Energy Research and Development Division

FINAL PROJECT REPORT

Solar-Reflective "Cool" Walls: Benefits, Technologies, and Implementation

Appendix R: Advancements in Infrastructure Development - Building Standards and Incentive Programs (Task 6.3 Report)

California Energy Commission
Gavin Newsom, Governor

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Appendix R: Advancements in infrastructure development: building standards and incentive programs (Task 6.3 report)

Haley Gilbert[1] and Ronnen Levinson[1]

[1] Heat Island Group, Lawrence Berkeley National Laboratory

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Abstract

This report describes our efforts to advance the infrastructure needed to promote the appropriate use of cool wall technologies. Following the model successfully used for cool roofs, our activities included developing guidelines, pursuing development of a product rating program, encouraging utility rebates, investigating ENERGY STAR label qualification, and pursuing credits/requirements in building energy standards and energy-efficiency programs (e.g., Title 24, ASHRAE 90.1, LEED). We began our efforts by searching for all existing references to cool walls in building energy standards and incentive programs. We also formed a Working Group of key cool wall stakeholders to support and contribute to the activities.

1 Introduction

Cool roofs can be found on rooftops across the United States. They are included in many city, state, and federal building codes/standards. To advance the adoption of cool walls, we can follow and learn from the cool roof adoption model. Cool roofs were first incorporated in many codes/standards as credits and later transitioned to prescriptions. The timeline in Figure 1shows how the adoption of cool roofs took time and was also accompanied by incentives, such as ENERGY STAR certification and utility rebates. The process was aided by the establishment of the Cool Roof Rating Council (CRRC). The CRRC is an independent organization that has developed methods for evaluating and labeling roofing products for reference by codes, standards, and rebates. It has also propagated the cool roof concept and its rating program.

Following the model successfully used for cool roofs, we set out to develop the infrastructure needed to advance the appropriate use of cool walls. Our activities included

- preparation of Cool Wall Application Guidelines;
- initiation of a product rating program;
- initiation of a utility rebate program;
- initiation an ENERGY STAR program for cool walls;
- support for the development of cool wall credits in California, U.S., and international building energy standards/programs (e.g., Title 24, ASHRAE 90.1, LEED); and
- coordination of project results workshop.

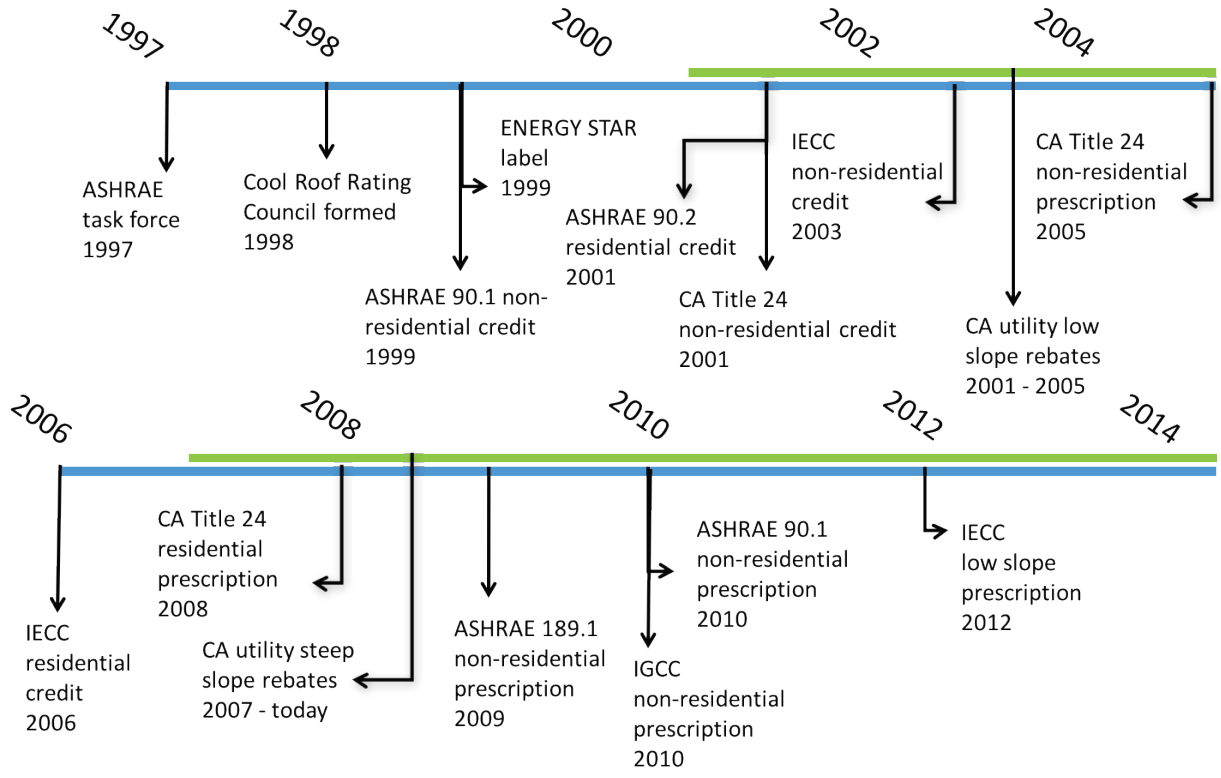

Figure 1. A timeline of the inclusion of cool roofs in major building codes/standards and other milestones (Akbari & Levinson, 2008).

We began our efforts by searching for all existing references to cool walls in building energy standards and incentive programs. We also formed a Working Group of key cool wall stakeholders to support and contribute to the activities.

We drew upon the data and results from the reports of Task 2 (*Quantify Cooling, Heating, and Lighting Energy Use Savings*) Task 3 (*Quantify the Environmental and Energy Co-benefits of Cool Walls*) to support our activities to advance cool wall adoption.

2 Current references in building standards and incentive programs

One of our initial activities was to investigate existing references to cool walls in building standards, green building programs, and incentive programs. We needed to understand where cool walls were currently referenced to know where and how to focus our efforts.

2.1 Building standards and green building programs

While cool wall references in building standards and green building programs are not prevalent, we found references in *ANSI/ASHRAE/IES Standard 90.1-2016—Energy Standard for Buildings Except Low-Rise Residential Buildings* (ASHRAE 90.1)*; ANSI/ASHRAE/IES/USGBC Standard for the Design of High-Performance Green Buildings 189.1-2014, Standard for the Design of High-Performance Green Buildings* (ASHRAE 189.1); California Green Building Standards Code; Green Building Initiative's Green Building Assessment Protocol for Commercial Buildings; and in Hawaii's State Energy Conservation Code (Hawaii Energy Code, 2015).

New to ASHRAE 90.1-2016 was the inclusion of a cool wall measure in ASHRAE climate zone 0, which is found in hot and tropical regions outside of the United States (e.g., Hyderabad, India). This measure is found in Section 5.5.3.2 of the building envelope chapter. In addition to the above-ground wall insulation requirements, in ASHRAE climate zone 0, above-grade walls need to either be "cool" walls with solar reflectance index (SRI) greater than or equal to 29 on 75% of East and West walls; or 30% of East and West walls should be shaded (ASHRAE 90.1). The previous version, ASHRAE 90.1-2013, did not include this measure.

ASHRAE 189.1-2014 also includes a cool wall exception for shading on East and West walls. This measure is in the Site Sustainability section under the mitigation of urban heat island effect sub-section (Section 5.3.5.2). ASHRAE 189.1 is a high-performance green building code, therefore includes measures that provide a range of environmental benefits—not just energy savings. The exception, adopted in 2011, allows for 75% of East and West walls to have an SRI greater than or equal to 29, in place of the 30% East and West wall shading requirement (ASHRAE 189.1).

Similar to ASHRAE 189.1 is the California Green Building Standards Code (CALGreen). This statewide mandatory green building standard features provisions to "reduce energy, water, waste, and transportation impacts while protecting the environment and public health" (Papke, 2015). Beyond the mandatory measures, the code includes three levels of reach standards that California cities can voluntarily adopt (Papke, 2015). It includes an elective reflective wall

measure under the Site Development section for exterior wall shading (Section A5.106.7.2). The exterior wall shading provision can be met by either (1) shading the building's fenestration, or (2) surfacing 75% of walls to have an SRI greater than or equal to 29. However, the requirement for opaque walls areas can also be met with shading provided by vegetation (CBSC, 2016).

The voluntary Green Building Initiative's (GBI) Green Building Assessment Protocol for Commercial Buildings includes a provision for reflective walls in their Mitigating Heat Island Effect section (7.3.4.3). This is a rating program similar to U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED). The provision states that 75% of East, West, and South wall surfaces should have an SRI greater than or equal to 29 or be covered with vegetation. This provision is not applicable for ASHRAE climate zones 6 through 8 and is worth 3 points in their rating program (GBI, 2017).

We also contacted Howard Wiig of Hawaii's State Energy Office to learn more about the cool wall exception in Hawaii's State Energy Conservation Code. Hawaii adopted the 2015 International Energy Conservation Code (IECC) in 2015 but included several amendments. The 2015 IECC does not include any references to cool walls. However, they amended 2015 IECC to include an exception for continuous wall insulation for wood or metal framed buildings when walls either have a visible reflectance value greater than or equal to 0.64, or overhangs that shade the walls (Wiig and Makela, 2015).

The presence of several existing cool wall references in building standards and green building programs is very helpful to further increase cool wall adoption. While the existing references are not ideal, we have found it easier to edit and update existing references than to develop new language for adoption. We have begun to work with our contacts involved in these various codes, standards, and programs to share our project results and resources, and discuss how we can improve and strengthen these existing references. Our efforts are further described in Section 8.

2.2 Incentive programs

We also looked for cool wall references in utility rebate programs, U.S. EPA ENERGY STAR, and other building energy efficiency incentive programs. Incentive programs can be critical to helping new building energy efficiency technologies gain market share. Incentives can help defray the cost premium (if any) of a new energy efficiency technology, and advertise its benefits to consumers.

One incentive program to increase building energy efficiency in existing building is Property Assessed Clean Energy (PACE) financing programs. PACE programs can now be found across the United States but need to be authorized by state law. PACE financing was initiated in California in 2007 with the passage of California Assembly Bill 811 (Contractual Assessments: energy efficiency improvements, 2007), which amended the state's existing laws to allow PACE financing for renewable energy and energy efficiency improvements to homes and businesses.

PACE program availability varies by city and county across the California. PACE financing allows property owners to fund energy efficiency, water efficiency and renewable energy projects. The financing covers the cost of the materials/product and installation. Property owners can finance up to 100% of their project and pay it back over time through their existing property tax bill as a voluntary property tax assessment (Center for Sustainable Energy, 2018).

There are 12 PACE financing programs in California for residential and commercial buildings (Table 1). The PACE programs often restrict funding to eligible products that have been vetted by the organization to provide the intended energy and water benefits. Many of the PACE programs provide the list of eligible products on their websites. We found that three PACE programs available in California include cool walls as eligible products (Table 1). The three programs are the Home Energy Renovation Opportunity (HERO) program, PACE Funding, and Energy Efficient Equity. The HERO program is offered by Renovate America in partnership with the Western Riverside Council of Government and is one of the most popular PACE loan programs offered in California (Matasci, 2017). The specifications for cool wall product eligibility are listed in Table 2. Therefore, a homeowner can pay for and install an eligible cool wall product with PACE financing.

Table 1. PACE financing programs for residential and commercial buildings in California. The table indicates whether the program includes a cool walls measure.

Program	Building Type (Residential/Commercial/Both)	Cool Walls Measure
AllianceNRG Program (https://www.alliancenrg.com/retail/)	Both	Noa
California First (https://renewfinancial.com/product/californiafirst)	Both	Noa
Energy Efficient Equity (https://www.energyefficientequity.com/)	Residential	Yes
FigTree Financing (http://www.figtreefinancing.com/)	Commercial	Noa
Green Finance San Francisco (https://sfenvironment.org/residentialpace)	Commercial	Noa
Home Energy Renovation Opportunity (HERO) Program (https://heroprogram.com/)	Residential	Yes
LA County Commercial PACE Program (http://lapace.org/commercial.html)	Commercial	Noa
MPower (http://www.mpowerplacer.org/)	Both	Noa
PACE Funding (http://www.pacefunding.com/homeowner/)	Residential	Yes
Samas Capital PACE (http://samas-pace.com/)	Commercial	Noa
Sonoma County Energy Independence Program (SCEIP) (http://sonomacountyenergy.org/)	Both	Noa
Ygrene (https://ygreneworks.com/)	Both	Noa

[a] The program websites did not offer enough information on specific eligible products or the program accepts custom measures not listed.

Table 2. The PACE program specifications for cool wall product eligibility.

PACE program	Cool wall eligibility specifications
HERO program (https://heroprogram.com/products)	Product must have a solar reflectance rating greater than 0.5 as tested by a recognized third-party laboratory using the ASTM C1549-09 standard test method or equivalent standard. Product manufacturer, brand, and model must be a pre-approved HERO Cool Wall Coating. Product primary application surface must be exterior wall surfaces of conditioned (heating and/or cooled) buildings. Trim, soffit, and/or fascia may also be included as secondary work scope items, as applicable. Product is only eligible for properties located within California Energy Commission building climate zones 4 through 10 and 12 through 15. Product is not eligible for properties located within CEC building climate zones 1 through 3, 11, and 16.
PACE Funding (http://www.pacefunding.com/homeowner/)	Product must be included on PACE Funding Cool Wall Eligible Product List. Product must have solar reflectance ≥ 0.5 as tested by recognized third-party laboratory to ASTM C1549-09 standard. Product is only eligible to be installed on properties located within California building climate zones 4-10 and 12-15. Installed per manufacturer specs.

3 Application guidelines

Since the benefits of cool walls can vary by building type, vintage, and location, the Task 6.1 report: *Cool wall application guidelines* provides guidance for their building- and climate-appropriate use to conserve energy and reduce emissions of greenhouse gases and criteria pollutants across California and the United States. First, it explores the nature of cool walls through a series of questions & answers. Second, it provides a simple guide to cool wall effects by detailing the energy cost savings (or penalties) that arise from increasing wall reflectance in three common building categories—single-family home, medium office, and retail stand-alone. Third, it provides a detailed guide to these effects by describing the operation and application of the Cool Surface Savings Explorer, a database tool that can report the cool wall and cool roof energy, energy cost, peak power demand, and emission savings simulated for many building categories. Fourth, it discusses how to adjust cool walls savings and penalties to account for shading and reflection by neighboring buildings.

4 Stakeholder working group

The Cool Walls Working Group is comprised of research team members and other cool wall stakeholders. It was formed in Fall 2017 to advance the appropriate adoption of cool walls by incorporating the technology into building codes and incentive programs. Group members are expected to meet quarterly, collaborate on activities, and help communicate activities/results to other stakeholders. The timeline of the formation of the Working Group and its first year of meetings is shown in Figure 1.

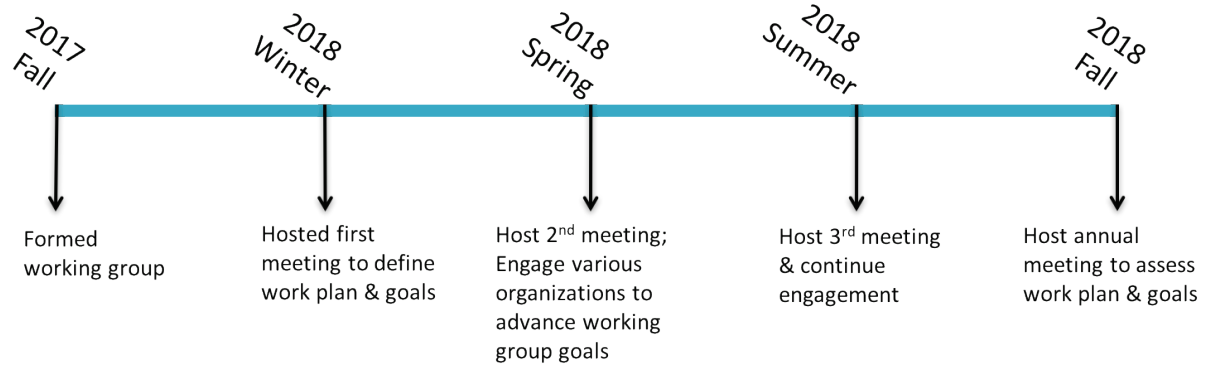

Figure 2. The Cool Walls Working Group was announced at the project workshop in October 2017. As the timeline depicts, the Group will meet quarterly.

Given the composition of the Working Group, we are positioned to provide a diverse perspective on how best to increase cool wall adoption, and also be able to provide information needed regarding the science, benefits, market and use of cool wall products. This will be extremely helpful when working on cool wall measures for building codes/standards and cool wall incentive programs.

One of the Cool Walls project objectives was to initiate the development of cool wall infrastructure. The Cool Walls project period is not long enough to cover the full implementation of cool wall infrastructure, therefore the Working Group will also be critical in providing continued support for cool walls in the absence of project support.

The Working Group participants include manufacturers, California utilities, rating organization, state building code official, California and national environmental program officials, and researchers. Current Working Group members are listed in Table 3. The Working Group consists of 24 members and three observers from 18 organizations. Membership is open allowing us to continually recruit key new members as we pursue different activities.

This project initiated and investigated cool wall measure inclusion for many building codes and standards, green building programs, and incentives. The research team identified current cool wall references upon which to build, and researched the processes to establish new and revise

existing cool wall measures. The research team connected with key staff and stakeholders in the various organizations who will be critical when pursuing the development of cool wall measures. The information and contacts that the research team gathered will be the shared with the Working Group to aid future activities.

Table 3. There are 24 members (two observers not listed) in the Cool Walls Working Group.

Name	Organization	Name	Organization
Bill Dean	California Environmental Protection Agency	Jerry Wu	Dexerials
Bill Yanetti	Mitsubishi Chemical Composites America	Jim Moses	Mitsubishi Chemical Composites America
Brandon Bethke	Tempo Chemicals & Solutions	Michael Biel	Ultimate Coatings
Craig Tranby	Los Angeles Department of Water and Power	Olivier Rosseler	Saint Gobain
David Story	PPG	Peter Turnbull	Pacific Gas & Electric
Gary Ilalaole	Homeowner	Rich Wipfler	Eastman Chemical
Gen Minase	Eastman Chemical	Ronnen Levinson	LBNL Heat Island Group
Haley Gilbert	LBNL Heat Island Group	Tim Hebrink	3M
Hiroko Furumi	Dexerials	Tim Hyer	Gardner-Gibson
Howard Wiig	State of Hawai'i	Tsutomu Nagahama	Dexerials
Hugo Destaillats	LBNL Heat Island Group	Victoria Ludwig	U.S. Environmental Protection Agency
Jeff Steuben	Cool Roof Rating Council	Yisheng Dai	Eastman Chemical

One of the first efforts of the Working Group is to establish a work plan that prioritizes our activities and focuses our resources. To help develop the work plan, a poll was shared with all the Working Group members to identify initial priorities. The poll listed potential activities brainstormed during the Working Group's kick-off call in December 2017. Members were directed to select up to five choices. The results of the poll (Figure 2) clearly indicate a strong interest from members to prioritize the development a cool wall product rating system.

A work plan is now under development using the results of the poll. The work plan will also take into account available resources, impact of the activity, and timing. Many of the activities that are described in Sections 5 through 8 of this report will be included in the work plan. The Working Group will leverage the resources and findings from the research team to successfully pursue and implement cool wall measures in codes, standards, and incentive programs. A draft work plan will be circulated for comments to all the Group members ahead of the Fall 2018

meeting. The final work plan will be presented to the Working Group during the Fall 2018 meeting.

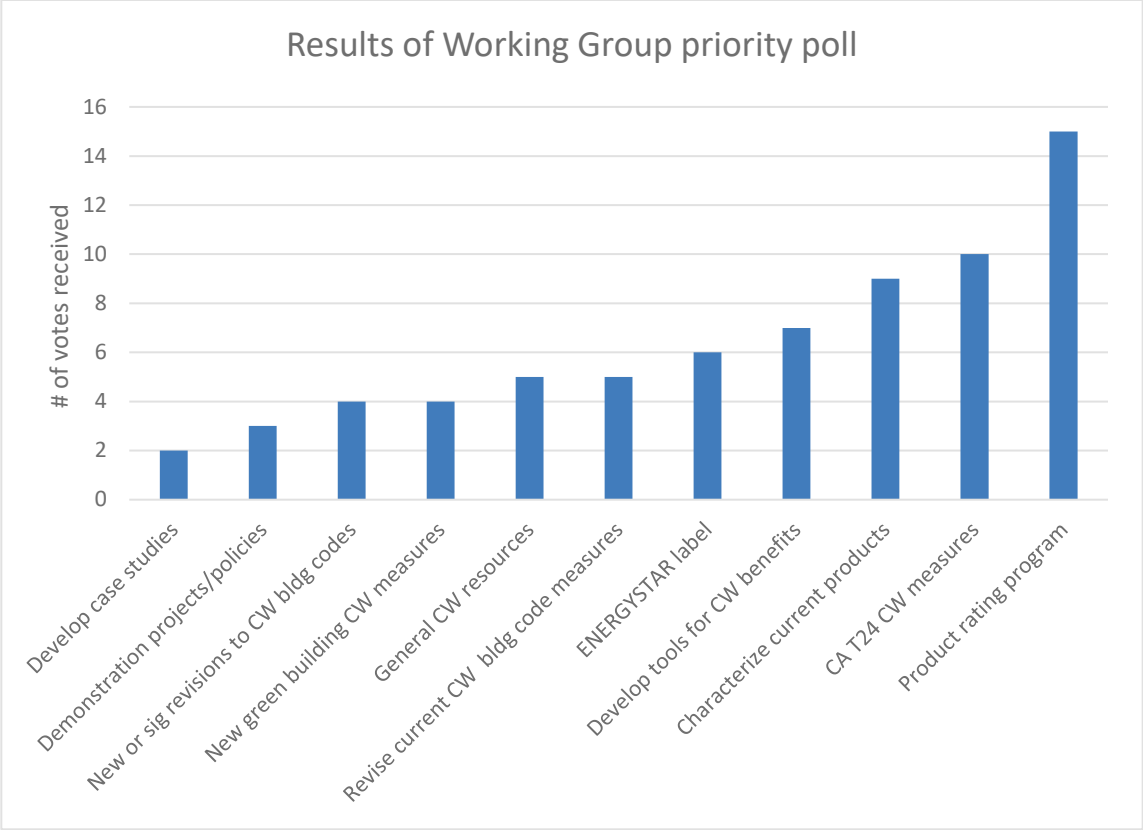

Figure 3. The most popular activities identified in the Working Group priority poll were the development of a product rating program followed by interest in California Title 24 cool wall ("CA T24 CW") measures and characterization of currently available cool wall products.

5 Product rating program

To increase the adoption of cool wall measures in building codes, standards, and green building programs, a third-party rating system will need to be developed. An independent rating system will give confidence to these organizations that products meet the specified property requirements. A rating system would involve the development of a credible method to evaluate and label the radiative properties of wall products.

Cool roof adoption provides a helpful model. The Cool Roof Rating Council (CRRC) was established in 1998. Its mission is to develop methods to measure and label the radiative properties of roofing products. The CRRC administers a product rating program that provides strict guidelines for the measurement, reporting, and labeling of products submitted by manufacturers for evaluation. It enables the use of cool roof codes, standards, incentives, and specifications by providing third party verified data on radiative properties which can be referenced (CRRC, 2018). The CRRC ANSI/CRRC 100 standard developed and followed by CRRC

is now referenced in ASHRAE 90.1, ASHRAE 90.2, ASHRAE 189.1, IECC, and International Green Construction Code (IgCC)). The CRRC program manual (CRRC-1) is referenced in California's Building Energy Efficiency Standards (T24) and ENERGY STAR (Ms. S Schneider 2018, pers.comm., 23 January).

There are two options for establishing a cool wall rating system: develop a new organization modeled on existing and successful programs, like the CRRC; or expand the scope of an existing organization to include wall products. We have decided to pursue the latter option first because it is more time and resource efficient. We identified the CRRC as the first organization to approach because a cool wall rating organization would operate similarly, and the CRRC has evaluation methods and metrics closely aligned to those required for cool wall products. Dating back to 2009, the CRRC's strategic plan included a measure to expand their scope to rate wall products. In addition, there is overlap among cool roof and cool wall manufacturers. We found that there are nine CRRC Class A (commercial) members and/or licensees that are participants in our cool walls project. We also identified a further 19 members and/or licensees that produce or have an interest in wall products.

To advance the idea of expanding the scope of the CRRC to include wall products, we have presented project updates to the CRRC's board of directors (November 2015 and January 2018), technical committee (October 2015 and August 2017), and membership (CRRC newsletter article, January 2016; membership meeting, June 2016). During the board of directors meeting in January 2018, we presented final project results and proposed that CRRC develop in 2018 an actionable plan to begin rating wall products in 2019. In response, the board of directors created a task group that is to prepare a cool walls expansion plan that includes technical measures and a financial analysis. The plan was discussed with the technical committee and presented to the membership in spring 2018. It will be voted on by the board of directors in fall 2018. The CRRC will issue in February 2018 a memorandum outlining this effort.

6 Utility incentives

Utility incentives can be designed to encourage the use of building energy efficiency technologies by spurring development and sales. Utility rebates were offered for cool roofs in California before they were prescribed in the California's Title 24 building energy efficiency standards (Akbari and Levinson 2008). Something similar for cool walls would help increase the adoption of these technologies. Thus, one of our activities was to initiate utility incentive programs in California.

In California, there are investor owned utilities (IOUs) and publicly owned utilities (POUs). The major IOUs in California include Pacific Gas and Electric (PG&E), Southern California Edison (SCE) and San Diego Gas and Electric (SDG&E). These three comprise approximately 75% of electricity supply in California. There are more than 40 POUs in the state and the largest one, Los Angeles Department of Water and Power (LADWP) services 3.9 million customers. (CEC, 2018).

To initiate a utility incentive program for cool wall products, we reached out to PG&E and LADWP. California IOUs are mandated by CPUC to develop and offer similar rebates . LADWP is a POU and therefore designs its rebate programs independently of the IOUs (Mr. C Tranby 2018, pers.comm., 9 January). By contacting both organizations, we can learn about the rebate development process for California IOUs and POUs.

6.1 Los Angeles Department of Water and Power

We spoke with Craig Tranby of LADWP's Environmental Affairs Department in January 2018. He expressed great interest in exploring the feasibility of offering a cool wall utility rebate. LADWP has offered a cool roof rebate since 2011 (LADWP, 2014), therefore are supportive of solar reflective building products.

We discussed several cool wall incentive options: downstream, upstream, and direct install. Downstream incentives are offered to consumers in the form of rebates when they purchase and install an energy efficient product. Upstream incentives are for manufacturers or distributors to off-set any price premiums in the manufacture and/or distribution of these products. Direct install programs are run by utilities. They staff crews that survey buildings, assess which energy efficiency products are good options, and install the products free of cost to the building owner. These programs typically operate in income-targeted communities (Mr. C Tranby 2018, pers.comm., 9 January).

Cool roofs were supported with downstream incentives in the form of rebates to consumers when they purchased and installed the qualifying cool roof products. These rebates require the customer to complete an application specifying address, proof of purchase, approved building permit, and installation contract. The rebate processing team will sometimes use aerial imagery to confirm the size of the rooftop. It also reserves the right to conduct a post-installation visit. This could be a good option for cool walls but a bit trickier to enforce since many homeowners chose to paint their exterior on their own and do not hire a licensed contractor. Pre- and post-installation photos might be required to verify installation. It would also be important to have develop clearly labeled cool wall products to aid consumer identification This might prove challenging since there is not yet a rating program or ENERGY STAR label. However, we have are working to develop both a rating program and ENERGY STAR label as part of Task 6 activities. A consumer rebate could be trialed during a seasonal promotion period—during late spring in preparation for summer months—with extra outreach to see if consumers were interested (Mr. C Tranby 2018, pers.comm., 9 January).

In addition to downstream incentives, we also discussed the feasibility of an upstream incentive for manufacturers. These incentives would be designed to off-set any price premiums for cool walls products. For example, this type of incentive might work well for cool-colored wall products that are formulated with special pigments that often cost more than traditional pigments. Incentives to manufacturers can sometimes be smaller than consumer rebates because the incremental cost for manufacturers to produce the product is less than the cost

premium for consumers to buy the product. There is also precedent for energy efficiency program administrators working with manufacturers to increase the availability of energy-efficiency products in a region, like California. We would need to identify which manufacturers to target.

Lastly, we discussed the idea of including cool walls as one of the upgrades offered in LADWP's direct install program. They have crews that are sent out to income-targeted communities to assess and install free energy efficiency upgrades. The crew could easily assess the existing color of the home and paint the exterior if it is in need of replacement and is a dark color (Mr. C Tranby 2018, pers.comm., 9 January).

For these cool wall incentive options, Tranby will be discussing the ideas with his management. We will also share our cool wall application guidelines with LADWP and highlight the benefits of using cool walls in the LADWP service area climate zones. These resources help justify the incentives, and also inform the type and amount of any incentives that can be offered.

In addition to incentives programs, LADWP offered to help communicate the idea of cool walls to its client base and to other local POUs. For example, LADWP has an active Twitter account that can link to stories or resources on cool walls. Since LADWP is the largest POU in California, other local POUs, like Pasadena Water and Power, often consult LADWP for guidance and direction on energy efficiency programs. Pasadena Water and Power followed LADWP's lead and now offers cool roof rebates (Mr. C Tranby 2018, pers.comm., 9 January).

6.2 Pacific Gas and Electric

We have not yet had an opportunity to connect with PG&E. We continue to reach out to PG&E through our existing network of contacts but have not contacted staff knowledgeable about the rebate program process. We will continue through various means and contacts to learn more about their incentive program process and potential options for cool wall incentives.

7 U.S. EPA ENERGY STAR label

The U.S. Environmental Protection Agency (EPA) ENERGY STAR's label is widely recognized by consumers nationwide. ENERGY STAR labeled products are the same or better than standard products but benefit consumers by using less energy and saving money. Typical ENERGY STAR certified products for appliances, HVAC equipment, lighting, and other product types reduce energy costs by 30% or more (U.S. EPA, 2018b). There have been ENERGY STAR certified roof products since 1999 establishing a precedent for certifying cool building envelope products (Akbari and Levinson 2008).

U.S. EPA has established the following criteria for ENERGY STAR certification (U.S. EPA, 2018c), which we quote here:

- Product categories must contribute significant energy savings nationwide.

- Certified products must deliver the features and performance demanded by consumers, in addition to increased energy efficiency.
- If the certified product costs more than a conventional, less-efficient counterpart, purchasers will recover their investment in increased energy efficiency through utility bill savings, within a reasonable period of time.
- Energy efficiency can be achieved through broadly available, non-proprietary technologies offered by more than one manufacturer.
- Product energy consumption and performance can be measured and verified with testing.
- Labeling would effectively differentiate products and be visible for purchasers.

The specification development cycle for ENERGY STAR certification is illustrated in Figure 3. The first steps are to pull information together about

- Product features & functions (overview of technology)
- Consumer perspectives
- Industry overview and market analysis
- Testing & performance metrics
- Energy efficiency potential
- Energy cost savings & consumer payback
- Related voluntary & regulatory measures
- Related utility incentives, activities, and education programs

This collection of data normally involves various stakeholders but the there is also ample opportunity throughout the specification process to receive feedback during workshops or public comment periods (U.S. EPA, 2018a).

Our project results from Task 2 *Quantify Cooling, Heating, and Lighting Energy Use Savings* reports will help provide the information needed to establish energy efficiency potential and energy cost savings. However, we will need to work with industry stakeholders to conduct a market analysis and to collect consumer perspectives.

We have been in touch with U.S. EPA staff to learn more about the process and the prospects of initiating a new cool wall ENERGY STAR specification. We met with U.S. EPA ENERGYSTAR management in January 2018 to share our findings and to solicit their support. We will share the final project deliverables in February 2018 and host a follow-up call to review in detail the energy-saving benefit calculations.

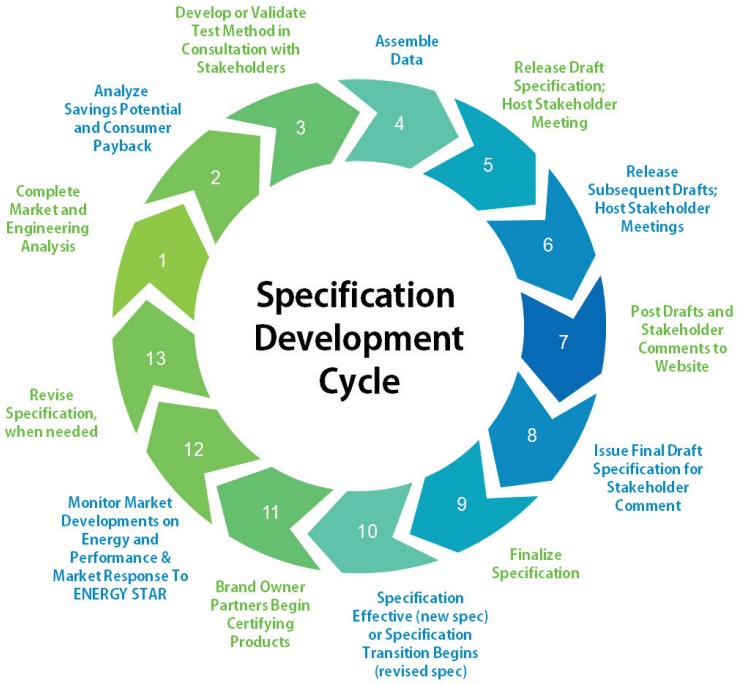

Figure 4. The U.S. EPA ENERGY STAR specification development cycle (U.S. EPA, 2018a).

8 Measures in building energy standards and green building programs

We set out to develop language to introduce and/or improve cool wall measures in building energy codes and standards as well as in green building programs. We investigated ASHRAE 90.1, ASHRAE 189.1, California Title 24, CALGreen, and U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED). We prioritized our efforts to take advantage of the timing of code cycles, build upon current cool wall measures, and focus on California standards and other widely referenced standards and programs.

The activities initiated by the research team will be continued by the Cool Walls Working Group.

8.1 ASHRAE standards

8.1.1 ASHRAE 90.1

There are existing cool wall measures in the 2016 version of ASHRAE 90.1. However, we would like to improve the measures by clarifying the language and extending the measures to U.S. ASHRAE climate zones 1 through 3.

First, we would like to replace specification of Solar Reflectance Index (SRI) by specification of solar reflectance (SR) and thermal emittance (TE). SRI is determined from the summer-afternoon

energy balance of a well-insulated horizontal or low-slope surface, such as a roof. It is not appropriate for a wall because the solar and thermal infrared radiations received by a vertical surface differ from those incident on a horizontal surface. Wall convection coefficients may also differ from those for a roof.

Second, we would like to extend the cool wall measures from ASHRAE climate zone 0, a hot and humid climate not found in the U.S., to ASHRAE climate zones 1 through 3 (Figure 4). We found that there are building energy cost saving benefits that extend through climate zone 4 in our Task 2: *Quantify Cooling, Heating, and Lighting Energy Use Savings* analysis. To initiate these changes, we are fortunate to be in touch with key members of ASHRAE—Martha Van Geem, an independent code consultant, and Rahul Athalye, a research engineer at Pacific Northwest National Laboratory. We have had early conversations with Martha and Rahul to discuss these changes and to share findings from our draft project reports and tools. Martha and Rahul will be drafting revised language to share with the sub-committee chair in January 2018. We will meet with them again to share additional project resources and updates in February 2018.

These changes would be introduced to ASHRAE as amendments to the current (2016) version. An amendment is used to incorporate changes during times outside of the three-year revision cycle. The amendment would still go through two public review periods to solicit comments and would be voted on by ASHRAE for final approval and inclusion.

8.1.2 ASHRAE 189.1

There are existing cool wall measures in ASHRAE 189.1 that could be strengthened and expanded. First, it should specify values of solar reflectance and thermal emittance, rather than SRI. Second, we would like the language to specify that 75% of the east, west, and *south* walls meet the SR requirement. Third, we would like to raise the minimum solar reflectance from about 0.28[1] to 0.40 to increase its environmental benefits.

[1] Under the medium wind speed conditions commonly used to compute SRI, a well-insulated horizontal surface with solar reflectance 0.28 and thermal emittance 0.90 would have an SRI of 29.

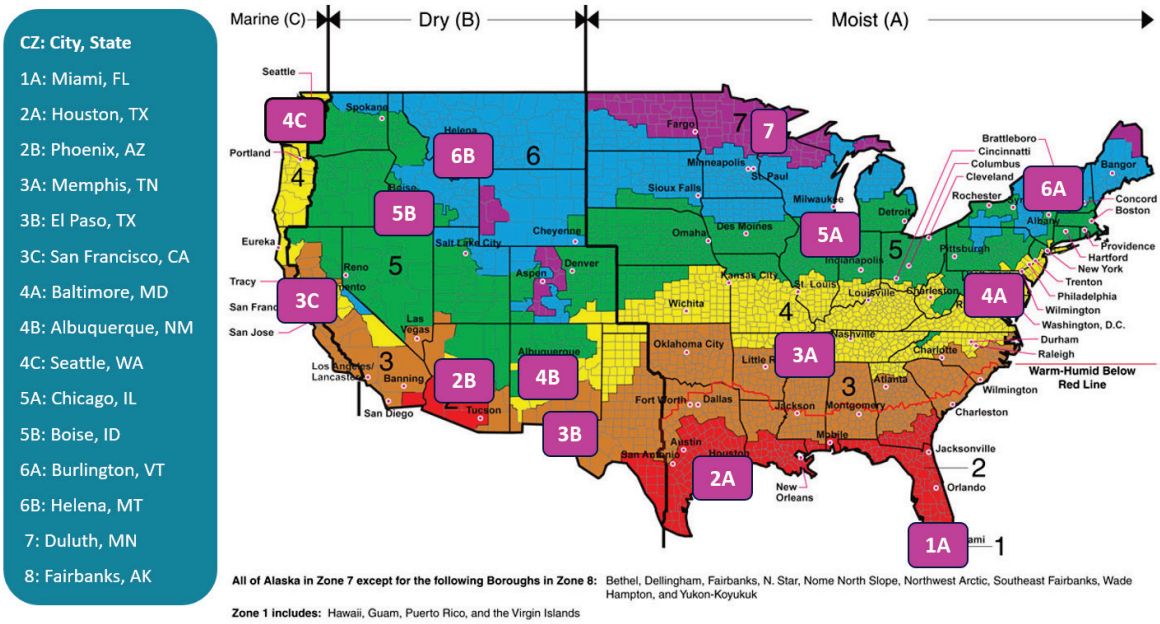

Figure 5. Map of ASHRAE climate zones in the United States, locating representative cities. Adapted from Briggs et al. (2003a,b).

8.2 California Building Energy Efficiency Standards

There are no references to cool walls in the current 2016 California Building Energy Efficiency Standards (Title 24) nor any under consideration for the 2019 update. We are targeting the 2022 edition for inclusion of cool wall measures.

We have been communicating with staff in the California Energy Commission (CEC), Building Standards Office, Efficiency Division—Payam Bozorgchami and Michael Shewmaker—to learn more about the process of including new measures. We have shared our project findings and they agree that cool walls inclusion would be worth further investigation via a Codes and Standards Enhancement (CASE) initiative. The CEC uses a Codes and Standards Enhancement (CASE) process to develop and vet changes to the standards. A CASE initiative for cool walls would build upon the current cool wall research. It would require re-simulating building energy savings with CEC-approved software and completing a market assessment to evaluate the cost-effectiveness of cool walls on residential and non-residential buildings across California climate zones. It would also propose specific language to include in Title 24.

CEC staff will meet with the California IOUs in Winter 2018 to brainstorm a list of potential new measures for 2022 CA T24. The list will be narrowed and several measures will be selected for CASE initiatives. We will work with CEC staff to support the selection of cool walls for a CASE initiative.

8.3 California Green Building Standards

There is an elective voluntary measure for cool walls for nonresidential buildings in the California Green Building Standards (CALGreen). CALGreen is on a triennial code cycle similar to California Title 24. However, unlike CA T24, it features mandatory provisions as well as defines three levels of reach standards that California cities can voluntarily adopt. More than 100 local governments have adopted standards that go beyond the 2013 CALGreen mandatory provisions (Papke, 2015).

Cool roof and cool pavement measures are found in the voluntary Tier 1 and Tier 2 levels that exceed the baseline code. Cool walls are noted in the exterior wall shading measures as a voluntary elective. All three are included as urban heat island countermeasures. Since they are voluntary, they can be adopted by local governments. For example, the City of Los Angeles has adopted a cool roof ordinance that meets the Tier 1 requirement and exceeds the cool roof requirements from CA T24 (City of Los Angeles, 2013).

We would like to see the language improved for the cool wall measure, and included as a provision in Tier 1 and Tier 2. First, we would like to replace specification of Solar Reflectance Index (SRI) by specification of solar reflectance (SR) and thermal emittance (TE) for the reasons identified above. In addition, we would like to see the cool wall measure separated from fenestration measure in the exterior wall shading section. These are both good measures and provide very different benefits to the building occupants and environment. The standard could require both, rather than one or the other. Or, the standard could separate the fenestration and wall requirements into two provisions. We would also like to move the cool wall measure from an "elective" provision to one that is listed in Tier 1 and Tier 2 so it can be easily adopted by local governments. We also would like to increase the SR requirement since these are designed as reach code provisions. Tier 1 requirements could include cool wall products with SR greater than or equal to 0.40 and less than 0.60. Tier 2 could include products with SR greater than or equal to 0.60. These two tiers of SR requirements are described in more detail in the Task 6.1 report: *Cool wall application guidelines*.

We are in contact with California Air Resources Board (CARB) regarding improvements to the cool wall measures in CALGreen since they have led other standard changes. The California Buildings and Standards Commission must accept state agency input on revisions and/or new provisions to CALGreen. However, similar to California Title 24, a report needs to be completed to develop and vet changes to the standards. This analysis is based on broader environmental benefits since CALGreen refers to California Building Energy Efficiency Standards for all energy-related measures (Ms. D Papke 2015, pers.comm., 17 November). Unfortunately, this is a resource-intensive effort so finding funds to invest in a standard change will be challenging. We will be in contact with ARB to present and share our final project deliverables.

8.4 U.S. Green Building Council's Leadership in Energy and

Environmental Design

U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) is the most widely used green building rating system in the world (USGBC, 2018). LEED is available for all building types and is divided into nine measurements to address wide-ranging environmental impacts of building construction and operations. LEED includes a heat island reduction credit under its Sustainable Sites section with measures for roofs and nonroofs (LEED v4, 2016).

Levinson served on LEED's Sustainable Sites (SS) Technical Advisory Group (TAG) from 2013 to 2017. As a member of the SS TAG he was (and still is) consulted on improvements to the heat island reduction credit. He presented an overview of the cool walls project to the SS TAG during the USGBC's *Convergence* meeting held in June 2016, and was invited to develop a cool walls pilot credit. All pilot credit submissions require an application that presents the intent of the credit, provides background information to justify the credit, and lists the applicable rating systems and project phase impacts. Levinson will be working to draft the cool pilot credit for submission in spring/summer 2018.

While there are other codes, standards, and green building programs, like the IECC, International Green Conservation Code (IgCC) and the GBI Green Building Assessment Protocol for Commercial Buildings, we will focus our near-term efforts on those presented here. We hope to reevaluate cool wall prospects in these other codes, standards and programs pending interest and resources from the Working Group.

9 Project results workshop

We hosted our Cool Walls results workshop on 25 October 2017 with 38 in-person and six remote participants from government, utilities, manufacturers and university sectors. The one-day workshop featured 10 presentations and several discussion sections to get feedback from participants on the research and results. The Cool Walls project results workshop proceedings can be found in the Task 6.2 report: *Cool wall workshop proceedings*.

10 Summary

We accomplished our goals this activity. We completed the cool wall application guidelines to provide guidance for their building- and climate-appropriate use to conserve energy and reduce emissions of greenhouse gases and criteria pollutants across California and the United States. We hosted a workshop to share our project results and solicit feedback from key stakeholder. We are in touch with key staff at ENERGY STAR and California utilities to develop cool wall incentives, such as an ENERGY STAR label and consumer rebate program. We are in contact with several building energy standard/code organizations and green building programs to introduce new cool wall measures or improve cool wall measures where they existed previously. This includes efforts to engage with the California Energy Commission and California utilities

to complete a CASE initiative to develop and vet new cool wall specifications for Title 24. Under our guidance, the Cool Roof Rating Council announced the formation of a task group that will prepare a cool walls expansion plan tentatively scheduled for a board-of-directors vote in fall 2018.

There is a need for continued effort and support for cool wall infrastructure after this project concludes so we convened a Cool Walls Working Group comprised of key stakeholders. The Group will build upon the research team efforts to see many of these activities through to completion.

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