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Energy Efficiency Credits
An Expansion of C406

REID HART, PE, PACIFIC NORTHWEST NATIONAL LABORATORY

Thanks to: James McNeill, Matt Tyler, Michael Myer, Doug Maddox, Jeremy Lerond, Michael Tillou, Ellen Franconi, Mike Rosenberg, The Energy Credits working group and many others

May 11th, 2022; IECC Modeling Subcommittee
PNNL-SA-169566

U.S. DEPARTMENT OF ENERGY

Formats being used or being contemplated for energy codes…

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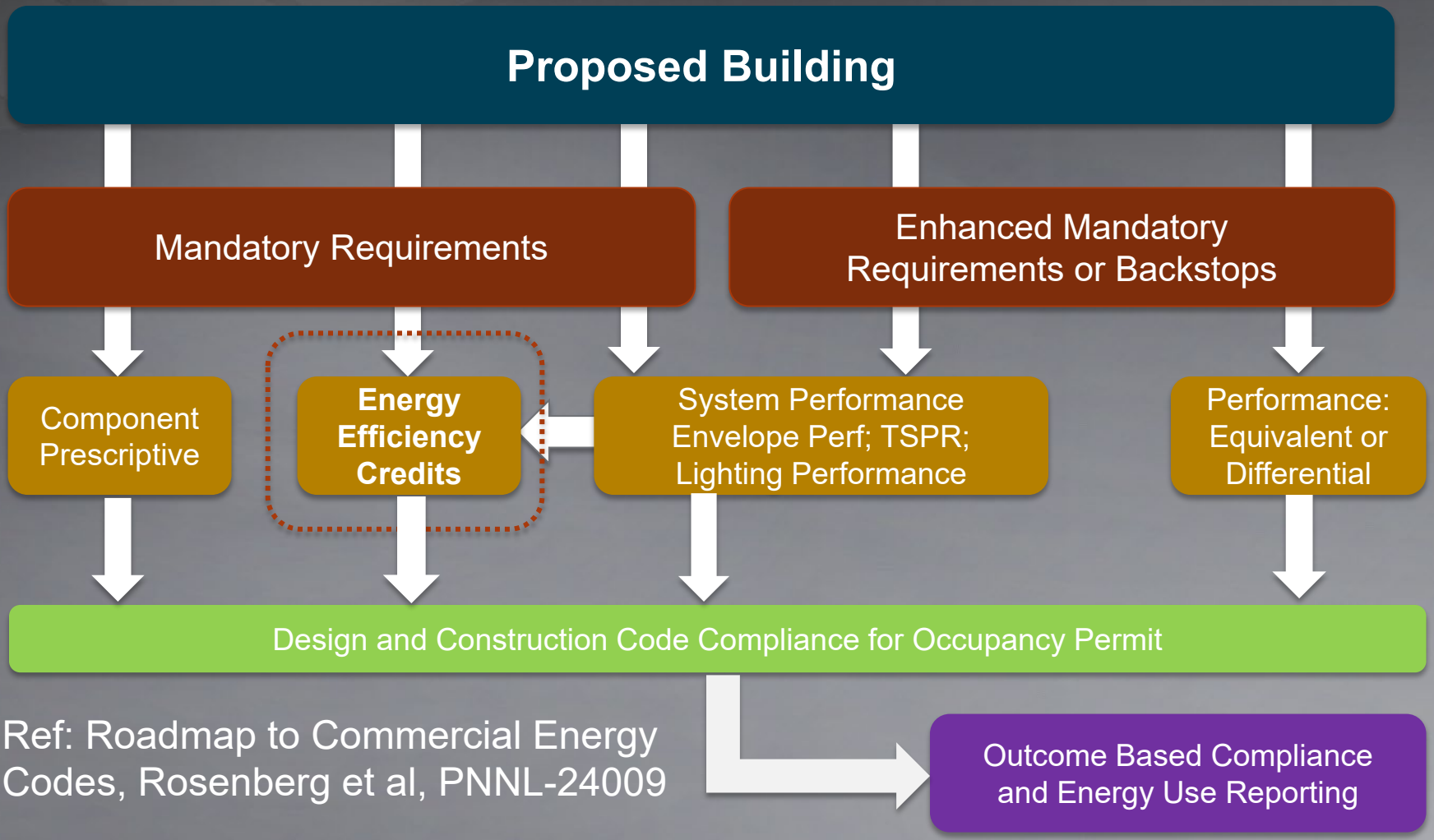

Ref: Roadmap to Commercial Energy Codes, Rosenberg et al, PNNL-24009

CEPI-193; How does C406 change

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2021 IECC

- 16 energy efficiency measures
- Fixed requirement all building occupancies
  - 10 credits (0.25%@)
  - ~2.5% of building energy cost
- 50% credits for build outs
- No alteration or addition
- Applies greater than 500 sf

- Renewable included
- No Load Management

2024 IECC

- 31 energy efficiency measures
- Custom requirement by building occupancy and climate zone
  - 30 to 90 credits (0.1%@)
  - ~6.8% of building energy use
- 83% for core/shell & build outs
- No alteration or addition
- Applies greater than 2000 sf
  - 1000 sf for build-outs
- Renewable & Load Management:
  - Separate requirement > 5000 sf
  - 7 new LM measures
  - Credits based on TOU cost

Benefits of "Energy Efficiency Credits"

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- Credit measures can offer more flexibility
  - Do not need to apply to most buildings
  - Niche oriented savings opportunities can be included
  - Does not require a custom performance analysis
  - Provides flexibility of choice to each project
- Can mix options to achieve a target savings
- Can include choices that are not generally cost effective
- Deal with large-saving strategies that may not be appropriate for all buildings
- Lays groundwork for future performance tradeoffs and target for smaller simple buildings

From 16 efficiency measures in 2021 IECC to 31 efficiency measures for 2024

Table 2: Energy Efficiency Credit Measures compared to 2021 IECC

ID	New C406	Measure Name	2021 IECC	Compare to 2021
E01	C406.2.1.1	Envelope performance (90.1 Appendix C basis)		New
E02	C406.2.1.2	UA reduction (15%)	C406.8	Same
E03	C406.2.1.3	Envelope leakage reduction	C406.9	Same
E04	C406.2.1.4	Add Roof Insulation	C406.8 sim	New
E05	C406.2.1.5	Add Wall Insulation	C406.8 sim	New
E06	C406.2.1.6	Improve Fenestration	C406.8 sim	New
H01	C406.2.2.1	HVAC performance (TSPR)		New
H02	C406.2.2.2	Heating efficiency	C406.2.1	Expanded
	in above	5-20% Heat efficiency by formula	C406.2.3	in H02
H03	C406.2.2.3	Cooling efficiency	C406.2.2	Expanded
	in above	5-20% Cool efficiency by formula	C406.2.4	in H03
H04	C406.2.2.4	Residential HVAC control		New
H05	C406.2.2.5	DOAS/fan control	C406.6	Modified
W01	C406.2.3.1 a	SHW preheat recovery	C406.7.2	Same
W02	C406.2.3.1 b	Heat pump water heater	C406.7.4	Modified
W03	C406.2.3.1 c	Efficient gas water heater	C406.7.3	Same
W04	C406.2.3.2	SHW pipe insulation		New

From 16 efficiency measures in 2021 IECC to 32 efficiency measures for 2024

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ID	New C406	Measure Name	2021 IECC	Compare to 2021
W05	C406.2.3.3 a	Point of use water heaters		New
W06	C406.2.3.3 b	Thermostatic balancing valves		New
W07	C406.2.3.3 c	SHW heat trace system		New
W08	C406.2.3.4	SHW submeters		New
W09	C406.2.3.5	SHW distribution sizing		New
W10	C406.2.3.6	SHW shower drain heat recovery		New
P01	C406.2.4	Energy monitoring	C406.10	Same
L01	C406.2.5.1	Lighting performance		*Future*
L02	C406.2.5.2	Lighting dimming & tuning	C406.4	Expanded
L03	C406.2.5.3	Increase occupancy sensor		New
L04	C406.2.5.4	Increase daylight area		New
L05	C406.2.5.5	Residential light control		New
L06	C406.2.5.6	Lighting power reduction	C406.3.1	Expanded
	in above	*20% LPA reduction*	C406.3.2	in L06
	in above	Residential lamp efficacy	C406.3.3	in L06
Q01	C406.2.7.1	Efficient elevators		New
Q02	C406.2.7.2	Efficient commercial kitchen equipment	C406.12	Same
Q03	C406.2.7.3	Efficient residential kitchen equipment		New
Q04	C406.2.7.4	Fault detection and diagnosis (FDD)	C406.11	Same

Determined that climate zone matters

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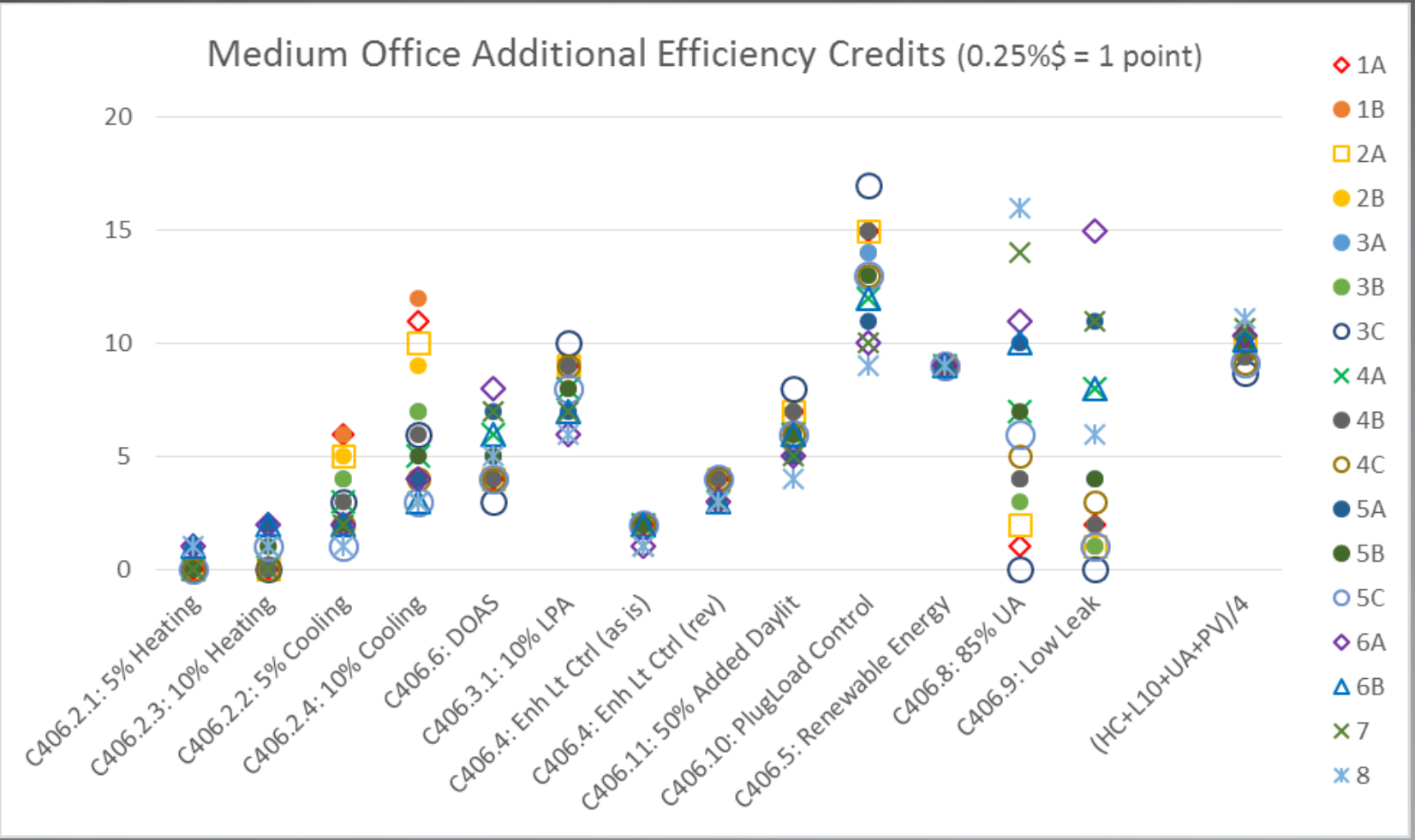
- Medium Office across climate zones (prior analysis):



Energy Credit Requirements Table

Table C406.1.1 Energy Credit Requirements by Building Occupancy Group

Building Occupancy Group	Climate Zone																	
	0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
R-2, R-4, and I-1	65	66	67	77	80	86	80	81	90	86	90	90	86	90	90	79	89	80	78
I-2	43	42	38	37	36	38	32	32	30	36	36	35	43	43	44	46	47	50	53
R-1	63	62	66	65	70	71	77	80	84	81	83	88	85	86	90	83	87	87	85
B	62	62	64	66	66	65	64	64	68	70	72	74	71	73	77	71	74	74	71
A-2	70	70	72	72	75	75	70	73	82	69	74	78	67	72	78	60	67	57	51
M	80	79	83	79	81	84	67	74	87	80	66	65	79	62	50	75	67	75	58
E	56	57	55	58	58	57	59	62	59	61	66	62	64	67	67	65	67	63	58
S-1 and S-2	61	60	61	60	58	57	44	54	62	85	68	75	90	82	72	90	89	90	90
All Other	31	31	31	32	32	33	30	32	36	35	35	35	37	36	36	36	37	36	34

- Each Credit represents 1/10 % whole building energy use
- Limited to 90 credits or 9% building energy savings
- Demonstration package selected to be cost effective and practical
- Generally warmer and colder climate zones or high intensity buildings have slightly reduced requirements
- “Other” buildings have ~50% average requirement of analyzed buildings

Major AM Changes in CEPI-193 from original submitted proposal

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- Reduced requirements to
  - fit new IECC cost effectiveness
  - Demo LPD reduction <= 10%
- Remove additions and alterations
- Clarify core/shell & build out
- Updates from 90.1 public review
- Add CEPI 198,199,200 verbatim commercial kitchen equip. (Q02)
- Combined envelope measures (E04, E05, E06)
- Increased VT requirement in E06 to maintain daylight; align U-factors/SHGC with 189.1
- Revise residential piping (W09) to just fixture flow reduction
- Air leakage coordinated with CEPI-3, CEPI-58 & CEPI-71;
- Window shading (G03) coord with CEPI-195 & CEPI-196
- Correct credit tables for H04 & L05; H01 TSPR HVAC (CEPI-76)
- Revise for clarity and simplification: L03; L04
- Match renewable credit (R01) to CEPI-2, including off-site
- Incorporate language updates from working group and othesr
- Clarify peak period for load management measures

Demonstration Package: selected measures for cost effectiveness

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ID	Energy Credit Measure	Measure Life, yr	Multifamily	Healthcare	Hotel/Motel	Office	Restaurant	Retail	Education	Warehouse
E01	Glazing U & SHGC reduction	40	CZ 0A-1A	all CZ	all CZ	all CZ			all CZ	
E02	Envelope UA reduction	40						CZ 4-8		
H02	Heating efficiency	18		5%, CZ 5-8				5%, CZ 7-8		10%, CZ 4-8
H03	Cooling efficiency.	15	10% CZ 0-2	10%, CZ 0-2	15%, CZ 0-2	15%, CZ 0-2	15%, CZ 0-3B	15%, CZ 0-3B	15% CZ 0-3B	15% CZ 0-3B
H04	Residential HVAC control.	15	all CZ							
W02	Heat pump water heater or HR	19		30% all CZ	30% all CZ		30% all CZ	100% CZ 0-5		100% CZ 3
W03	Efficient gas water heater	15		70% all CZ	70% all CZ		70% all CZ			
W05	Point of use water heater	15				all CZ			all CZ	
W06	Thermostatic balancing valves	15		all CZ	all CZ					
W08	SWH flow reduction	15	all CZ		all CZ					
L04	Increase daylighting area	15						10% CZ 0-6		all CZ
L06	Light power reduction	20	5% all CZ	10% all CZ	10% all CZ	10% all CZ	10% all CZ	10% all CZ	10% all CZ	10% all CZ
Q02	Efficient kitchen equipment	15					all CZ			
Q04	Fault detection	15		all CZ	all CZ	all CZ		CZ 4B, 7-8	all CZ	

Scalar Cost Effectiveness
Cost: $/sf & User Payback (no carbon $)

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- Whole building cost $/ square foot ($0.52 average)

Building Use Type	Climate Zone																		
	0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
Multifamily/Dormitory	0.26	0.26	0.26	0.23	0.23	0.23	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
Healthcare	0.56	0.56	0.56	0.56	0.56	0.56	0.36	0.36	0.36	0.36	0.36	0.36	0.38	0.38	0.38	0.38	0.38	0.38	0.38
Hotel/Motel	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28
Office Buildings	0.59	0.59	0.59	0.59	0.59	0.59	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38
Restaurant Buildings	1.83	1.83	1.83	1.83	1.83	1.83	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63
Retail Buildings	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.29	0.45	0.45	0.57	0.45	0.45	0.45	0.41	0.41	0.56	0.56
School/Education Buildings	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Warehouse and Semiheated	0.19	0.19	0.19	0.19	0.19	0.19	0.21	0.21	0.14	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13

- Whole building scalar (simple payback – no carbon adder)

Building Use Type	Climate Zone																		
	0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
Multifamily/Dormitory	5.0	5.2	6.0	5.0	5.6	5.5	5.3	5.2	4.7	4.7	4.6	5.1	4.4	4.2	5.0	4.1	4.2	4.2	4.0
Healthcare	3.3	3.6	3.8	3.8	3.8	4.5	2.9	3.1	2.6	2.6	2.8	2.4	2.7	2.8	2.0	2.7	2.5	2.2	2.2
Hotel/Motel	4.1	4.5	5.2	5.1	5.3	6.1	6.0	6.1	6.1	3.7	3.7	3.9	3.7	3.6	3.8	3.5	3.6	3.2	3.1
Office Buildings	8.3	7.5	8.2	7.9	8.4	8.9	6.2	6.3	6.7	5.8	5.7	6.2	5.7	5.5	6.1	5.2	5.4	5.3	5.2
Restaurant Buildings	3.0	3.2	3.8	3.5	3.8	4.1	4.1	4.1	4.2	4.0	4.0	4.0	3.9	3.9	3.9	3.8	3.8	3.6	3.6
Retail Buildings	3.2	3.4	3.9	3.7	4.4	4.5	5.2	5.1	3.2	4.4	5.2	6.6	4.1	5.0	5.9	3.4	4.0	6.3	6.8
School/Education Buildings	5.0	5.6	6.6	6.1	6.9	7.7	7.7	7.6	5.4	4.7	4.7	5.1	4.6	4.5	5.0	4.2	4.5	4.2	4.1
Warehouse and Semiheated	8.2	8.0	9.8	9.1	10.5	10.2	12.3	11.9	8.9	4.1	6.1	5.8	3.1	4.5	6.1	2.2	3.0	2.3	2.4

Scalar SIR: Threshold / Payback >1.0 is cost effective; two cases

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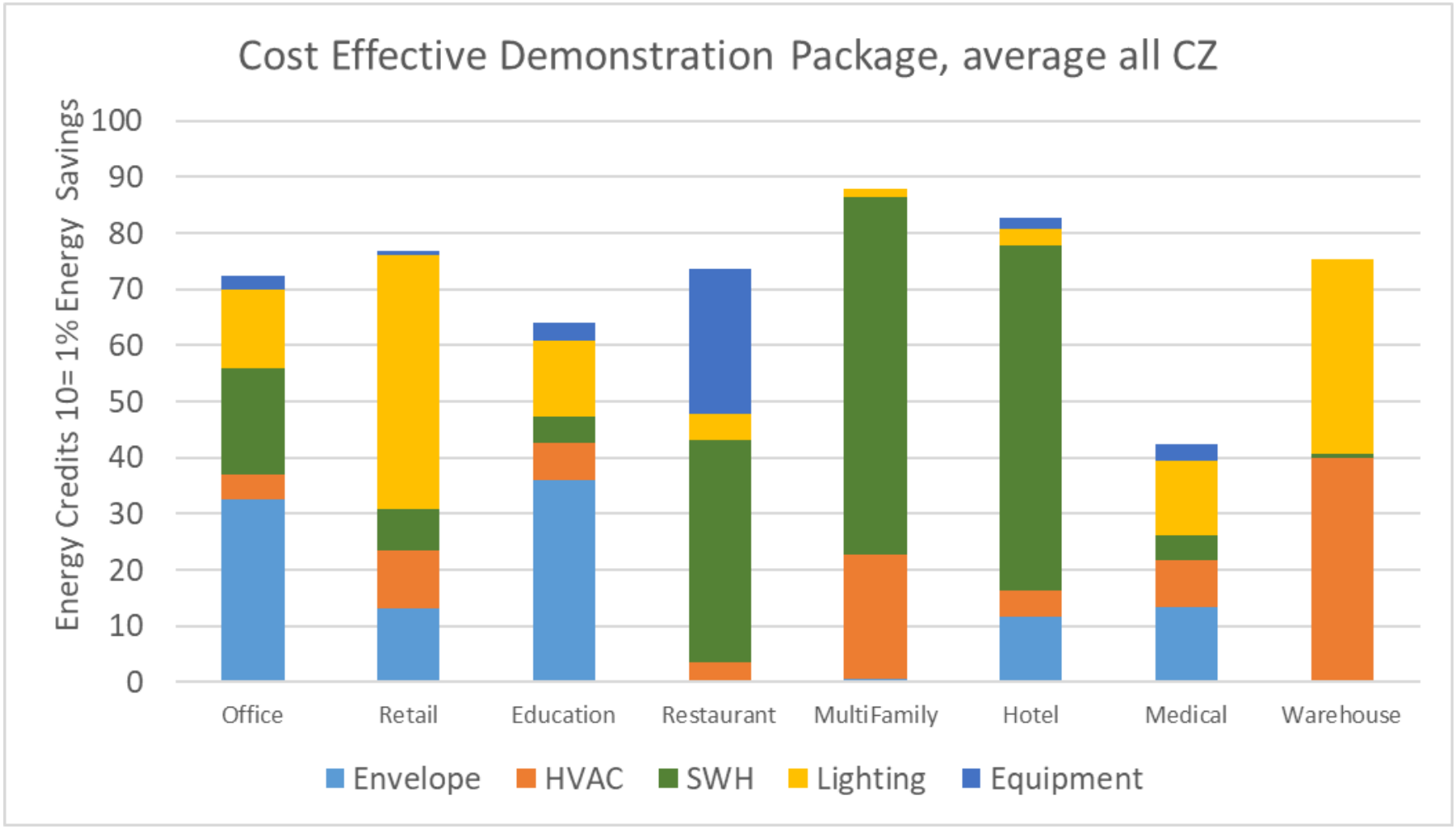
- Owner view: 7% discount rate & no social cost of carbon

Building Use Type	Climate Zone																		
	0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
Multifamily/Dormitory	2.6	2.5	2.3	2.5	2.2	2.3	2.5	2.5	2.7	2.7	2.8	2.6	3.0	3.1	2.6	3.1	3.1	3.1	3.3
Healthcare	4.4	3.9	4.0	4.0	4.2	3.6	6.0	5.6	6.9	6.8	6.5	7.6	6.5	6.4	9.1	6.6	7.2	8.0	8.2
Hotel/Motel	3.3	3.0	2.7	2.8	2.7	2.4	2.6	2.5	2.6	4.3	4.2	4.0	4.2	4.3	4.1	4.4	4.3	4.9	5.2
Office Buildings	1.9	2.0	1.9	2.0	2.0	1.9	2.9	2.9	2.7	3.2	3.3	3.0	3.3	3.4	3.1	3.6	3.5	3.6	3.7
Restaurant Buildings	3.9	3.6	3.1	3.3	3.1	2.9	2.9	2.9	2.8	3.0	3.0	3.0	3.1	3.1	3.0	3.2	3.2	3.3	3.3
Retail Buildings	3.8	3.6	3.1	3.3	2.8	2.7	2.4	2.4	3.9	3.4	2.5	2.0	3.7	2.7	2.2	4.8	3.8	2.6	2.2
Education Buildings	2.9	2.6	2.4	2.5	2.4	2.2	2.3	2.3	3.3	4.0	4.0	3.6	4.1	4.2	3.8	4.5	4.2	4.5	4.7
Warehouse	1.5	1.6	1.3	1.4	1.2	1.3	1.0	1.1	1.4	3.1	2.1	2.2	4.1	2.9	2.1	5.9	4.3	5.5	5.4

- Societal view: 3% discount rate with social cost of carbon

Building Use Type	Climate Zone																		
	0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
Multifamily/Dormitory	3.2	3.1	2.7	3.1	2.7	2.8	2.9	3.0	3.4	3.3	3.4	3.1	3.6	3.7	3.1	3.8	3.8	3.7	3.9
Healthcare	5.6	5.1	5.1	5.0	5.4	4.5	7.5	7.0	8.5	8.5	8.1	9.4	8.2	8.0	11.3	8.3	9.0	10.1	10.3
Hotel/Motel	4.3	3.9	3.6	3.6	3.5	3.1	3.3	3.2	3.3	5.5	5.5	5.2	5.4	5.6	5.3	5.8	5.6	6.3	6.7
Office Buildings	2.4	2.6	2.5	2.5	2.5	2.4	3.6	3.6	3.4	4.0	4.1	3.7	4.1	4.2	3.8	4.5	4.4	4.5	4.5
Restaurant Buildings	5.5	5.1	4.5	4.7	4.4	4.1	4.3	4.2	4.2	4.4	4.4	4.4	4.6	4.6	4.5	4.7	4.7	4.9	4.9
Retail Buildings	5.1	4.8	4.2	4.4	3.7	3.7	3.2	3.3	5.2	4.9	3.4	2.7	5.5	3.7	2.9	7.1	5.4	3.9	3.3
School/Education Buildings	3.7	3.3	3.0	3.2	2.9	2.7	2.8	2.9	4.1	4.9	4.9	4.5	5.0	5.1	4.6	5.5	5.1	5.5	5.7
Warehouse and Semiheated	2.0	2.1	1.7	1.9	1.6	1.7	1.4	1.5	2.0	4.5	2.9	3.1	6.1	4.1	3.0	8.7	6.3	8.1	8.0

Mix of Measures in Cost Effective Demonstration Package



Compare to Maximum Possible

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- What if we included more measures in a cost-effective package?
- Could have a significant increase in requirements
  - Current average requirement (except “Other”) = 6.8% savings
- Limited credits to 9% building savings for this proposal
  - Allows alternative packages without difficult measures or EPACT issues
  - Seems like a good next step; creates flexibility for buildings
  - Exceeds the 2021-IECC 2.5% energy credit requirement

Is ~7% too much? Max by building type (not overlapping measures)

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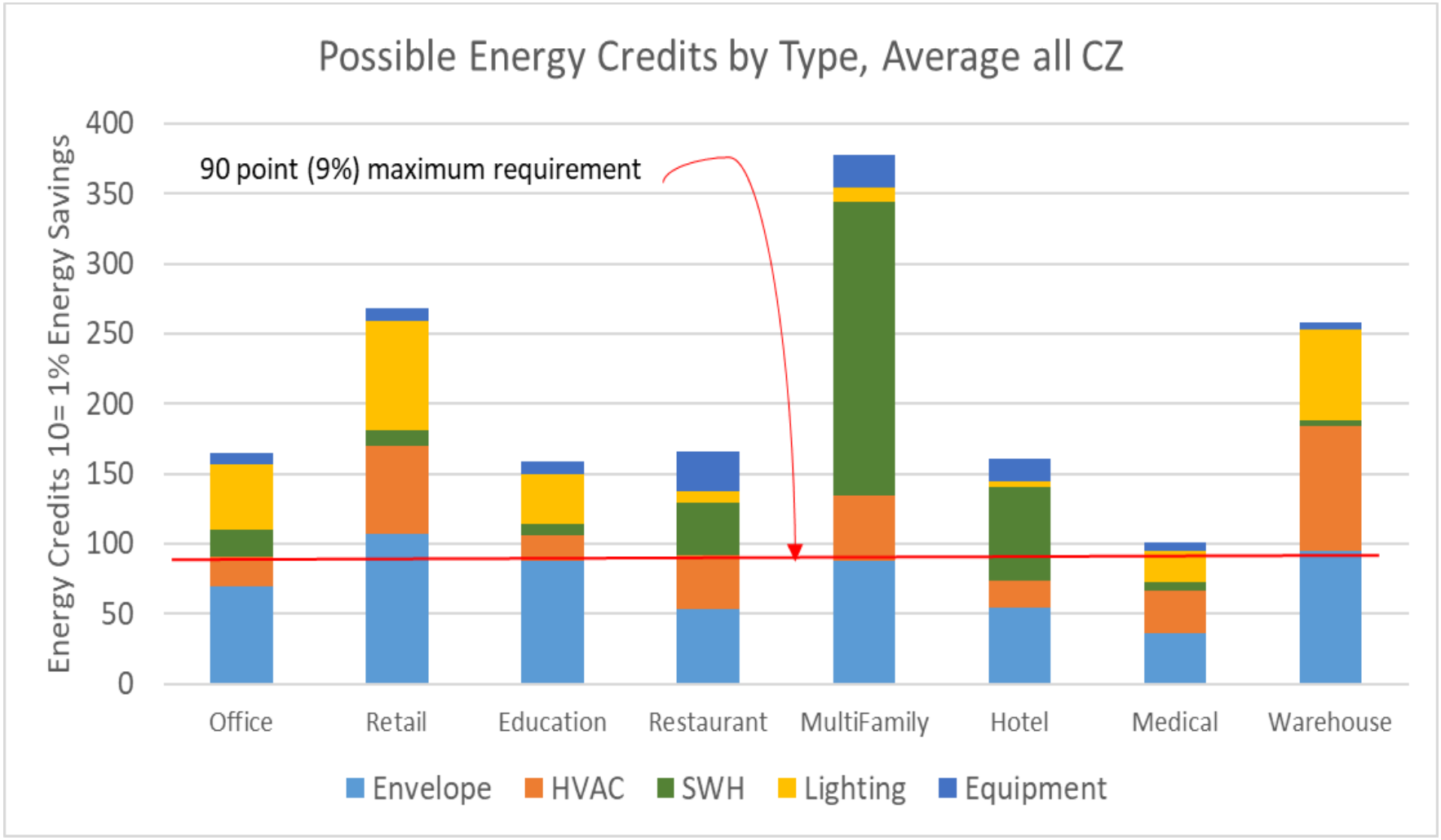

Is 7% too much? Max by climate (not overlapping measures)

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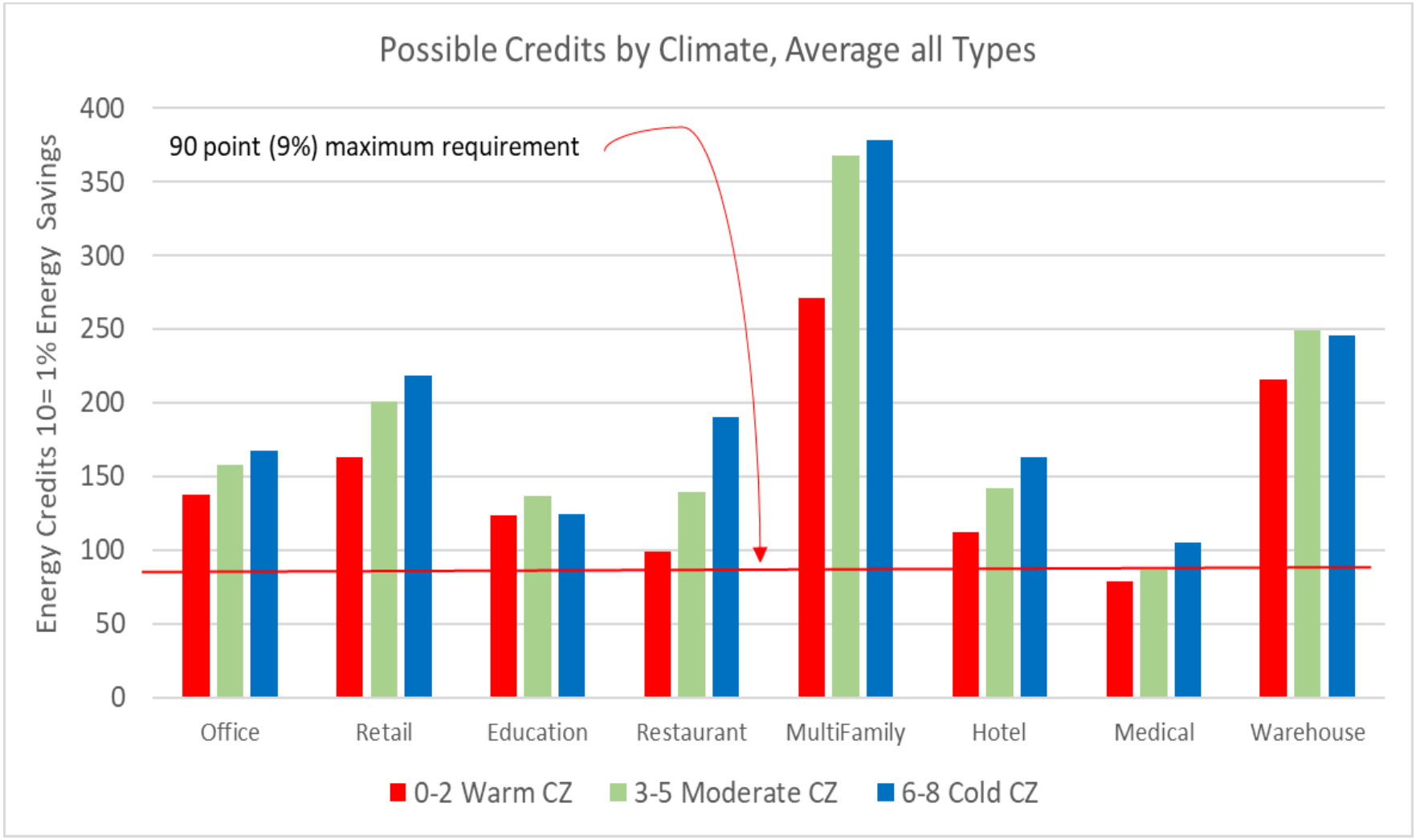

Separate Renewable / Load management Requirement

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- There is a separate renewable and load management requirement
  - For buildings >5000 sq ft conditioned floor area
  - Renewable does not dilute energy efficiency
  - Based on time-of-use savings
- Prepares buildings for future electric grid impact
- Can work with
  - Local building demand metering
  - Utility demand response
- Can be met with several LM measures or just renewable

- R01: Renewable Energy
  - (2021 IECC Section C406.5)
  - Both on-site and off-site allowed
- G01: Lighting load management
- G02: HVAC load management
- G03: Automated shading
- G04: Electric energy storage
- G05: Cooling energy storage
- G06: SHW energy storage
- G07: Building thermal mass and night flush

- Cost effectiveness in TechBrief
- Basis 0.4 W/sf R01 + G01

Summary

- The Energy Credits Proposal includes 31 energy saving measures
- Potential ~7% added savings
- Provides design flexibility
- Includes grid response
- EPACT and practicality have been considered
- Cost effective package
- Developed with significant workgroup, public and IECC participant input
- Solid and enforceable code language

- Emailed:
  - May 10 version for voting
- May 16 Modeling Subcommittee
- May 18 Main Commercial Com.

- Open for questions or discussion

Questions?