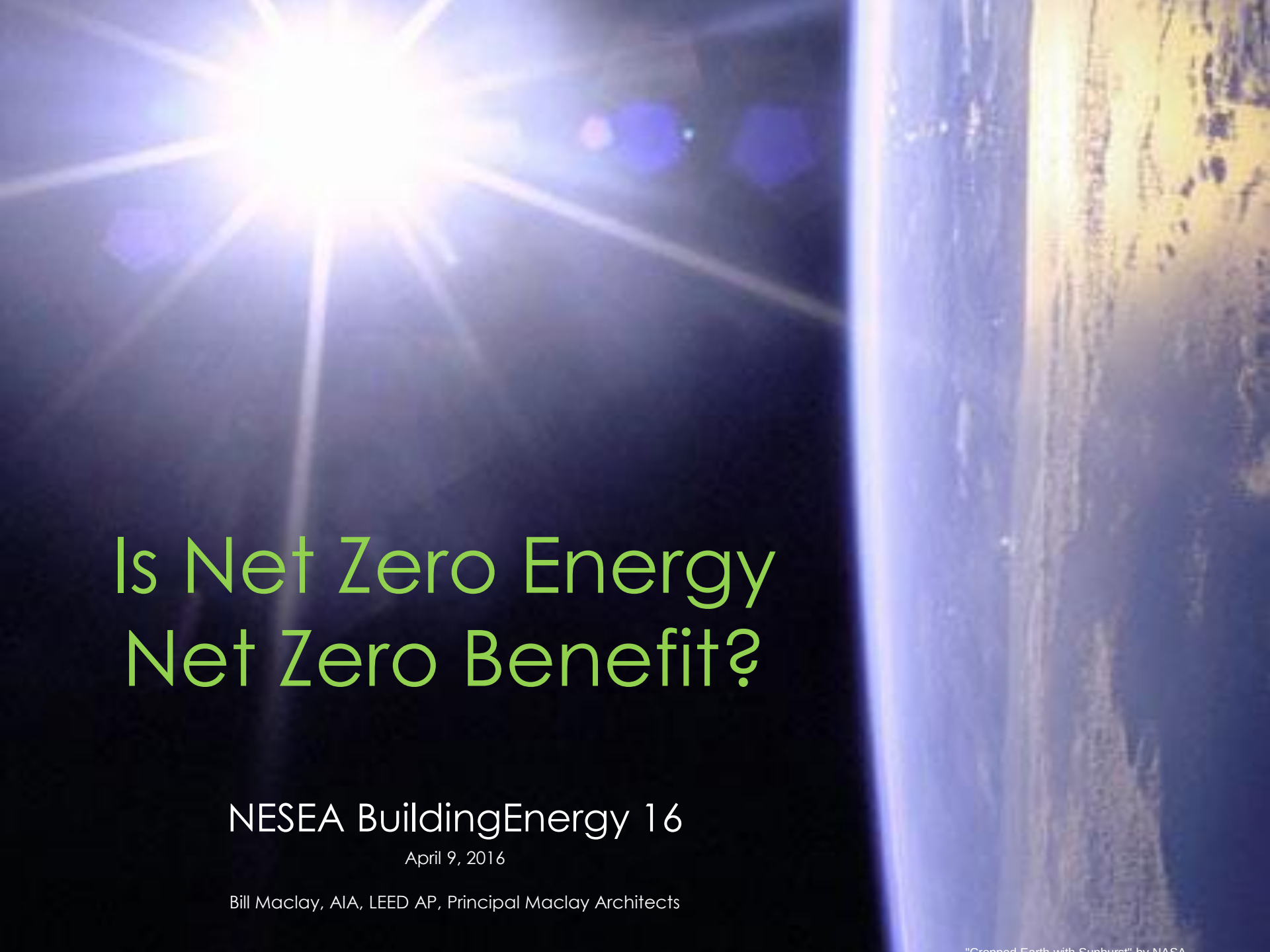


# Is Net Zero Energy Net Zero Benefit?

NESEA BuildingEnergy 16

April 9, 2016

Bill Maclay, AIA, LEED AP, Principal Maclay Architects

"Cropped Earth with Sunburst" by NASA

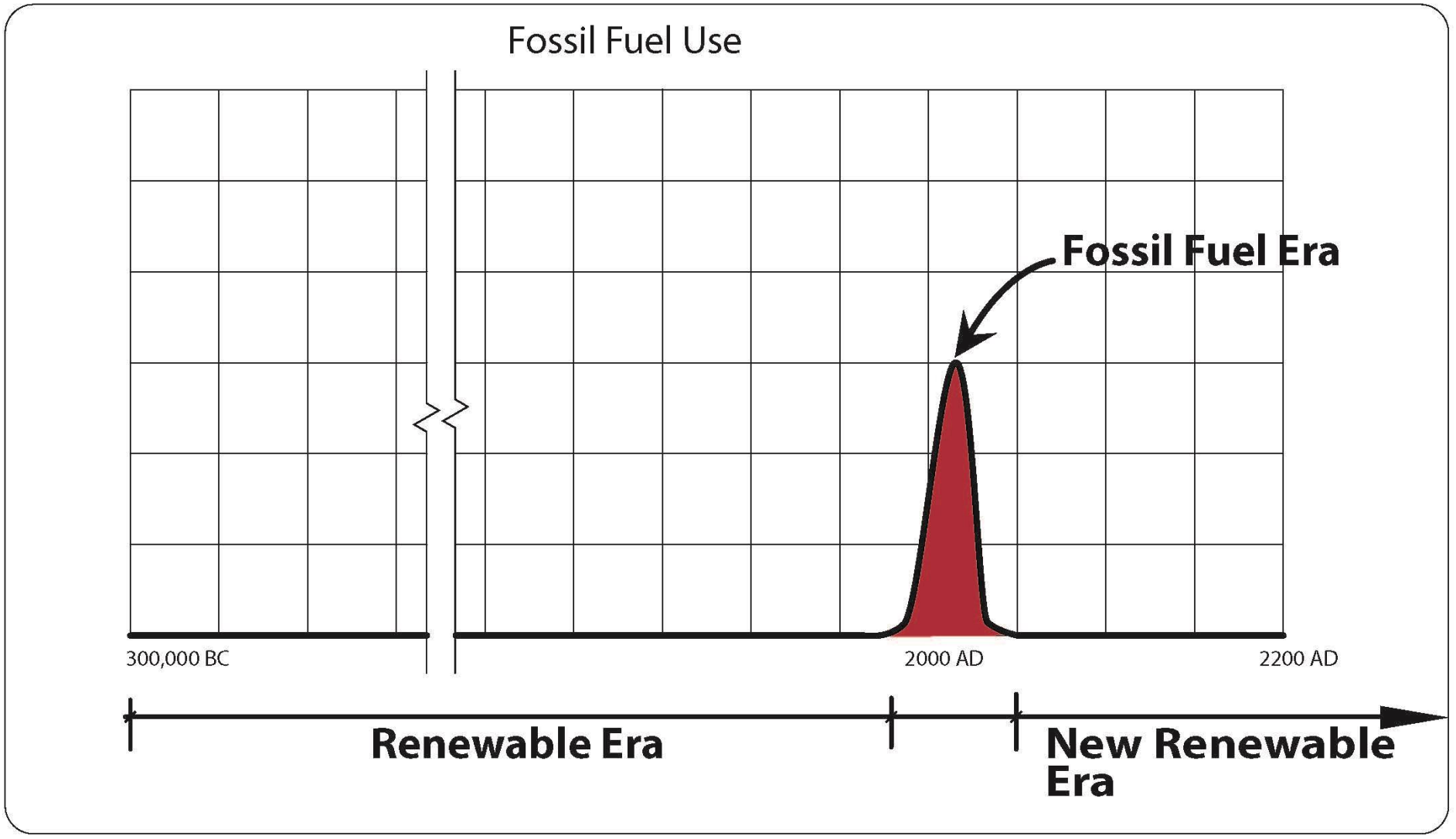
# Is Net Zero Energy Net Zero Benefit?

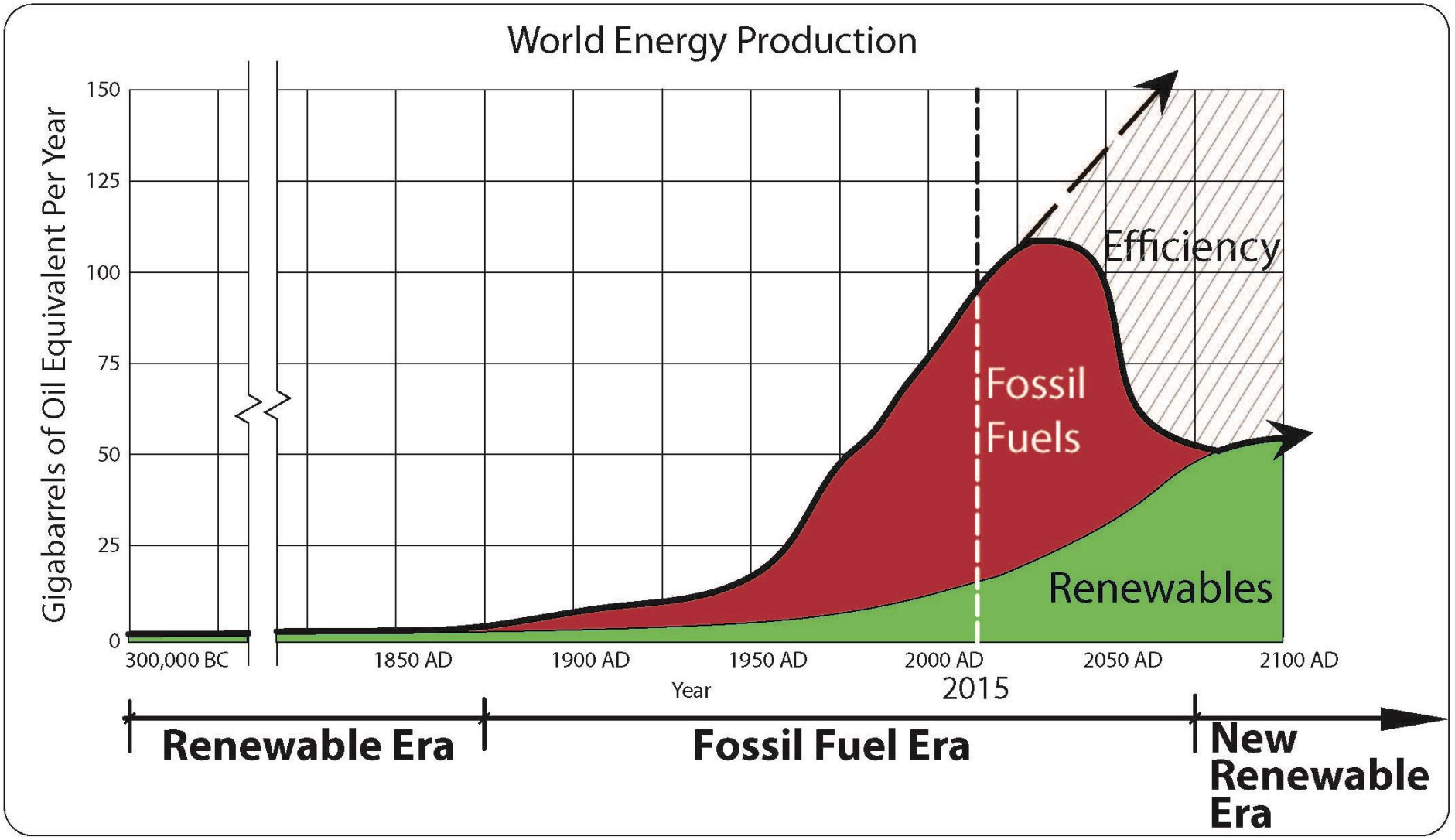
# Yes, but what is Net Zero?

# Do we need to think differently about Net Zero?

# Do we need new terms?

Photo by Martin St-Amant / CC-BY-SA-3.0





# Why Net Zero Today?

Public Domain

Public Domain

No Carbon

=

Net Zero Energy

No Carbon

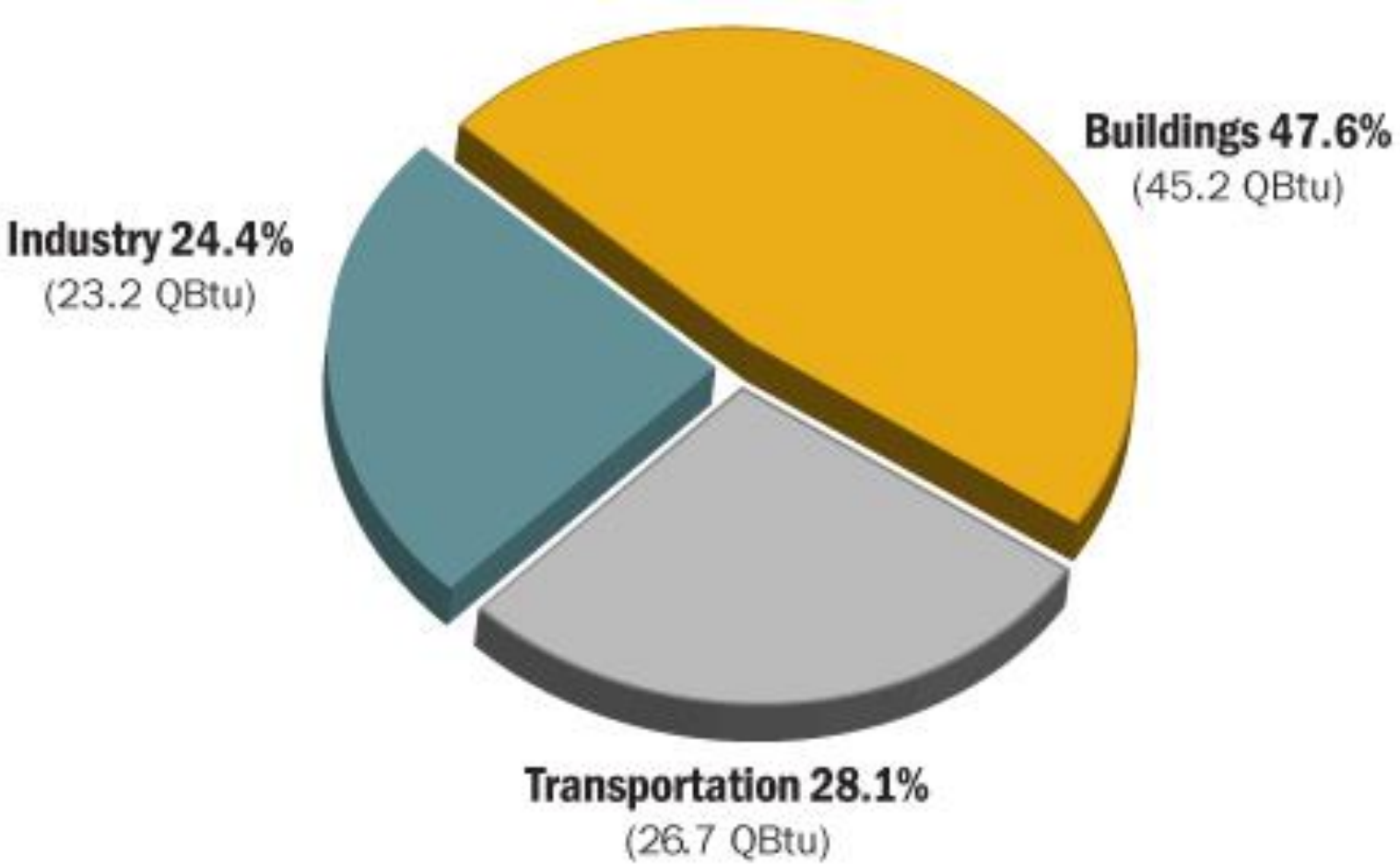
=

Net Zero Energy

=

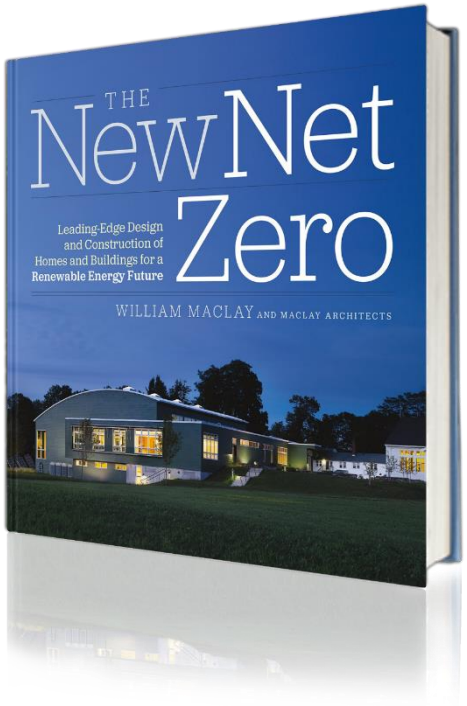
Renewably Powered Planet

# Building impact



# What is net zero?

## The New Net Zero Definition




A building, a community, a country, or a planet that produces as much energy as it consumes on an annual basis using only renewable energy

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

| Option Number | ZEB Supply-Side Options |
|---|---|
| 0 | Reduce site energy use through low-energy building technologies |
| | **On-Site Supply Options** |
| 1 | Use renewable energy sources available within the building's footprint |
| 2 | Use renewable energy sources available at the site |
| | **Off-Site Supply Options** |
| 3 | Use renewable energy sources available off site to generate energy on site |
| 4 | Purchase off-site renewable energy sources |

NREL Definition

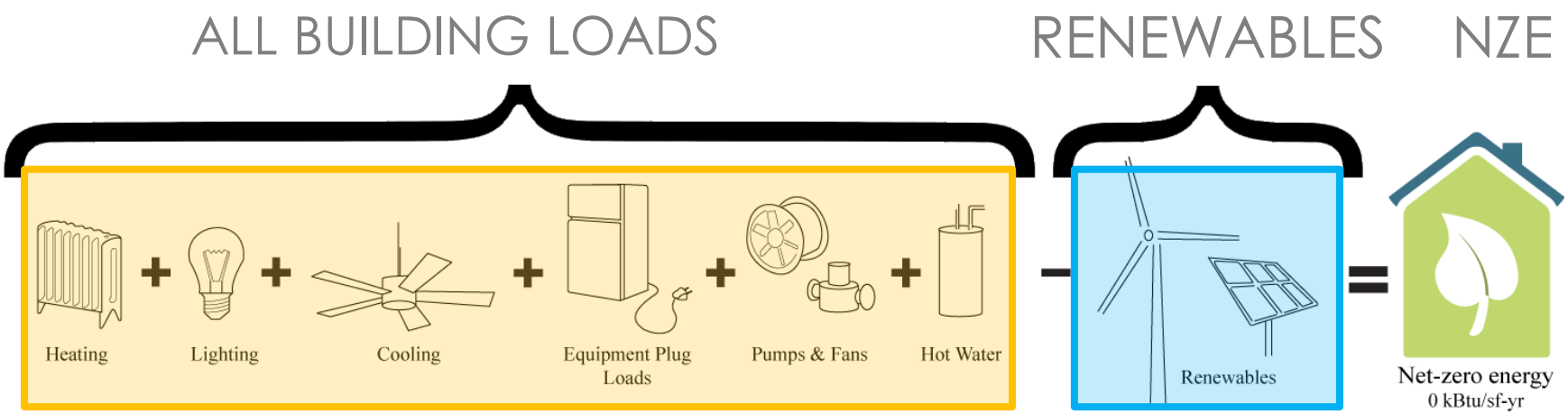
ENERGY
NET POSITIVE ENERGY

IMPERATIVE

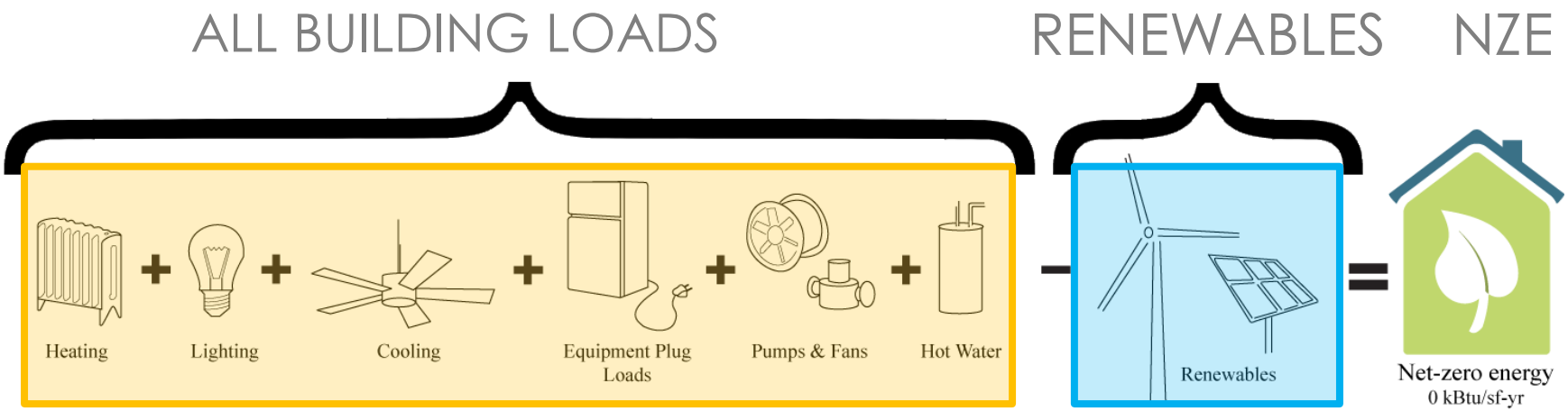
06

Living Futures Definition

# Net zero buildings



# Net zero or net zero ready?




NET ZERO READY − RENEWABLES = NZE

# Fuel mileage for buildings?

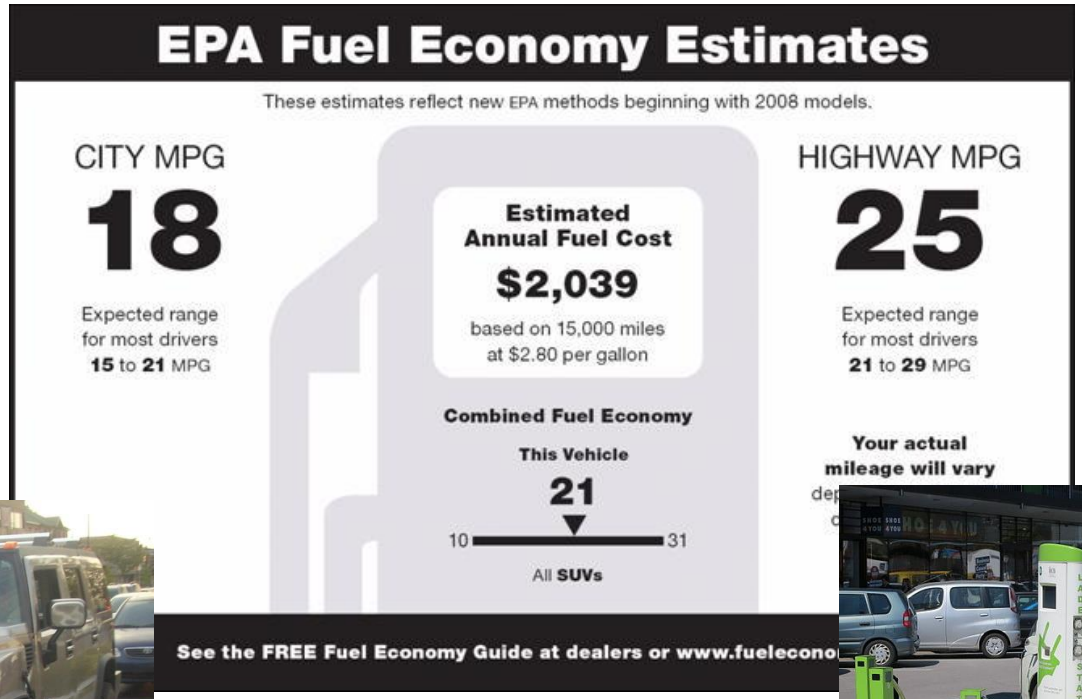


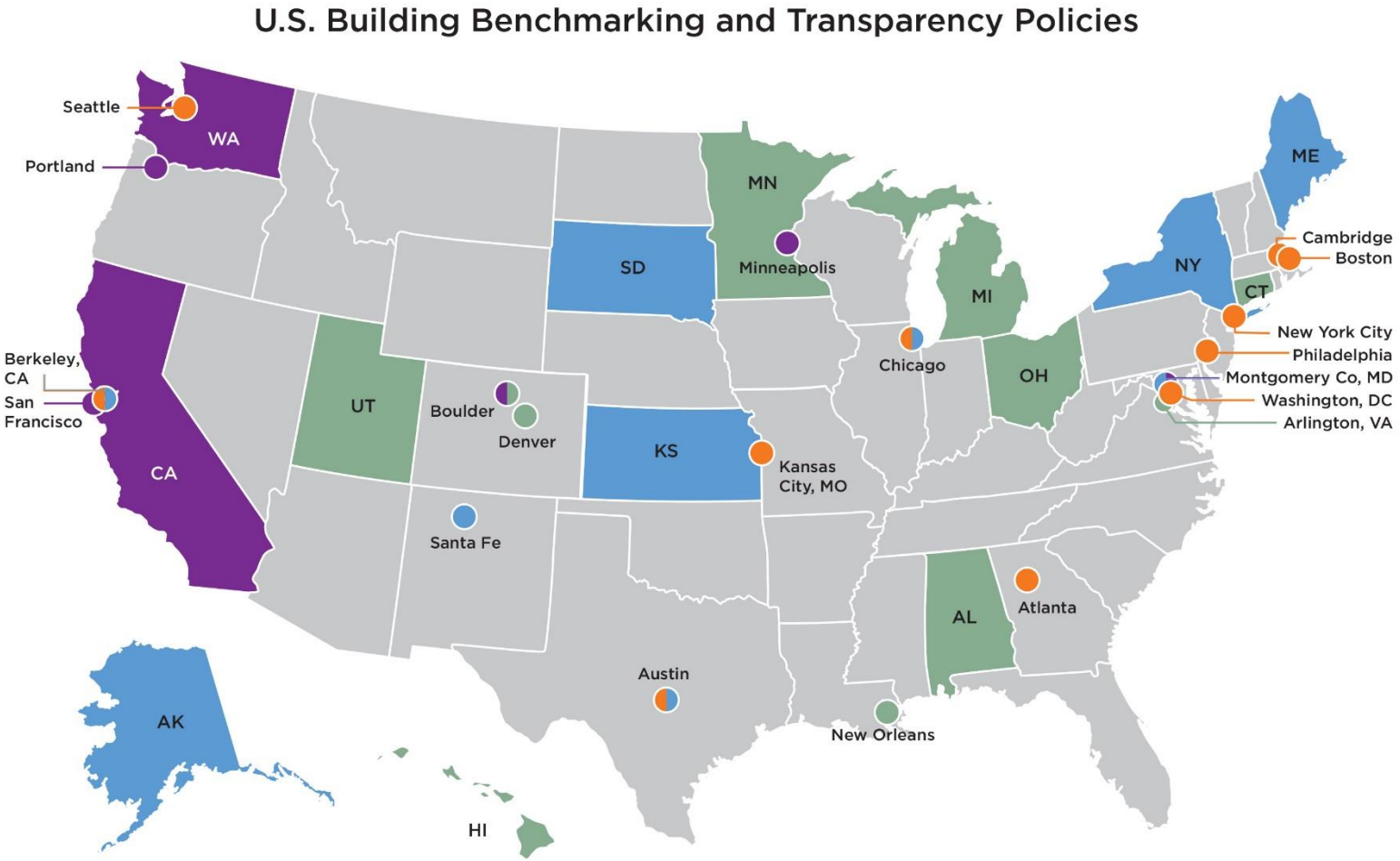


Photo by $B_{ull\text{-}Doser}$ / public domain

Photo by Reinraum

# Energy Use Intensity (EUI)

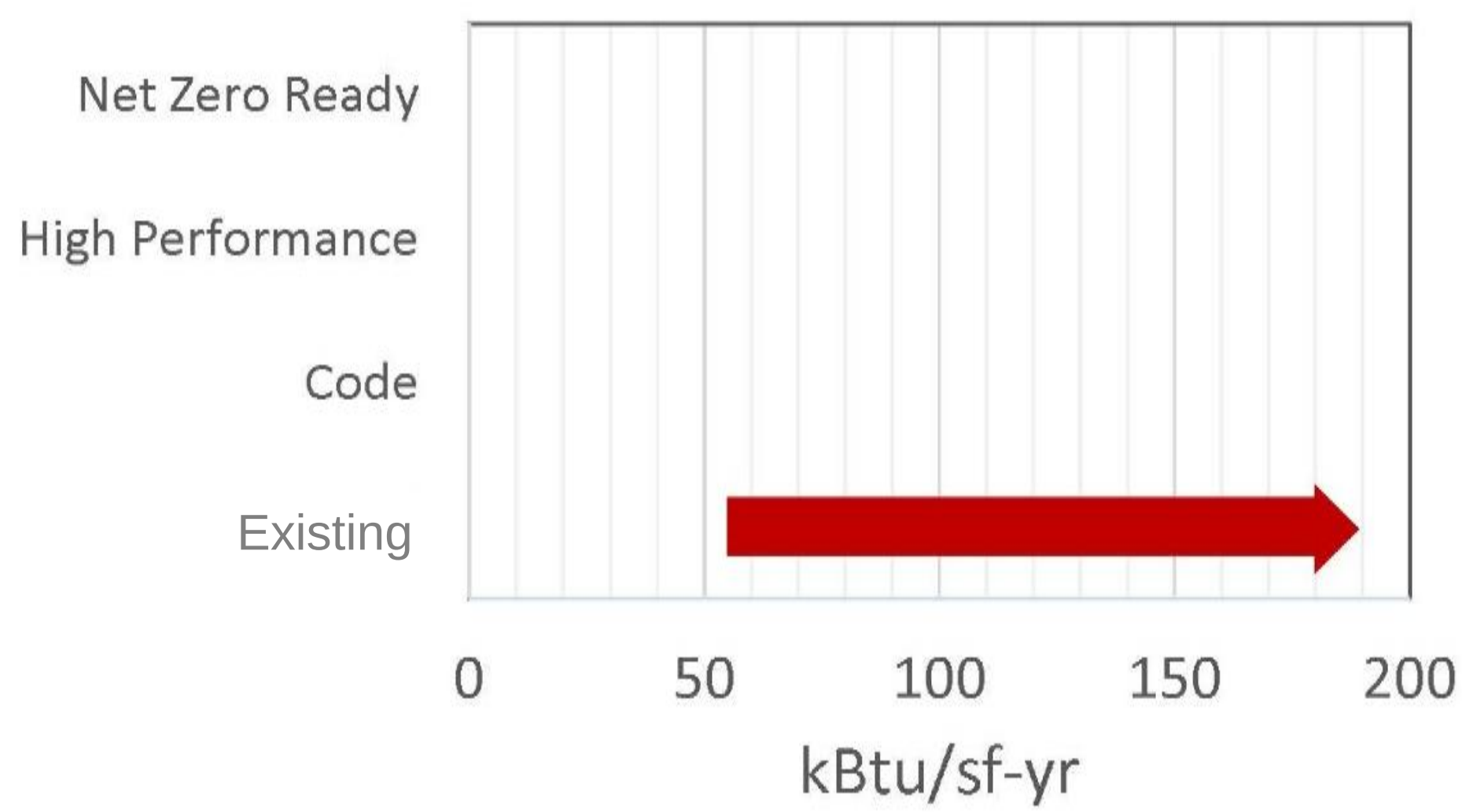
# Building Energy Disclosure Policies



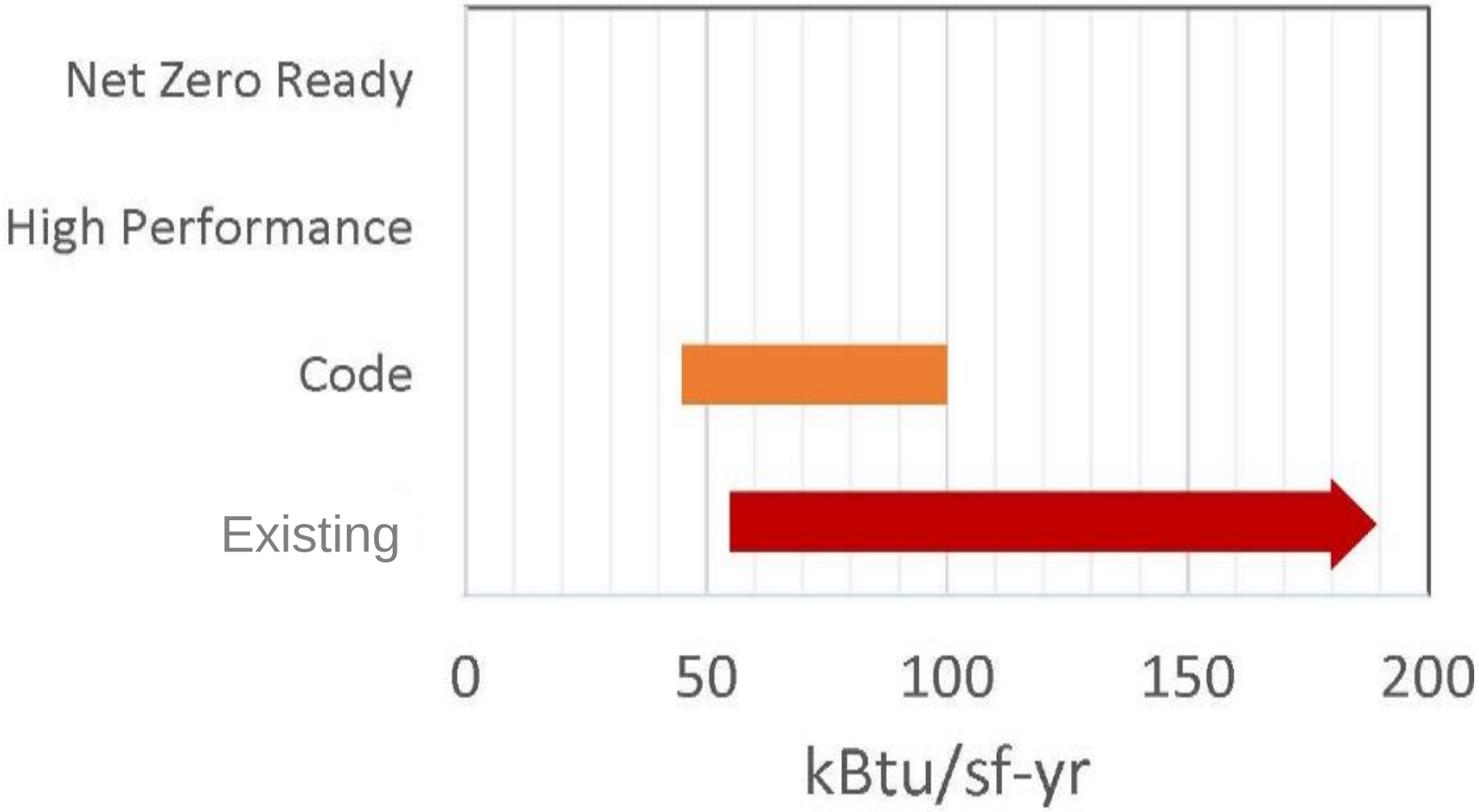

Building Rating
SHARING TRANSPARENCY FOR A MORE EFFICIENT FUTURE

IMT
INSTITUTE FOR MARKET TRANSFORMATION

# EUI is the foundation



# EUI is the foundation



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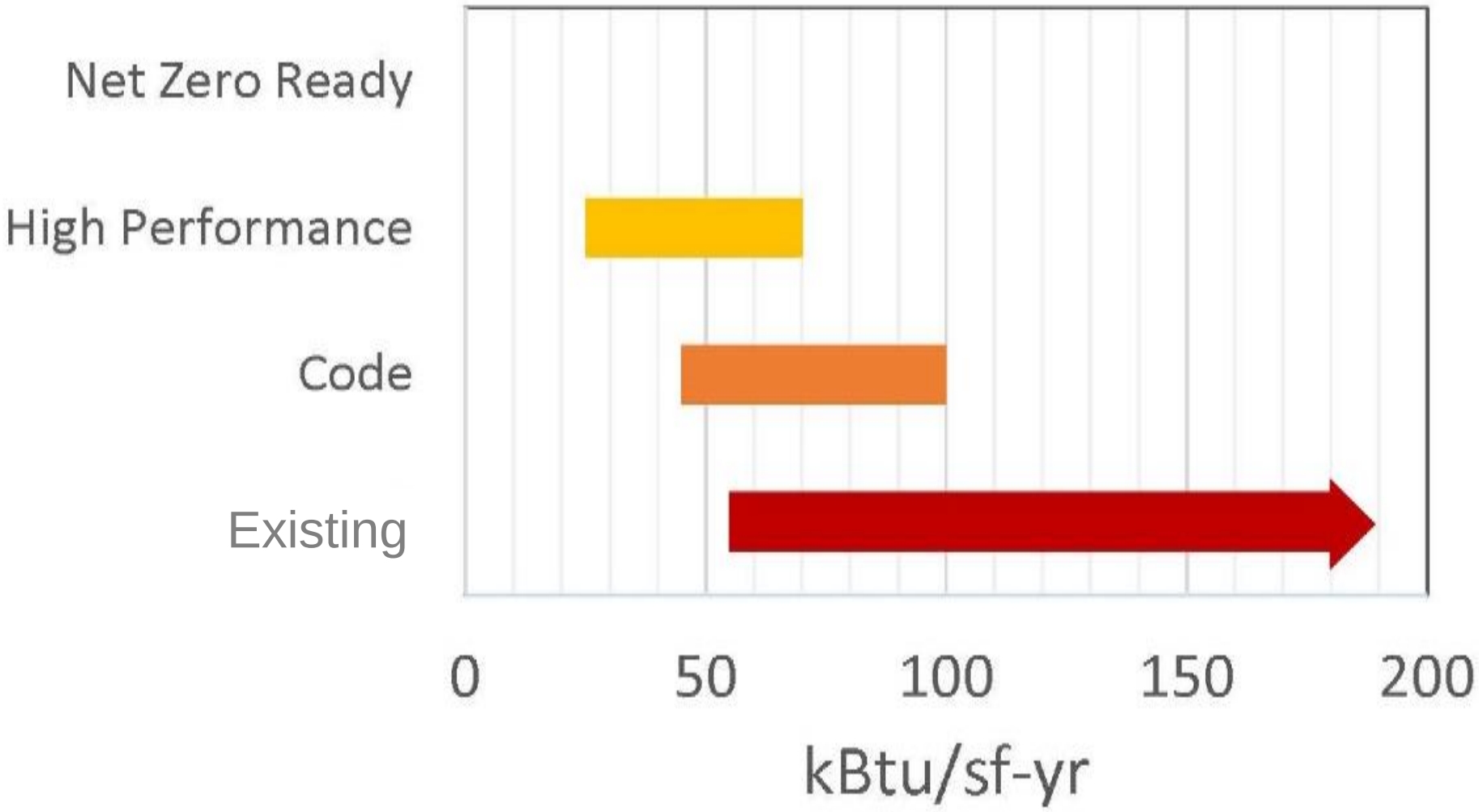
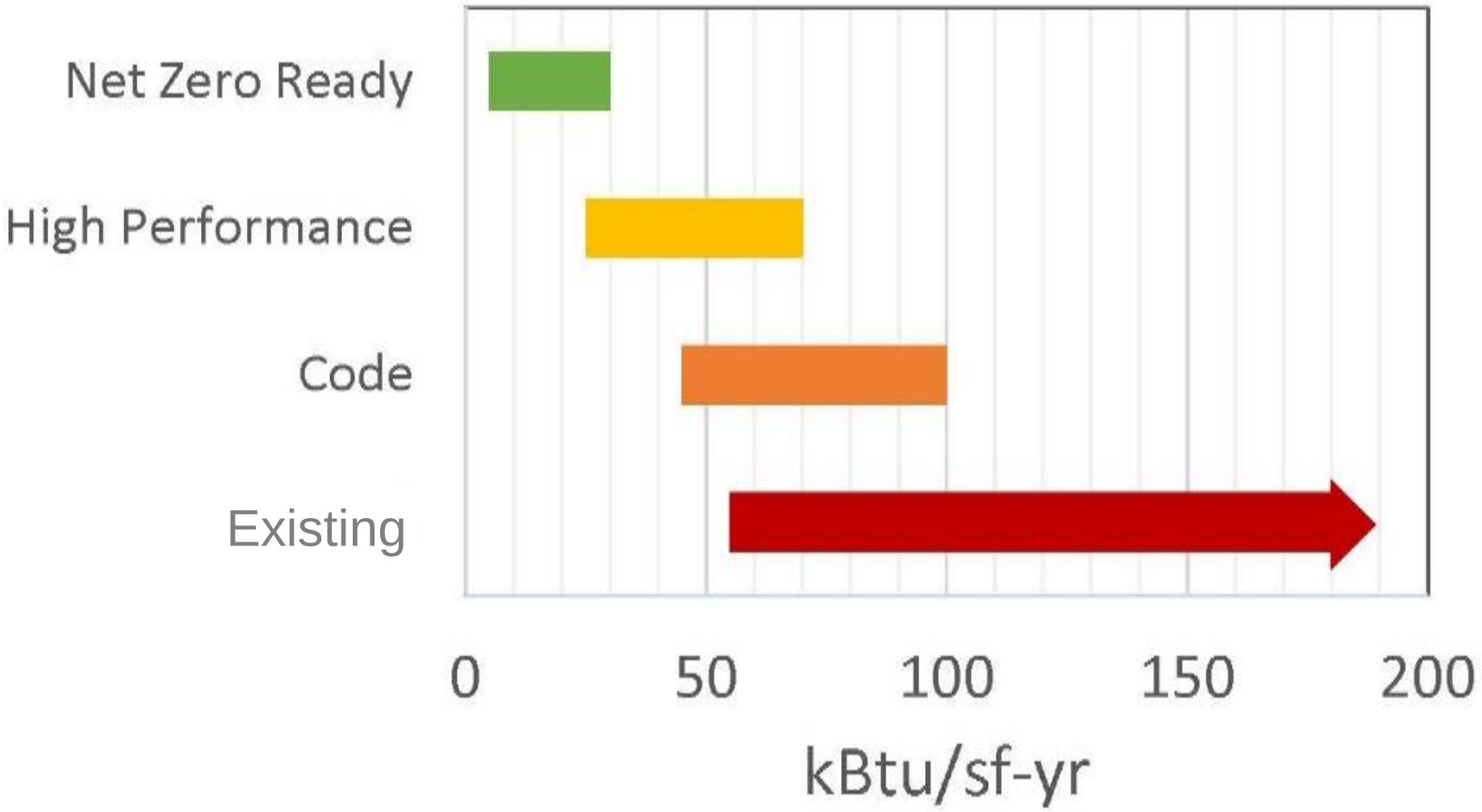
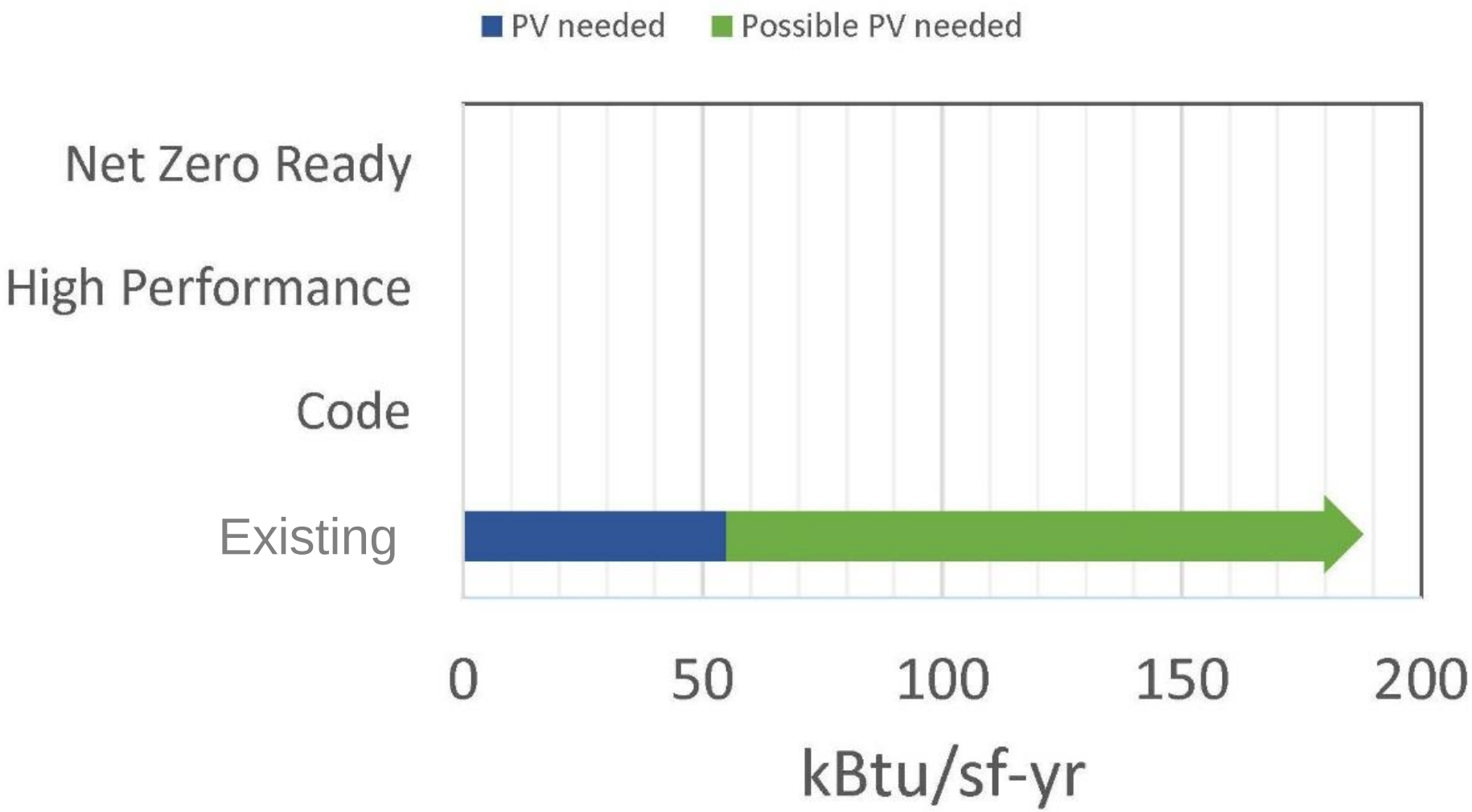


# EUI is the foundation



# PV Required to Become Net Zero Energy



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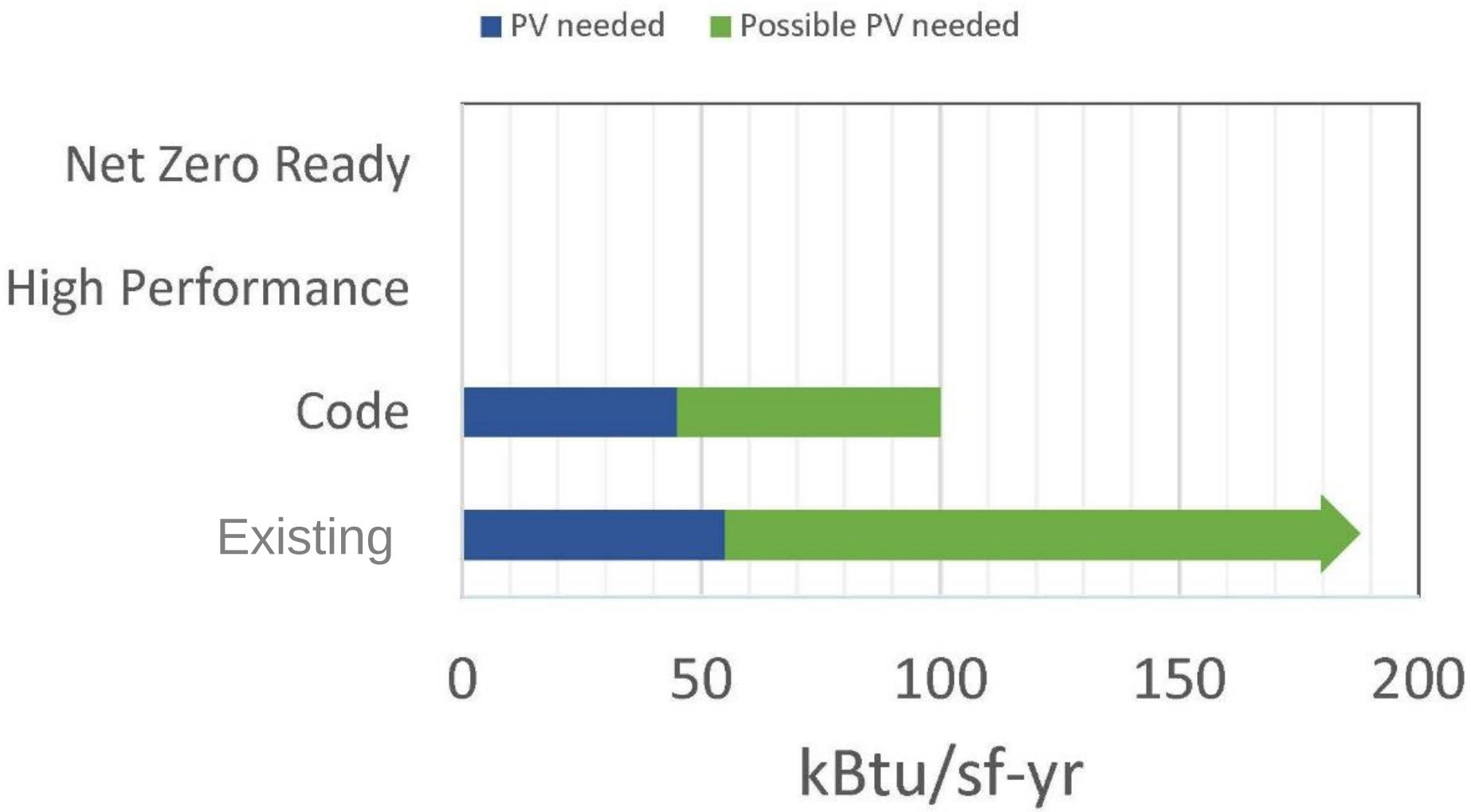
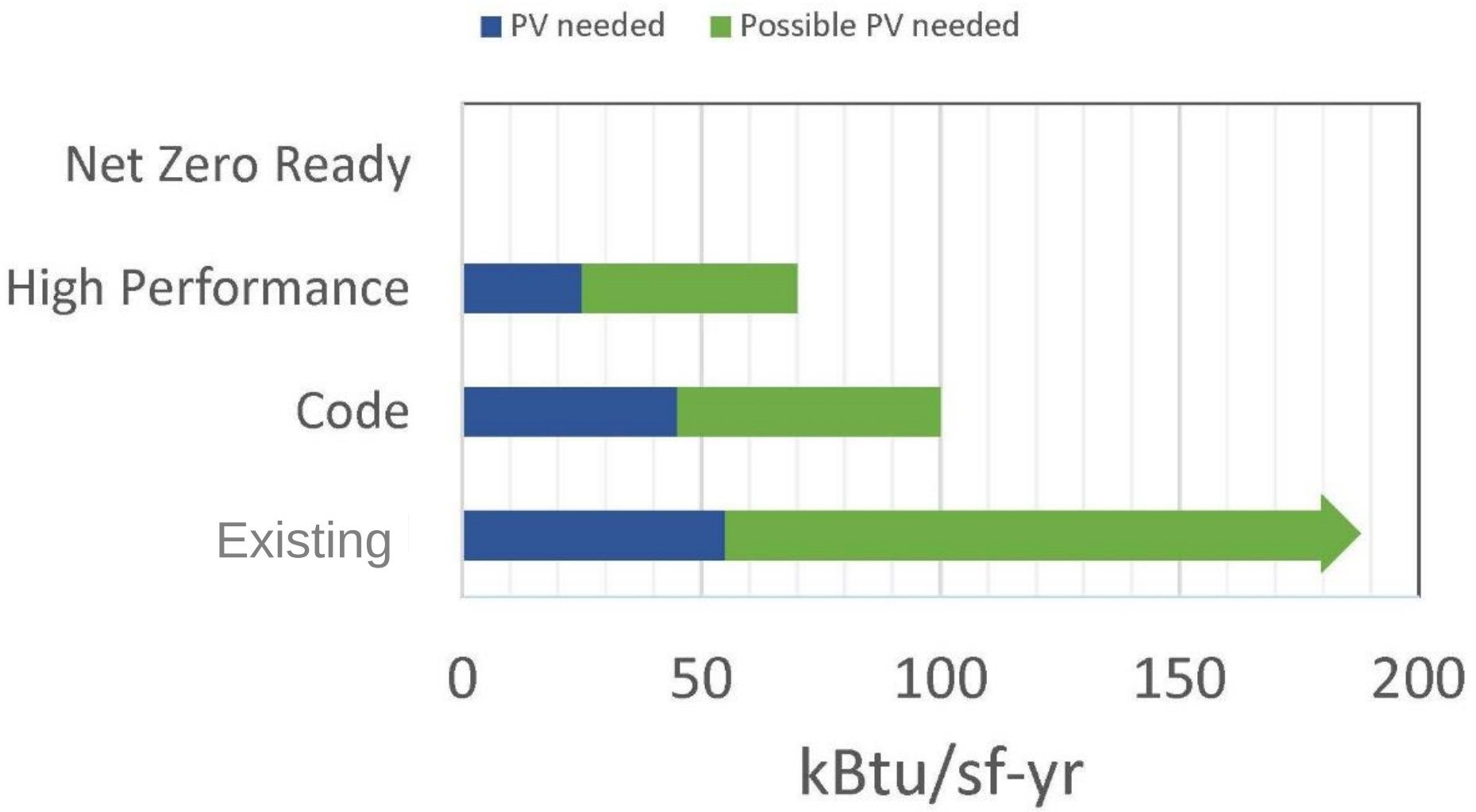
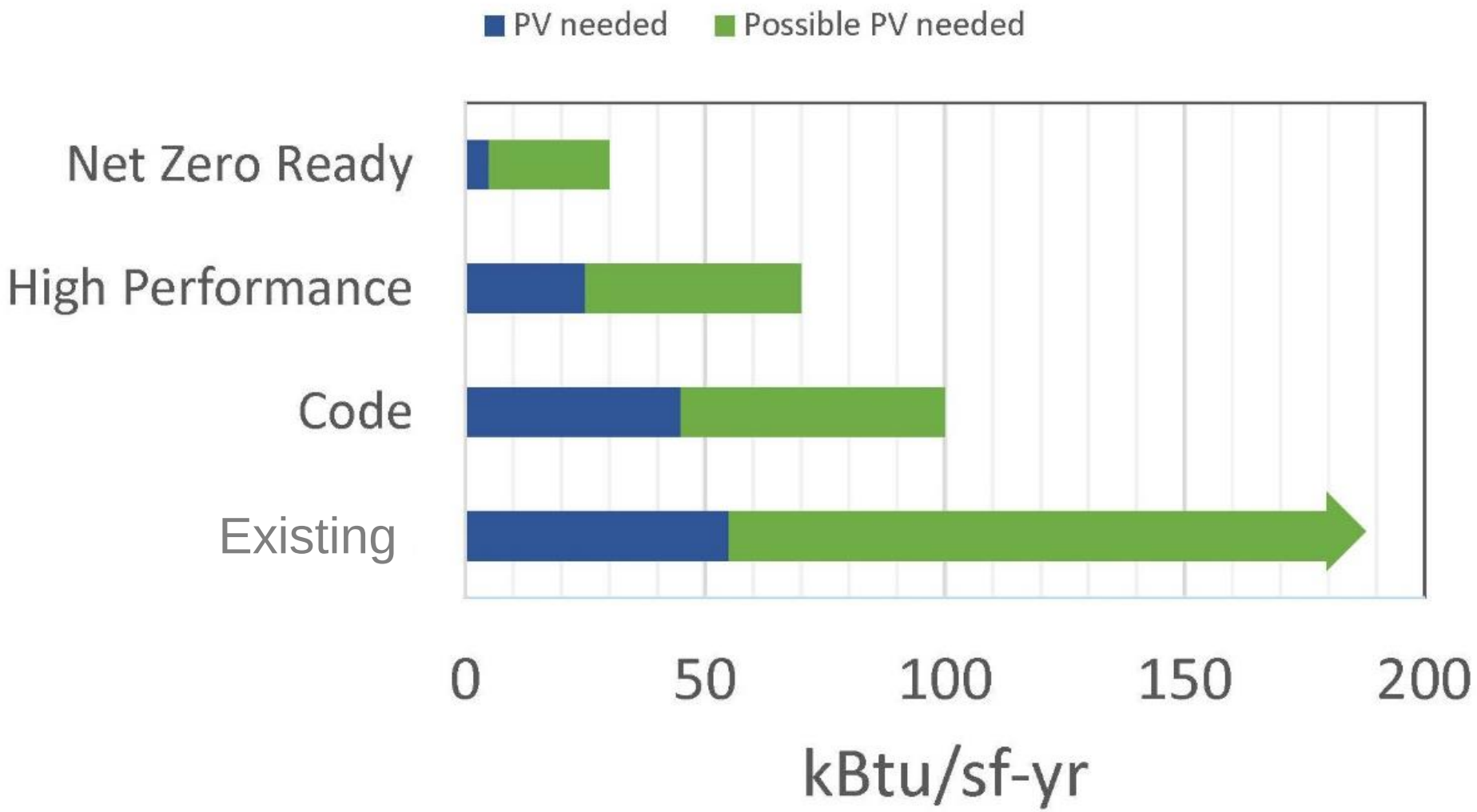


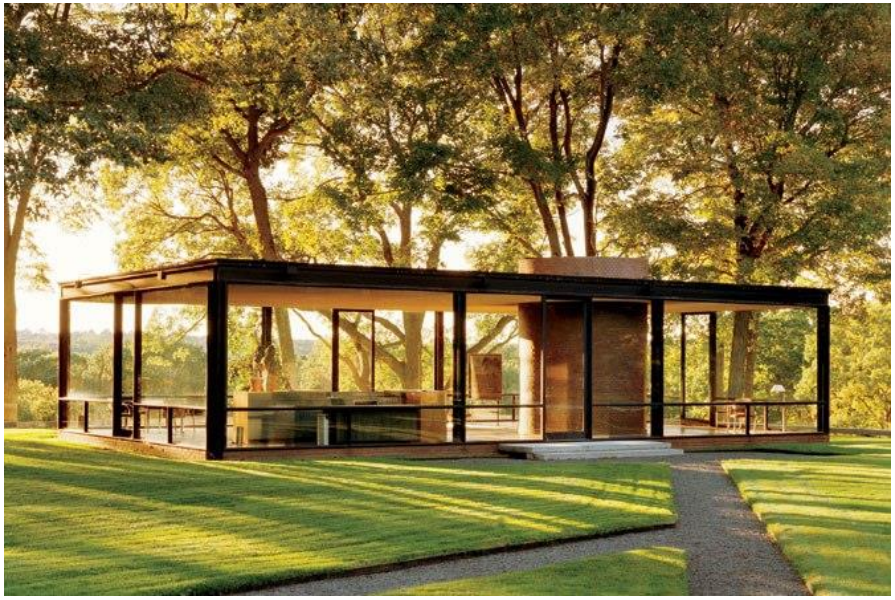
# PV Required to Become Net Zero Energy

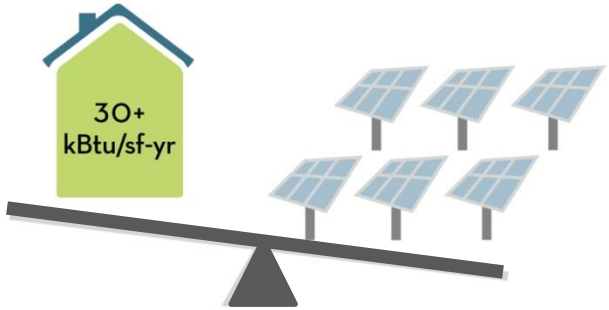


# PV Required to Become Net Zero Energy



# Is this net zero?



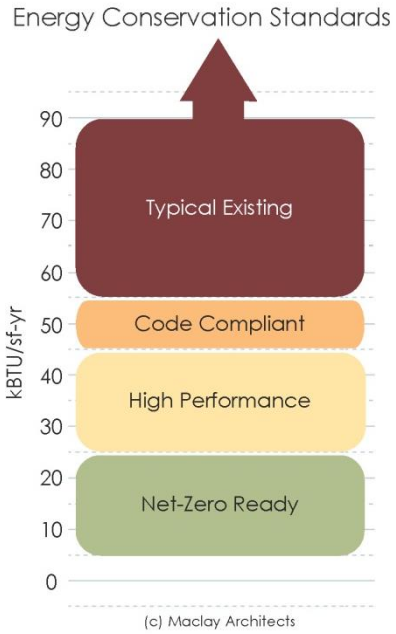




minimal insulation and poor energy performance

disproportionate cost of renewables

# Key elements

Conservation + High-Efficient Systems + Renewables




Energy Use Intensity (EUI)


Heat Pumps (COP 2.3-3.0)


Usually Photovoltaics (sized for annual load)

# Net Zero is the Best Investment Today

- $5-$20/sf Increased Initial Construction Cost

# Net Zero is the Best Investment Today

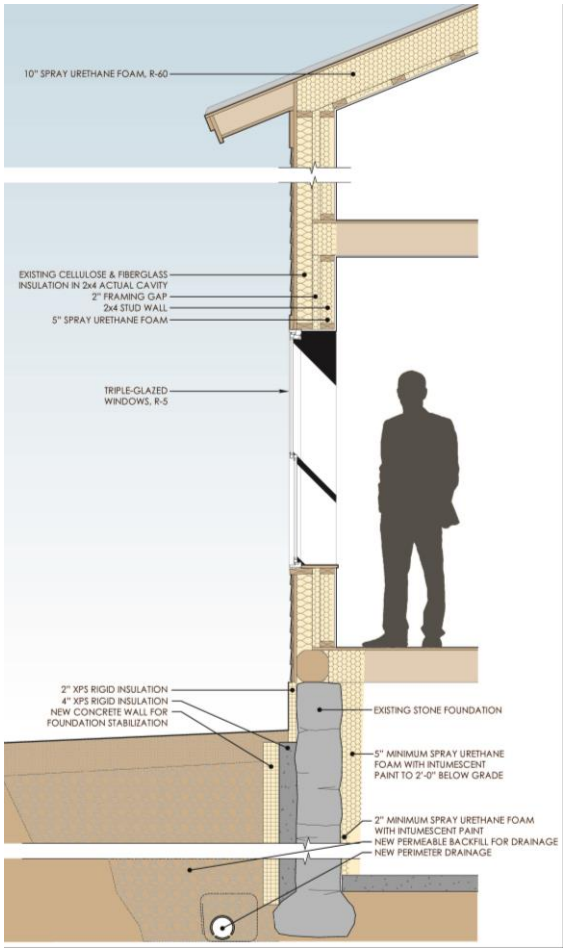
- 3-10% of Construction Cost

# Net Zero is the Best Investment Today

- Solar Financing Options

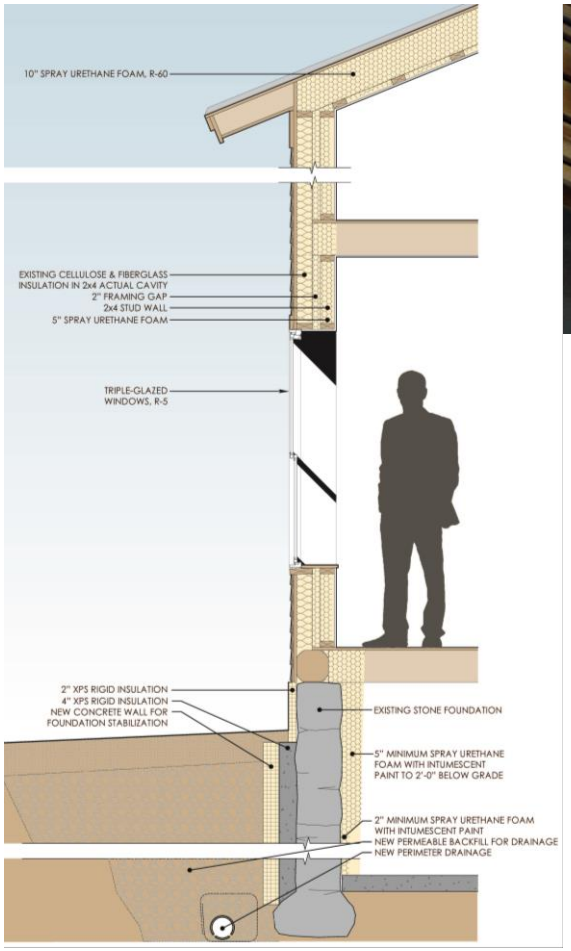
# Net Zero is the Best Investment Today

- Envelope + ROI



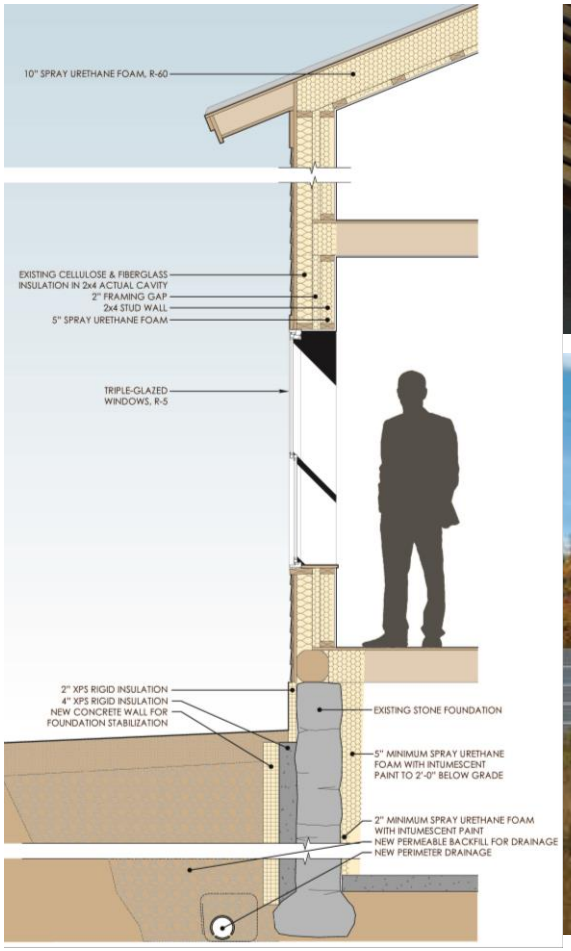
# Net Zero is the Best Investment Today

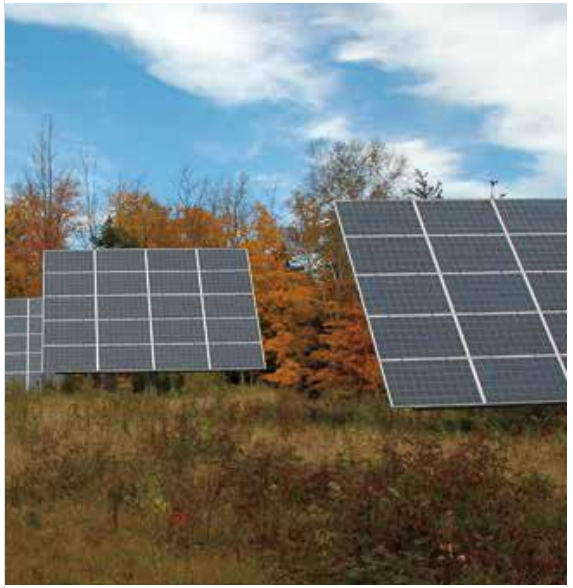
- Envelope + ROI
- Heat Pumps + ROI



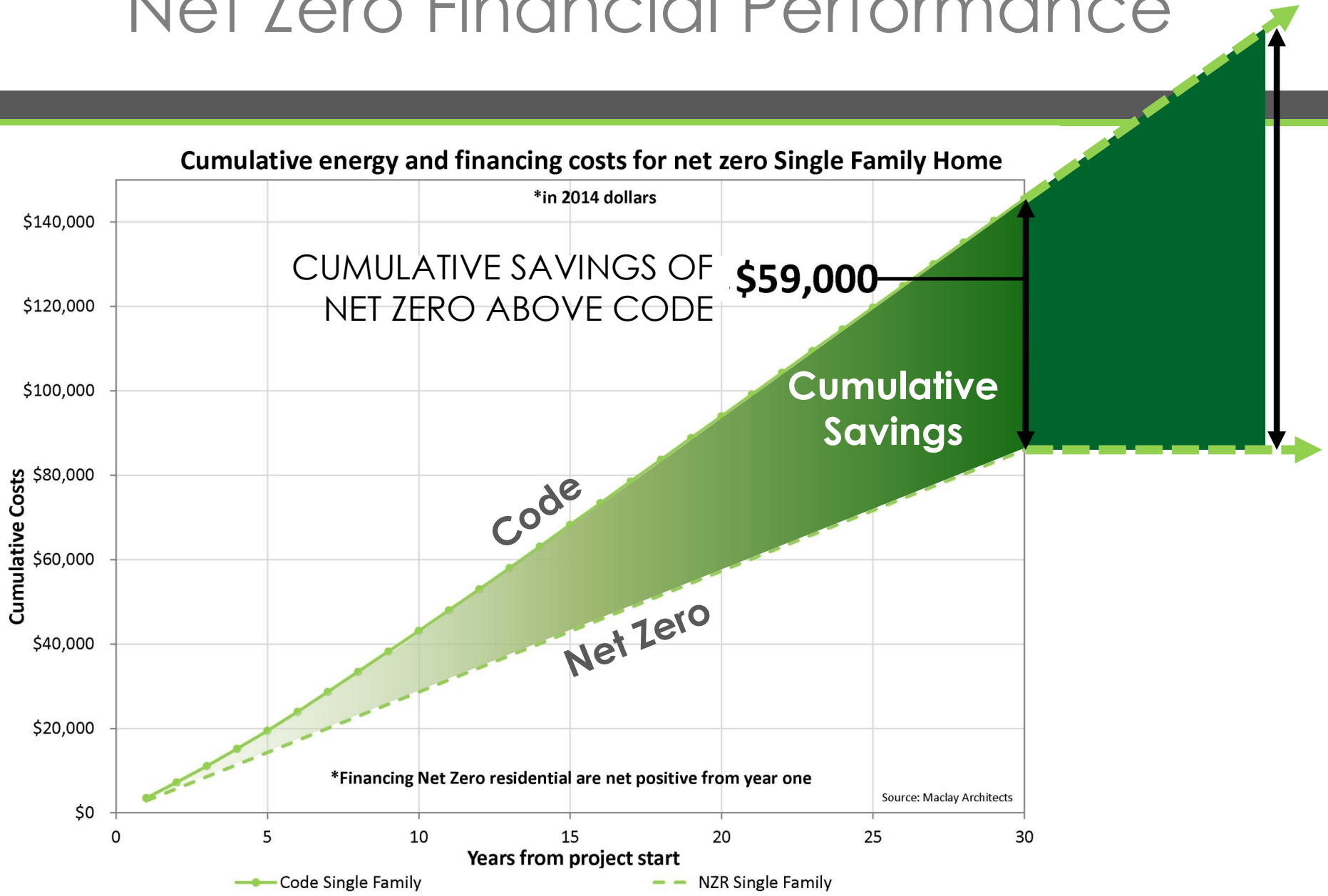

# Net Zero is the Best Investment Today

- Envelope + ROI
- Heat Pumps + ROI
- Renewables + ROI



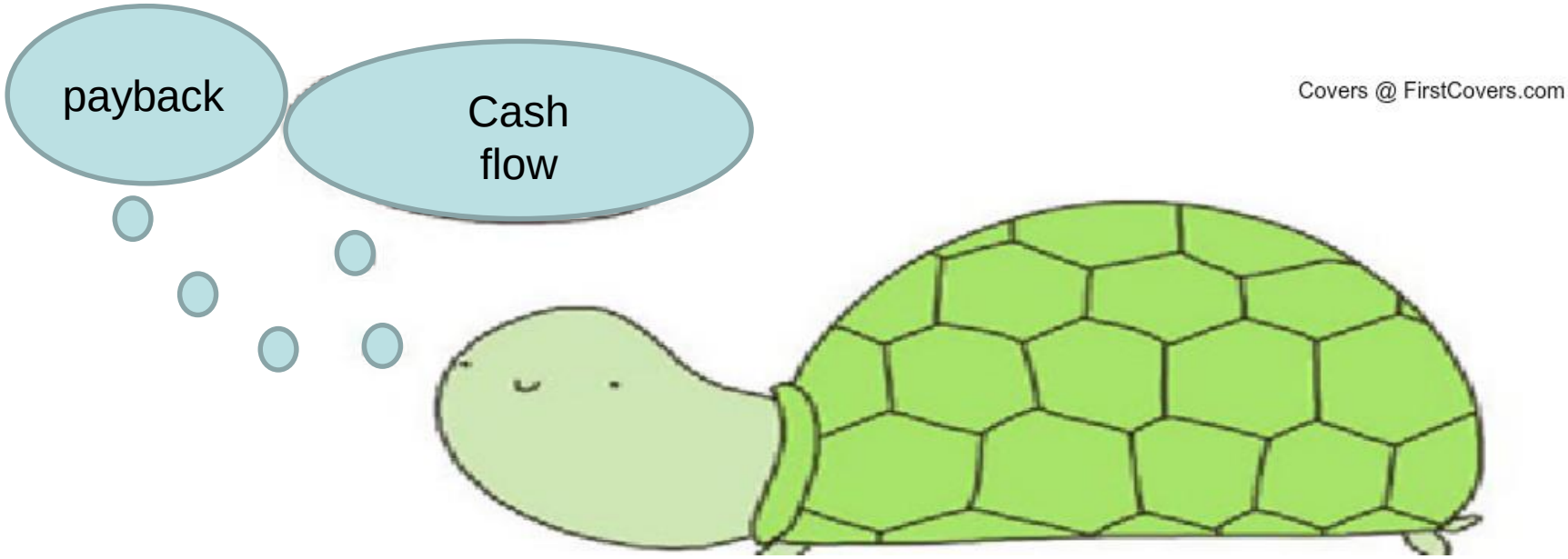



# Net Zero Financial Performance



# Why is Net Zero not happening?

# Paradigm shift



# Are the benefits beyond energy savings?

# Are the benefits beyond energy savings?

## Health

# Are the benefits beyond energy savings?

## Productivity

# Are the benefits beyond energy savings?

## Resilience

# Are the benefits beyond energy savings?

## Beauty

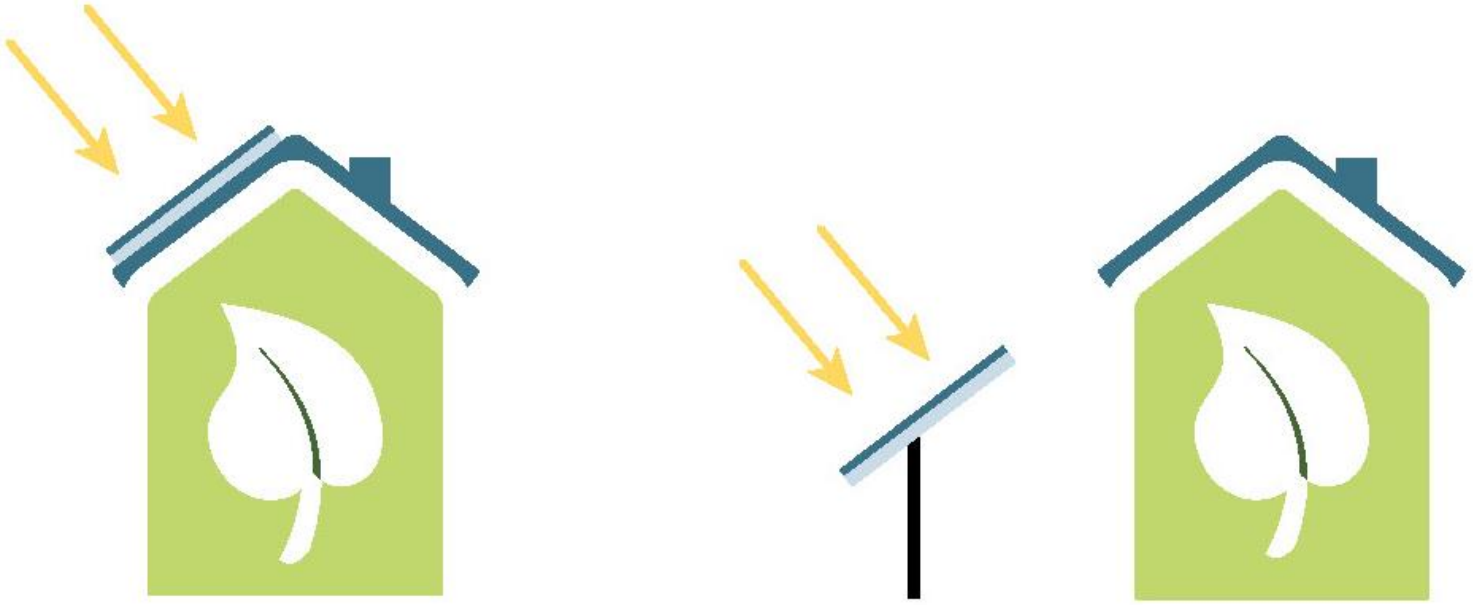
# How do we make a Net Zero Planet?

1. Net Zero Ready Buildings (All new & existing buildings)

# How do we make a Net Zero Planet?

## 2. Make Net Zero with Renewables Onsite

- Building
- Site (carports, ground mount, etc.)



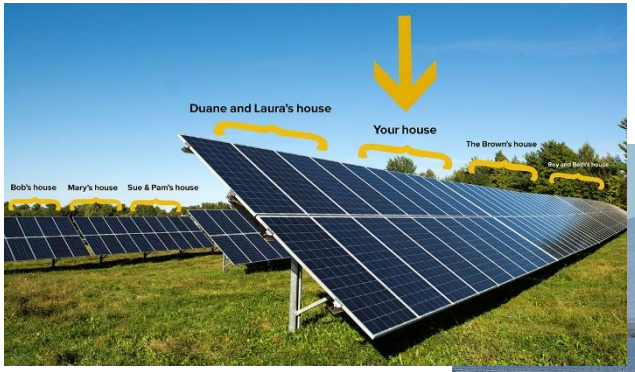
# How do we make a Net Zero Planet?

## 2. Make Net Zero with Renewables Offsite

- Individual
- Community
- Utility

# Net Zero


Campus




Community

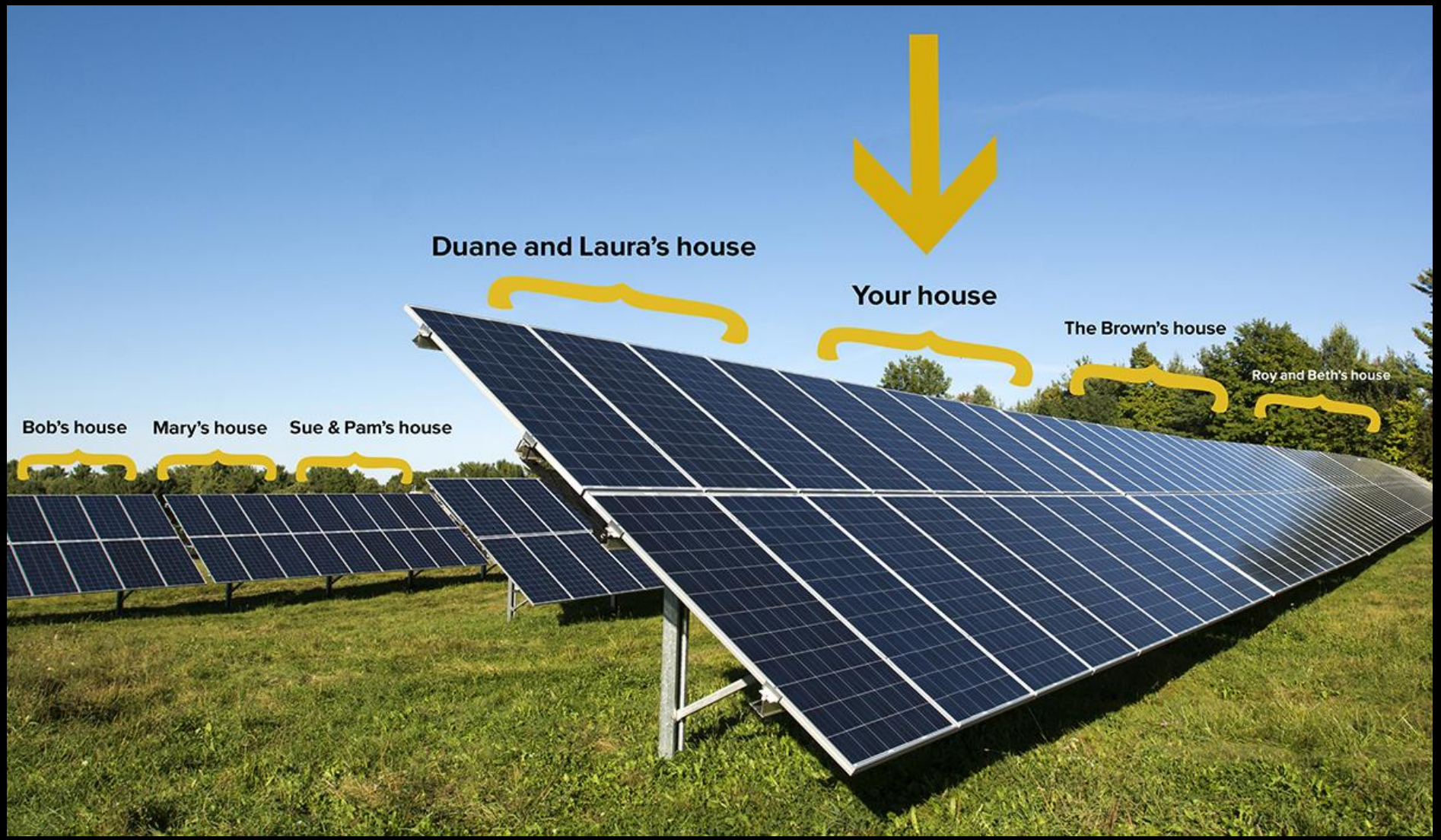

Utility


Shared


Individual - onsite

Individual - roof

# Community Solar



# Case Studies

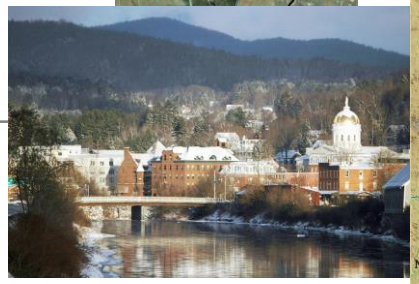
BUILDING

CAMPUS

NEIGHBORHOOD

WATERSHED

CITY



STATE


http://www.freeworldmaps.net/united-states/vermont/map.html

# Case Studies

BUILDING

CAMPUS

NEIGHBORHOOD

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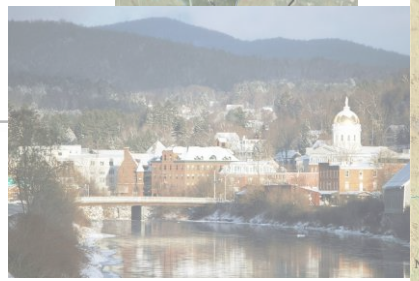


STATE


http://www.freeworldmaps.net/united-states/vermont/map.html

# Maclay Architects' Office

- Net Zero since 2011
- Historic
- Mixed Use

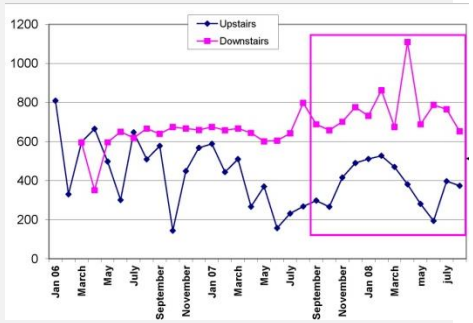
- SF: 2,568 sf office 2,207 sf Apt building
- EUI: Office 22 kBtu/sf/yr (actual)
  Apartment: 28 kBtu/sf/yr (actual)
- EUI with Renewables: -3 kBtu/sf/yr

# Timeline

*Metrics and Office NZR*
*Phase I: 1998-2003*

*Apartment NZR*
*Phase II: 2009*

*ASHP + Renewables*
*Phase III: 2004-2016*

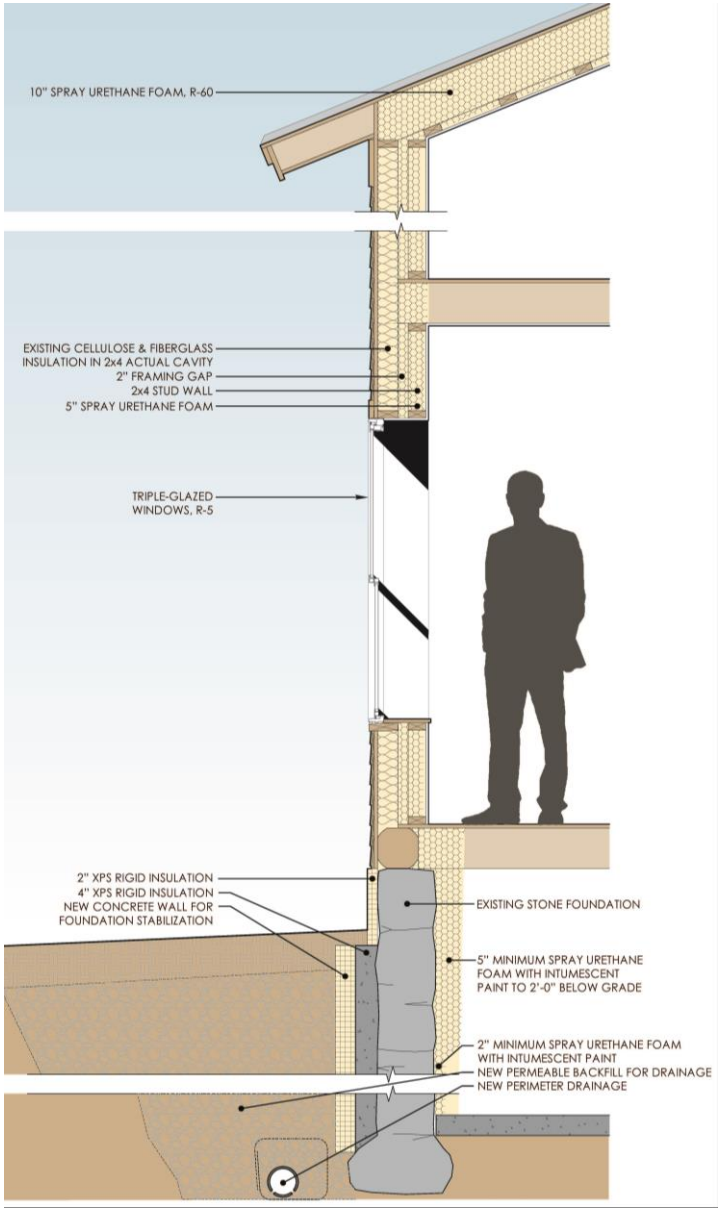



MaclayArchitects
CHOICES IN SUSTAINABILITY

# Waitsfield Context

MaclayArchitects
CHOICES IN SUSTAINABILITY

# Apartments: Envelope Upgrades & Load Reduction




# Install Renewables

**2004** *- 2 kW PV NRG tracker Onsite*

*Office purchased with tax credits*

**2010** *-17 kW PV Alteris Carport Onsite*

*Office financed plus utility and USDA grants*

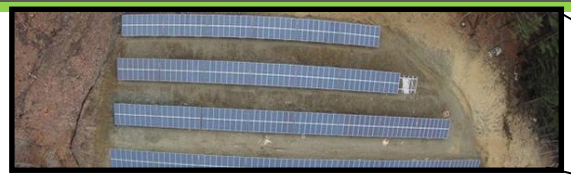
**2011** *- 20 kW PV All Earth Renewables Trackers Offsite*

*Power Purchase Agreement*

**2015** *– 22 kW Share in Community solar system*

***2016 -*** *PPA agreement terminated and lease land for trackers - energy to local non-profit*

# PV locations



*Community Solar – 22 kW*

*Solar carport & 1 Tracker – 19 kW*

*All Earth Renewables Trackers – 20 kW*

# Case Studies

BUILDING

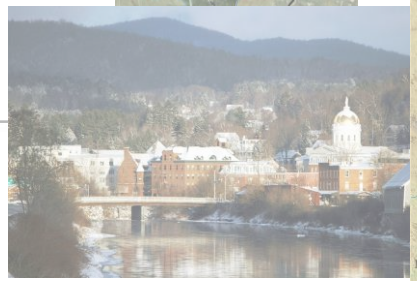
CAMPUS

NEIGHBORHOOD

WATERSHED



CITY



STATE


http://www.freeworldmaps.net/united-states/vermont/map.html

# The Putney School, Putney, VT

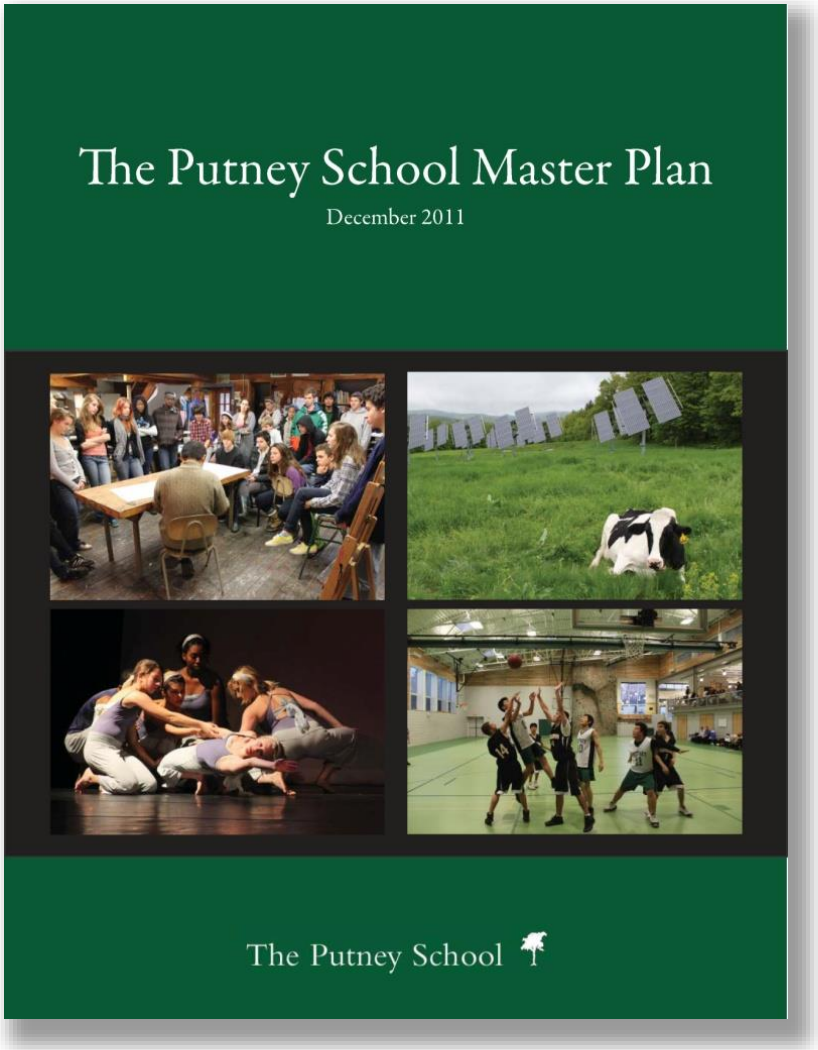
# The Putney School Net Zero Field House

- Net Zero since 2011
- Financial paradigm shift

- SF: 16,800
- EUI:  9 kBtu/sf/yr
- EUI with renewables: 0 kBtu/sf-yr
- LEED Cert: Platinum

Photo by Jim Westphalen

# The Putney School Masterplan



# The Putney School Energy Use

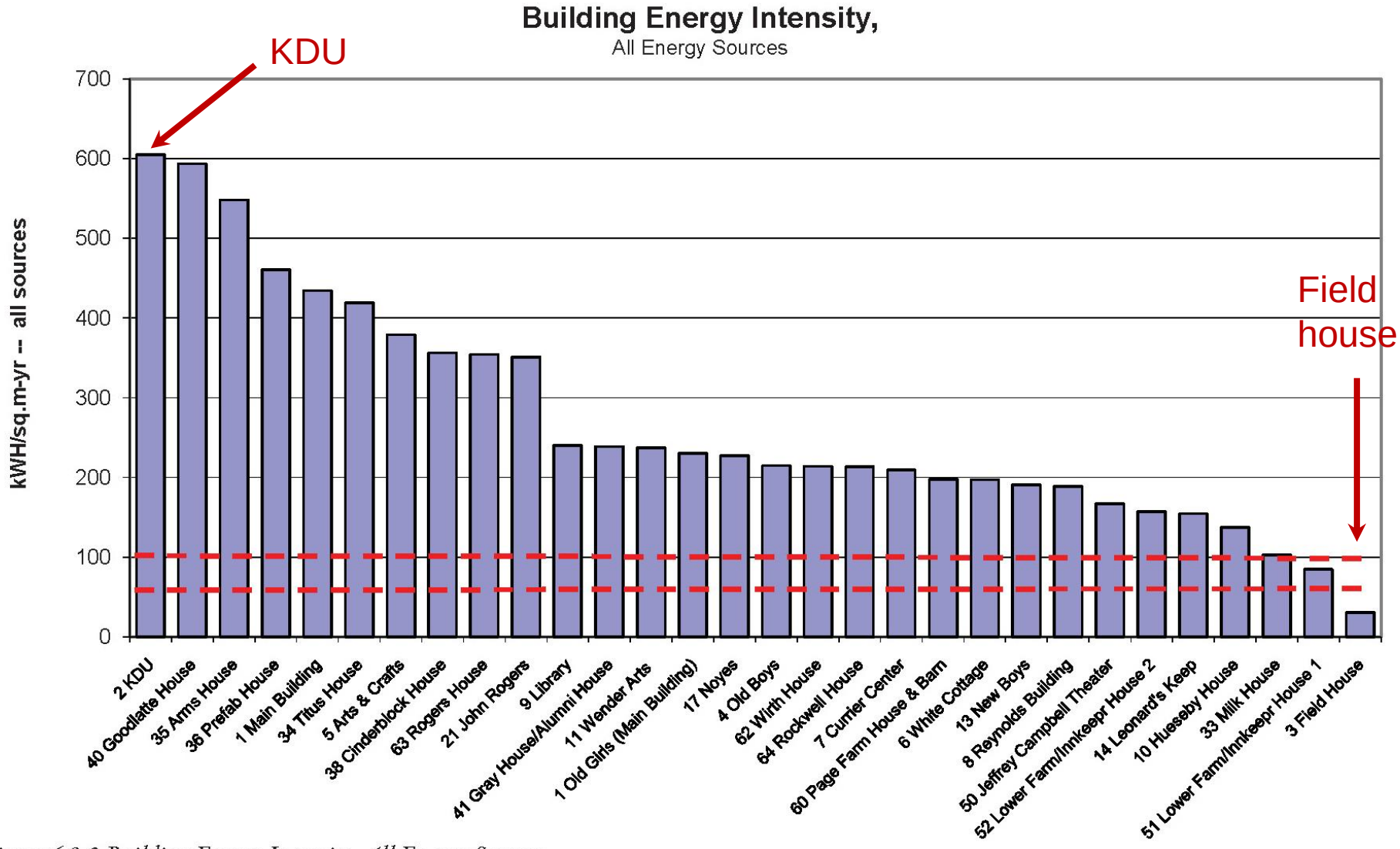


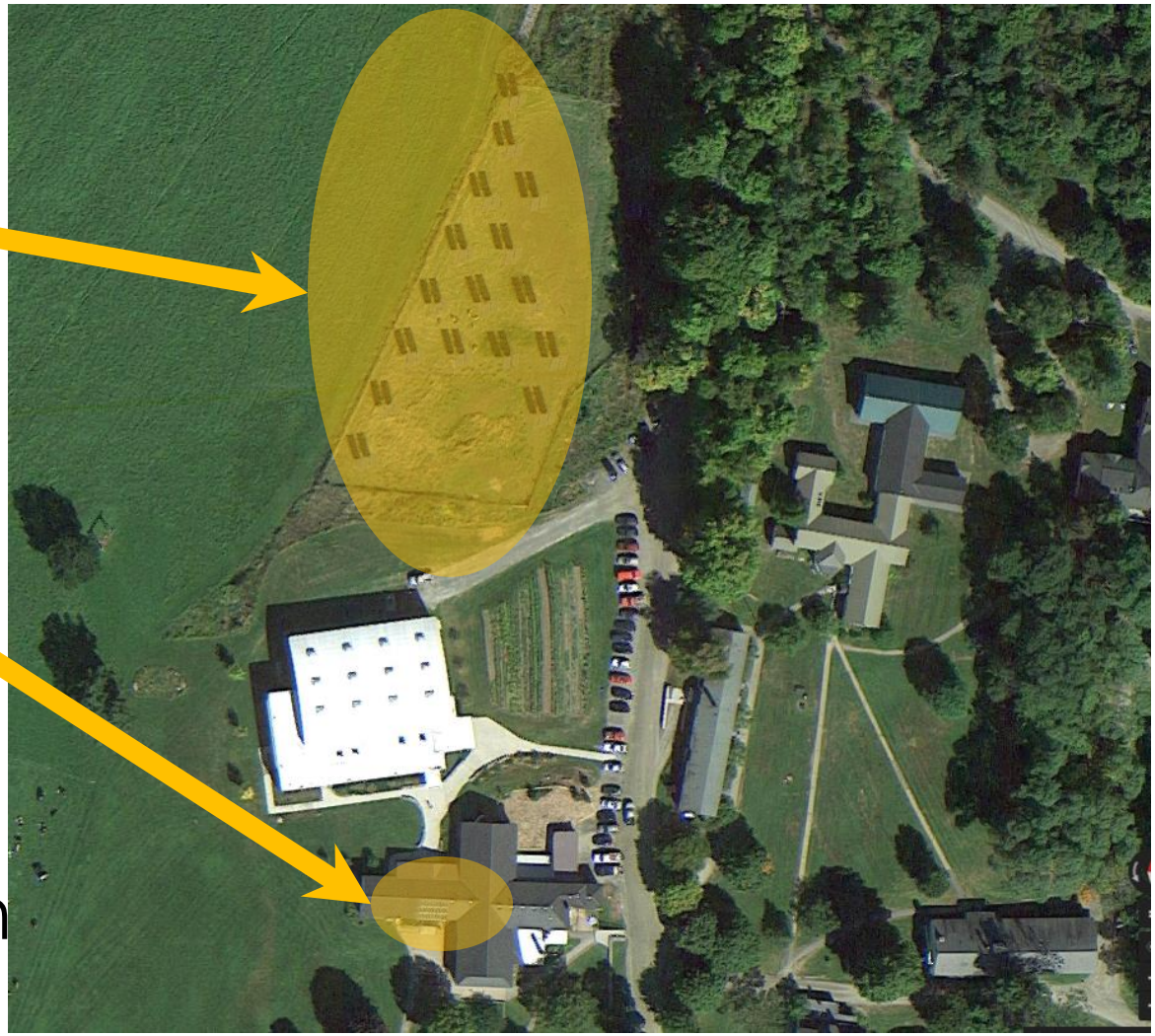

*Figure 6.3.2 Building Energy Intensity, All Energy Sources*

# The Putney School PV

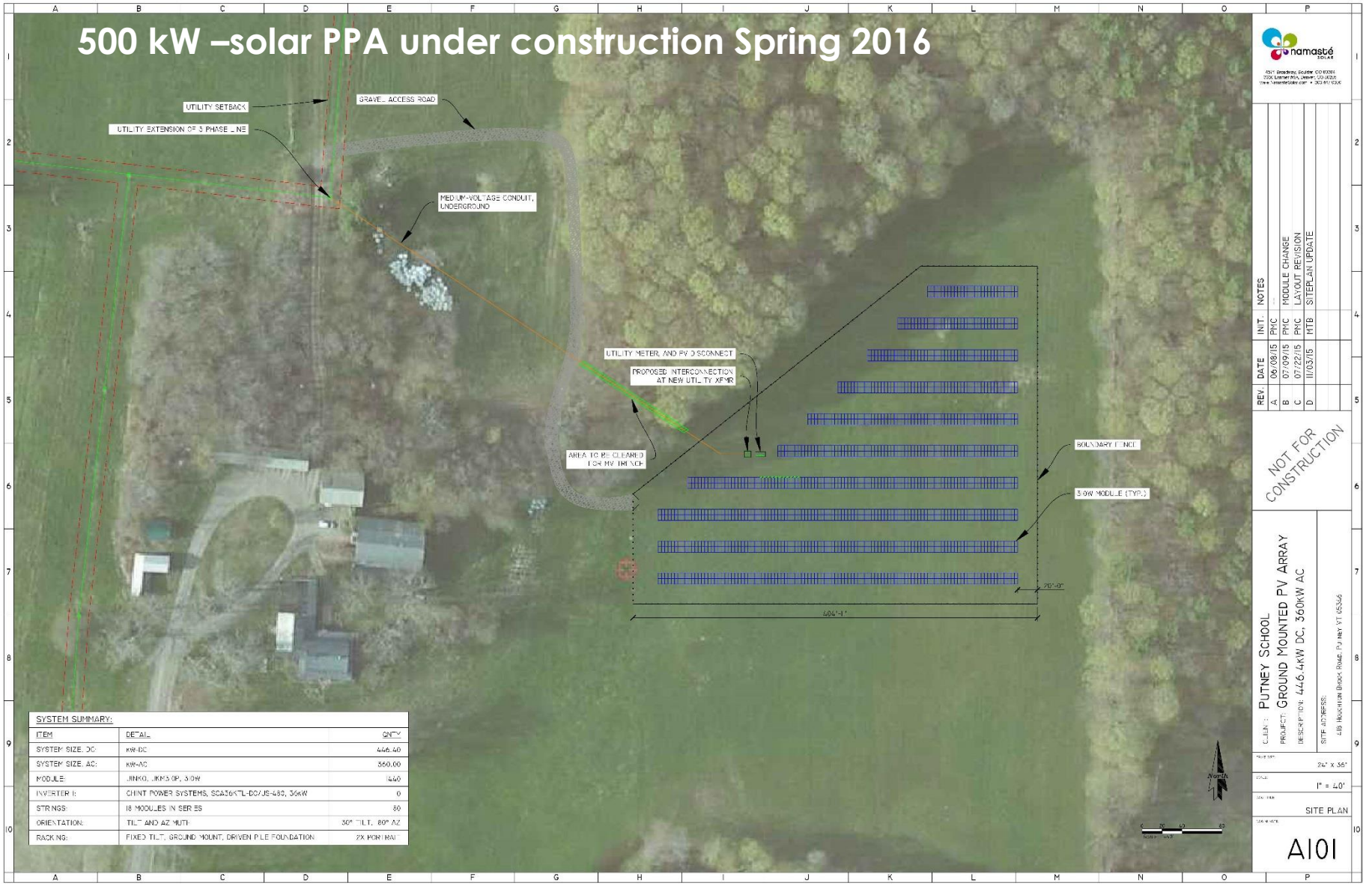
Trackers for Field House

Dining Hall Roof Mounted PV

500 kW –solar PPA under construction Spring 2016



# The Putney School PV



# Case Studies

BUILDING

CAMPUS

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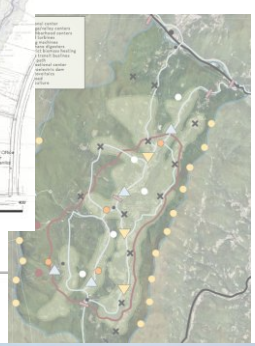
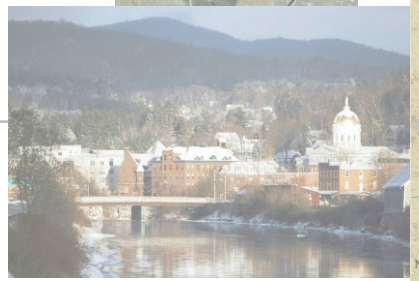


CITY



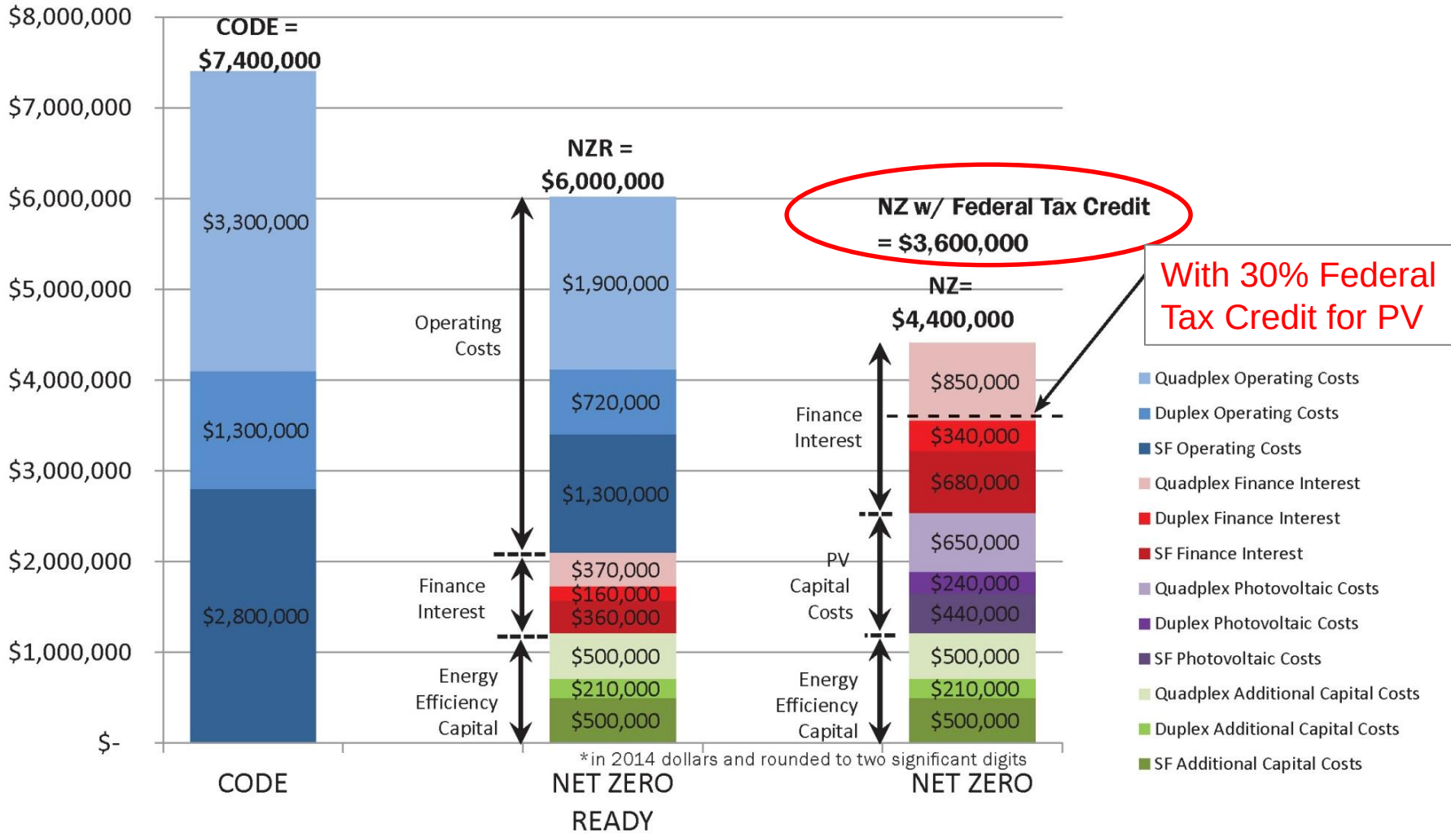
STATE


http://www.freeworldmaps.net/united-states/vermont/map.html

# Renewable NRG Systems Net Zero Feasibility Study

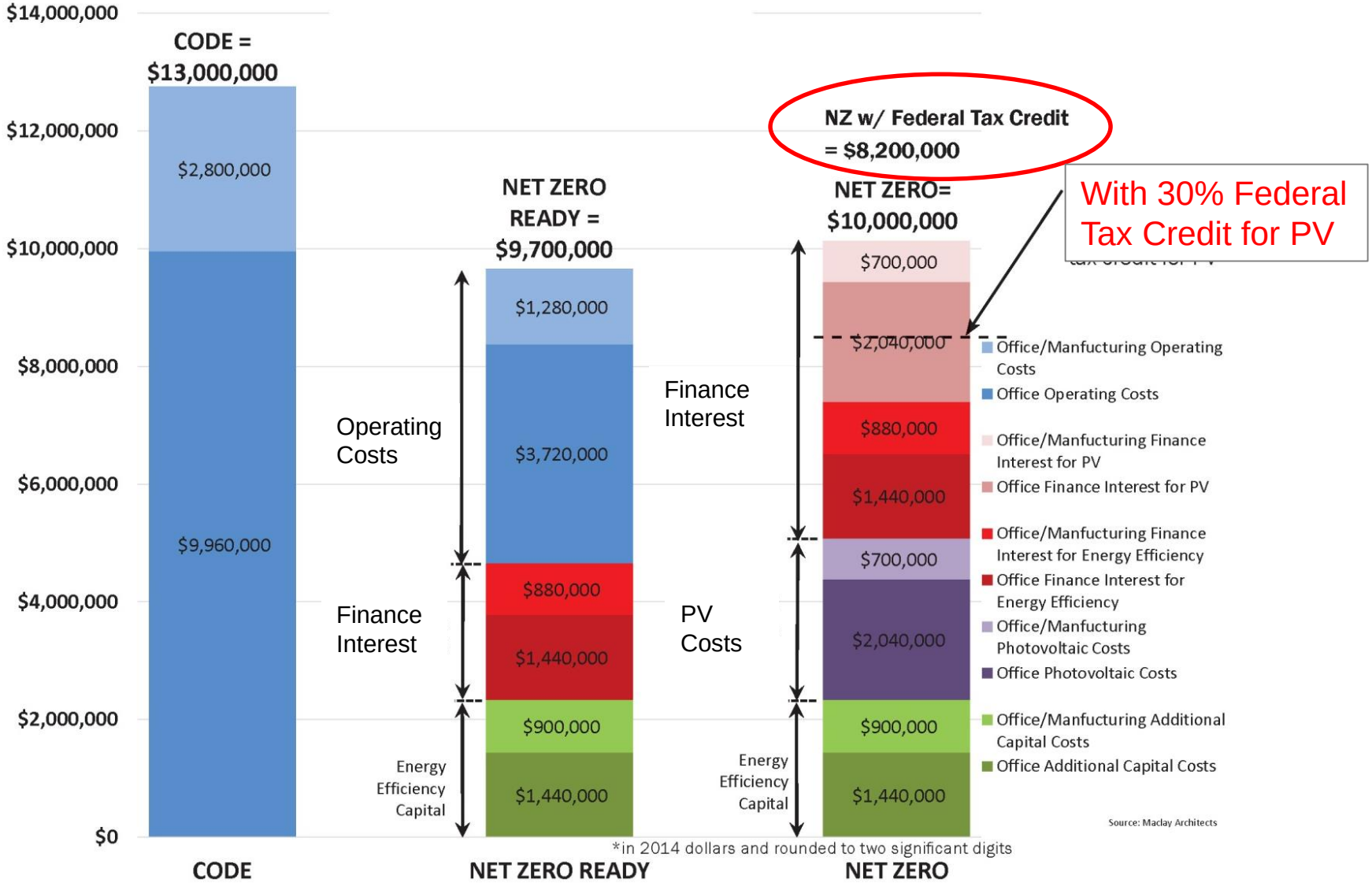
# Community Residential 30-Year Costs

- NZ cumulative savings of $3.8 million including PV tax credits



# Community Commercial 20-Year Costs

- NZ with the federal tax credit saves $4.8 million over 20 years



# Case Studies

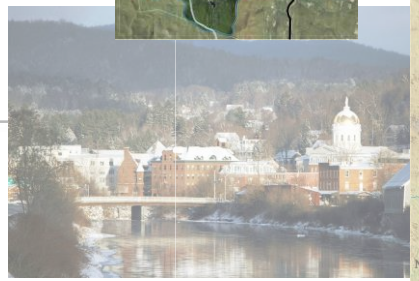
BUILDING

CAMPUS

NEIGHBORHOOD

WATERSHED

CITY



STATE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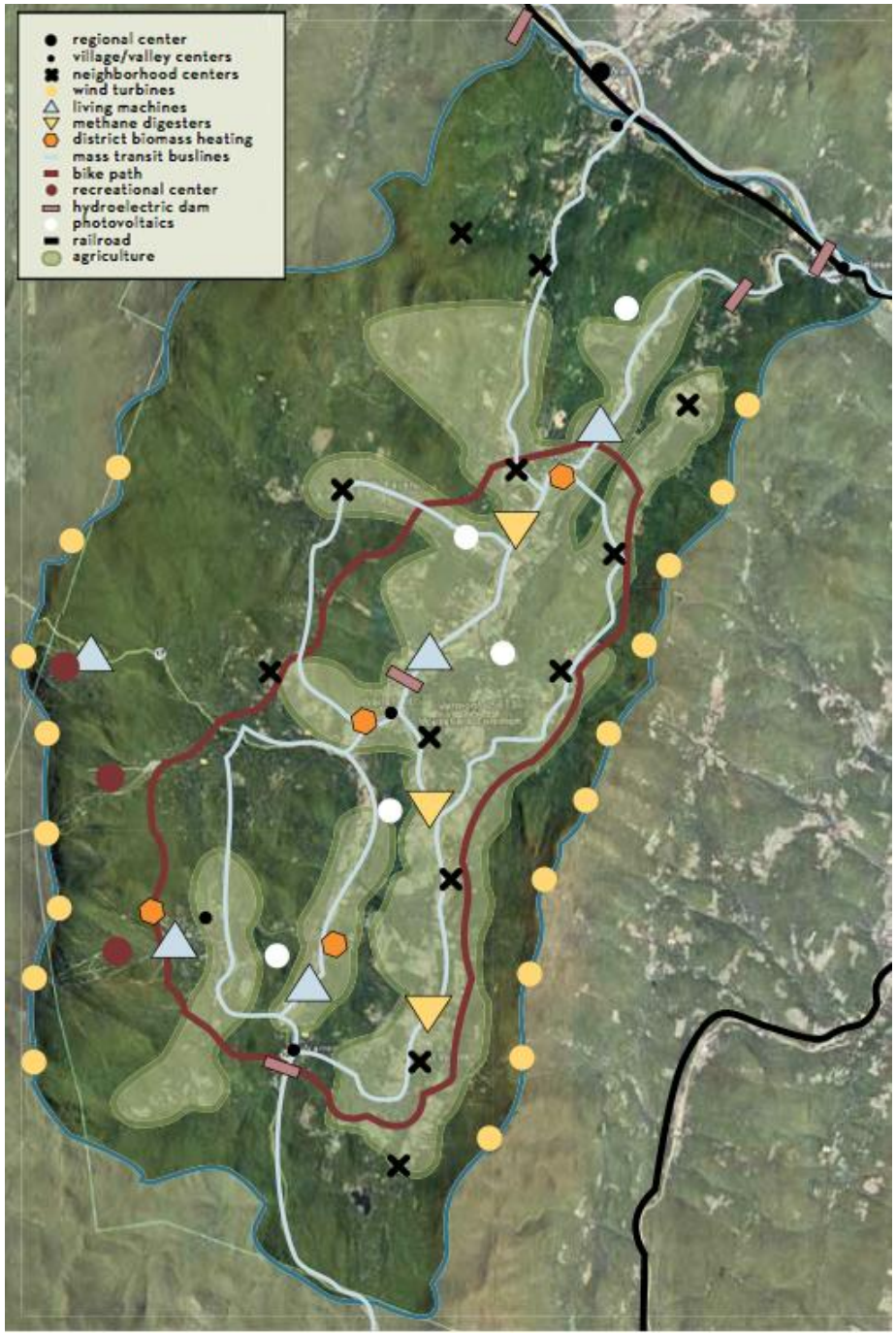



# Mad River Valley Vermont

- Integration of buildings, community & beyond

With energy conservation we can realistically expect to reduce total energy loads by 75%.

We would then need:

65,00 barrels of oil
27,000 cords of wood, 28,000 acres of woodland or 44 square miles ( 30% of the entire Valley)
94,000 kW of installed PV, 550 acres or 1 square mile
13 wind turbines (2.3 Mw with 100 meter blades)

assuming a wind speed of 7.5 mps, requiring ridgeline placement

Sources: Utility Facts, 2013 by The Vermont Department of Public Service

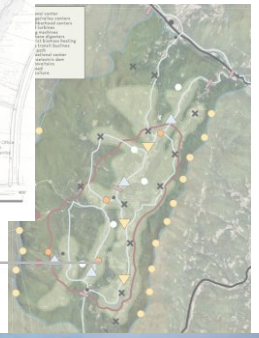
# Case Studies

BUILDING

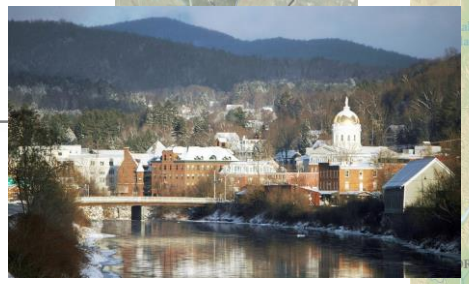
CAMPUS

NEIGHBORHOOD

WATERSHED



CITY



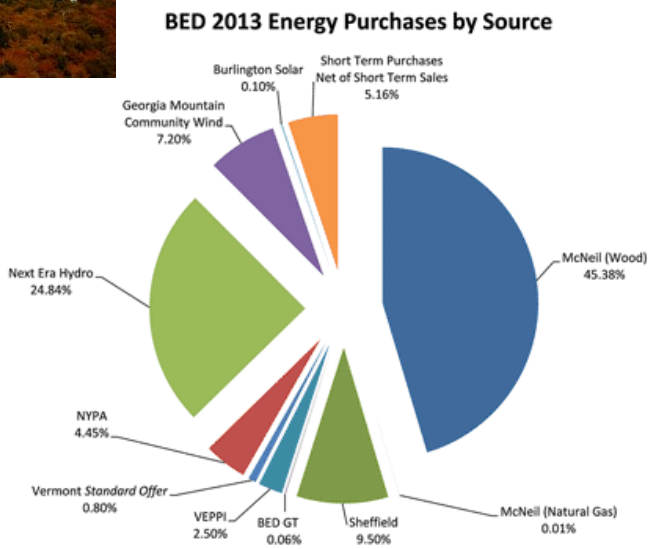
STATE

# Burlington, Vermont – 100% Renewable Electricity

Sheffield Wind

Burlington Solar

NextEra Hydro




Georgia Mountain Community Wind

Winooski One Hydro Plant

McNeil Generating Station (wood)

# Rutland, Vermont – The Solar Capital of New England

Together, Green Mountain Power and the City of Rutland established a bold vision for Rutland, Vermont to be the Energy City of the Future using energy innovation as a focal point for economic development and revitalization.


## Rutland Shines

Rutland now has the most solar per capita of any city in New England:

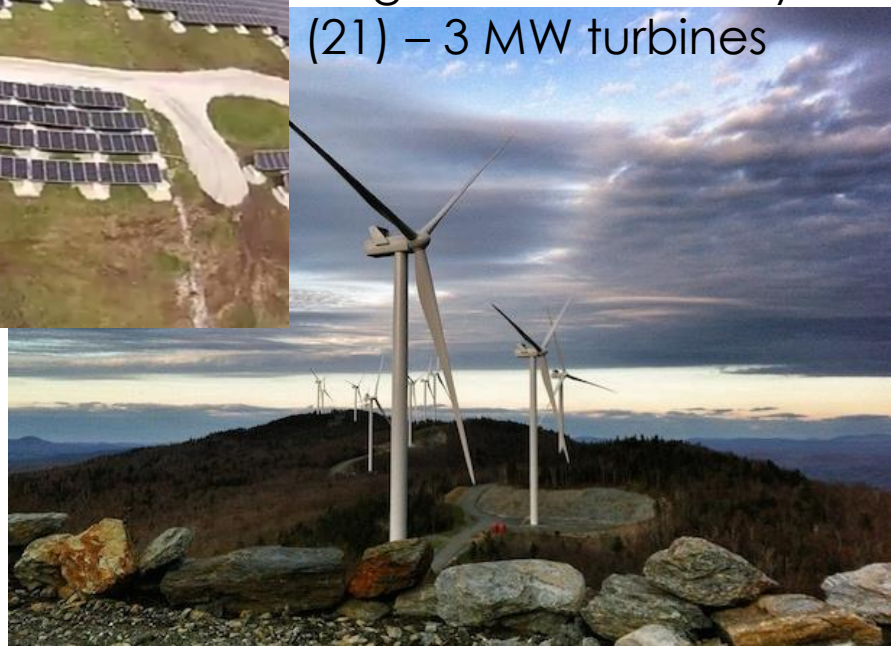
- 51 homes, businesses and other projects are generating clean solar energy
- 7.87 MW of solar installed
- 7.87 MW of solar generates enough energy for 1,600 homes all year
- Stafford Hill is the largest project in Rutland - 2.5 MW of clean power
- Stafford Hill uses cutting edge battery storage to increase reliability and power an emergency shelter
- Local organizations generating solar energy include:
    - Rutland Regional Ambulance

# Green Mountain Power

Stafford Hill 2 MW Solar Farm

Sources: Green Mountain Power
http://www.greenmountainpower.com/innovative/solar_capital/stafford-hill-solar-farm/

Kingdom Community Wind
(21) – 3 MW turbines



Sources: Green Mountain Power
http://www.greenmountainpower.com/innovative/wind/

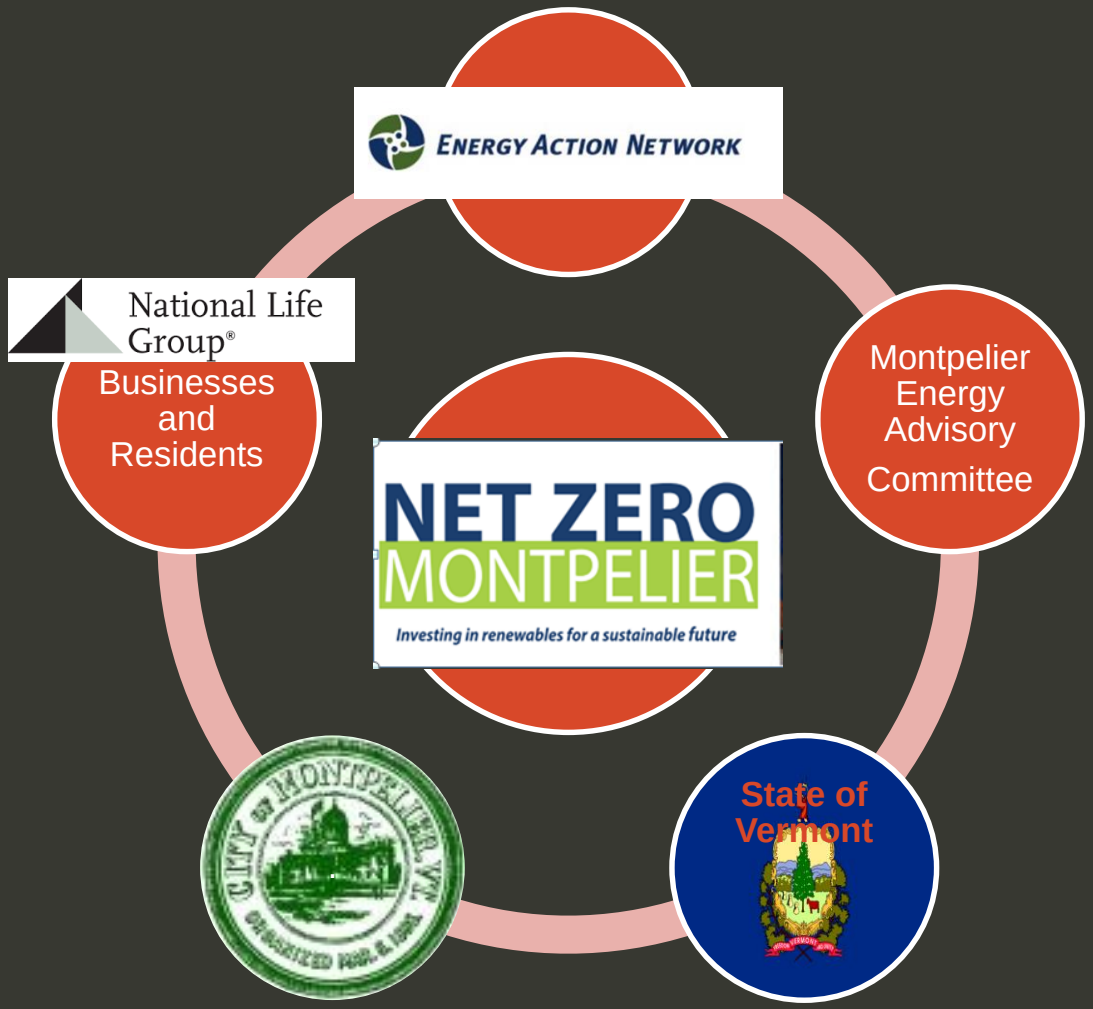
NET ZERO MONTPELIER

*Investing in renewables for a sustainable future*

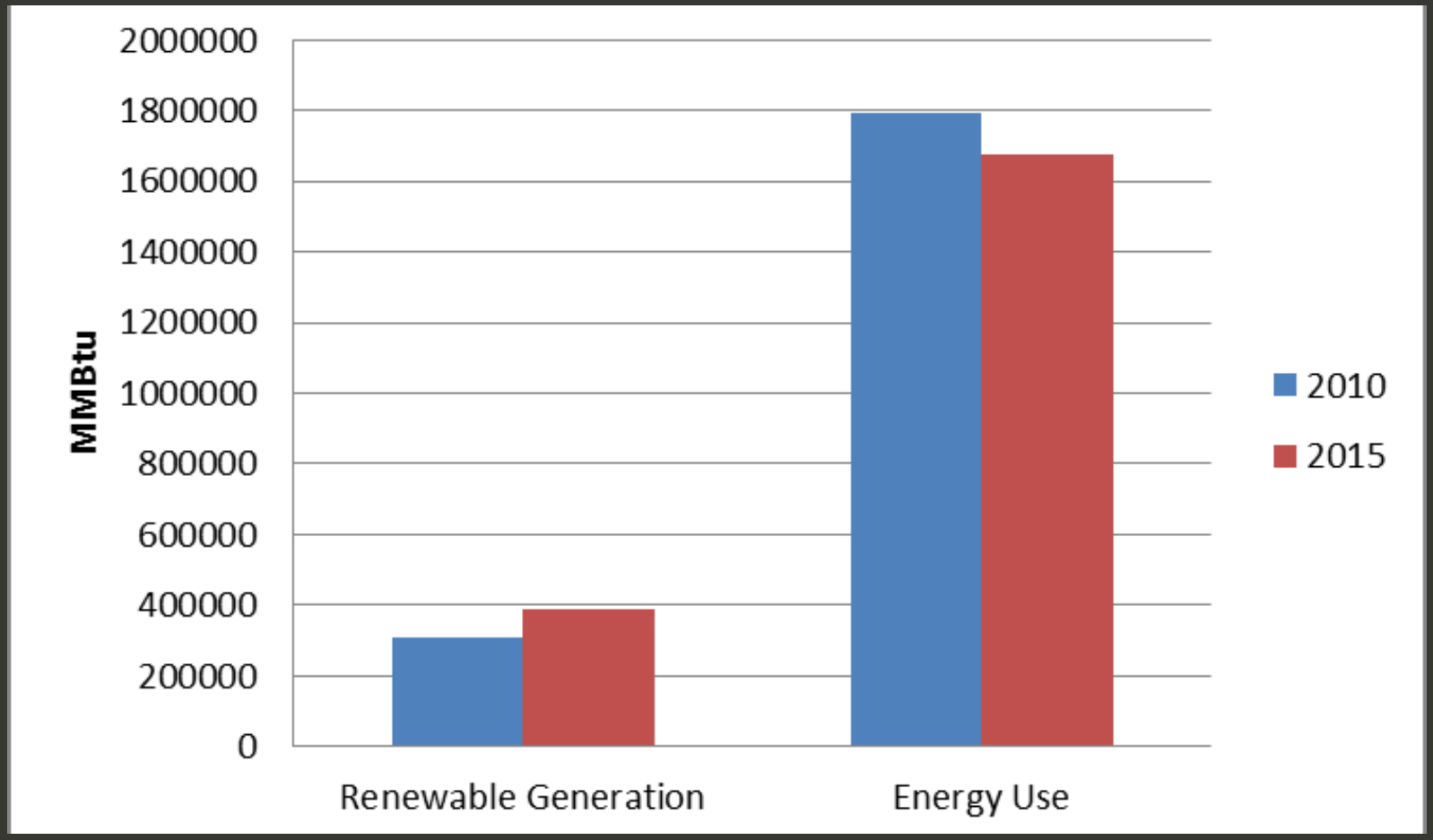

The community's energy needs are: produced or offset by renewable energy sources

Vision

# Who is Net Zero Montpelier?



# Progress to Date



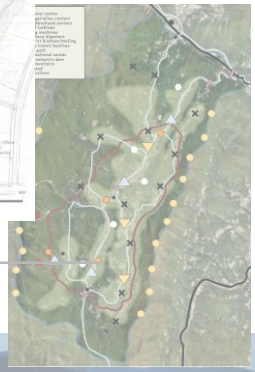
# Case Studies

BUILDING

CAMPUS

NEIGHBORHOOD

WATERSHED



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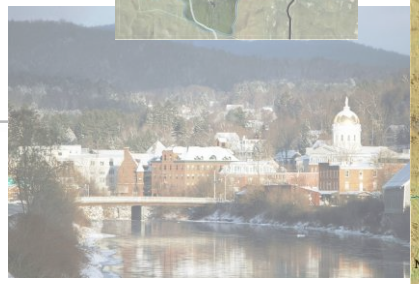


STATE


http://www.freeworldmaps.net/united-states/vermont/map.html

# State of Vermont

GOAL: *transition to a clean energy economy by replacing fossil fuels with renewables and increasing efficiency*

**90% by 2050**

Vermont Energy Investment Corporation

# Pathway to 90% Renewables by 2050

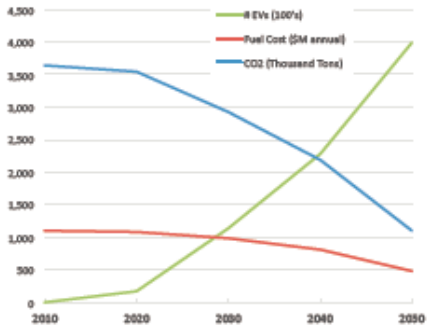
## 3 Examples from EAN's Analysis

### 1 TRANSPORTATION

Electric vehicles (EV) and plug-in hybrid electric vehicles (PHEV) offer the promise of greatly reduced energy use and operating cost per vehicle mile.

By transitioning 70% of our automobiles (light vehicle fleet) to EVs and PHEVs run on renewable fuels, Vermonters could save $500M annually at today's gasoline prices and cut vehicle greenhouse gas (GHG) emissions to less than a third of 2010 levels.

Electric Vehicle Impacts

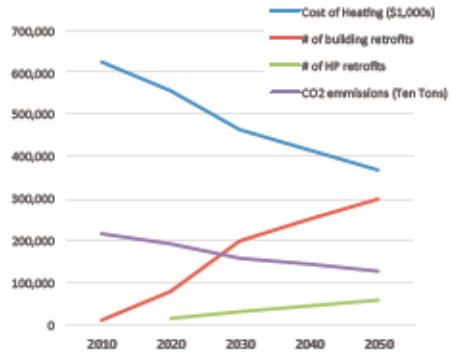



### 2 THERMAL

This chart (right) shows the impact of combining a statewide efficiency program that reaches 300,000 homes by 2050 (with 30% average savings) and heat pump retrofits of 60,000 buildings (20% penetration rate).

At today's fuel and electricity cost, this would save Vermonters $260 M per year when fully implemented. It would also cut GHG emissions by over 40% from current levels.

Efficiency and Heat Pump Impacts

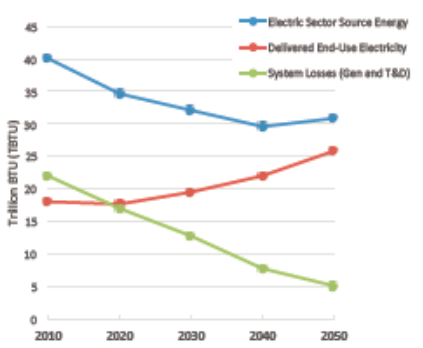



### 3 ELECTRIC

Transitioning our electric system to rely predominantly on renewables is the foundation of achieving 90% by 2050. Not only will it allow for electrification of transportation and a portion of our heating needs, but it is the single most important element to minimize waste in our overall energy system and reduce GHG emissions.

EAN's 90% by 2050 energy analysis shows that despite increasing our end-use electrical consumption by 43% in 2050 to power transportation and thermal sectors, the electrical sector overall source energy consumption will actually decrease by 23% because of new more efficient renewable generation that has no source losses *(see page 1)*.

Renewable Electricity Impacts




## Key Pathways to Reach 90% by 2050

While efficiency is our most cost-effective pathway, to achieve the goals of the CEP we will need to invest in efficiency and new renewable energy resources simultaneously.

***These technology pathways have the greatest capacity to transform Vermont's energy economy.***

| TRANSPORTATION | THERMAL | ELECTRICITY |
|---|---|---|
| Electric Vehicles | Building Efficiency | Solar Power |
| CAFE Standards | Heat Pump | Wind Power |
| Biofuels | Biomass and Biofuels | Hydro Quebec |

http://eanvt.org/resources/

Vermont Energy Investment Corporation

# Obstacles to Net Zero

1. Utility opposition

# Obstacles to Net Zero

1. Utility opposition
2. Grid capacity

# Obstacles to Net Zero

1. Utility opposition
2. Grid capacity
3. Equity

# Obstacles to Net Zero

1. Utility opposition
2. Grid capacity
3. Equity
4. Storage

# 4 Steps to Net Zero Benefit for All

1. Know your EUI

"Cropped Earth with Sunburst" by NASA

# 4 Steps to Net Zero
# Benefit for All

1. Know your EUI
2. Set EUI Goals

"Cropped Earth with Sunburst" by NASA

# 4 Steps to Net Zero Benefit for All

1. Know your EUI
2. Set EUI Goals
3. Build to EUI

"Cropped Earth with Sunburst" by NASA

# 4 Steps to Net Zero Benefit for All

1. Know your EUI
2. Set EUI Goals
3. Build to EUI
4. Power with Renewables any way possible

"Cropped Earth with Sunburst" by NASA

# THE New Net Zero

Leading-Edge Design and Construction of Homes and Buildings for a **Renewable Energy Future**

WILLIAM MACLAY AND MACLAY ARCHITECTS

Bill Maclay, AIA, LEED AP / bill@maclayarchitects.com
www.maclayarchitects.com / 802-496-4004