Zeroing In on Net-Zero Buildings: Can We Get There? How Will We Know When

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Sub-optimization

- "Optimizing the performance of a sub-system of a more complex overall system, at the expense of the optimum performance of the bigger system"
- A key problem to avoid in approaching net zero buildings

Motivation for net zero buildings

- The IPCC goal for the U.S. requires reducing all greenhouse gas emissions by at least 80% by 2050
  - Buildings account for 39% of emissions themselves
  - Personal transportation to buildings is another 18%
  - Construction and demolition of buildings may add ~5%
    - This percentage will inevitably get bigger as everything else declines
- We have more experience saving energy at low cost in buildings than in other uses

What are the metrics?

- Site energy?
- Source energy?
- Annual energy cost?
- Climate emissions?

Sub-Optimization 1: Site Energy

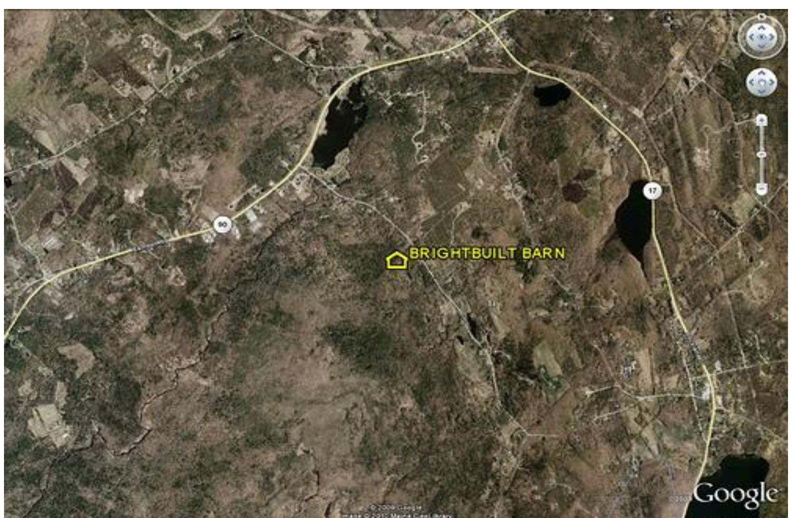
- Flavor 1: ignore gas and oil use
  - Makes the net zero goal too easy to meet
  - Encourages heroic efforts at saving/producing electricity while ignoring efficiency measures for fuels that cost less and reduce emissions and energy bills more
    - Encourages misguided tradeoffs (such as fenestration stategies that save cooling energy but waste heating energy)
- Flavor 2: count fuel at 3413 Btu=1 kWh
  - Encourages use of electricity for applications where gas is cheaper and lower in emissions
  - A net zero site energy building *could have been* net producing if these uses employed gas and the extra electricity returned to the grid

Sub-Optimization 2: Solar Access vs. Density

Sub-Optimization 3: Energy vs Location Efficiency

BrightBuilt Barn
Rockport, Maine

- LEED-Homes Platinum
- USGBC's 2009 Innovative Project Award
- "Net-Zero Plus"



Walkscore
8 out of 100
"Car-Dependent/Driving Only: Virtually no neighborhood destinations within walking range. You can walk from your house to your car"

Sub-Optimizations 2 and 3: Transportation Energy is Key

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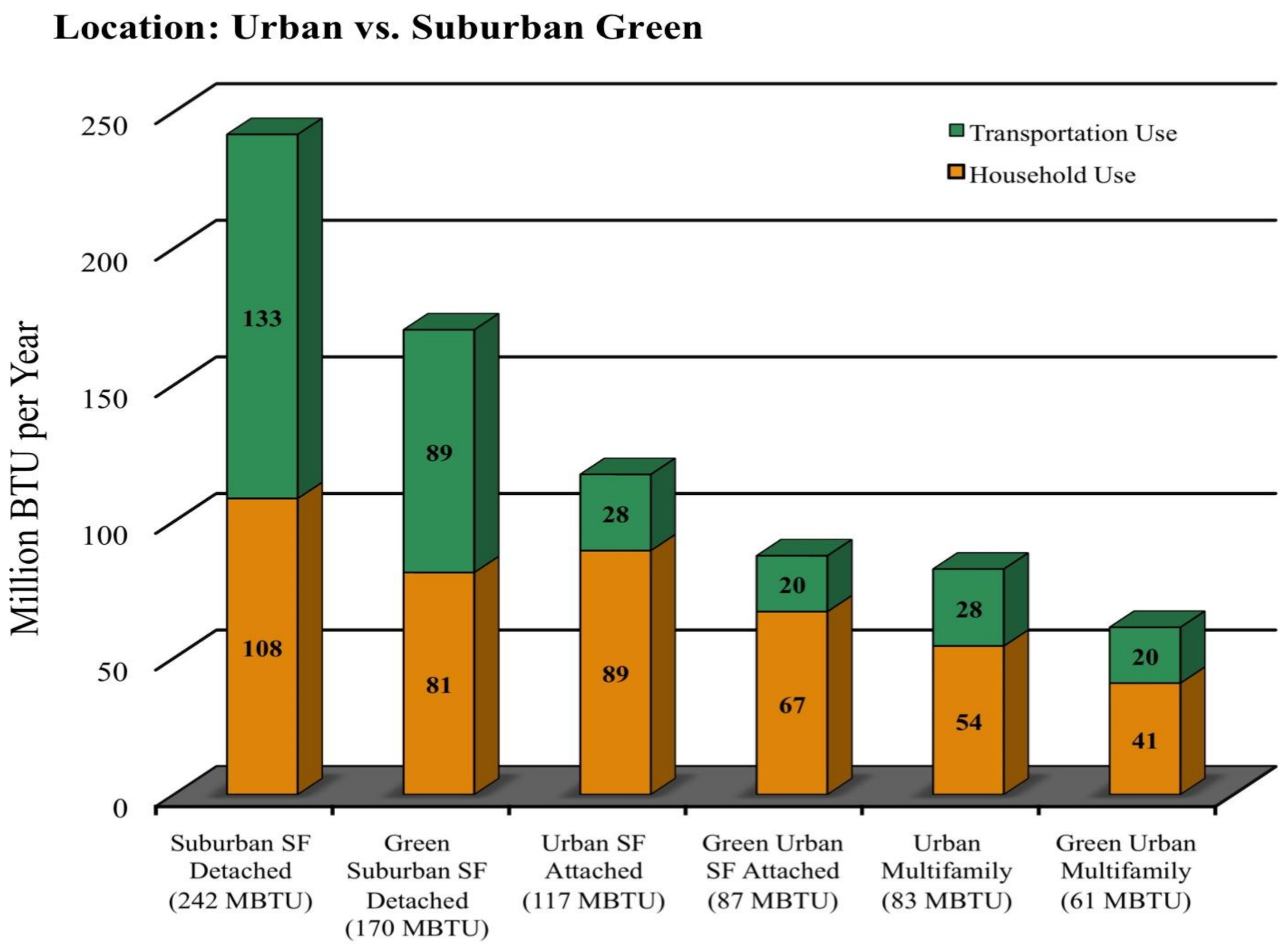

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Where do we draw the boundaries?

- Geographically:
  - At the unit?
  - At the property?
  - At the subdivision?
  - At some distance?
- Scope:
  - Operational energy only?
  - Include water?
  - Include construction?
  - Include transportation?

Consequences of the Choice of Boundaries

- The narrower the boundaries, the greater the dangers of losses from sub-optimization
  - Energy use will be “outsourced” to lower efficiency
  - Costs will be even more adversely affected
- The broader the boundaries, the harder it is to get to zero
  - And the greater the risk that the renewables will not be additional

Questions implicit in the goal

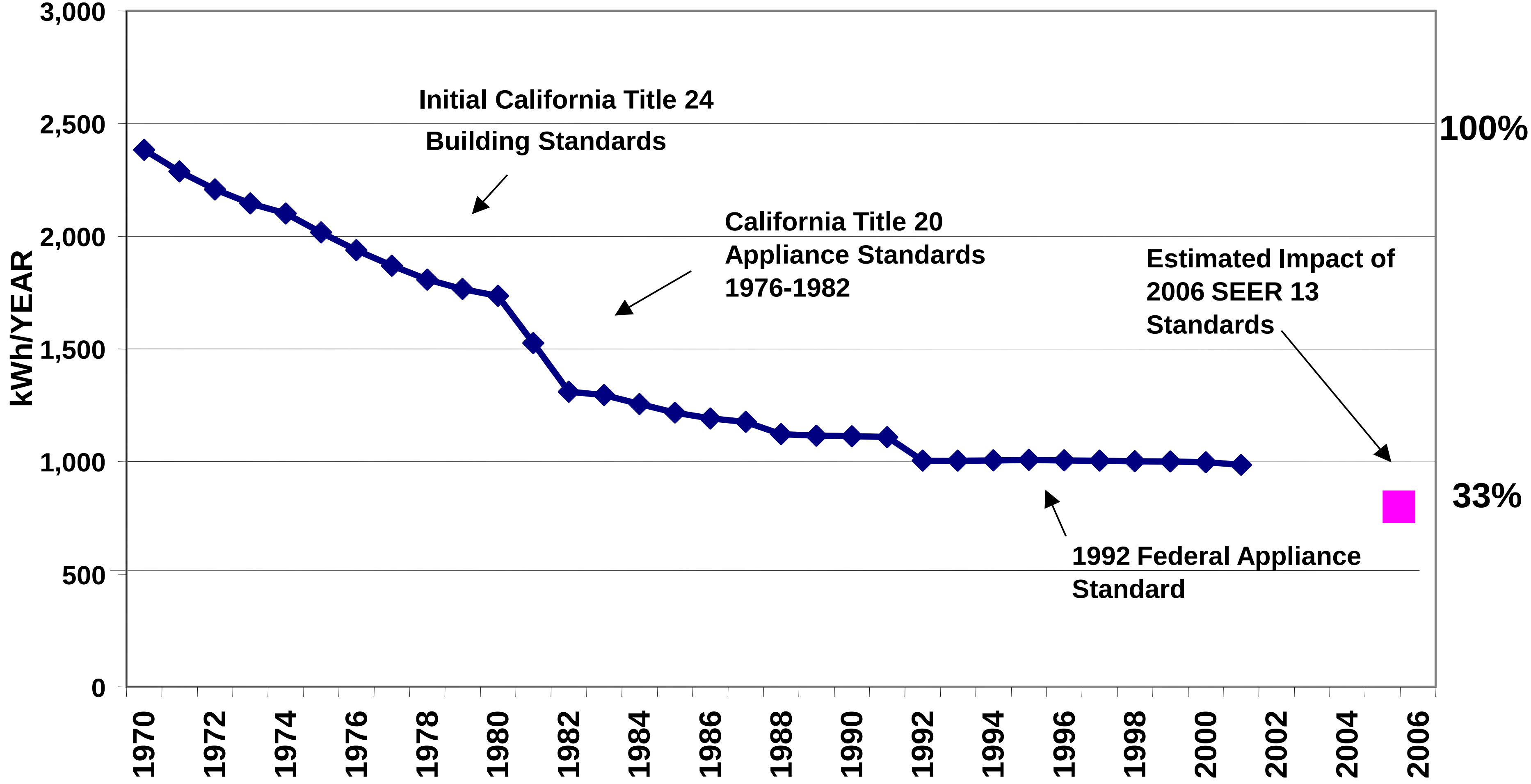
- Where is it best for our renewable energy sources to be?
  - To what extent does this depend on the scale of renewable generation?
- What are the real-world constraints on getting more from renewables?
  - Does promoting renewables on-site avoid some of the constraints?

Policies to get to net zero

- Most of our long term successes in efficiency have been through continuing incremental improvement
  - We know how to do this
- Demonstrations of very advanced technologies and designs seldom have led to serious market uptake
  - We knew how to build net-zero buildings in the 1970s
- Which variant of net zero should the goal be?
  - We don't need to decide now, but as we approach the looser definition, it will start to matter

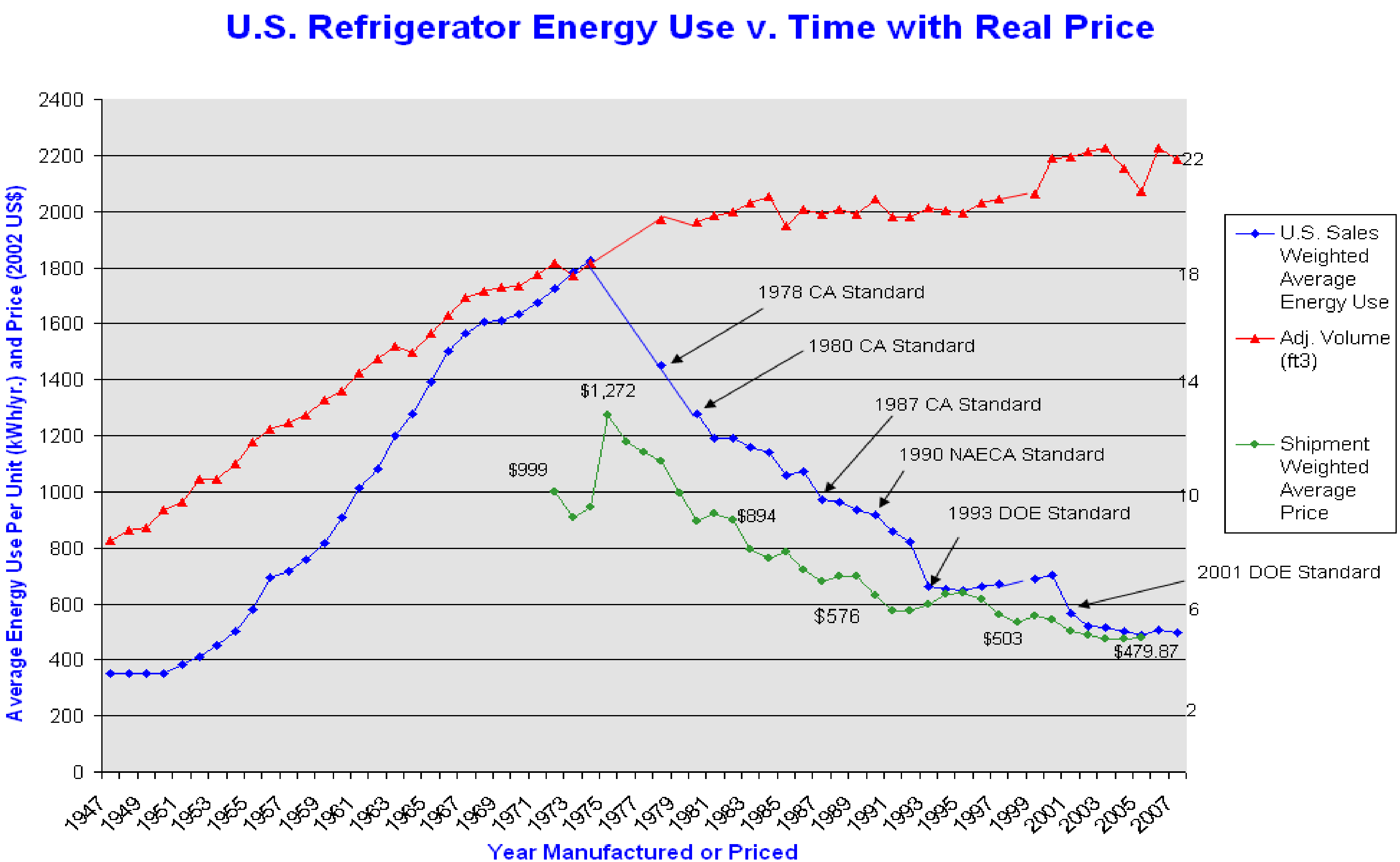
Incremental Improvement:

Annual Usage of Air Conditioning in New Homes in California



Source: CEC Demand Analysis Office

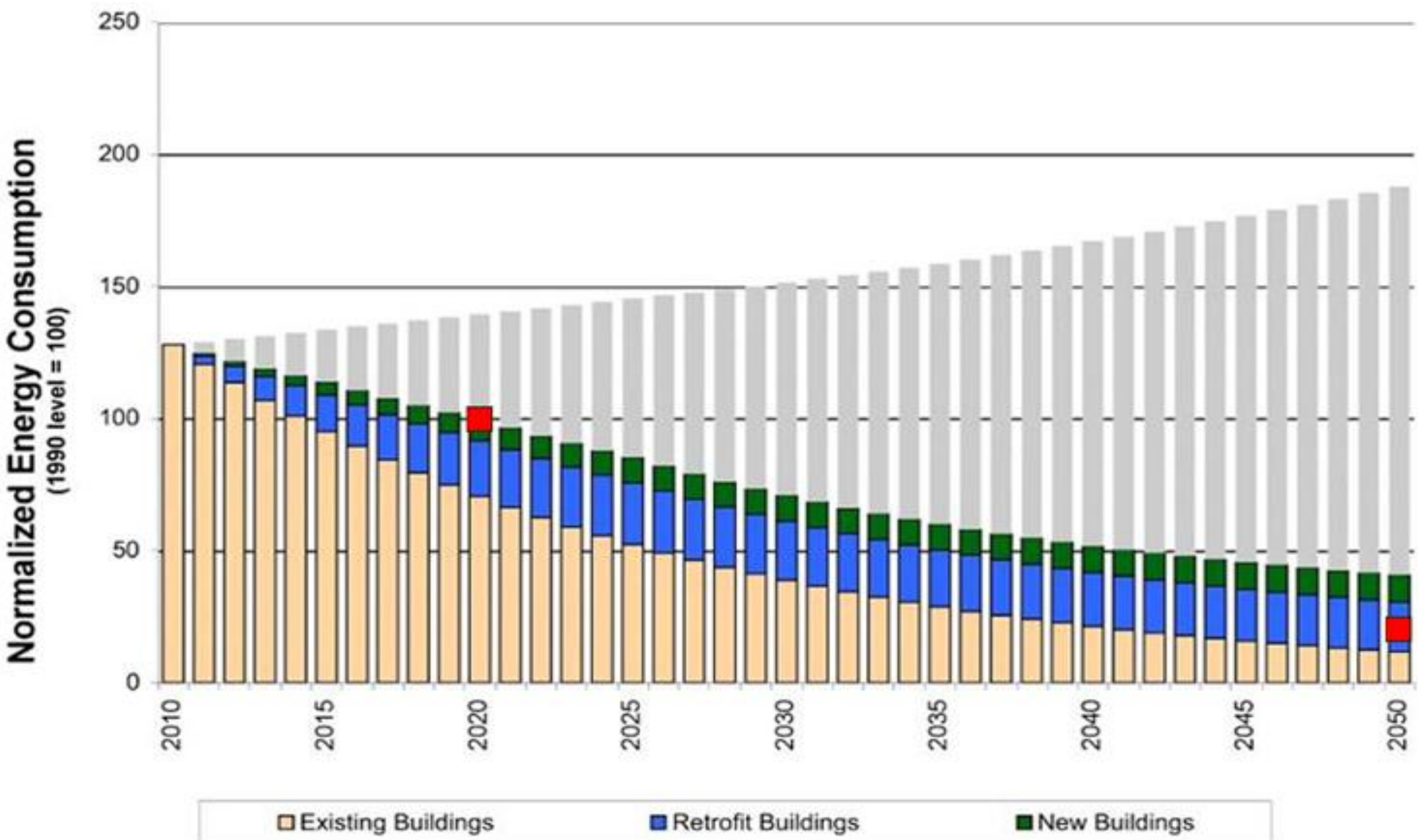
Incremental Improvement 2:
US Refrigerator Energy Use & Price



Success at approaching zero

- Over 100 buildings have been identified that get to 50
  - Several buildings reduced designed energy use by 70-80%
    - Modest amounts of PV could get these to zero
    - www.newbuildings.org/advanced-design/getting-50-beyond
- How to get there, technically:
  - It is rare to achieve low energy use without integrated daylighting control.
  - Features previously considered as innovative, such as natural ventilation and underfloor air/displacement ventilation, appear to be growing trends.
  - Low-energy buildings were found across the country, but more were located in states with strong energy efficiency programs.
- How to get there with policies
  - Moderate-term incentives with leading edge targets, ~ 50 and 30.
  - Monitoring of actual performance to allow capitalization of savings.

Meeting California's Climate Goals



Questions & Discussion

Tight Thermal Envelope with Solar Heat Gain Control


AHU 1