Webinar - April 21, 2022

Workshop 3. Beyond Code, Net Zero Energy & Existing Buildings

HAWAII STATE Energy Office | Building Energy Education fundamentals | SEDAC ILLINOIS

Presentation Collaborators

Hawai'i Energy | AIA Honolulu | ASHRAE Hawaii Chapter | HAWAII | BOMA HAWAII

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Phillip Camp, hi·arch·y llp

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Building Energy Education fundamentals

SEDAC SMART ENERGY DESIGN ASSISTANCE CENTER

ILLINOIS

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AIA Honolulu

ASHRAE Hawaii Chapter

U.S. GREEN BUILDING COUNCIL USGBC HAWAII

BOMA HAWAII Building Owners and Managers Association

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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

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COURSE DESCRIPTION

This is the third in a series of three webinars covering building energy efficiency and the energy code in Hawaii. This final session covers the topics of designing to exceed energy code requirements, efficiency strategies in both new and existing buildings and incentives that are available for energy efficiency measures.

LEARNING OBJECTIVES

At the end of this course, participants will be able to:

1. Select appropriate beyond-code performance targets
2. Identify strategies to achieve high efficiency in new construction
3. Assess energy performance of existing buildings to identify savings opportunities
4. Identify incentives available for energy efficiency projects

Introductions

Presenters

- Howard Wiig, State Energy Office
- Erik Kolderup, Kolderup Consulting
- Phil Camp, hi.arch.y
- Ben Sullivan, City & County of Honolulu
- Lily Koo, Hawaii Energy

Acknowledgments

- Karen Shishido, Hawaii Energy
- Gail Suzuki-Jones, State Energy Office
- Kiera Williams, State Energy Office
- Alan Okimoto, State Energy Office
- Elena Arinaga, State Energy Office

Section 1

Introduction

Training series

Now available online

Workshop 1
Building Energy Education Fundamentals and Energy Code Basics
4/7/2022

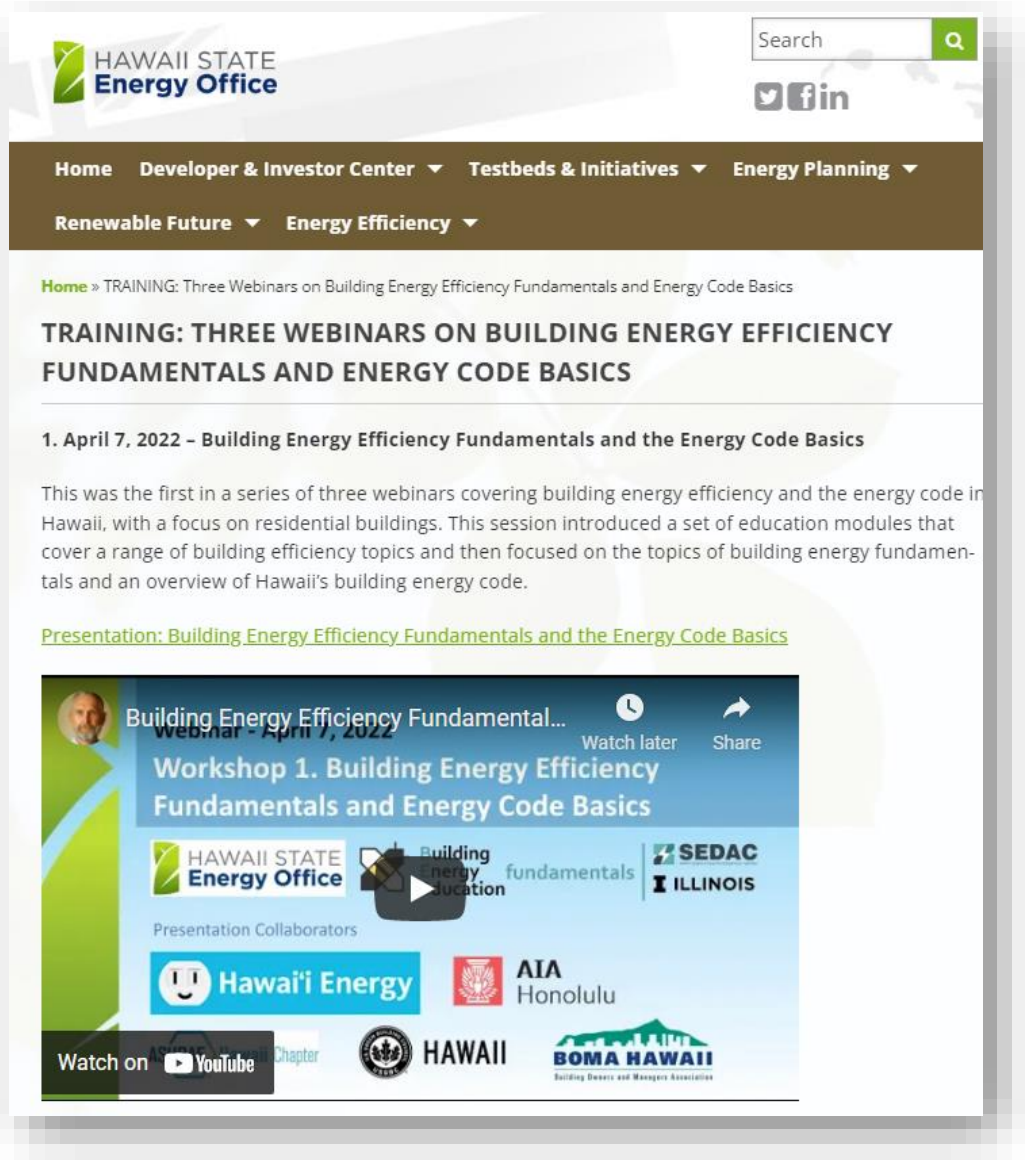
Workshop 2
Comfort, Air Quality and Lighting
4/14/2022

PDF & video recording

https://energy.hawaii.gov/building-energy-efficiency-and-energy-code

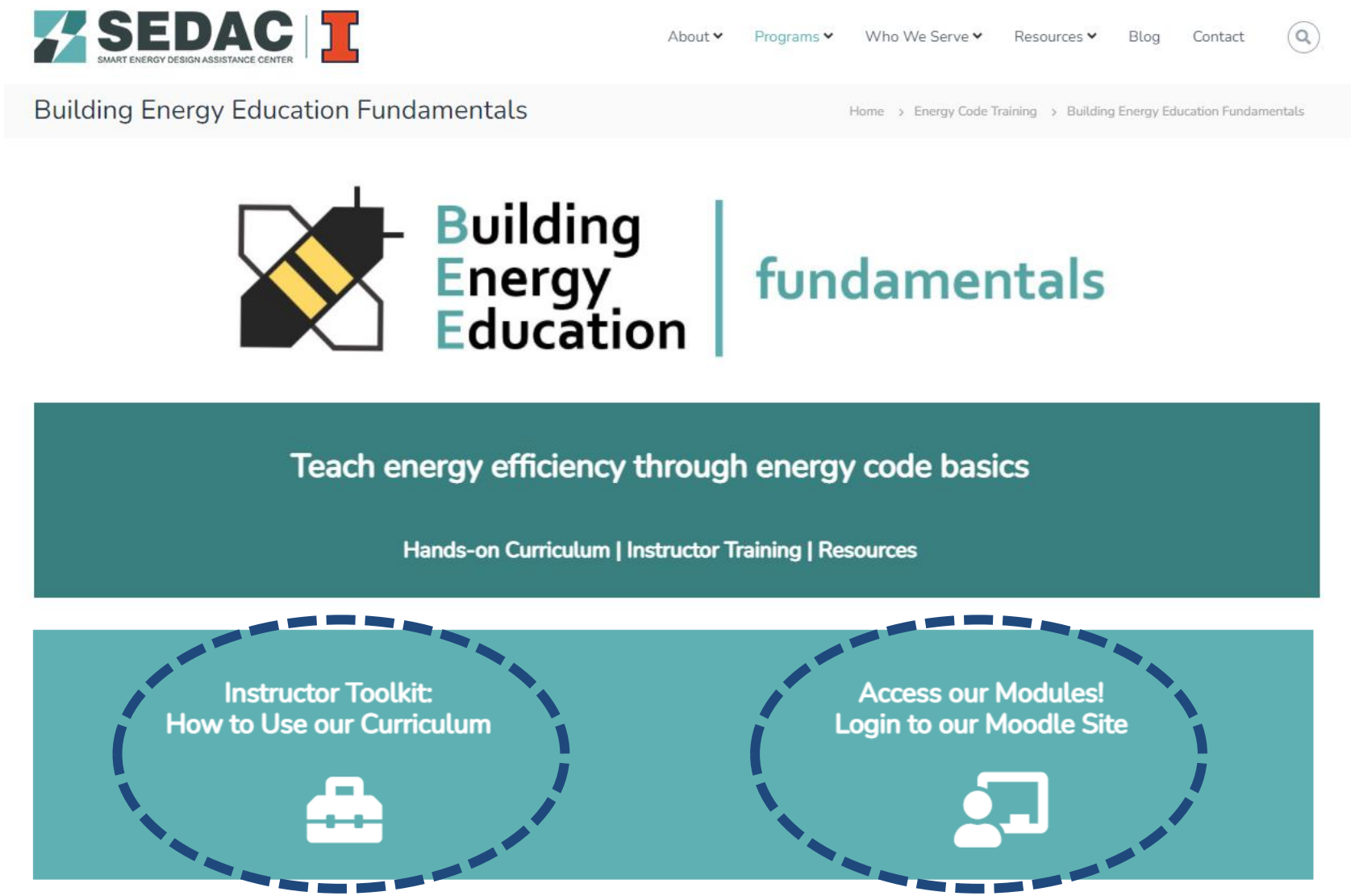
Next Week

Train the Trainer
BEE Fundamentals: Train-the-Trainer Workshop
Friday, 4/29/2022 9:00 – 11:00am HST
https://smartenergy.illinois.edu/bee_fundamentals/



BEE Fundamentals Program Webpage

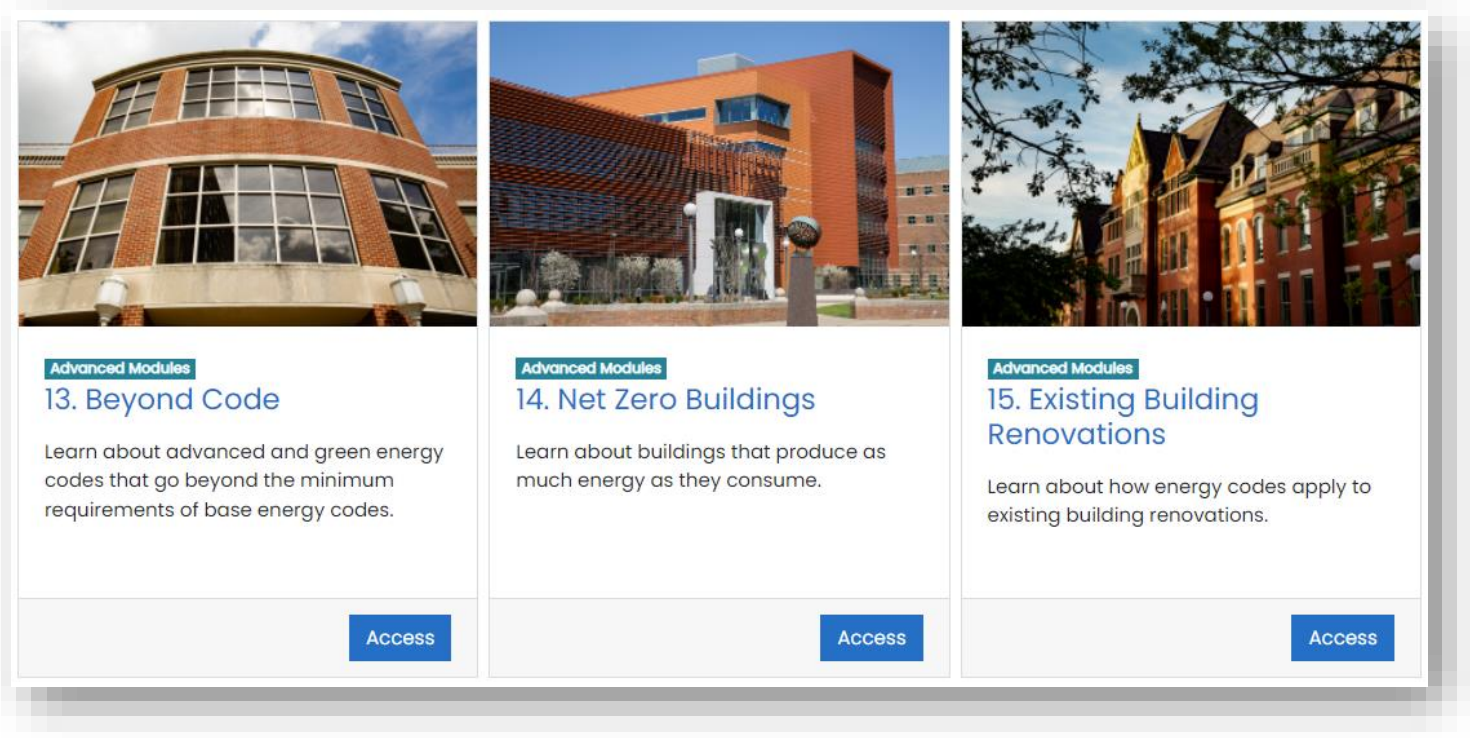
https://smartenergy.illinois.edu/bee_fundamentals/



Today’s topics

- Beyond code targets
  - Definition of beyond code
  - Hawaii project examples
- Net zero buildings
  - Defining net zero
  - Reducing energy use
  - Renewables
- Honolulu energy code
  - EV and PV ready
- Existing buildings
  - Assessing existing buildings
  - Tools for inspections
- Hawaii Energy programs
- Zippy’s gift cards!

Building Energy Education fundamentals



Section 2

Beyond Code

LIVING
BUILDING
CHALLENGE

BEE Modules

13. Beyond Code

- 13.1 Definition of Beyond Code
- 13.2 Benefits of Beyond Code
- 13.3 Challenges of Beyond Code

Hawaii project examples

Building Energy Education fundamentals

13.1 Definition of "Beyond Code"

Module 13: Beyond Code
Part 1

Objective: Understand the difference between the definitions of base codes and beyond code, and why beyond code is important.

13.1 Definition of “Beyond Code”

Module 13: Beyond Code
Part 1

Objective: Understand the difference between the definitions of base codes and beyond code, and why beyond code is important.

What is “beyond code” or “above code”?

The term “beyond code” typically is used to describe programs or codes that **exceed minimum requirements** under widely adopted codes and standards such as:

- The International Energy Conservation Code (IECC),
- The American Society of Heating, Refrigerating and Air-conditioning Engineers (ASHRAE) Standards 90.1,
- The International Residential Code (IRC), and
- The International Building Code (IBC).

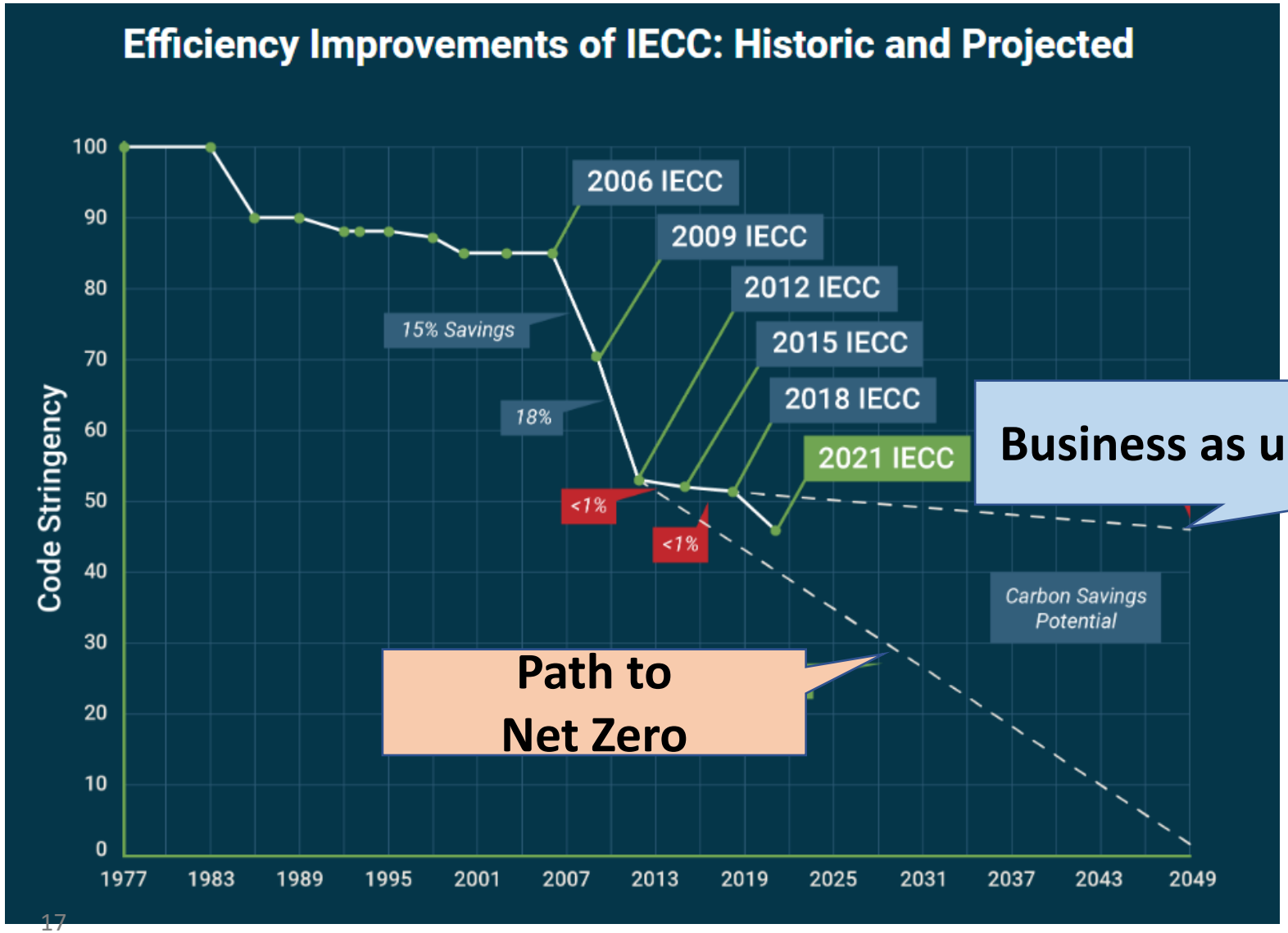
What does it mean to meet energy code requirements?

- The energy code provides **minimum** construction requirements.
- Increase energy efficiency, sustainability, and resilience by **going above and beyond** the minimum requirements.

Grade C (passing grade) for buildings

- Complying with the energy code or meeting minimum requirements ensures that buildings do not fail in energy performance.
- Energy code compliance only guarantees a passing grade for a building.

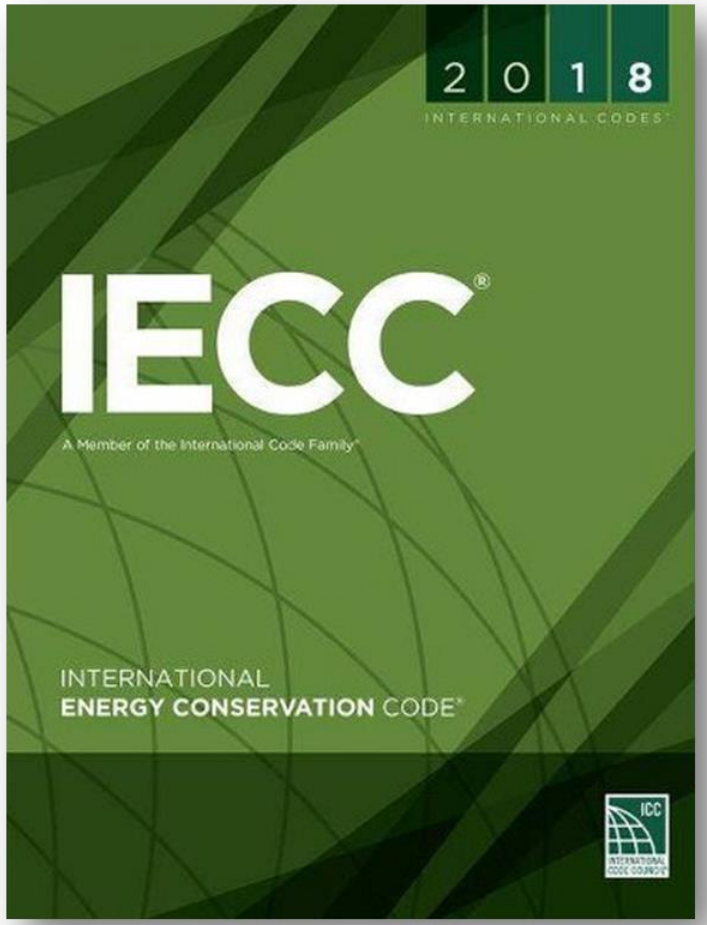
Business as usual vs. path to Net Zero

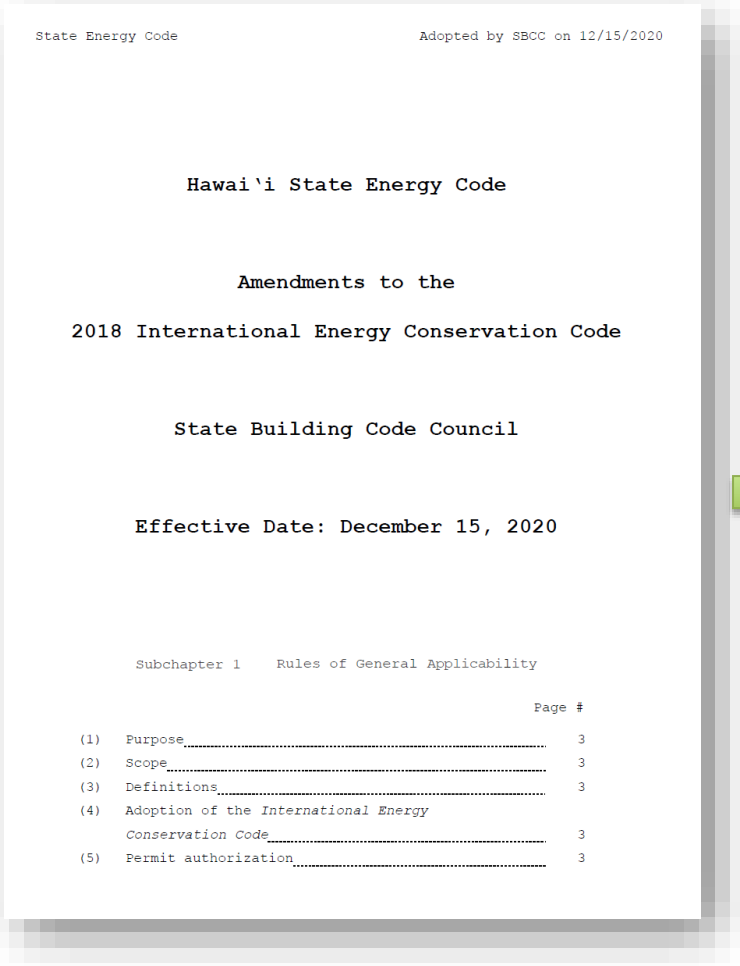


- Energy efficiency improvements of model codes are getting smaller.
- Simply meeting energy code minimum requirements does not provide a path to Net Zero

https://energyefficientcodes.org/iecc/

Hawaii Energy Code





State Energy Code Adopted by SBCC on 12/15/2020

Hawai'i State Energy Code

Amendments to the

2018 International Energy Conservation Code

State Building Code Council

Effective Date: December 15, 2020

Subchapter 1 Rules of General Applicability

Page #

State amendments
Adopted 2020

December 2022
deadline for adoption

County amendments

Checklist

RESIDENTIAL CHECKLIST
IECC 2018 with State Amendments

HAWAII STATE Energy Office

Hawaii Energy
YOUR CONSERVATION & EFFICIENCY PROGRAM

This checklist covers requirements of the 2018 IECC with State-adopted amendments, approved in December 2020. Check with individual Counties for County - adopted versions of the code. See https://energy.hawaii.gov/hawaii-energy-building-code.

Red text in this checklist indicates changes between this 2018 version of the code and the previous 2015 IECC with Hawaii Amendments.

SCOPE

Detached one- and two-family dwellings and multiple single-family dwellings (townhouses) as well as Group R-2, R-3 and R-4 buildings three stories or less in height above grade plane. The code applies to new construction, additions and alterations. See a separate Commercial Checklist for high-rise residential and commercial buildings.

RESIDENTIAL COMPLIANCE OPTIONS

Tropical Zone	Prescriptive	Simulated Performance Alternative	Energy Rating Index Compliance Alternative
Allowed when: 1. ≤50% air conditioned, 2. not heated, and 3. elevation < 2,400 feet.	Includes three options for walls and roof compliance: 1. Prescriptive 2. Total UA (typically with ResCheck software) 3. Points option (added by Hawaii amendment)	Simulated energy performance analysis for heating, cooling and SHW. Proposed design must have annual energy cost less than or equal to energy cost of reference design.	Third-party Home Energy Rating System (HERS) calculation. Allows the designer to pick and choose from many efficiency options. Scores range from 100 to 0. The 100 score indicates compliance with the 2006 IECC. Each efficiency measure beyond 2006 lowers the score. A passing score for Climate Zone 1 is 57.
See Tropical Zone Checklist below	See Prescriptive Checklist below. See Points Option tables below.	See code Section R405	See code Section R406

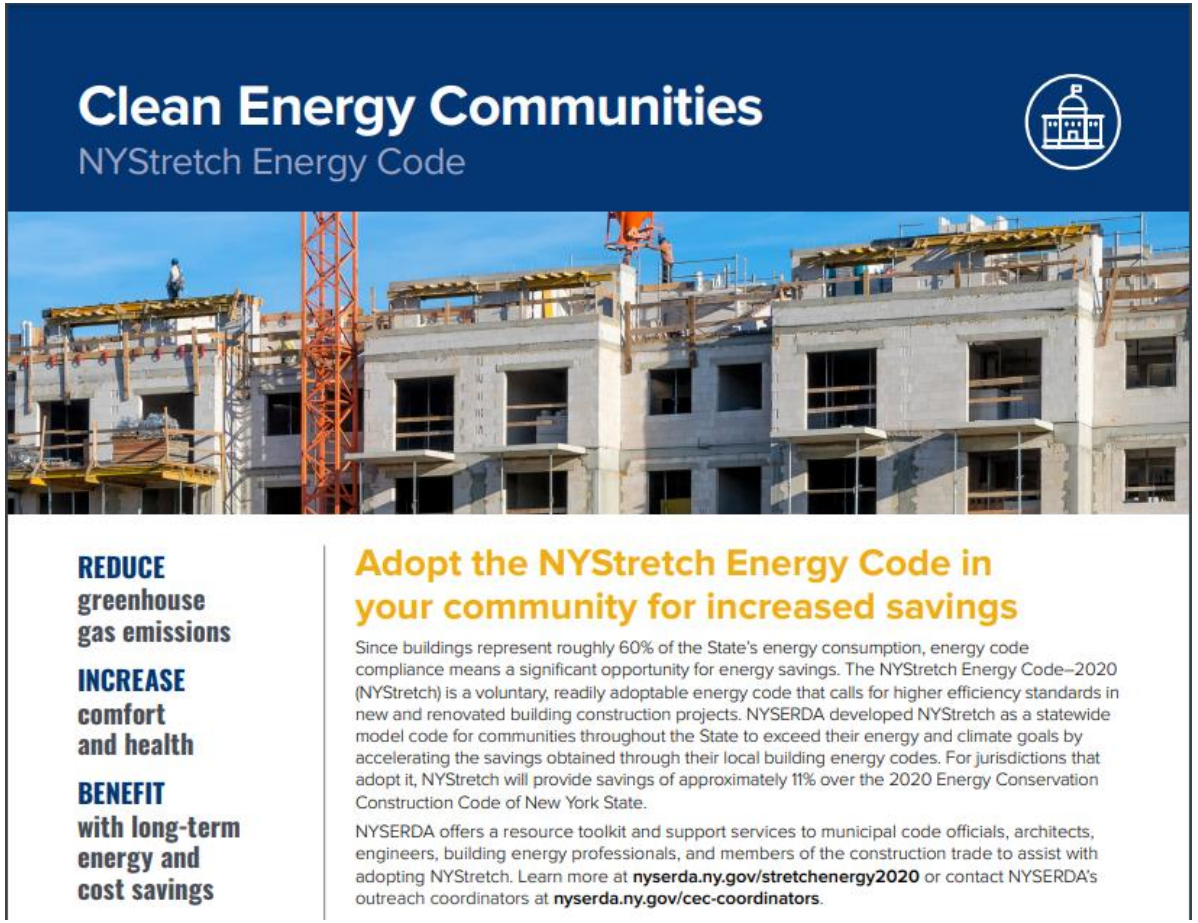
CHECKLIST CONTENTS

Sponsor: Hawaii State Energy Office
Acknowledgment: This material is based upon work supported by the Department of Energy under Award Number EE0006986

https://energy.hawaii.gov/hawa ii-energy-building-code/building-code-resources

Stretch codes definition

- A **stretch energy code** is an appendix to a mandatory energy code that goes beyond the minimum requirements.
- States establish the stretch code; municipalities voluntarily adopt it
- Stretch codes sometimes include strategies that will be adopted in future code cycles, making it easy for future adoption.



https://southerntiercec.org/high-impact-items/nystretch

Energy + other sustainability requirements

- Like stretch codes, green codes go beyond minimum requirements.
- In addition to energy, they usually cover environmental impacts such as water and resource efficiency.
- Two common green codes are ASHRAE 189.1 and the International Green Construction Code (IgCC) which were consolidated in 2018.

LEED (Leadership in Energy and Environmental Design) (# required items/optional points)

Certified	40-49
Silver	50-59
Gold	60-79
Platinum	80-110

- **Integrative Process (1/1 pts)**
- **Location and Transportation (0/9 pts)**
- **Sustainable Sites (2/9 pts)**
- **Water Efficiency (3/11 pts)**
- **Energy and Atmosphere (4/35 pts)**
  - Minimum Standard: Comply with ASHRAE 90.1-2016
- **Materials and Resources (2/19 pts)**
- **Indoor Environmental Quality (2/16 pts)**
- **Innovation (0/6 pts)**
- **Regional Priority (0/4 pts)**

LEED energy and atmosphere (required/optional points)

Certified	40-49
Silver	50-59
Gold	60-79
Platinum	80-110

- **Energy and Atmosphere Prerequisites**
  - Fundamental commissioning
  - Minimum energy performance: Comply with ASHRAE 90.1-2016
  - Building level energy metering
  - Refrigerant management
- **Enhanced Commissioning (2-6 pts)**
- **Improve Energy Performance (1-18 pts) [2 pt/5% improvement]**
- **Advanced Metering (1 pt)**
- **Grid Harmonization (1-2 pts)**
- **Renewable Energy (1-5 pts)**
- **Enhanced Refrigeration Management (1 pt)**

Recent Hawaii LEED certified commercial projects

July 2017 to present

Project Name	Certification Level	Floor Area
Daniel K. Inouye College of Pharmacy	Silver	40,687
Medical / Dental Clinic Kaneohe Bay	Silver	8,986
Hawaii State Hospital NPF	Silver	189,403
West Oahu Medical Office at Kapolei	Gold	41,154
University of Hawaii West Oahu Admin	Gold	38,642
University of Hawaii Life Sciences Bldg	Silver	79,280
University of Hawaii Law Clinical Bldg	Gold	8,500
NSC Homeport NED/C4IT Addition	Certified	9,900
P-320 SPSF for PHNSY-IMF	Silver	44,182
NSC Homeport FRC Addition	Certified	4,731
Ola Ka 'Ilima Artspace Lofts	Platinum	104,485
FY15 MCON P-861-3D Radio Auto Org Shop	Gold	17,840
FedEx Express ITOA Van Station	Certified	28,343
P-910 Bachelor Enlisted Quarters	Gold	49,092
Victoria Ward Block M	Silver	564,290
MCBH WOF Maintenance Building	Silver	12,860
Ward Village Block O - Ke Kilohana	Certified	508,210
Ainahau Vista 2	Certified	34,565
MCBH WOF Administration Bldg	Silver	7,630
Kahului OGG ConRAC	Silver	1,784,290

Project Name	Certification Level	Floor Area
Westin Nanea Ocean Villas	Gold	810,721
Kapolei Community Center	Silver	6,000
Block C	Silver	552,312
Manoa Heritage Center	Gold	2,365
Park Lane Ala Moana	Certified	621,145
Anaha	Silver	649,162
University of Hawaii LCC Ka Imi Ike EIIF	Gold	19,500
NMCP Public Information Center	Silver	7,460
University of Hawaii Culinary Institute	Gold	13,113
Kamamalu Building	Silver	90,476
University of Hawaii WO Classroom	Silver	82,934
University of Hawaii WO Campus Center	Silver	63,469
Nanakuli Public Library	Silver	18,078
Waimano Ridge - Hale Ola & Kitchen Bldg	Silver	51,087
DAGS Hawaii District Ofc Hilo Baseyard	Silver	15,364
Medline Industries, Inc.	Silver	98,419
DOW Agrosciences Kauai Admin Building	Silver	5,664
FY13 Whole Barracks Renewal Group	Silver	146,570
KMCWC NICU PICU Building	Silver	189,293
Symphony Honolulu	Certified	574,030

https://www.usgbc.org/projects?Country=%5B%22United+States%22%5D&State=%5B%22Hawaii%22%5D

Living Building Challenge

PETALS

Imagine a building that is as efficient as a flower; a simple symbol for the ideal built environment. The Living Building Challenge is organized into seven performance areas.

PLACE

Restoring a healthy interrelationship with nature.

WATER

Creating developments that operate within the water balance of a given place and climate.

ENERGY

Relying only on current solar income.

HEALTH & HAPPINESS

Creating environments that optimize physical and psychological health and well being.

MATERIALS

Endorsing products that are safe for all species through time.

EQUITY

Supporting a just and equitable world.

BEAUTY

Celebrating design the uplifts the human spirit.

https://living-future.org/lbc/

Living Building Challenge

LIVING
BUILDING
CHALLENGE

- 70% reduction in building energy from baseline
- 20% reduction in embodied energy
- Net Zero ready
- Red List of materials (no PVC, CFC, HCDC, BPA, CPVC, VOC paint, etc.)

Well Buildings

- **No specific energy code version connected**
- **Several aspects are connected i.e., ventilation, comfort, etc.**

THE WELL BUILDING STANDARD™

Section 3

Beyond-code examples

Phillip Camp, hi·arch·y llp

LOCAL CASE STUDIES

BEYOND CODE, NET ZERO ENERGY, AND EXISTING BUILDINGS

hi·arch·y
architecture·planning·interiors

4-21-2022

hi·arch·y

architecture·planning·interiors

WHO WE ARE

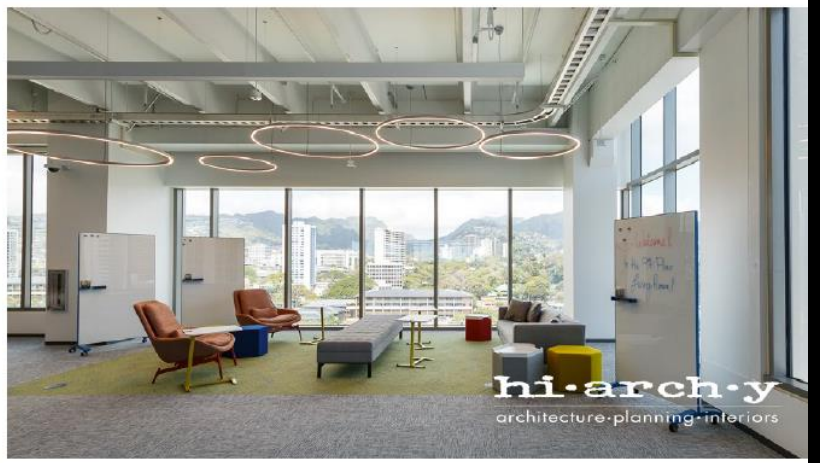
- 26+ years of architectural experience in HI & CA focusing on large scale mixed-use residential, office, and civic / educational projects
- Sustainability-focused design team with both LEED APs, WELL APs and AEEC Certified Energy Managers
- First LEED Platinum Affordable Mid-Rise TOD project in Hawaii: Keauhou Lane (209 units + 30,000 sf retail)
- First WELL Health-Safety Rating earned on American Savings Bank Campus in Honolulu during 2020 pandemic

American Savings Bank Campus Tower

Office, Financial Center

Hi•arch•y llp | Honolulu, HI

- 3-30-300 Rule
- Bringing together more than 650 ASB team members from 5 different locations under 1 roof
- 1st WELL Health-Safety Certified space in Hawaii



- View Dynamic Glass
- State of the art air and water quality management systems
- Central Staircase
- Access to fresh air
- Collaboration Corners

- Tenant Improvement project - significant efforts into improving existing glazing, HVAC, daylight, electrical, and water fixtures
- Achieved LEED Platinum rating

- Recycled Materials
- Cork Flooring

- The project involved six stories with 209 units of mixed-use residential space. Approximately 31,000 SF is for commercial use on the ground floor, with the upper five floors for residential.
- Achieved LEED Platinum rating

- Access to open spaces
- High efficiency lighting & plumbing fixtures
- Energy star appliances
- Recycled Materials


THANK YOU!
hi·arch·y
architecture·planning·interiors
hiarchy.net

Section 4
Net zero buildings

BEE Modules

14. Net Zero Buildings

- 14.1 Defining Net Zero
- 14.2 Reducing Energy Use
- 14.3 Renewables

Hawaii net zero examples

Building Energy Education fundamentals

14.1 Defining Net Zero

Module 14: Net Zero
Part 1

Objective: List several definitions of Net Zero and explain the differences between those definitions.

14.1 Defining Net Zero

Module 14: Net Zero
Part 1

Objective: List several definitions of Net Zero and explain the differences between those definitions.

Definitions matter!

- Net Zero electricity
- Net Zero energy
- Net Zero emissions
- Zero carbon emissions

Net Zero electricity

- Net Zero electricity: renewable electricity produced equals electricity consumed

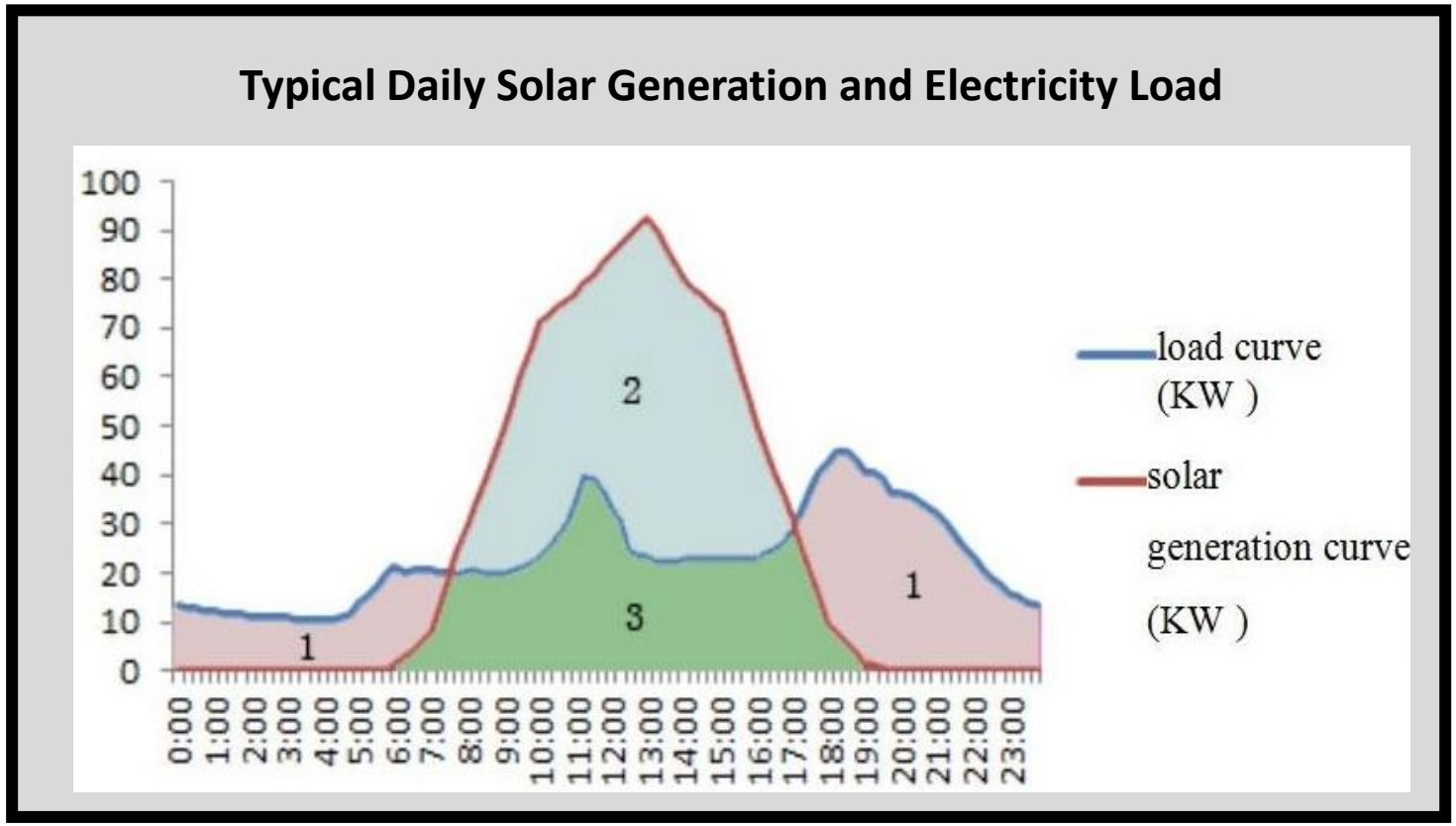
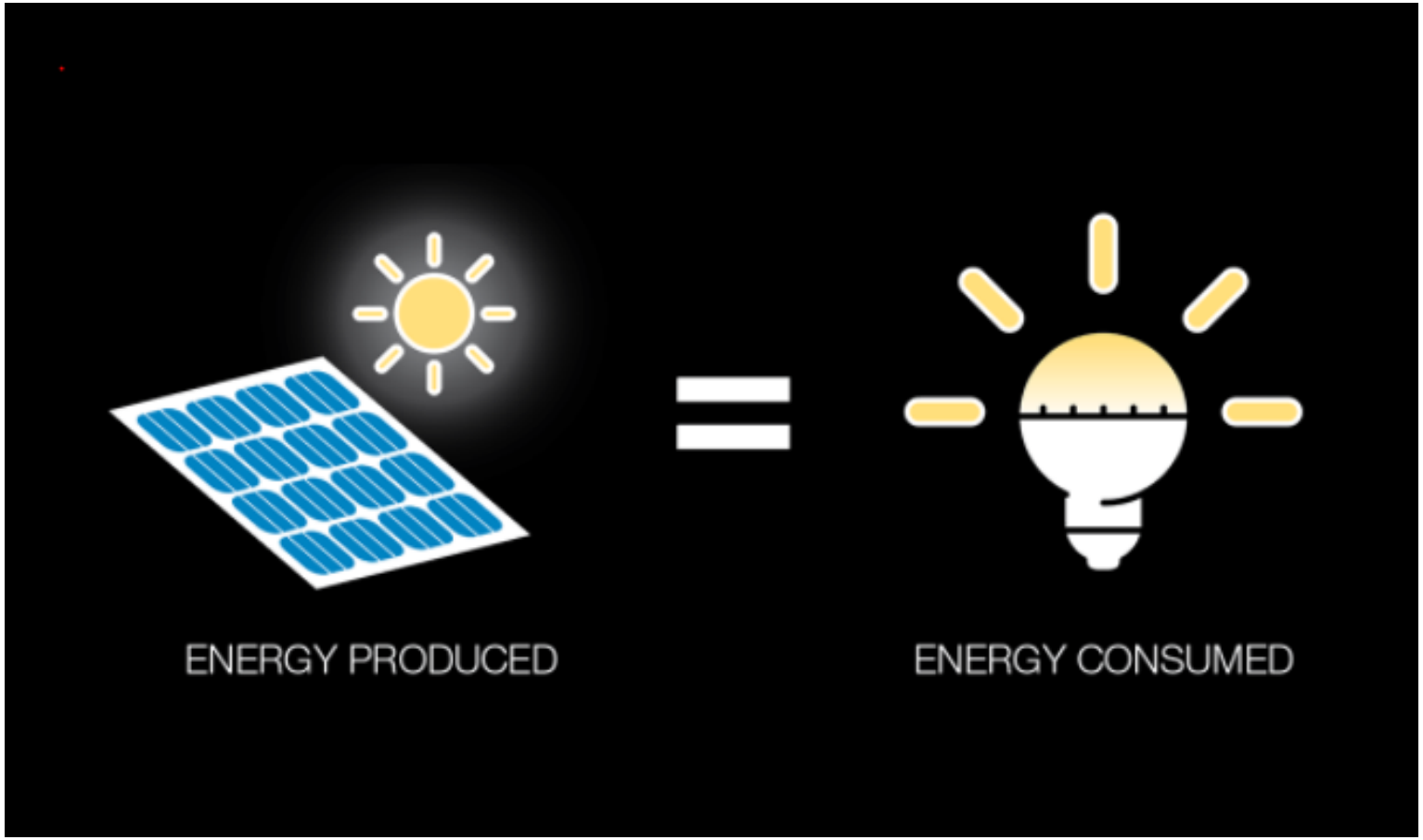


Image source: https://www.researchgate.net/figure/Typical-daily-solar-generation-curve-and-load-curve_fig1_326118936

The time of day that **energy is produced** may not coincide with the time when **energy is needed**. Therefore, some type of energy storage or grid interconnection is needed.

Net Zero energy

- Net Zero energy: Renewable energy produced equals energy consumed



https://bonestructure.ca/en/netzero/

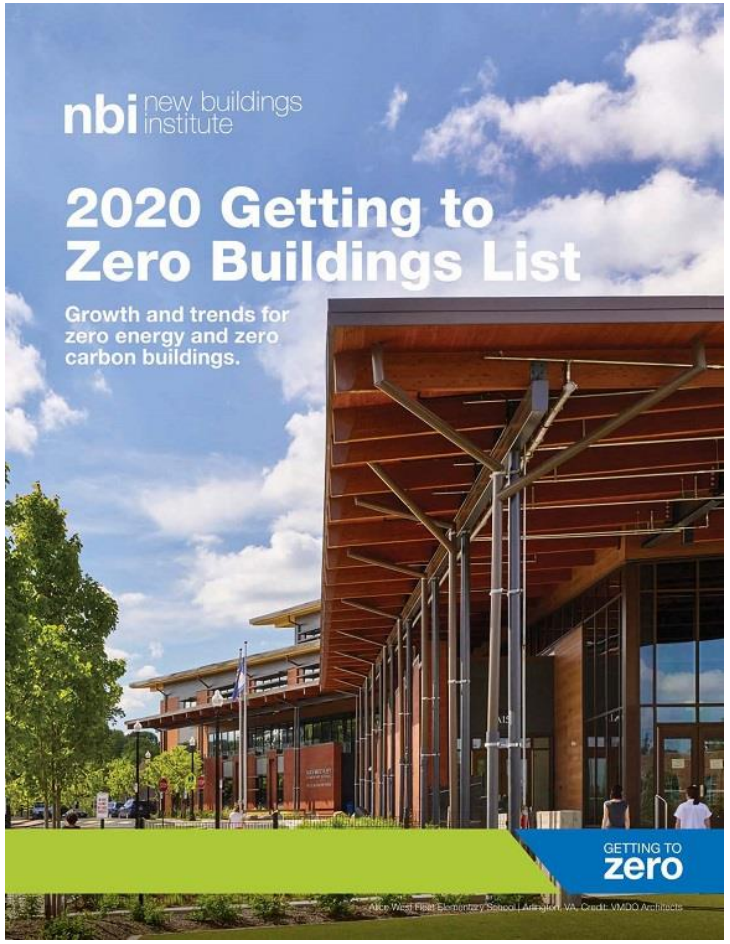
Net Zero emissions

- Net Zero emissions usually refers to carbon dioxide (CO2) emissions.
- Net Zero emissions refers to the balance between the amount of greenhouse gas produced and the amount avoided or removed from the atmosphere.
- Different types of fuels emit different amounts of CO2.

Energy Type	CO_2 Factor
Bituminous Coal	93 kg per mmBtu
Natural Gas	53 kg per mmBtu
Fuel Oil (#2)	74 kg per mmBtu
US Electricity Avg	118 kg per mmBtu 0.4 kg per kWh

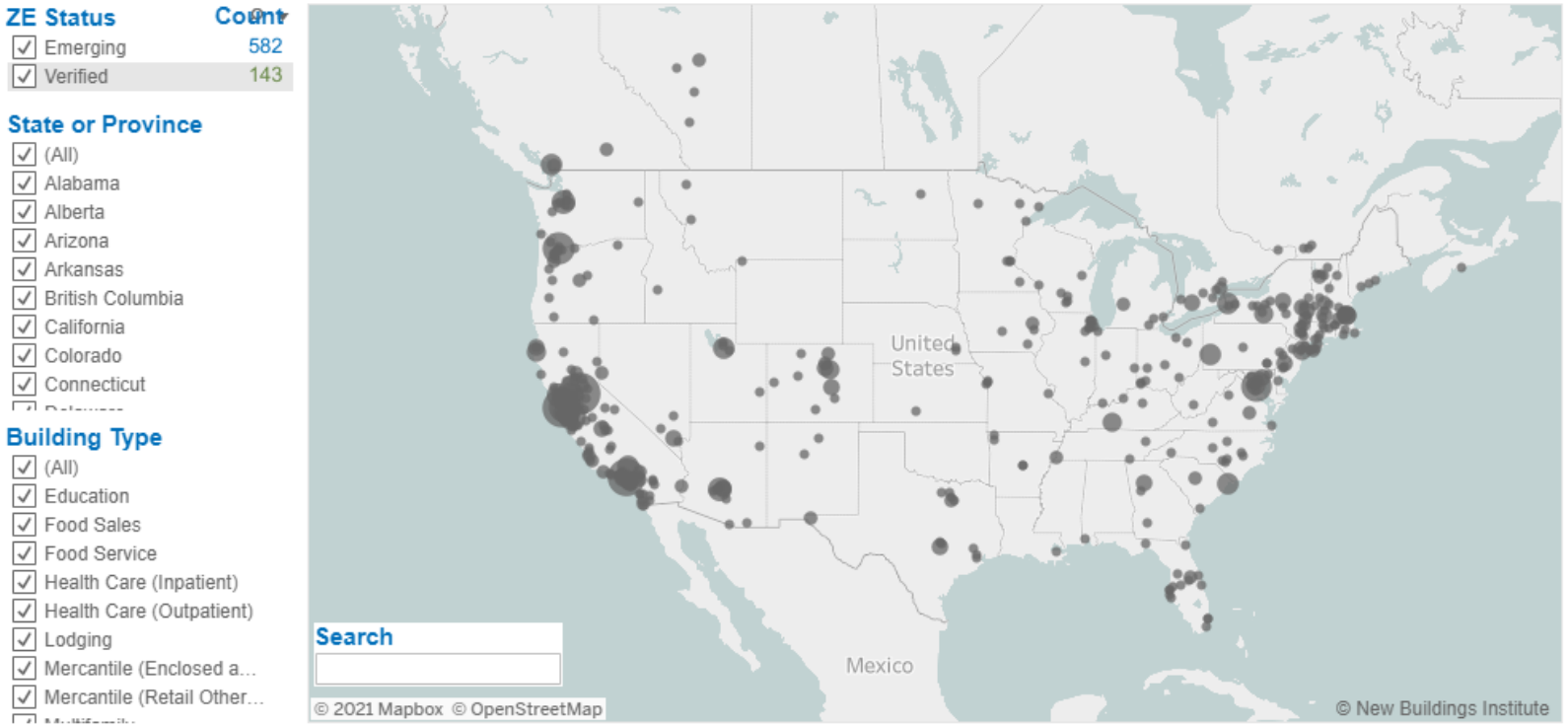
1 mmBtu = 1,000,000 Btu = 293 kWh

Net Zero energy buildings: Energy consumed = energy produced onsite through renewables

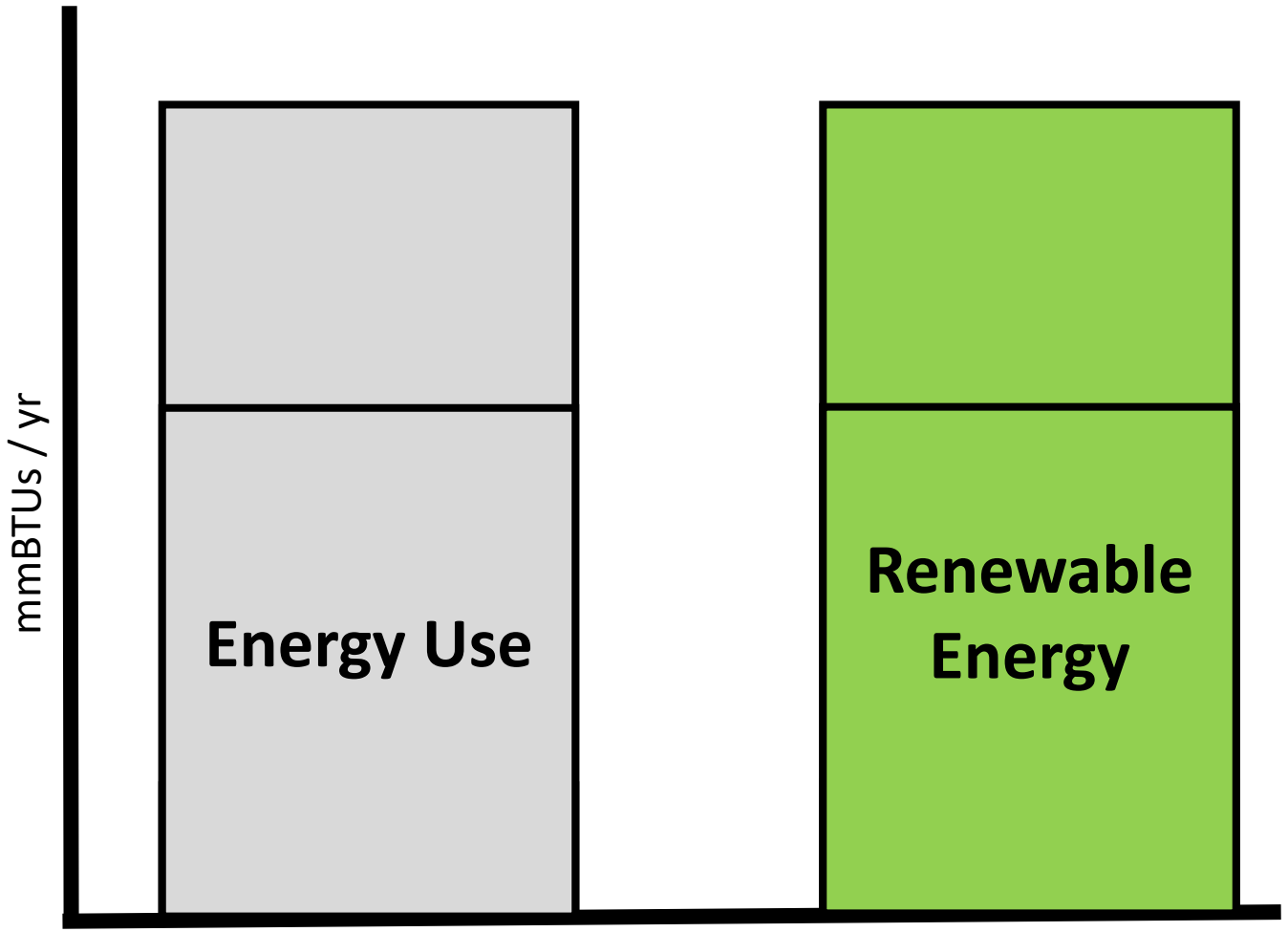


https://newbuildings.org/?s=2020+getting+to+zero+buildings+list

- In 2020 there were 143 verified Net Zero buildings and 582 emerging Net Zero buildings.
- The New Building Institute is a great source for information.



Achieving Net Zero



You can add renewables to match the existing load!

You can radically reduce energy use with extreme efficiency measures and add very few renewables!

Most commonly and cost effectively, energy efficiency reduces use by ~1/3 and renewable energy is added for the remaining energy use.

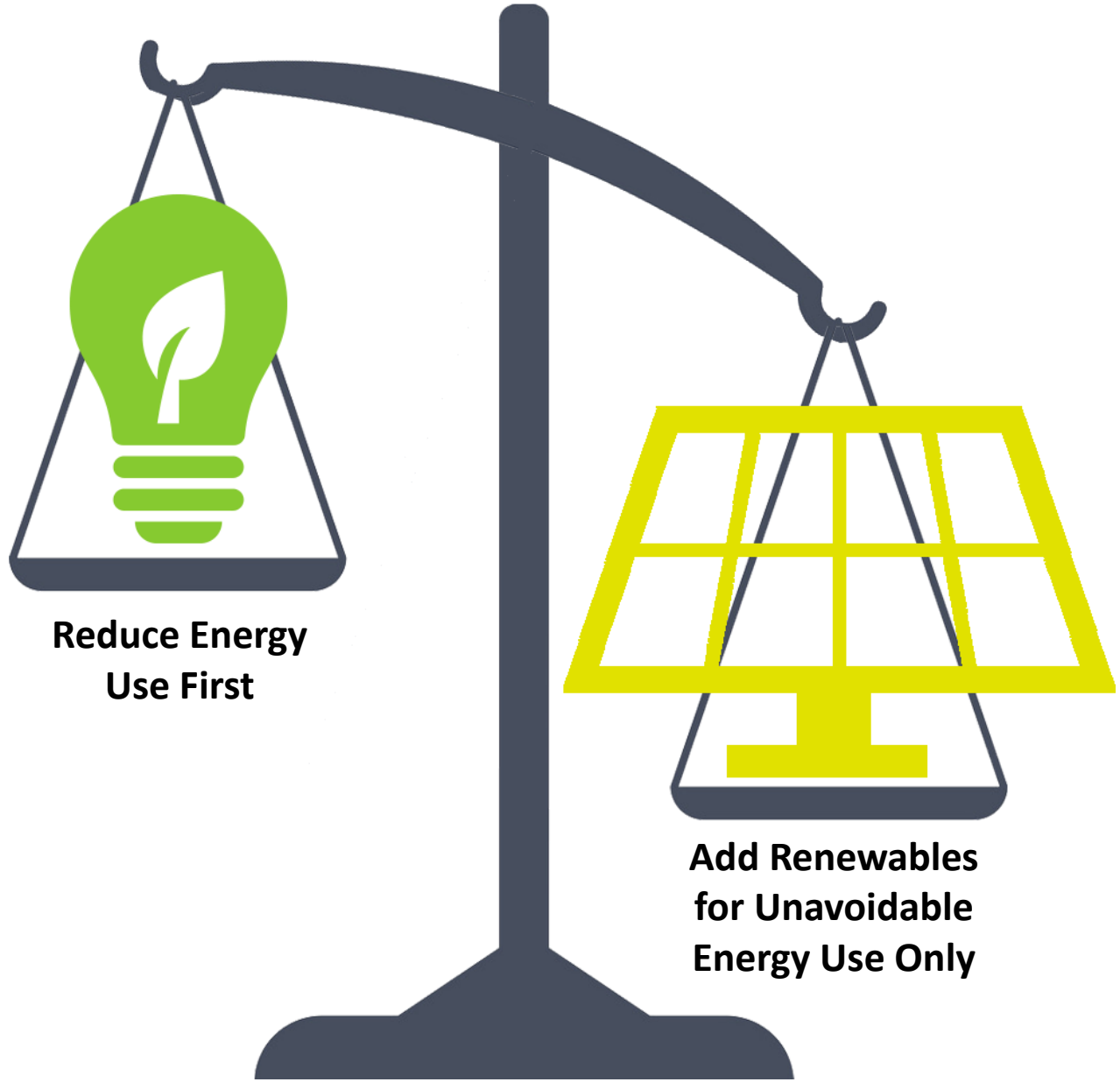
Path to Net Zero

Two steps to achieving Net Zero:

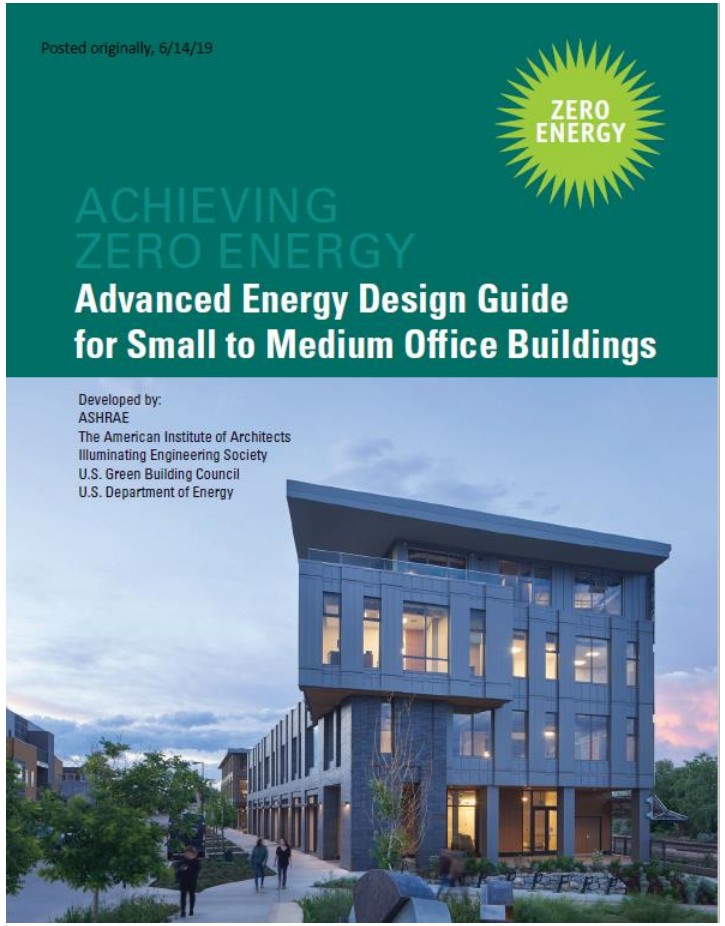
✓ Reduce Energy Use
✓ Add Renewables

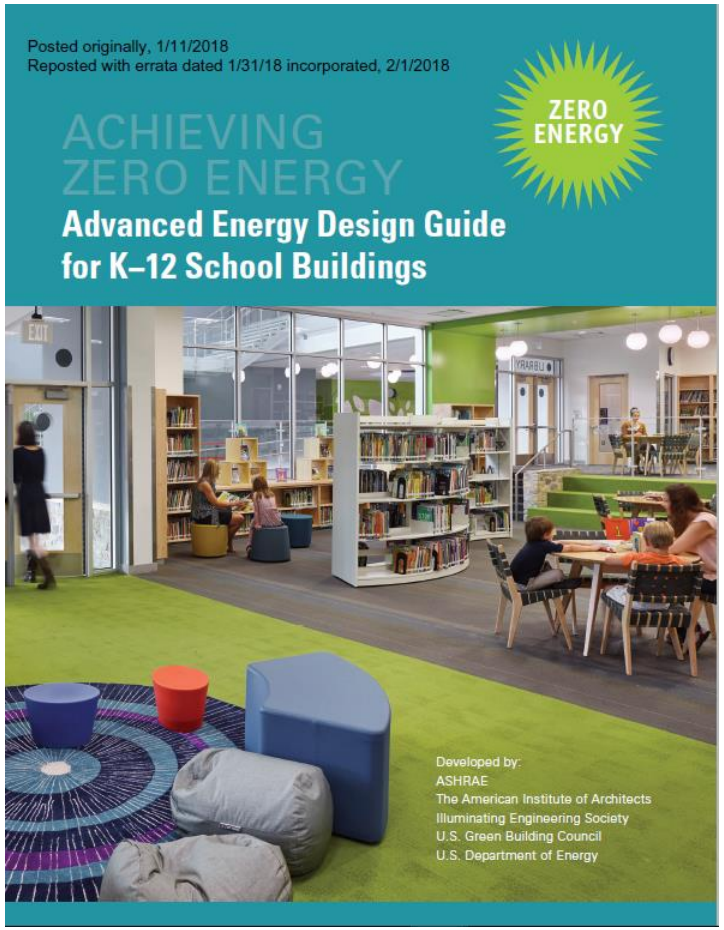
Generally, energy efficiency measures are financially, environmentally and practically the best investment (generally a 30%+ reduction depending on baseline efficiency).

Prioritize efficiency first!



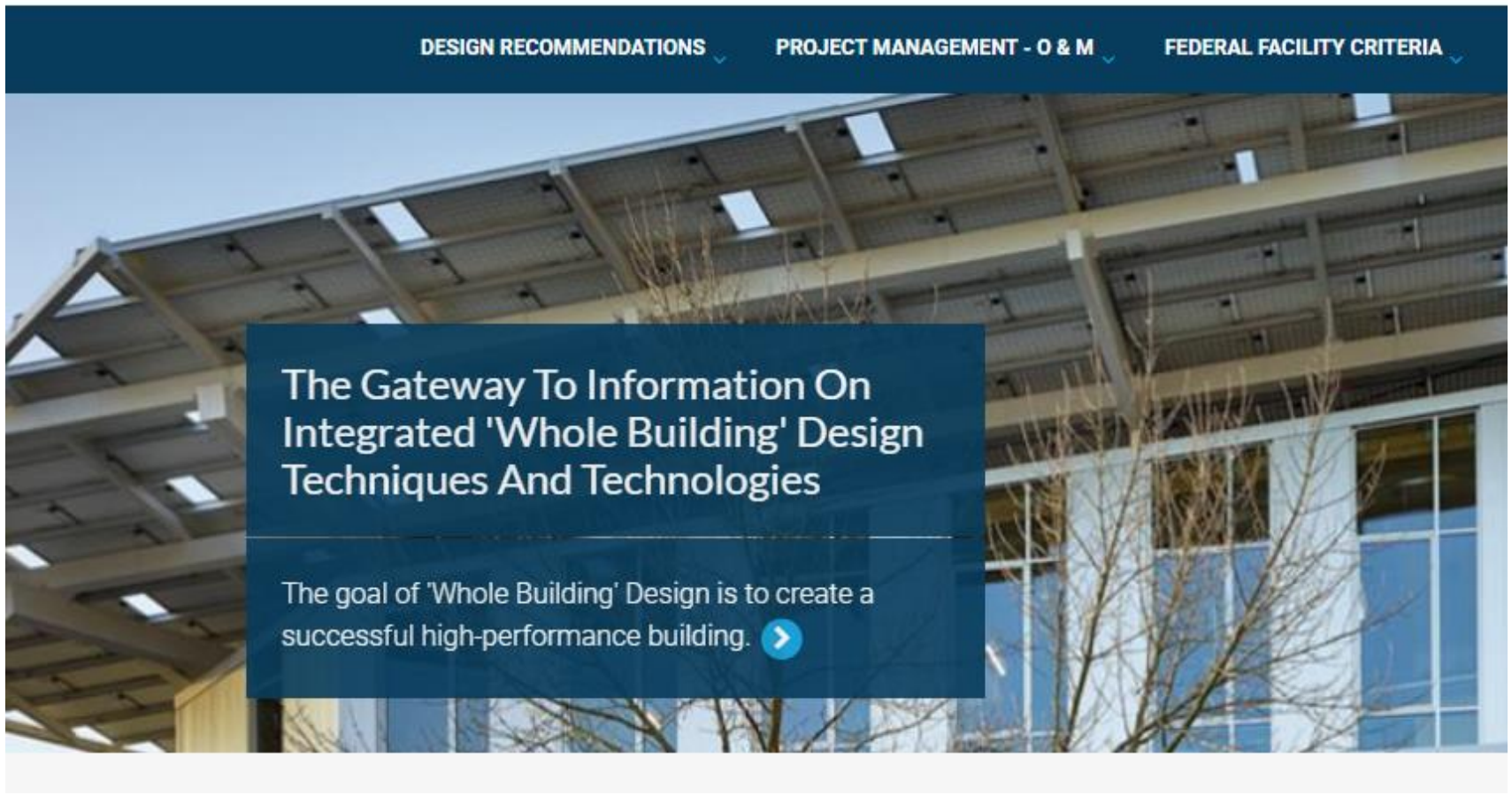
Design guides to reduce energy use





https://www.ashrae.org/technical-resources/aedgs

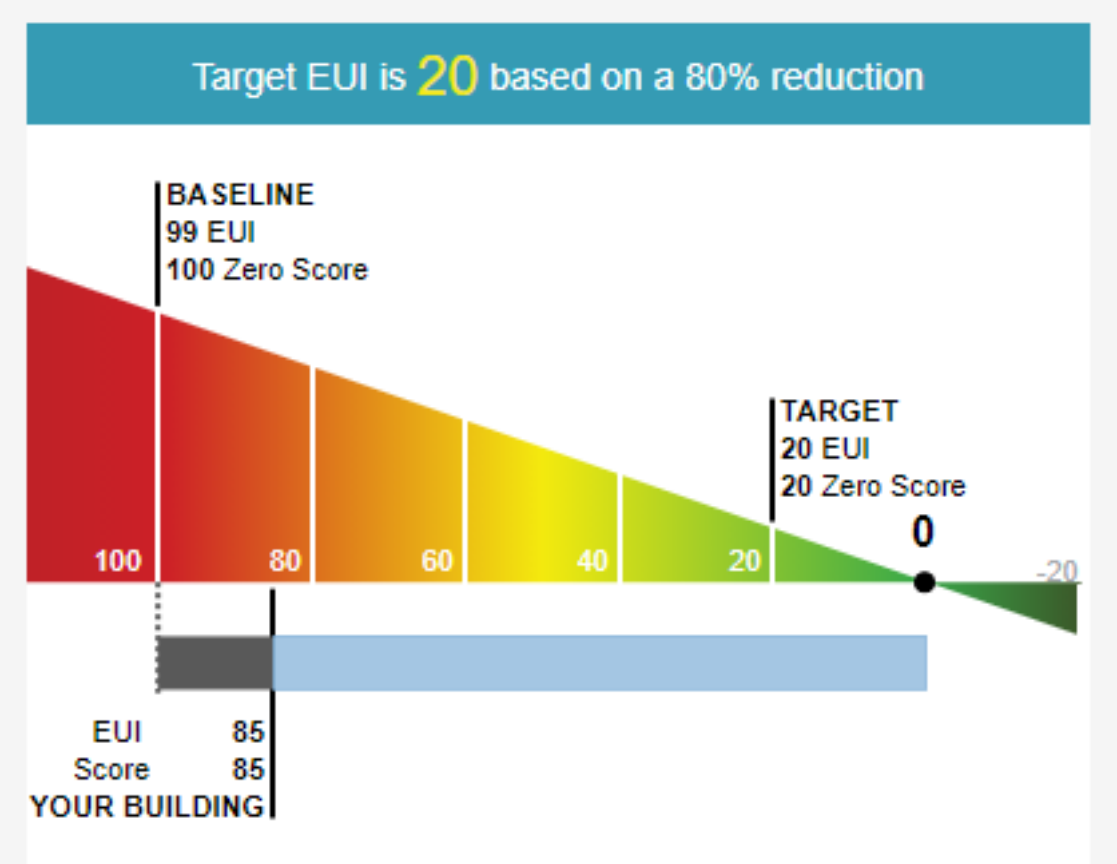
Design guides to reduce energy use



https://www.wbdg.org/resources/net-zero-energy-buildings

Tools to help reduce energy use

- The American Institute of Architecture (AIA) commitment: Transform the practice of architecture to carbon neutral buildings by 2030.
- The 2030 Challenge https://architecture2030.org/2030_challenges/2030-challenge/
- Architecture 2030 has a Zero Tool that benchmarks existing and new buildings http://zerotool.org/zerotool/



14.2 Reducing Energy Use

Module 14: Net Zero
Part 2

Objective: Understand how to reduce building energy use to reduce the quantity of renewables needed.

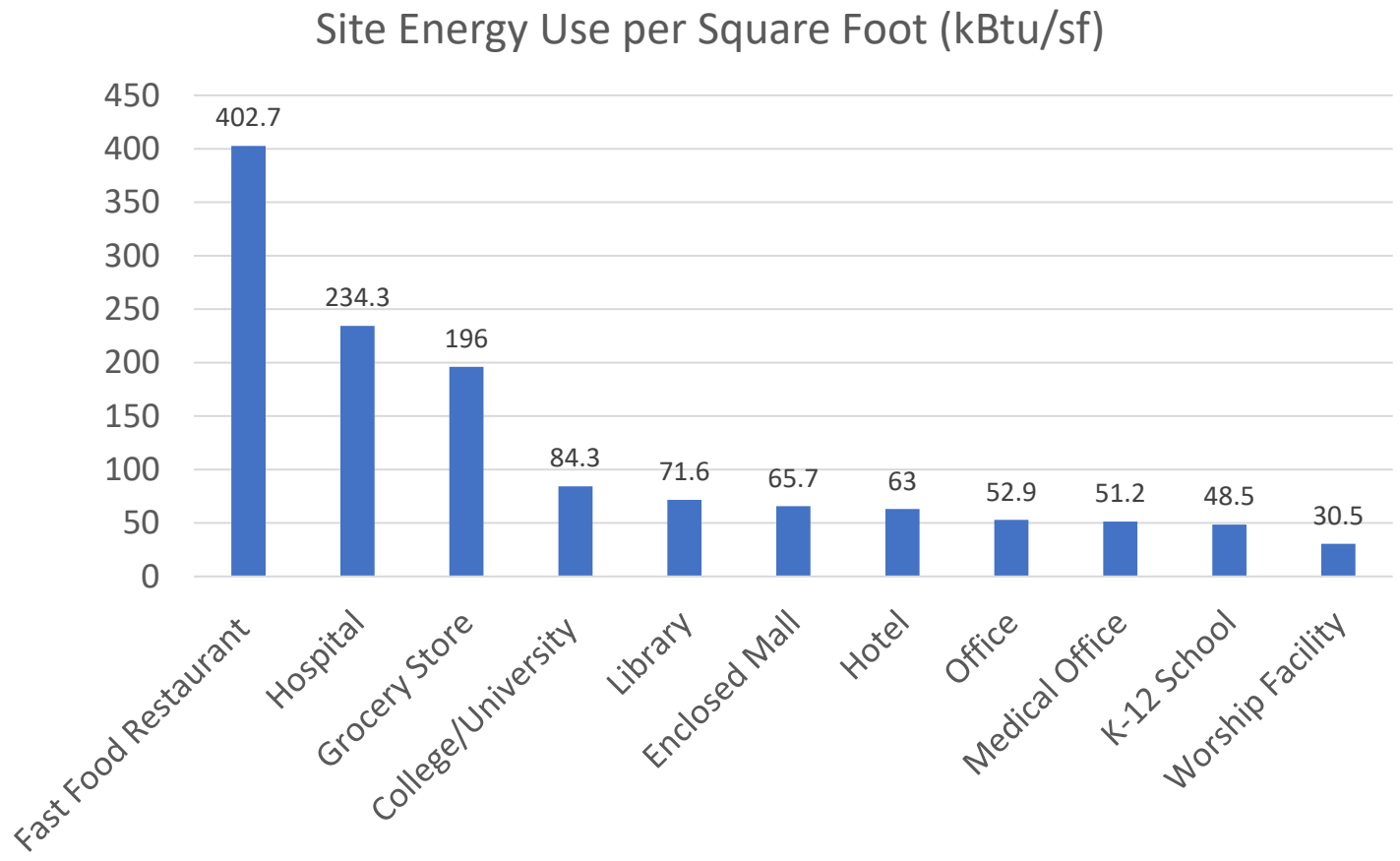
Estimating Building Savings Potential

- Step One - Calculate the **energy use intensity**
- Step Two – Compare to **similar buildings**
- Step Three – Identify major **energy users**

Energy Use Intensity (EUI) is used to compare buildings

- EUI is energy use per square foot (then subtract on-site energy production).
- EUI units are thousands of British thermal units per square foot (kBtu/sf).
- EUI is typically calculated on an annual basis.
- It is used to compare similar buildings' energy use.
- EUI can vary greatly between different building types.

Step Two – Compare EUI by building type



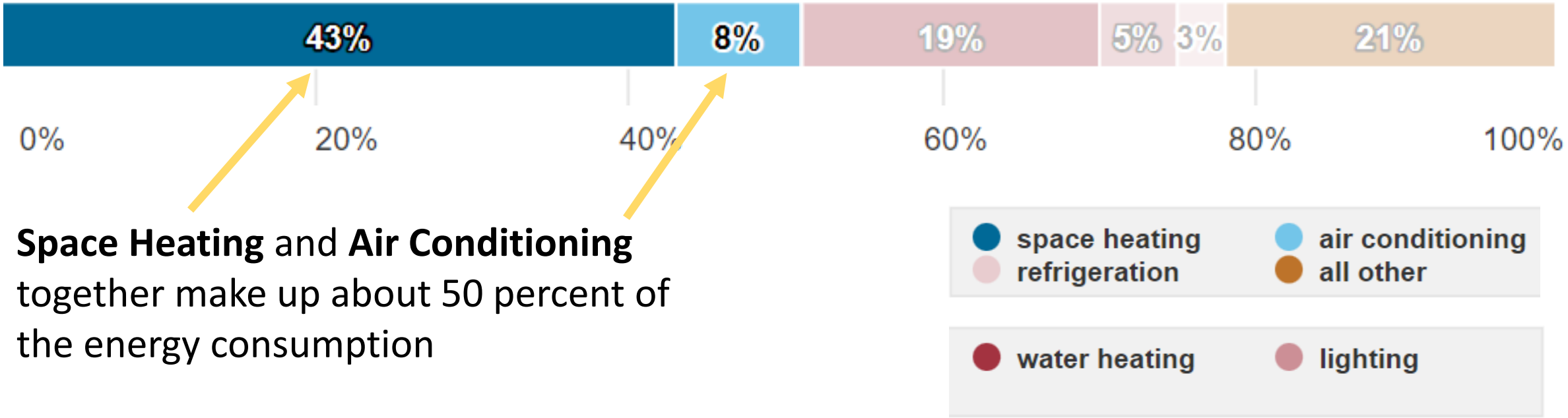
https://www.energystar.gov/buildings/benchmark/understand_metrics/what_eui

https://portfoliomanager.energystar.gov/pdf/reference/US%20National%20Median%20Table.pdf

Step Three: Identify major energy uses

HVAC Uses

End-use consumption shares of U.S. homes, 2015



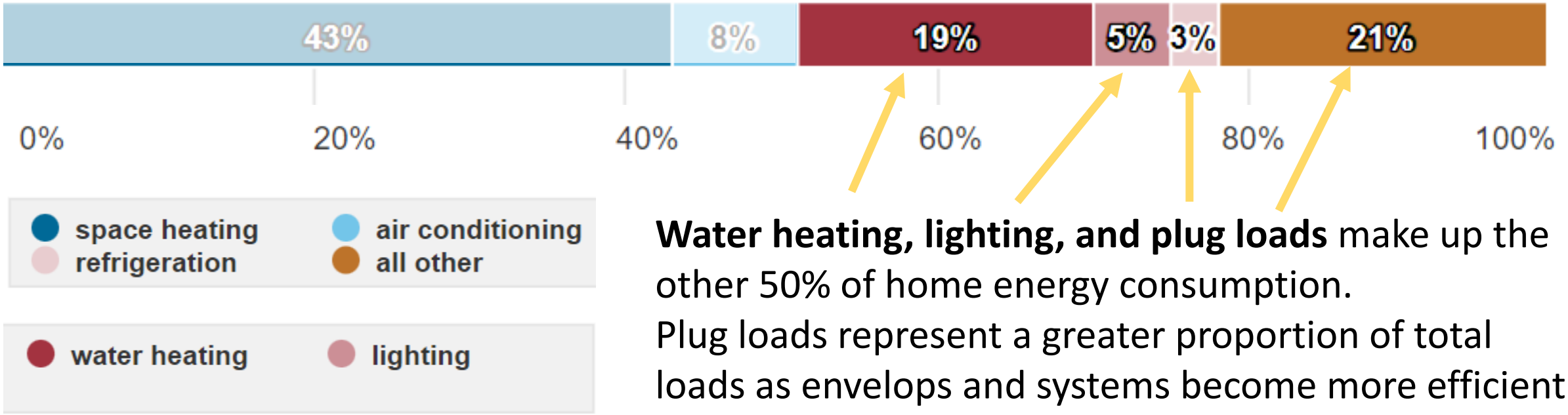
Space Heating and **Air Conditioning** together make up about 50 percent of the energy consumption

https://www.eia.gov/energyexplained/use-of-energy/homes.php

Step Three: Identify major energy uses

Water heating, Lighting, and plug loads

End-use consumption shares of U.S. homes, 2015

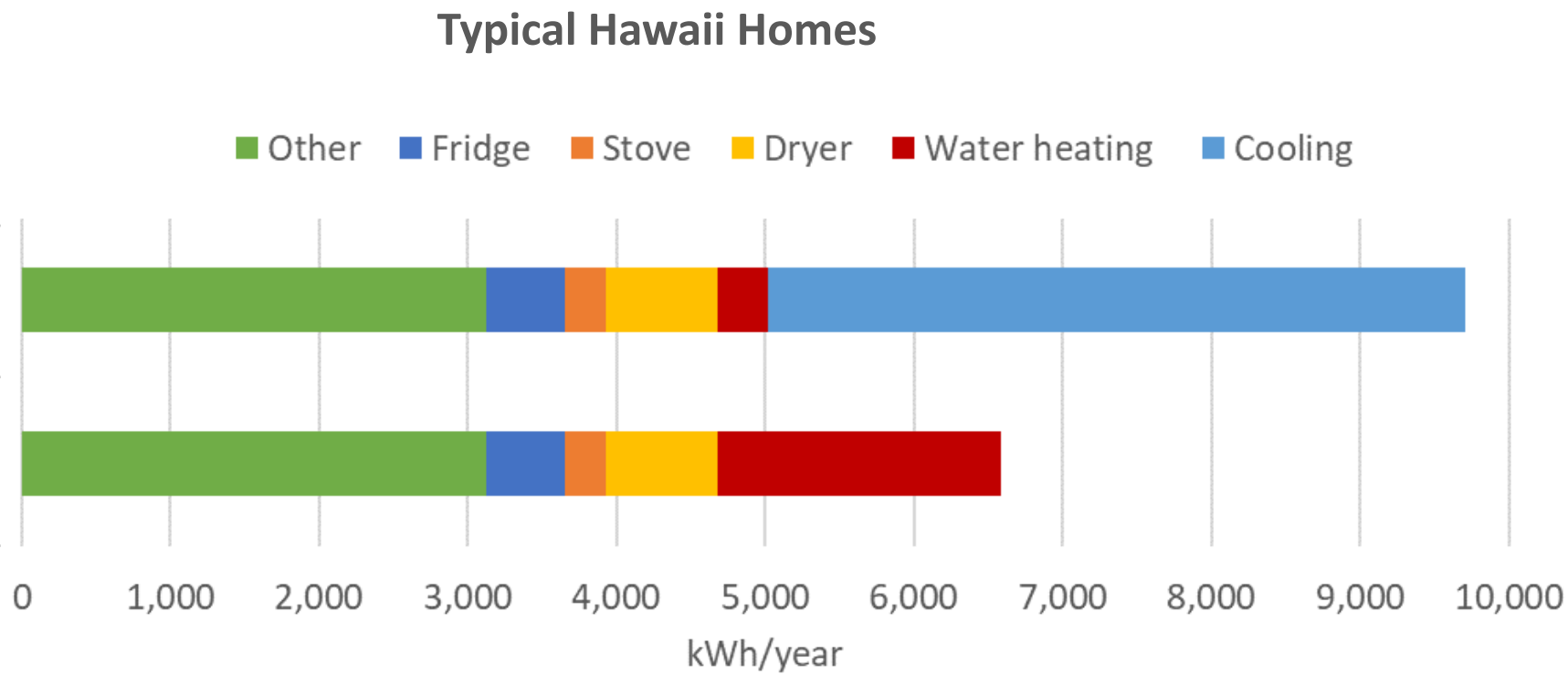


Water heating, lighting, and plug loads make up the other 50% of home energy consumption.
Plug loads represent a greater proportion of total loads as envelops and systems become more efficient

https://www.eia.gov/energyexplained/use-of-energy/homes.php

Step Three: Identify major energy uses

Air conditioning	Solar water heating
Yes	Yes
No	No



Based on The State of Hawaii Public Utilities Commission 2020 Market Potential Study.

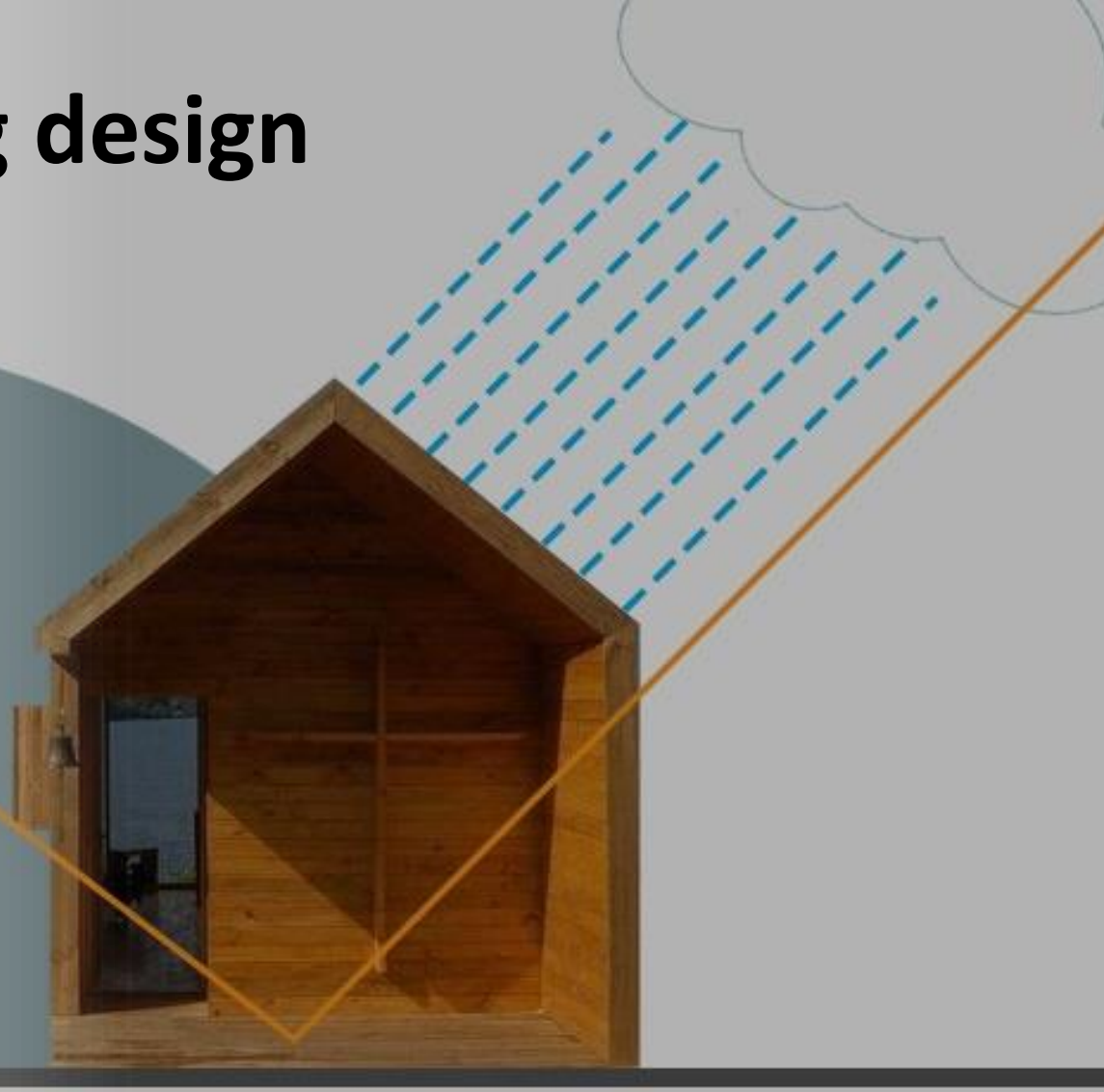
Steps to Net Zero for new construction

1. Create a climate-responsive building design
2. Reduce the size of the building, if possible
3. Select efficient equipment and appliances
4. Take advantage of interactions between systems
5. Improve the design through the iteration: model energy use intensity for each design option until energy use intensity is as low as possible
6. Determine how much renewable energy will be required to meet remaining load
7. Consider how to incorporate renewable energy into existing building/site and what types to pursue
8. Size renewable systems to determine energy output.

https://newbuildings.org/hubs/zero-energy/

Climate responsive building design

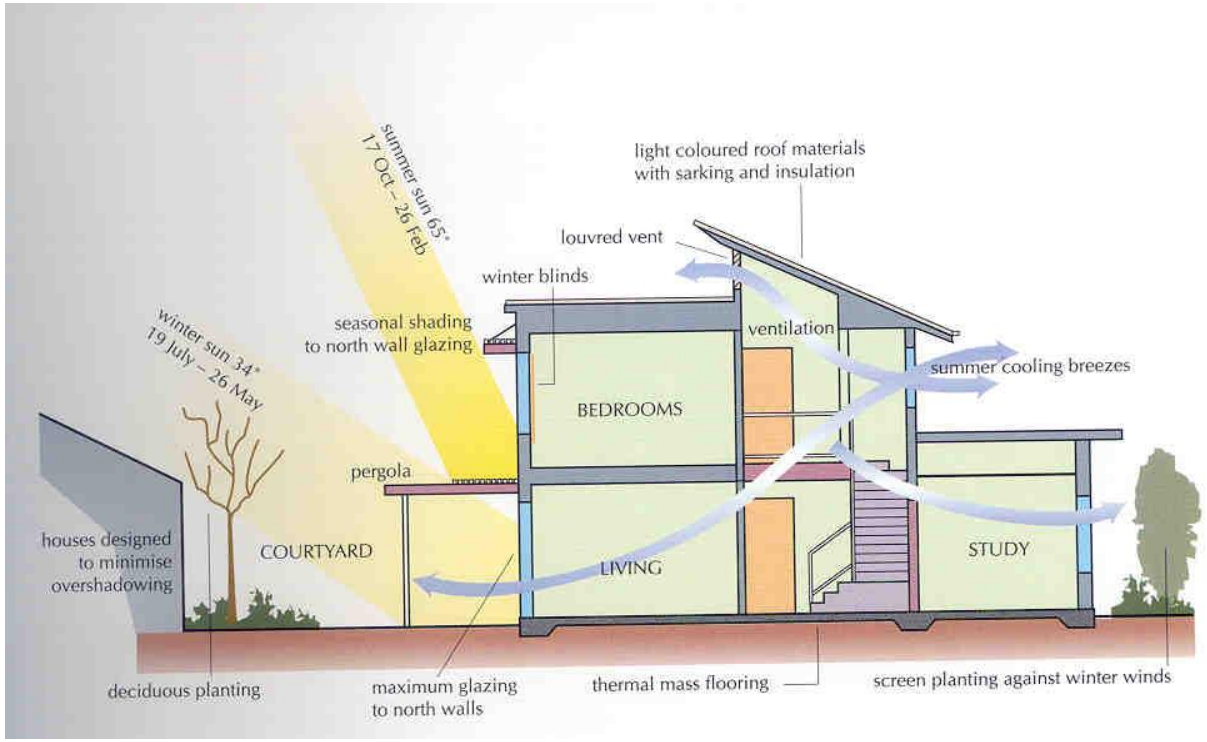
- Building design should be responsive to climate
- How do the sun and wind impact building loads?
- HVAC systems respond to loads imposed on the thermal envelope of the building
- Good building design can result in substantially reduced loads on the HVAC systems
- Smaller HVAC = less energy use = fewer first and recurring costs.



https://www.re-thinkingthefuture.com/designing-for-typologies/a2180-15-examples-of-climate-responsive-buildings-around-the-world/

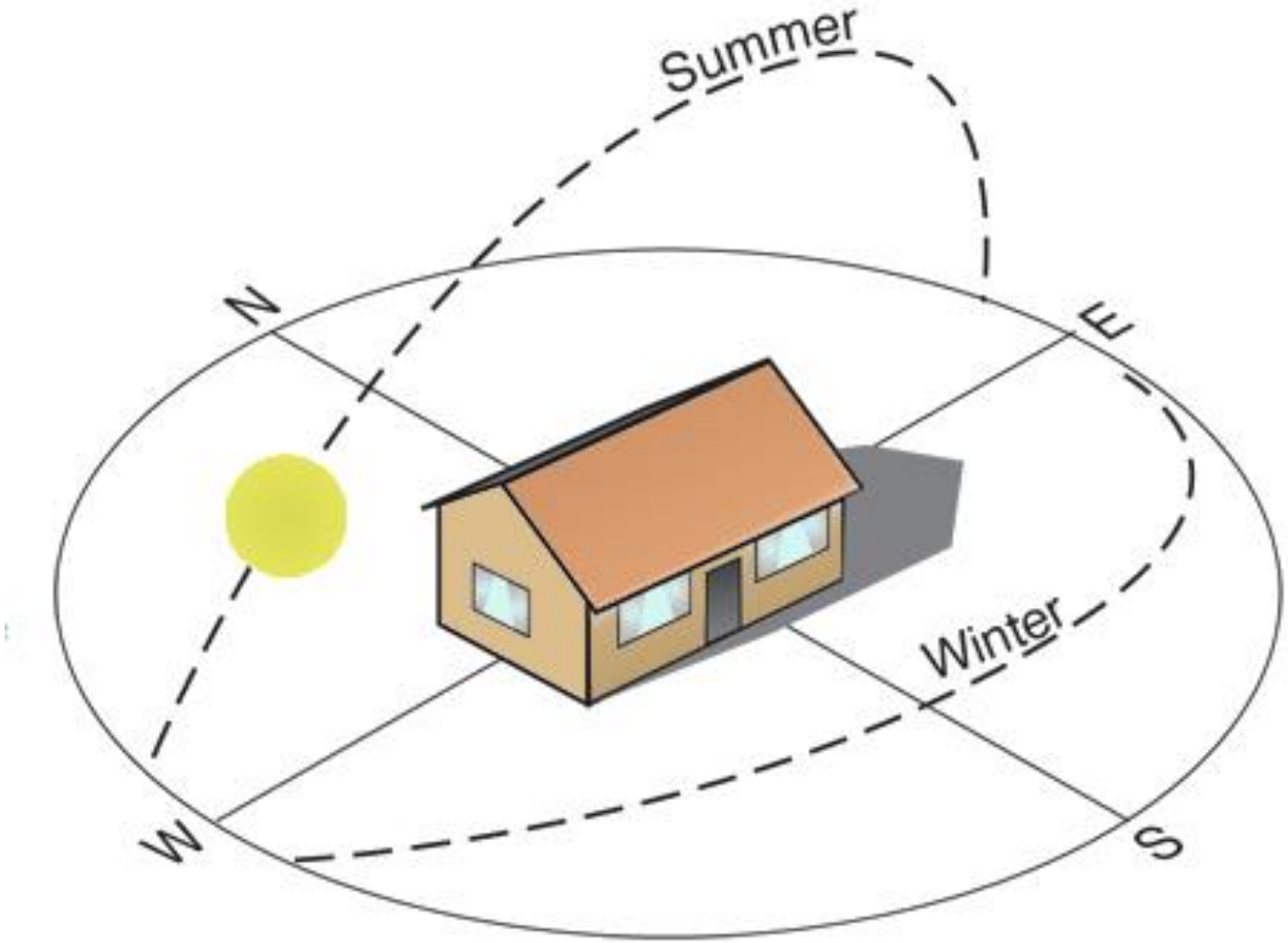
Climate responsive building design

- For new designs, optimizing a building's design is an orderly progression through opportunities.
  - Site and Massing
  - Layout/Spatial
  - Envelope
  - Fenestration
  - Lighting
  - Ventilation
  - Air Conditioning
  - Heating
- And feedback
- And feedback
- And feedback
- And feedback……..

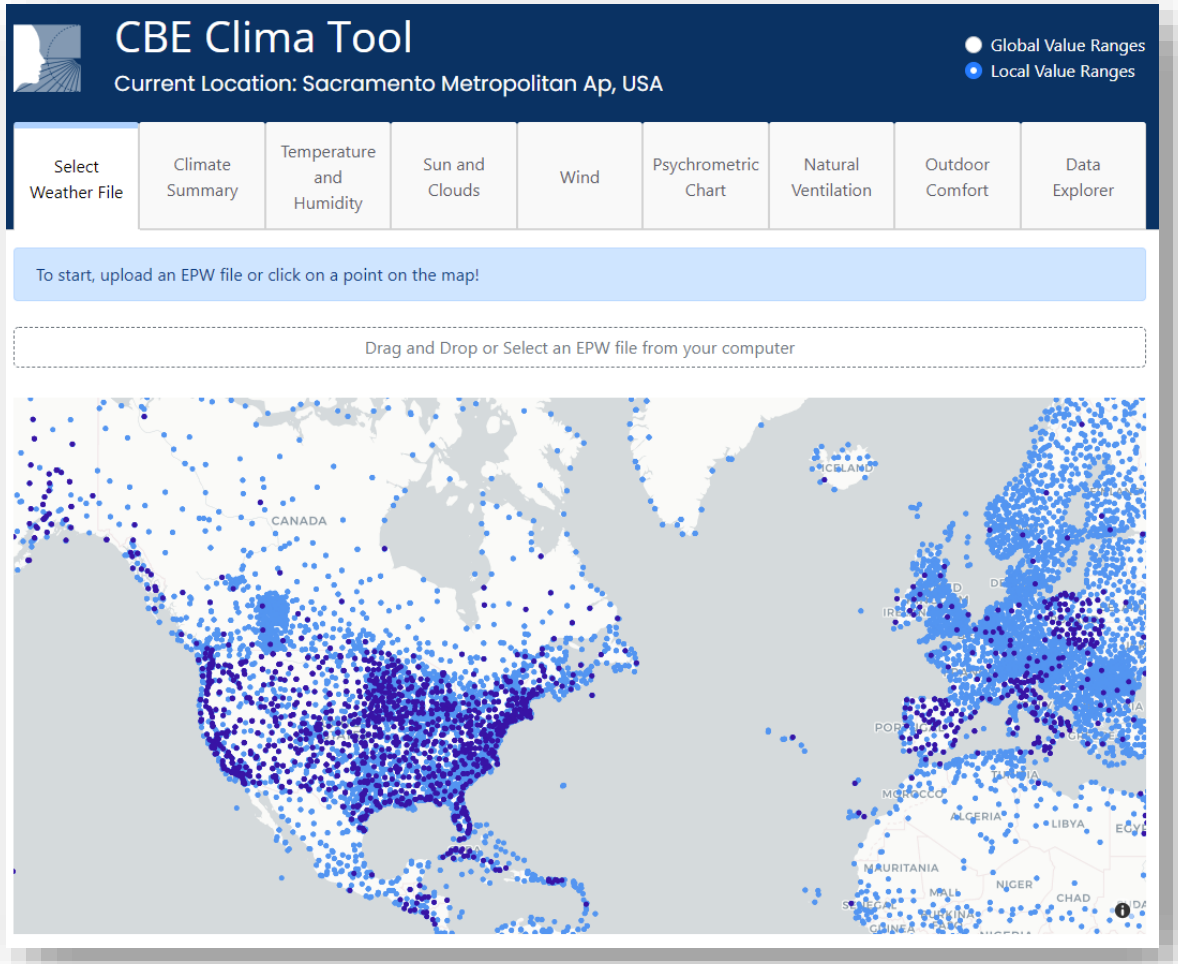


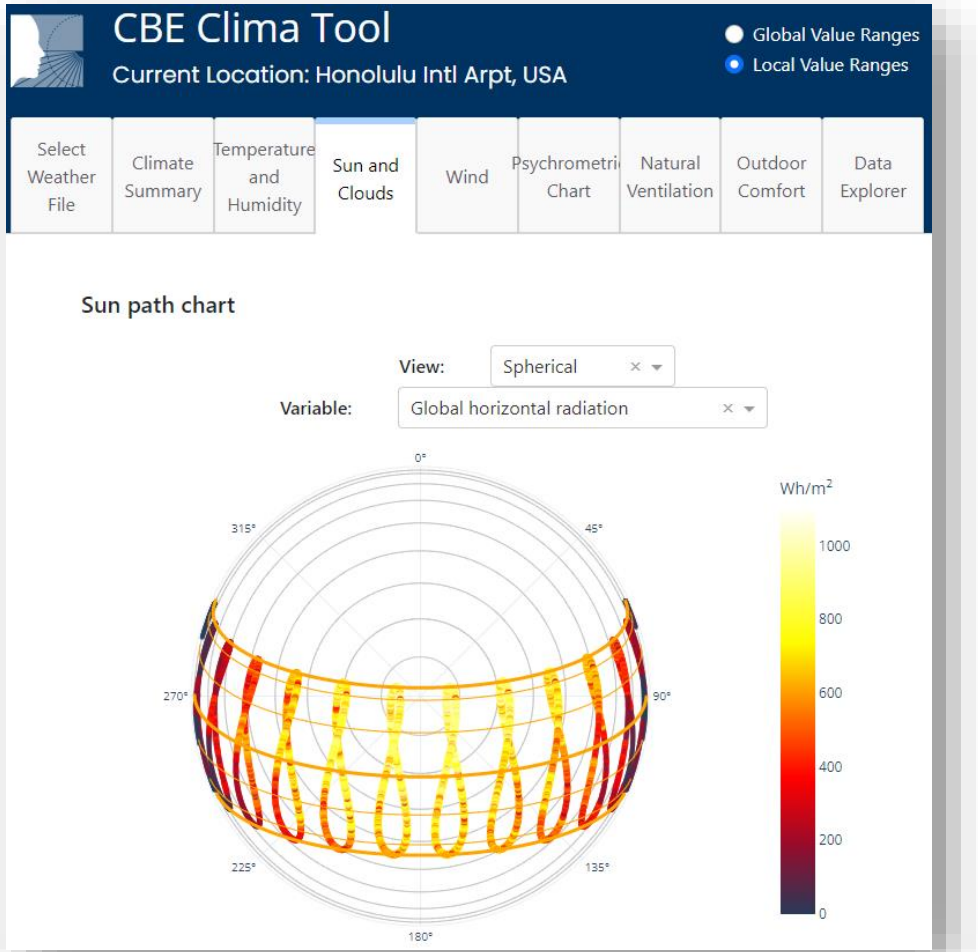
http://www.croftandassociates.com/croft-and-associates-architecture/bioclimatic-design

Path of the sun



Clima online tool





UC Berkeley Center for the Built Environment. https://clima.cbe.berkeley.edu

Example Net Zero new construction

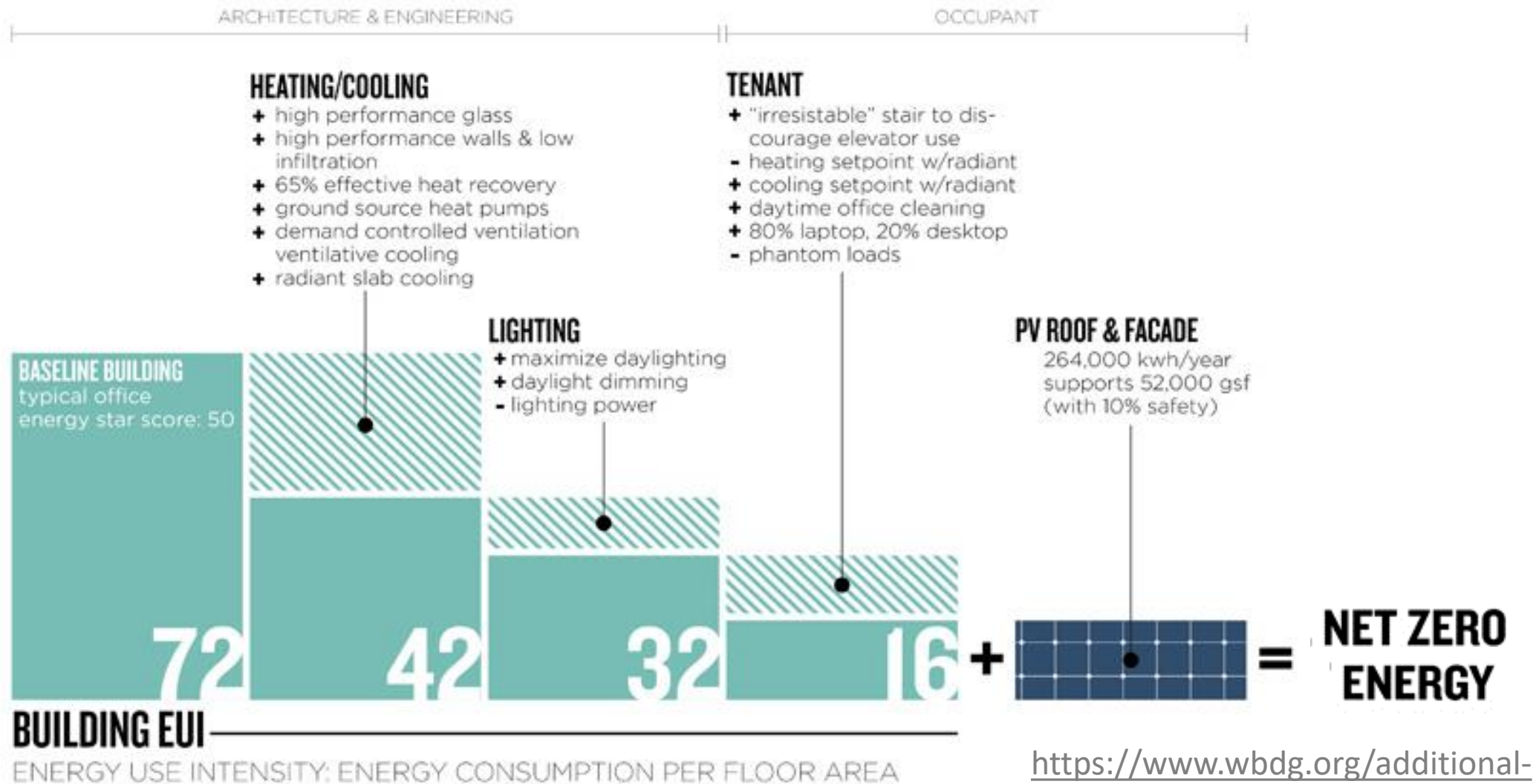
- Built in 2012/13, the Bullitt Center in Seattle WA has extensive documentation on the steps used to design, build and operate it.

http://www.bullittcenter.org/wp-content/uploads/2015/08/living-proof-bullitt-center-case-study.pdf

https://www.wbdg.org/additional-resources/case-studies/bullitt-center

Steps to Net Zero

Bullitt Center Reduction Strategy



https://www.wbdg.org/additional-resources/case-studies/bullitt-center

Net Zero example – new construction

DETAILS

Project Area:
Building Area: 50,956 sf
Building Footprint: 26,335 sf
Start of construction: November 2009
Start of Occupancy Period: July 2012
Owner occupied: Yes
Number of occupants: 120
Number of visitors (est. per day): 20
Typical hours of operation:
M-F 8:30am - 5:00pm

Living Building Challenge™ Net Zero Energy Building Certified

David & Lucile Packard Foundation Headquarters
Los Altos, California

https://living-future.org/lbc/case-studies/david-lucile-packard-foundation-headquarters/

Net Zero example – new construction

Living Building Challenge™ Net Zero Energy Building Certified

David & Lucile Packard Foundation Headquarters
Los Altos, California

Annual Energy Use
Designed/simulated: 277 MWh
Actual Energy Use: 351.30 MWh
Actual Energy Use intensity: 24.38 KBtu
Annual electricity generated: 418.04 MWh
Net Energy Use: -66.73 MWh

End Use Breakdown
Heating: 324,000 kWh
Cooling: 106,600 kWh
Lighting: 508,400 kWh
Fans/Pumps: 390,000 kWh
Plug Loads/Equipment: 745,000 kWh
Domestic Hot Water: 535,000 kWh
Other: 322,300 kWh

Energy Performance Period
August 1, 2012 - July 31st, 2013

https://living-future.org/lbc/case-studies/david-lucile-packard-foundation-headquarters/

Net Zero example – new construction

Key features

Triple-element glazing (R-7.7)

Continuously Insulated wood-framed walls (R-24)

Chilled beams and radiant panels

Automatic diming lighting

Solar electric/thermal

Living Building Challenge™ Net Zero Energy Building Certified

David & Lucile Packard Foundation Headquarters
Los Altos, California

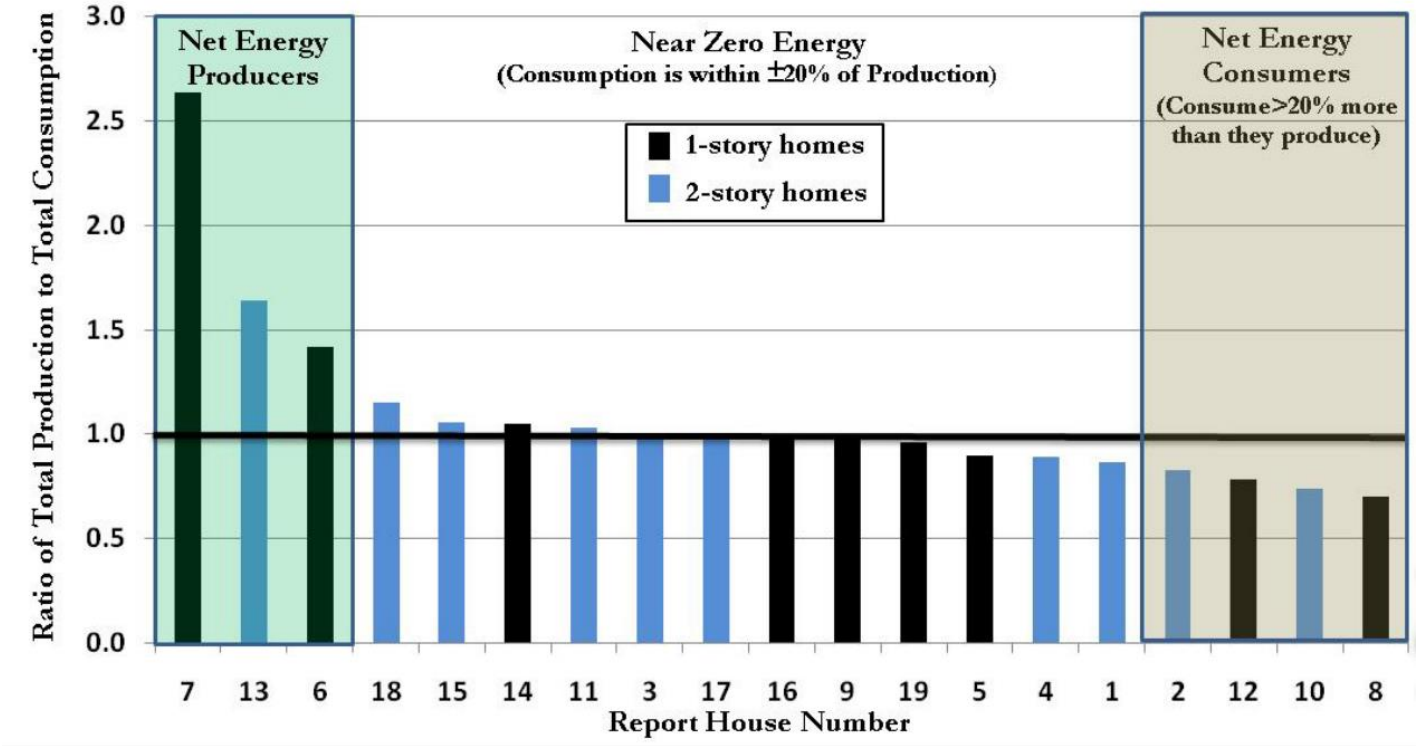
https://www.youtube.com/watch?feature=player_embedded&v=48VA83sOe7U

https://living-future.org/lbc/case-studies/david-lucile-packard-foundation-headquarters/

Kaupuni Village, Waianae

19 affordable homes
Built in 2011

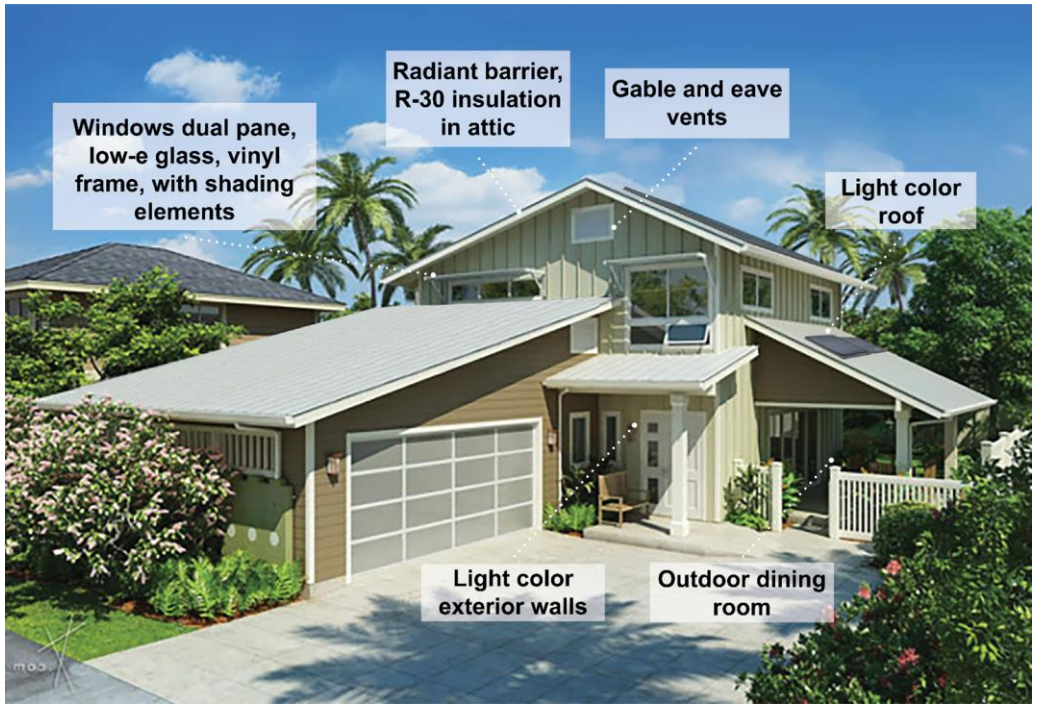
Image credit: Group 70



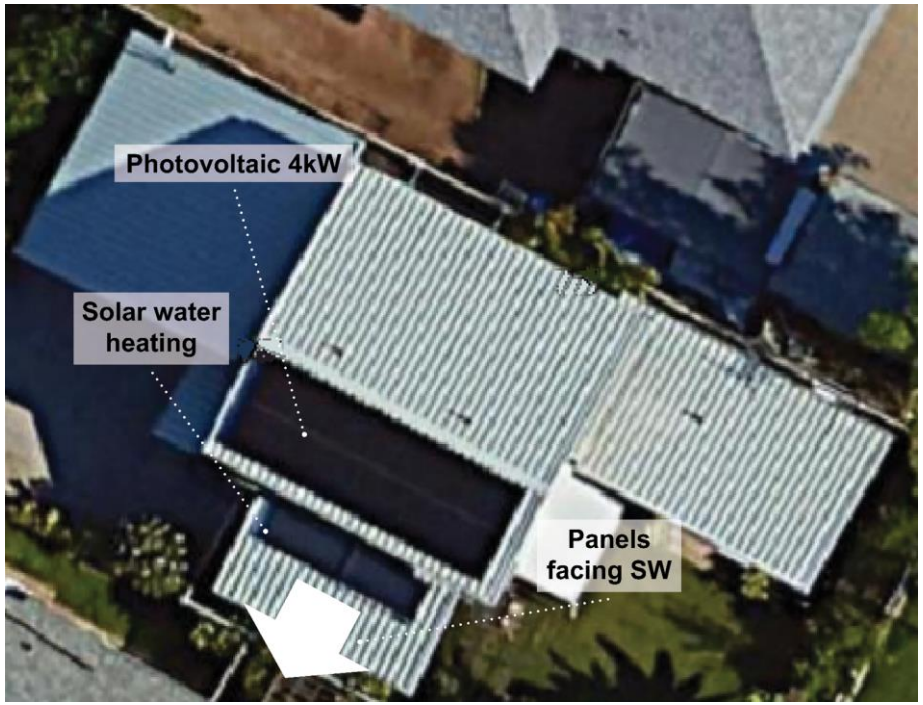
https://www.nrel.gov/docs/fy13osti/58000.pdf

Building Industry Association (BIA): New Hawaiian Home 2011, Kaimuki

Designed and constructed: Armstrong Builders
Monitored: Hawaii Natural Energy Institute / Sea Grant / Environmental Research and Design lab



Rendering by Jeff Brink, edited by Darlyn Chau and Aiko Tells



Google Earth accessed 10/25/21

Recorded Zero Energy Home Design webinar

HAWAII ENERGY BUILDING CODE TRAINING

The Hawaii State Energy Office and allied professional organizations sponsor free training sessions on energy building code requirements.

April 29, 2022: Train-the-Trainer Workshop – Building Energy Education Fundamentals

April 2022: Three Webinars on Building Energy Efficiency Fundamentals and Energy Code Basics

December 9, 2021: Complying With the Energy Code – 2018 IECC with Hawaii Amendments

December 2, 2021: Zero Energy Home Design

May 2021: Low-rise and Commercial, High-rise Residential Requirements

July 2020: Dueling UV Pulses: The Most Efficient Way of Zapping the COVID Virus?

https://energy.hawaii.gov/building-code-training

Makamae, Ewa

Gentry Homes
Designed net zero

Efficiency features
Solar hot water system with 120 gallon tank
20-SEER air conditioning
Dual pane Low E vinyl windows
LED lighting
Open cell spray foam insulation
Digital thermostat with WIFI and mobile access
5.6 kW PV and battery

https://www.gentryhawaii.com/makamae

UH Manoa Project Frog Classrooms

- North-South orientation
- R-24 walls, R-30 roof decks
- High/low operable windows for natural ventilation
- Low-e, PPG Solarban 70XL glazing
- External shade structure on south glazing
- Direct/Indirect LED lighting with daylight
- Six speed, variable speed ceiling fans
- High efficiency split system AC (EER: 11.8)
- PV systems: 8.0 kW each

https://seagrant.soest.hawaii.edu/wp-content/uploads/2020/10/2018_Maskrey-et-al-Frog-Buildings.pdf

Photo: UH News

Drone photos: Neal Atabara

Leeward College

3,579 PV modules
1.68 megawatts

https://www.hawaii.edu/news/2020/07/19/leeward-first-uh-net-zero-campus

Maui College

3,330+ PV modules
1.58 megawatts

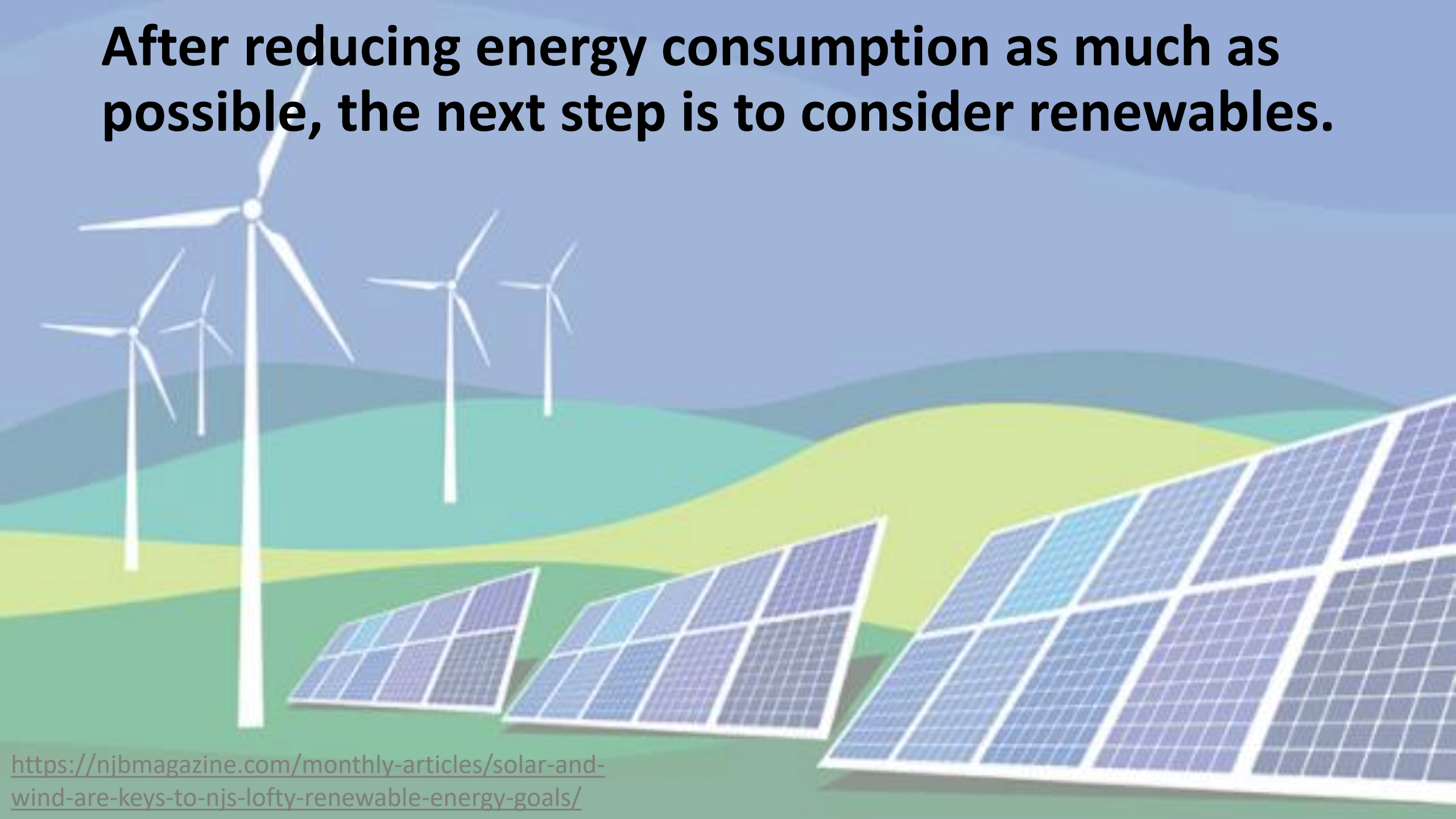
https://www.hawaii.edu/news/2021/01/24/uh-maui-college-achieves-net-zero-goal

14.3 Renewables

Module 14: Net Zero
Part 3

Objective: Calculate building level or site level renewable energy capacity and understand the relationship between renewable energy potential compared to actual building energy consumption.

After reducing energy consumption as much as possible, the next step is to consider renewables.



https://njbmagazine.com/monthly-articles/solar-and-wind-are-keys-to-njs-lofty-renewable-energy-goals/

How much renewable energy is needed?

- To what level should EUI be reduced so that energy needs can be satisfied with renewable energy?
- What is the on-site renewable energy potential?
- Photovoltaics (solar) are the most common renewable option.
- Renewable energy can also be purchased and does not have to be produced on-site.

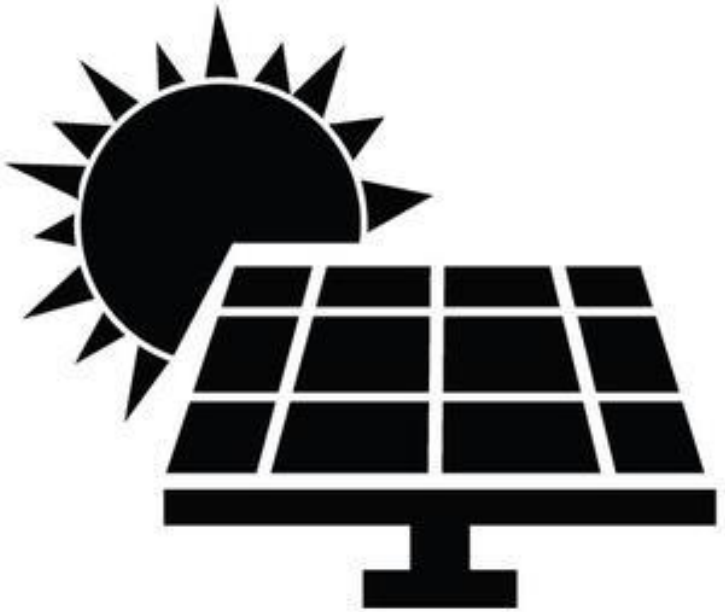
Solar photovoltaic (PV) potential

How much power can be produced on-site?

What type of panels are being installed? Different types of panels have different outputs.

Generally, for rooftop solar it takes approximately 200 SF per kW potential

A 1 kW system in the Midwest produces approximately 1,400 kWh per year. This is equivalent to ~7kWh/SF or ~24kBtu/SF.

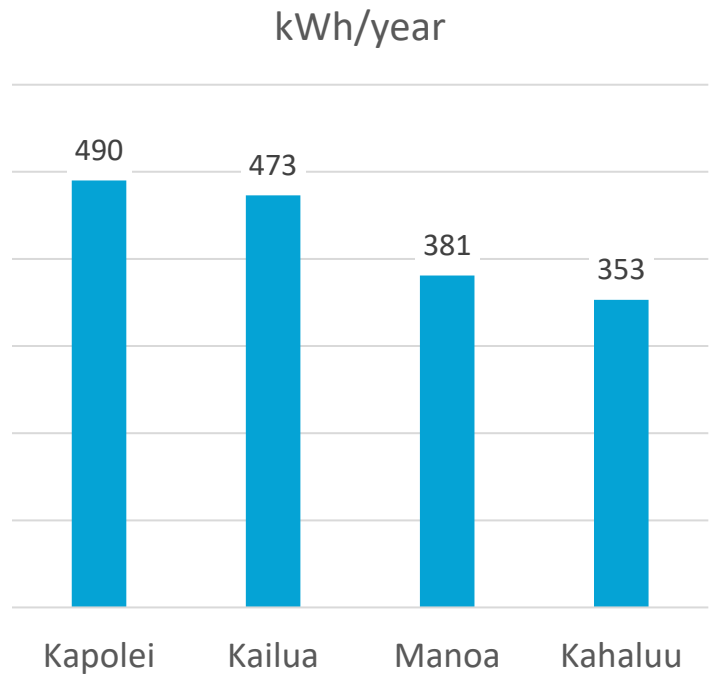


Photovoltaic energy in Hawaii

~300 watts DC

~250 watts AC

Common panel size
65” x 40”
18 ft^2

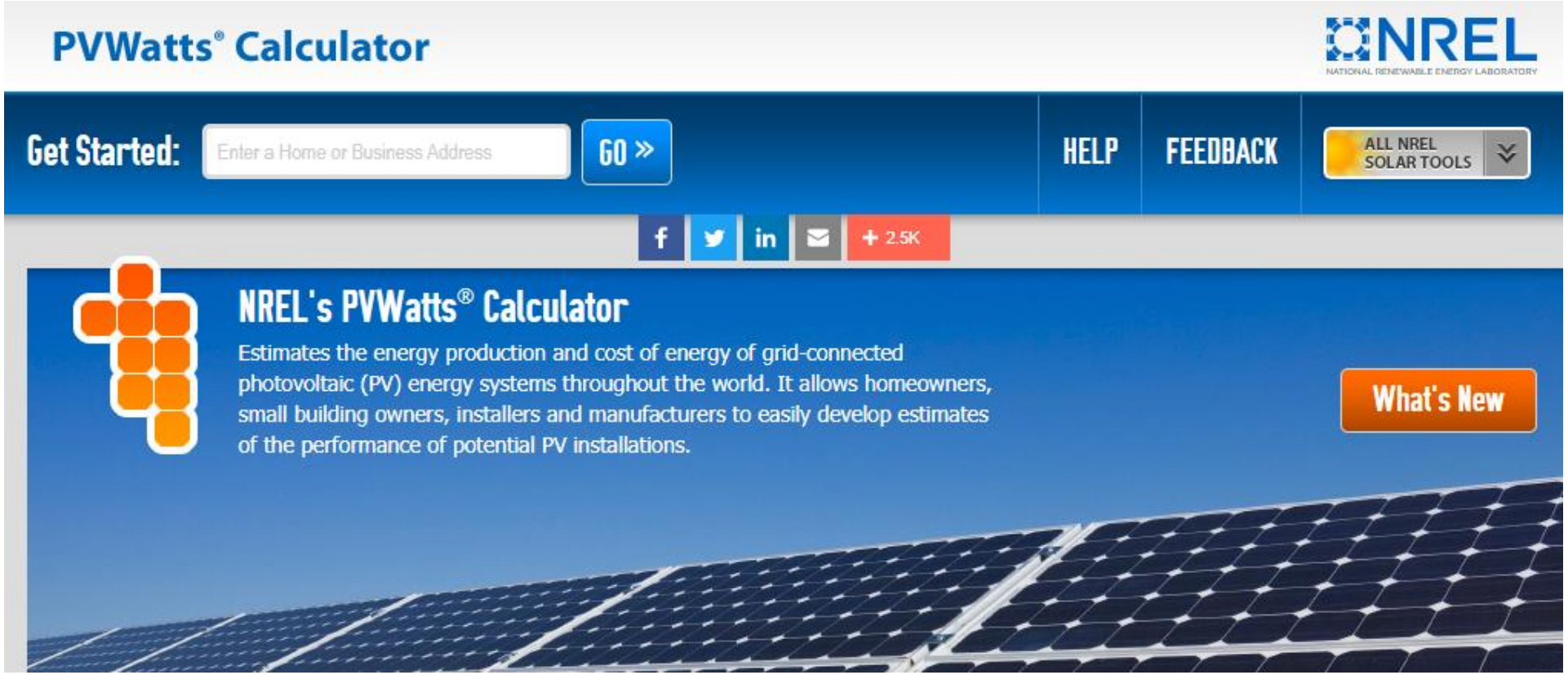


19-27 kWh/ft^2 per year

https://pvwatts.nrel.gov
Facing south, 20° tilt

PV tools

- The National Renewable Energy Laboratory (NREL) has an online tool that can be used to rapidly estimate renewable energy potential using solar data for your site.



https://pvwatts.nrel.gov/

Solar PV locations

Rooftop

- Typically, lower cost
- Be aware of current roof condition
- Best on new roof
- Locate inverters in convenient location; inside is best

https://www.pointloadpower.com/articles/10-common-questions-commercial-building-owners-have-about-rooftop-solar

Canopy

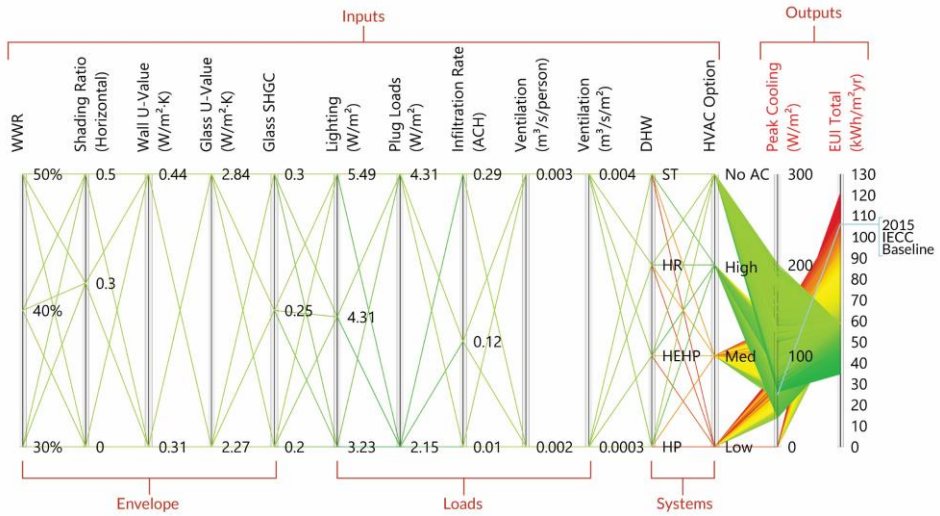
- Typically, highest cost
- Can make use of space otherwise taken by parking without displacing the parking

https://www.solarips.com/blog/2019/september/solar-carports-and-canopies-a-practical-solution/

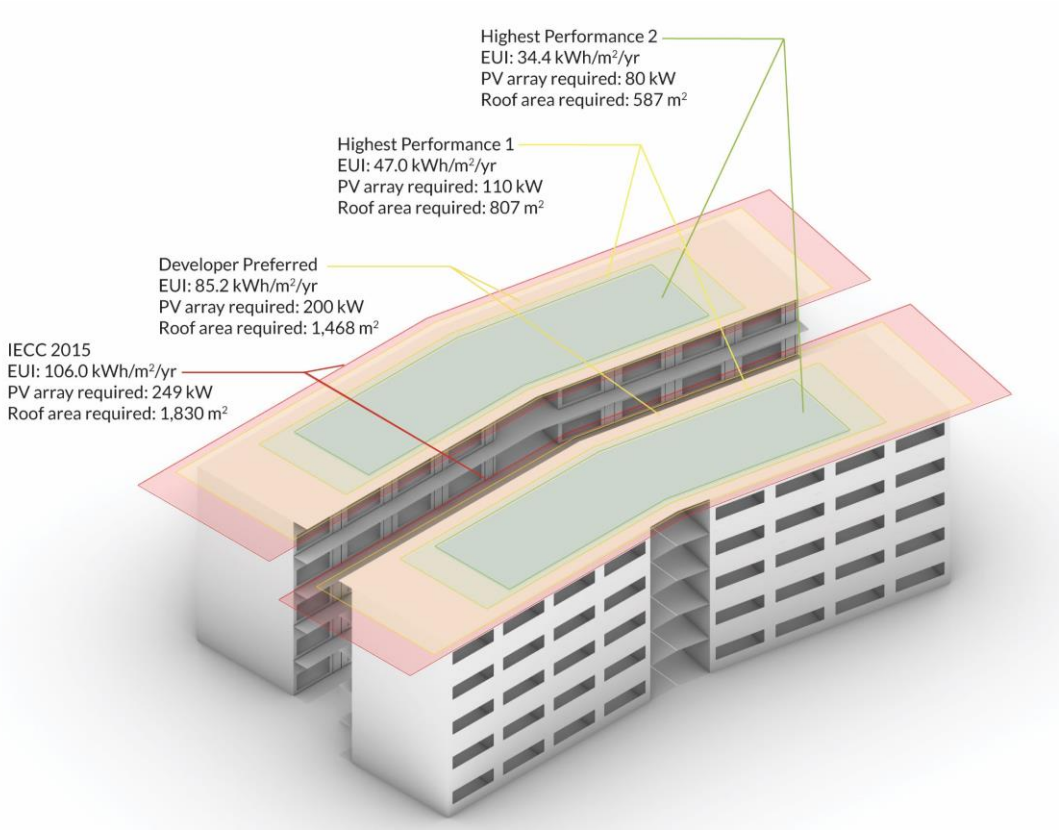
Evaluating Energy Targets and Efficiency Measures in Multifamily Subtropical Buildings through Automated Simulation

Wendy Meguro
University of Hawai'i at Mānoa

Elliot J. Glassman
WSP Built Ecology



Multifamily concept design for Waipahu Transit Oriented Development (TOD) area



Wendy Meguro & Elliot J. Glassman (2021) Evaluating Energy Targets and Efficiency Measures in Multifamily Subtropical Buildings through Automated Simulation, Technology|Architecture + Design, 5:1, 82-95, DOI: 10.1080/24751448.2021.1863676

Section 5
Honolulu Energy Code
EV and PV ready

City and County of Honolulu

Affordable Readiness

For solar and electric vehicle deployment on O'ahu

HSEO Energy Code Presentation
April 21, 2022

Energy Code Adoption Timeline for O'ahu

Mar 14 '22

SBCC forms IECC 2021 review subcommittee

Apr-Jun

CCSR to conduct stakeholder outreach for input on draft local amendments to the 2018 State Energy Code

May 15- Jun 15

CCSR to host (3) public meetings with partners re: proposed revisions & future roadmapping

- EV & PV Ready
- Energy Stretch Code & ZNE for large homes
- Envelop, lighting, and mechanical amendments

Aug '22

Council Introduction/1st reading (tentative)

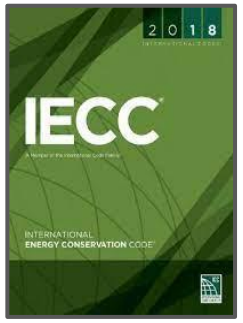
Nov 1

Adopt local amendments to State Energy Code

2018 IECC

SBCC amendments

Honolulu Local Amendments



Feb '23

SBCC passes IECC 2021 (estimate)

Mar '23

Begin building sector climate & energy code roadmapping process

The above *draft* timeline is intended to communicate the City's planned engagement for local adoption of the 2018 IECC with Hawai'i Amendments, and is subject to change, please check https://resilientoahu.org/energy for updates

Energy Codes: **Purpose**

C101.3 Intent This chapter sets forth *minimum requirements for the design and construction of buildings for the effective use of energy and is intended to provide flexibility to allow the use of innovative approaches and techniques.*

These measures are intended to help our buildings have ***lower energy costs, improved grid stability, reduced greenhouse gas emissions, and increased resilience from current and future climate impacts.***

ICC: The Important Role of Energy Codes in Achieving Resilience

Electric Vehicle Ready (existing)

For construction of new parking stalls at new residential or commercial buildings include panel capacity and conduit for a future L2 EV-charger at a certain percentage of parking stalls.

Baseline: 25% of stalls at 32A/240VAC

Points based: common area placement, full equipment installation, L3 chargers

Ordinance 20-10 Compliance Guide

Solar Ready for Residential Properties (existing)

R404.2 Solar Conduit and electrical panel readiness

New single family, two-family, and duplexes

Provide panel capacity for future 5kW PV system for each residence

New multi-family dwellings

Install an electrical panel that includes space reserved to accommodate a PV system

(1) sized to serve common area electrical loads, or

(2) sized to the roof space available.

Solar Ready for Commercial Properties (proposed)

Solar Ready zone on the roof

Area free of penetrations, protrusions, or equipment & sized to the lesser of

(1) 40% of the roof or

(2) 20% of the building load

Ready for interconnection

Panel Capacity

Location for future PV system equipment

See Seattle example here

Mahalo!

Office of Climate Change, Sustainability and Resiliency
resilientoahu.org

Section 6
Existing buildings

BEE Modules

15. Existing Building Renovations

- 15.1 Assessing Existing Buildings
- 15.2 Tools for Building Inspection
- 15.3 Addressing Common Building Issues
- 15.4 Energy Code Application to Existing Buildings

Building Energy Education fundamentals

15.1 Assessing Existing Buildings

Module 15: Existing Building Renovations
Part 1

Objective: Describe best practices for assessing existing buildings, including process flow and prioritization of projects.

15.1 Assessing Existing Buildings

Module 15: Existing Building Renovations
Part 1

Objective: Describe best practices for assessing existing buildings, including process flow and prioritization of projects.

How to conduct a facility assessment

1. Benchmarking

Break-out HVAC vs baseline consumption
Compare to other facilities to obtain idea of magnitude of savings potential

2. Site tour

Assess envelope for major leaks
Assess equipment and lighting for upgrades/controls
Assess HVAC for upgrades/repairs

3. Report findings

Explain existing conditions
Prioritize measures based on client goals

1. Benchmarking

- Input all utility bills into a tracking program.
  - EPA's Portfolio Manager is a common platform.
- Program should compare facility to other similar facilities.
  - Similar use and size
- Program should have input or access to weather data.
  - Can be used to separate energy consumption into weather-affected and baseline energy.
  - Helps in targeting priority projects.

1. Benchmarking:
Using benchmark to assess buildings

Comparing the facility's

Energy Use Intensity

to a

Benchmark

based on similar facilities indicates energy savings potential.

Energy Benchmarking For Sample College		
Sample College	92.3	kBtu/ ft2/yr
Benchmark	131	

1. Benchmarking:
Using weather data to assess buildings

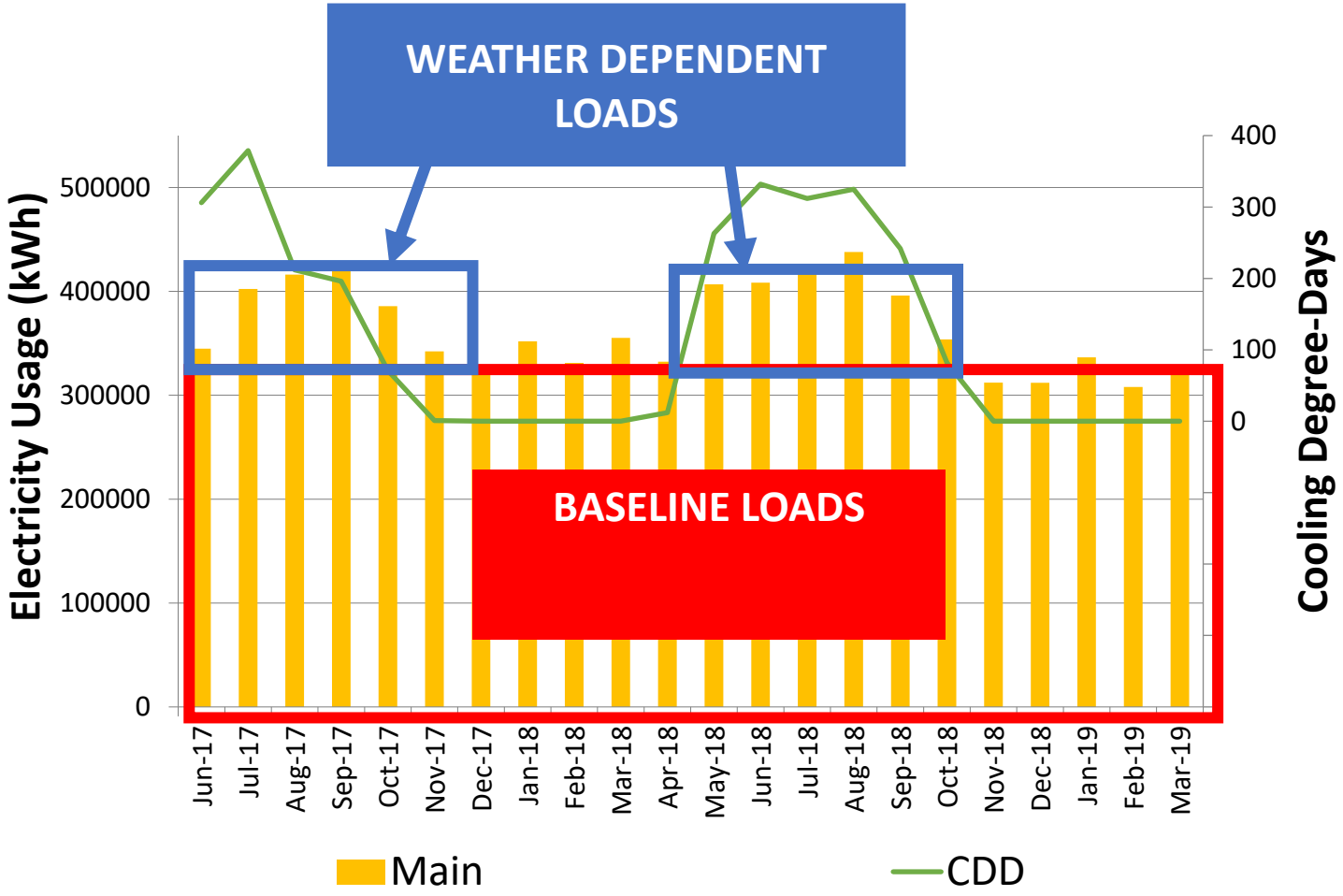
Comparing

Weather Data

and

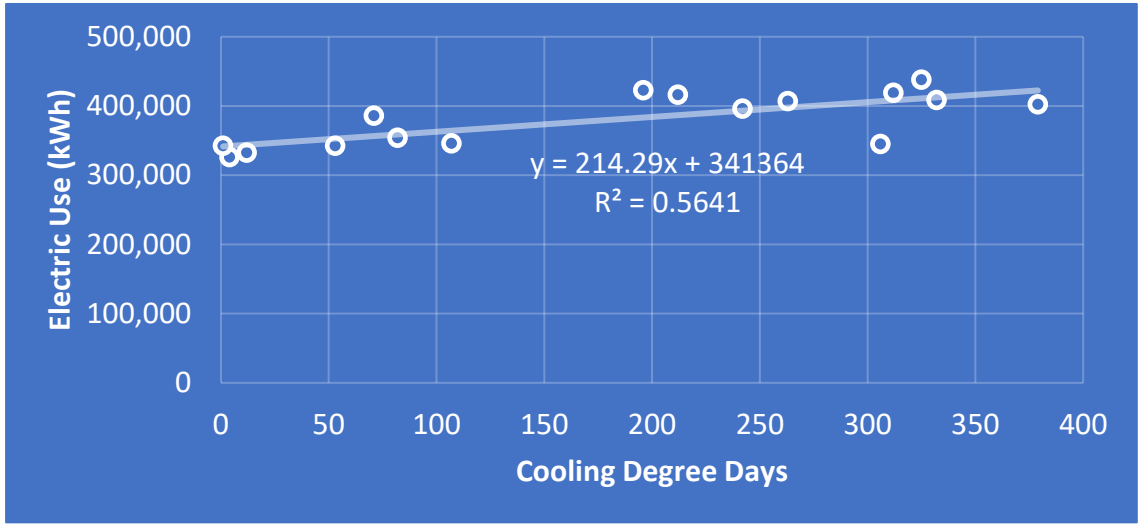
Energy Use

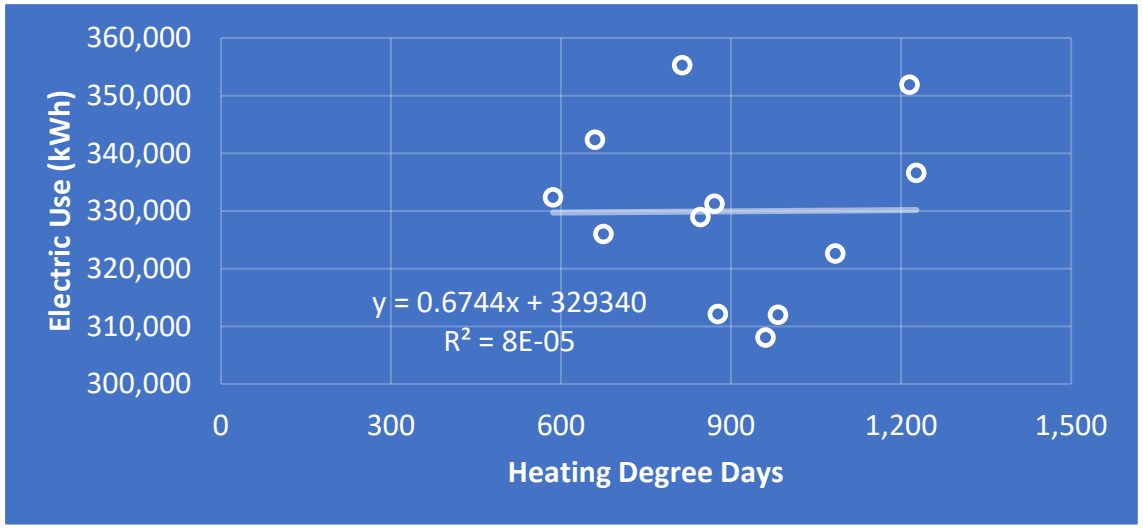
identifies Baseline loads and weather dependent loads.



1. Benchmarking:
Using weather data to analyze electric consumption

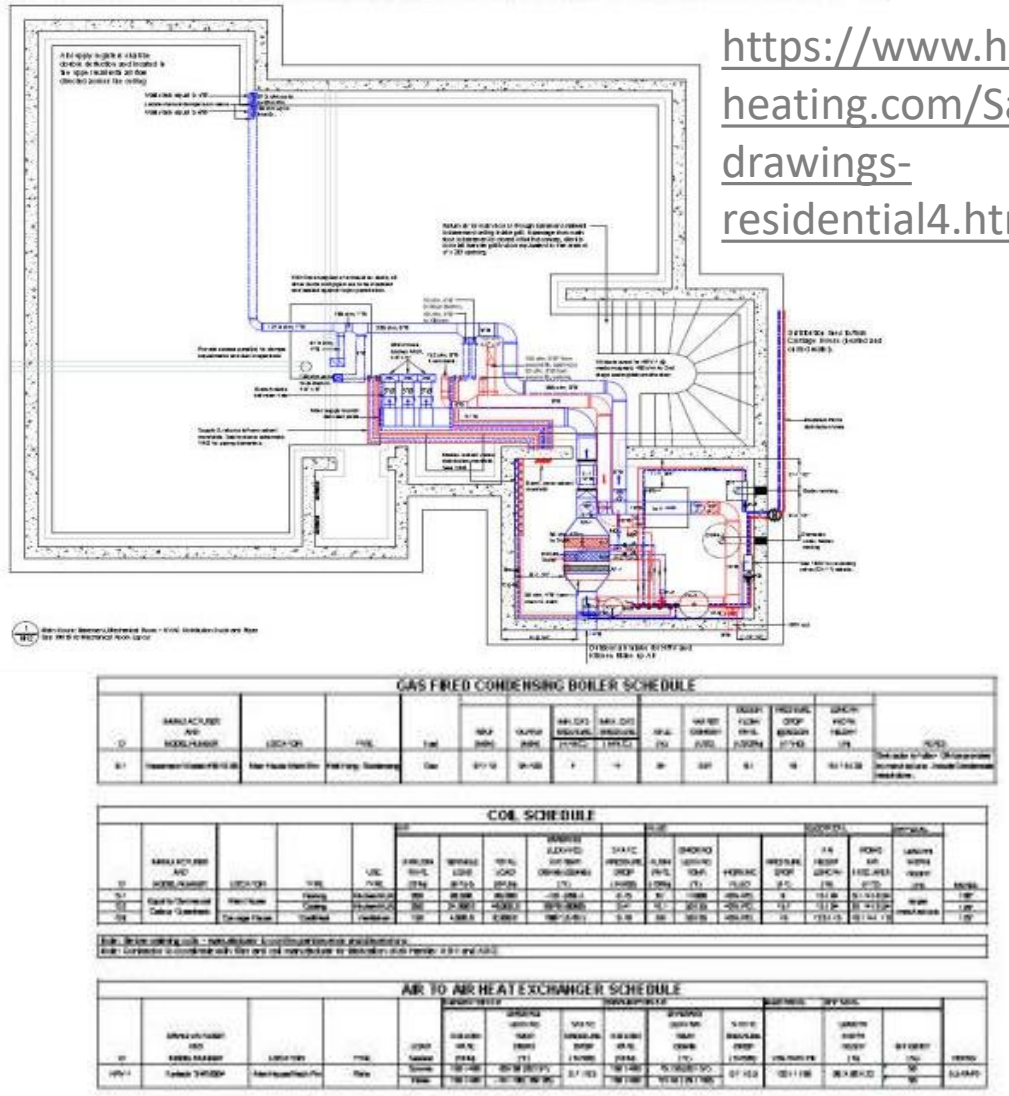
- Using heating and cooling monthly degree day data; plot with electric consumption.
- X-coefficient is related to weather-affected energy.
- Constant is related to baseload energy.
- **Scatter indicates if there is correlation with weather.**





2. Site Survey: Initial equipment survey can reveal opportunities

- Discuss equipment with client.
- Obtain design drawings if possible.
  - Can refine these initial findings during an on-site visit.
- Large equipment/systems documented
  - Fans
  - Pumps
  - Lighting types and counts
  - DHW systems
  - Process equipment for industrial sites



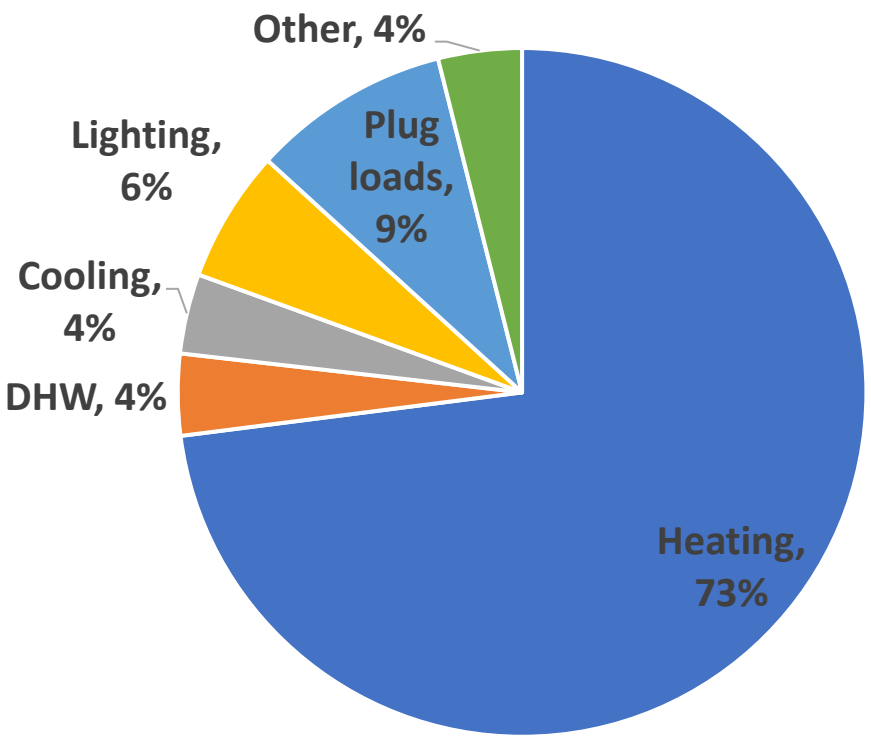
https://www.healthyheating.com/Sample-drawings-residential4.htm

2. Site Survey: Facility assessment will help prioritize measures

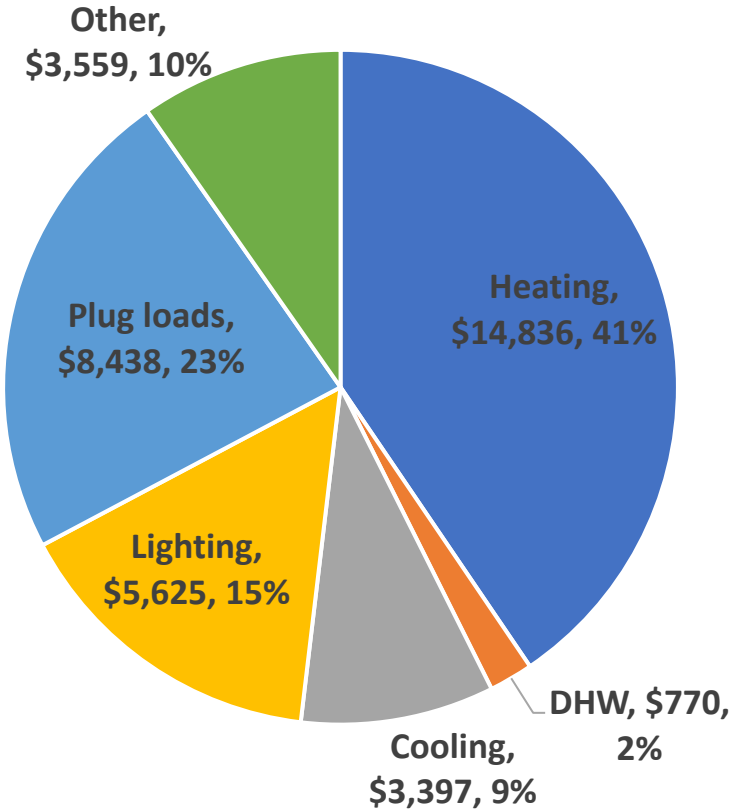
- Identify energy efficiency measures.
- Prioritize measures based on energy savings, economics, health & safety, or other factors.
- Can confirm or prioritize measures identified in benchmarking analysis.

3. Report: Estimating where energy is used helps to determine greatest savings potential

- Energy breakdown



- Cost breakdown



Basic Components of a facility site assessment

- **Major envelope issues**
  - Identify significant air leakage.
  - Check window/door weather strips.
  - Specifically target sources of humidity/moisture issues.

- **Lighting/appliance issues**
  - Look for lights and equipment operating when unoccupied.
  - Look for outdated, inefficient equipment.
  - Check for over- or under-lighting.

- **Envelope insulation issues**
  - Roof/attic insulation often cost-effective, easy to check levels.
  - Check on locations where occupants complain of excessive cold/heat.

- **Mechanical system issues**
  - Correct existing controls issues.
  - Evaluate addition of new controls.
  - Identify inefficient equipment and operations.

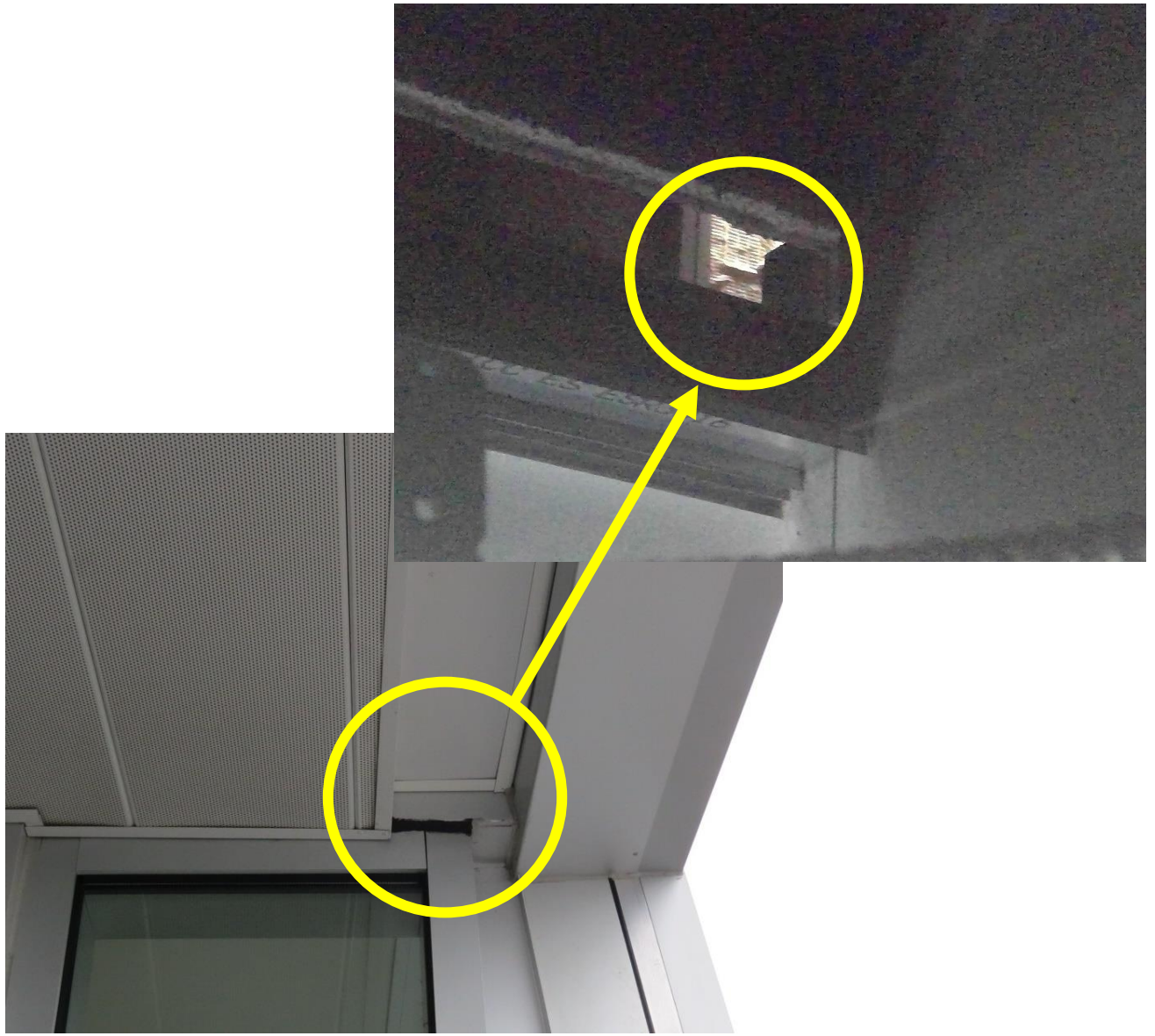
Identify water leaks first!

- Due to health concerns and structural integrity, these should be a **priority** item in any assessment:
  - Mold
  - Mildew
  - Structural integrity
- Some leaks are related to envelope issues, some are related to piping and duct systems.

https://www.epa.gov/
https://basc.pnnl.gov/

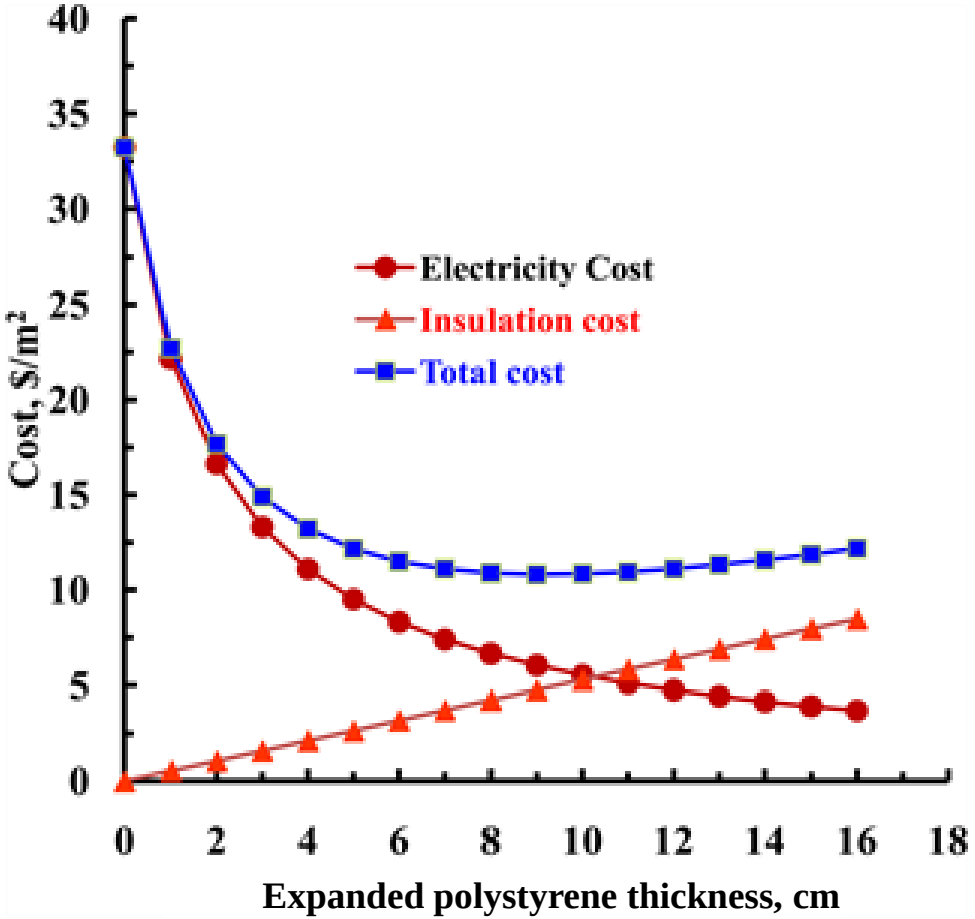
Identifying major envelope issues

- Identify any large air leaks in envelope:
  - Failed windows
  - Missing weather stripping
  - Porch/patio roof connections to building
  - Tight framing corners
- Can allow condensation moisture damage in air-conditioned spaces.



Envelope insulation

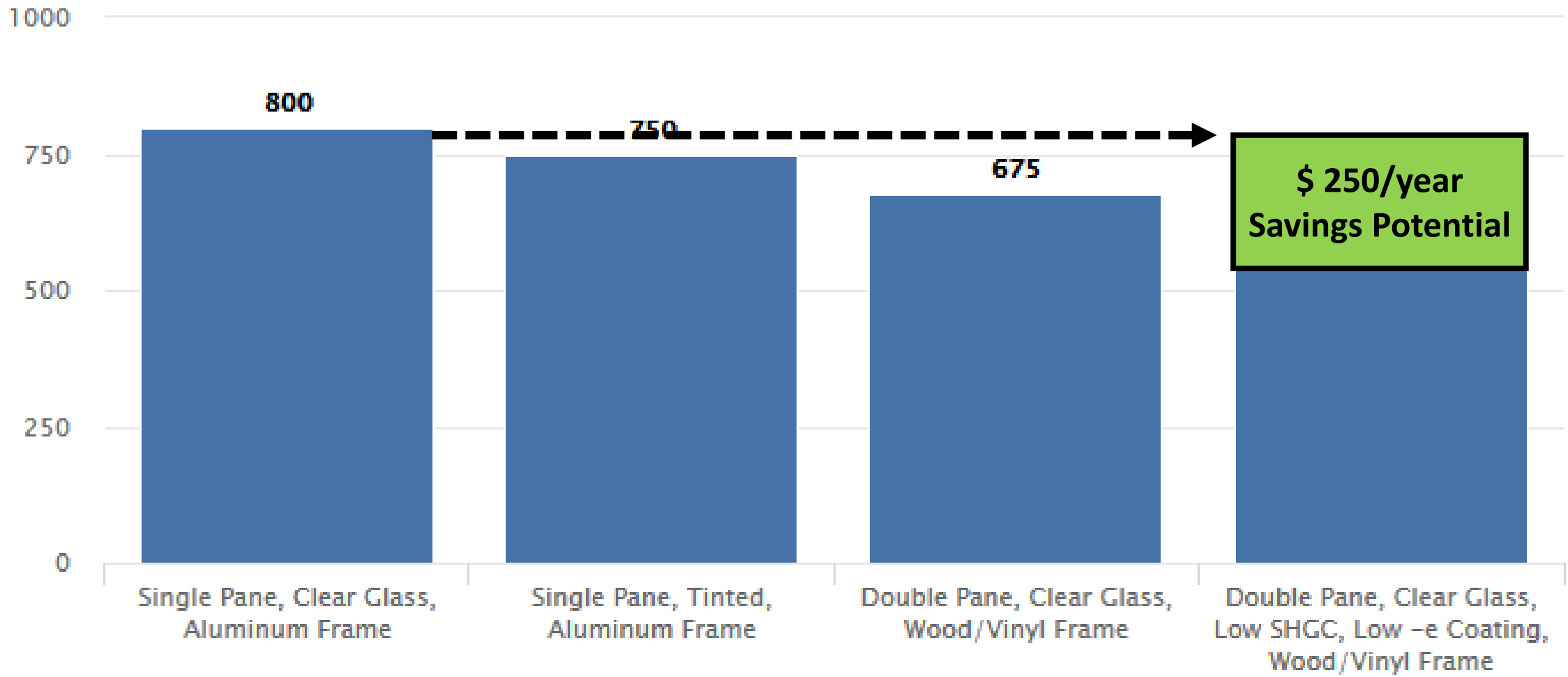
- **Roof insulation** usually most cost effective.
  - Large area with relatively easy access
- Often **air/water leak** investigations will reveal insulation issues, too.
- Insulation generally **maintains performance** over life of the building.
- Look for **low levels of insulation** – they will see the most benefit from adding additional insulation.



https://www.energy.gov/sites/prod/files/2013/12/f5/issue5_enclosure_insulation.pdf

https://www.scirp.org/journal/paperinformation.aspx?paperid=100999

Looked at walls, what about windows?



Cooling Cost ($) for Window Types in AZ

Lighting upgrades and controls

- LED lighting is a relatively easy upgrade for building energy efficiency.
  - 50% or less wattage than traditional lamps
  - Reduced cooling loads from reduced lighting heat output
- Lighting controls also straightforward
  - Occupancy and daylight sensors automatically turn off lights when not needed.

Various types of occupancy sensors and photosensors

www.ledligthexpert.com
www.EPA.gov
www.wbdg.org

Lighting retrofit options

- Multiple ways to upgrade to LED
  - Just lamps replaced
  - Lamp and socket kits
  - Whole fixture replacement (Luminaires)
- Select upgrade based on existing condition of fixtures.

Recommended Upgrade

Upgrade May Have Issues

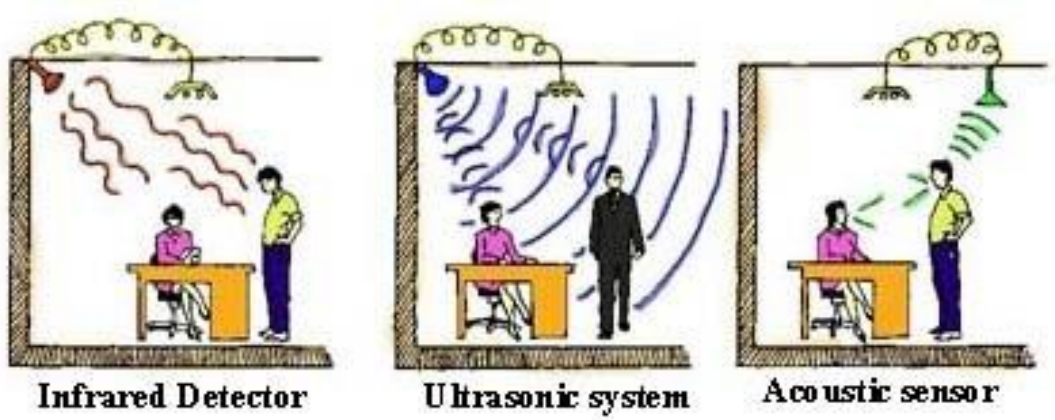
Not Recommended

https://www.energy.gov/sites/prod/files/2016/04/f30/mccullough_tleds_lightfair2016.pdf

EXISTING CONDITIONS TO CONSIDER	DESCRIPTION	LAMPS	KITS	LUMINAIRES
Condition of sockets	Look like new	●	●	●
	Some wear but no major cracks	▲	●	●
	Look old, blackened, cracks apparent	■	●	●
Condition of interior surfaces	Nice and white	●	●	●
	Slightly worn but no major scratches or peeling paint	▲	▲	●
	Very worn, scratches in paint, some peeling paint	■	▲	●
Condition of lens or louvers	Looks new; very little wear apparent	●	●	●
	Some minor color variations or scratches in surface	▲	▲	●
	Looks old, obvious cracks or yellowing	■	■	●
Ceiling access	No concerns with working above the ceiling; easy access	●	●	●
	Some concerns about working above the ceiling; limited access	●	●	▲
	Working above the ceiling should be avoided	●	▲	■

Lighting controls savings available everywhere!

- Lighting controls most cost-effective if non-LED lighting in place, and no previous controls
- Target areas where lights are typically always on or forgotten
  - Stairwells can have dimming occupancy controls
  - Parking lots and landscaping with 24/7 lighting
  - Site tour can reveal where lights are on when spaces unoccupied/unused
- Wireless controls can reduce install costs
  - Reduced wiring/conduit installation
  - Reduced labor costs



ubuy.com; ilimnet.com; intermatic.com

Selecting efficient equipment

- ENERGY STAR appliances can replace older, inefficient equipment.
- Ensure PCs, printers, etc. have energy savings features enabled (sleep mode).
- Peripherals (monitors, speakers, etc.) can be linked to advanced power strips.
- Replace/upgrade gas appliances with continuous pilot lights with electronic pilots.

https://dothemath.ucsd.edu/2012/03/pilot-lights-are-evil/
https://www.energy.gov/energysaver/articles/choose-right-advanced-power-strip-you

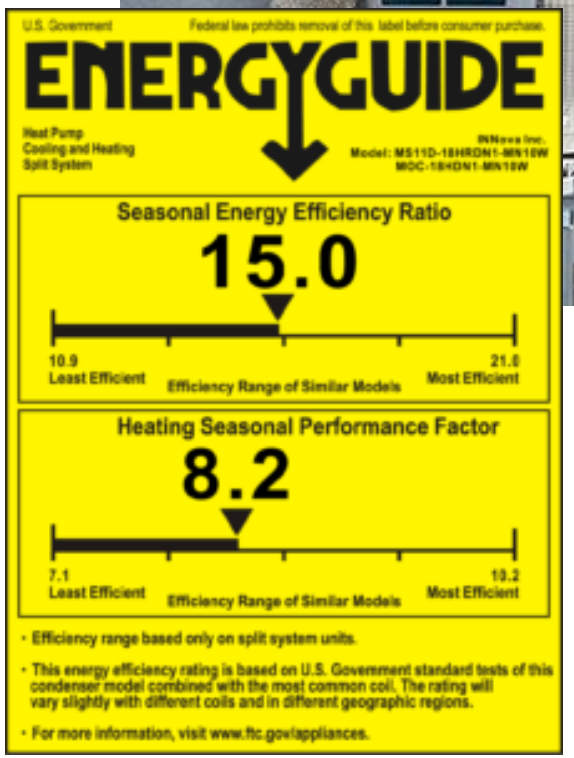
HVAC – identify inefficiencies

- Correct existing controls issues.
- Evaluate addition of new controls.
- Identify inefficient equipment and operations
- Look for deferred maintenance and needed repairs

Deferred Maintenance can cause inefficient operation. A filthy condensing unit is cheap to correct and radically reduces cooling efficiency.

HVAC upgrade options

- Good options for existing systems
  - Add programmable thermostats.
  - Seal ductwork.
  - Commission existing controls.
  - Focus is increasing existing system operational efficiency.
- Good options for replacing systems
  - Increase unit efficiency (AFUE, SEER, COP, etc.).
  - Properly size equipment to building loads.
  - Ensure new system properly commissioned.



https://www.energy.gov/energysaver/shopping-appliances

https://amerenillinoissavings.com/business/

HVAC upgrades – ideally, the last project

- System resizing should always be completed after other projects when possible.
  - Envelope, lighting, and air tightness improvements reduce HVAC loads.
  - Replacing HVAC first can result in over-sizing and comfort issues.
  - Smaller equipment = smaller capital costs

https://www.carrier.com/commercial/en/us/products/packaged-outdoor/outdoor-packaged-units/

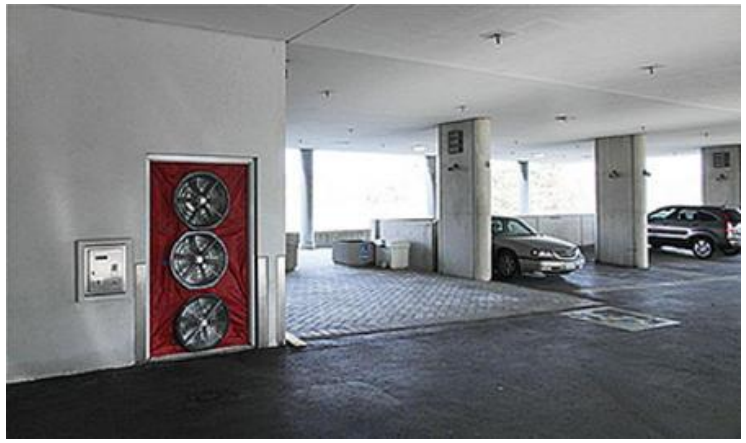
15.2 Tools for Building Inspections

Module 15: Existing Building Renovations
Part 2

Objective: Identify diagnostic techniques and explain how they are used to assess energy performance and identify problems.

Blower doors & building pressure testing

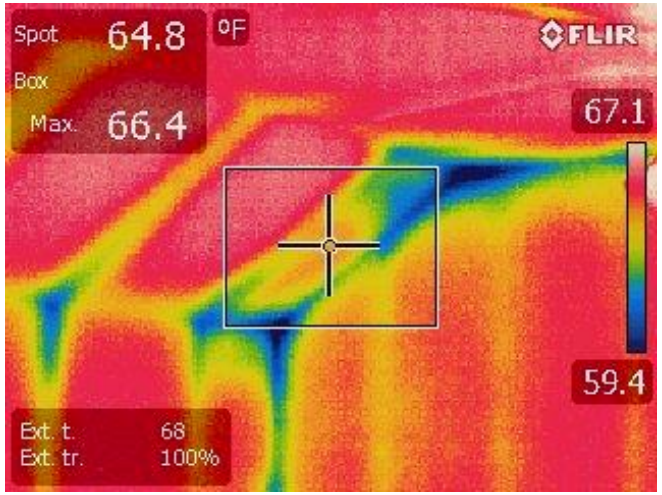
- Residential - pressurize or depressurize home to 50 Pa (20 mph wind equivalent).
- Commercial - pressurize or depressurize to 75 Pa (25 mph wind equivalent).
- Airflow to maintain pressure converted to equivalent leakage area.
  - Gives idea of leakage area to seal
- Benchmark overall building leakage in terms of air changes per hour.
  - Air change per hour is number of times entire air volume in building is exchanged with outdoor air.
  - Allows comparison to other buildings.



https://www.buildingscience.com/documents/digests/bsd-040-airtightness-testing-in-large-buildings

Infra-red thermography and diagnostics

- IR imaging can show missing insulation.
- In combination with pressure testing, can clearly show air leaks!
- Reveal hidden air leaks in chases and building cavities.
- Examples at right from residential assessment conducted by SEDAC.



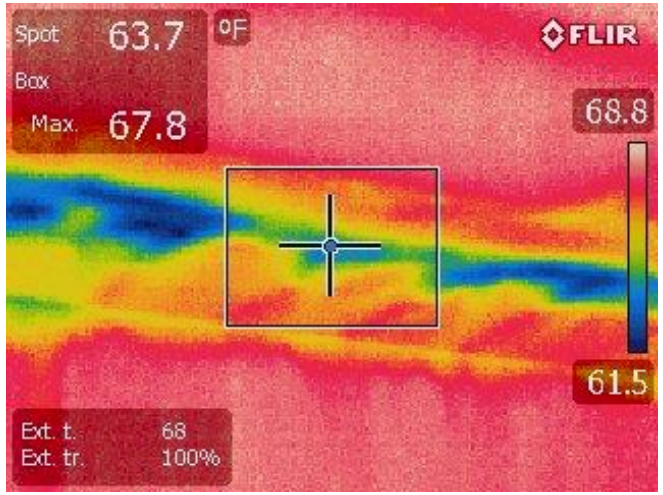


Image sources: SEDAC

IR thermometer R-value estimate

- Can use IR to calculate level of insulation in a wall/ceiling cavity.
- Need to know outdoor & indoor air temperatures, then measure wall temperature.
  - Rest of calculation uses some basic assumptions
- Outline of process and video can be found here:

  https://woodgears.ca/physics/r-values.html

Smoke testing can reveal airflow paths

- Air leaks can be located with smoke pencil.
  - Smoke will follow natural drafts.
  - Can be enhanced with building pressure testing.
  - Limited to spot checks
- Whole building smoke test can be completed with a fog machine.
  - Air leakage often corresponds with water leaks.
  - Sample video: https://www.youtube.com/watch?v=UKruif-kIHc

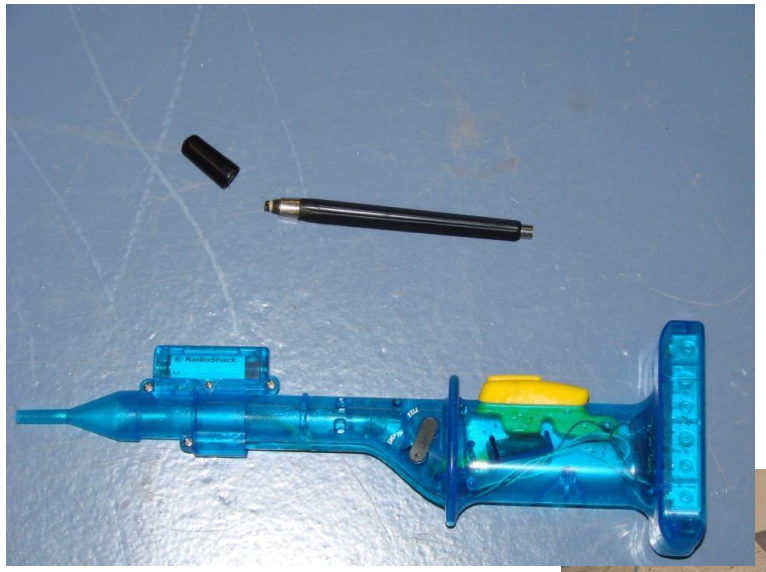
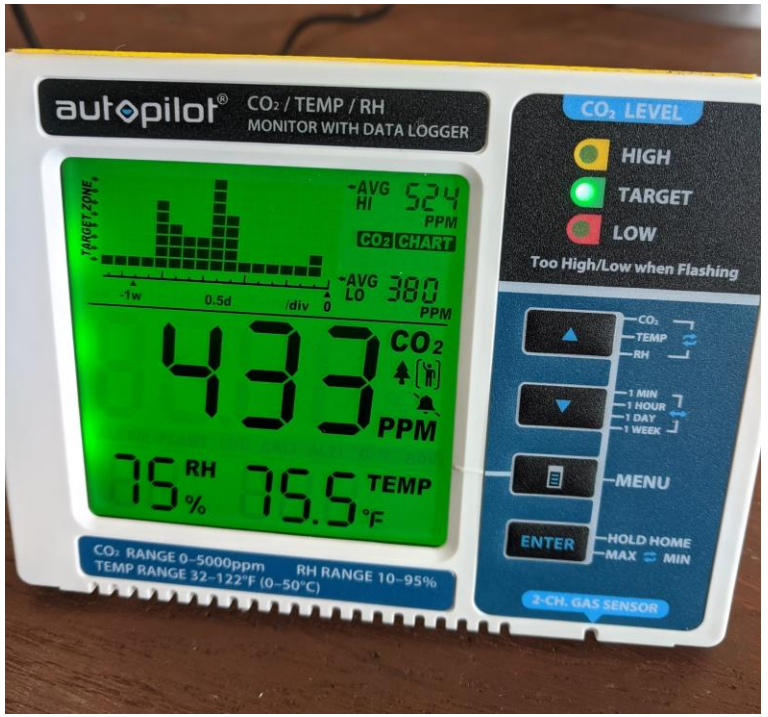


Image source: https://basc.pnnl.gov/

Image source: https://www.greenbuildingadvisor.com/article/pinpointing-leaks-with-a-fog-machine

Other Envelope Tools

- Air Quality Tester
  - Can indicate adequacy of ventilation.
  - Can identify humidity issues
  - Can assess consistency.
- Moisture Meter
  - Can identify moisture or condensation issues that are not visible.
  - If time allows, can be used to investigate the source of moisture (rain, temperature extremes, equipment operation, etc.).



Loggers – Wide array of data tracking options

- Data loggers can track multiple variables, depending on unit.
  - Light and occupancy
  - Temperature and humidity
  - Motor current draw
  - On/off equipment logging
  - CO_2 and other gas detection
- Can be used for envelope, lighting, equipment, and HVAC logging and verification of operations.

Temp/RH/CO_2 logger

Occupancy/light logger

Current logger

Motor on/off logger

Airflow/temp logger

www.onsetcomp.com

Existing BAS systems – trend logs reveal issues

- Existing **Building Automation Systems (BAS)** can provide data
- May eliminate the need for loggers

Image from Johnson controls, Inc.

Footcandle meters verify lighting levels

- Lighting renovations may require verification of lighting levels.
  - Target Illuminating Engineering Society (IES) lighting levels, which have changed over time.
  - Can reduce lighting requirements in some cases.

Building Area & Task	Average Maintained Footcandles (Horizontal) (FC)	Range of Maintained Footcandles (Horizontal) (FC)	Average Maintained Footcandles (Vertical) (FC)	Range of Maintained Footcandles (Vertical) (FC)
EDUCATIONAL (SCHOOLS)				
Classroom	40	30 - 50		
Gymnasium				
Class I (Pro or Div. 1 College)	125		30	
Class II (Div. 2 or 3 College)	80		20	
Class III (High School)	50		150	
Class IV (Elementary)	30		100	
Auditorium	7.5	3 - 10	5	2.5 - 10
Corridor	25	10 - 40		

http://www.extech.com/products/LT505

https://www.lightingdesignlab.com/sites/default/files/pdf/Footcandle_Lighting%20Guide_Rev.072013.pdf

Section 7

Hawaii Energy

Hawai‘i Energy

YOUR CONSERVATION & EFFICIENCY PROGRAM

Lily Koo
Business Energy Advisor

Standard Custom Rebate Rates	Power Move Custom Rebate Rebates
$0.12 per kWh saved	**$0.12 per kWh** saved
$125 per kW saved during 5-9pm peak	**$400 per kW** saved during 5-9pm peak

Power Move – Demand Savings Bonus

- Technology Focus: Custom HVAC, exterior lighting, refrigeration, Transformers, UPS;
- Pre-approval Required; First come first served
- Some projects might require data logging
- Maximum rebate is capped at 50% of project costs
- Application Deadline: Jan 2023
- Project completion: June 30, 2023
- Retrofit projects only

Commercial Energy Storage

Type of Commercial Storage Installation	Rebate Per Kilowatt-Hour (kWh)*	
	Dispatched from 6:00 to 8:30 p.m.	Dispatched from 5:00 to 6:00 p.m. and/or 8:30 to 9:00 p.m.
Tied to solar PV—the majority of battery system charges daily from on-site solar generation	$250	$125
No renewable generation attached	$150	

COMMERCIAL ENERGY STORAGE

Requirements:

- HECO interconnection
- Scheduled battery dispatch for 2+ hours between 5-9pm daily
- Must be installed by August 2023

Encourage coupling with HECO Battery Bonus program though not required

Limited funding available—contact us ASAP

EV Charging Station

Available Rebates

Level 2 Station (must have at least 2 ports)

- **(New Installation) $4,500** per networked station
- **(Retrofit) $3,000** per networked station

**Additional funding is available for Level 2 stations installed at affordable housing properties. Please contact us for more information.*

DC fast-charging station

- **(New Installation) $35,000** per networked station
- **(Retrofit) $28,000** per networked station

Waitlist

Energy Audit & Retro-Commissioning

Energy Audits & Energy Studies	Incentive
ASHRAE Level 2 Audit	$0.05 per sq. ft. of the audited facility up to $15,000, capped at 85% of the audit cost Additional 10% rebate applied to projects identified in audit and implemented within 2 years of audit completion.
ASHRAE Level 3 Audit	$0.10 per sq. ft. of the audited facility up to $25,000, capped at 85% of the audit cost. Additional 10% rebate applied to projects identified in audit and implemented within 2 years of audit completion.
Re-Commissioning & Retro-Commissioning	**Incentive**
Re- or Retro-Commissioning	$0.20 per sq. ft. of the commissioned facility up to $30,000, capped at 50% of the Re-or Retro-Commissioning cost. Additional $0.08 per kWh saved in the first year + $125 per kW saved between 5 to 9pm.

NAR Green Designation

Maui + Hilo - April 18-19 [M & T]

Honolulu – May 23-24 [M & T]

9:00am – 4:30pm | Online | FREE

Join Franklin Energy for a two-day training to learn green real estate concepts, principles, practices and benefits. Upon completion, you will have earned the only green designation for real estate agents conferred by the National Association of REALTORS® and 12 hours of Continuing Education Units.

Maui + Hilo Registration

Honolulu Registration

https://hawaiienergy.com/education-outreach/professionals

Questions?

Business Energy Efficiency Advisor

Lily Koo
kool@leidos.com
(808) 848-8563

Get the latest updates! Sign up for our e-newsletter at hawaiienergy.com/newsletter

Section 8

Wrap Up

Q&A

Howard Wiig, State Energy Office

Erik Kolderup, Kolderup Consulting

Phil Camp, hi.arch.y

Ben Sullivan, C&C of Honolulu

Lily Koo, Hawaii Energy

Zippy’s gift cards

Hawai‘i Energy

https://www.zippys.com/

Training series

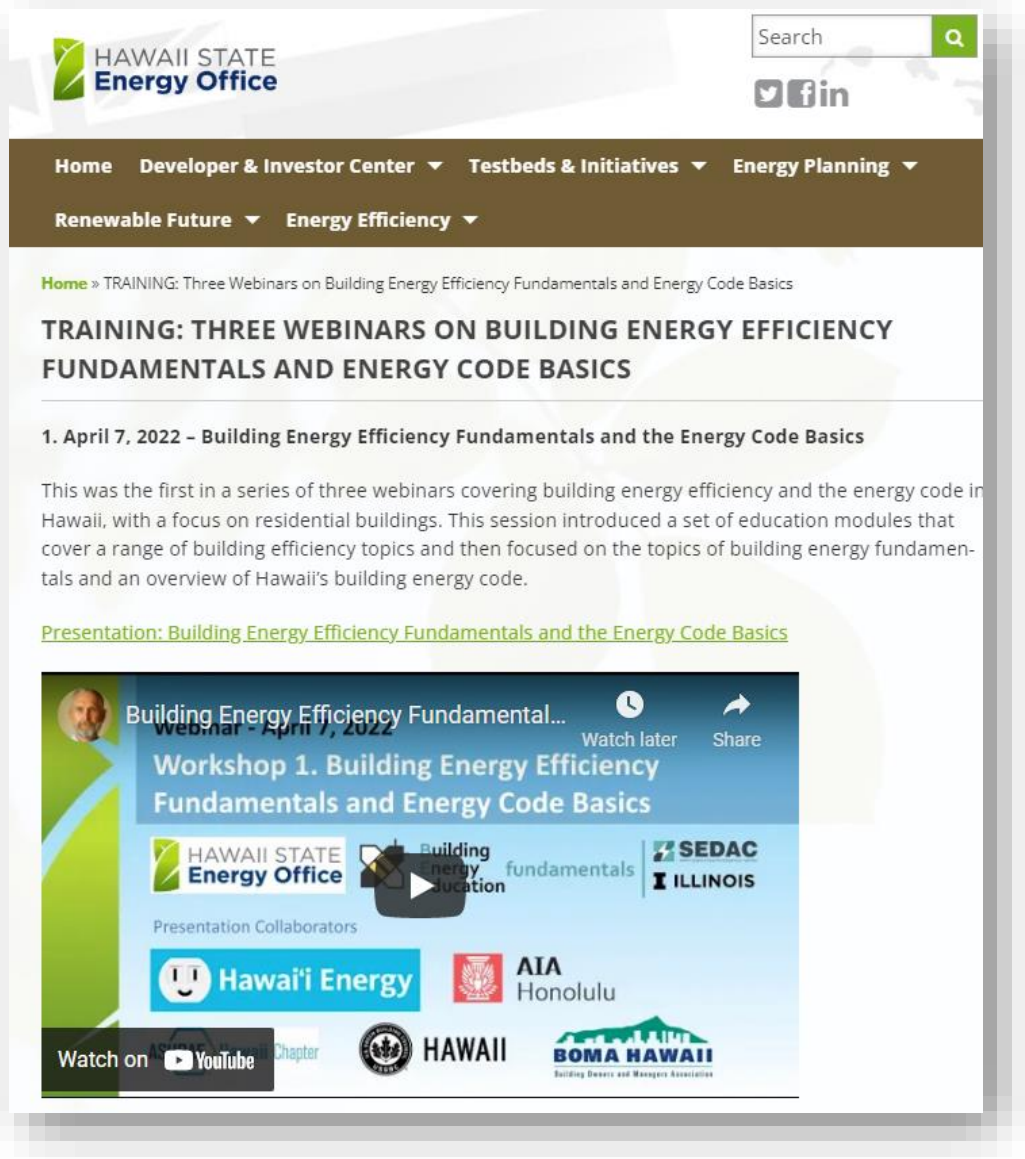
Now available online

Workshop 1
Building Energy Education Fundamentals and Energy Code Basics
4/7/2022

Workshop 2
Comfort, Air Quality and Lighting
4/14/2022

PDF & video recording

https://energy.hawaii.gov/building-energy-efficiency-and-energy-code



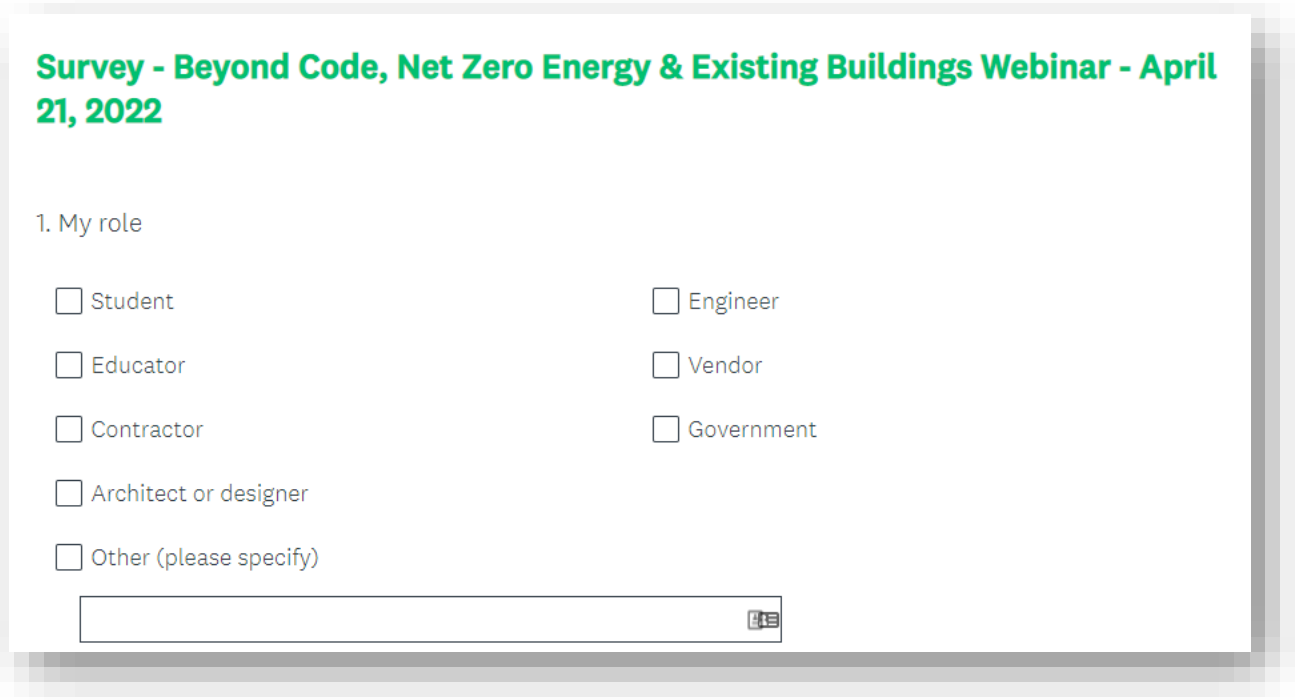
Next Week

Train the Trainer
BEE Fundamentals: Train-the-Trainer Workshop
Friday, 4/29/2022 9:00 – 11:00am HST
https://smartenergy.illinois.edu/bee_fundamentals/

Evaluation Survey

https://www.surveymonkey.com/r/6KVKBST

Please also provide suggestions for future training topics



For more energy information

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Office (808) 590-9555
Howard.c.wiig@Hawaii.gov

Building Energy Education Fundamentals
- https://smartenergy.illinois.edu/bee_fundamentals/

2018 IECC available
- http://iccsafe.org/publications
- https://codes.iccsafe.org/content/iecc2018

State Energy Code Website
- http://energy.hawaii.gov/hawaii-energy-building-code

Hawaii Energy Code Website
- https://hawaiienergy.com/codes