2018

Under 1 Roof: Performance Assessment of High-Solar Reflectance Roofs in San Antonio

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1. Introduction

1.1. What Are High-Solar Reflectance (Cool) Roofs?

Fig. 1: Solar-Hide Underlayment

High-solar reflectance roofs, also known as cool roofs, are a type of roofing materials designed to reflect more solar energy into the atmosphere and absorb less heat compared to conventional roofing material. Cool roofs can have multiple benefits (US DOE 2018) including:

- Reducing energy bills by decreasing air conditioning needs.
- Improving indoor comfort for spaces that are not air conditioned.
- Decreasing roof temperature, which may extend roof service life.
- Benefit the environment, especially when many buildings in a community have them, through reducing local air temperatures, also known as the urban heat island effect, as well as reducing air pollution, lowering peak electricity demands, and reducing power plant emissions.

High-solar reflectance roofs can be installed on any building type and can be made from different types of material including highly-reflective paint, sheets, tiles, of shingles, provided that they meet minimum performance requirements. Table 1 describes the minimum performance criteria defined by the US EPA Energy Star program for cool roofs (Energy Star 2013). More information about cool roofs can be obtained from US EPA (2008) and Cool Roof Rating Council (2018).

Cool roofs are still more common in commercial building than residential buildings despite the potential they offer for both markets. EPA (2008) reports that shipments of ENERGY STAR products constitute about 25% of the commercial roofing market and about 10% of the residential market. This project is part of a larger project implemented by the City of San Antonio (CoSA) Neighborhood & Housing Services Department (NHSD) to install high solar reflectance roofs in low-income residential buildings in San Antonio. The project aims to provide an assessment of the impact of the new cool roofs on building interior thermal conditions and overall electricity use as a means of assessing their potential positive impact for the home owners. This report describes the results of Phase I of the project, which involved the performance monitoring of 30 homes, all located in CoSA's Council District 1. Phase II of the project will include the monitoring of an additional 30 homes and is expected to start in April 2018 and continue through May 2019.

Performance Characteristic	Solar Reflectance Index (SRI)
Low-Slope Roofs[1]:	
Initial Solar Reflectance Index [2]	Greater than or equal to 0.65
Maintained Solar Reflectance Index[3]	Greater than or equal to 0.50
Reliability	Warranty for reflective roof must be equal in all respects to warranty offered for comparable non-reflective products
Steep-Slope Roofs[1]:	
Initial Solar Reflectance Index [2]	Greater than or equal to 0.25
Maintained Solar Reflectance Index[3]	Greater than or equal to 0.15
Reliability	Warranty for reflective roof must be equal in all respects to warranty offered for comparable non-reflective products

Table 1. Minimum Performance Criteria for Cool Roofs (Energy Star 2013)

[1] Low-slope roof are roofs in which the uppermost part is installed at a slope of 2/12 (9.5 degrees) or less. While steep-slope are roofs in which the uppermost part is installed at a slope greater than 2/12 (9.5 degrees).

[2] Solar Reflectance Index (SRI) is a value that incorporates both solar reflectance and thermal emittance in a single value to represent a material's temperature in the sun. This index compares how hot a surface would get compared to a standard black and a standard white surface.

[3] SRI after three years after installation under normal conditions

1.2. Project Objectives

The Under 1 Roof project is a project implemented by the CoSA NHSD to install high solar reflectance roofs in low-income residential buildings in San Antonio. The Under 1 Roof project has the following objectives:

- Maintain home integrity by addressing roofing needs.
- Improve energy efficient and reduced utility bills.
- Demonstrate benefits of cool roofs to builders and residents.

As part of the third objectives, the University of Texas at San Antonio is conducting an assessment of the impact of the new cool roofs on the performance of the homes. The assessment includes:

- Assessing change in attic temperatures due to new roof installation.
- Assessing change in electricity use due to new roof installation.

A total of 60 homes will be monitored as part of this project. This report describes the results of phase I of the project which includes the monitoring of 30 homes, which had their new cool roofs installed in august 2016 and January 2017. Th

1.3. Anticipated outcomes

Based on previous studies, the anticipated outcomes of this study include achieving a reduction in attic temperatures and in the electricity use of the homes being monitored. This outcome would validate the positive impacts that cool roofs can have for home owners particularly low-income home owners, for whom utility costs represent a relatively large percentage of their disposable income.

Fig. 2: Installation of new high-solar reflectance, cool, roofs

2. Methodology

2.1. Participant Selection

Homes monitored as part of this study were selected through a two-phase process. First. the CoSA NHSD conducted a pre-qualification of all interested home owners, which involved both an assessment of the condition of the homes to ensure its suitability for the program, as well as an assessment of the financial situation of the home owners. Subsequent to that, the research team identified a subset of the homes included in the project for performance monitoring. In making the selection, the team attempted to identify homes which offered more potential for achieving performance improvements through the installation of the new roofs. These criteria included: 1) building condition, 2) type of cooling and heating systems, and 3) user behavior. A total of 30 homes were monitored as part of Phase I of the work. A list of all homes selected for phase I of the project and their characteristics can be found in Appendix A. The work conducted in this project included three major parts:

1. Monitoring home attic temperatures pre- and post-installation of the cool roof to determine the impact of the roof on average attic temperatures. See Appendix B for details of monitoring periods.
2. Collecting and analyzing home electricity use information to assess the impact of the cool roof installation on electricity use.
3. Conducting a home-owner survey to identify any external factors that may have affected electricity use. Home owner survey results were only used to diagnose anomalies in utility data analysis.

2.2. Roof Specifications

The following roof specifications were used in all roofs assessed within this project: Owens Corning Single 3-tab Shasta White Shingles, SRI of 0.31, with a Solarhide Reflective underlayment, SRI of 0.97. The combined performance of the shingles and underlayment meets the minimum 0.65 initial SRI performance requirement of the US EPA Energy Star Program (see table 1). All roofs were installed by qualified contractors under the supervision of the CoSA NHSD team.

2.3. Attic Temperature Monitoring

The first part of the monitoring activities involved installing temperature / relative Humidity data loggers in the attics of the selected homes to assess the impact of installing the new roofs on average attic temperatures. Two types of data loggers were used:

- Homes CR1 through CR11 used the U12-012 HOBO Temperature/ Relative Humidity/Light/External Data Logger (ONSET 2018a)
- Homes CR13 through CR25 and CR30 through CR31 used the MX1101 HOBO Bluetooth Low Energy Temperature/Relative Humidity Data Logger (ONSET 2018b).

Both data loggers offer relatively similar capabilities in terms of measurement range (-4° to 158°F) and accuracy (± 0.35°C for the U12 and +/- 0.2C for the MX1101). However, the MX1101 offers the potential for Bluetooth connectivity and data download which facilitates the data retrieval process.

The research team aimed to install the data loggers for a minimum of two weeks before and two weeks after the installation of the new roofs. Post-installation periods mostly exceeded this target. In three cases, however, pre-installation monitoring periods were limited by home availability and construction schedules. Pre-installation monitoring periods for these three homes were 6 days, 7 days, and 9 days respectively. In total, data loggers were installed in 24 homes, with 11 of these homes having their new roofs installed in August 2016 and 13 having the new roofs installed in December 2016 and January 2017. The team was unable to install data loggers in 6 homes because of low attic slope and other difficult home conditions. Pre- and post-roof installation monitoring periods for all homes are included in Appendix B.

To assess the impact of the roof installation on the attic temperature, a pre- and post-roof installation average daily temperature profile was developed for each home being monitored. The profile included hourly temperatures during a 24-hour period. This profile was then used to generate a similar pre- and post-installation average daily profile of the difference between attic temperatures and corresponding outside temperatures. Outside temperatures from the San Antonino International Airport Weather Station were used to generate this profile. The airport is located approximately 3-4 miles from the area in which the homes are located.

The sample was divided into two groups based on the time of roof installation and monitoring to account for seasonal differences in the impact of the cool roof. In total, 11 homes were monitored during the summer season (July through September 2016) and 13 homes were monitored during the winter season (December 2016 through February 2017). An analysis of average outside temperature in the pre- and post-installation periods was also conducted to identify the potential impact of outside conditions on the outcomes. These pre- and post-installation daily temperature profiles were then compared to assess the impact of the roof installation.

2.4. Utility Electricity Use Analysis

To assess the impact of installing the new roof on the electricity use of the homes, home-owners' consent was obtained to collect utility bill data from CPS Energy. Electricity use data were collected for the period before and after the installation of the cool roofs. For the pre-installation period, at least one year of electricity use data was collected, and in some cases two years were collected. For the post-installation period, at least one year of electricity use data was collected. All utility bill information was inputted into the EPA Portfolio Manager Online Tool (Energy Star, 2017), which was then used to calculate electricity and gas use by calendar month. Portfolio manager was also used to conduct a weather normalization of electricity use data to account for weather differences in the pre- and post-installation periods. A more detailed discussion of the weather normalization process in Portfolio Manager can be found in Energy Star (2017).

The analysis of the energy use data involved the comparison of one full year of pre-installation electricity use data with one full year of post-installation electricity use data to identify the impact of the cool roof installation.

As stated above, weather differences between the pre- and post- periods, were accounted for through the weather normalization process in the Portfolio Manager tool, which calculates a weather normalization factor for each period based on the specific period being analyzed and adjusts the data accordingly. The weather normalization factor was based on overall energy use and did not distinguish between the hot and cold seasons. In all cases, one full year of data were analyzed and normalized to account for weather differences. While electricity use data was collected for all 30 homes in phase I, only 28 homes were analyzed for this report. CR30 and CR31, for which the new roofs were installed in March 2017, have not yet completed a full year of post-installation electricity use and therefore could not be included in this report.

2.5. Home-Owner Surveys

A home-owner survey was conducted to assist in diagnosing the electricity use data. Home-owners were surveyed after the installation of the new roof and close to the completion of the post-installation period. The survey aimed to assess the owners' energy use characteristics and behavior and focused on any changes in these characteristics and/or behavior in the post-installation period compared to the pre-installation period. A listing of all survey questions is included in Appendix D, and a sample of the consent form used in the survey is included in Appendix E. Out of the 28 homes analyzed for this Phase I report, a total of 21 surveys were conducted. The research team was unable to conduct the surveys for 7 homes (CR 9, 10, 14, 16, 19, 27, and 28) due to owner unavailability of refusal to participate in the survey.

Based on the analysis of survey results, four homes (CR 17, 20, 22, and 27) were identified as having notable differences in their energy use characteristics between the pre- and post-installation period that affect their suitability for this study. In the case of CR 17 & CR 20, this involved large number of friends and relatives (4 people) staying with the home owners for extended periods in the post-installation year. For CR 22, the house was occupied by one person before installation, however, the owner's daughter moved in with her shortly after the installation of the new roof. In the case of CR 27, analysis of utility data indicated that the house was almost unoccupied for almost half of the pre-installation period. Because of this, two electricity use analysis results will be reported. The first will include all homes in the sample, while the second will exclude these four homes.

3. Results and Discussion

3.1. Impact on Attic Temperature

As discussed previously, the attic temperature analysis was conducted separately for homes monitored during the summer and winter seasons. Figures 2 through 5 show the results of the analysis for the summer monitoring, which included 11 homes, while figures 6 through 9 show the same results for winter monitoring, which included 13 homes. It is worth noting that all homes had open, unobstructed attic ventilation properly designed for airflow

For the summer season, the results of the monitoring generally indicate that the cool roof had a positive impact on reducing attic temperatures. Figures 2 and 3 show the average daily profile of the difference between attic temperatures and outside temperature pre- and post-installation respectively. Figure 4 shows a comparison between these two daily profiles to assess the impact of the roof installation on attic temperature. Figure 4 shows that the installation of the cool roofs resulted in an average reduction in attic temperatures of 6.3 °F in daytime temperatures (8 am through 6 pm), and a larger average reduction of 10.1 °F in attic temperatures in the afternoon, peak, period. A comparison of figures 2 and 3 further shows that before the installation of the new roofs, peak attic temperatures considerably exceeded outside temperatures by up to 30 - 35°F in some cases. After the installation of the cool roof, these peak temperature differences dropped to ±10-15°F in most cases. This represents a note-worthy positive impact for the cool roofs, which is consistent with their performance in other locations and shows good promise for reducing electricity use in air-conditioned homes and improving indoor user thermal comfort in homes without central air-conditioning. Figure 5 further shows that outdoor temperatures did not vary significantly between the pre- and post-installation periods and therefore the positive impact identified through the monitoring can be reasonably attributed to the installation of the new roof.

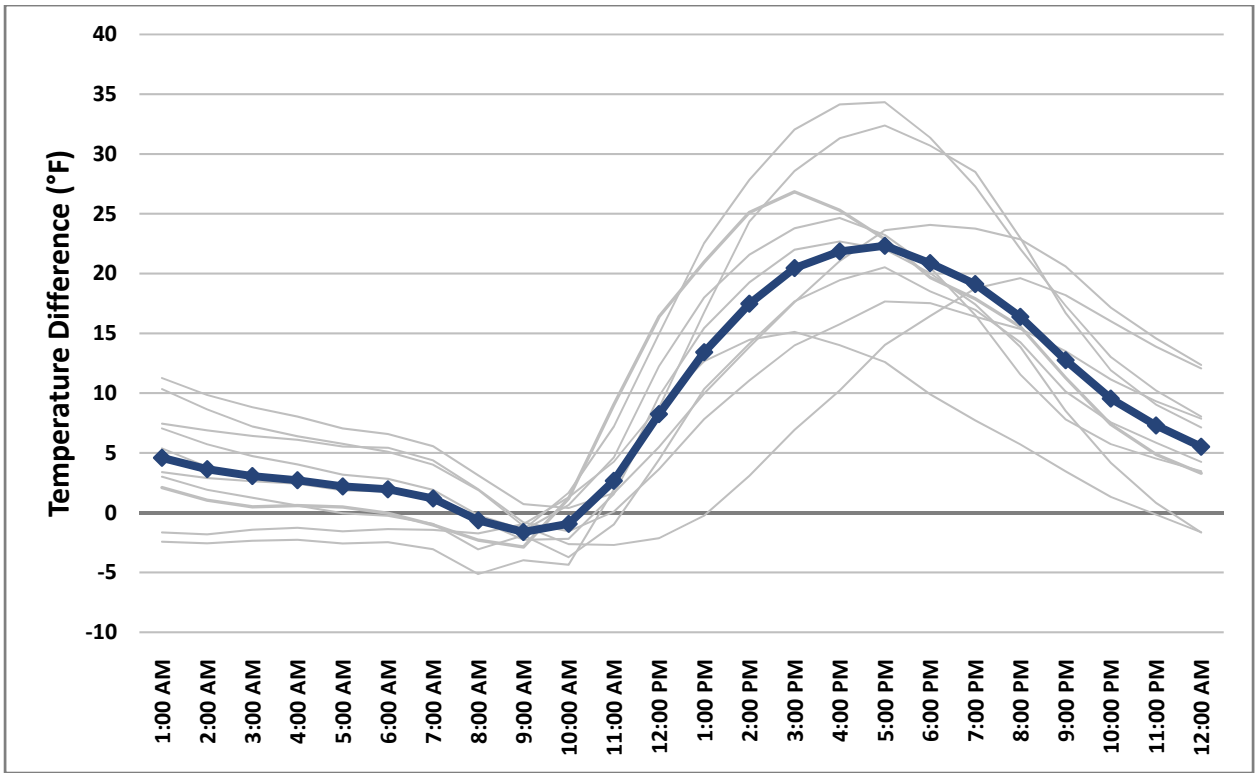

Fig 3. Average Summer Temperature Difference between Attic & Outdoor – Pre-Installation

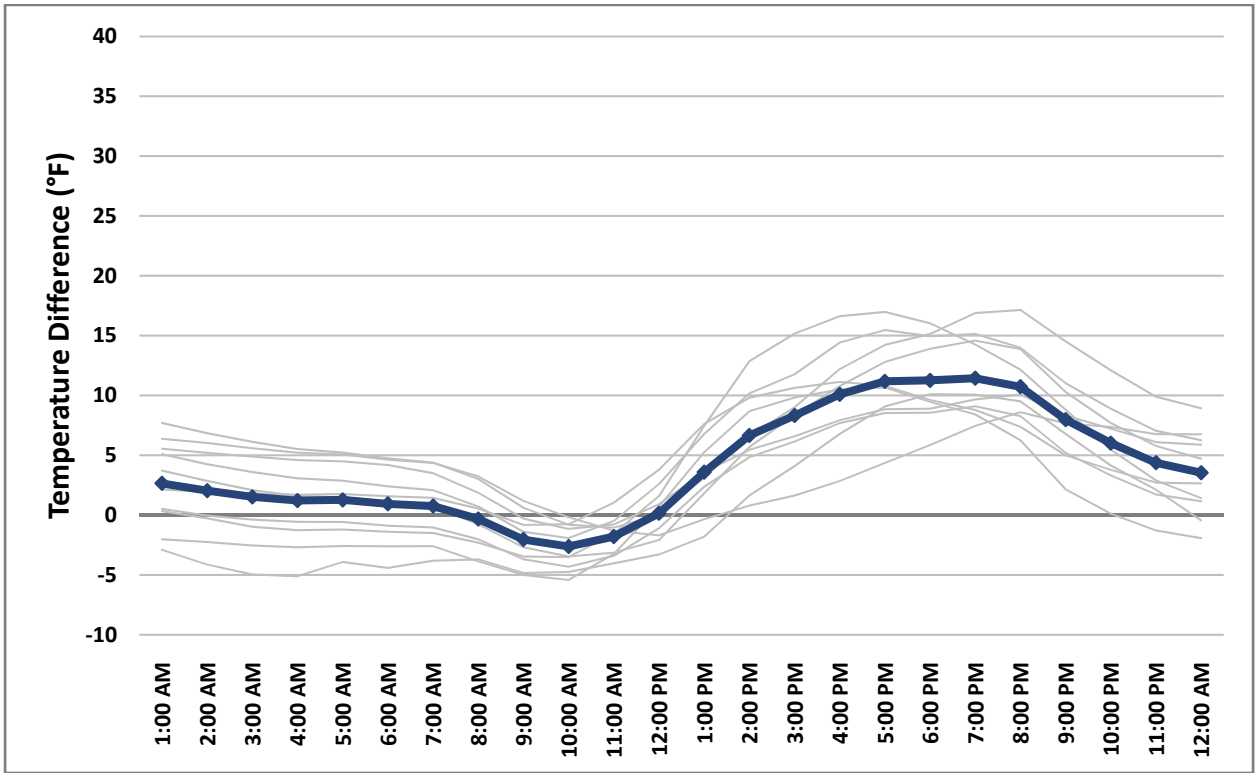

Fig 4. Average Summer Temperature Difference between Attic & Outdoor – Post-Installation

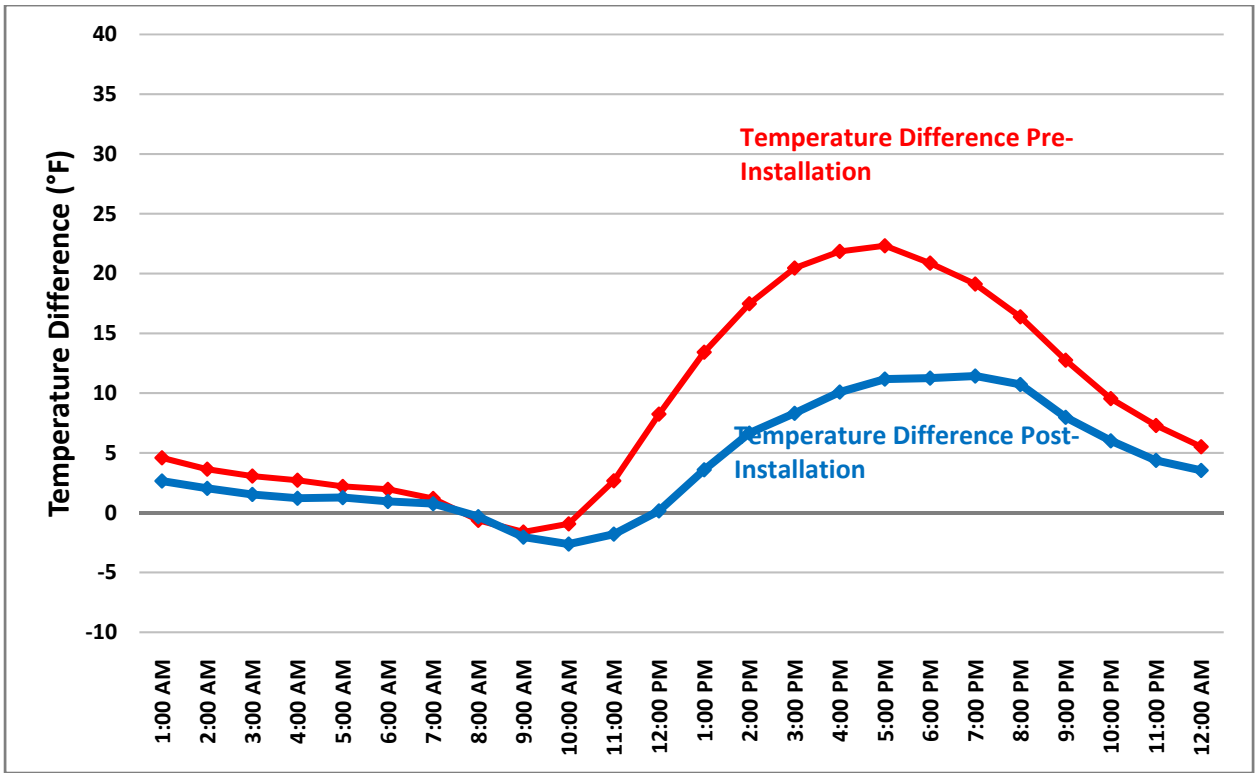

Fig 5. Summer Temperature Difference Pre- and Post-Installation

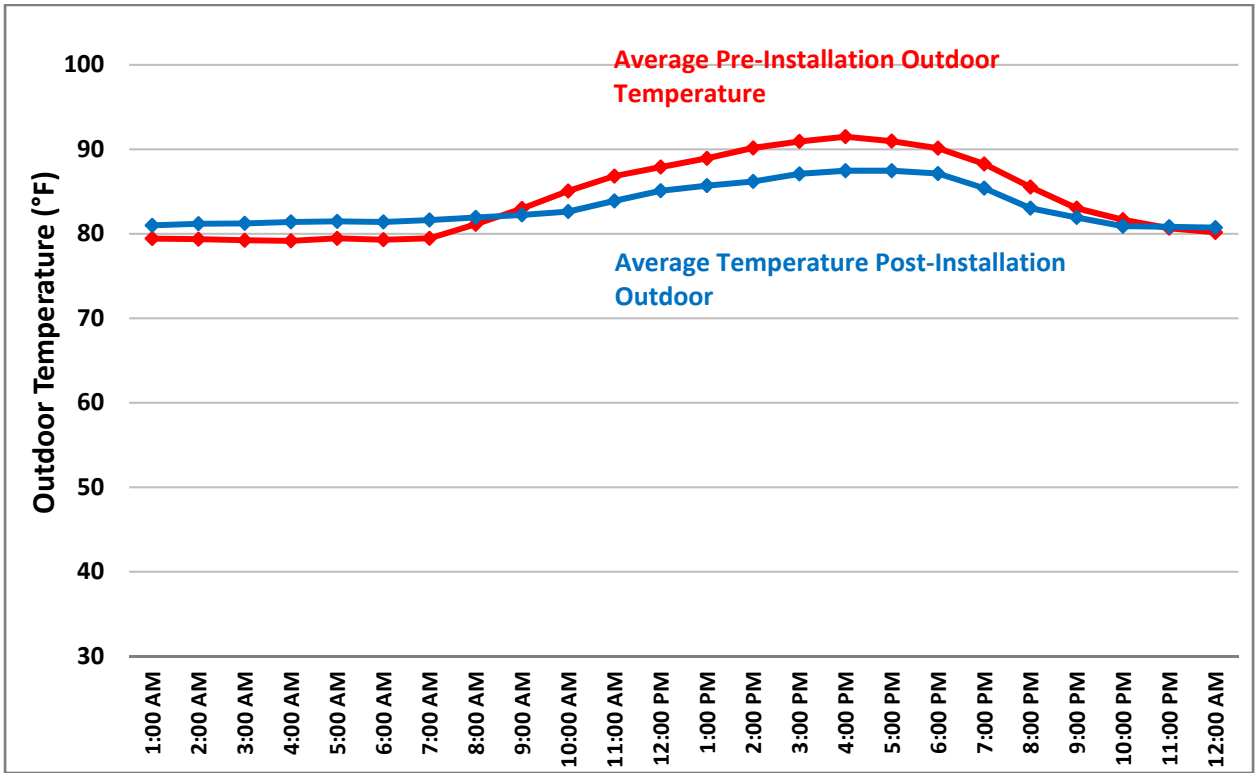

Fig. 6: Average Summer Outdoor Temperature Pre- and Post-Installation

For the winter monitoring period, the objective was to make sure that the cool roof did not adversely impact home conditions by reducing useful solar5 gain during winter months. The results obtained from the monitoring generally indicate that the impact of the cool roof during winter months was minimal. Figure 8 shows that the installation of the cool roofs has resulted in a relatively small average reduction in attic temperatures of only 0.7 °F in daytime temperatures (8 am through 6 pm), and an average reduction of only 1.8 °F in attic temperatures in the afternoon, peak, period. Furthermore, attic temperatures at night in the post-installation period were generally higher than the pre-installation period, indicating a potential positive impact of the roof in maintaining the homes' heat at night. While a comparison of figures 6 and 7 still show that post-installation peak attic temperatures were lower than their pre-installation counterparts, the impact during winter months was smaller than in summer months. Figure 9 shows that the post installation period was in general slightly lower in outdoor temperature than the pre-installation period. However, even accounting for this, it is still reasonable to conclude that the cool roof has had a minimal negative impact on daily attic temperatures during winter months, combined with a small positive impact during the night. This indicates a corresponding minimal impact on heating demand and thermal comfort conditions during the winter.

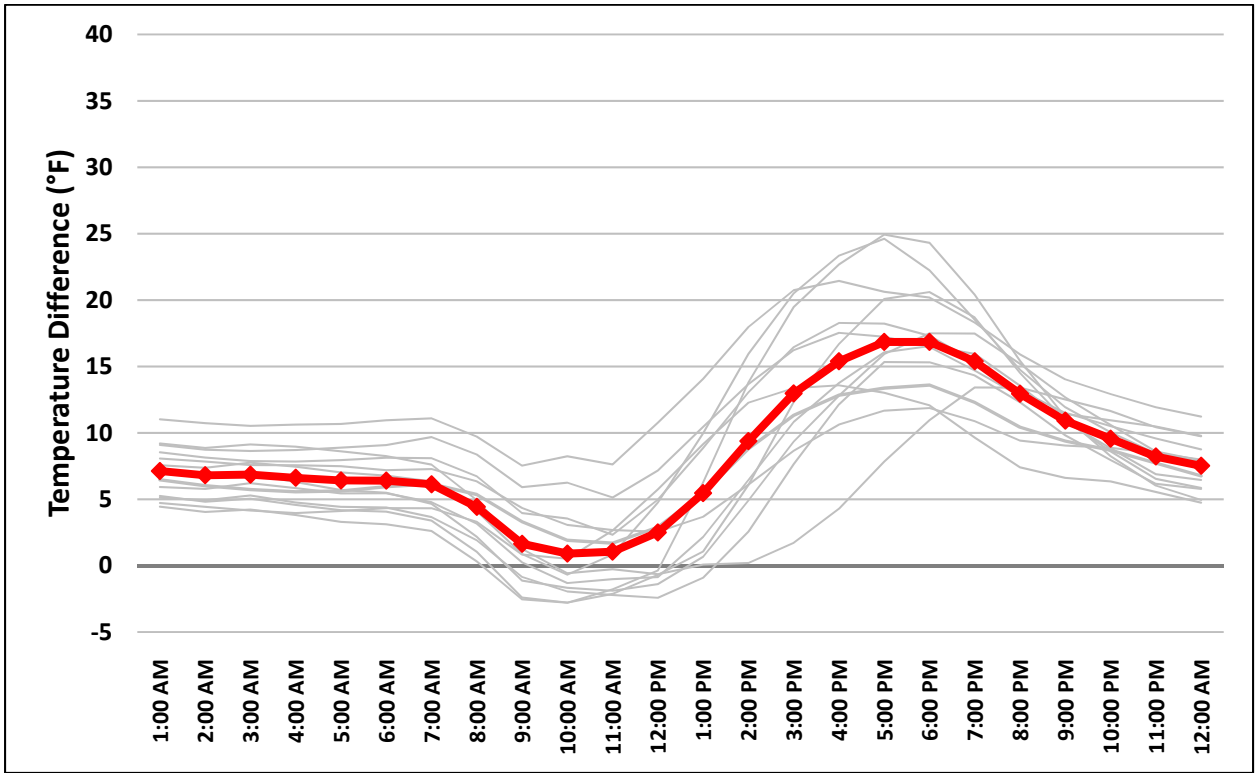

Fig. 7: Average Winter Temperature Difference between Attic & Outdoor – Pre-Installation

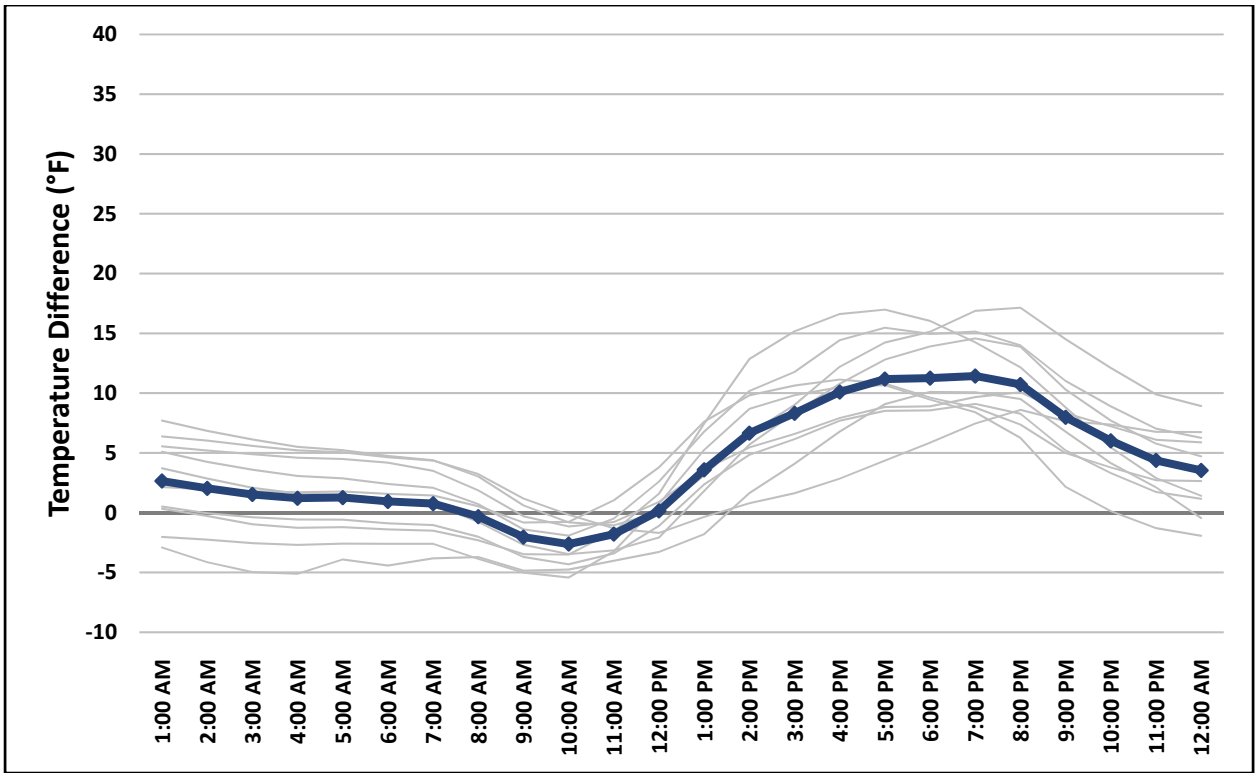

Fig. 8: Average Winter Temperature Difference between Attic & Outdoor – Post-Installation

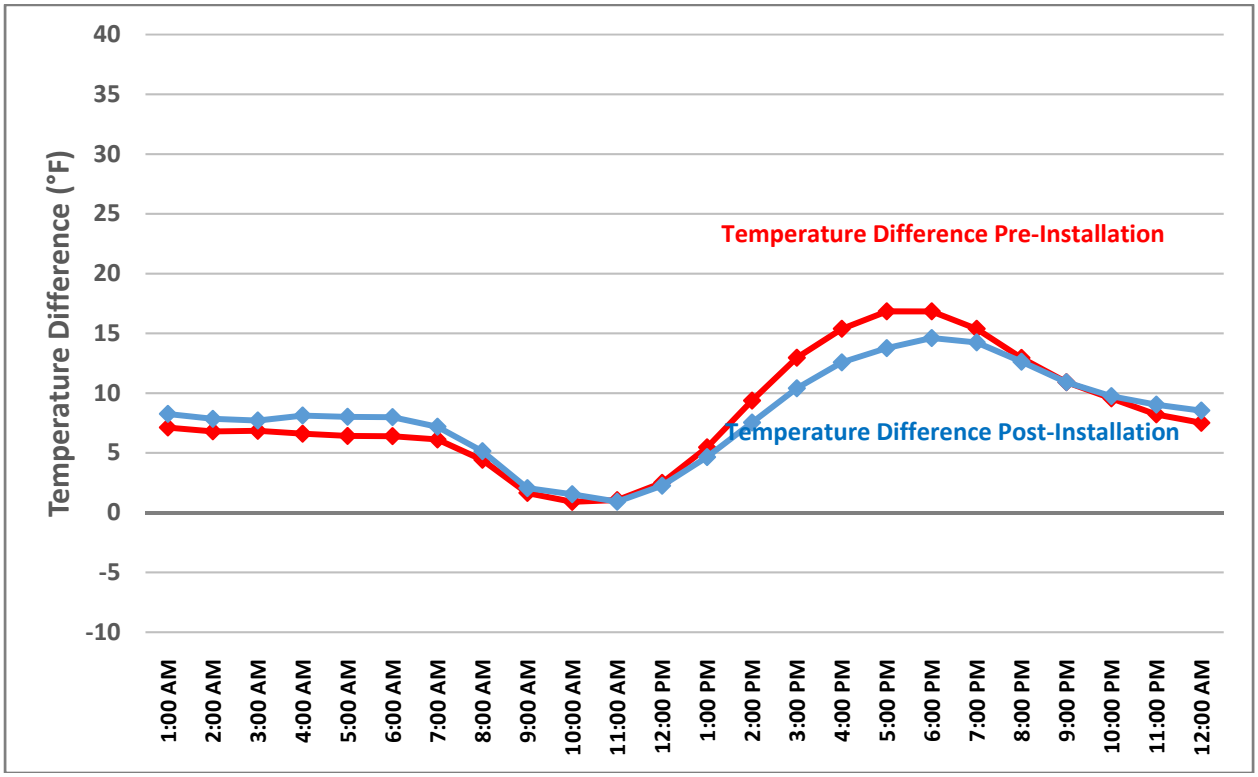

Fig. 9: Winter Temperature Difference Pre- and Post-Installation

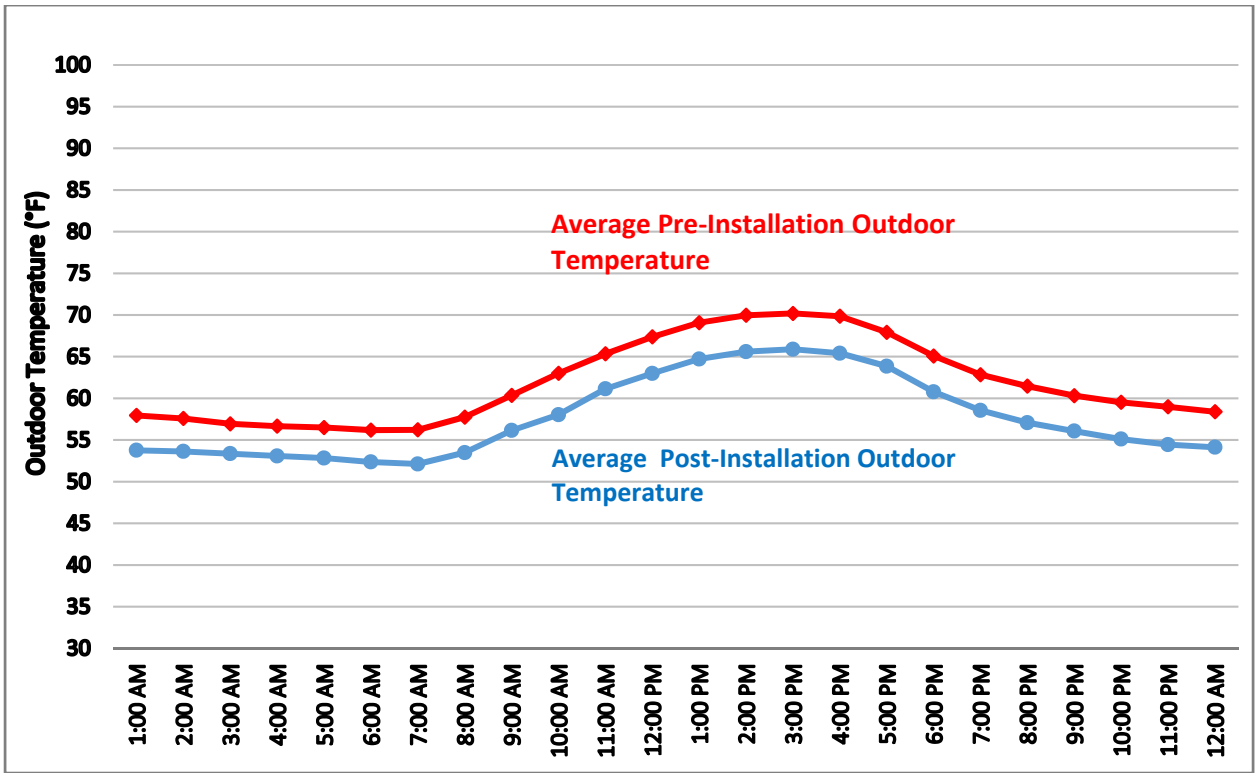

Fig. 10: Average Winter Outdoor Temperature Pre- and Post-Installation

3.2. Impact on Electricity Use

Analysis of the electricity use data for the 28 homes included in this Phase I report generally shows a positive impact of the installation of the new roof on the electricity use in the sample homes. Comparing the Energy Use Intensity (EUI, measured in kBtu/ft^2.year) of the pre- and post-installation periods, and normalizing for weather differences, we found that the installation of the new cool roof resulted in an average reduction of 5.1% in the EUI of the homes. When we exclude the four homes discussed in section 2.5, the average reduction in EUI increases to 7.3%. Furthermore, as anticipated by the project team, homes with central air-conditioning systems showed a higher level of reduction compared to those without one. This is because the installation of the cool roof primarily impacts cooling energy use, and therefore, homes without a central HVAC system, which typically do not use large amounts of energy for cooling, will have a lower potential for reductions in their energy use. Average electricity EUI in homes with central air-conditioning dropped by 12.5% compared with 3.9% for those without central air-conditioning (when excluding the four homes with different post installation conditions). These results indicated good potential for the cool roof in terms of reducing home electricity use and subsequent utility costs. Figure 10 shows a comparison of pre-and post-installation EUI for all groups disused above, while figure 11 shows the post-installation percentage of reduction in EUI for the same groups. It is worth noting that the EUI analysis in this report only considered electricity use and did not include natural gas usage.

On the other hand, the sample homes showed a relatively wide range of individual performance. After excluding the 4 homes with external uncontrollable variables, 15 out of the 24 remaining homes showed a reduction in electricity EUI ranging between 0.8% and 35.9%, while 9 showed an increase in EUI ranging between -0.3% to -13.8%. While this is not uncommon in these types of studies given the large number of variables that affect building energy use, the additional 30 homes planned for phase II of the project should provide additional evidence of the performance of the cool roofs. It is worth noting that 8 out of the 9 homes with a central air-conditioning system showed a reduction in EUI, consistent with expectations. It is also worth mentioning that most homes showing a relatively large increase in energy use in the post-installation period were determined to be affected by external circumstance (see section 2.5 and the discussion above). Detailed results of the pre- and post-installation EUI for all homes are included in Appendix C.

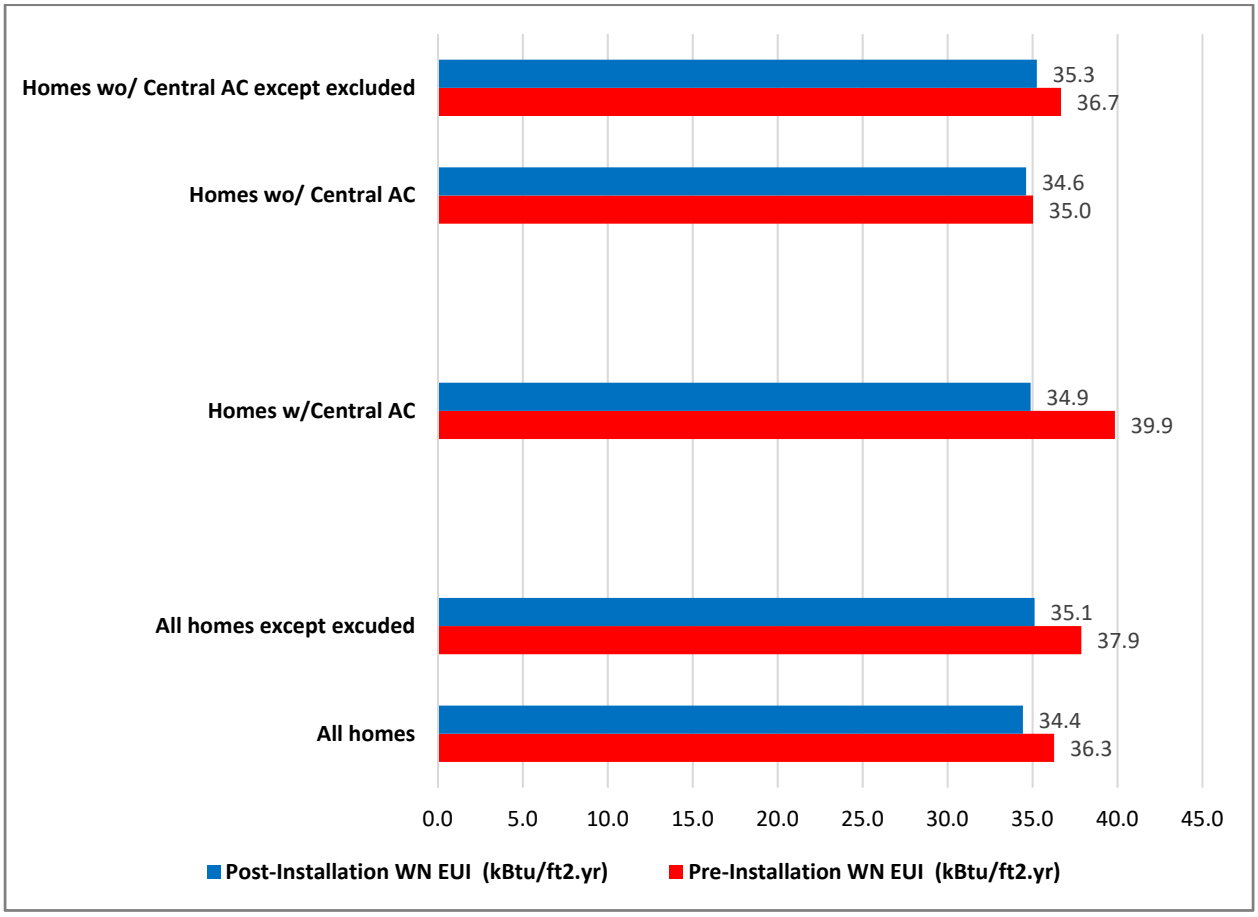

Fig. 11: Pre-and Post-installation EUI for Phase I Homes

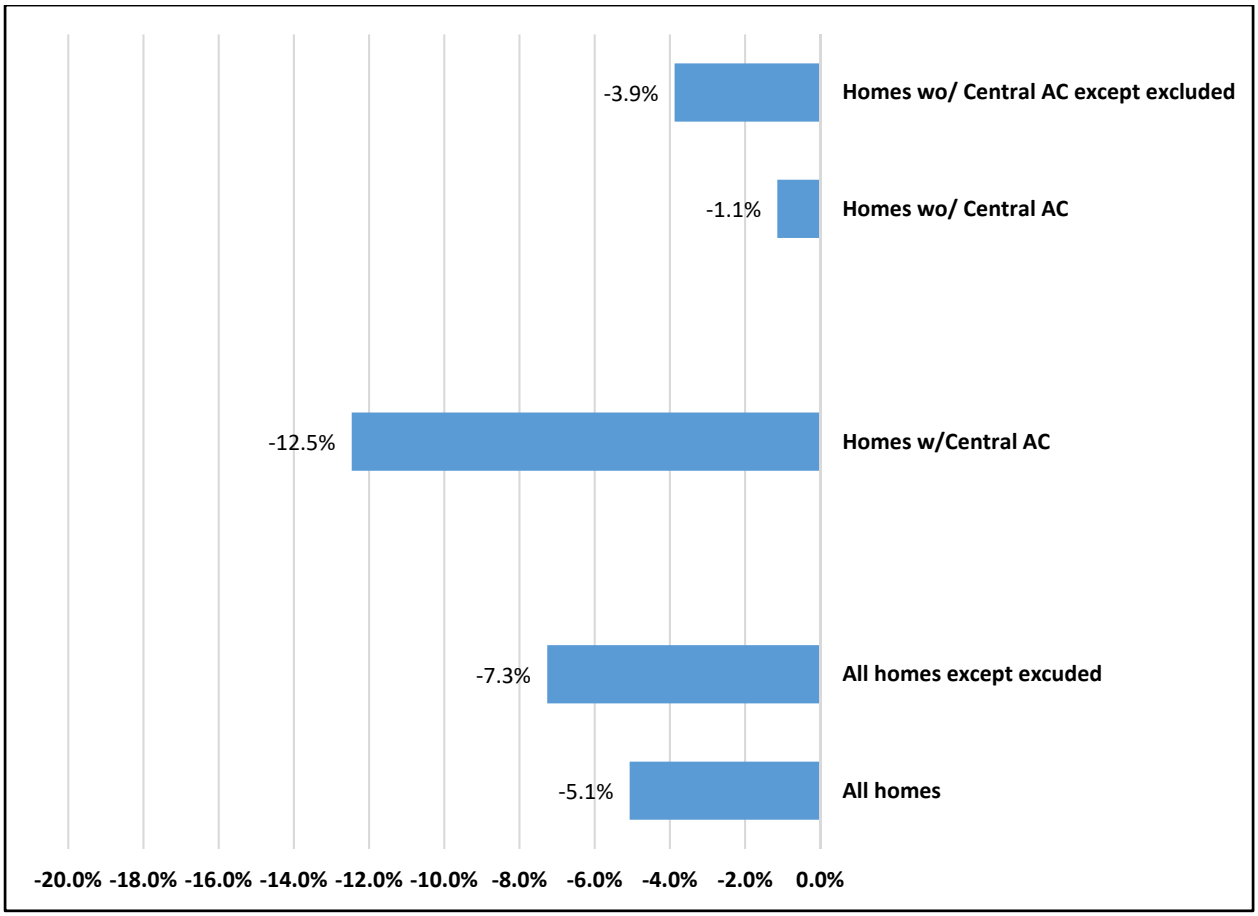

Fig. 12: Percentage of Reduction in EUI for Phase I Homes

4. Conclusions & Recommendations

The results of the Phase I work presented in this report show that the installation of the cool roof had a positive energy and attic temperature performance impact on the homes studied within this phase. Analysis of attic temperatures show that the installation of the cool roof had a note-worthy positive impact during summer months reducing both average daily temperatures and, more importantly, temperatures during peak afternoon period. This reduction should have a positive impact on electric energy use especially for buildings with central air-conditioning systems, and will positively impact thermal comfort conditions for homes without central air-conditioning. Analysis of winter temperature shows a minimal adverse impact from the installation of the cool roofs on attic temperature indicating a minimal impact on the homes' heating needs.

More importantly, analysis of utility data indicates a relatively high cooling energy savings from the new cool roofs, with the highest savings happening, as expected, in the homes with central air conditioning. Homes without central air-conditioning still showed a reduction in cooling energy use from installing the cool roofs, though smaller than ones with central AC. However, results from individual homes showed a relatively high level of variability in terms of the impact of the cool roofs on electricity use. This variability should be reduced with the addition of the 30 homes expected for Phase II of the project.

The positive impacts shown in this report are consistent with previous studies of cool roofs and indicate strong potential for continuing and expanding the program both in CoSA 's District 1 and other city districts.

Acknowledgements

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Appendix A: **List of Homes Included in Phase I**

Home #	Construction Year	Floor Area (ft^2)	BR / Bath	Cooling System Type	Heating System Type
CR1	1948	980	3/2	Central	Central - Forced Air
CR2	1952	1562	3/2	Central	Central - Forced Air
CR3	1955	1001	3/1	Central	Central - Forced Air
CR4	1951	1243	3/2	window	Space Heater
CR5	1951	990	2/1	window	2 wall furnace/ 2 electric space heater
CR6	1948	1120	3/1	Central	Central - Forced Air
CR7	1950	1432	3/1	Central	Central - Forced Air
CR8	1950	944	2/1	Central	Central - Forced Air
CR9	1950	1064	3/2	central	Central - Forced Air
CR10	1950	1514	3/1	Central + 1 WU	Central - Forced Air
CR11	1950	1034	2/1	window	wall furnace
CR12	*Application suspended*				
CR13	1949	1032	3/1	Window	Central - Forced Air
CR14	1949	720	2/1	Window	wall furnace
CR15	1950	992	3/1	Window	wall furnace
CR16	1950	1019	2/2	Window	wall furnace
CR17	1950	1164	3/1	Window	wall furnace
CR18	1951	1296	3/1	Window	wall furnace
CR19	1950	944	3/1	Window	wall furnace
CR20	1952	960	2/1	Window	wall furnace
CR21	1949	994	3/1	Window	wall furnace
CR22	1950	946	3/2	Window	wall furnace
CR23	1947	900	3/1	Window	wall furnace

Home #	Construction Year	Floor Area (ft^2)	BR / Bath	Cooling System Type	Heating System Type
CR24	1947	1408	3/1	Central	Central - Forced Air
CR25	1945	768	2/1	Window	wall furnace
CR26	1940	1112	2/1	Central	Central - Forced Air
CR27	1948	1116	2/1	Window	wall furnace
CR28	1949	732	2/1	Window	wall furnace
CR29	1949	1108	3/3	Window	wall furnace
CR30	1920	1148	2/1	Window	Space heater
CR31	1915	1062	3/1	Window	wall furnace

Appendix B: **Attic Temperature Monitoring Periods**

Home #	Roof Installation Month	Pre-Installation Monitoring Period	Post-Installation Monitoring Period
CR1	July / August 2016	6 days	95 days
CR2	July / August 2016	18 days	67 days
CR3	July / August 2016	9 days	118 days
CR4	July / August 2016	20 days	78 days
CR5	July / August 2016	17 days	110 days
CR6	July / August 2016	20 days	65 days
CR7	July / August 2016	18 days	68 days
CR8	July / August 2016	16 days	61 days
CR9	July / August 2016	18 days	39 days
CR10	July / August 2016	18 days	88 days
CR11	July / August 2016	7 days	27 days
CR12	Application Suspended		
CR13	Dec-16	21 days	52 days
CR14	Dec-16	22 days	51 days
CR15	Dec-16	26 days	48 days
CR16	Dec-16	27 days	47 days
CR17	Dec-16	19 days	53 days
CR18	Dec-16	33 days	40 days
CR19	Jan-17	35 days	39 days
CR20	Jan-17	15 days	162 days
CR21	Jan-17	22 days	117 days
CR22	Jan-17	23 days	124 days
CR23	Jan-17	31 days	118 days
CR24	Jan-17	29 days	112 days
CR25	Jan-17	30 days	87 days
CR26	Jan-17	No datalogger installed due to low attic slope and other limitations	
CR27	Jan-17	No datalogger installed due to low attic slope and other limitations	
CR28	Jan-17	No datalogger installed due to low attic slope and other limitations	
CR29	Jan-17	No datalogger installed due to low attic slope and other limitations	
CR30	Mar-17	No datalogger installed due to low attic slope and other limitations	
CR31	Mar-17	No datalogger installed due to low attic slope and other limitations	

Appendix C: **Home Electrical Energy Use Intensities Pre- and Post-Installation**

Home #	Central AC?	Const. Month	Pre-Installation		Post-Installation		% Change in EUI
			EUI (kBtu/ft2.yr)	WN EUI	EUI (kBtu/ft2.yr)	WN EUI	
CR1	Yes	Jul-16	42.7	41.7	37	33.7	-19.2%
CR2	Yes	Jul-16	21	20.7	22.4	22.9	10.6%
CR3	Yes	Jul-16	77.7	81.7	71.5	79.2	-3.1%
CR4	No	Jul-16	18.8	19	18.4	19.6	3.2%
CR5	No	Jul-16	27	26.8	24	24.5	-8.6%
CR6	Yes	Jul-16	62.1	68	43.6	43.6	-35.9%
CR7	Yes	Jul-16	37.4	35.7	38.4	35.4	-0.8%
CR8	Yes	Jul-16	29.4	28.9	25.8	25.7	-11.1%
CR9	Yes	Jul-16	35.7	33.9	32.6	32.1	-5.3%
CR10	No	Jul-16	20.2	20.1	14.9	14.9	-25.9%
CR11	No	Jul-16	26.9	26.3	29.2	27.1	3.0%
CR12	*Application suspended*						
CR13	No	Dec-16	41.2	39.3	41.1	41.7	6.1%
CR14	No	Dec-16	72.5	80.9	85.9	92.1	13.8%
CR15	No	Dec-16	41	45	45.3	46.6	3.6%
CR16	No	Dec-16	22.1	22.3	23.7	23.4	4.9%
CR17	No	Dec-16	11.5	11.9	13.5	13.5	13.4%
CR18	No	Dec-16	19.7	18.5	19.2	18.3	-1.1%
CR19	No	Jan-17	44.3	46.3	37.1	36.1	-22.0%
CR20	No	Jan-17	65.3	68.1	66.2	65.7	-3.5%
CR21	No	Jan-17	54.7	58.4	51.5	51.6	-11.6%
CR22	No	Jan-17	23.1	22.7	25.5	25.9	14.1%

Home #	Central AC?	Const. Month	Pre-Installation		Post-Installation		% Change in EUI
			EUI (kBtu/ft2.yr)	WN EUI	EUI (kBtu/ft2.yr)	WN EUI	
CR23	No	Jan-17	44.6	46	49.5	50.3	9.3%
CR24	Yes	Jan-17	28.6	27.2	22	20.7	-23.9%
CR25	No	Jan-17	14	14.3	14.8	14.9	4.2%
CR26	Yes	Jan-17	20.6	20.9	20.4	20.7	-1.0%
CR27	No	Jan-17	12.6	12.6	23.9	23.9	89.7%
CR28	No	Jan-17	40.7	43.2	29.6	29.6	-31.5%
CR29	No	Jan-17	42.1	43.8	38.2	38.2	-12.8%
CR30	No	Dec-16	41.2	39.3	41.1	41.7	6.1%
CR31	No	Dec-16	72.5	80.9	85.9	92.1	13.8%

Appendix D: **Home Owner Questionnaires**

Under 1 Roof Survey Questionnaire

All questions below for home owner:

GENERAL QUESTIONS:

1. In what year, did you move into the current house?
2. Is the home owner-occupied or rented?
    a. If rented, are electric and gas utility costs paid separately by the tenant?
3. What are the number of people living in the home in the following age ranges:
    a. Number of home occupants below age 17:
    b. Age 18 thru 59:
    c. Age 60 and over:
4. On a typical week day, is there someone at home all day?
    a. If yes, do you operate a home-based business or service?
    b. If yes, did you start your home-based business or service after the new roof was installed? When?
    c. If not, could you please tell us what that activity is?
5. Was your home vacant for more than 2 weeks in the past three years?
    a. If so, when was the vacancy? And how long was the vacancy?
    b. When your home was vacant, was your air-conditioning or heating system turned off?
6. Do you have a central air-conditioning system in your home?
    a. If yes, approximately how old is the air-conditioning equipment in your home?
    b. Was the air-conditioning equipment out of order since the new roof was installed?
    c. Was the air-conditioning equipment replaced since the new roof was installed?

QUESTONS REALTED TO THE NEW ROOF INSTALLATION

Since the new roof was installed, did any the following take place:

7. Were there any visitors in your home who stayed longer than a week?
    a. If yes, how many visitors did you have?
    b. If yes, did the visitors stay at home during weekdays?
8. Was there any activity occurring in your home that uses a lot more energy than would normally be used in a home?
9. Was there any damage on your new roof?
    a. If yes, could you please tell us what damage it was?

b. If yes, when the damage was made?

c. If yes, was the damage fixed? When?

10. Was there any additional construction in your house?

    a. If yes, can you tell us what type of construction was made?

11. Was any of the mature trees near your house removed?

    a. If yes, how many trees were removed? When?

    b. If yes, how tall the trees were?

12. Was any of your original windows replaced?

    a. If yes, how many of the original windows have been replaced?

    b. If yes, what type of new windows was installed? (Single-pane glass, Double-pane glass, Double-pane glass with Low-e coating, Triple-pane glass, Triple-pane glass with Low-e coating)

13. Was there any new kitchen appliances (i.e. refrigerator, dishwasher, stove, microwave, cooking device, etc.) purchased and installed in your house?

    a. If yes, what type of appliances were installed?

    b. If yes, when they were installed?

14. Was there any new electronics (i.e. TV, computer, electric heater, fan, etc.) purchased and installed in your house?

    a. If yes, what type of electronics were installed?

    b. If yes, when they were installed?

15. Was your thermostat setting for cooling changed?

    a. If yes, what was your original temperature setting for cooling?

    b. If yes, what is your current temperature setting for cooling?

    c. If yes, can you tell us the reason for the temperature change?

    d. Do you turn off your air-conditioning system while no one is home?

16. Was your thermostat setting for heating changed?

    a. If yes, what was your original temperature setting for heating?

    b. If yes, what is your current temperature setting for heating?

    c. If yes, can you tell us the reason for the temperature change?

    d. Do you turn off your heating system while no one is home?

17. Were there new lights installed in your house?

    a. If yes, how many new lights were installed?

    b. If yes, do they have energy efficient bulbs such as fluorescent tube, compact fluorescent lamp, or LED lamp?

    c. Do you turn off lights while no one is home?

Field Survey Questionnaire
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Appendix E: **Consent Form for Home Owner Questionnaires**

Permission to Take Part in a Human Research Study		
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Title of Research Study: Under 1 Roof Home Energy Assessment

Principal Investigator: Hazem Rashed-Ali

Purpose of the Study and Reason for Your Involvement:

If you are providing consent for someone else (e.g., your child, a next-of-kin, or someone for whom you are the legal guardian or are designated as a surrogate decision maker on a medical power of attorney), please note that in the sections that follow the word "you" refers to the person for whom you are providing consent.

This project aims to evaluate the impact of installing low-solar-reflectivity roofs on residential buildings in the City of San Antonio. The study includes collecting information about attic temperatures before after roof installation, as well as analyzing and comparing home utility data before and after installation. The survey question are meant for the owners of the homes in which the roofs have been installed, and aim to assist the research team in diagnosing differences in utility use. The results of the study will help the city assess the success of the project and therefore determine the possibility of extending it to cover more home owners.

We invite you to take part in a research study because you are the owner of one of the homes which received a new roof funded by the City of San Antonio.

Participation in the Study:

- Whether or not you take part is up to you.
- Participation is totally voluntary.
- You can agree to take part in the study and later change your mind.
- Your decision not to participate will not be held against you.
- You may ask all the questions you want about the study before you decide.

Contact information:

If you have questions, concerns, complaints, or think the research has harmed you, you may talk to the research team at: hazem.rashedali@utsa.edu or 210-458-3088

This research is being overseen by an Institutional Review Board ("IRB"). You may also talk to them at (210) 458-6473 or IRB@utsa.edu if you have questions regarding your rights as a research participant or other questions, concerns, or complaints.

Participant Role in the Research Study:

if you participate in the study, you will be asked to respond to a number of questions relating to your use of energy in your home before and after the installation of the new roof. You will only be asked to answer the survey questions once, which is expected to take about 30 minutes of your time. Participation in the survey is not expected to have any negative impacts for you or your family. Your individual information wil be kept confidential and you will not be individually identified in the report results. Data collected may be kept for use in future reseach.

Other Options for Participation in the Research Study:

If there are alternatives to participation in the study that may be advantageous to the participant, please include a description of those alternatives; otherwise, delete this section.

Additional information:

1. *This research is being funded by the City of San Antonio.*

Permission to Take Part in a Human Research Study		
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Risks and Discomforts:

There are no risks or discomforts associated with participating in this study.

Benefits for Participation:

We cannot promise any benefits to you or others for participating. However, the results of our project will inform the City of San Antonio with regard to the success of the Under 1 Roof Program, and the potential for continuing or expanding it.

Participant Privacy and Research Record Confidentiality:

The surveys will be confidential. Your research records will not be released without your consent unless required by law or a court order. Your records may be viewed by the Institutional Review Board, but the confidentiality of your records will be protected to the extent permitted by law. The data resulting from your participation may be used in publications and/or presentations but your identity will not be disclosed.

Signature Block

Your signature documents your permission for the named participant to take part in this research.

Name of participant (Age if minor)	
Signature of Participant (or participant's legally authorized representative)	Date
Signature of person obtaining consent	Date

Form modified by UTSA IRB Staff 7/26/16
Created by WIRB Copernicus Group, Inc. for University of Texas San Antonio