2013 Building Energy Efficiency Standards Staff Workshop

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for the
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Nonresidential Cool Roof Proposal

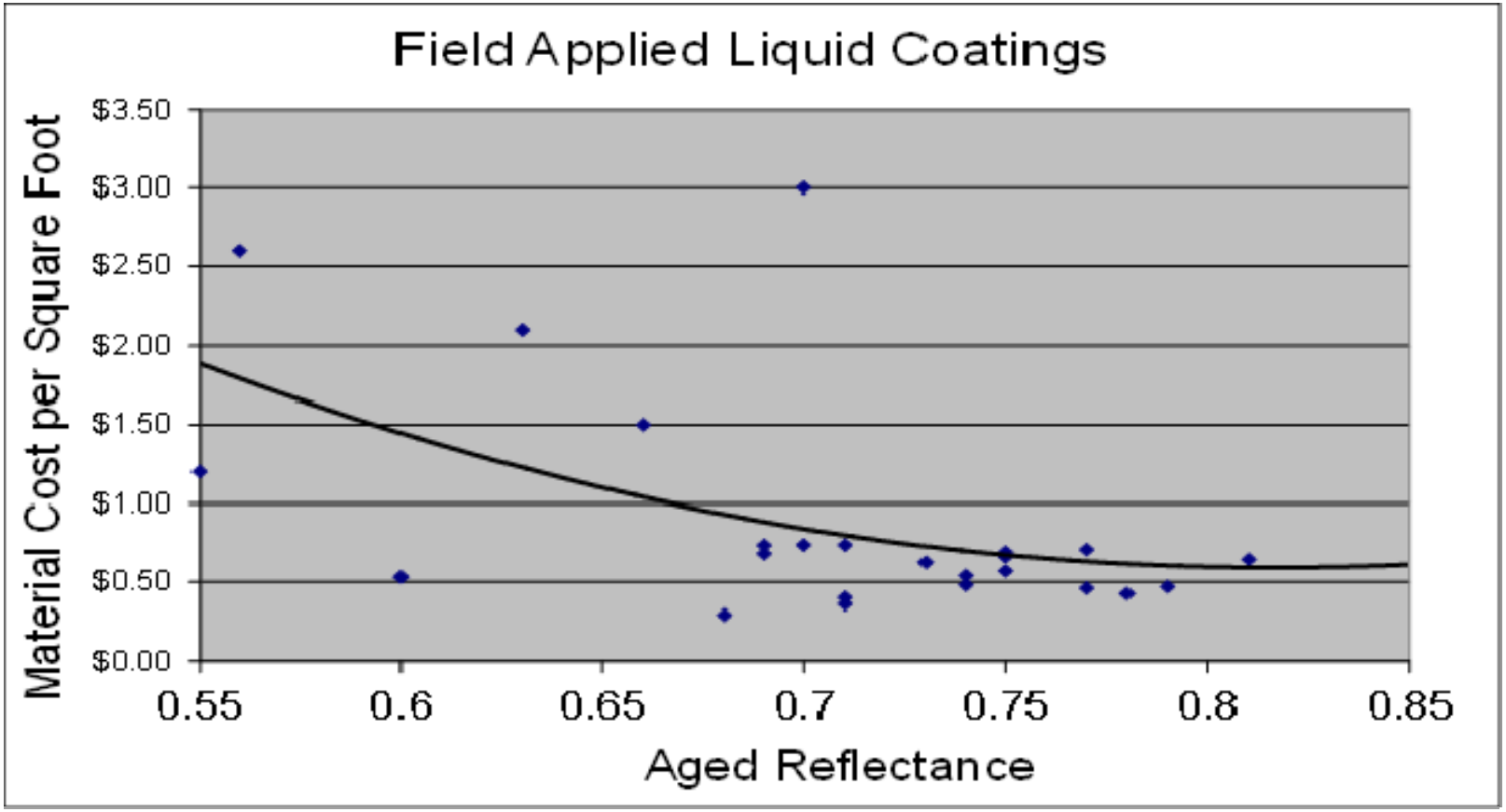
Prescriptive	R_{aged} ≥	Climate Zones
Low-Sloped		
Standard	0.70	1-16
High-rise Res	0.70	2-15
Steep-Sloped		
Standard	0.24	1-16
High-rise res	0.24	2-15
Research conducted on behalf of California's Independently Owned Utilities		

Mandatory Minimums	R_{aged} ≥	Climate Zones
Low-sloped		
Standard	0.55	1-16
High-Rise Res	0.55	2-15
Code change proposal developed by the California Energy Commission		

Prescriptive Rationale

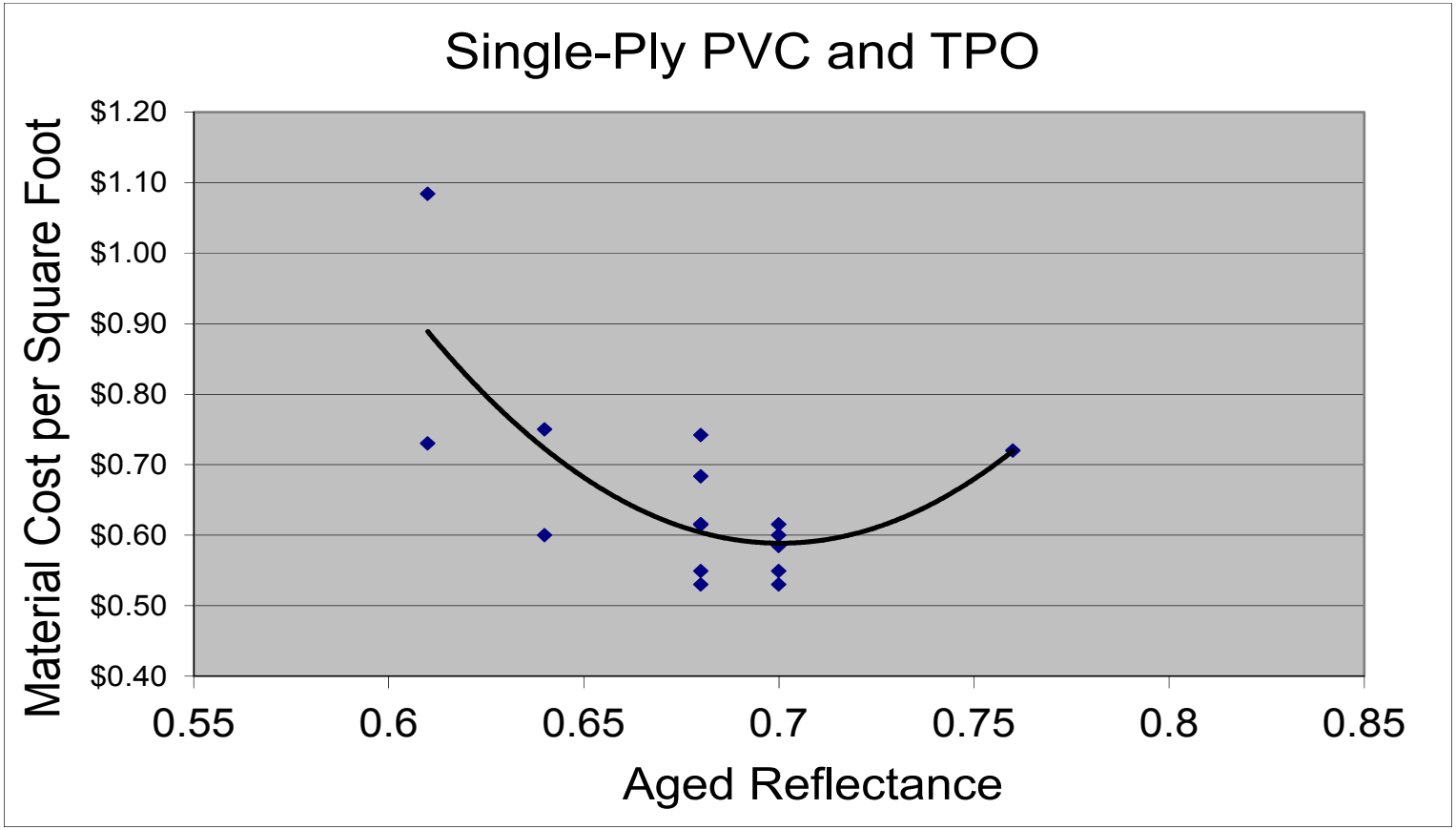
- Why move to an $R_{aged} \geq 0.70$ Standard?
  - For climate zones currently at $R_{aged} \geq 0.55$, no additional cost
  - Significant energy savings
  - Enough energy savings to offset costs in most climate zones without a reflectance standard at this time
  - Excellent product availability at $R_{aged} \geq 0.70$

Costs - Moving from $R_{aged} = 0.55$



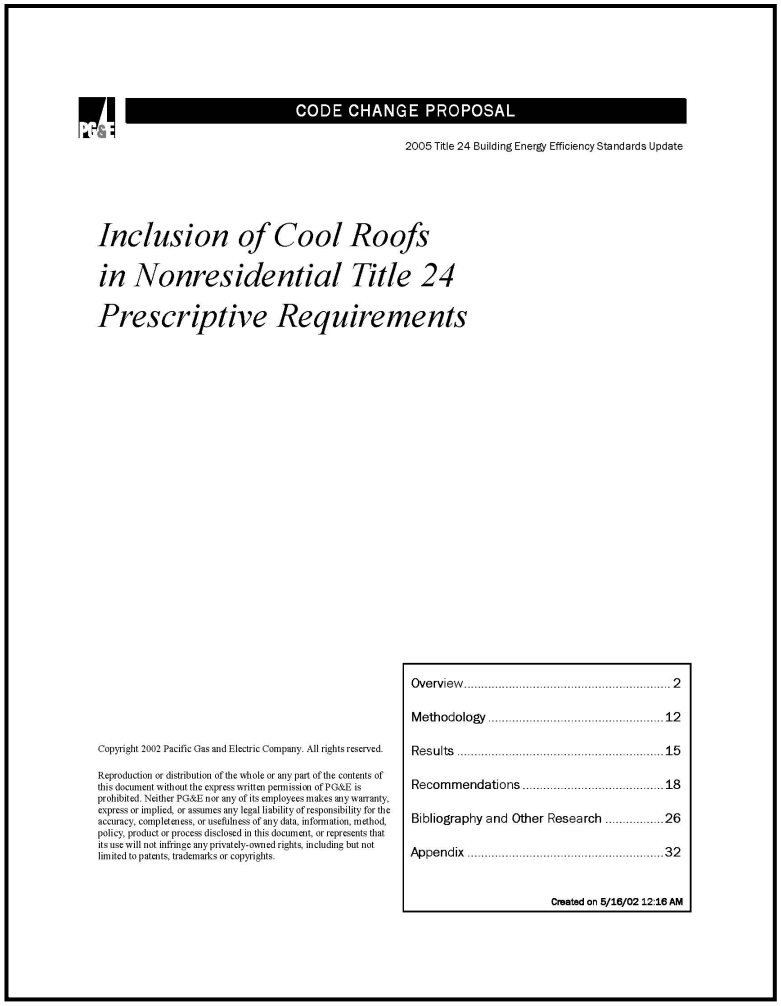
Source: Distributors and retailers serving California

Costs - Moving from $R_{aged} = 0.55$



Source: Distributors and retailers serving California

Costs – Moving from No Standard



CODE CHANGE PROPOSAL

2005 Title 24 Building Energy Efficiency Standards Update

Inclusion of Cool Roofs in Nonresidential Title 24 Prescriptive Requirements

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- 2002 LBNL study establishing the original reflectance standard for Title 24 2005
- Standard set at:

$$R_{initial} \geq 0.70$$

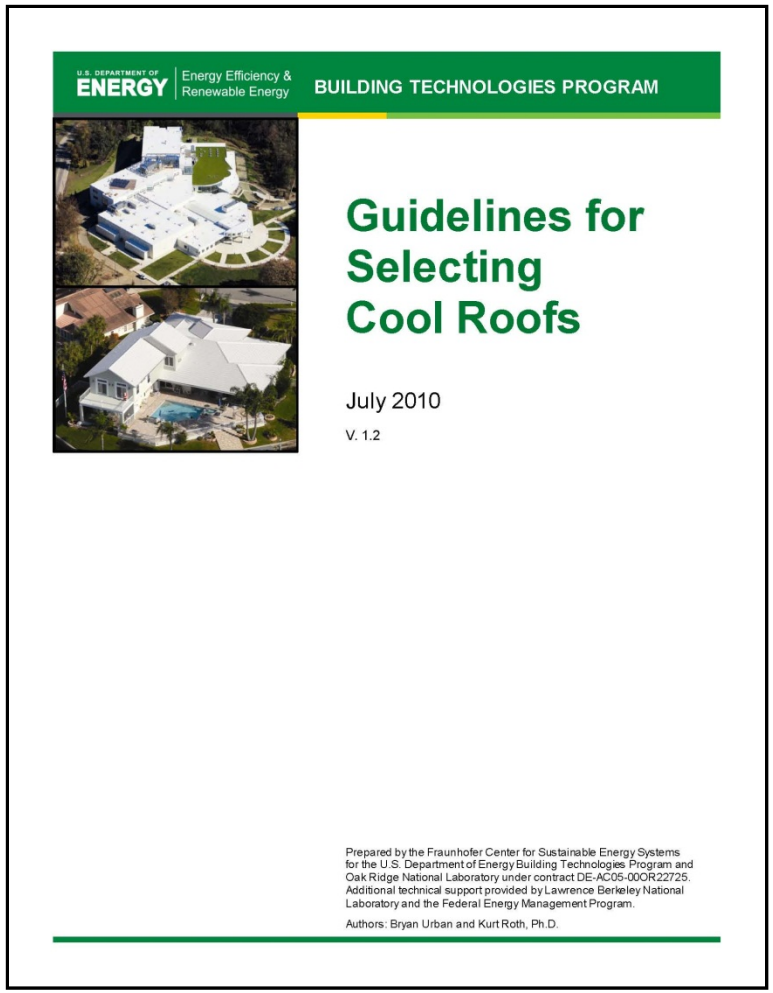
Climate Zones 1-16

Costs – Moving from No Standard

Table 4. Cost premiums for cool varieties of common low-sloped roofing products.

Roofing Product	Cool Variety	Cost Premium ($/ft²)
ballasted BUR	use white gravel	up to 0.05
BUR with smooth asphalt coating	use cementitious or other white coatings	0.10 to 0.20
BUR with aluminum coating	use cementitious or other white coatings	0.10 to 0.20
single-ply membrane (EPDM, TPO, CSPE, PVC)	choose a white color	0.00 to 0.05
modified bitumen (SBS, APP)	use a white coating over the mineral surface	up to 0.05
metal roofing (both painted and unpainted)	use a white or cool color paint	0.00 to 0.05
roof coatings (dark color, asphalt base)	use a white or cool color coating	0.00 to 0.10
concrete tile	use a white or cool color	0.00 to 0.05
cement tile (unpainted)	use a white or cool color	0.05
red clay tile	use cool red tiles	0.10

Costs – Moving from No Standard



- 2010 DOE Study on Cool Roof options

Costs – Moving from No Standard

Table 5: Roof Surfaces, Cool Alternatives, and Approximate Price Premiums*

Roof	Typical Non-Cool Surface	Cool Alternative	Price Premium ($/ft^2)
Built-Up Roof	Mineral aggregate embedded in flood coat	Light-colored aggregate, like marble chips, gray slag	0.00
	Asphaltic emulsion	Field applied coating on top of emulsion	0.80-1.50
	Mineral surfaced cap sheet	White mineral granules	0.50
Metal[§]	Unpainted metal	May already be cool	0.00
		Factory applied white paint	0.20
	Painted metal	Cool-colored paint	0.00-1.00+
Modified Bitumen	Mineral surfaced cap sheet	Factory applied coating, white mineral granules	0.50
	Gravel surface in bitumen	Light colored gravel	0.00
	Metallic foil	May already be cool	0.00
		Field applied coating	0.80-1.50
	Asphalt coating	Field applied coating on top of asphaltic coating	0.80-1.50
Shingles[§]	Mineral granules	White granules	0.00
		Cool-colored granules	0.35-0.75
Sprayed Polyurethane Foam	Liquid applied coating	Most coatings are already cool to protect the foam	0.00
	Aggregate	Light colored aggregate	0.00
Thermoplastic Membranes	White, colored, or dark surface	Choose a white or light colored surface	0.00
Thermoset Membranes	Dark membrane, not ballasted (adhered or mechanically attached)	Cool EPDM formulation	0.10-0.15
		Factory cool ply or coating on dark EPDM	0.50
Tiles[§]	Non-reflective colors	Clay, slate: naturally cool	0.00
		Cool colored coatings	0.00

*Premiums are the extra cost, per square foot of roof area, of installing the cool roof option as compared with the corresponding non-cool option. Premiums are based on achieving the minimum cool roof characteristics described in Table 1. Values are approximate, and are based on discussions with roofing contractors, manufacturers, wholesalers, and RSMeans cost data.
[§]These roofs may be used in steep slope applications where cool roof requirements are less stringent. Uncoated metal roofs normally meet requirements for steep slope, but not for low slope. Premiums for shingles & tiles are based on steep slope requirements. All other premiums are based on low slope requirements.

Costs – Moving from No Standard

07 54 Thermoplastic Membrane Roofing

07 54 19 – Polyvinyl-Chloride Roofing

07 54 19.10 Polyvinyl-Chloride Roofing (P.V.C.)

0010	**POLYVINYL-CHLORIDE ROOFING (P.V.C.)**									
8200	Heat welded seams									
8700	Reinforced, 48 mils, 0.33 P.S.F.									
8750	Loose-laid & ballasted with stone/gravel (12 P.S.F.)	G-5	51	.784	Sq.	97	25	3.69	125.69	153
8800	Mechanically attached		35	1.143		90	36.50	5.40	131.90	166
8850	Fully adhered with adhesive		26	1.538		118	49.50	7.25	174.75	220
8860	Reinforced, 60 mils, .40 P.S.F.									
8870	Loose-laid & ballasted with stone/gravel (12 P.S.F.)	G-5	51	.784	Sq.	96.50	25	3.69	125.19	152
8880	Mechanically attached		35	1.143		89.50	36.50	5.40	131.40	165
8890	Fully adhered with adhesive		26	1.538		118	49.50	7.25	174.75	219

07 54 23 – Thermoplastic Polyolefin Roofing

07 54 23.10 Thermoplastic Polyolefin Roofing (T.P.O)

0010	**THERMOPLASTIC POLYOLEFIN ROOFING (T.P.O.)**									
0100	45 mils, loose laid & ballasted with stone(1/2 ton/sq.)	G-5	51	.784	Sq.	90.50	25	3.69	119.19	146
0120	Fully adhered		25	1.600		80.50	51.50	7.55	139.55	182
0140	Mechanically attached		34	1.176		80	38	5.55	123.55	157
0160	Self adhered		35	1.143		88	36.50	5.40	129.90	164
0180	60 mil membrane, heat welded seams, ballasted		50	.800		107	25.50	3.77	136.27	165
0200	Fully adhered		25	1.600		96	51.50	7.55	155.05	200
0220	Mechanically attached		34	1.176		99	38	5.55	142.55	178
0240	Self adhered		35	1.143		109	36.50	5.40	150.90	187

Source: RS Means, *Building Construction Cost Data*, 2010

Costs – Moving from No Standard

07 51 13 – Built-Up Asphalt Roofing

	07 51 13.20 Built-Up Roofing Systems	Crew	Daily Output	Labor-Hours	Unit	2010 Bare Costs Material	Labor	Equipment	Total	Total Incl O&P
1100	4 plies glass fiber felt (type IV), mopped	G-1	20	2.800	Sq.	135	92.50	24	251.50	330
1150	On nailable decks		19	2.947		121	97.50	25	243.50	325
1200	Coated & saturated base sheet, 3 plies #15 asph. felt, mopped		20	2.800		104	92.50	24	220.50	294
1250	On nailable decks		19	2.947		96.50	97.50	25	219	296
1300	4 plies #15 asphalt felt, mopped		22	2.545		121	84	21.50	226.50	297
2000	Asphalt flood coat, smooth surface									
2200	Asphalt base sheet & 3 plies #15 asphalt felt, mopped	G-1	24	2.333	Sq.	100	77	19.85	196.85	260
2400	On nailable decks		23	2.435		92.50	80.50	20.50	193.50	259
2600	4 plies #15 asphalt felt, mopped		24	2.333		117	77	19.85	213.85	279
2700	On nailable decks		23	2.435		110	80.50	20.50	211	278
2900	Coated glass fiber base sheet, mopped, and 2 plies of									
2910	glass fiber felt (type IV)	G-1	25	2.240	Sq.	86.50	74	19.05	179.55	239
3100	On nailable decks		24	2.333		81	77	19.85	177.85	240
3200	3 plies, mopped		23	2.435		104	80.50	20.50	205	272
3300	On nailable decks		22	2.545		97.50	84	21.50	203	271
3800	4 plies glass fiber felt (type IV), mopped		23	2.435		123	80.50	20.50	224	292
3900	On nailable decks		22	2.545		116	84	21.50	221.50	291
4000	Coated & saturated base sheet, 3 plies #15 asph. felt, mopped		24	2.333		98.50	77	19.85	195.35	258
4200	On nailable decks		23	2.435		91.50	80.50	20.50	192.50	257
4300	4 plies #15 organic felt, mopped		22	2.545		116	84	21.50	221.50	291
4500	Coal tar pitch with gravel/slag surfacing									
4600	4 plies #15 tarred felt, mopped	G-1	21	2.667	Sq.	183	88	22.50	293.50	375
4800	3 plies glass fiber felt (type IV), mopped	"	19	2.947	"	150	97.50	25	272.50	355
5000	Coated glass fiber base sheet, and 2 plies of									
5010	glass fiber felt, (type IV), mopped	G-1	19	2.947	Sq.	148	97.50	25	270.50	355
5300	On nailable decks		18	3.111		130	103	26.50	259.50	345
5600	4 plies glass fiber felt (type IV), mopped		21	2.667		206	88	22.50	316.50	400
5800	On nailable decks		20	2.800		188	92.50	24	304.50	385

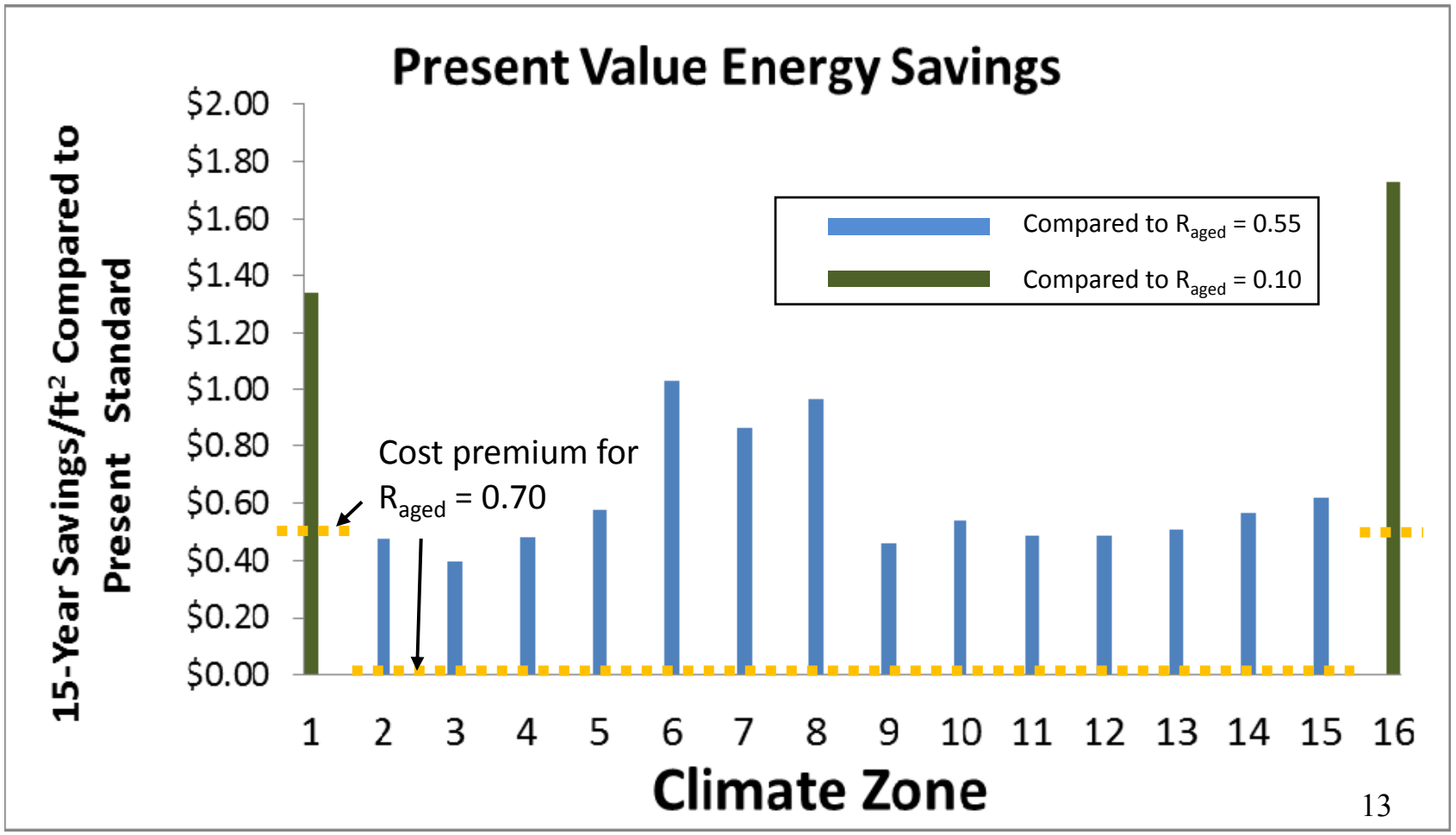
Source: RS Means, *Building Construction Cost Data*, 2010

Costs – Moving from No Standard

- RS Means:
  - Built-up roofing ≈ $2.60/ft^2
  - Single-ply membrane ≈ $1.75/ft^2
  - Suggests cost savings in moving to a cool roof even without energy benefits
- Cost Premium from No Standard to R_{aged} = 0.70

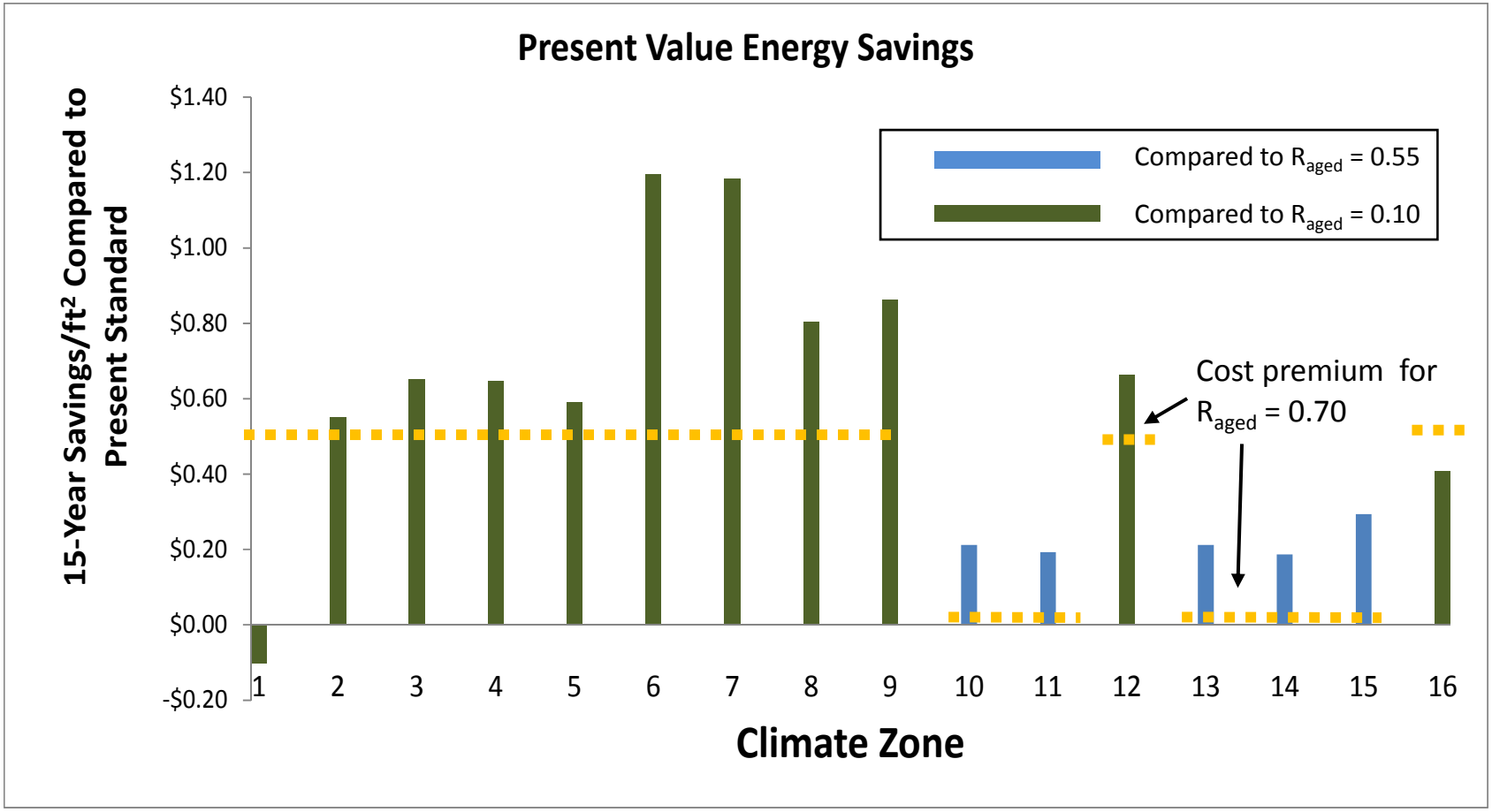
Conservative estimate of $0.50/ft$_2$

Energy Benefits - Moving to $R_{aged} = 0.70$



Energy Benefits - Moving to R_{aged} = 0.70

Nonresidential High-Rise, Hotel, Motel



Cool Roof Availability

	Average R_{aged} of products with $R_{aged} \geq 0.55$	Products with $R_{aged} \geq 0.70$	Products with $R_{aged} \geq 0.55$
Field-applied coatings	0.70	134	of 248
Single-ply Thermoplastics	0.67	22	of 57

Source: CRRC website

Code Change Proposal

Proposed Revisions to Table 143-A and Table 143-B

- Low-sloped roofs

Climate Zone:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
143-A Nonres	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
143-B High-Rise	NR	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	NR

Steep-sloped nonresidential roofs will derive a new reflectance standard based on the residential CASE research:

- $R_{aged} = 0.24$
- Table 143-A, Climate Zones 1-16

Code Change Proposal - New Construction

- Section 143(a)1.a.i: "Nonresidential buildings with low-sloped roofs ~~in climate zones 2-15~~ shall have a minimum 3-year aged solar reflectance of ~~0.55~~ 0.70 and a minimum thermal emittance of 0.75, or a minimum aged SRI of ~~64~~ 85."
- Section 143(a)1.a.iii: "High-rise residential buildings and hotels and motels with low-sloped roofs in climate zones ~~10, 11, 13,14, and 15~~ 2-15shall have a minimum 3-year aged solar reflectance of ~~0.55~~ 0.70 and a minimum thermal emittance of 0.75, or a minimum aged SRI of ~~64~~ 85."

Code Change Proposal - Alterations

- Section 149(b)1.B.i: "Nonresidential buildings with low-sloped roofs ~~in climate zones 2-15~~ shall have a minimum aged solar reflectance of ~~0.55~~ 0.70 and a minimum thermal emittance of 0.75, or a minimum SRI of ~~64~~ 85."
- Section 149(b)1.B.iii: "High-rise residential buildings and hotels and motels with low-sloped roofs in climate zones ~~10, 11, 13,14, and 15~~ 2-15 shall have a minimum aged solar reflectance of ~~0.55~~ 0.70 and a minimum thermal emittance of 0.75, or a minimum SRI of ~~64~~ 85."

Cool Roof Exceptions

- No proposed changes to Section 143(a) exceptions
- A roof with 25 lbs/ft^2 of thermal mass will be deemed equivalent to $R_{aged} = 0.70$ just as it was deemed equivalent $R_{aged} = 0.55$

NR Cool Roof Mandatory Minimums

NR Cool Roof Mandatory Minimums

- The Energy Commission would like to see cool roofs of at least $R_{aged} = 0.55$ become standard practice
- Proven cost effectiveness

NR Cool Roof Mandatory Minimums

- No trade-offs below $R_{aged} = 0.55$
- Simplifies enforcement for building officials
  - If it is a low-sloped roof, it will need a light roof in the applicable climate zones
  - Climate zones 1-16 for standard nonresidential construction
  - Climate zones 2-15 for high-rise residential, hotel, motel, constuction

NR Cool Roofs for Unconditioned Buildings

Cool Roofs for Unconditioned Buildings

- We are investigating the environmental and associated economic benefits of cool roofs on unconditioned buildings based on “negative radiative forcing”
- Light color roofs bounce energy back into space, reducing global warming
- Based on research at the Lawrence Berkeley National Labs and the California Air Resources Control Board

Cool Roofs for Unconditioned Buildings

- The reduction in heating through negative radiative forcing can be compared to reducing a given amount of carbon emissions
- Any measures associated with this research will likely be included in the Reach Code
  - Reach Code places a higher priority on reducing global warming than the Base Code

Nonresidential Cool Roof Standards

- Questions?
- Comments?

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