Bureau of Energy Efficiency

सत्यमेव जयते
Government of India
Ministry of Power

german cooperation
DEUTSCHE ZUSAMMENARBEIT

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

ANGAN

Augmenting Nature by Green Affordable New-habitat

A Courtyard for Revolutionary Change in Building Energy Efficiency

An International Conference on Building Energy Efficiency

9th-11th September, 2019 | Hotel The LaLiT, New Delhi

Bureau of Energy Efficiency

सत्यमेव जयते
Government of India
Ministry of Power

german cooperation
DEUTSCHE ZUSAMMENARBEIT

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

THIS PRESENTATION WAS SHARED BY

David Goldstein

Natural Resources Defense Council

FOR THE SESSION:

"Steps towards Net Zero Energy Buildings"

DURING ANGAN 2019

Knowledge Partner

teri The Energy and Resources Institute
Creating Innovative Solutions for a Sustainable Future

Event Partner

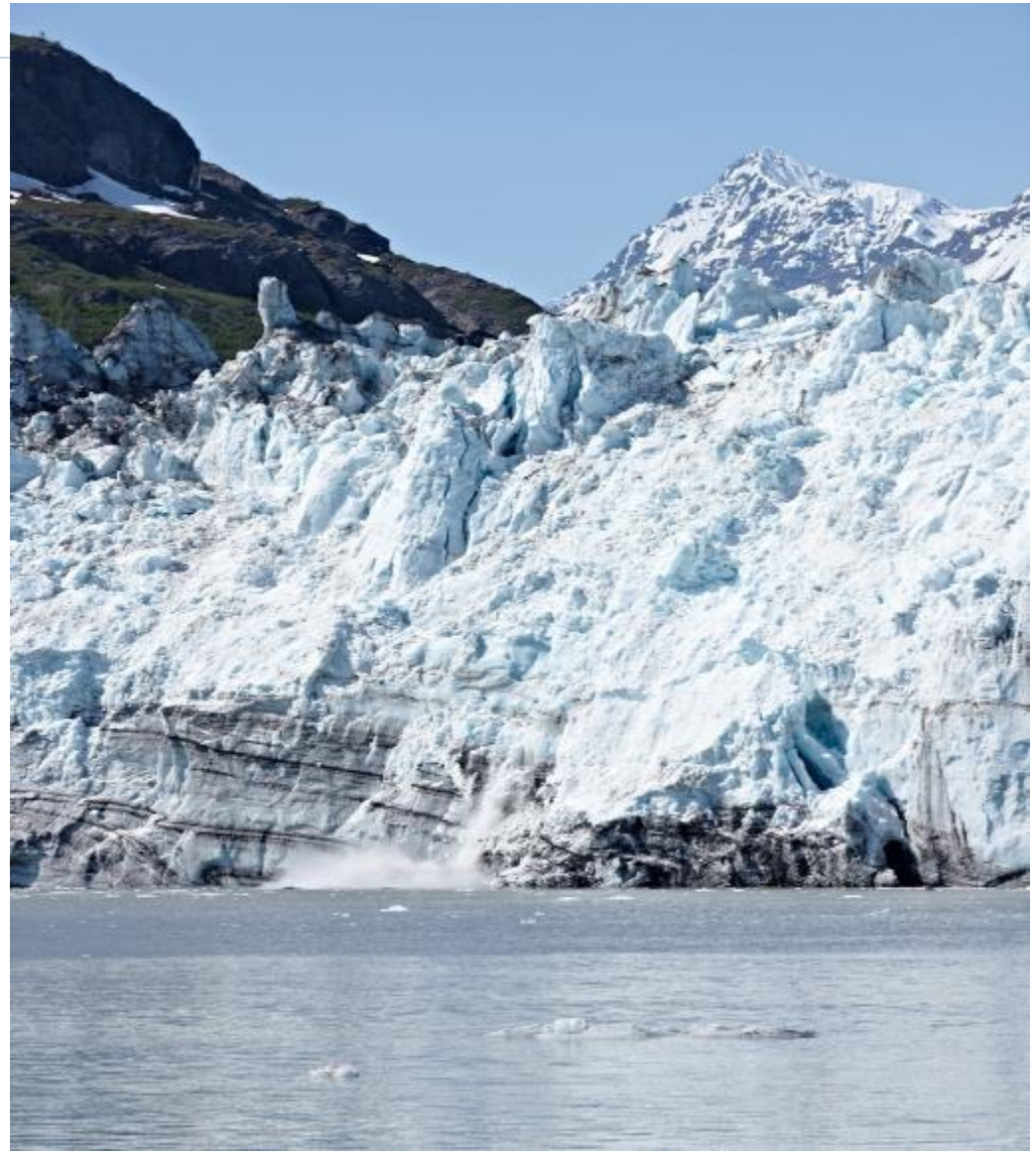
TEC INDIA™
Event & Brand Management Co.

Zero Energy Standards: Global Policies

David B. Goldstein, Ph.D.

Natural Resources Defense Council

Climate Change: Melting Glaciers

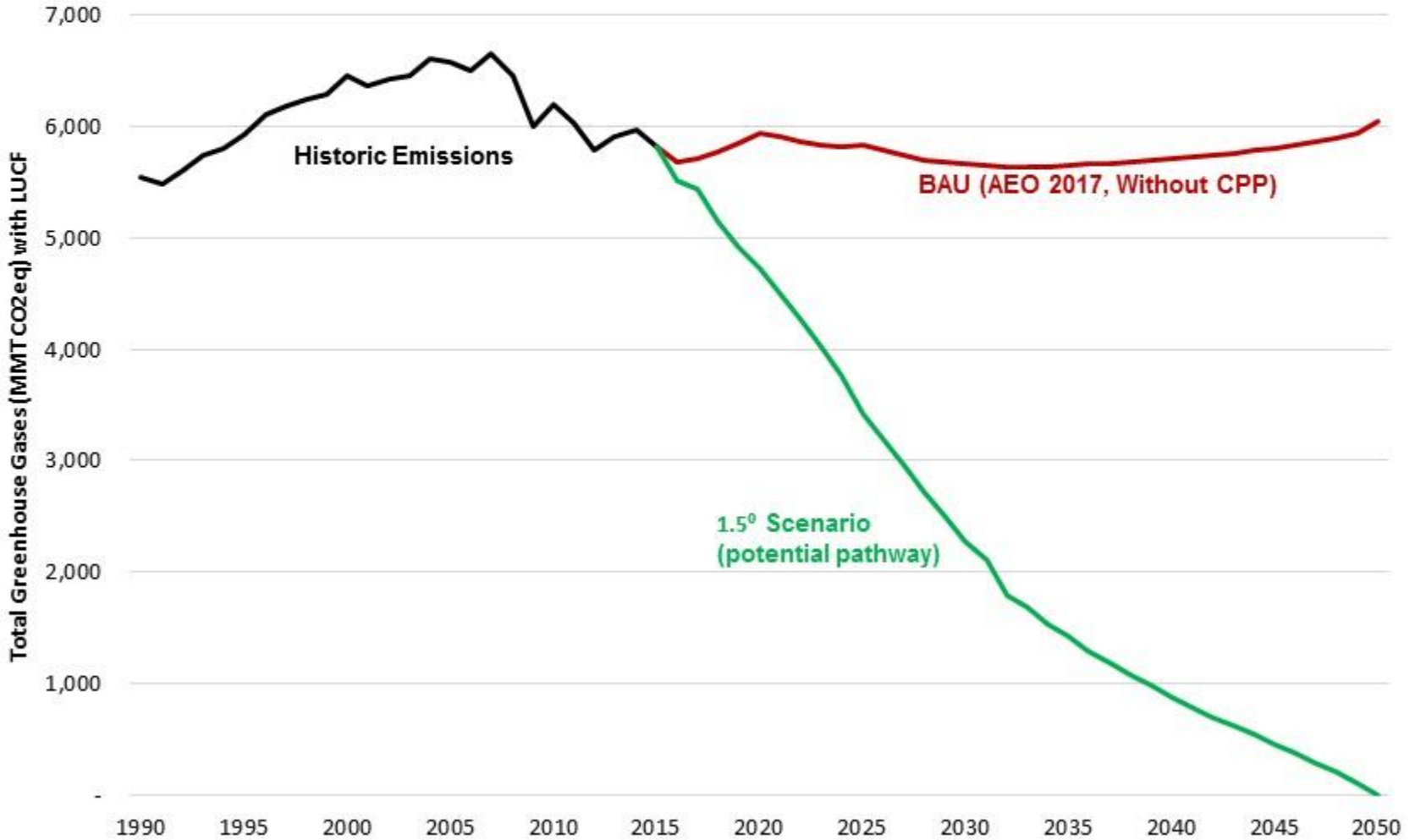


Climate Change: Forest Fires

Introduction to Zero Net Energy (ZNE)

- Zero net energy goals are an important tool for meeting globally accepted climate goals (see next slide)
- This talk describes 4 levels of “zero” with increasing levels of ambition
- These levels can be integrated with the continual improvement goals in ISO 50001 and “Strategic Energy Management”

One U.S. Pathway to Paris 1.5C Goal



“Nothing is better than zero”

Zero Energy has attracted rapidly growing interest around the world

Growth rates of projected and verified Zero Energy buildings are continuing to be high

- Some industrial facilities claim Zero Energy performance

Zero Energy is an easily understood concept that ***helps make efficiency visible***

Zero Energy buildings ***may not cost more to build*** than conventional practice, but they provide non-energy benefits such as comfort, health, etc.

Zero Energy *industrial plants* may also provide improved profitability and quality

But…

- What do we mean by zero?
  - Zero Net Energy (ZNE) does not mean zero energy bills
  - After Zero Net Energy facilities--or even stand-alone solar and wind energy--become common, Zero Net Energy does not mean zero emissions from the grid
- Key questions this talk will address:
  - What is the scope of a Zero Energy facility: how do you count energy?
  - How can you zero out ***emissions***?
    - What if you count supply chain energy of construction of the facility?
    - What if you count transportation energy to service it?

What is a Zero Net Energy Building?

A Zero Net Energy (ZNE) building* is highly energy efficient and meets ≥100% of its annual energy from renewables.

- ***Energy*** *= All energy (electric, gas, steam, liquid fuel etc.) consumed on site*
- ***Net*** *= One year or more of on-site renewable energy production minus energy use*
- ***Verified*** *= A year of more of documented performance at net zero*
- ***Emerging*** *= not yet a year or more of data (may be on a path to ZNE)*

**Also known as Net Zero Energy (NZE), or Zero Energy (ZE). Zero Energy Building (ZEB)*

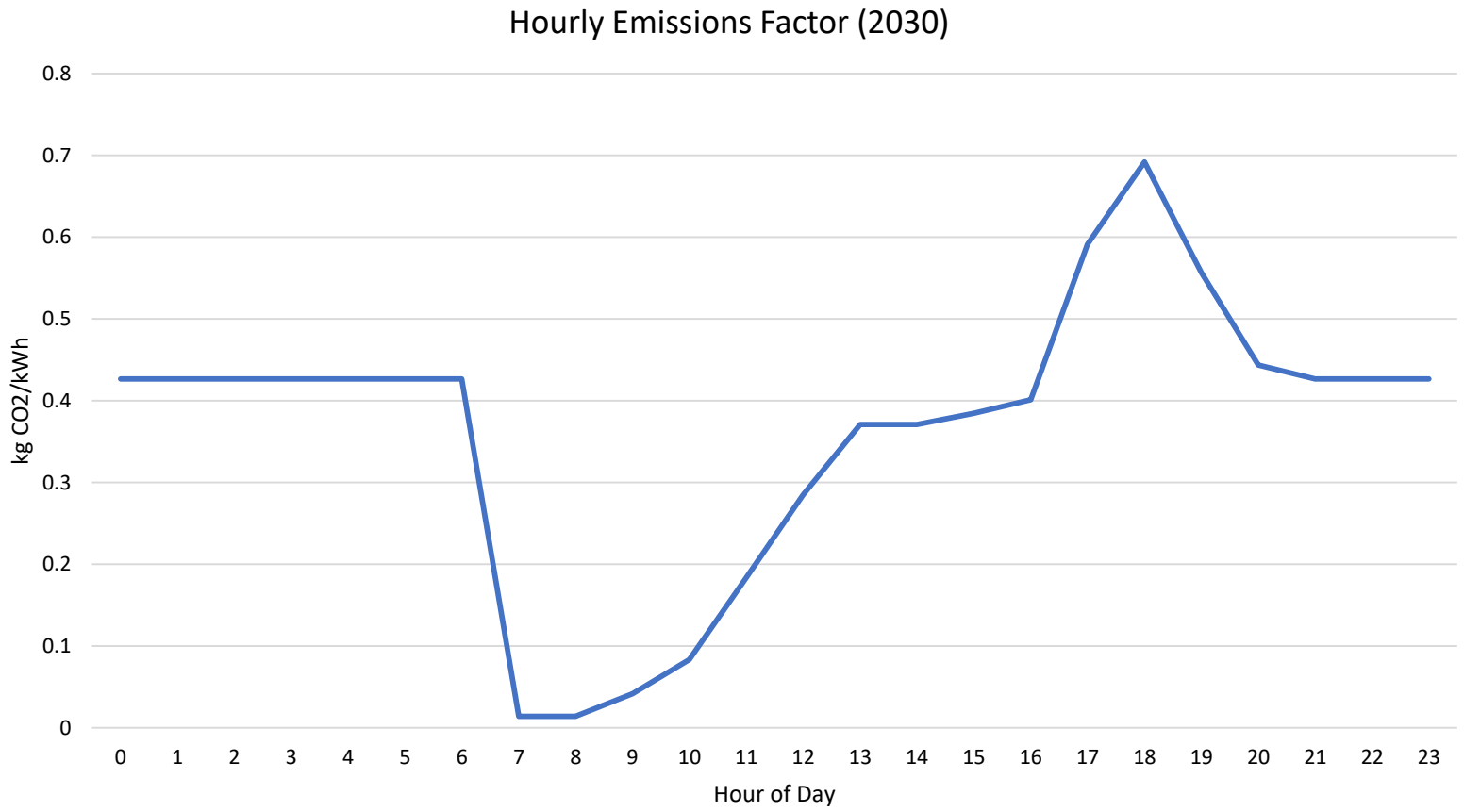
Zero Net Energy is the same thing as 100% renewable energy, right?

- Not exactly:
  - 100% renewables can be achieved by just spending money, while ZNE requires thought and action within the facility
  - 100% renewables might include renewable energy far removed from the plant site (such as solar in Sri Lanka for a plant in Alabama)
    - Are the offsite renewables additional? How do we know?
- ZNE *buildings* almost always are extremely efficient: efficiency comes first and renewables second

What about net zero carbon?

- As noted net zero energy equals net zero carbon only for a grid with minimal variable-output renewable energy sources. If most facilities achieve ZNE, this equality ceases to be the case:
  - Energy produced when the sun is shining is hard to use; and
  - Energy consumed after the sun goes down is more problematic
- There are two dimensions to this mismatch: Diurnal and Seasonal
  - Energy storage is not difficult (but not cheap) on a diurnal basis
  - but storage more challenging on an annual basis

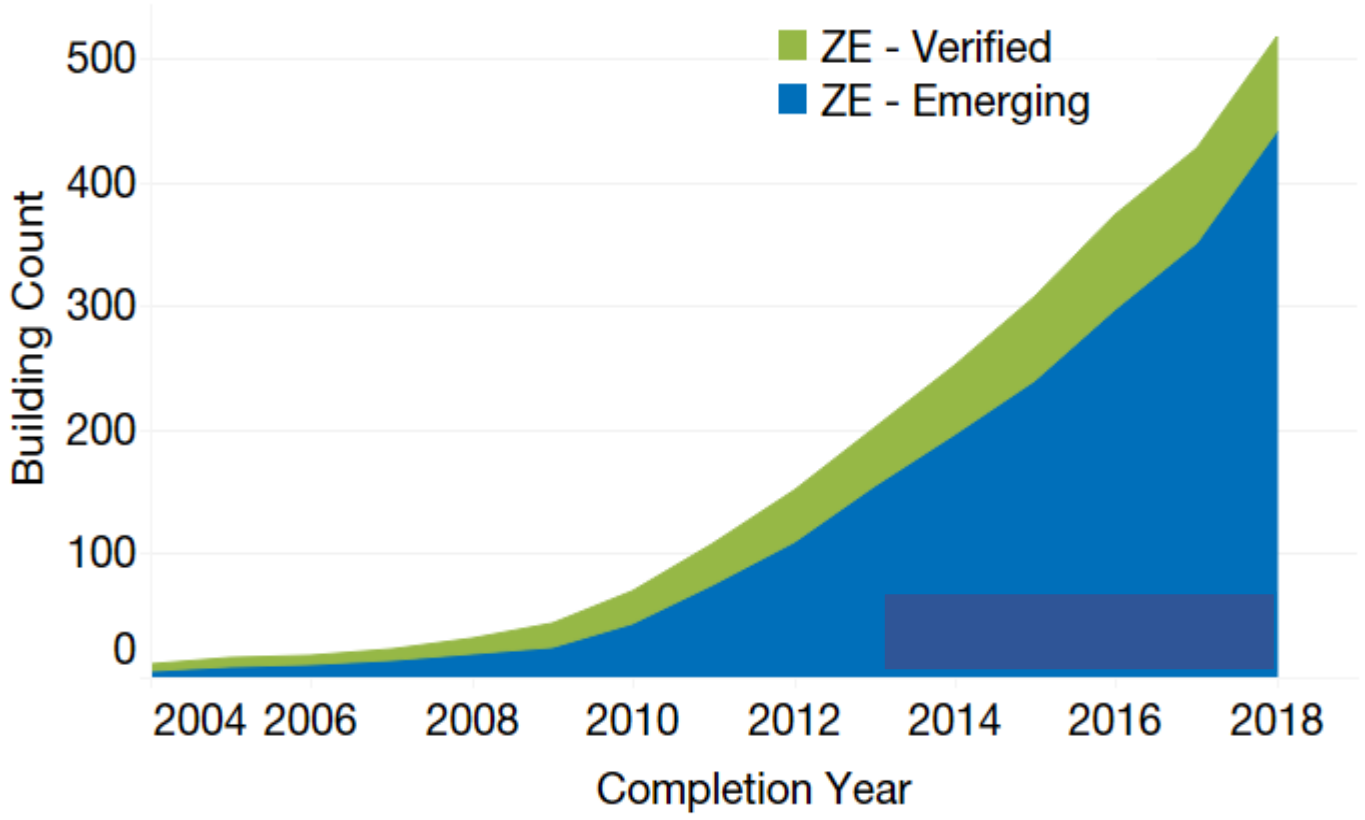
California GHG Emissions Factors 2018



* CPUC Avoided Cost Model 2018: http://www.cpuc.ca.gov/General.aspx?id=5267

Growth in Zero Energy Buildings

Growth by Construction Year



Growth in NBI's
Getting to Zero List

482 total

ZNE - Emerging	443
ZNE - Verified	76
Grand Total	**519**

Private Sector is Paying Attention to ZE

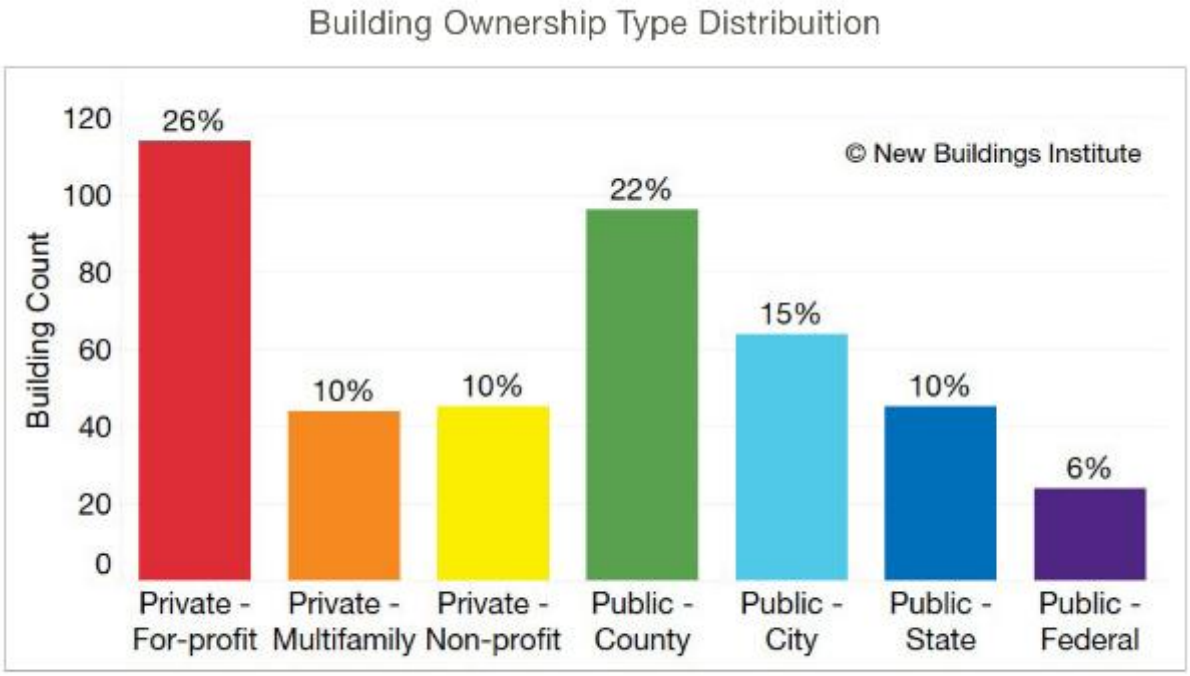


Fig 8. Buildings owned by for-profit companies now making up 26% of the List.

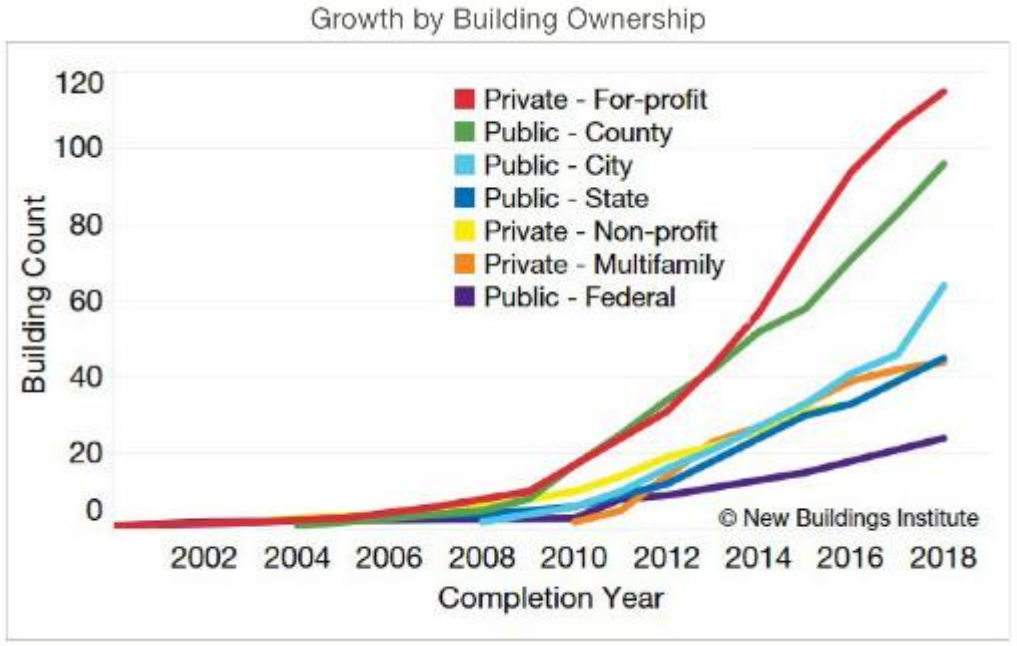


Fig 10. ZE Verified and ZE Emerging projects by ownership. Projects with missing ownership data are excluded.

- 26% of the full list is **for-profit private** sector buildings and overall private ownership is now at 46%.

Schools Rule, but many building types are getting to zero

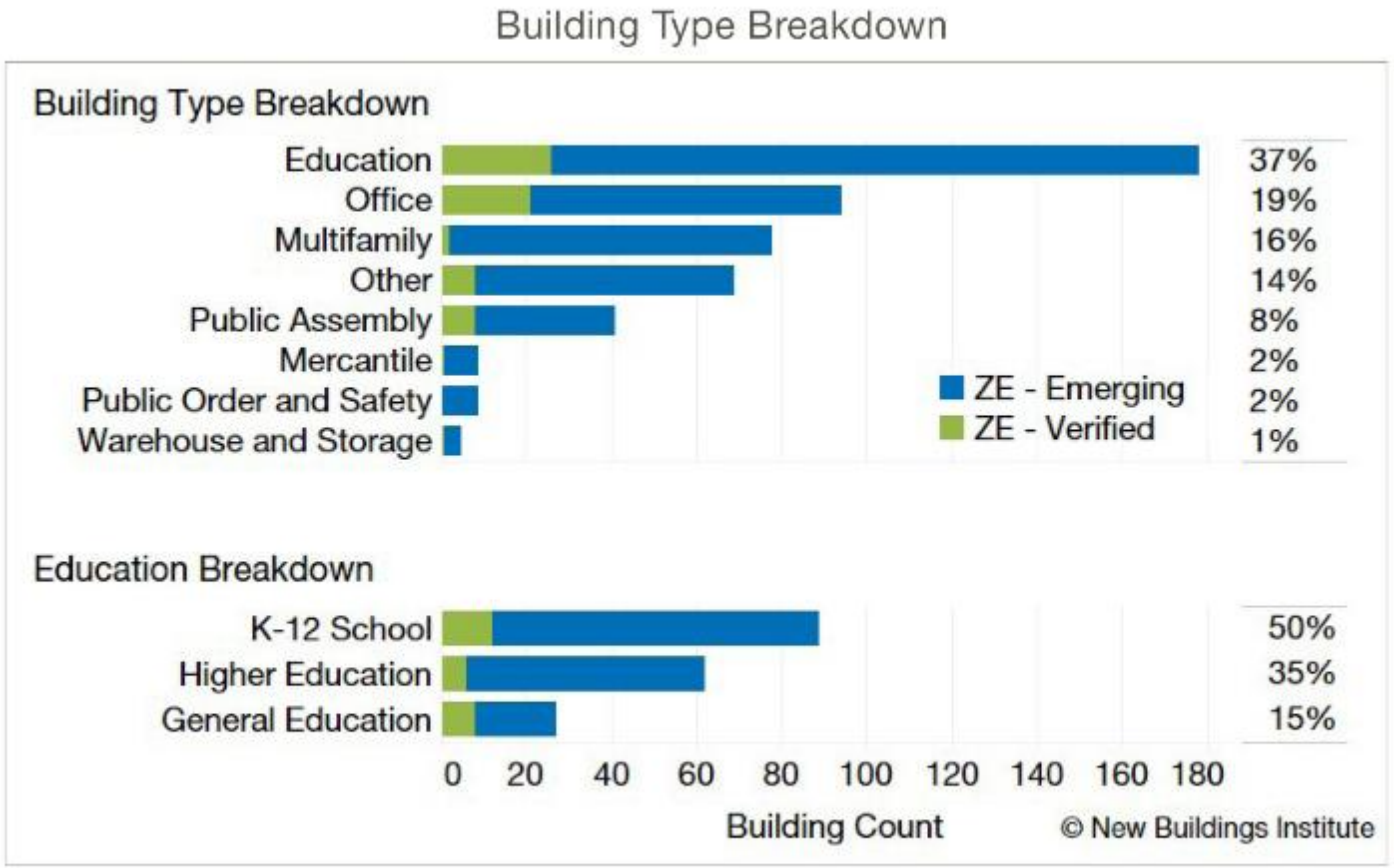


Fig 7. Zero energy buildings can be found across many different building types.

Putting Performance into Perspective

ZE Verified buildings on average use **60% less energy** than comparable existing U.S. commercial buildings and 46% less than new buildings under one of the most stringent U.S. base code (California Title 24).
[20kBtu/sf is about 60 kWh/square meter]

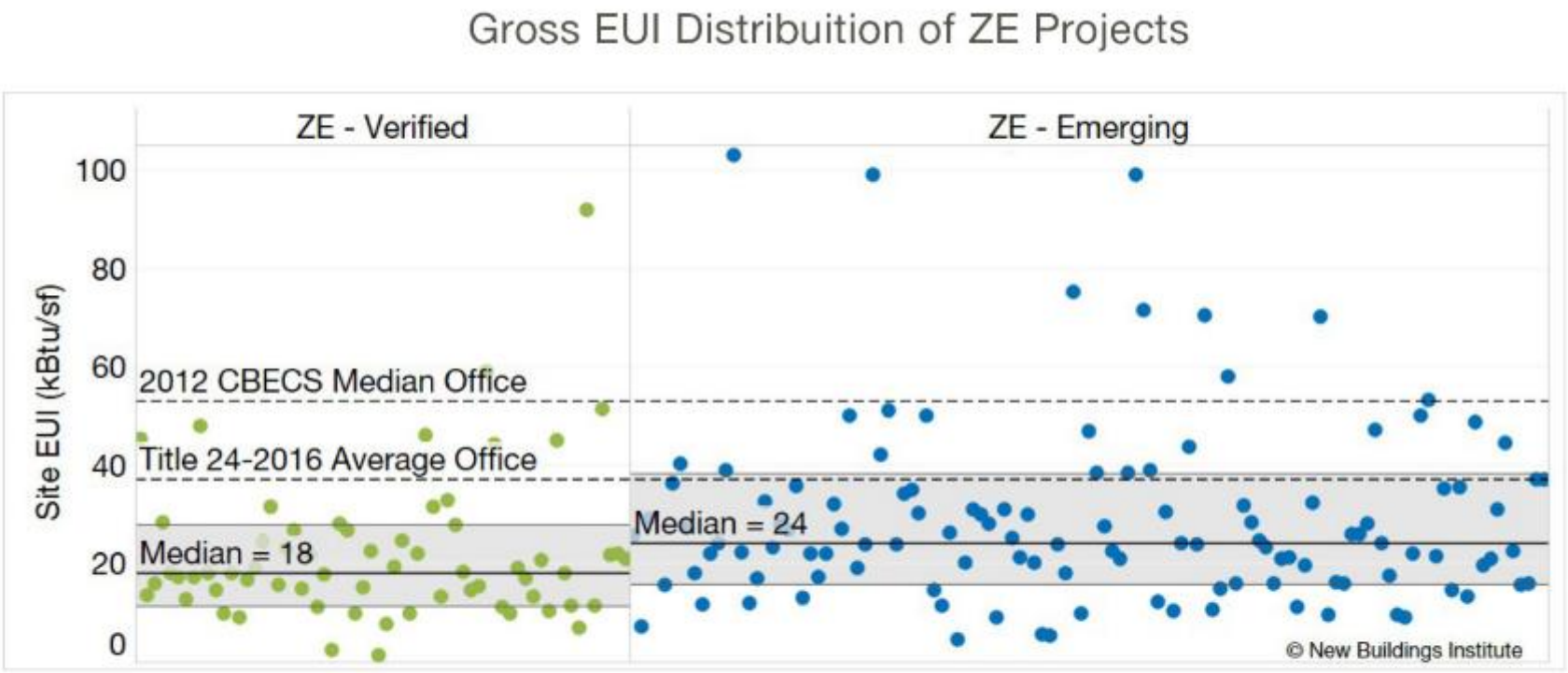
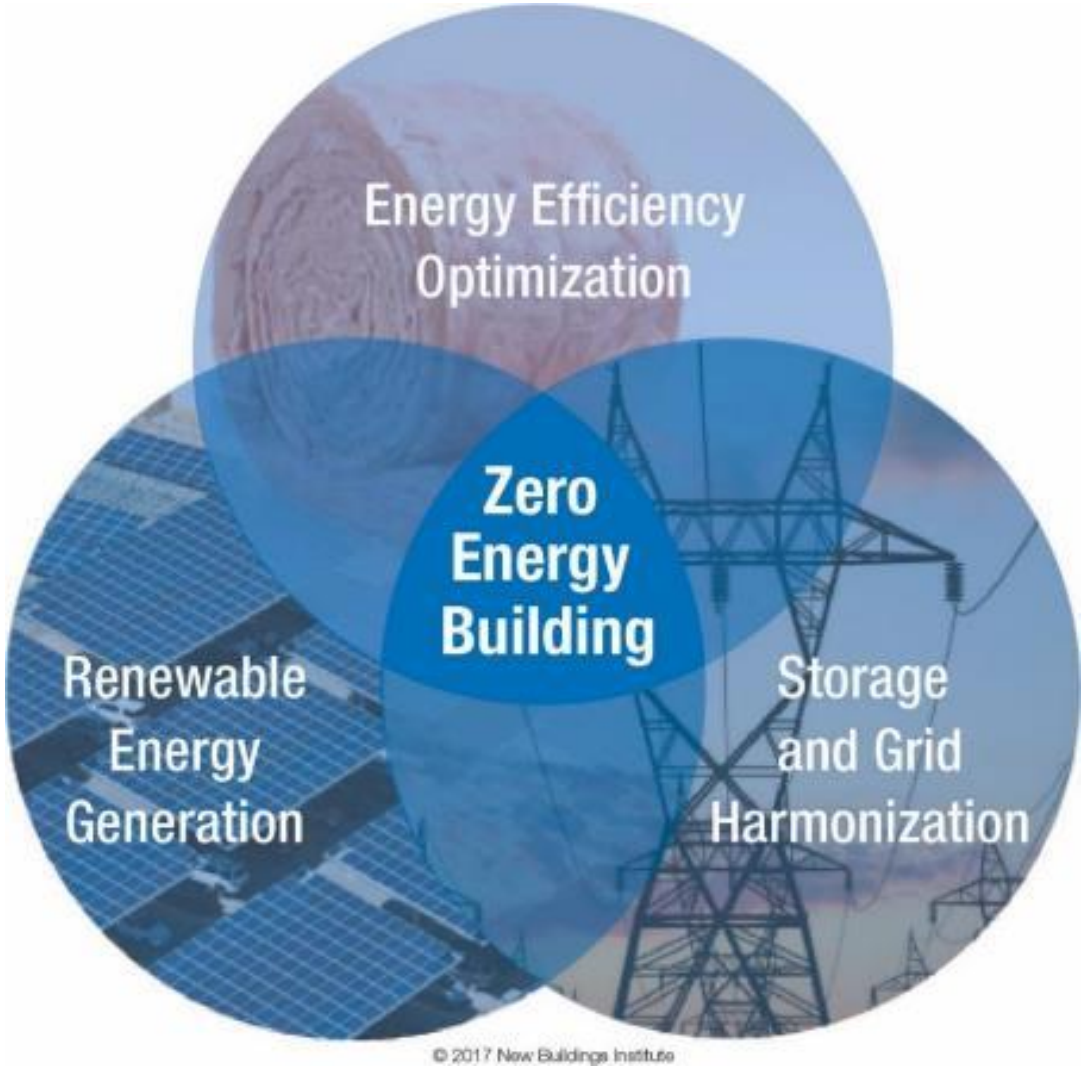


Fig 5. This chart shows the range of energy usage (gross site EUI, not including renewables) for the zero energy projects in this List. The grey band covers the 20th to the 80th percentile in each group.

Complementary Elements of Zero Energy Buildings



Example from United States

- Building codes are adopted and enforced at the state or municipal level
  - There has never been deep federal efforts on codes
- Most states adopt model codes adopted by NGOs often with changes, generally weakening changes
- Many cities are adopting mandatory disclosure of energy performance data and mandatory energy audits or retrofits
- An increasing number of states require utilities to fund energy efficiency programs with numerical targets that have grown to 3%* annually
  - The Consortium for Energy Efficiency has a program specification for Zero Net Energy residential new construction. https://library.cee1.org/content/cee-residential-new-construction-initiative/

*(savings achieved in year N's program compared to energy sales in year N)

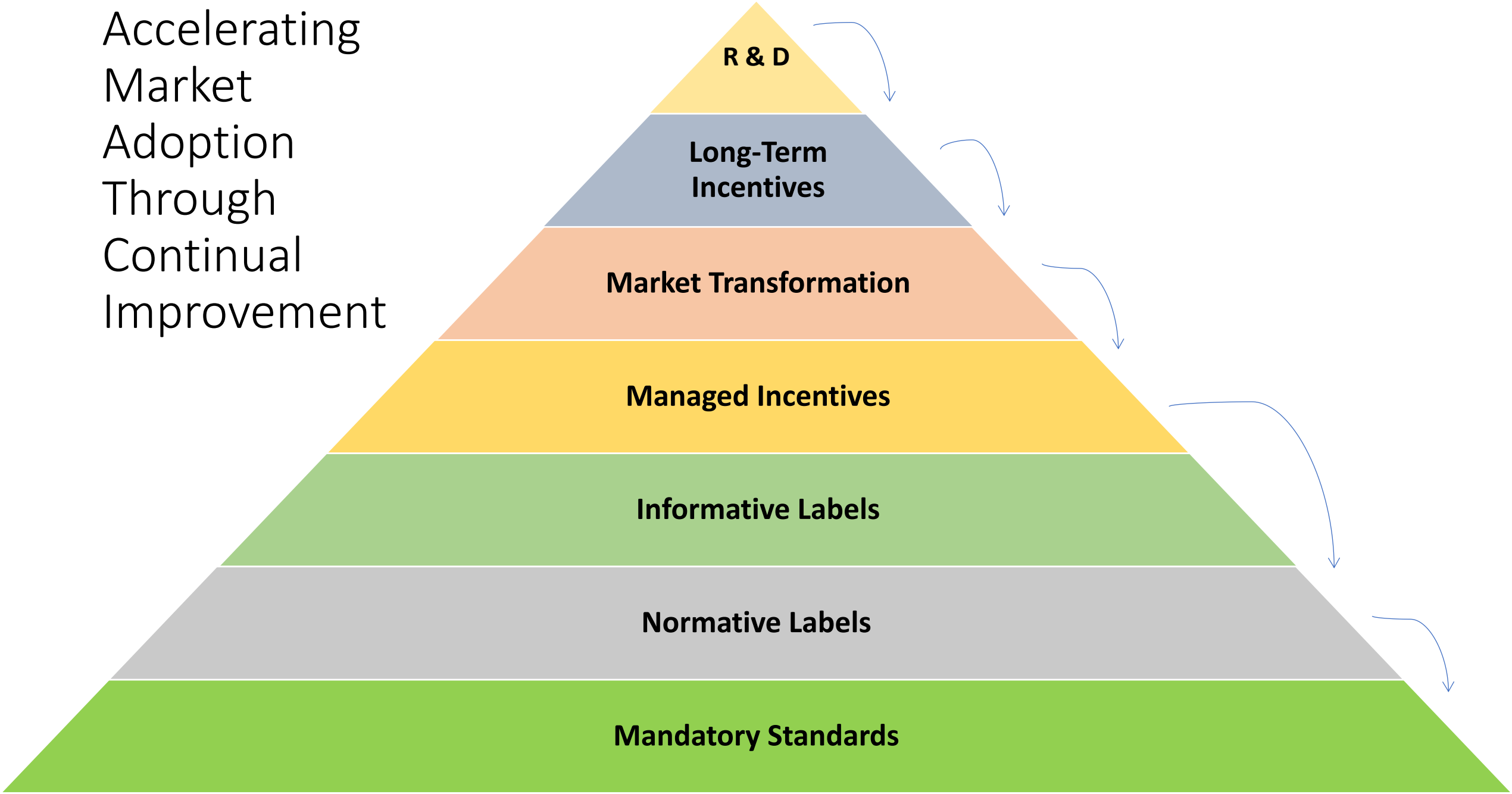
Example from United States

- An increasing number of residential buildings are rated for energy efficiency on a scale where a score of 0 indicates Zero Energy
- This rating scale has been a part of the model International Energy Conservation Code since 2015
- Despite the near absence of mandates, many home builders, especially the larger ones, voluntarily choose to compete based on low energy consumption ratings

Explicit ZNE policies

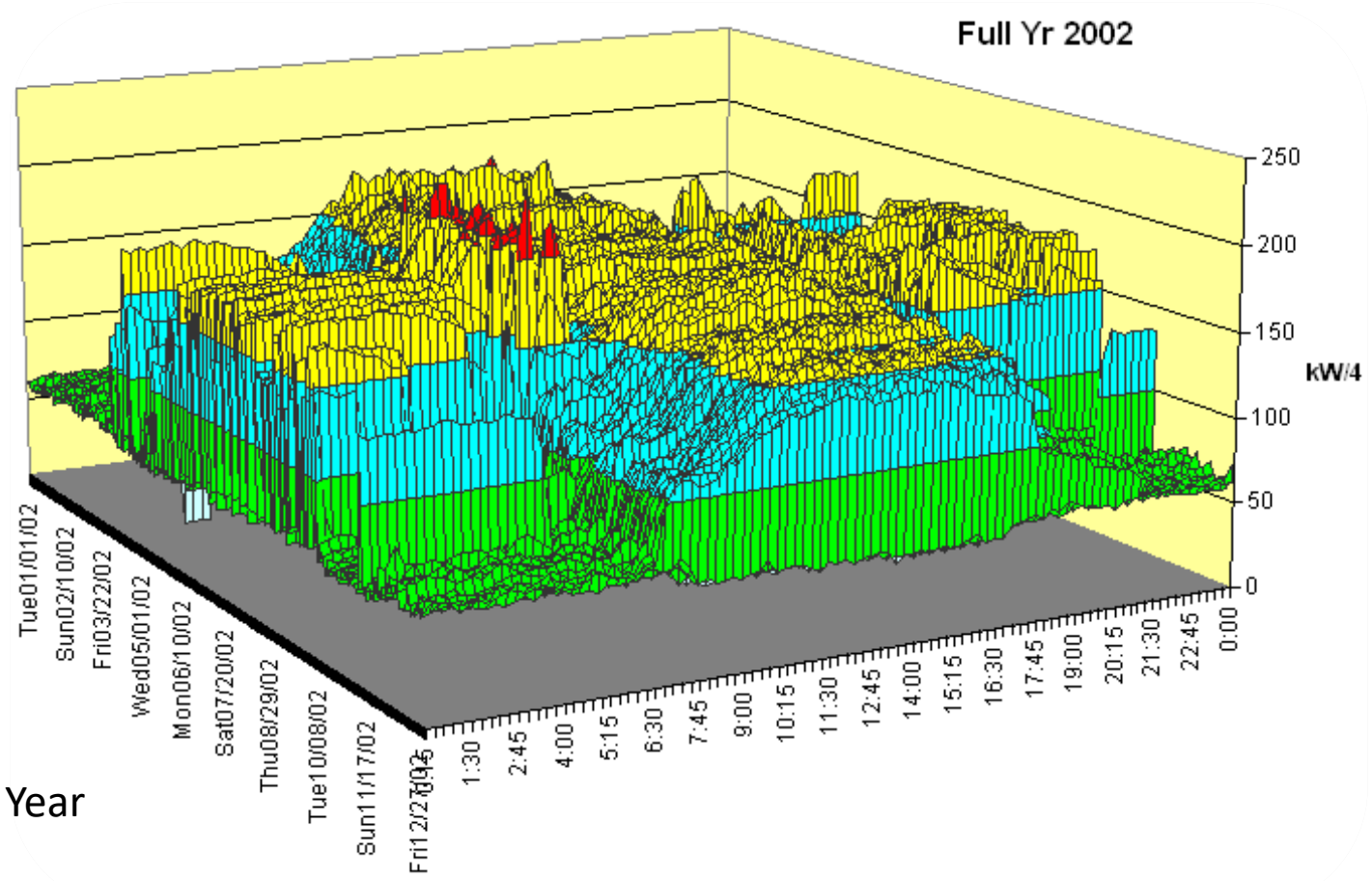
- California set a goal of ZNE by 2020 for residential around 2030.
  - As a consequence, the last 4 triennial code updates saved far more energy as a percentage than previous updates
  - The 2019 code is advertised as Zero Net but it ignores gas in the calculation of zero.
  - Nonetheless the outcome is closer to true zero than would have been projected in 2005.
- Tax credits for low income housing often give credit for near-Zero residential buildings
- Many states have mandatory Renewable Energy Targets
  - But rooftop solar generation may not count toward meeting them
    - They may count only utility-scale renewable generation

Accelerating Market Adoption Through Continual Improvement



Building design evaluation should include load shape predictions so that fixed and adjustable building features can be incorporated to manage load shape.

Energy Modeling



3D Electric Profile, Full Year

Conclusions

- The Zero Net Energy concept is proving an attractive way of making efficiency visible and encourage renewable energy use
- Zero Net Energy will not result in zero utility bills nor in zero carbon emissions, but
- Continual improvement can allow zero emissions at a projected year in the foreseeable future
- Zeroing out construction energy and transportation makes the goal much more difficult and requires much greater use of renewables

Thank You

Questions can be addressed to me at

DGoldstein@nrdc.org

Annex 1:

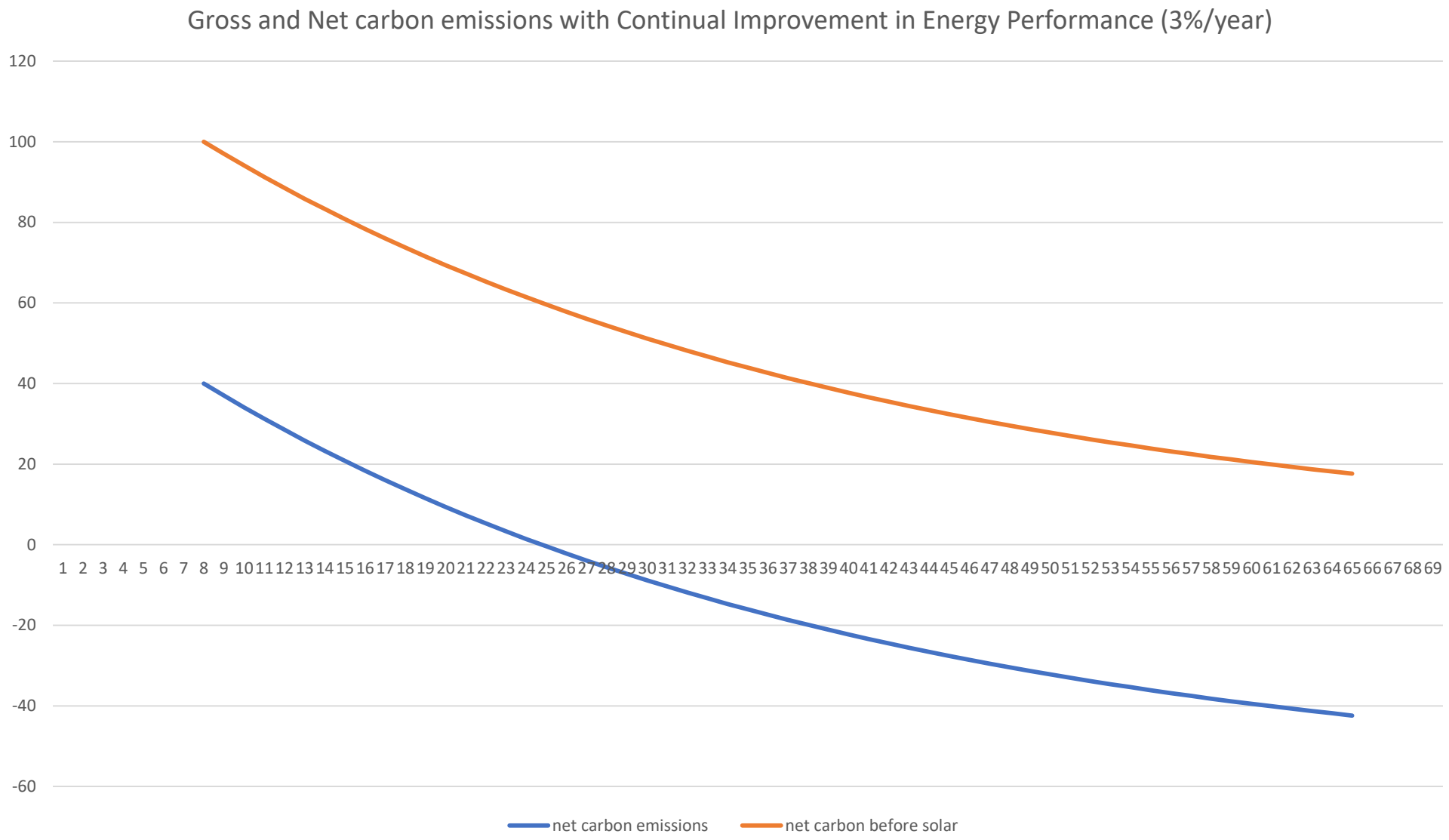
Integrating Zero Energy with Energy Management Systems

Working with ISO Standard 50001

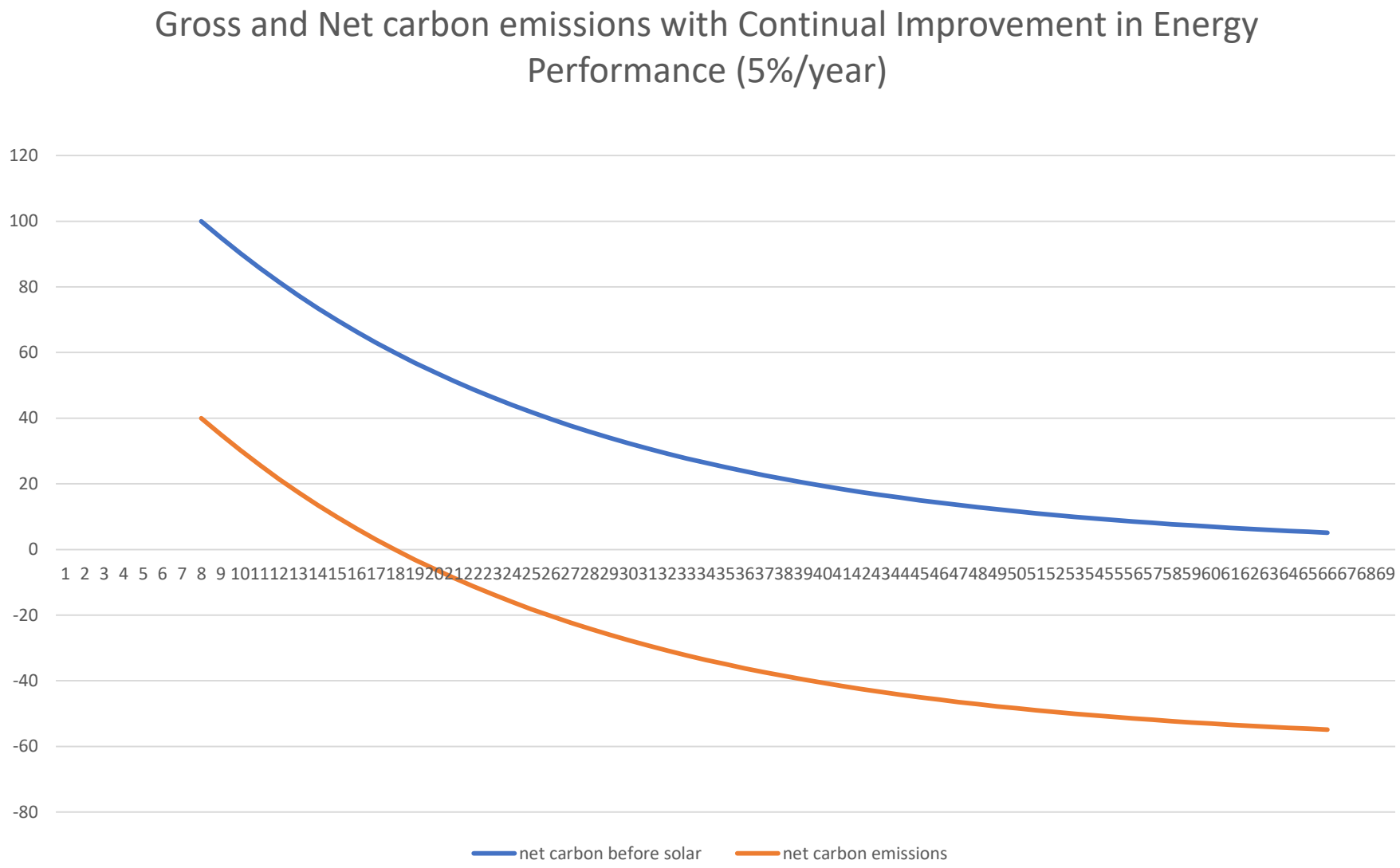
Zero Energy and Continual Improvement

- Definitions of zero energy often focus on metered energy use
- If energy performance (which doesn't count renewables) is continually improving, net zero in year N means net consumption in years N-1, N-2…etc.
  - And it also implies net positive interaction with grid in years N+1, N+2…
- Designers can specify an energy policy for continual improvement that brings the facility to Zero Net in a planned year
- Outcomes are projected using a very simplified model

Carbon Emissions over Time



Carbon Emissions over Time



Zero Energy May Include Scope 3 Energy and Emissions

- Scope 3 includes:
  - Construction energy—initially and for remodels/renovations
  - Transportation energy: getting people and goods to and from the site
- Each of these new energy uses is about equal in magnitude to the energy consumption of the fuels and electricity used in a building, THEREFORE
- Zero energy with a broader scope is MUCH more challenging