energy use with respect to heating.

In addition to hefty wall insulation, all windows are double-layered—each window is two panes of glass thick. This extra layer provides a greater level of insulation while still allowing for the same visibility as traditional windows. These windows are on each side of the house, meaning that at all times of day, sunlight can enter. In the winter, this is especially helpful for minimizing heat loss, which is one of the largest consumers of household energy. The windows are also found in the basement of the home, which provides more heat to a portion of the house that is often lacking in both light and heat in most homes.

The location of the house is proximal to multiple important resources, such as schools, grocery stores, and the central town area that has multiple other stores. Walkability to these areas is especially important in energy-conserving homes because using cars regularly creates an additional energy-dependent source that negatively impacts the efficiency of the household. With the consideration that public transportation could also be used, all the necessities of everyday life are within reasonable distance from the house so that car-usage is minimal.

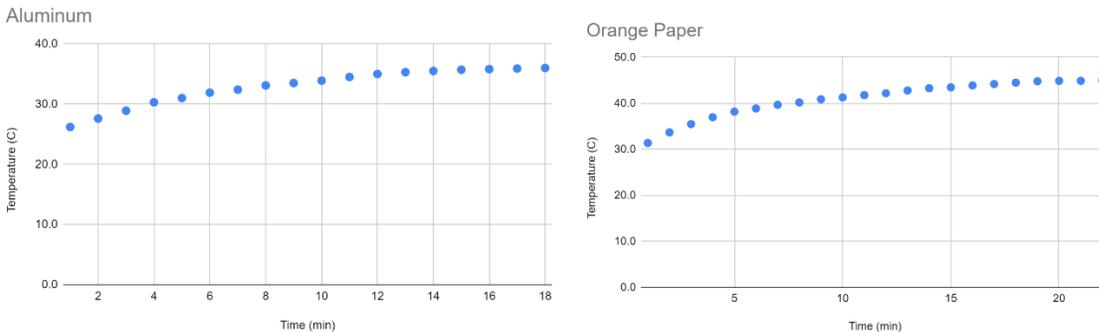
Many of the appliances used in the house allow for a greater efficiency rating while still maintaining everyday life and not altering the life of the residents much. The house uses LED lighting for most of the lights around the house, which operate with much less electricity required while running them. LEDs are crucial to homes hoping to get close to net-zero since lighting is a daily requirement and using as little electricity as possible each day is important. In a similar fashion, the current water heating system is tankless. More modern homes are opting to have tankless water heaters due to their energy efficiency, and since heating is one of the biggest challenges when lowering the energy consumption of the house.

Unfortunately, as is very typical of homes of this era, there is plenty of room for improvement towards net zero energy consumption. The first problem is the heating efficiency. Baseboard heating systems are effective but require a large amount of energy to constantly radiate heat. This makes them very inefficient because they are constantly using energy. The combination of baseboard and gas heating systems helps efficiency because gas heating systems use large amounts of energy to increase the temperature to the desired temperature and then a

small amount of energy to maintain that temperature. A heat pump system would be much more efficient since it does not generate heat, rather, it simply moves it from one volume of air to another. There are also controllers for each room so that they are not all on one master switch. Another problem with the house is the lack of renewable energy sources. Since no domestic energy is produced, clean energy is supplied to the house entirely by the renewable portion generated by JCP&L, all other energy is produced in fossil-fuel power facilities. This is perhaps the greatest sin of the home, as net-zero implies that all energy used is produced on-site.

Another aspect of the home that is a problem is the building materials. The house is built out of, mostly, wood and concrete which are two of the most common and highest emitting building materials. This means that the environment is getting destroyed to provide the building materials. Not much can be done about this, since the home is already built, but environmentally friendly materials should certainly be kept in mind for future renovations.

Additionally, while the windows are double-paned, they are lacking in some areas. One way to improve this is to install thermal curtains or films on the windows to help increase thermal efficiency and conservation throughout the home. Shown clearly by *Figure 1*, the amount of heat absorbed by the house is highly dependent on what is absorbing the light. Having thermal curtains installed would result in the curtains absorbing the sunlight and heat while the curtains are drawn, meaning that even though light may not get through, the heat can still be absorbed. One way to reduce the cost is by only installing curtains on south facing windows, as they encounter the most sunlight throughout the day.



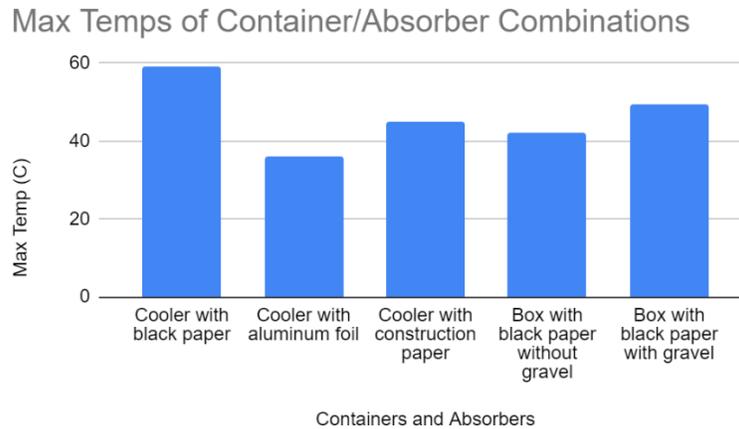
**Fig. 1**  
*Effectiveness of Curtain Materials*

These problems with the house can easily be solved, assuming an unlimited budget. First off, to improve heating efficiency, the baseboard and gas heaters currently installed must be replaced with vastly more efficient heat pumps. Not only would the heat pumps be more energy efficient by transferring heat around the house, but it can also focus its energy into select rooms instead of heating the entire house on one master switch. Furthermore, they are ideal for the moderate New Jersey climate.

As far as energy solutions, installing solar panels and wind turbines would be a leap in the right direction. The solar panels would absorb energy from the sun during the day, while the wind turbines would gather energy from the wind both day and night. A combination of both would lead to a surplus of energy. Not only would the house have multiple sources of power, but redundancy would minimize the risk of an outage due to generator failure in storms – a fairly common occurrence in the area. While the financial aspect of installing solar panels and wind turbines is a deterrent for some, a net-zero energy home’s energy production would most likely

lead to a profit gained from redistributing excess energy produced from the home, meaning that at some point after installation, on-site production is more financially sustainable.

In addition to production, adding thermal curtains to the windows would insulate heat inside the house, therefore mitigating energy loss. As shown in *Figure 2*, the black paper kept thermal energy inside for a longer period compared to tin foil or a colored construction paper.



**Fig. 2**  
*Insulating Properties of Curtains*

As for the basement, some of the appliances such as the freezer and the fridge can be replaced with energy-star rated models, which in turn would be more energy efficient.

While the proposed solutions are fool proof in theory, budgeting is a huge factor. Regardless of financial situation, the amount of money that it would take to complete everything that was listed off may not be worth it just to cut down the energy bill a bit. Implementing the most reasonable would be beneficial. For instance, installing the solar panels and wind turbines (which would be compensated for by the federal government in some cases) would be something to consider. Picking and choosing the best from the bunch is a more cost-effective way to do it.

Despite being nearly 60 years-old, the home is quite serviceable in terms of energy efficiency. It has seen numerous improvements over the years and will continue to make improvements for years to come. Perhaps the easiest solutions come in the form of upgrades rather than total overhauls. Cutting off the electrical grid is an accessible first step. Solar panels are abundant and becoming more cost effective each year. In lieu of shadows cast by trees, solar power could be supplemented with domestic wind power. While disposing of old refrigerators may cause refrigerants, potent greenhouse gasses, to leak into the atmosphere, the energy efficiency of upgraded models will likely offset the refrigerant issue in the long term. It makes sense to look at upgrades for a primary solution, as they provide a minimally destructive, cost-efficient path forward. It is important to focus on what can be done in the short term, as it will likely provide a fast track to long term solutions. Making incremental progress towards the goal of zero net energy consumption is key to an affordable and carefully considered solution.