



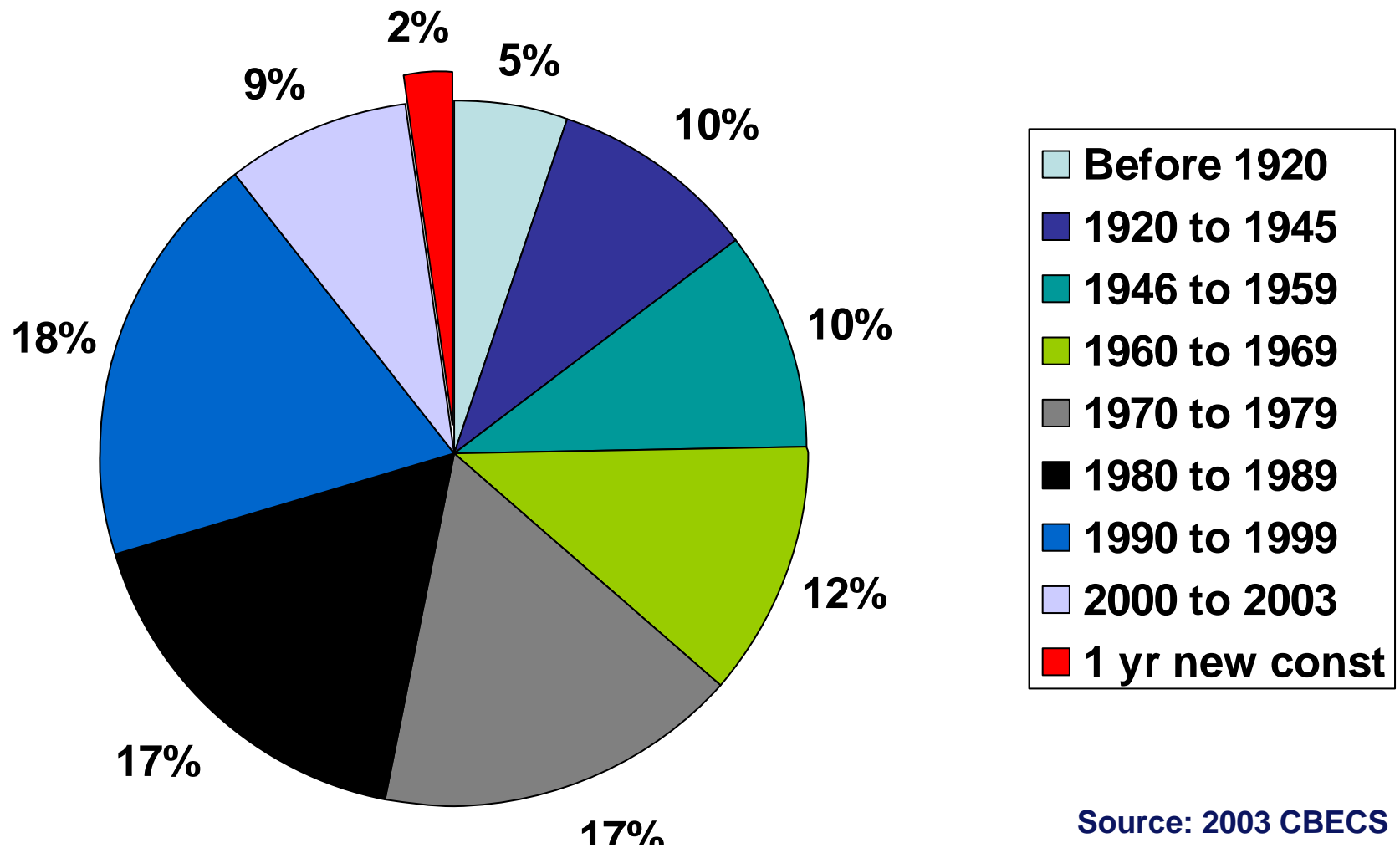
A New Class of Retrofits: “Repair Indefinitely”

Presented by:

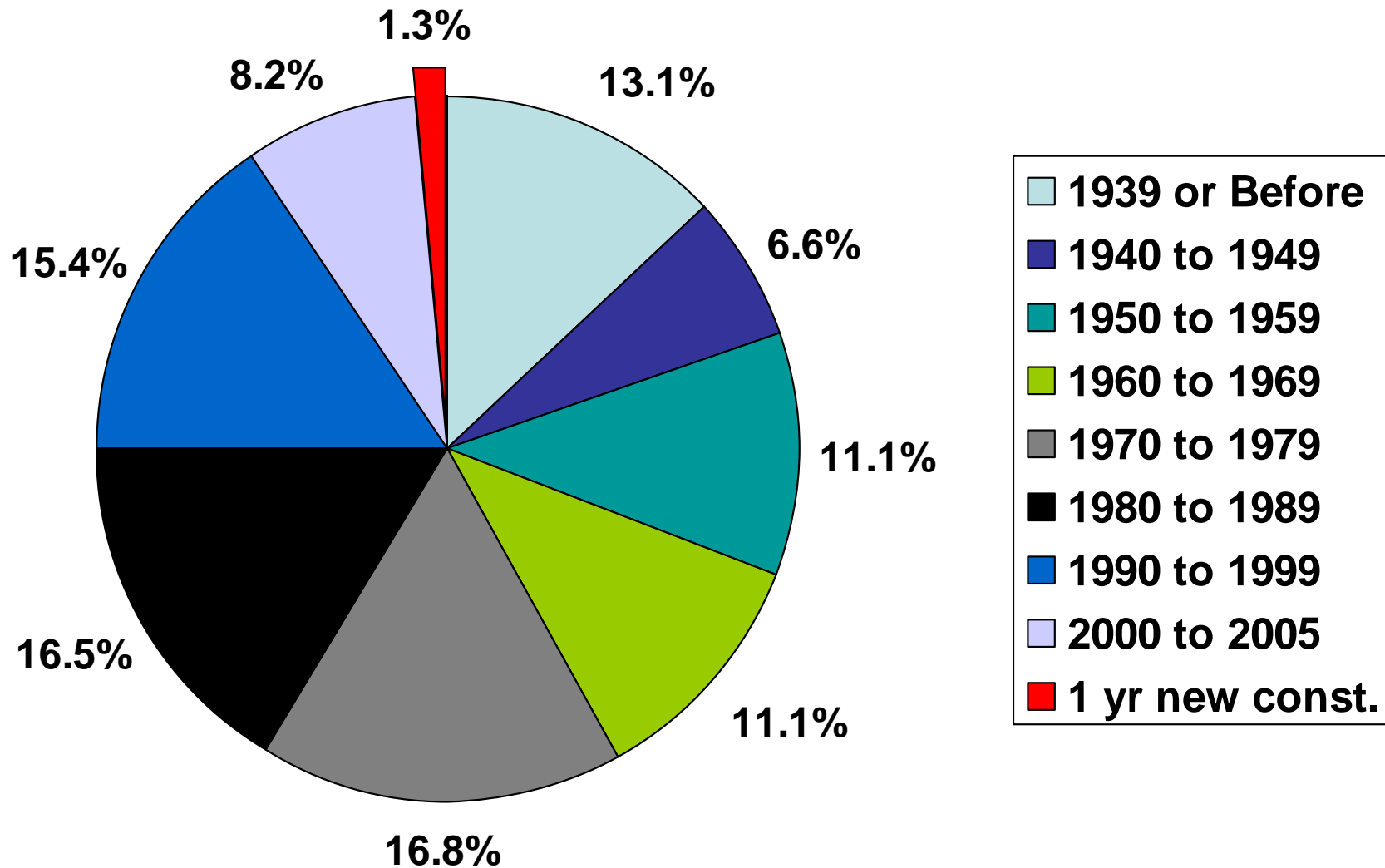
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Cal Technical Forum

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Originally: ACEEE 2010 Summer Study

Commercial Building sf by age (72 Billion sf)



Residential dwelling units by year built



Importance and Challenge of Retrofits

- Large societal energy reductions –
state adopted major retrofit initiatives
- Cost of retrofits higher than new construct.
 - Total cost versus incremental cost
 - Difficulty of access and replacement
- Major program evaluation barriers
 - Free-ridership
 - Code baseline

Key evaluation criteria

- *“What would have happened without the program?”*
 - ROB: failed and replaced w/ code required product
 - Early replacement: Self-motivated or incented
 - Replacement beyond useful life:
 - Lasts beyond “effective useful life” (EUL) before failure and code replacement
 - Fails but “patched-up” for years
 - Retrofit or remodel not otherwise considered
- Risk of first two scenarios result in programs not offered for other scenarios
 - Retrofits not offered for the least efficient bldgs.

The Energy Code as a Convenience Baseline

- Code requirements applied to retrofits
 - Reasonable baseline for replace on burnout.
- Code baseline well defined
 - Inconvenient to estimate existing efficiencies
 - OK if was going to be replaced anyway
 - Incentives offered for exceeding code
- Preferred by evaluators
 - Simpler, less risk of free-rider savings
- But: not actual baseline for some cases

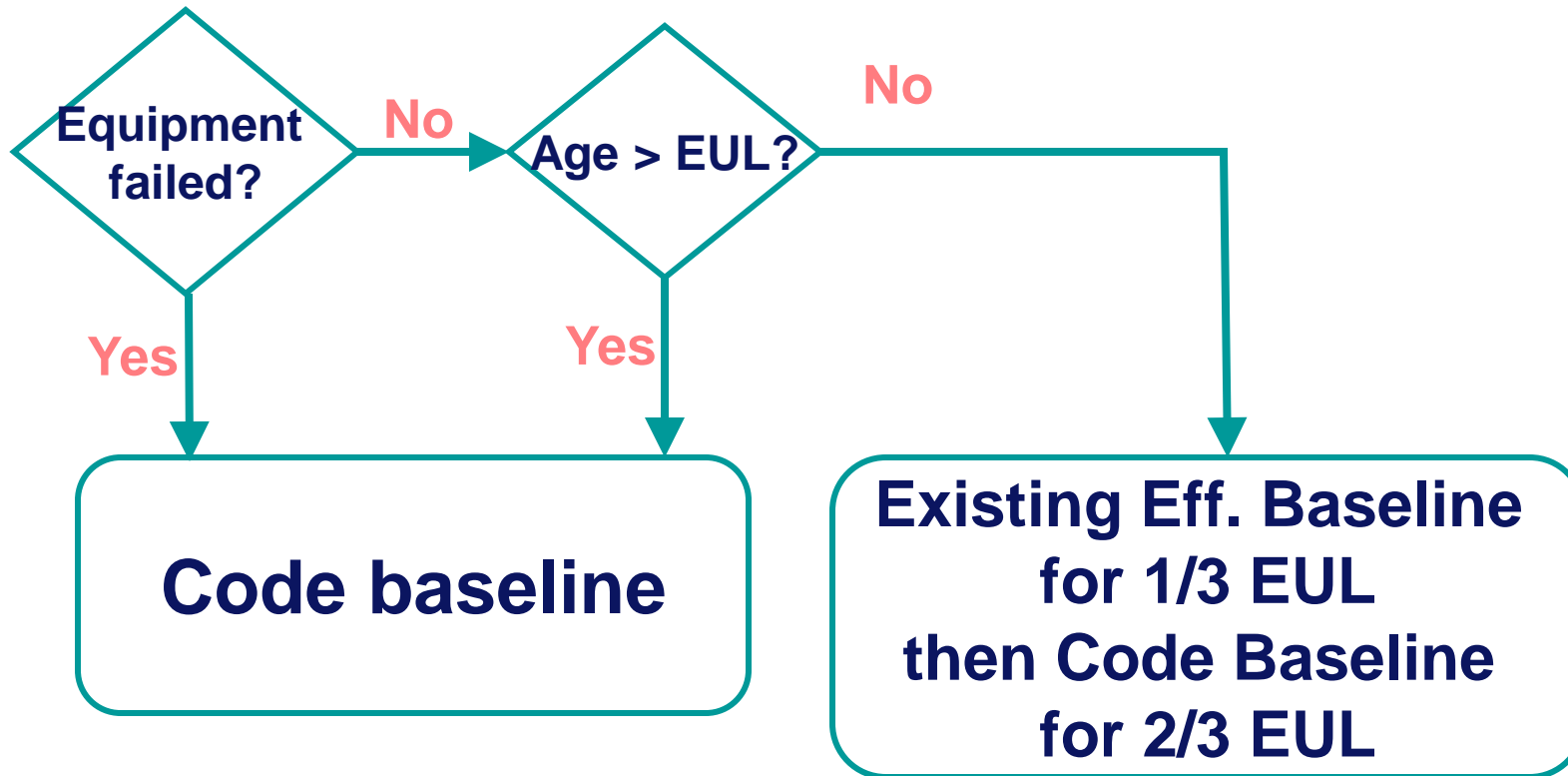
Code Baseline Problem for Retrofits

- CPUC believes
 - Incenting to reach code is paying customers to do what law already requires
 - All equipment fails at end of EUL
 - Max EUL is 20 yrs
 - Exception: special cases allow 30 yrs EUL (schools, local governments)
- Problems
 - Owners are not required to retrofit
 - Equipment often lasts beyond EUL
 - Many measures last longer than 20 yrs

Current Baselines Associated with Failure Scenarios

- Retrofit: Replace on burnout (ROB)
 - Triggers code required efficiency
 - Savings evaluated relative to the code baseline
- Early replacement.
 - If program induced upgrade (equipment had some useful life left)
 - Baseline is existing efficiency, for the remainder of old EUL
 - Baseline is code efficiency, for remainder of new EUL
 - CPUC: Assume 1/3 EUL and 2/3 EUL, Max EUL = 20 yrs
- Retrofit: Replacement beyond useful life.
 - CPUC: Equipment operating past EUL (max 20 yrs), is deemed close to failure and treated like ROB
 - Code baseline applies

Current Retrofit Rule Set



Code Baseline as Barrier to Retrofits

- Simple rule - treat all measures as replace on burn-out with code baseline.
 - But many measures will not be cost-effective
 - Especially with new stringent codes
- Financial barrier to early retirement programs
 - If owner must first bring measures to code
- Result: wait until inefficient equipment fails
 - Many measures operate beyond 20 yrs
 - Code minimum during crisis ROB
 - No program for small, “beyond code” savings

A New Class of Retrofits: Repair Indefinitely Measures

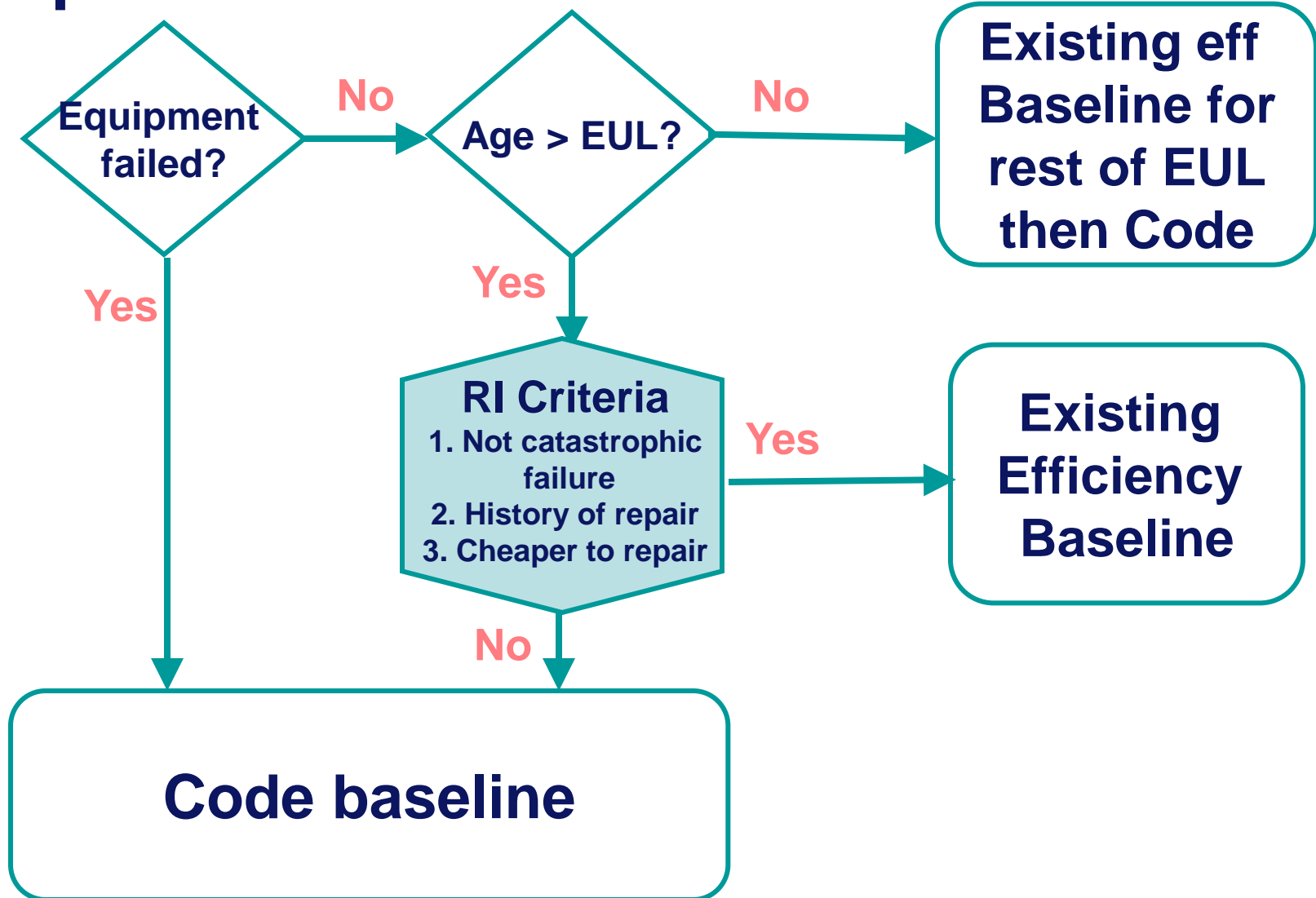
Three Criteria

1. Failure mode is not catastrophic - kept in service indefinitely through repairs and part replacements;
2. History of rebuild/repair rather than replace; and
3. Far cheaper to rebuild/repair than to replace

Examples

- Large electric motors – often rewind
- Large pumps and fans - difficult to replace, easier to repair
- Chillers - often rebuilt and repaired
- Lighting fixtures – can change lamps/ballasts; in spaces seldom renovated
- Windows – can last the life of the building

Proposed Retrofit Rule Set



Program Design to Minimize Free Ridership

- Anticipate free-riders and set services so program is still cost-effective
- Lower incentives (based on code baseline) for likely *Replace on Burnout* measures.
- Higher incentives (based on existing efficiency over predicted life) for measures meeting *Repair Indefinitely* criteria.

Program motivated retrofit that triggers code: Skylight Retrofits

- Example program: High performance roof/daylighting retrofit for re-roofed warehouses
 - Install roof insulation and cool roof
 - Install skylights and daylighting controls
- Currently: Adding skylights triggers requirements for daylighting controls (CA T-24 and ASHRAE 90.1-2010), thus with code baseline no energy savings from adding skylights and controls.
- Without program no skylights or controls
- New rule set would allow program

Potential Savings from Skylighting Retrofit Program

- California Savings
 - Detailed calculation using SkyCalc and CEUS database for sf warehouse by climate zone
 - Retrofit only $\frac{1}{4}$ of 550 M sf of warehouse
 - Save approximately 186 GWh/yr electricity
 - Increase gas consumption 0.29 Million therms
 - Net CO₂ reduction of 110,067 tons/yr
- Nationwide savings approximate 10 times
 - Savings 1.9 TWh/yr!
 - CO₂ reduction 1.1 Megaton/yr

Repair Indefinitely Conclusions

- Removing barriers to full implementation of retrofit programs enables deep retrofits
- Energy codes becoming increasingly more stringent
- Counterfactual: Not always code for retrofits
- This paper defines new class of retrofits: **Repair Indefinitely**
- Other actions needed:
 - Document code measures that kick in upon retrofit
 - Identify cases ripe for Repair Indefinitely treatment
 - Develop estimates of lost energy savings potential

Extending These Issues to Programs

- CPUC Decision: Code will always be baseline for retrofits, except...
 - Early replacement (1/3 – 2/3 rule)
 - Extend EUL to 30 years for schools, local govt
- Code retrofit requirements – when routinely ignored
 - Duct test/seal when A/C replaced
 - Lighting controls when lighting replaced
 - Treat as new lighting system when >10% new
 - Etc.
- Optional retrofits – program only pays for beyond code; costly for owner to upgrade to code

Challenges from CPUC

- Provide data, not anecdotes
 - Document cases where this is a problem
 - Document cost to owner to get to code vs. cost to go beyond code (programs)
 - Document magnitude of problem (lost savings)
- Explain how to avoid free-riders and double counting of savings
- Explain how to not waste ratepayer dollars helping people do what code requires

Work to Address Issue

- Navigant Potential Study update (starting soon)
- ED/IOU pilot programs (per Decision)
- IOU C&S Program White Paper
 - Document Decision history & comments
 - Document code triggers for existing bldgs.
 - Describe the “Poorly Specified Counterfactual”
- Cal Tech Forum –
how should we get involved?

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