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The Sponsors of Energize Connecticut, and in partnership with Connecticut Passive House, are pleased to offer *Passive House & All-Electric Homes Initiative* to support workforce development and help transform the energy efficiency and building construction industries in Connecticut.

CTPH

CONNECTICUT PASSIVE HOUSE

For more information, please visit EnergizeCT.com/passive-house
or email PassiveHouseTrainingCT@icf.com

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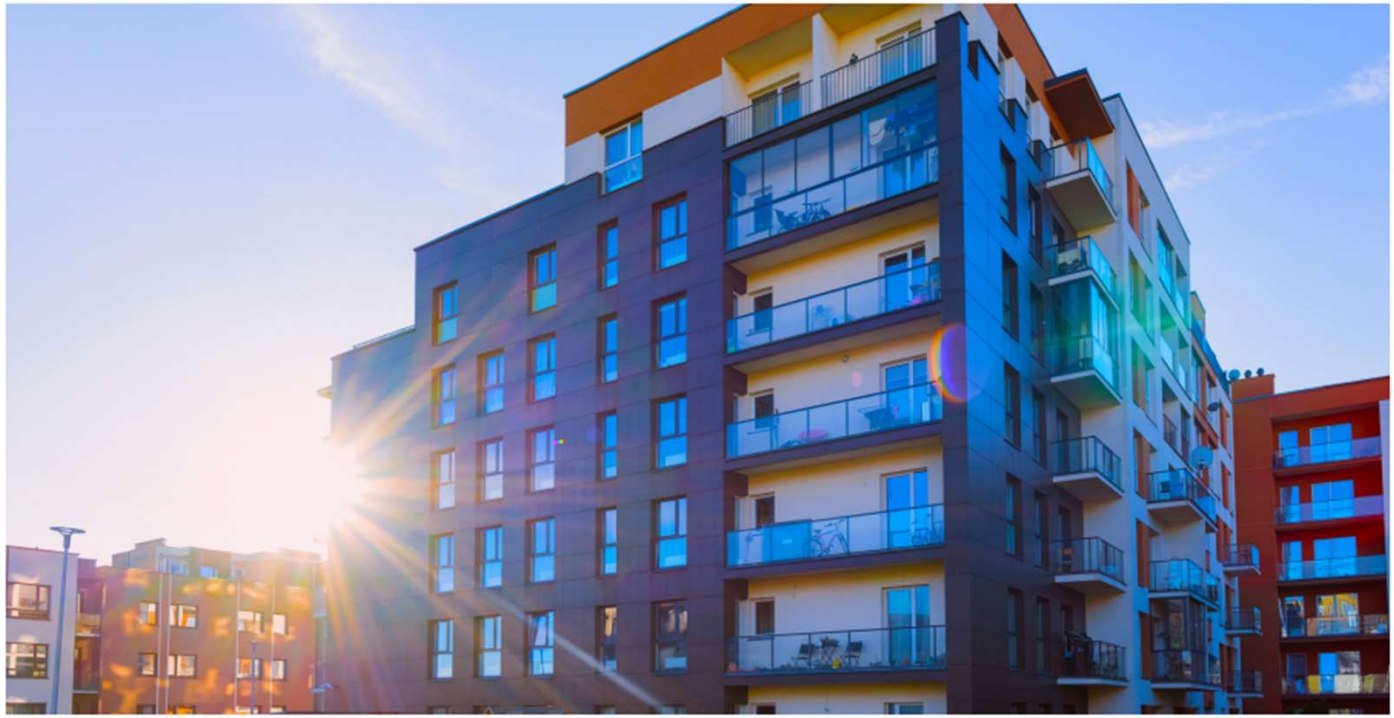
Take energy efficiency to a new level

Residential New Construction Passive House Multi-family buildings with five units or more



PASSIVE HOUSE INCENTIVE STRUCTURE FOR MULTI-FAMILY (5 UNITS OR MORE)				
Incentive Timing	**Activity**	**Incentive Amount**	**Max Incentive (Per Unit)**	**Max Incentive (Per Project)**
Pre-Construction	Feasibility Study[1]	Up to 100% of Feasibility Study Costs	N/A	$5,000.00
	Energy Modeling[2]	75% of Energy Modeling Costs (Before 90% Design Drawings)	$500.00	$30,000.00
		50% of Energy Modeling Costs (90% Design/50% Construction)	$250.00	$15,000.00
Post Construction	Certification[3]	Up to 100% of Certification Costs	$1,500.00	$60,000.00

1. Feasibility Study will require documentation in the form of a Feasibility Study report and invoice from the Passive House Consultant
2. Incentives will only be awarded prior to 50% Construction Drawings for Passive House projects. No incentives will be granted after 50% Construction Drawing set.
3. Certification may be either through PHIUS, PHI, or EnerPHit certification offerings.

Next steps you can take...
Contact your Energy Efficiency Representative or

Go to EnergizeCT.com or call 1-877-WISE USE for more details.

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The future of high-performance, all-electric homes starts here.

	LEVEL 1		LEVEL 2	
	Single Family (Detached Dwellings)	Multifamily (Attached Dwellings)	Single Family (Detached Dwellings)	Multifamily (Attached Dwellings)
Total UA Alternative Compliance or HERS Index Score †	Total UA ≥ 7.5% better than 2021 IECC or HERS Index Score ≤ 55		Total UA ≥ 15% better than 2021 IECC or HERS Index Score ≤ 45	
Heat pump for space heating ††	Required		Required	
Space Conditioning Connectivity & Controls †††	Optional		Required	
Heat pump for water heating	Required	Optional	Required ††††	
Hot Water Distribution †††††	Required		Required	
Envelope Infiltration Rate (ACH)	ACH50 ≤ 2.5	CFA > 850ft2: ACH50 ≤ 4.0 CFA < 850ft2: ACH50 ≤ 5.0	ACH50 ≤ 2.0	CFA > 850ft2: ACH50 ≤ 3.0 CFA < 850FT2: ACH50 ≤ 4.0
Duct Leakage Rate (CFM)	2021 IECC code minimum requirements		All ductwork must be located in conditioned space	
Balanced Ventilation Systems	Optional		Required HRV/ERV (≥70% SRE / ≥40% TRE)	
Induction Cooking	Optional		Required †††††	Optional
Electric Vehicle Readiness †††††††	Required		Required	

ALL-ELECTRIC HOME INCENTIVE STRUCTURE		
	Level 1	Level 2
Single Family	$7,500	$10,000
Single Family Attached	$3,000	$5,000
Multifamily	$1,500	$2,500

Next steps you can take...
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HIGH PERFORMANCE ALL-ELECTRIC HOME DESIGN AND CONSTRUCTION

FOR COLD CLIMATES

LEARNING OBJECTIVES

1

Lesson 1.

Identify current innovative high-performance technology options

2

Lesson 2.

Identify envelope efficiency considerations

3

Lesson 3.

Evaluate the feasibility of those options in a variety of presented in scenarios.

4

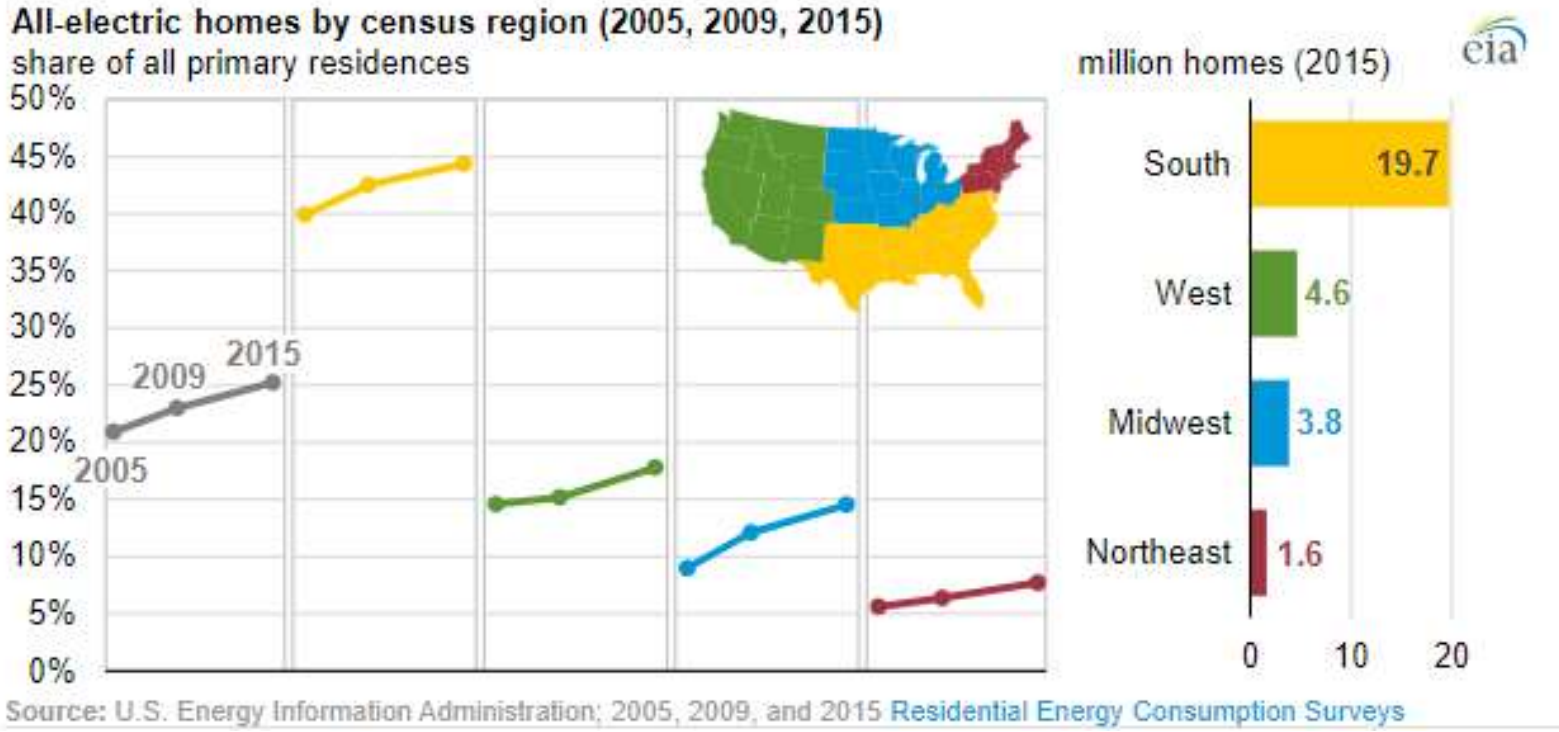
Lesson 4.

Measuring homes energy consumption

5

Lesson 5.

All Electric Homes Summary



Source: U.S. Energy Information Administration; 2005, 2009, and 2015 Residential Energy Consumption Surveys

ONE IN FOUR U.S. HOMES IS ALL ELECTRIC

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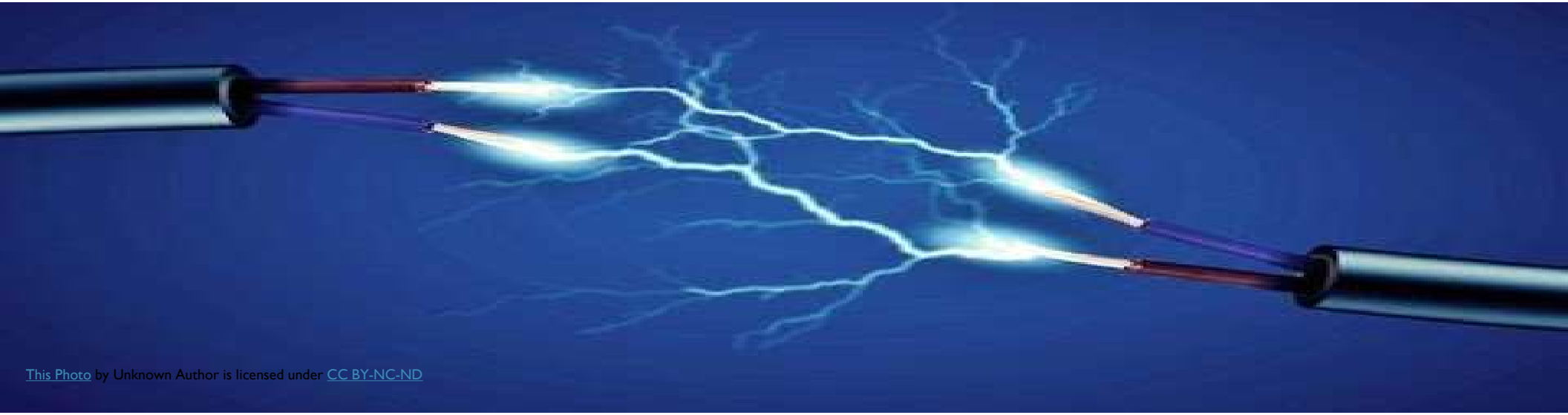
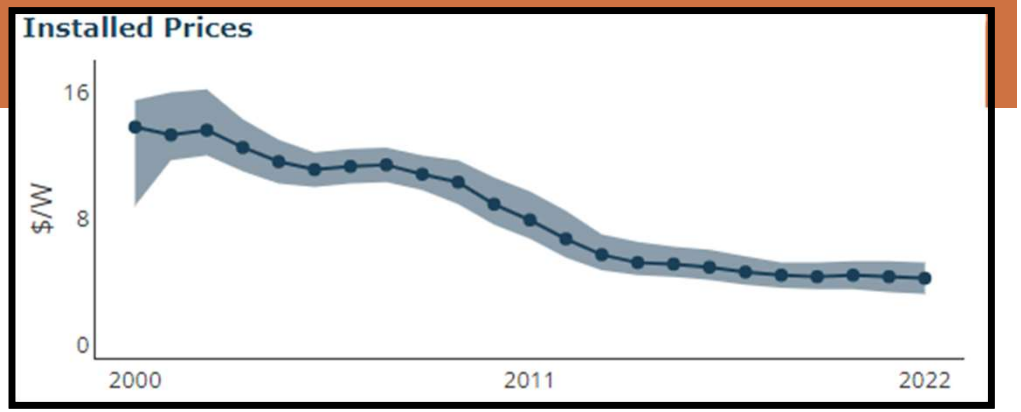
GOING ALL ELECTRIC?

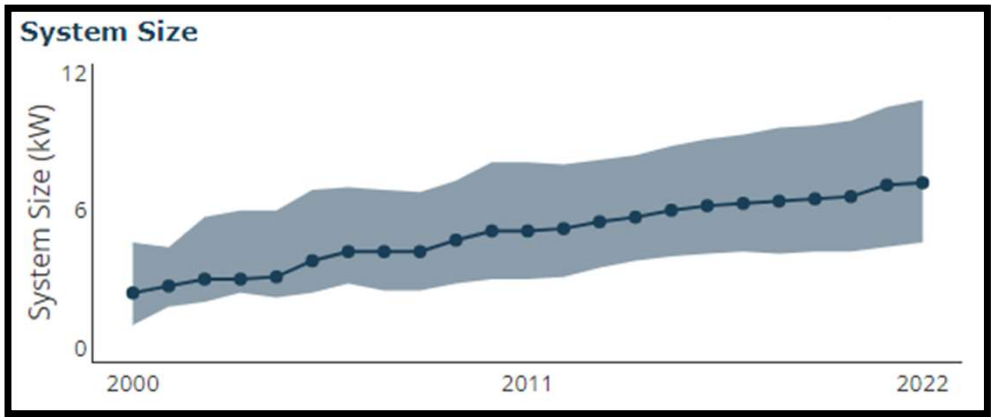
- What is currently electric in our homes?
- What systems can be either gas or electric?



EVOLUTION OF SOLAR

- Over 3.2 million homes have gone solar in the U.S.
- Data from Lawrence Berkeley National Laboratory:
  - https://emp.lbl.gov/tracking-sun-tool





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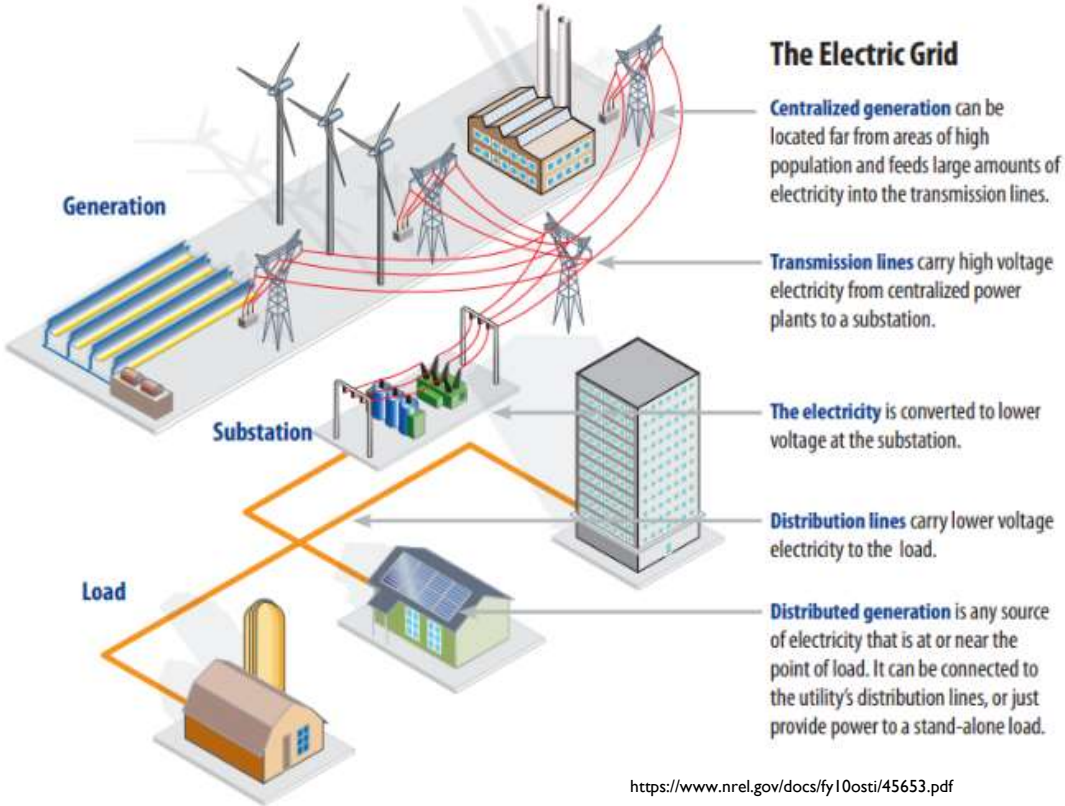
SOLAR DISTRIBUTION



https://www.nrel.gov/docs/fy10osti/45653.pdf

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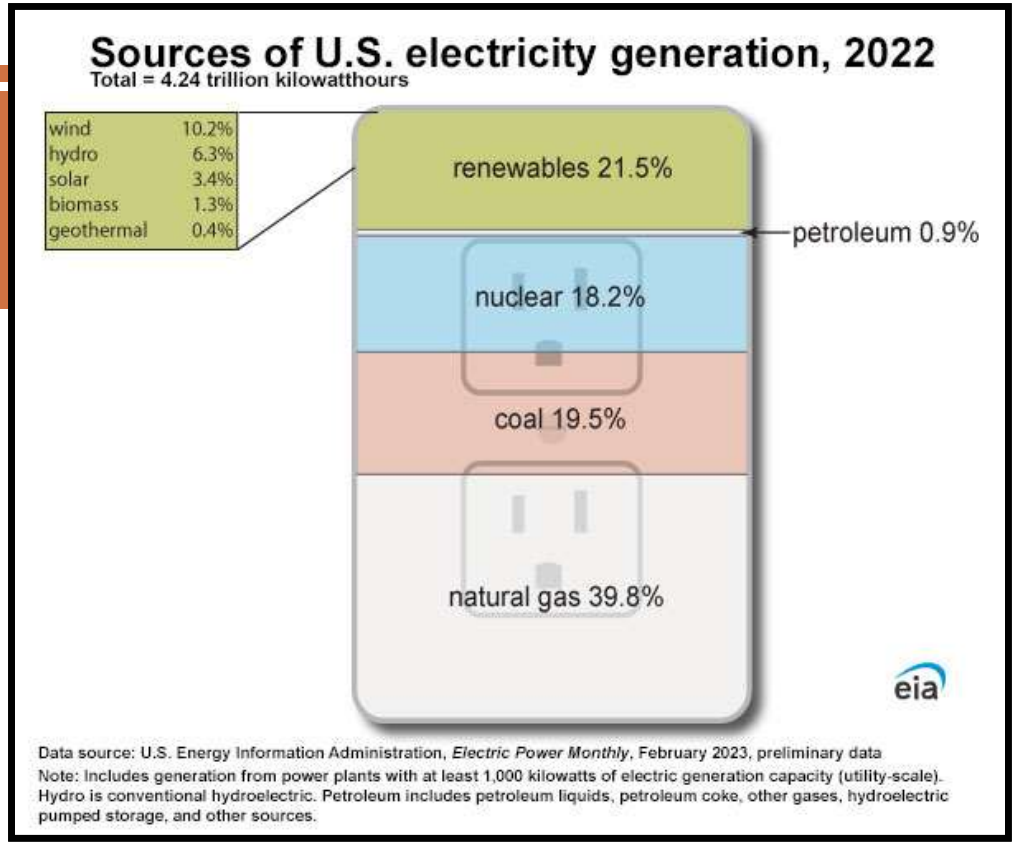
WHY GO ELECTRIC?

- Source electricity is getting cleaner
  - Electricity produced from coal has dropped from 51% to 19.5% since 2008
- Solar and wind now account for 13.6% for source electricity and is growing
- Combustion safety
  - Homes are built tight
  - Non-sealed combustion appliances need mechanical rooms with make-up air
  - Added cost with the room
  - Non-sealed combustion appliances are typically less efficient
- Rooftop PV and small wind turbines have substantial potential to provide electricity with little impact on land, air pollution, or CO2 emissions



- Electrification reduces greenhouse gases
- Fossil fuels are being phased out
  - California, Washington and Massachusetts are just a few examples

INNOVATIVE

- More than half of energy use in homes is for heating and air conditioning
- Water heating is the next biggest energy consumer in a home
- An all electric home with improperly sized heating and or cooling and not tightly built can create issues….

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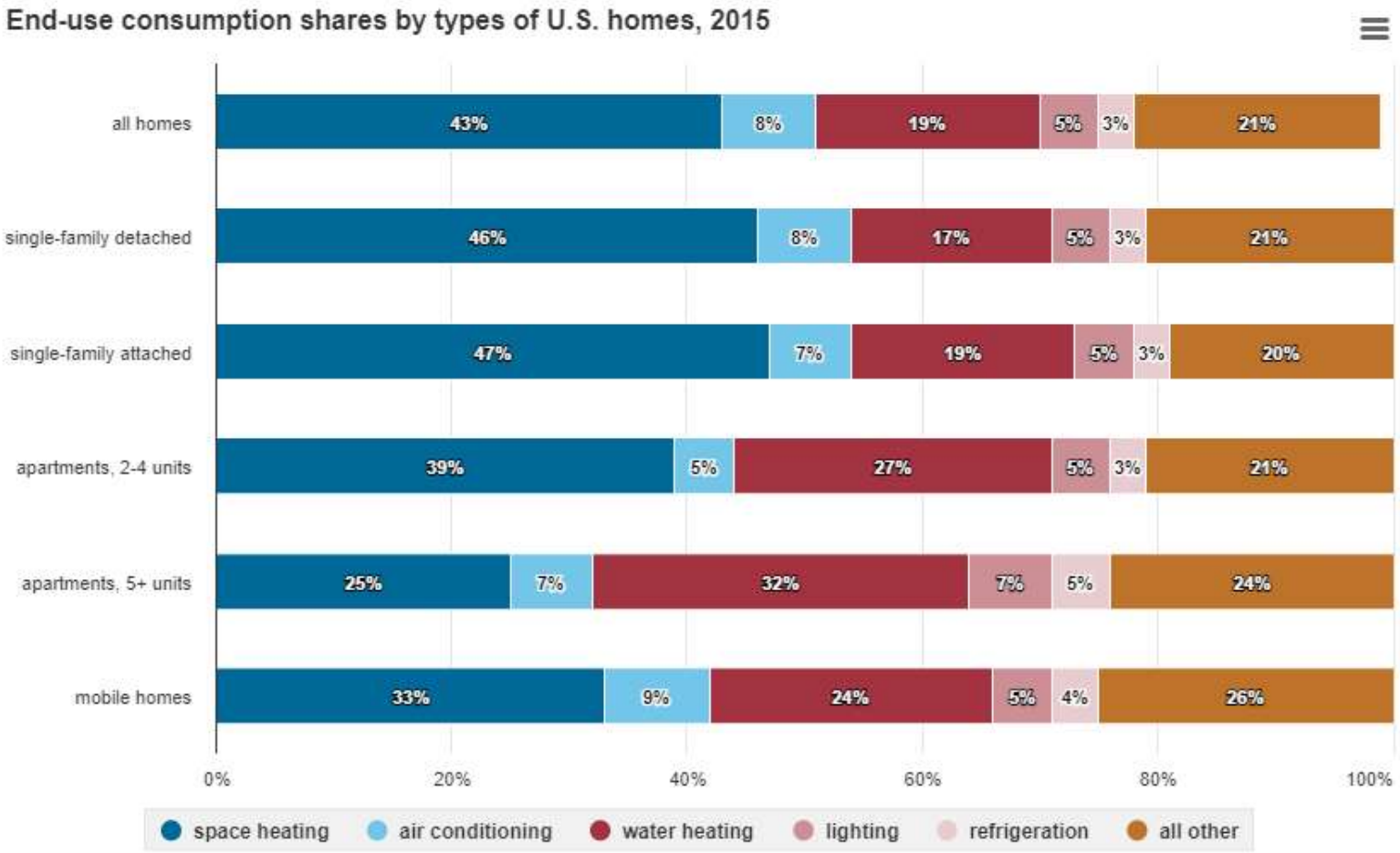
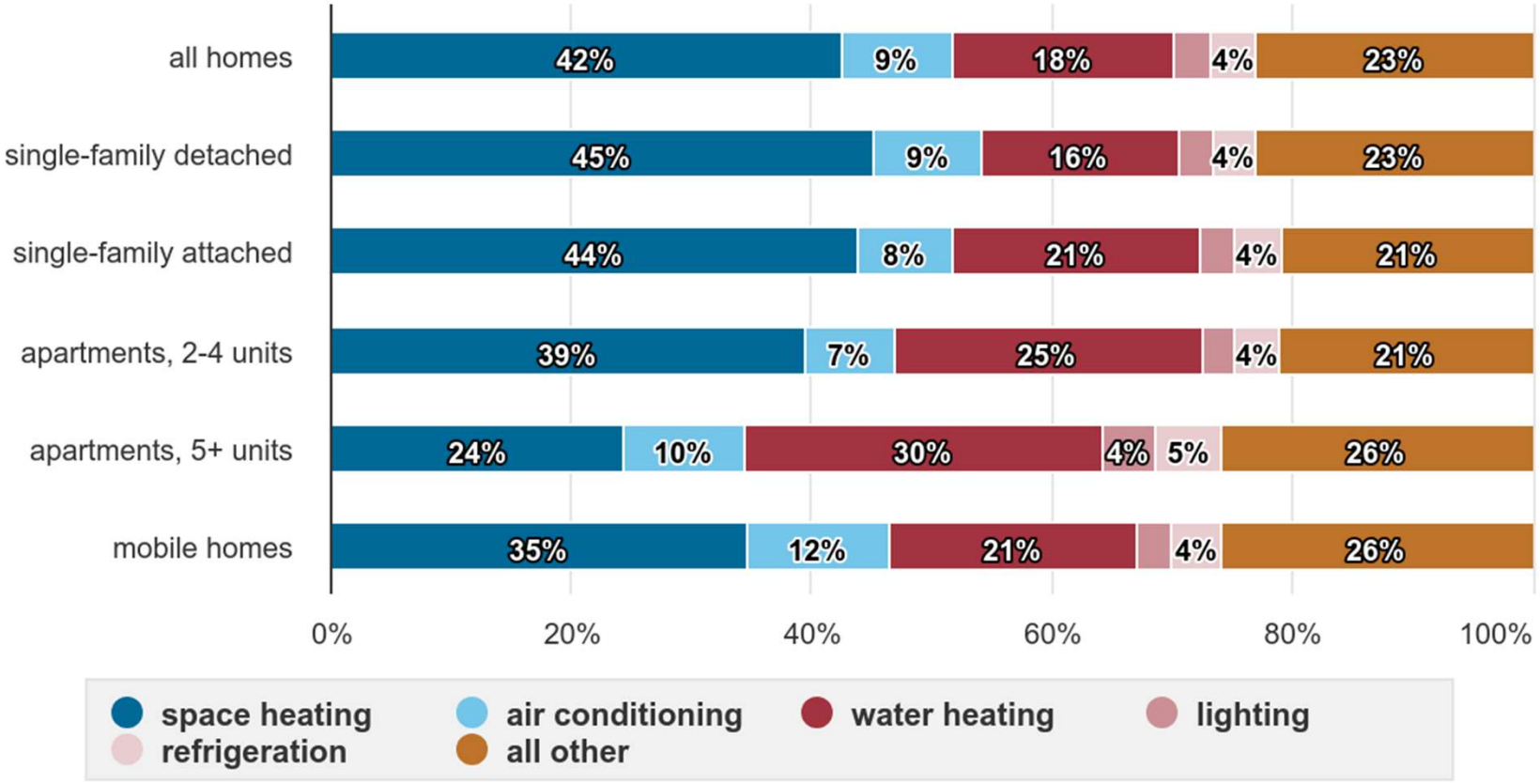


Note: Shares are a percentage of annual site energy consumption. Site energy consumption excludes the losses in electricity generation and delivery.
Source: U.S. Energy Information Administration, *2015 Residential Energy Consumption Survey*

End-use consumption shares by type of U.S. home, 2020



Data source: U.S. Energy Information Administration, *2020 Residential Energy Consumption Survey*
Note: Shares are a percentage of annual site energy consumption. Site energy consumption excludes the losses in electricity generation and delivery.

INNOVATIVE HIGH-PERFORMANCE TECHNOLOGY OPTIONS

We will cover these technologies:

- Lighting
- Heat Pumps
  - Air Source
  - Ground Source
- Heat Pump Water Heaters
- Heat Pump Dryers
- Home Battery
- Induction Cooking Equipment
- Home Monitoring And Controls

STARTING EASY

- Lighting the home
- Incandescent
  - Cheaper
  - Use more electricity
  - Short life
  - Not as bright
- LED
  - Cost more (minimal)
  - Use less electricity
  - Long life
  - Brighter
  - Changeable color

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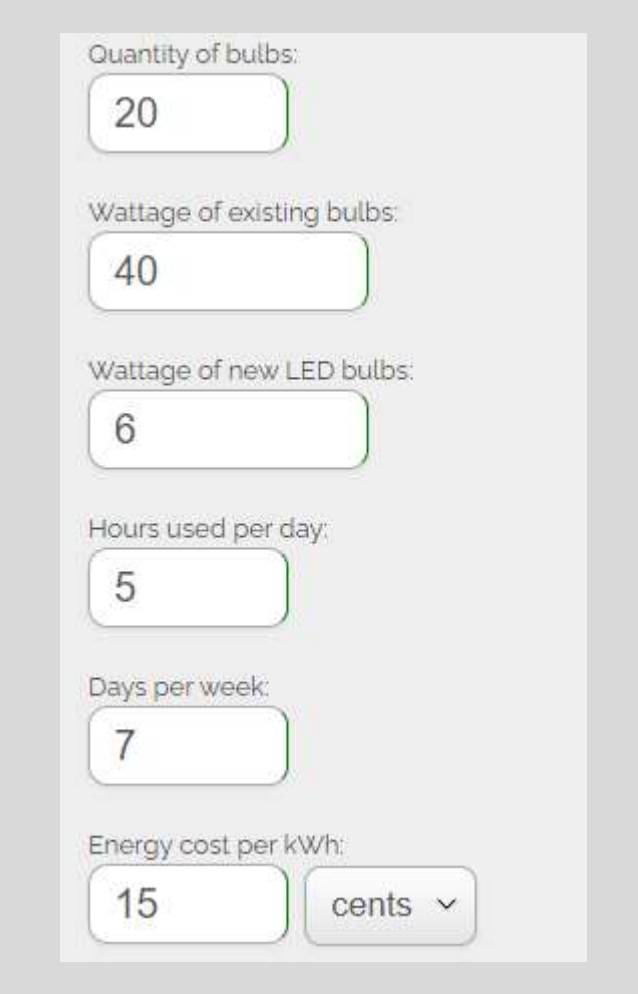
LED SAVINGS CALCULATOR



Comparison of electricity costs and CO2 emissions for standard non-LED light bulbs and LED bulbs.

	Year 1	Year 2	Year 3	Year 5	Year 10
Non-LED energy use:	1456 kWh	2912 kWh	4368 kWh	7280 kWh	14560 kWh
LED energy use:	218 kWh	437 kWh	655 kWh	1092 kWh	2184 kWh
Non-LED CO2 emissions:	789 kg	1578 kg	2367 kg	3946 kg	7892 kg
LED CO2 emissions:	118 kg	237 kg	355 kg	592 kg	1184 kg
CO2 saving:	671 kg	1342 kg	2012 kg	3354 kg	6708 kg
Non-LED energy cost:	$218.40	$436.80	$655.20	$1092.00	$2184.00
LED energy cost:	$32.76	$65.52	$98.28	$163.80	$327.60
$ Saving:	$185.64	$371.28	$556.92	$928.20	$1856.40

https://www.thecalculatorsite.com/energy/led-savings-calculator.php

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AIR SOURCE HEAT PUMPS

- CCASHP operate economically down to 5°F or below.
- Provide efficient heating and cooling
- Can deliver one-and-a-half to three times more heat energy to a home than the electrical energy it consumes
- Offers a legitimate space heating alternative in colder regions

Types:

Ductless or Ducted

Split or Packaged

Multi Zone or Single Zone

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GROUND SOURCE HEAT PUMPS

- Provide very efficient heating and cooling
- Can deliver up to six times more heat energy to a home than the electrical energy it consumes
- Offers a legitimate space heating alternative in colder regions
- Reduce energy cost
- Financing as low as $140 a month

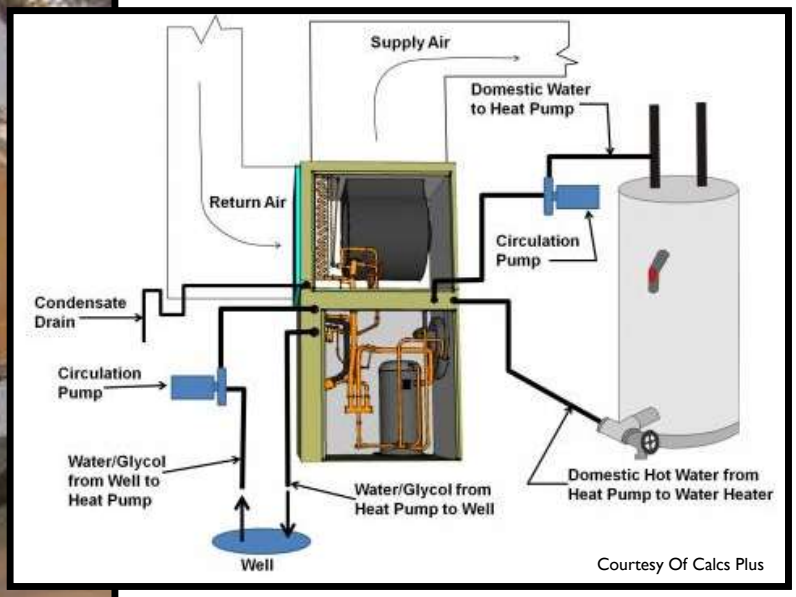
Types:

Vertical wells

Horizontal loops

Pond loops

Courtesy Of Greenhill Contracting



Courtesy Of Calcs Plus

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TECHNOLOGY COMPARISON

Technology	ASHP	GSHP
Cost	Less expensive	More expensive
Efficiency	Less efficient	More efficient
Incentives	Yes	Yes
Lifespan	Shorter	Longer
Space Requirements	Less space required	More space required

Both systems can be paired with solar energy…

Incentives: https://programs.dsireusa.org/system/program

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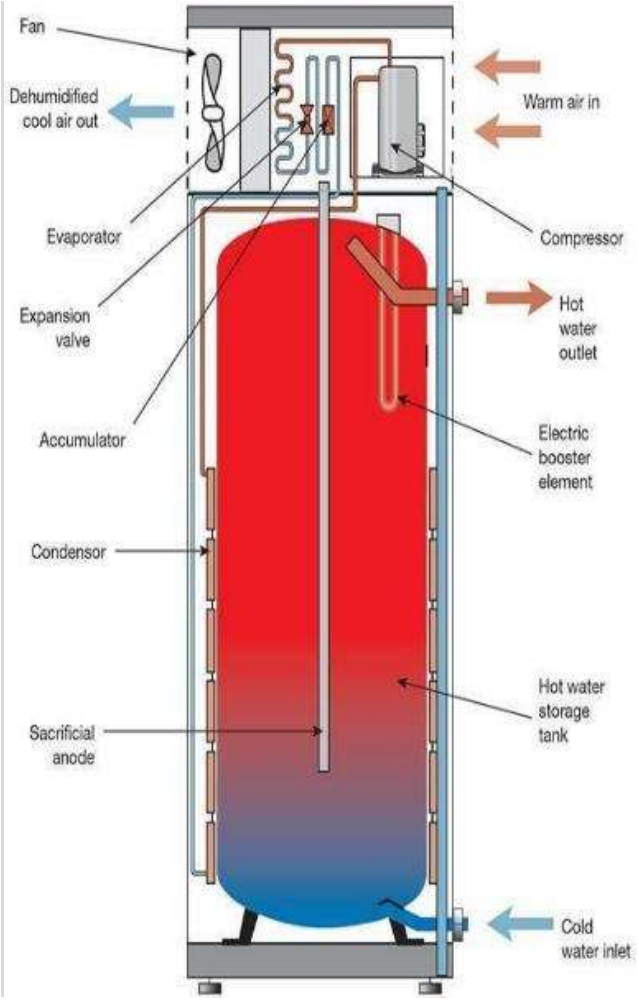

HEAT PUMP WATER HEATERS

- two to three times more energy efficient than conventional electric resistance water heaters
- air-source heat pump systems can combine heating, cooling, and water heating.
- higher initial costs than conventional storage water heaters but lower operating cost.
- the one on the left has solar assist tied in with it.
- 240v and 120v
- 7.5 million water heaters replaced annually
- 85% of water heaters are emergency replacements

GEOTHERMAL AND WATER HEATING

- Desuperheater: takes waste heat from the compressor of the geothermal system.
- Electric water heater or ASHP water heater makes up the difference.
- Example:
  - Water entering home is 40°F
  - Desuperheater warms water to 85-90°F
  - Primary water heater rises temperature to 125°F

SOLAR WATER HEATER

- Strong solar resource at the site
- Will need a backup system for cloudy days or high demand
- Direct circulation systems
  - Household water pass through collectors, best used in warm climates
- Indirect circulation systems
  - Pumps circulate a heat transfer liquid through the collectors to heat the water in the home

DISTRIBUTION OF WATER IN THE HOME

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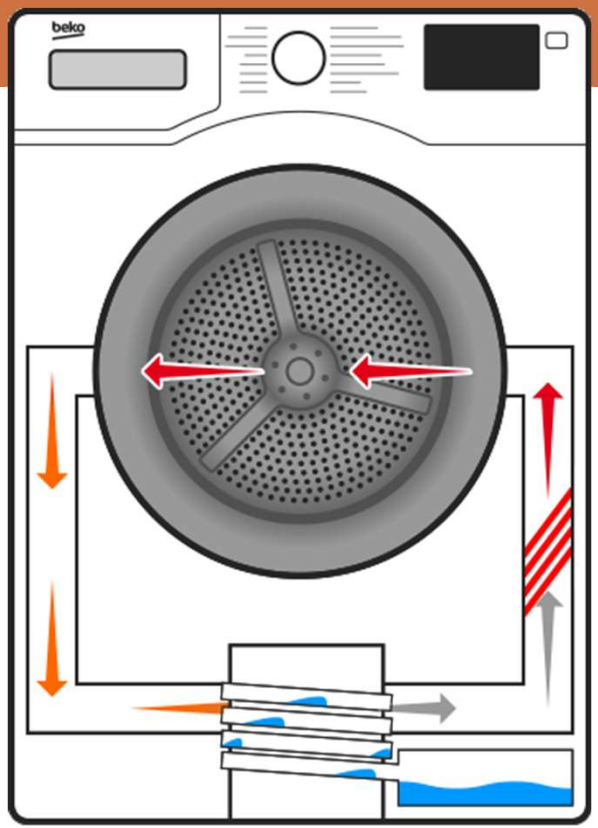
HEAT PUMP DRYERS

- A heat pump dryer passes hot air over your clothes to collect moisture and dry them. This same air then goes through an evaporator, where the moisture is condensed and collected in a water tank.
- Where other dryers simply blow hot air on your clothes, heat pump dryers use a more sophisticated energy-efficient heat exchange system to conserve and reuse the same air (think of it as recycling air).
- Super Efficient
- Cheaper to run
- Gentler on clothes



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HOME BATTERY

- Store electricity generated by solar panels
- Power used at night or during peak grid times
- Range in power from 3-14 kWh nut storage can increase by linking more batteries. Cost $2000-$12,000
- One System at 30 kWh retails for $36,000.
- Start small and add to the system over time
- Power used to charge electric cars
- Many home batteries systems have links to electric car manufacturers

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SPEAKING OF BATTERIES

- Vehicle-to home system
- storing solar electricity generated by a residential solar power generation (PV)
- Use power from an EV when demands peaks and rates are high.
- The EV can be charged overnight when rates are low.
- Home must disconnect from the grid completely
  - Power not used would go onto the grid
  - Power outages you don't want live lines leaving your house
- Nissan Leaf, Tesla, Audi

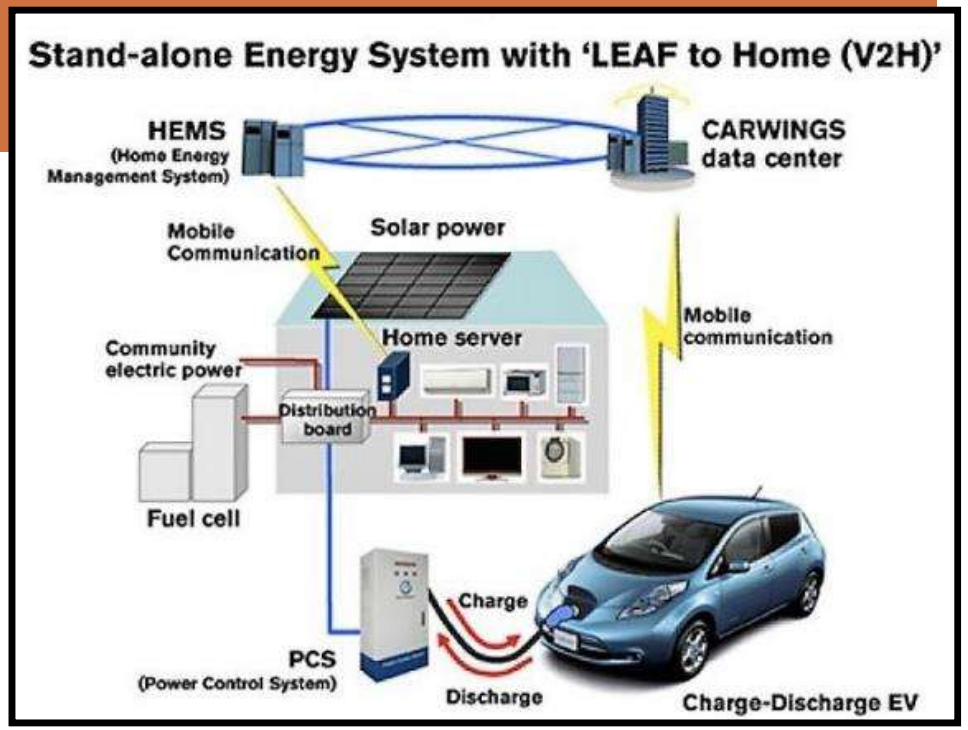

Image: Solar Solutions


https://www.greenbuilt.org/wpcontent/uploads/blog/inductionstovee1452609051118.jpg?x74149


www.friedmansideasandinnovations.com

INDUCTION COOKING EQUIPMENT

- Available for stoves and cooktops
- uses magnetic currents to directly heat your pots and pans
- quicker heat than electric and gas counterparts
- No lost energy to the air
- Only the cookware heats equaling energy and cost savings
- precise temperature control
- Need induction compatible cookware

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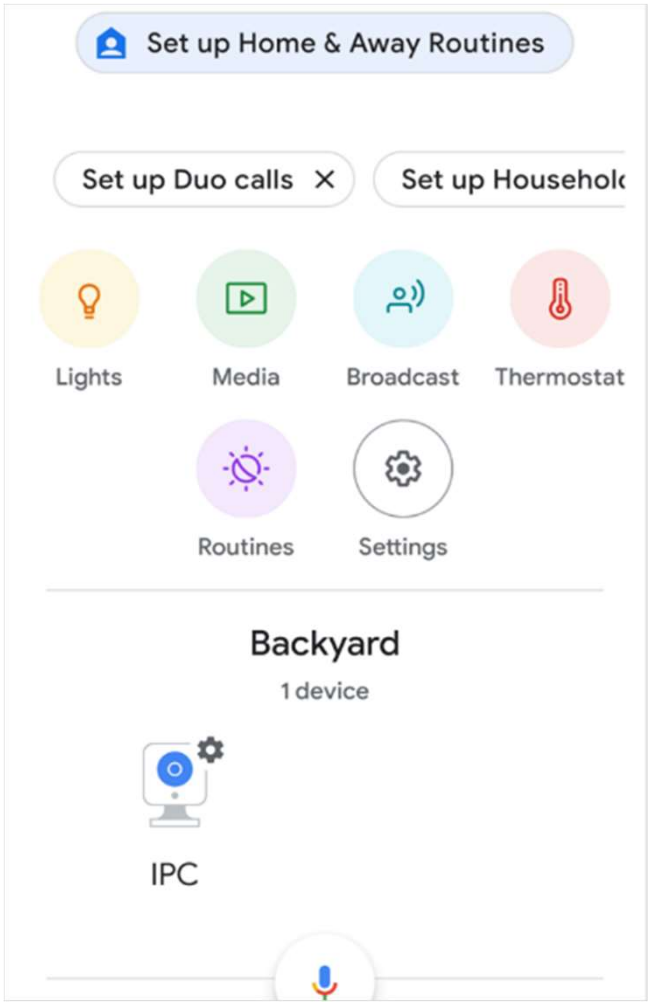
WHAT ABOUT A FIREPLACE

- Water Vapor Fireplace
  - LED lights
  - Water reservoir to produce fire effects
  - Look real, cool to the touch
  - Heat is an option (typically 400 square feet)

Source: https://electricfireplacesdepot.com/

HOME MONITORING AND CONTROLS

- Smart thermostats to smart phones they both offer capabilities to track and monitor energy consumption in the home.
- Tracking energy consumption in the home and turning off unused lights and appliances will reduce the electric load.
- Track what is on and when.
- Dim lights, reduce temperature setting and remotely turn on/off appliances and lighting.



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SMART ELECTRIC PANELS

- Control every circuit in your home
- See real time energy consumption
- Keep tabs on solar/battery charge
- Extend backup up time if home powered by batteries
- Prioritize circuits during power outages
- Can be used on any home with or without solar or batteries installed
- Connects via Wi-Fi, Cellular, Bluetooth, Ethernet

SUMMARY:
INNOVATIVE HIGH-PERFORMANCE TECHNOLOGY OPTIONS

- Off the shelf
- Rebates
- Energy Savings (compared to alternative fuel options)
- Energy Savings (compared to current standard electric equipment)
- Ability to remote monitor and control

ENVELOPE EFFICIENCY CONSIDERATIONS

We will cover these technologies:

- Air Sealing
- Insulation Levels
- Windows and Doors
- House Layout And Placement

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PATHS TO ENERGY EFFICIENT HOMES

Prescriptive Path

- Dictates how the thermal envelope of a home will be built.
- It requires the use of specific components the meet R-Values and U-Factors
- This approach must be followed with few alternative options

Performance Path

- Allows for alternative options to meet the Energy Code
- Gives builders flexibility with design and assemblies
- Allows for the homes systems to be included in the calculation of the homes performance
- Energy performance/consumption must meet or be better than a prescriptive complaint home

HIDDEN BEHIND/UNDER THE SURFACE

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HIDDEN BEHIND/UNDER THE SURFACE

- Plan Ahead
- Minimize Materials
- The R-Value through a typical 2x6 wood stud is 6.88
- What is a typical R-value of a 2x6 wall cavity?

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AIR SEALING

- Improved comfort
- Lower utility bills
- Improved indoor air quality
- Increased durability
- Manual J impacts

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INSULATION LEVELS

- Energy code sets minimal levels of insulation needed in homes based on Climate Zones.
- Higher R-values, the greater the performance of the insulation.
- Cavity and/or continuous insulation

Climate Zone	Ceiling R-Value	Wood Frame Wall R-Value
1	30	13 or 0 &10ci
2	49	13 or 0 &10ci
3	49	20 or 13&5ci or 0&15ci
4 except Marine	60	30 or 20&5ci or 13&10ci or 0&20ci
5 and Marine 4	60	30 or 20&5ci or 13&10ci or 0&20ci
6	60	30 or 20&5ci or 13&10ci or 0&20ci
7 and 8	60	30 or 20&5ci or 13&10ci or 0&20ci

WINDOWS AND DOORS

- Measured via U-factor

Climate Zone	Fenestration U-Factor	Glazed Fenestration SHGC
1	NR	0.25
2	0.40	0.25
3	0.32	0.25
4 except Marine	0.30	0.40
5 and Marine 4	0.30	0.40
6	0.30	NR
7 and 8	0.30	NR

HOUSE LAYOUT AND PLACEMENT

- Slab on grade home where do we put the systems?
- Homes with basements where do we put the systems?
- Systems:
  - Heating
  - Cooling
  - Water Heater
  - Laundry Room
  - Bathroom/Kitchens with respect to waterlines

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SUMMARY:
ENVELOPE EFFICIENCY CONSIDERATIONS

- All electric homes and apartments are here now
- Built tight with HRV/ERV ventilation
- At or Above code insulation levels
- Net Zero Ready, Net Zero and beyond

EVALUATE THE FEASIBILITY OF OPTIONS

We will cover these technologies:

- Current Practice
- Advanced Practice
- Cost Impacts
- The Future

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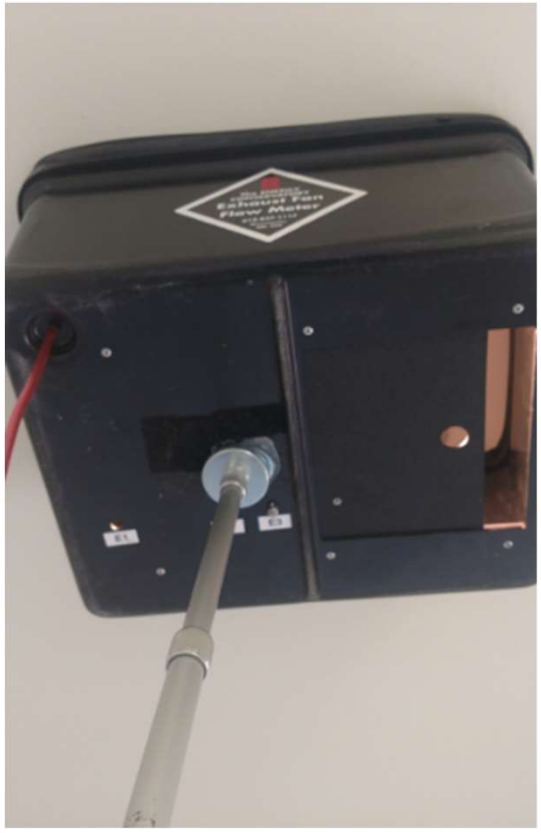
CURRENT PRACTICE

- Code minimum
  - Insulation Levels
- Minimal commissioning
  - Checking model numbers
- Accurate Manual J/S reports
  - Size of system



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ADVANCED PRACTICE

- Modeling homes for performance before built
- Air sealing measures
- Increased R-Value
  - In stick built
    - 2x4 with continuous
    - 2x6 with continuous
    - Double Stud
    - Others….
  - ICF's (R-23+ continuous)
  - SIPS
    - 4.5" panel (R-15 Continuous)
    - 12.25" panel (R-45 Continuous)
  - Others?
- Properly sized HVAC

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ACCURACY OF MANUAL J

System 1 Summary Loads

Component Description	Area Quan	Sen Loss	Lat Gain	Sen Gain	Total Gain
1D-cv-o: Glazing-Double pane, operable window, clear, vinyl frame, u-value 0.57, SHGC 0.56	254	10,133	0	15,112	15,112
11P: Door-Metal - Polyurethane Core	21	426	0	171	171
15A11-0fcw-6: Wall-Basement, , framing with R-11 sill to floor in 2 x 4 cavity, filled core, no board insulation, plus interior finish, wood studs, 6' floor depth	873	3,904	0	374	374
12E-0sw: Wall-Frame, R-19 insulation in 2 x 6 stud cavity, no board insulation, siding finish, wood studs	2078.7	9,896	0	2,743	2,743
16B-38: Roof/Ceiling-Under Attic with Insulation on Attic Floor (also use for Knee Walls and Partition Ceilings), Vented Attic, No Radiant Barrier, Dark Asphalt Shingles or Dark Metal, Tar and Gravel or Membrane, R-38 insulation	837.5	1,523	0	1,132	1,132
21A-20: Floor-Basement, Concrete slab, any thickness, 2 or more feet below grade, no insulation below floor, any floor cover, shortest side of floor slab is 20' wide	938	1,773	0	0	0
Subtotals for structure:		27,655	0	19,532	19,532
People:	6		1,200	1,380	2,580
Equipment:			0	1,200	1,200
Lighting:	0			0	0
Ductwork:		0	0	0	0
Infiltration: Winter CFM: 109, Summer CFM: 54		8,306	794	1,010	1,804
Ventilation: Winter CFM: 0, Summer CFM: 0		0	0	0	0
AED Excursion:		0	0	1,141	1,141
System 1 Load Totals:		35,961	1,994	24,263	26,257

Check Figures			
Supply CFM:	1,114	CFM Per Square ft.:	0.428
Square ft. of Room Area:	2,605	Square ft. Per Ton:	1,190
Volume (ft³) of Cond. Space:	24,399		

System Loads				
Total Heating Required Including Ventilation Air:	35,961	Btuh	35.961	MBH
Total Sensible Gain:	24,263	Btuh	92	%
Total Latent Gain:	1,994	Btuh	8	%
Total Cooling Required Including Ventilation Air:	26,257	Btuh	2.19	Tons (Based On Sensible + Latent)

	Manual J Report	Newport's Data
Design Date: Reference County	Albany	Saratoga
Construction Type	Semi-loose	Tight
Windows	U 0.56/ SHGC 0.66	U 0.23/ SHGC 0.27
Attic Insulation	R-38	R-44
Floor Insulation	R-19	Not applicable
Foundation Wall	Not shown	R-25
Window Area	84	154
AGW Area	396	2828
Square Footage	432	2400 (1200 FF and 1200 Basement)
Ceiling Area	432	1200

NP
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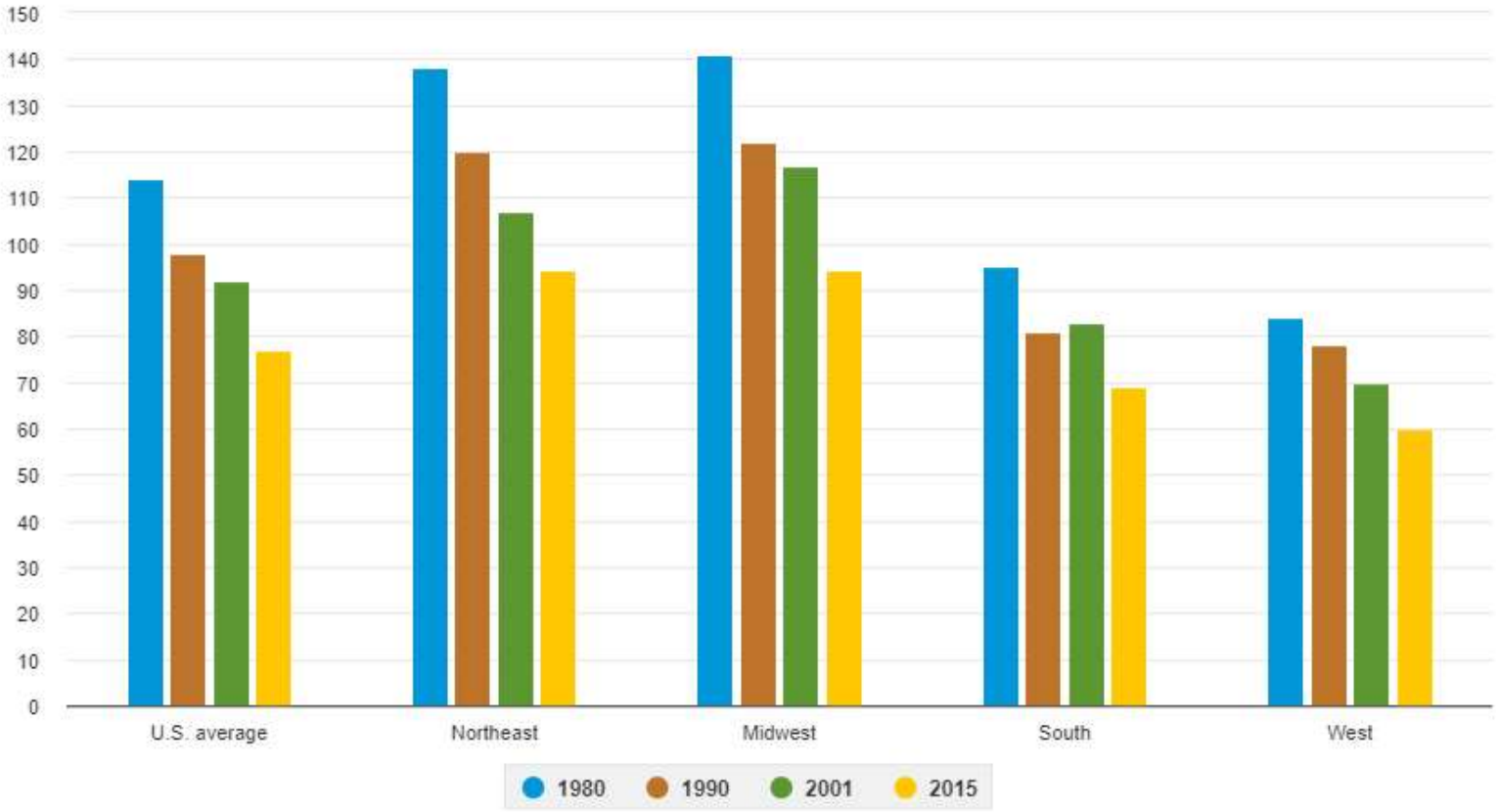
SUMMARY:
EVALUATE THE FEASIBILITY OF OPTIONS

- Modeling Software
- HERS Index
- Above Code Programs
- Happening Now

Energy consumption per household, U.S. average and by census region in selected years



Note: Excludes losses in electricity generation and delivery, and consumption of wood fuels.
Source: U.S. Energy Information Administration, *Residential Energy Consumption Survey* for indicated years

MEASURING HOMES ENERGY CONSUMPTION

We will cover these areas:

- Home Energy Rating System (HERS)
- Towards Net Zero
- Programs For Above Code Compliance

REM/Rate™

ekotrope

EnergyGauge®
Energy and Economic Analysis Software

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SOFTWARE MODELING

The ability to estimate the homes utility bills, energy consumption, performance and ventilation needs.

Analysis

Updated: 09:00:41 AM

WH Infiltration	
Natural ACH	0.11
ACH50 (Pa)	3.00
CFM50 (Pa)	2671
ELA (sq.in)	146.6
SLA	0.00027
CFM50/sf shell	0.22
WH Ventilation (continuous)	
Type	Balanced
Asls (equiv.cfm)	75
62.2-2010 (cfm)	52
62.2-2013 (cfm)	45

Analysis

Updated: 09:00:41 AM

HourlyHERS	
HourlyHERS Index	N/A
Seasonal Engine	
No ENERGY STAR	N/A
Tax Credit	Passes
DOE ZERH	Fails
HERS Index	9
2015 ERI	9
2018 ERI	9
Code	
IECC 2018 UA	Fails
IECC 2018 Performance	Fails
IECC 2018 ERI Path	Fails
IECC 2015 UA	Fails
IECC 2015 Performance	Fails
IECC 2015 ERI Path	Fails
IECC 2012	Fails
IECC 2009	Fails
IECC 2006	Fails
State Code	
Iowa Code	Fails
Michigan Code	Fails
Illinois 2018 Code	Fails
NY-ECCC 2020	Passes
North Carolina 2018 Code	Fails

Analysis

Updated: 09:00:41 AM

Design Loads (kBtu/hr)	
Heating	30.0
Cooling	20.2
Annual Loads (MMBtu/yr)	
Heating	47.8
Cooling	18.8
Water Heating	6.7
WH w/out Tank Loss	6.2
Annual Consumption (MMBtu/yr)	
Heating	13.0
Cooling	4.4
Water Heating	1.9
Lights and Appliances	25.4
Photovoltaics	-33.9
Total	10.7
Annual Energy Costs ($/yr)	
Heating	686
Cooling	229
Water Heating	99
Lights and Appliances	1338
Photovoltaics	-1789
Service Charge	60
Total	623

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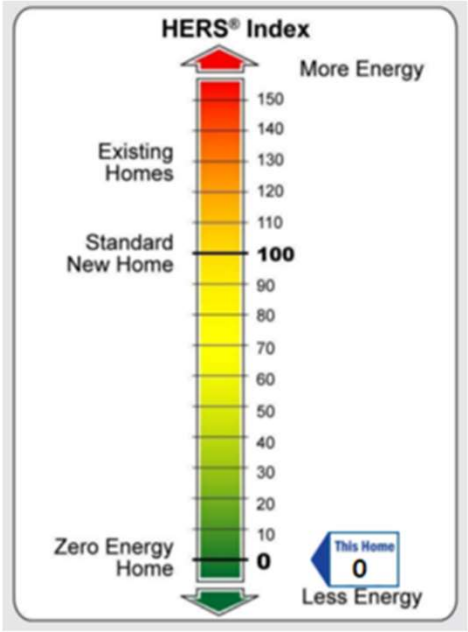
MEASURING PROGRESS TOWARDS ZERO

The Home Energy Rating System (HERS) Index:

- The more energy efficient a home is, the lower the HERS index score.
- Typical home circa 2006 = 100 points.
- Most new homes score below 100 points.
- Net Zero Energy home = 0 points.
- National and regional builders rate and market their homes using the HERS Index.
- 3+ million homes rated on the HERS Index.
  - 299,000+ HERS Rated homes in 2020 (new all time high)
  - 241,000 HERS Rated home in 2019 (former all time high)



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Three million HERS rated homes equals the reduction of carbon dioxide emissions by over 49 million tons (the equivalent of taking nearly 9.7 million passenger vehicles off the road for one year), has improved the health and comfort of more than 13 million residents, and saved homeowners over $8 billion in energy costs. - RESNET

GETTING THERE WITH SOFTWARE

- All exterior walls (above and below grade)
- Floors over unconditioned spaces (like garages or basements)
- Ceilings and roofs
- Attics, foundations and crawlspaces
- Windows and doors
- Vents and ductwork (leakage)
- Air leakage of the home
- Mechanical ventilation
- **Appliances**
- **HVAC system**
- **Water heating system**

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EARLY MODELING HELPS WITH DECISIONS…

Early Modeling				
HERS Index	40	41	38	39
Annual Energy Cost	$2,009	$2,057	$1,917	$1,959
Electric $/kWH	0.14	0.14	0.14	0.14
ENERGY STAR V 3.1	YES	YES	YES	YES
Assumptions:				
Ceiling R-Value	60	60	60	60
Walls R-Value				
Cavity	30	30	30	30
Continuous	10	0	10	0
Rim/Band Joist	30/10	30	30/10	30
Foundation Walls	23	23	23	23
Windows				
U Value	0.29	0.29	0.29	0.29
SHGC	0.4	0.4	0.4	0.4
Blower Door ACH	3	3	1.5	1.5
Ligthing LED	100%	100%	100%	100%
Mechanical Ventilation				
HRV	60%	60%	60%	60%

AND EVEN MORE MODELING…

Net Zero Goal	Per Plans	Per Plans w/Solar	Option A 1.5 ACH	Option B 0.6 ACH	No Continuous	No Continuous 1.5 ACH	No Continuous	No Continuous 1.5 ACH	2x6 Walls 3 ACH	2x6 Walls 1.5 ACH	2x6 Walls 3 ACH	2x6 Walls 1.5 ACH	Goal
HERS Index	39	6	5	5	40	39	6	6	41	40	7	7	0
Annual Energy Cost	$1,991	$336	$252	$205	$2,033	$1,947	$368	$282	2091	$2,002	$427	$338	$33
Electric $/kWH	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14
ENERGY STAR V 3.1 Tier 3	YES	YES	YES	YES	YES	YES	YES	YES	NO	YES	YES	YES	YES
Assumptions:													
Ceiling R-Value	60	60	60	60	60	60	60	60	49	49	49	49	58
Walls R-Value													
Cavity	30	30	30	30	30	30	30	30	21	21	21	21	30
Continuous	10	10	10	10	0	0	0	0	0	0	0	0	10
Rim/Band Joist	30/10	30/10	30/10	30/10	30	30	30	30	21	21	21	21	30/10
Foundation Walls	23	23	23	23	23	23	23	23	19	19	19	19	23
Windows													
U Value	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.27
SHGC	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.27
Blower Door ACH	3	3	1.5	0.6	3	1.5	3	1.5	3	1.5	3	1.5	0.48
Ligthing LED	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Mechanical Ventilation													
HRV	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	62%
Solar Array													
Orientation	x	South	South	South	x	x	South	South	x	x	South	South	South
Array Area (sq. ft.)	x	586	586	586	x	x	586	586	x	x	586	586	586
Array Peak Power (Watts)	x	9440	9440	9440	x	x	9440	9440	x	x	9440	9440	9440
Array Tilt (degrees)	x	30	30	30	x	x	30	30	x	x	30	30	30
Inverter Efficiency	x	95%	95%	95%	x	x	95%	95%	x	x	95%	95%	95%

THE ENERGY EFFICIENT HOME

- Building Envelope Priorities:
  - Insulation quantity
  - Insulation quality
  - Air Sealing/Built Tight
  - Window Performance
  - House Orientation

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DOE ZERO ENERGY READY HOMES

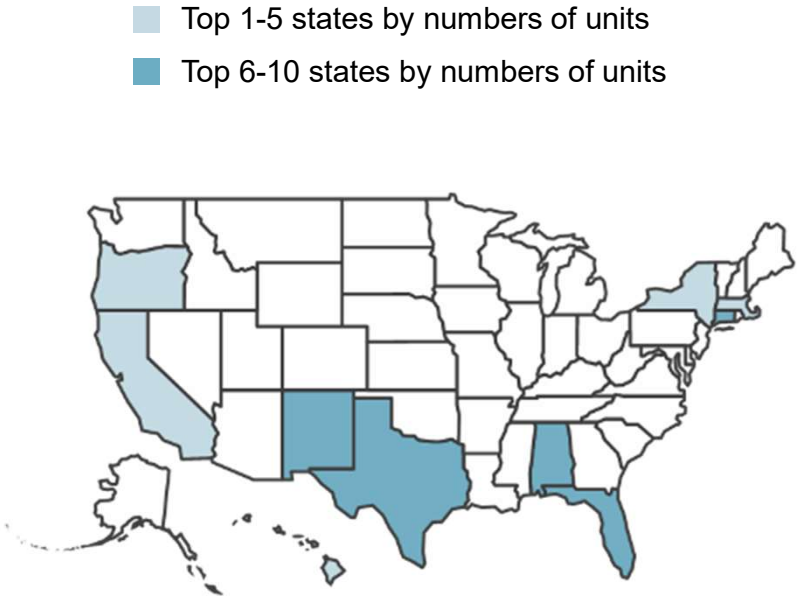
- A high-performance home, so energy efficient, all or most annual energy consumption can be offset by renewable energy.
- Efficiency Threshold:
  - HERS in 50s generally.
  - Project specific.
- Performance Provisions:
  - IAQ.
  - Comfort.
  - Moisture management.
  - PV-Ready.

OTHER ABOVE CODE OPTIONS

ZNE PROJECT LOCATIONS

ZNE Units by State:

- California #1 state by number of units AND builders.
- Massachusetts #2 state by number of units.
- Vermont highest number of homes per capita.
- New York 4th by number of units, 3rd by builders.



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THE FUTURE

- All Electric Homes
  - Smart House options
  - Remote and real time energy usage
  - Smaller size vs large size

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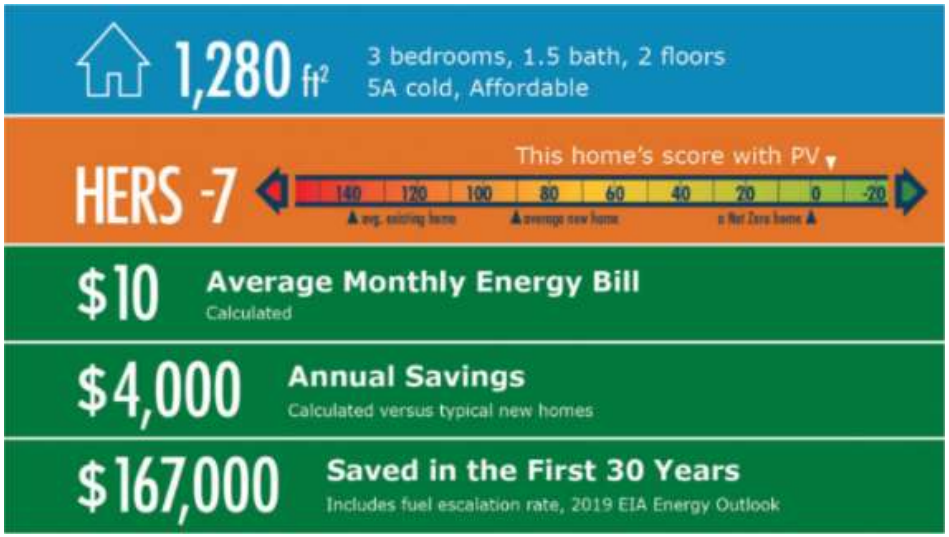
ITS ALREADY BEING DONE



- Habitat Home is Zero Energy
- https://youtu.be/nzHCtTjmcUo

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ALL ELECTRIC HOME

ZERO ENERGY READY HOME
U.S. DEPARTMENT OF ENERGY

Under the Sun Building and Remodeling

Easton Carriage House | Schaghicoke, NY | UndertheSunBuildgreen.com

U.S. DOE ZERO ENERGY READY HOME 2022 WINNER Housing Innovation Awards

Photos courtesy of Under the Sun Building and Remodeling

KEY FEATURES

- Walls: Double wall, R-53 total. Two 2x4 walls, 24" o.c., set 5.5" apart. Cavity filled with
- R-15+R-23+R-15 mineral wool batts. Coated OSB, 7⁄16" furring strips. Vinyl siding.
- Roof: Gable truss roof: 5⁄8" coated OSB sheathing, self-adhered membrane at eaves and valleys, #30 felt; architectural shingles. Ridge vent and vented cupola at peak.
- Attic: Vented attic: 1⁄2" foil-faced polyisocyanurate foam board vents (R-3.2) and 1-1⁄2" x
- 1-1⁄2" furring as spacer, 20" R-70 blown-in cellulose above ceiling/plenum.
- Foundation: Slab on grade: frost-protected shallow slab sits on 12" compacted gravel, topped by 15-mil vapor/radon barrier, and 8" (R-38.4) Type IX EPS under slab and at slab edge, plus 24" tapered wing extending out from base of slab.
- Windows: Triple-pane; argon-filled; low-e; vinyl-framed; U=0.13; SHGC=0.22.
- Air Sealing: 0.69 ACH50. All openings taped; air-tight electric boxes.
- Ventilation: Two ERVs with MERV. 13 filters, boost settings; ultraviolet air cleaner.
- HVAC: Mini-split heat pump, 14 HSPF, 33 SEER, 1 indoor/1 outdoor unit. Five 1,000-W electric wall heaters for bedrooms, baths, garage; ERV has heat and cool modes.
- Hot Water: Heat pump, 45-gal, 3.75 UEF, Wi-Fi controlled.
- Lighting: 100% LED lighting with motion sensors and timers.
- Appliances: ENERGY STAR refrigerator, dishwasher, clothes washer, clothes dryer.
- Solar: 25-kW system on farm property.
- Water Conservation: Whole house is EPA WaterSense certified.
- Energy Management System: ERV app monitors IAQ.
- Other: Low/no VOC paints and finishes, recycled-content insulation, flooring, decking.

PROJECT DATA

- Layout: 2 bdrm, 2 bath, 1 fl, 1,156 ft2
- Climate: IECC 5A, cold
- Completed: December 2021
- MODELED PERFORMANCE DATA
- HERS Index: without PV 31
- Annual Energy Costs: without PV $850
- Annual Energy Cost Savings: (vs
- typical new homes) without PV $1,550
- Annual Energy Savings: without PV 8,750 kWh
- Savings in the First 30 Years: without PV $63,550

EXISTING HOMES

- What can be done to existing homes?
- Start by doing an Energy Audit and analyzing the home with energy software.

Try Solar Calculator

www.energysage.com/solar/community-calculator/

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ENERGY EFFICIENCY FOR NEW AND CURRENT HOMES

- New mortgage products can finance energy efficiency in mortgage loans
- For example the "GreenCHOICE" mortgage by Freddie Mac
- This is a way to finance energy-efficient homes and upgrades of existing homes
- Covers up to 15% of the home's appraised value
- Improvements over $6,500 will require an energy report that can be completed by a certified HERS Rater
- A HERS rating has the option of producing the energy-efficient mortgage report.

2023 ENERGY EFFICIENCY STANDARDS FOR AIR CONDITIONERS AND HEAT PUMPS

SEER Requirements		
Region	2015	2023
North	13	14
South & Southwest	14	15

- New (and more efficient) standards for residential HPs and AC units.
- The test method and rating metric have changed.
- Efficiency standard has been raised for several equipment types including residential split system HPs and Acs.
- Resource: https://www.ahrinet.org/2023-energy-efficiency-standards

	Old Metrics (Appendix M)	New Metrics (Appendix M1)
Full-load Cooling Efficiency	SEER	SEER2
Part-load Cooling Efficiency	EER	EER2
Heating Efficiency	HSPF	HSPF2

CLOSING THOUGHTS

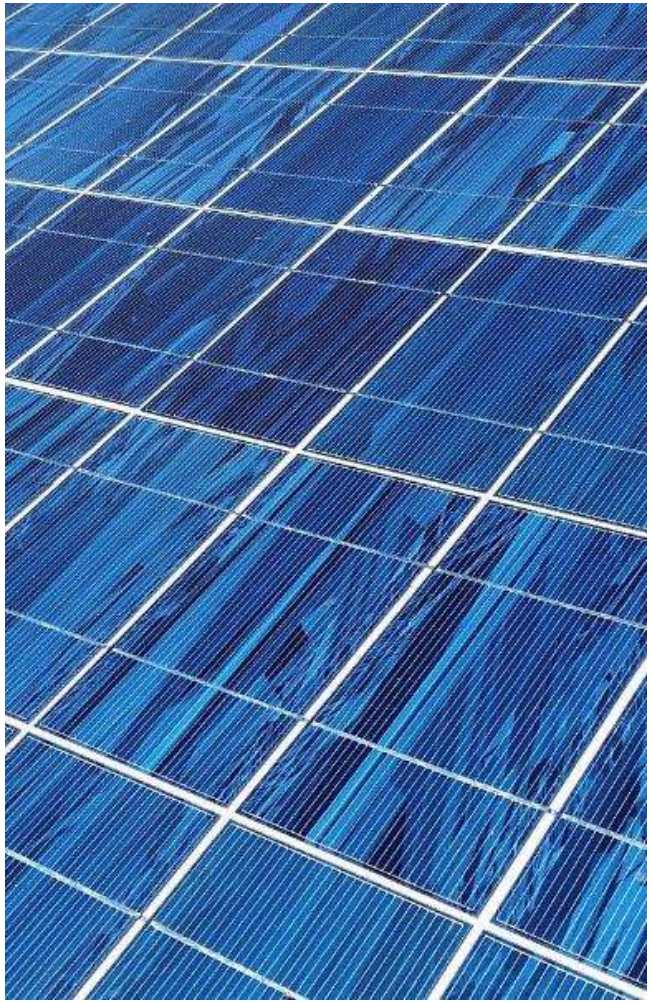
- Hundreds of cities and corporations are on the path to zero carbon emissions. For most, to achieve this ambition, the best path is to generate all energy with renewable electricity, then electrify all buildings and transportation.

- At present, only one out of every four U.S. homes is all-electric. Most use natural gas for heating water, heating the air and cooking. Some also use gas for washing and drying clothes and dishes. Natural gas is typically 85 percent methane, a super pollutant that traps 100 times the heat of CO2 over its 16-year life in the atmosphere. Much new natural gas used in buildings comes from fracking, increasingly associated with polluting local watersheds.

- Unless all homes and buildings are heated with renewable electricity, instead of natural gas, we will fail to fully decarbonize. The good news is there is an increase in all-electric building at the same time as there is a price decrease for renewables, heat pumps and energy efficient technology and materials.

QUESTIONS?

- Innovative high-performance technology options
- Envelope efficiency considerations
- Evaluate the feasibility of options



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RESOURCES

Building America Solution Center

Zero Energy Ready Homes

Net Zero Homes

Newport Partners www.newportpartnersllc.com

Newport Ventures www.newportventures.net

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THANK YOU!

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or email PassiveHouseTrainingCT@icf.com