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Application of the Cost-effectiveness Study Analyses
to 2022 Energy Ordinances:

Cool Roofs for Nonresidential, Multifamily, and Single Family Buildings



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Acronym List

ASR – Aged Solar Reflectance

C&S – Codes and Standards

CPUC – California Public Utilities Commission

CRRC – Cool Roof Rating Council

PG&E – Pacific Gas & Electric (utility)

SRI – Solar Reflectance Index

Title 24 – California Code of Regulations Title 24, Part 6



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1 Summary

The California Codes and Standards (C&S) Reach Codes program provides technical support to local governments considering adopting a local ordinance (reach code) intended to support meeting local and/or statewide energy efficiency and decarbonization goals. The program facilitates adoption and implementation of the code when requested by local jurisdictions by providing resources such as cost-effectiveness studies, model language, sample findings, and other supporting documentation.

Throughout 2022, the Statewide Reach Codes Team published several studies documenting the costs and benefits of implementing various measures and measure packages in newly constructed and existing buildings, including the impacts of installing cool roofing materials.

Referenced Cost-effectiveness Studies

- New Construction
 - [2022 Code: Nonresidential New Construction Reach Code Cost-effectiveness Study](#)
 - [2022 Cost-Effectiveness Study: Single Family New Construction](#)
- Existing Buildings
 - [2021 Reach Code Cost-Effectiveness Analysis: Non-Residential Alterations](#)
 - [2019 Cost-Effectiveness Study: Existing Single Family Residential Building Upgrades](#)
 - [2019 Cost-Effectiveness Study: Existing Multifamily Residential Building Upgrades](#)

The Statewide CASE Team reviewed the studies for relevancy with respect to an ordinance requiring the installation of cool roofing material that exceeds the 2022 Title 24, Part 6 requirements for new and re-roofing projects. The studies identified cost-effective options for cool roofs in nearly all occupancy types, vintages and climate zones in Los Angeles County (Climate Zones 6, 8, 9, 14, and 16). Although there are fewer options in Climate Zone 16, that climate zone represents a very small proportion of the building stock within the County (less than five percent), and is a heating dominated climate where cool roofs may not be recommended.

1.1 Los Angeles County Ordinance Requirements

The County of Los Angeles is seeking to extend its local energy ordinance requiring cool roofing materials to the 2022 code cycle. The performance requirements specified in the proposed ordinance are shown below, and are identical to the 2019 requirements. There are no changes to the minimum performance specifications. The requirements apply to both low-sloped and steep-sloped roofs for newly constructed and existing buildings. The Energy Code defines a low-sloped roof as a roof with a ratio of rise to run less than 2:12 (9.5 degrees from horizontal), and a steep-sloped roof as one with a ratio of rise to run equal to or greater than 2:12 (9.5 degrees from horizontal).

Newly constructed and qualifying re-roofing projects must install Cool Roof Rating Council (CRRC) rated roofing materials. Projects must either meet the minimum Aged Solar Reflectance (ASR) and Thermal Emittance (TE) requirements or the minimum Solar Reflective Index (SRI).

Table 1: Los Angeles County Cool Roof Ordinance Requirements

2022 Cool Roof Ordinance Minimum Performance Requirements				
	Roof Type / Slope	3-year Aged Solar Reflectance	Thermal Emittance	SRI
Nonresidential	≤2:12	0.68	0.85	82
	>2:12	0.28	0.85	27
High-rise Residential, Hotel/Motel	≤2:12	0.65	0.75	78
	>2:12	0.25	0.75	20
Residential	≤2:12	0.65	0.85	78
	>2:12	0.25	0.85	20

1.2 Study Methodology and Assumptions

The Statewide CASE Team reviewed the studies for relevancy with respect to an ordinance requiring the installation of cool roofing material that exceeds the 2022 Title 24, Part 6 requirements for new and re-roofing projects. Measures in the new construction measure packages are cost-effective individually and contribute to the overall improvement in cost-effectiveness of the efficiency package results.

- New Construction

Nonresidential: The 2022 study analyzed the measure for low-sloped medium office projects. As steep-sloped roofs are uncommon for projects of this size, the analysis did not include a steep-sloped option. The cool roof measure in the study requires a higher Aged SR value (0.70) than the ordinance (0.68). The team concluded that it is reasonable to assume a lower ASR value will also be cost-effective where the higher value is also cost-effective.

Multifamily Residential: The Reach Codes team anticipates publishing the 2022 study in Q1, 2023.

Single Family: The 2022 study analyzed the measure for steep-sloped single family homes, but did not include an analysis of the impacts of low-sloped roofs.

- Existing Buildings

Nonresidential: The NR alterations study analyzed the measure for low-sloped and steep-sloped projects, including offices, retail, and two types of restaurants, quick-service and full-service. The values assumed in the study are slightly lower than the ordinance requirements.

Low-Sloped: The study assumed an ASR value of 0.63, which is lower than the ordinance (0.68). After review, the team concluded that given improvements in envelope efficiency requirements, the results from the new construction analysis are conservative relative to the impacts for existing buildings. Given this, the new construction analysis results reasonably reflect measure performance and economic impacts for existing buildings also.

Steep-Sloped: The study assumed an ASR equal to 0.25, lower than the ordinance (0.28). Despite this difference, there are CRRC-certified products with an ASR equal to 0.25 that meet the minimum SRI requirements in the ordinance.

High-Rise Multifamily Residential:

Low-Sloped: The study assumed an ASR value of 0.63, which is slightly lower than the ordinance requires (0.65). The team does not believe the incremental cost, if any, to improve the ASR from 0.63 to 0.65 is significant enough to materially alter the results. After review, the team concludes that given improvements in envelope efficiency requirements, the results from the new construction analysis are conservative relative to the impacts for existing buildings. Given this, the new construction analysis results reasonably reflect measure performance and economic impacts for existing buildings also.

Steep-Sloped: The study analyzed the measure for low-slope high-rise multifamily buildings but did not include an analysis of the impacts of steep-sloped roofs, an uncommon design in high-rise multifamily buildings.

Single Family and Low-rise Multifamily:

Low-Sloped: The 2022 study did not include an analysis of the impacts of low-sloped roofs.

Steep-Sloped: The study assumed an ASR value of 0.25, identical to the minimum ordinance requirement.

1.3 Cost-Effectiveness Results

The referenced statewide cost-effectiveness studies identified cost-effective results for all occupancy types, across most building vintages and climate zones. The objective of the statewide analyses is to identify and document the estimated costs, benefits, energy impacts and greenhouse gas emission reductions that may result from implementing an ordinance to help local leadership, residents, and other stakeholders make informed policy decisions. The studies were conducted to complement the 2022 Building Energy Efficiency Standards (Title 24, Part 6), effective January 1, 2023 (California Energy Commission, 2022).

Below is a summary of the cool roof analysis results for residential and nonresidential buildings in the five climate zones within unincorporated Los Angeles County.

- New Construction:

Nonresidential: The analysis identified a cost-effective option for the medium office occupancy. The measure was not applied to other occupancies.

Multifamily: The team anticipates completing an analysis (low- and high-rise) in the first quarter of 2023.

Single Family: The study analyzed the cool roof measure for steep-sloped roofs within a package of efficiency measures but did not evaluate it individually. The measure was not applied to low-sloped roofs.

- Existing Buildings

Nonresidential: The analysis identified cost-effective options for nearly all occupancies and vintages with exceptions in the oldest vintage in Climate Zones 6 and 9, and several cases in Climate Zone 16.

High-rise Multifamily and Hotel/Motels: The analysis identified cost-effective options for nearly all occupancies and vintages with exception of Climate Zone 16 and one scenario in Climate Zone 14.

Low-rise Multifamily: The analysis identified cost-effective options for nearly all occupancies and vintages with exception of the newest vintage in Climate Zones 6 and 16.

Single Family and Low-rise Residential: The analysis identified cost-effective options for nearly all occupancies and vintages with exception of the newest vintage in Climate Zone 6 and the two newer vintages in Climate Zone 16.

Table 2 below documents the results for the five climate zones within Los Angeles County.

The result **Both** (shown in green shading) indicates that the result is cost-effective under both the On-Bill and TDV metrics. The result **TDV** or **On-bill** (shown in yellow shading) indicates that the result is either cost-effective On-Bill or TDV, respectively. The result -- (results with no shading) indicates that the result is cost-effective neither On-Bill or TDV.

The referenced existing building studies analyzed installing a cool roof at the time of roof replacement as an individual measure; thus more detailed results are available for existing buildings, documented in Table 2 below.

Table 2: Summary of Existing Building Cool Roof Cost-Effectiveness Results

Sector	Occupancy	Vintage	Climate Zone				
			6	8	9	14	16
Nonresidential	Office	1980s	--	TDV	--	Both	Both
		1990s	Both	Both	Both	Both	Both
		2000s	Both	Both	Both	Both	Both
	Retail	1980s	Both	Both	Both	Both	--
		1990s	Both	Both	Both	Both	--
		2000s	Both	Both	Both	Both	--
	QSR	1980s	Both	Both	Both	Both	Both
		1990s	Both	Both	Both	Both	Both
		2000s	Both	Both	Both	Both	On-bill
	FSR	1980s	Both	Both	Both	Both	Both
		1990s	Both	Both	Both	Both	TDV
		2000s	Both	Both	Both	Both	On-bill
Hotel/Motel and High-rise Multifamily	Hotel	1980s	Both	Both	Both	Both	--
		1990s	Both	Both	Both	Both	--
		2000s	--	Both	Both	Both	--
	High-rise Res	1980s	Both	Both	Both	Both	--
		1990s	Both	Both	Both	--	--
		2000s	Both	Both	Both	Both	--
Low-rise Residential (steep-sloped only)	Low-rise Multifamily	Pre-1978	Both	Both	Both	Both	On-bill
		1978-1991	Both	Both	Both	Both	On-bill
		1992-2010	--	Both	Both	Both	
	Single Family	Pre-1978	Both	Both	Both	Both	On-bill
		1978-1991	Both	Both	Both	Both	--
		1992-2010	--	Both	Both	Both	--

The referenced cost-effectiveness reports, model ordinance language and other resources are posted on the C&S Reach Codes Program website at LocalEnergyCodes.com. Local jurisdictions that are considering adopting an ordinance may contact the program for further technical support at info@localenergycodes.com.

2 References

California Energy Commission. (2022, Feb). *2022 Building Energy Efficiency Standards for Residential and Nonresidential Buildings*. CEC-400-2022-010-CMF. Retrieved from https://www.energy.ca.gov/sites/default/files/2022-08/CEC-400-2022-010_CMF.pdf

Get In Touch

The adoption of reach codes can differentiate jurisdictions as energy efficiency and built environment decarbonization leaders and help accelerate the adoption of new equipment, technologies, code compliance, and energy savings strategies.

As part of the Statewide Codes & Standards Program, the Reach Codes Subprogram is a resource available to any local jurisdiction located throughout the state of California.

Our experts develop robust toolkits as well as provide specific technical assistance to local jurisdictions (cities and counties) considering adopting energy reach codes. These include cost-effectiveness research and analysis, model ordinance language and other code development and implementation tools, and specific technical assistance throughout the code adoption process.

If you are interested in finding out more about local energy reach codes, the Reach Codes Team stands ready to assist jurisdictions at any stage in the process.



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