



Performance Trade-off Method for Life Cycle Equivalency

Jon McHugh, McHugh Energy
CalBEM 2025
Power Talk



McHugh Energy Consultants



Prescriptive vs Performance

Prescriptive Approach

- ❑ Mandatory Measures
- ❑ Prescriptive Measures
- ❑ Cookbook approach to compliance
- ❑ Developed by experts in a public review process
- ❑ Designed to be Cost-Effective in its entirety over the Life of the Building

Performance Approach

- ❑ Mandatory Measures
- ❑ Whole Building Simulation over Typical Year
- ❑ Greater flexibility due to trade-offs
- ❑ Proposed Design Lifecycle
Systemwide Cost \leq Prescriptive LSC





Building Component Expected Useful Life (EUL)

Commercial Building IRS Depreciation = 39 Years

Envelope EUL: Years

- ❑ TPO Roofing: 20-25
- ❑ Metal Roofing: 50+
- ❑ Steel Deck: 30-40
- ❑ Concrete Deck: 50-60
- ❑ Plywood Deck: 20-40
- ❑ Brick Veneer: 70-75
- ❑ Cement Block 80-100
- ❑ Concrete Tilt-up: 30-50
- ❑ Drywall ceiling: 50-75
- ❑ Metal Windows 35-60
- ❑ Vinyl Windows: 30-40

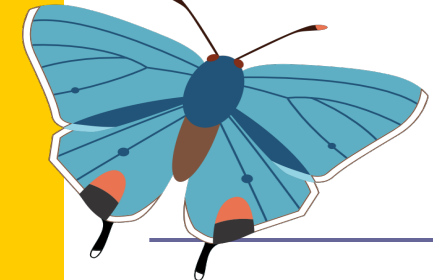
Equipment Avg EUL: Years

- ❑ Elevator: 25
- ❑ Res HVAC: 12-14
- ❑ Central HVAC: 13-16
- ❑ Make-up air unit 15-20
- ❑ Exhaust hood: 10-20
- ❑ VAV: 15-20
- ❑ Metal Ducts: 20
- ❑ Boiler 20-40
- ❑ Light Fixtures: 15-20
- ❑ Lighting controls: 10-15

<https://ccpia.org/estimated-life-expectancy-chart-for-commercial-building-systems-and-components/>
<https://www.reservedataanalyst.com/mt-content/uploads/2018/09/marshall-swift-life-expectancy-guidelines.pdf>
https://www.naturalhandyman.com/iip/infhvac/ASHRAE_Chart_HVAC_Life_Expectancy.pdf



McHugh Energy Consultants



Maximum Building Envelope Loads

- ❑ Set a maximum Building Envelope Loads (BEL) limit that every design must meet before any equipment tradeoffs count
- ❑ Design Envelope Consumption, similar to current area-weighted U-factor requirement (i.e. NR prescriptive fenestration).
 - Assembly U-factor (walls, roofs, windows, floor),
 - Infiltration, Thermal Mass, Solar Gain
 - Daylight?
- ❑ BELs calculated during the annual simulation,
 - Reported for both the baseline and proposed cases.
 - Similar to ASHRAE 90.1 Appendix C: Building Envelope Trade-Off
- ❑ Pros:
 - Values durable envelope measures; reduces over-reliance on short-lived equipment.
 - Maintains tradeoff flexibility within envelope choices.
- ❑ Cons:
 - BEL limit somewhat arbitrary
 - If set too high, its effect is negligible



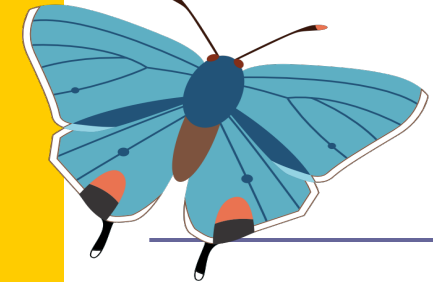


Life Cycle Equivalency Approach

- Envelope EUL at least 2x longer than equipment
 - Conservative assumption: Envelope EUL = 30 years, Non-envelope EUL = 15 years
- Alterations: equipment efficiency not impacted by NC performance trade-offs
- Current Trade-off: First year energy or energy cost savings
 - 1 kBtu/yr increase in envelope energy offset with 1 kBtu/yr decrease in non-envelope energy
- Proposed Trade-off: Life cycle energy = EUL x First year Savings (loss)
 - 2:1 Saving ratio: Loss ENV /yr x 30 yr ≤ Savings Non-ENV /yr x 15 yr
 - 1 kBtu/yr increase in envelope energy offset with 2 kBtu/yr decrease in non-envelope energy
- Equivalent to Life Cycle Prediction

$$\begin{array}{c} \text{Years 1- 15} \qquad \qquad \qquad \text{Years 16-30} \\ \text{[Proposed ENV \& Prop Non-ENV] x 15} + \text{[Proposed ENV \& Base Non-ENV] x 15} \leq \\ \text{[Base ENV \& Base Non-ENV] x 30} \end{array}$$





2025 CBECC-res Simulations CZ 12 Prototype

Prescriptive Case

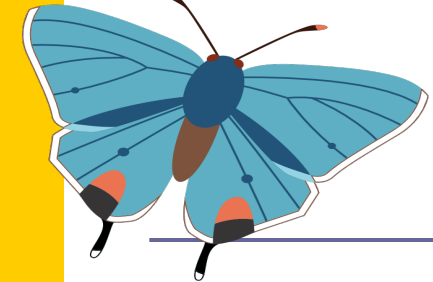
- ❑ R-15 Walls with R-5 Continuous Insulation
- ❑ Tile Roof with R-19 Insulation
- ❑ R-38 Floor of Attic
- ❑ Windows U-0.30, S-0.23
- ❑ HP Split System SEER2 =14.3, EER2=11.7, HSPF = 7.5
- ❑ HP WH NEEA Tier 3, 66 gal, UEF 2.7

Current Performance 1:1 Ratio

- ❑ HP System: SEER 17, EER 12.5, HSPF 9
- ❑ HP WH: NEEA Tier 4, 80 gal, UEF 3.1
- ❑ R-15 Walls with plywood sheathing and stucco
- ❑ Tile Roof with R-4 insulation (mandatory min)
- ❑ Floor of attic R-38
- ❑ Rest of envelope the same

Operational Energy Cost (LSC) is initially neutral





Medium Envelope Performance

2:1 Ratio Equip Savings to Env Eff Loss

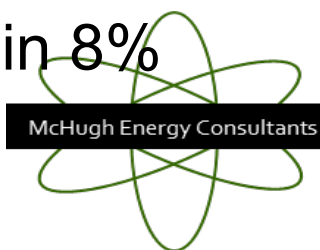
Performance w/Prescriptive Roof

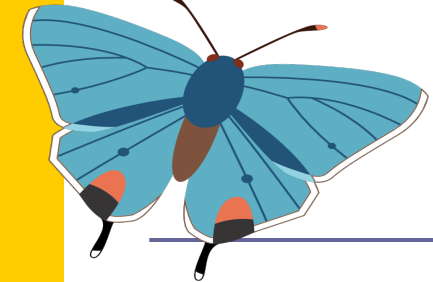
- Title Roof with R-19 under deck insulation
- Attic floor insulated to R-38
- Walls R-15 & Plywood Sheathing and Stucco (no rigid insulation)
- High performance equipment package
 - SEER 17, EER 12.5, HSPF 9
 - NEEA Tier 4 HPWH
- Current compliance margin 8%

Performance Outcome w/ Prescriptive Wall

- Walls R-15 + R-5 Continuous Sheathing and Stucco
- Tile Roof with R-4 under deck insulation
- Attic floor insulated to R-38
- High performance equipment package
 - SEER 17, EER 12.5, HSPF 9
 - NEEA Tier 4 HPWH
- Current compliance margin 8%

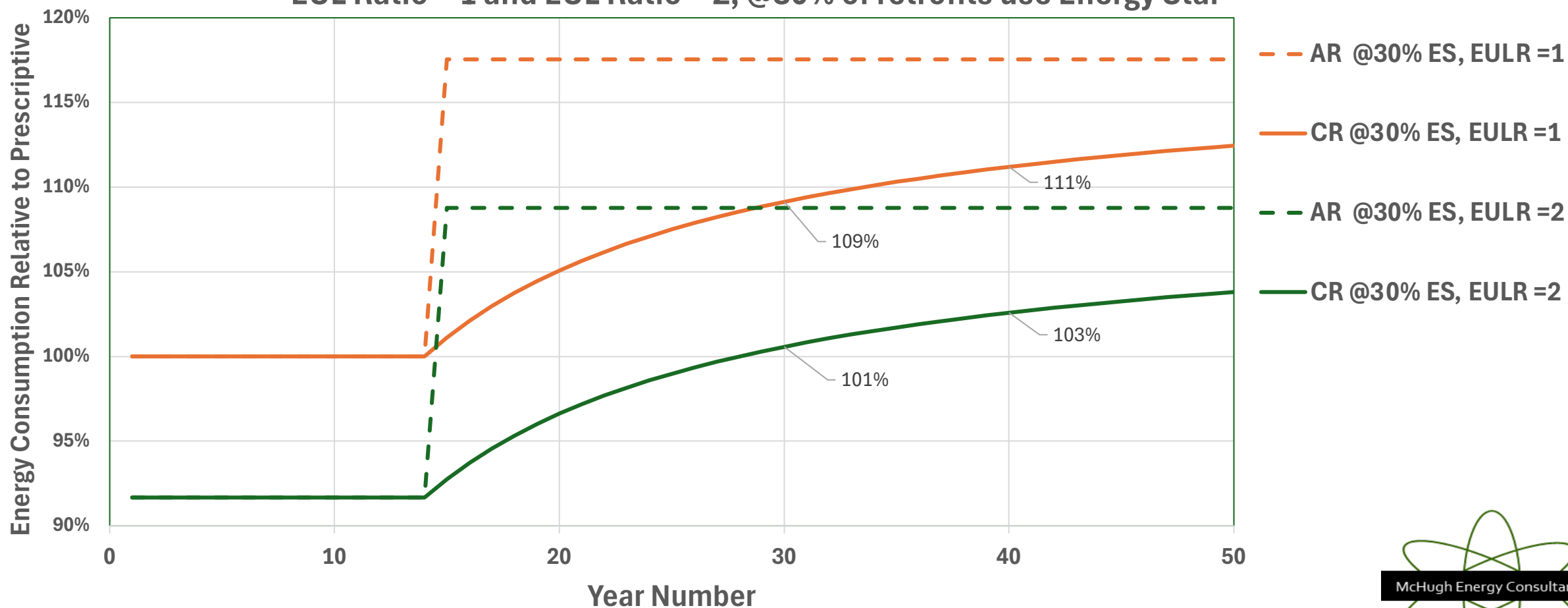
Minimally compliant packages with 2:1 Trade-Off ratio

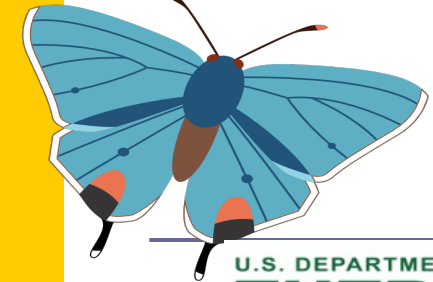




Long term annual and cumulative consumption

Annual and Cumulative Performance Relative to Prescriptive with
EUL Ratio = 1 and EUL Ratio = 2, @30% of retrofits use Energy Star



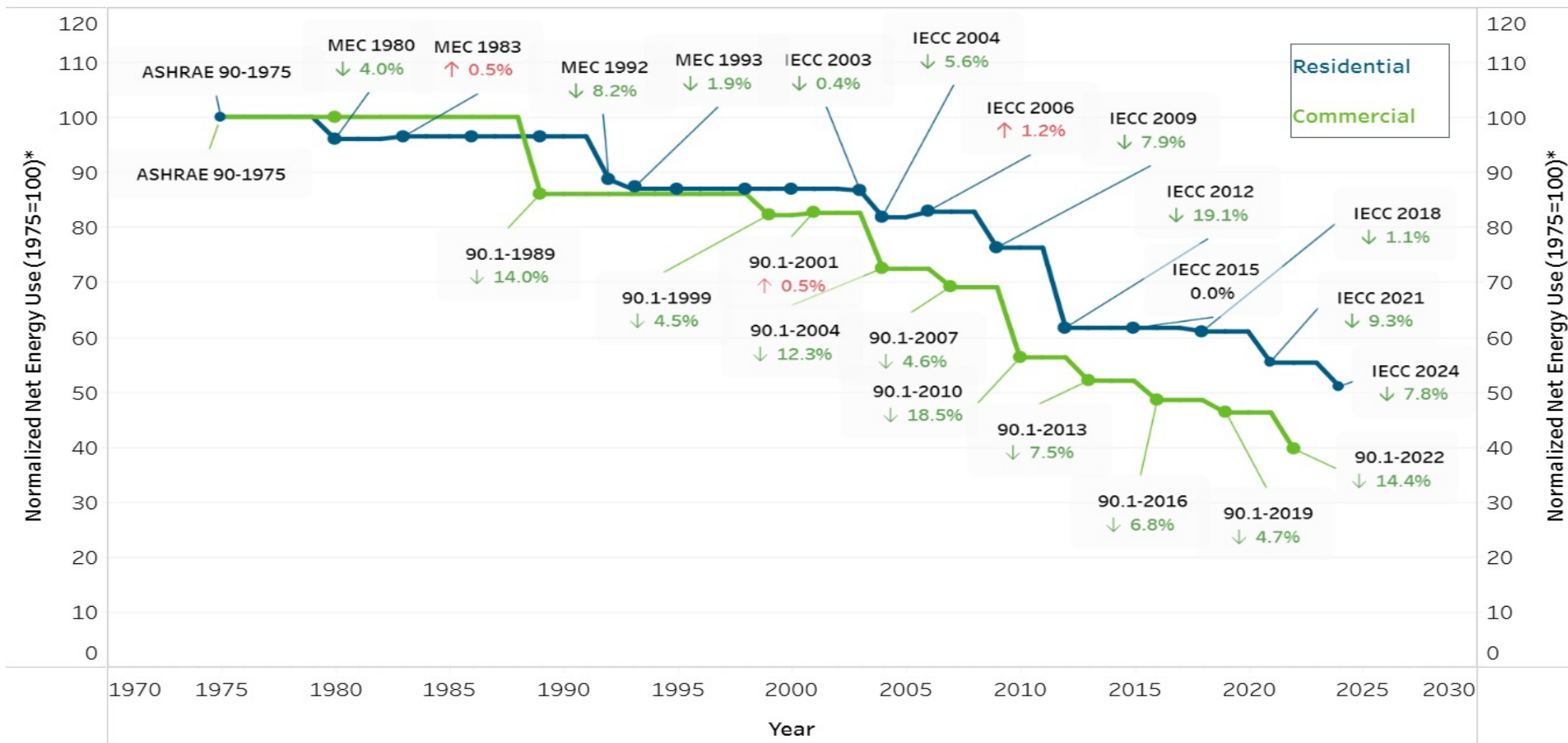


National Codes Increased Stringency

Res = 3.9% per cycle, NR = 5.5% per code cycle

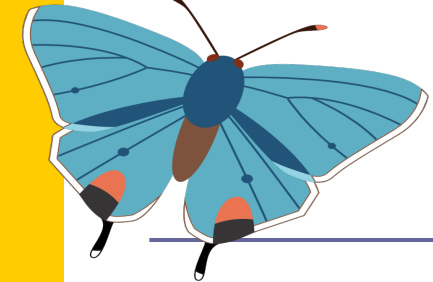


Estimated Improvement in Residential & Commercial Energy Codes
(1975 - 2024)



*Net energy use includes the contribution of renewable energy generation





Acknowledgements

Thanks to:

- ❑ California Statewide IOU Codes & Standards program
- ❑ Jessica Meylor, Frontier Energy
- ❑ Alea German, Frontier Energy
- ❑ California Energy Commission Staff
 - Gypsy Achong
 - Danny Tam
 - Payam Bozorgchami
- ❑ ASHRAE 90.1 Energy Cost Budget Committee

