Efficient Buildings in Sustainable Communities: Approaching Net Zero ***Total*** Energy

David B. Goldstein
Natural Resources Defense Council

Presented at the **ACEEE 30th Anniversary Symposium**
Laying the Foundation for 2040:
Inventing the Future for a Low-Energy Building Stock
Monday, March 7, 2011
University of California Washington Center
Washington, D.C. 20036

THE EARTH'S BEST DEFENSE

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 adds ~5%
    - This percentage will be more important as everything else declines
  - Water use in and around buildings adds ???
- We have more experience saving energy at low cost in buildings than in other uses
  - Therefore energy use in buildings themselves must be cut by more
- An 80% goal means considering this entire ~75% together

Risks of a Stove-Piped Approach

- 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”
- Siting renewable energy inappropriately
- Wasting embodied energy/emissions
- We risk solving one problem alone at the expense of the others when we could address them all: for example energy efficiency mortgage underwriting versus consideration of energy, transportation, and water costs

Sub-Optimization 1:
Solar/wind Access vs. Density

Sub-Optimization 2: Energy vs Location Efficiency

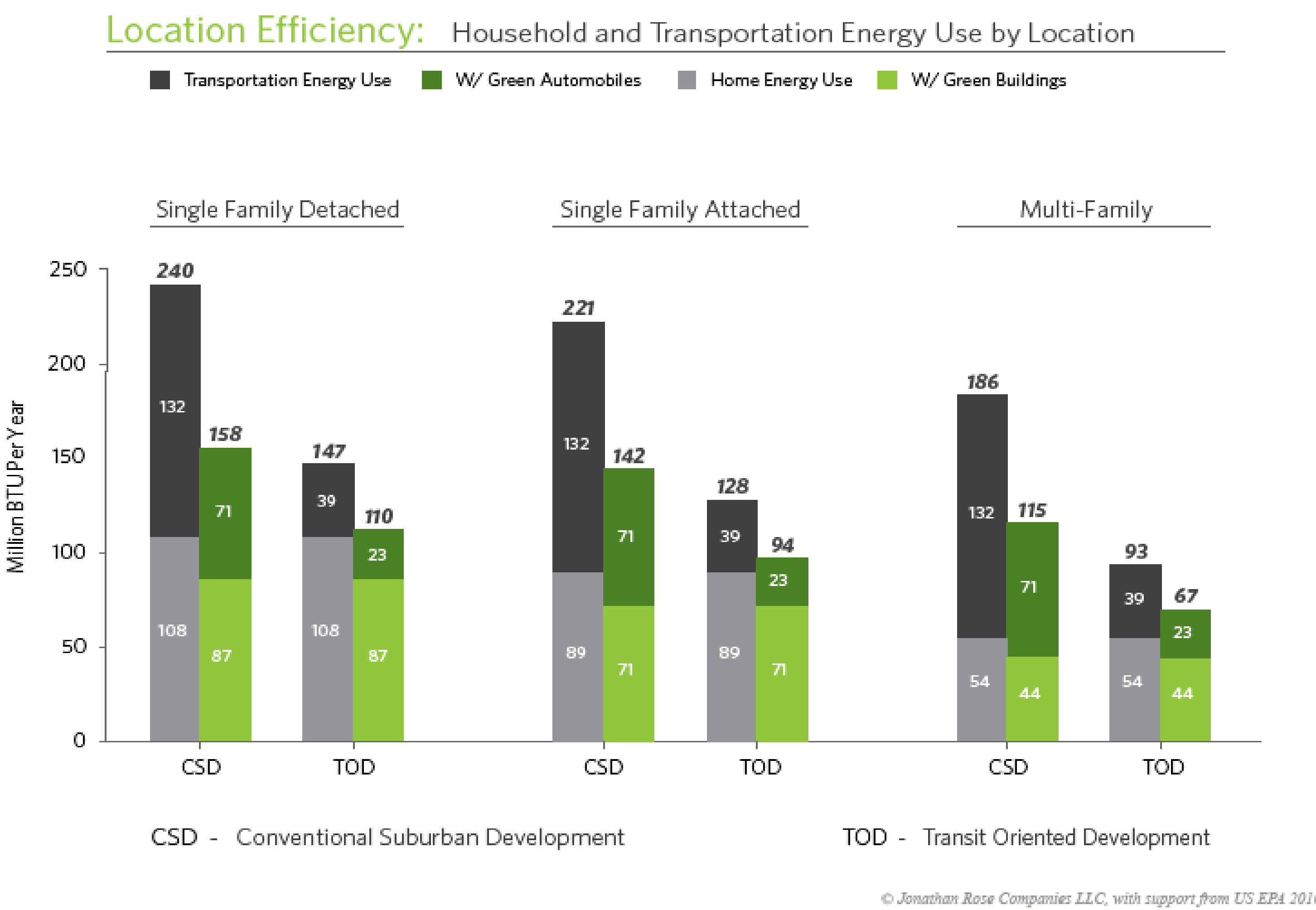
NRDC
THE EARTH'S BEST DEFENSE

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 1 and 2: Transportation Energy is Key



Maintaining Historic Built Environments

- Savings from exploiting existing infrastructure
- Cultural values of historic neighborhoods help make location efficiency more attractive in the market
- Efficiency retrofits can allow existing electric, gas, and water infrastructure to serve growing populations
- Older neighborhoods with low location efficiency can be retrofit to increase density, transit, mixes of uses, and pedestrian/bike friendliness
  - This can be done without demolishing all the old structures

Existing Conditions
(Mount Pleasant, SC)

Sidewalks and Street Lamps Enhance Walkability

On-Street Parking Reduces Need for Parking Lots

New Mixed-Used Development on Vacant Lots

More Growth Without Sprawl

Palmetto Trees for Regional Character

Shade Trees on Near Sidewalks

Additional Trees Curb Local Temperatures, Absorb Carbon

Street Trees on Near Side

Improved Environment Attracts Street Life

Adapting the Median for Future Public Transportation

Light Rail in Median

Embodied Energy in Construction

- We have life cycle analyses (LCAs) of construction that show energy use 10-20% as large as energy operation
  - Thus ~4-8% of GHGs
  - Compared to 19% for operation when we cut use by half:
  - See: http://www.thegreenestbuilding.org/ for an example calculation
- But this analysis is generic
  - Individual choices require product-specific data to inform tradeoffs:
    - Retrofit versus demo and replace
    - Mass construction and extent of fenestration
  - Product-specific data can likely be generated using systems now in existence or development
    - PAS 2050
    - WRI project with EPA
    - Supply-chain initiatives by private-sector companies

Embodied Energy in Infrastructure

- Embodied and indirect energy savings possibilities:

  Suburban homes use (Davis, CA) as a typical Nob Hill apartment (San Francisco):

  * 5x the copper pipe
  * 35x the land
  * 15x the roadway
  * 4x the lumber
  * mail carrier travels 300x as far
  * 70x as much water
  * 5x as much heating

  Ref: Phillips & Gnaizda, *CoEvolution Quarterly*, Summer 1980

- Thus savings are possible both from more compact new development but even more from using existing infrastructure for infill development

Embodied Energy in Infrastructure II

- Analysis in previous slide suggests that this may be quite large for sprawl and relatively MUCH smaller for smart growth
  - But this analysis is old and not very rigorous
  - Other informal analysis suggests a large fraction of industrial energy use ends up in sprawl infrastructure
- This is a major research vacuum
- An energy-based argument for retaining historic buildings
  - Analysis is suggesting that older buildings may be almost as easy to retrofit as newer ones

Zero Net Energy Policies as a Driver

- Many agencies and jurisdictions have adopted zero-net-energy goals for 2020-30
- These goals can drive simple building efficiency (and renewable energy) policies in the short term\
  - CA’s incentives for advanced EE and solar in new construction
- But as we approach these goals, we need to define the energy we are trying to zero out more inclusively
  - This will re-scale “zero” and make it harder to achieve

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 options
  - 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

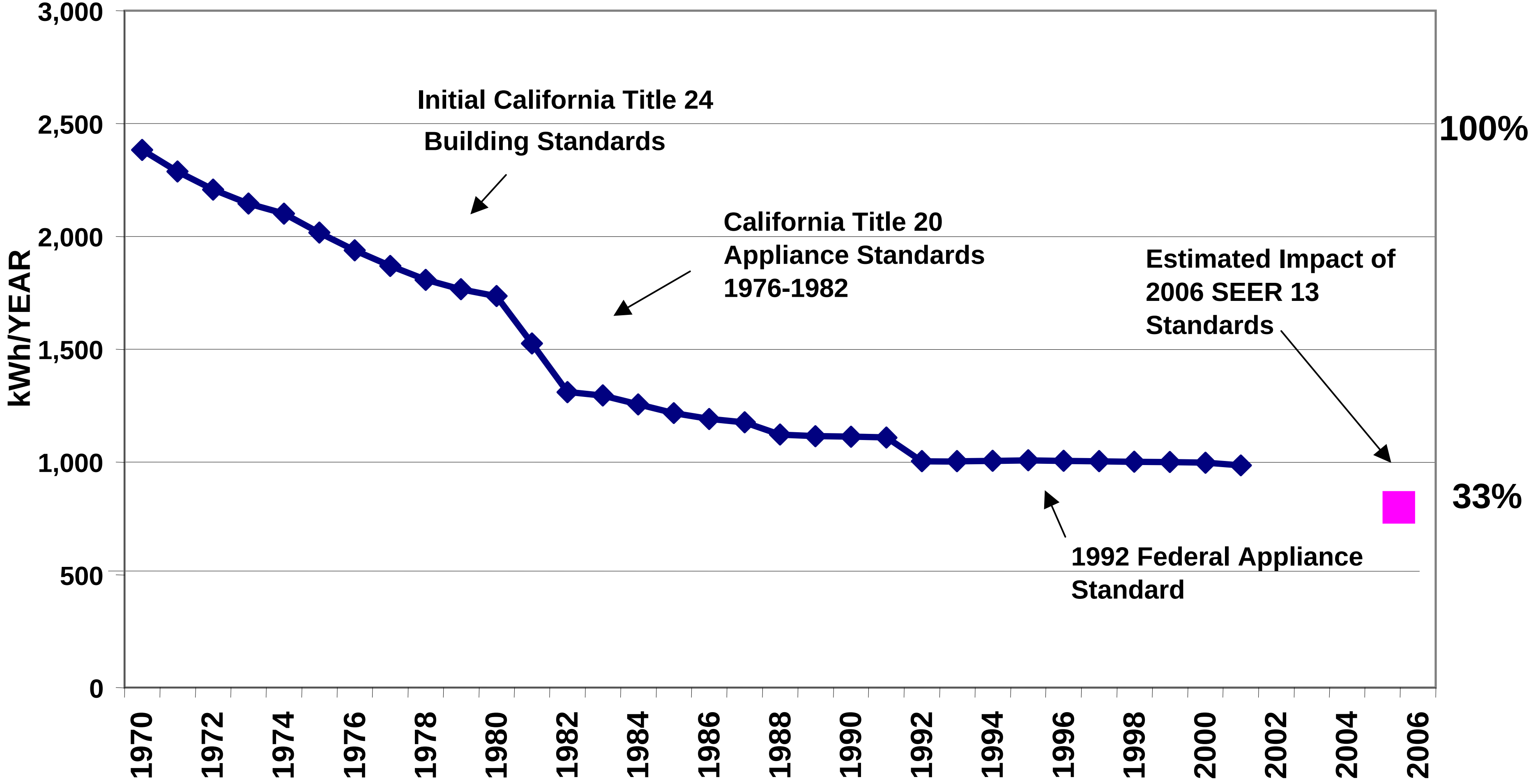
- Where is it best for our renewable energy sources to be?
  - To what extent does this depend on the scale of renewable generation?
- What are the real-world constraints on getting more from renewables?
  - Does promoting renewables on-site avoid some of the constraints?

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
  - Visionary Future scenarios like Disney, Brasilia, or Dulles “mobile lounges”
- We have templates for how to plan for smarter growth
  - SB 375 and improved modeling algorithms
  - Financing reform
- 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

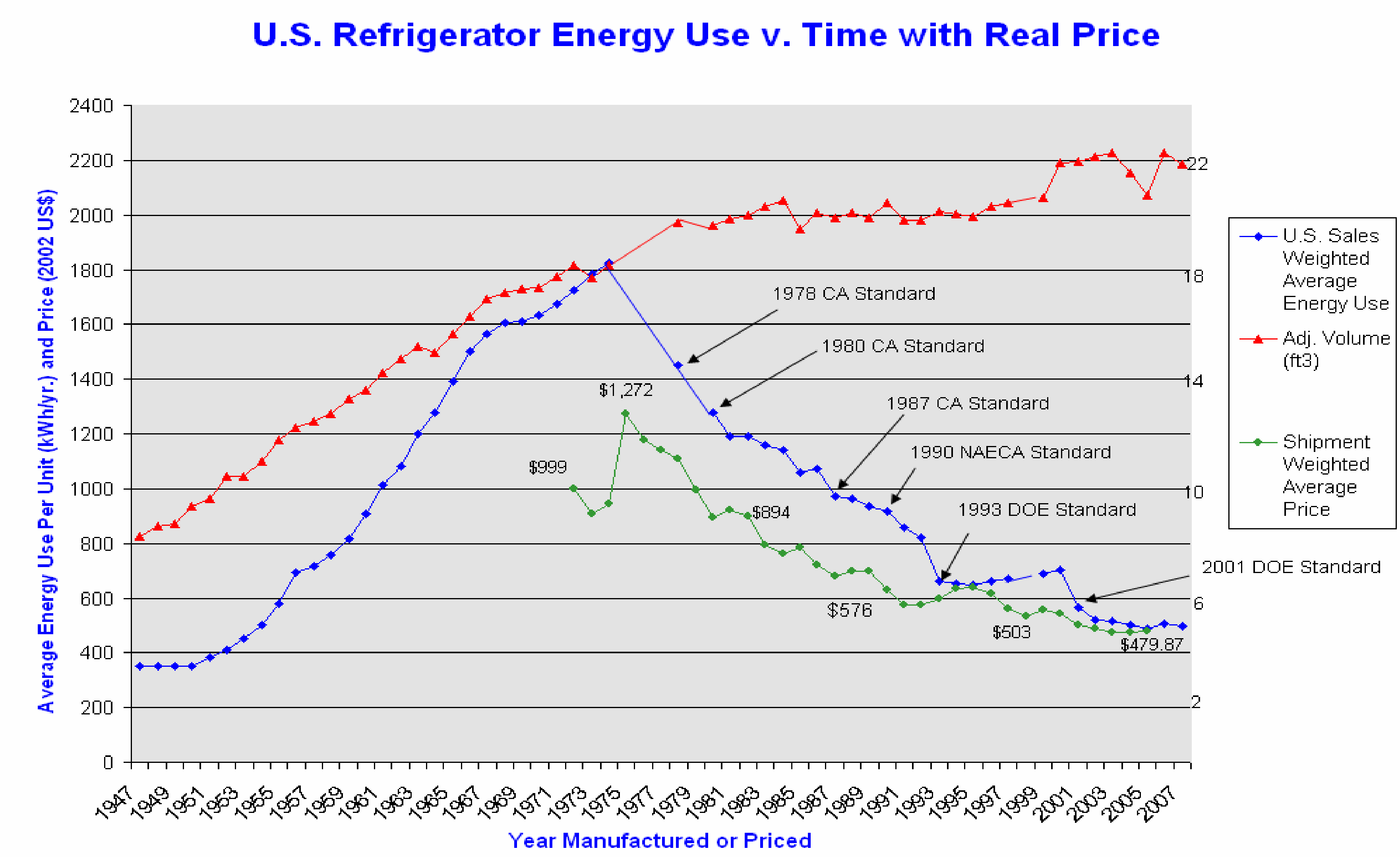
Incremental Improvement:

Annual Usage of Air Conditioning in New Homes in California



Source: CEC Demand Analysis Office

Incremental Improvement 2:
US Refrigerator Energy Use & Price



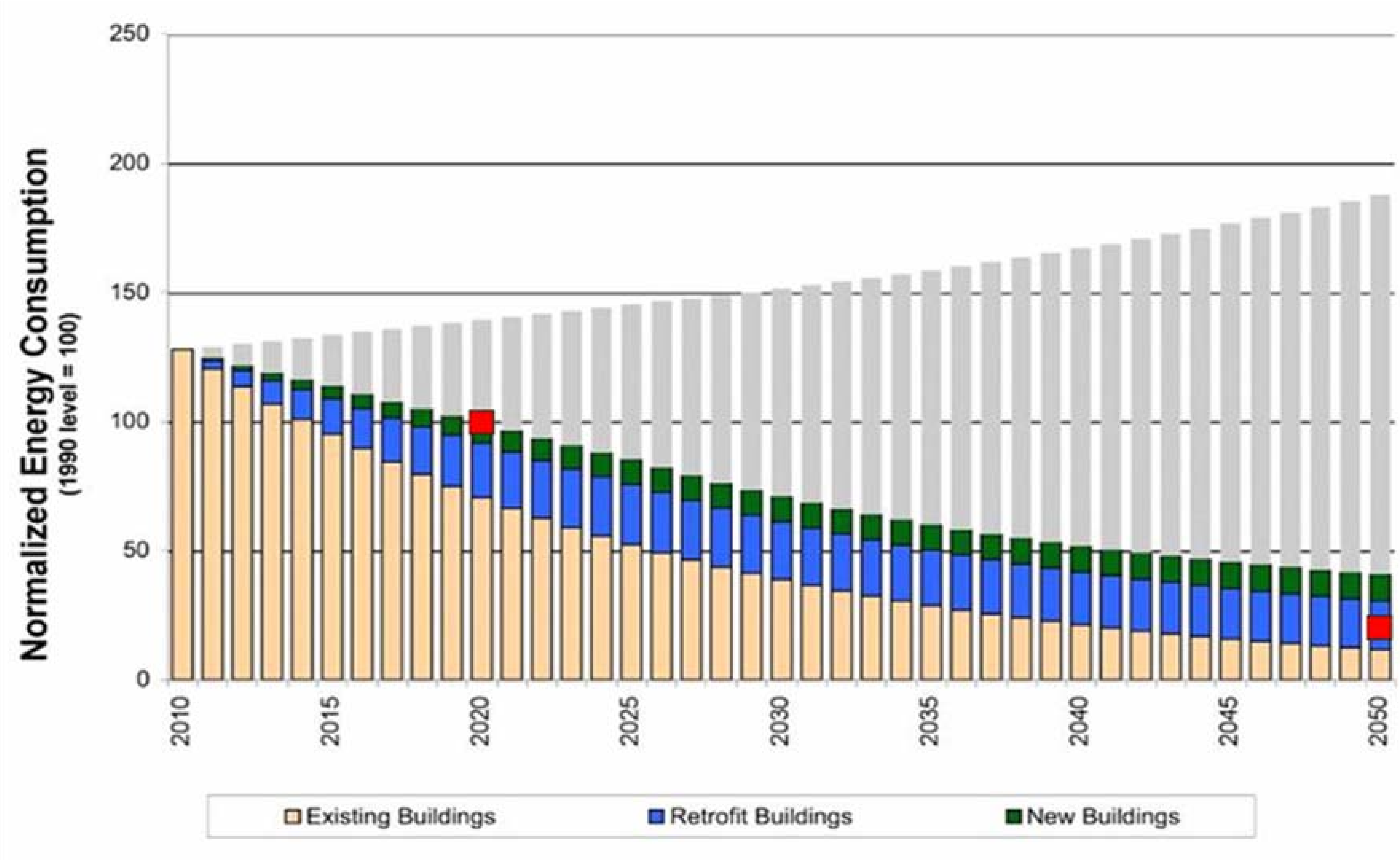
Success at approaching zero in commercial buildings

- 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.

Success at Approaching Zero in Homes

- Tax credit for 50% heating and cooling savings
  - ~500 Building America homes that (almost) met target by 2005
  - Tax credit of $2000 was enacted in EPACT 2005, and extended in small bites through 2011
    - NAHB did not even support credit because they claimed the target was impossible to meet
  - Market share of compliant homes sold rose to:
    - 0.8% in 2006
    - 3.0% in 2007
    - 4.6% in 2008
    - 10% in 2009
  - Largest U.S. homebuilders will label all their new homes for EE and promote very low HERS indices

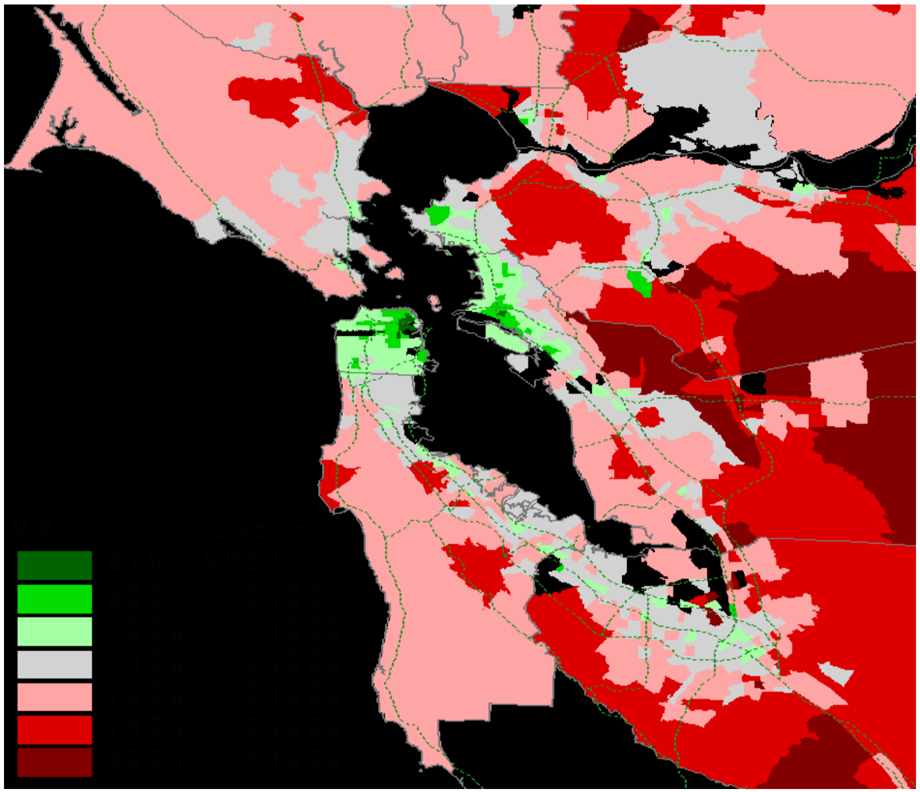
Meeting California's Climate Goals

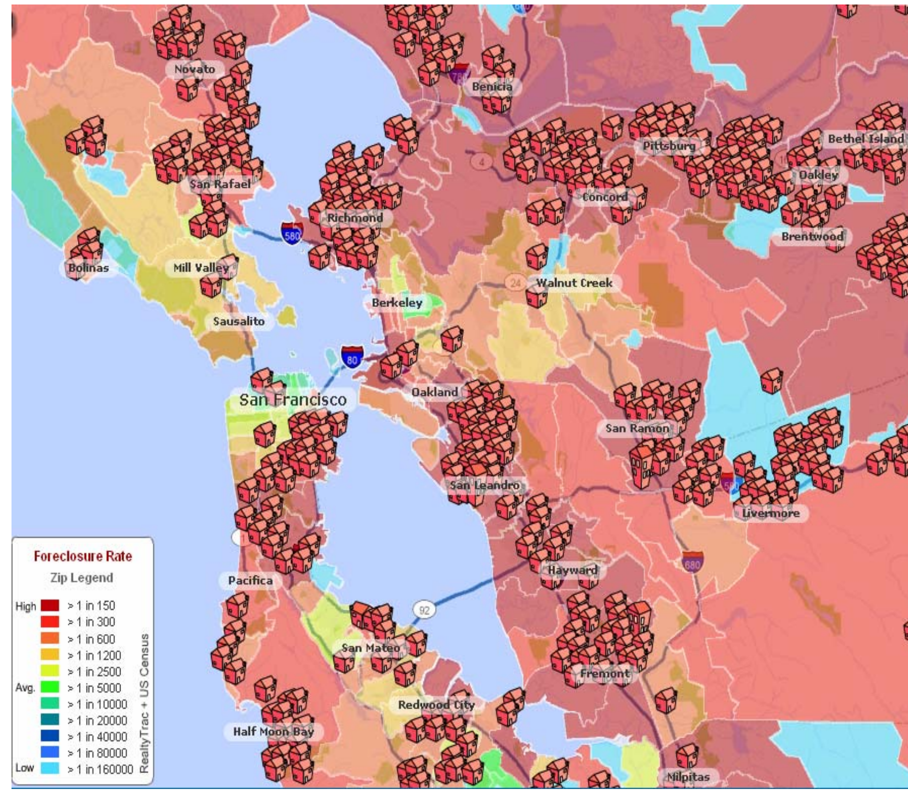


A Primary Cause of the Recession

- For a typical house in suburban sprawl:
  - The median price is $175,000
  - The average 30-year commitment to utility costs is $75,000
  - The cost to drive to and from it is $300,000.
  - (Utilities and transportation could be cut in half by green building practices and smart growth)
- It is not surprising that a lending system that looked only at the $175,000 commitment and not the $375,000 went wrong.

Household Mileage v. Foreclosures





Sources: Center for Neighborhood Technology; http://hotpads.com.

Questions & Discussion

Tight Thermal Envelope with Solar Heat Gain Control




Hybrid Dedicated Outside Air System (DOAS) with Natural Ventilation

High Use of Daylighting

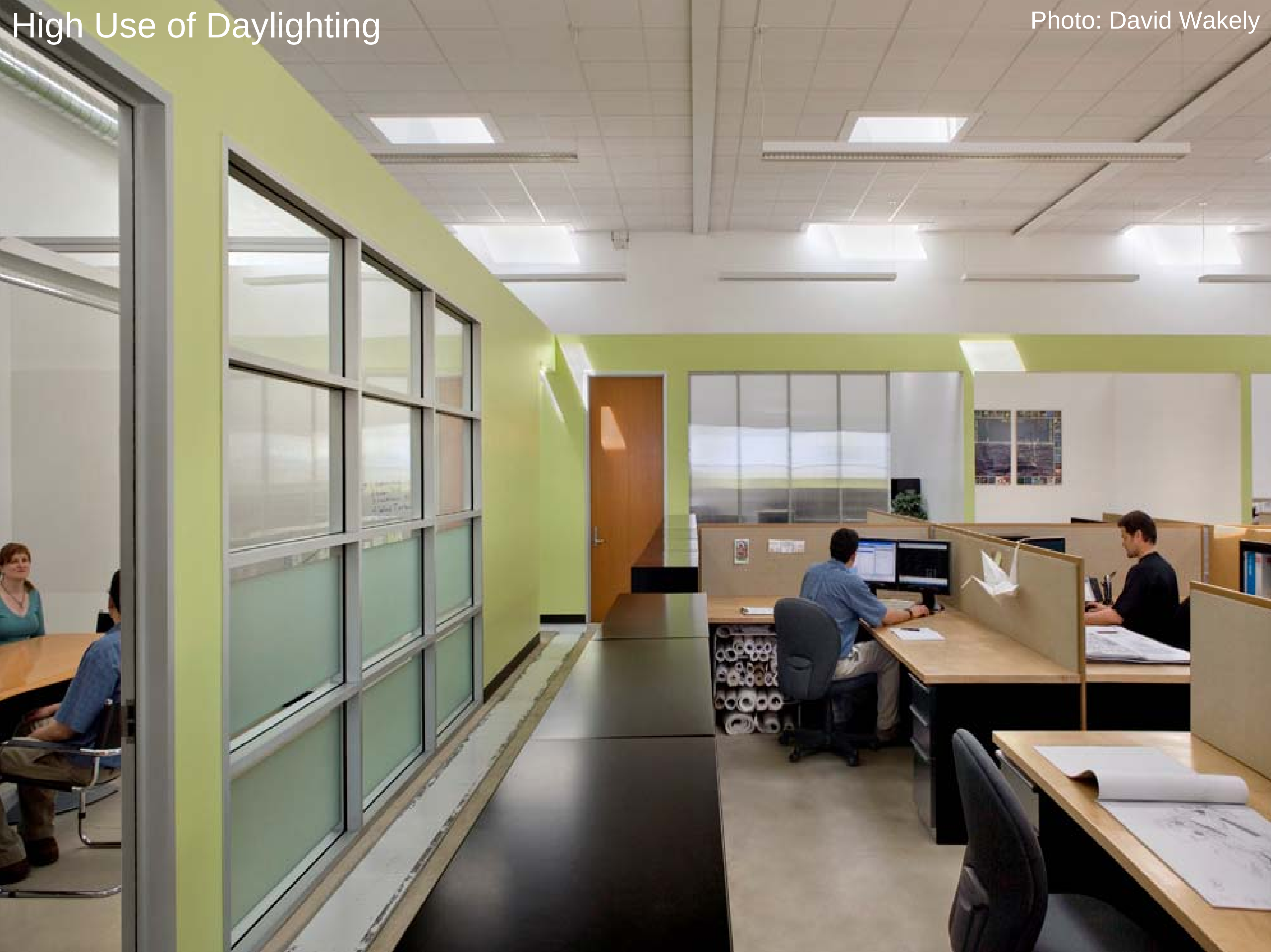


Photo: David Wakely