Solar Shingle Experience: Evaluating Their Value in Today's Market

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Solar technology has been on the rise in popularity in recent years and we are starting to see more of it across the US. As the technology and capabilities of photovoltaic (PV) cells advance, there has been an increase in the number of different product designs that incorporate PV cells. Building integrated Photovoltaic (BIPV) products have been some of the most popular introduced to the market. In the last five years, one of these BIPV products, a solar system integrated into the roofing shingles of residential homes has been sensationalized and, according to a California solar installer, that has encouraged a lot of homeowners to enquire about the product and eventually become solar adopters. Over the course of my research I conducted personal interviews with both the installers and the homeowners involved with the installation of a CertainTeed Apollo II Tile integrated solar system on a home in the Stockton, CA area. The most noteworthy shortcomings of these solar shingles are they that convert solar energy less efficiently cost than rack mounted panel systems. The biggest upside to these shingle systems is their appealing aesthetics and they have the potential to reduce time and costs involved with the labor and material for residential projects.

Key Words: Solar, Shingles, Integrated Solar System, CertainTeed Apollo II, Stockton, Roofing

Introduction

Photovoltaic solar collection systems have become significantly more popular among residential homeowners in the last few decades and with the increase in consumer demand, so to comes an acceleration in the development and innovation of these products. Both builders and developers of these products have increasingly realized the benefit building integrated photovoltaics (BIPV) can have on a construction project. "A BIPV system consists of integrating photovoltaics modules into the building envelope, such as the roof or the facade… BIPV systems often have lower overall costs than PV systems requiring separate, dedicated, mounting systems." (Strong, 2016) BIPVs reduce labor costs by combining the installs of separate systems into one task and save materials by utilizing systems that perform multiple functions.

Solar Shingles are a type of solar integrated roofing system that is installed on residential houses and it is one of the latest BIPV products to emerge in the market. Solar shingles are installed in the place of other shingles on a portion of the roof and the shingles eliminate the need for the additional mounting systems and roof penetrations required for traditional roof mounted solar panel assemblies. Another advantage of solar shingles is that homeowners generally perceive them to be more aesthetically pleasing than solar panels. Aesthetic appeal has turned out to be a much greater hinderance to solar adoption than researchers initially expected. "In the past, renewable energy systems have often been thought of as performance-driven rather than driven by styling. However, studies have suggested that their visual appearance is also important." (Bao, 2017) With aesthetics being acknowledged as a priority in solar design, solar shingles could have an important role in helping encourage solar adoption among homeowners.

Background

History of Solar Shingles

The first design of a solar shingle to be available commercially was produced by DOW Chemical Company back in 2005. (Thoubboron, 2019) Their Powerhouse shingle attracted interest from investors and in 2009 they released their

Powerhouse II model. This model was more durable and more efficient making it a promising new technology that had the potential to increase demand from consumers who were interested in solar but couldn't bring themselves to mount bulky rack mounted panel systems on the roofs of their homes. The Department of Energy's Office of Energy Efficiency and Renewable Energy (EERE) eventually partnered with DOW to help grow the use and popularity of the Powerhouse shingle:

> In 2011, DOE launched the SunShot Initiative, a national effort to make subsidy-free solar power cost-competitive with other sources of electricity by the end of the decade… EERE's efforts have catalyzed growth in a sector that has more than doubled the U.S. supply of solar power from 2008 to 2012, reduced solar energy installation costs by more than 30%... In October 2011, Dow Chemical Company launched a new solar shingle product, designed for easy installation alongside conventional asphalt roofing shingles—the result of its partnership with EERE. Dow is building a large-scale plant to manufacture the shingles in Midland, Michigan. (U.S. Department of Energy, 2012)

With public awareness of the shingles increasing, industry competitors started to develop their own roof integrated solar systems. CertainTeed, a building material manufacturer, released their own line of solar shingles in 2013 and quickly established themselves as major players in the solar shingle market.(Thurston, 2014) When DOW pulled their powerhouse shingles off the market in 2016, CertainTeed became the longest standing manufacturer of solar shingles on the market today. Solar shingles really caught the attention of the public eye in 2016 when Tesla released a video of their new solar roof. It was at this time that many consumers who may not have been interested in solar before, began calling installers to learn more about the new technology. (Interview, Zach Downs)

Engineering of the Apollo II Tile

CertainTeed's Apollo II Tile solar roofing system is an integrated solar system designed to replace asphalt shingles on the roof of a residential home. The dimensions of each shingle can be seen in Figure 1 below while the exposed area of each shingle is only 46 inches by 13.25 inches. (CertainTeed Corporation, 2019)

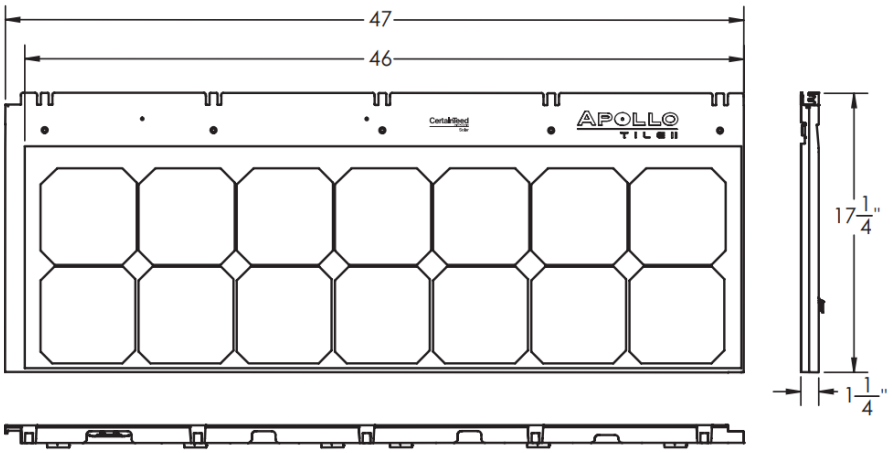

Figure 1: Apollo II Tile Dimensions

The Apollo II Tile assembly consists of five different elements that were selected to create a solar shingle that is lightweight and durable. The top layer of the shingle housing is made of strong tempered glass that lets light through to the PV system. The rest of the shingle housing is comprised of Phenol Formaldehyde (PF) which is a thermoset plastic with incredible dielectric strength. This indicates that the PF housing can withstand immense forces exerted by electric fields within the shingle without losing its insulating properties. PF also has a relatively low density compared to other thermoset plastics allowing the shingle to remain lightweight. (Makeitfrom.com, 2019) Beneath the tempered glass top layer is a series of 14 monocrystalline silicon cells which collect energy from sunlight and convert it into electric power. A bypass diode is also present in this layer to mitigate the risk of damage to the PV cells caused by uneven light exposure on the panel. (SolarEdge Technologies, 2019) Underneath the solar cells is a

black layer of Tedlar to give the shingles their dark appearance and assist in the weatherproofing of the unit. See Figure 2 for visual callouts of each layer.

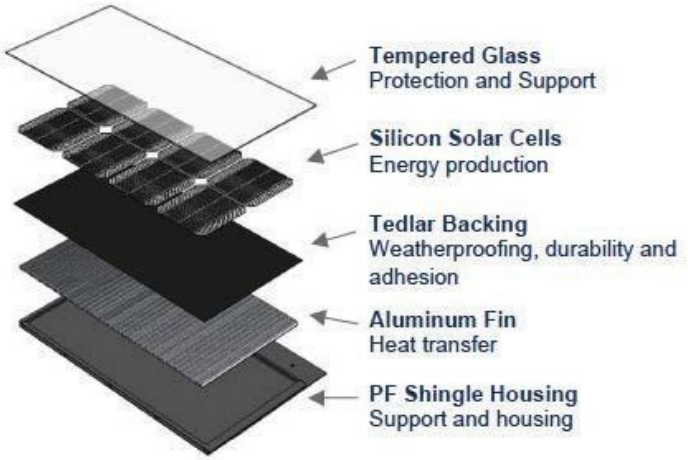

Figure 2: Solar Shingle Assembly

When installed, the shingles weigh 3.1 pounds per square foot, which is lighter than most standard asphalt shingles, so no special structural design considerations need to be employed when installing this shingle system. The mechanical load rating of the shingles is 250 lbs. per square foot which is comparable to the strength of a standard asphalt shingle. (CertainTeed Corporation, 2019) The shingle design also negates the need for roof penetrations required with rack mounted panels as the shingles lock into place against each other which can be seen in Figure 3.

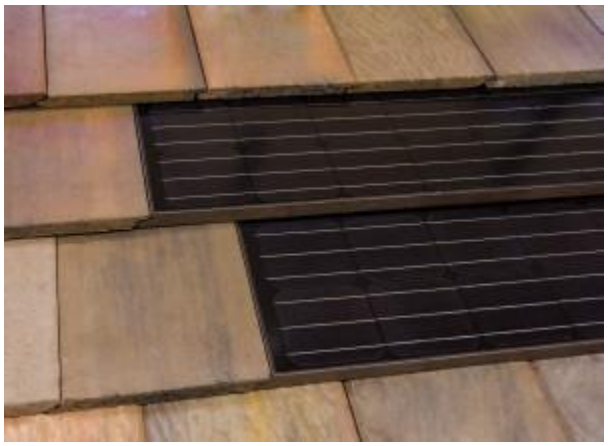

Figure 3: Installed Apollo II Tiles

The Apollo II Tiles have a 15.4 percent solar energy to electric power conversion efficiency which is about 4 percent less than most rack mounted panel systems that are commonly sold to homeowners. (Aggarwal, 2019) The shingle has a maximum power of 63 watts and an operating temperature of -40°F to 194°F. (CertainTeed Corporation, 2019)

Consumer Interest in Solar Shingles

MIT conducted a study in 2017 to better understand the role of visual appeal in consumer choice for solar products. "A survey of 138 California solar panel installers found that the aesthetics of solar panels was mentioned by 40% installers as a key factor when selecting a panel to recommend to homeowners." (Bao, 2017) Generally homeowners prefer black, or a color matching the rest of their roof, that are flush with their roof and not too intrusive in appearance. An attractive looking solar product is something this market segment is willing to pay more for. The study also stated, "a US survey reported that 17% of respondents who were not interested in installing solar

panels because they found the panels were not attractive." (Bao, 2017) The low-profile design of solar shingles integrated into the roof system could be the difference for some homeowners to install a solar system on their home.

Solar Incentives

The federal solar tax credit, also known as the investment tax credit (ITC), allows homeowners to deduct 30 percent of the cost of installing a solar energy system from their federal taxes in 2019. The ITC applies to both residential and commercial systems, and there is no cap on its value. Some form of this credit is available through 2021, although the amount will be reduced in the next few years. (Mitasci, 2019)

Research also suggests that a solar system adds value to a home. A recent study by the Lawrence Berkeley National Library indicates that homes with solar energy systems are more desirable to buyers, and, increase the value of these homes by an average of $14,329, or 3.9%. (Hoen, 2014) While these numbers differ depending on the size of the home and location, it strongly suggests that homebuyers are willing to pay more up-front when they buy a home that allows them to save money on electric bills in the future.

Methodology

The objectives of this case study are as follows:

- To examine the experiences of a customer and install contractor
- To analyze the characteristics of CertainTeed's Apollo II Tile design
- To determine why the homeowner elected to install an integrated solar system
- To report the level of customer satisfaction with the outcome of this project
- To identify the key quantifiable attributes of the solar shingle install for this case

For this case study, qualitative data collection was the most important part of this project and this was collected through a series of personal interviews conducted with both the project manager of the install contractor because there is very little literature that has been produced from unbiased sources regarding customer experiences with solar shingles. Qualitative data was collected through semi-structured interviews with the parties involved on the project being analyzed here. Quantitative data was also necessary to report the full story in this case. The quantitative data found for this project was acquired during the personal interviews with the contractor and homeowner, reviewing the specification sheets available on the official CertainTeed website, and reading other literature pertaining to customer preferences of solar collection products.

Case Study

Project Details

- Project Location: Stockton, CA
- Install Contractor: Solar Energy Collective
- Integrated System Manufacturer: CertainTeed Corporation (Subsidiary of Saint-Gobain)
- Integrated System Installed: Apollo II Tile – Solar Roofing System
- House Square Footage: 1,900
- Number of Solar Tiles Installed: 63
- Area of Exposed Tile System: 266.7 sq. ft.
- Size of System: 3.969 kW
- Production Estimate: 5,940kWh

Costs and Savings

- Project Upfront Cost: $14,391 ($3.62/Watt)
- Federal IT Credit: $4,317
- Net system price less FIT Credit: $8,760 ($2.54/Watt)
- Payback period: 6.9 years

- Financial return: 13.6%
- Projected electric bill savings over 20 years: $26,531

Summary of Qualitive Data

In an interview with Zach Downs, a project manager for a solar install contractor, Zach said that he has plenty of people call him to ask for information regarding solar shingles. He indicated that most people ask if they install Tesla shingles because they have seen articles and videos praising their efficiency. However, Zach always recommends that if they are interested in installing an integrated roofing system, they should only consider it if they also need a reroof so they can offset some of the material and solar install costs. In his experience, once Zach shows the price breakdown and ROI analysis to most customers, they experience "sticker [price] shock" and opt to install a panel system instead. According to Zach, the shingles are really only considered in affluent areas where he notices aesthetics are a high-priority criterion for a solar install. Of the dozen or so solar shingle install projects he has worked on since his company started offering the Apollo II Tile back in late 2016, every one of them has been in a more affluent neighborhood compared to the surrounding area. (Interview, Zach Downs)

A Stockton, CA homeowner who just had Zach install the Apollo II Tile roof integrated system on his home last year explained his reasoning for choosing solar shingles in a phone interview. He said he has always been interested in installing a solar system on his home, because he felt it made ethical sense to reduce his home's carbon footprint and he had read that, on average, Stockton has clear sky days for more than half of the year, so his home was in a prime location for a solar install. His wife, however, did not want their roof to be covered by the big unattractive panels she had seen on other homes, so they didn't seek an installation. This homeowner knew that the Federal Tax Credit would soon drop from the currently offered 30% credit, and he wanted to take advantage of the credit before it was too late. The homeowner continued to press his wife to change her mind and then he saw Tesla's solar roof video on Facebook and showed it to his wife. His wife agreed that the shingles looked much better than the panels and told her husband he could look into it. (Interview, Stockton Homeowner)

The Stockton homeowner's search for a contractor led him to find Zach Downs of Solar Energy Collective, as they are one of the only solar shingle installers in the region. One of the main factors for choosing Zach's company is that they are a CertainTeed Master Installer. A Master Installer entitles the homeowner to not only a limited 25-year power warranty, but also a 25-year workmanship warranty which is 15 years longer than a standard installer can offer. The workmanship warranty offers a replacement for any CertainTeed product that shows damage before 25 years have passed, regardless of the power production of that unit. Although Zach initially tried to dissuade the homeowner from installing a shingle system as his home did not need a reroof, they ultimately went with the shingle system. (Interview, Zach Downs)

In the end, the homeowner was satisfied that they received the expected savings in their electric bill, while maintaining an overall attractive look to the exterior of their home. The installation was completed on time and none of the shingles have had any problems or failures as of the time of our interview.

The Stockton homeowner has requested not to have his name and exact home location included in this report.

Conclusion

Analysis

A strong argument for solar shingles is that it's an investment that pays for itself. Although they are not quite as cheap or efficient as most panels on the market, they still offer homeowners considerable future savings on their electric bills. In this case study they paid for themselves in six years, with the Federal ITC taken into account. In addition, they are a good investment in a house since they increase the value of the home when it's sold by around 3.9% just after the install. This shingle project followed suit with expectations provided by past researchers that consider aesthetic value for solar projects. The customer was interested in adopting a solar system in their home but was hindered by the lack of attractive looking products available on the market. I expect to see more shingles in the many affluent neighborhoods in California because Californians so strongly consider aesthetic appeal in their solar

collection products. As solar technology improves and demand increases, it's reasonable to expect that future costs will come down making solar shingles a viable option for more homeowners, but I'm not sure they will ever be able to match the performance of solar panels. Their main advantages are a low-profile design desired by many consumers, and the fact they are a BIPV product that can limit time and costs of labor and materials on a building project.

Future Research

There is still a lot of research that can be done to expand on the knowledge assembled in this case study. Similar case studies can be conducted in other parts of California and the US to see if solar install contractors have the same experienced the interest from the same demographics of customers. It would be good to also do a case study on a solar shingle project that uses a different shingle from a company like Tesla or RGS Energy to see how the prices and efficiencies differ from CertainTeed's Apollo II Tile.

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