Encore Learning Presents

Save Money While Combating Climate Change: Sustainable Energy Solutions for Every Household

Presentation 2 of 3

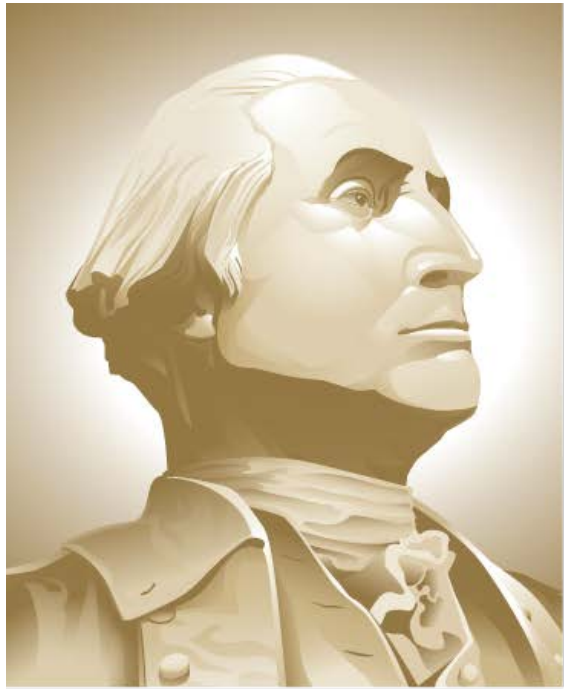
Presenter: Scott Sklar

June 1, 2020

The Stella Group, Ltd.

The Stella Group, Ltd.. is a strategic technology optimization and policy firm for clean distributed energy users and companies which include advanced batteries and controls, energy efficiency, fuel cells, geoexchange, heat engines, microhydropower (including tidal and wave), modular biomass, photovoltaics, small wind, and solar thermal (including CSP, daylighting, water heating, industrial preheat, building air-conditioning, and electric power generation). Scott Sklar serves on the national Boards of Directors of the non-profit Business Council for Sustainable Energy and The Solar Foundation. He teaches three unique interdisciplinary sustainable energy courses at The George Washington University (GWU) and serves as Energy Director of GWU's Environment & Energy Study Institute (EEMI). Scott Sklar was awarded the prestigious The Charles Greely Abbot Award by the American Solar Energy Society (ASES) and on April 26, 2014 was awarded the Green Patriot Award by George Mason University in Virginia. He was appointed to the US Department of Commerce (DOC) Renewable Energy & Energy Efficiency Advisory Committee (RE&EEAC), term ending 2020.

The Stella Group, Ltd. 703-522-1195 www.TheStellaGroupLtd.com solarsklar@aol.com



THE GEORGE WASHINGTON UNIVERSITY

WASHINGTON, DC

Adj Prof Scott Sklar
Energy Director
Environment & Energy Management Institute (EEMI)
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The George Washington University (GWU)
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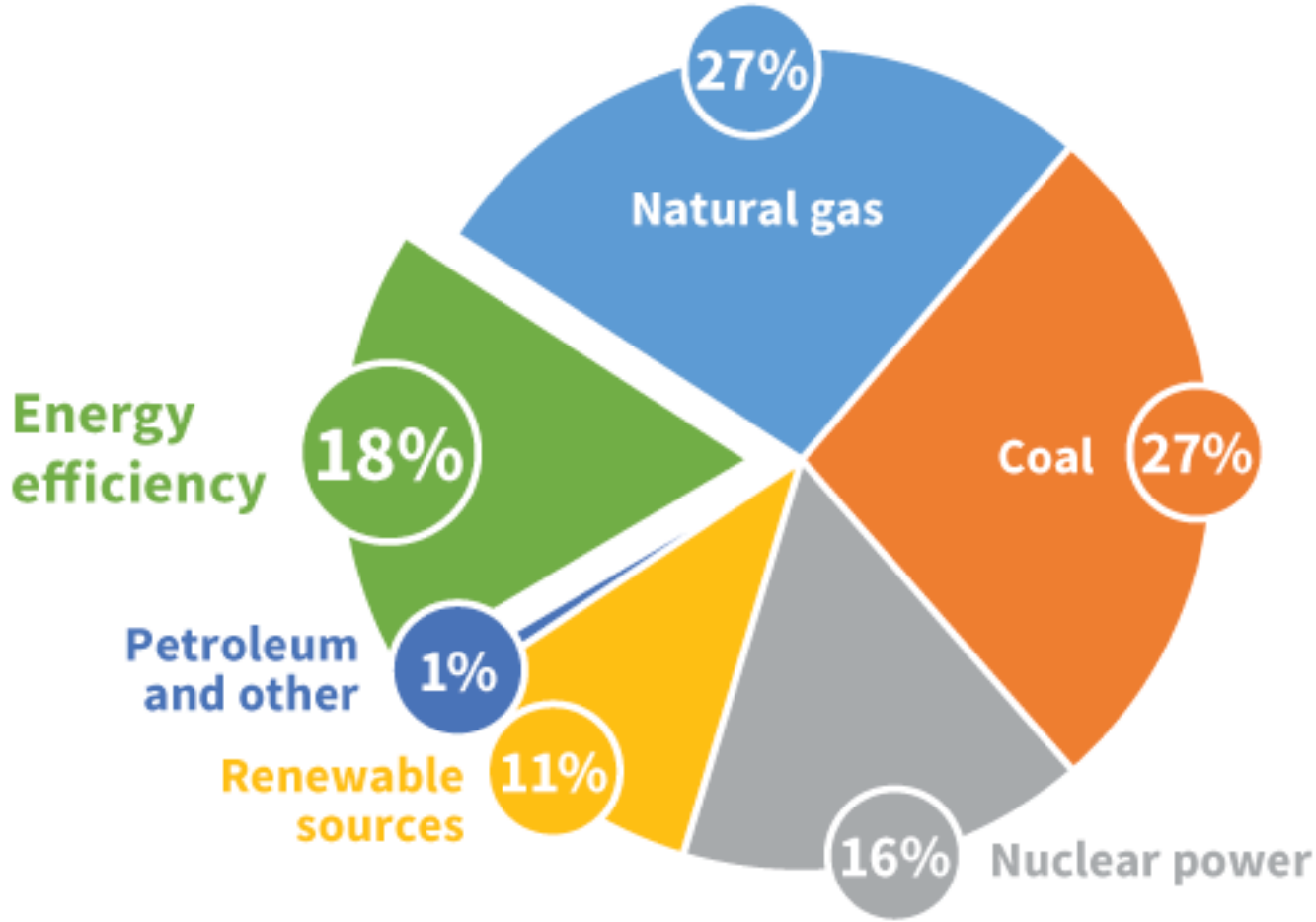
Share of US electricity generation by resource in 2015

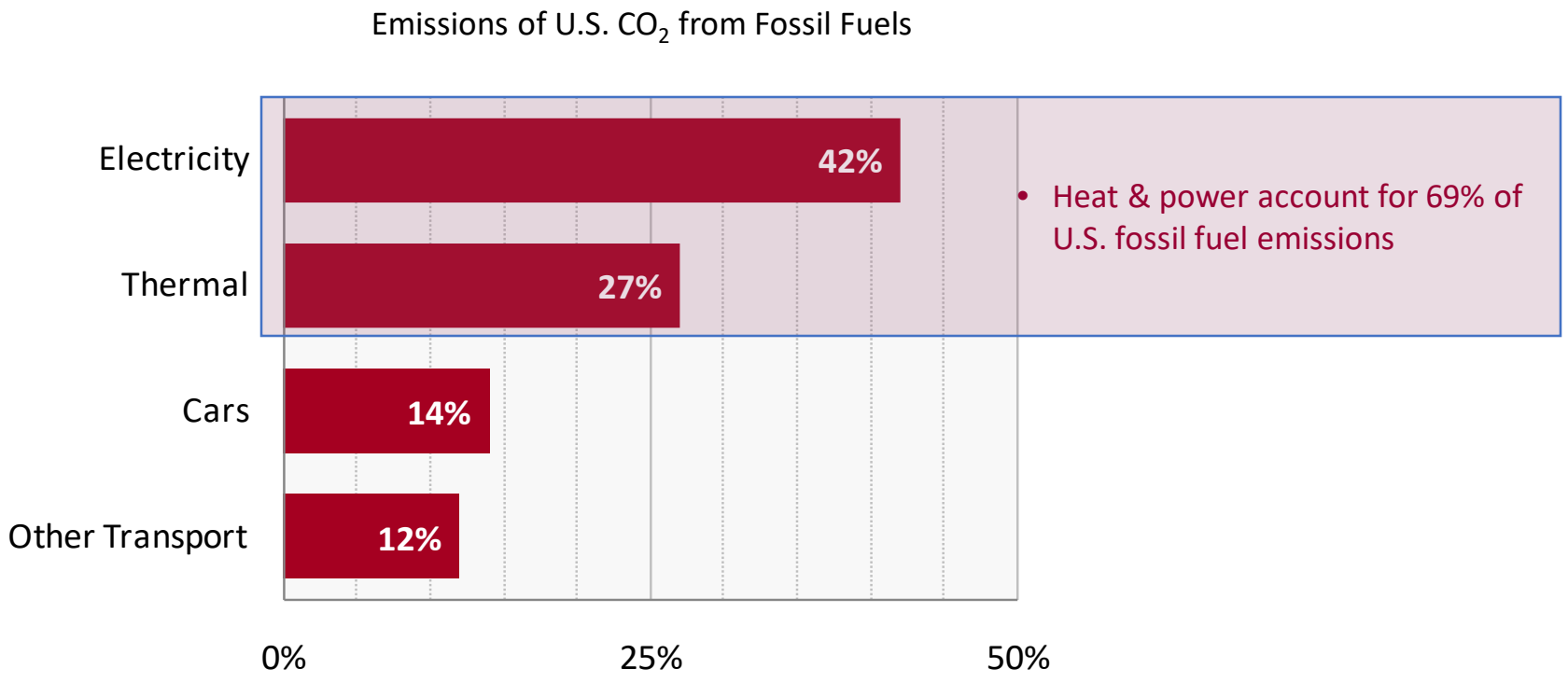


Source: EIA for all except energy efficiency, which is based on ACEEE estimates. EIA data source is May 2016 Monthly Energy Review, Table 7.2a Electricity Net Generation: Total (All Sectors).

ACEEE

http://www.ourenergypolicy.org/wp-content/uploads/2016/08/The-Greatest-Energy-Story.pdf

Heat and power generation responsible for two-thirds of U.S. CO_2



Source: RED calculations based on data from the U.S. Energy Information Agency and the U.S. Department of Transport

ACEEE Report Says Efficiency Could Halve U.S. Energy Usage by 2050:
Energy Manager Today, by Alyssa Danigelis, September 19, 2019

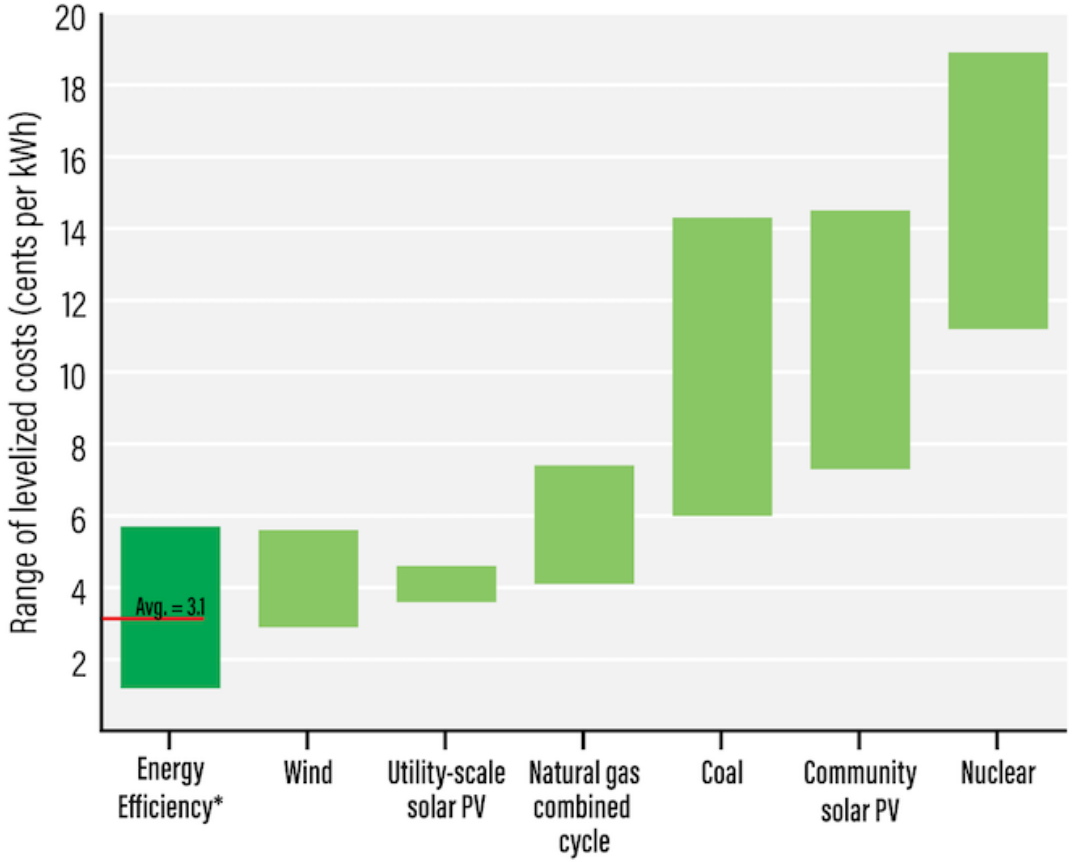
https://www.energymanagertoday.com/aceee-energy-efficiency-2050-0184387
and
https://aceee.org/press/2019/09/energy-efficiency-can-slash

A new report from the American Council for an Energy-Efficient Economy concludes that energy efficiency could cut US energy use and greenhouse gas emissions by 50% by 2050. The report, "Halfway There: Energy Efficiency Can Cut Energy Use and Greenhouse Gas Emissions in Half by 2050," builds on previous studies including ones from the International Energy Agency and the Natural Resources Defense Council. It identified 11 ambitious but cost-effective and technically possible measures that would avert emissions of nearly 2,500 million metric tons of heat-trapping carbon dioxide — equivalent to all emissions from cars, trucks, homes, and commercial buildings in 2050. For example, new homes and commercial buildings could cut their emissions by 70% with efficient design and use of cleaner electricity.

Berkeley Lab Turns Out Comprehensive Estimate of Efficiency Cost - and It's Cheap:
UtilityDive.com, by Robert Walton, July 7, 2018

https://www.utilitydive.com/news/berkeley-lab-turns-out-comprehensive-estimate-of-efficiency-cost-and-its/527263

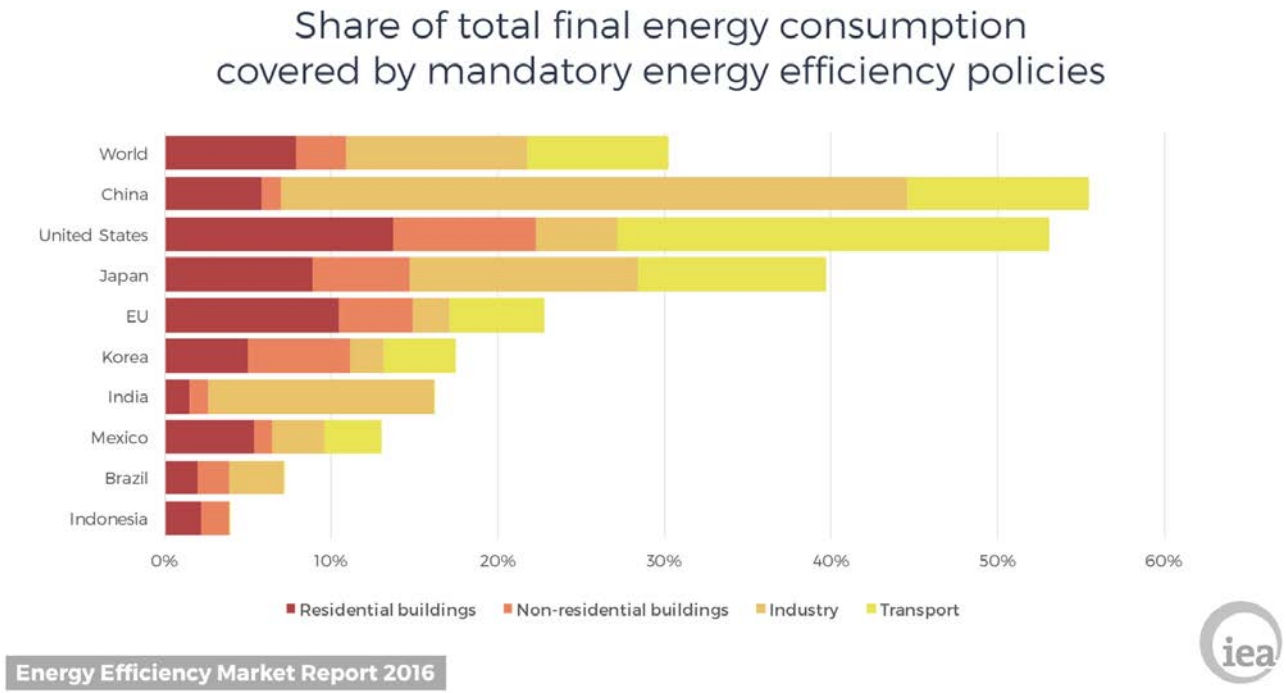
Research by the Lawrence Berkeley National Laboratory looked at efficiency programs funded by customers of investor-owned utilities. Some 30 states and the District of Columbia have adopted efficiency policies, including two dozen that adopted an energy efficiency resource standard. While the figure is highly variable, depending on geography and demographics, on average it costs $0.025 to save a kilowatt-hour of electricity. Costs were lower in the Midwest, where utilities have less experience with efficiency programs and more low-hanging fruit; in the Northeast, the cost reached $0.033/kWh, on average, because the region has several states with more developed efficiency programs.



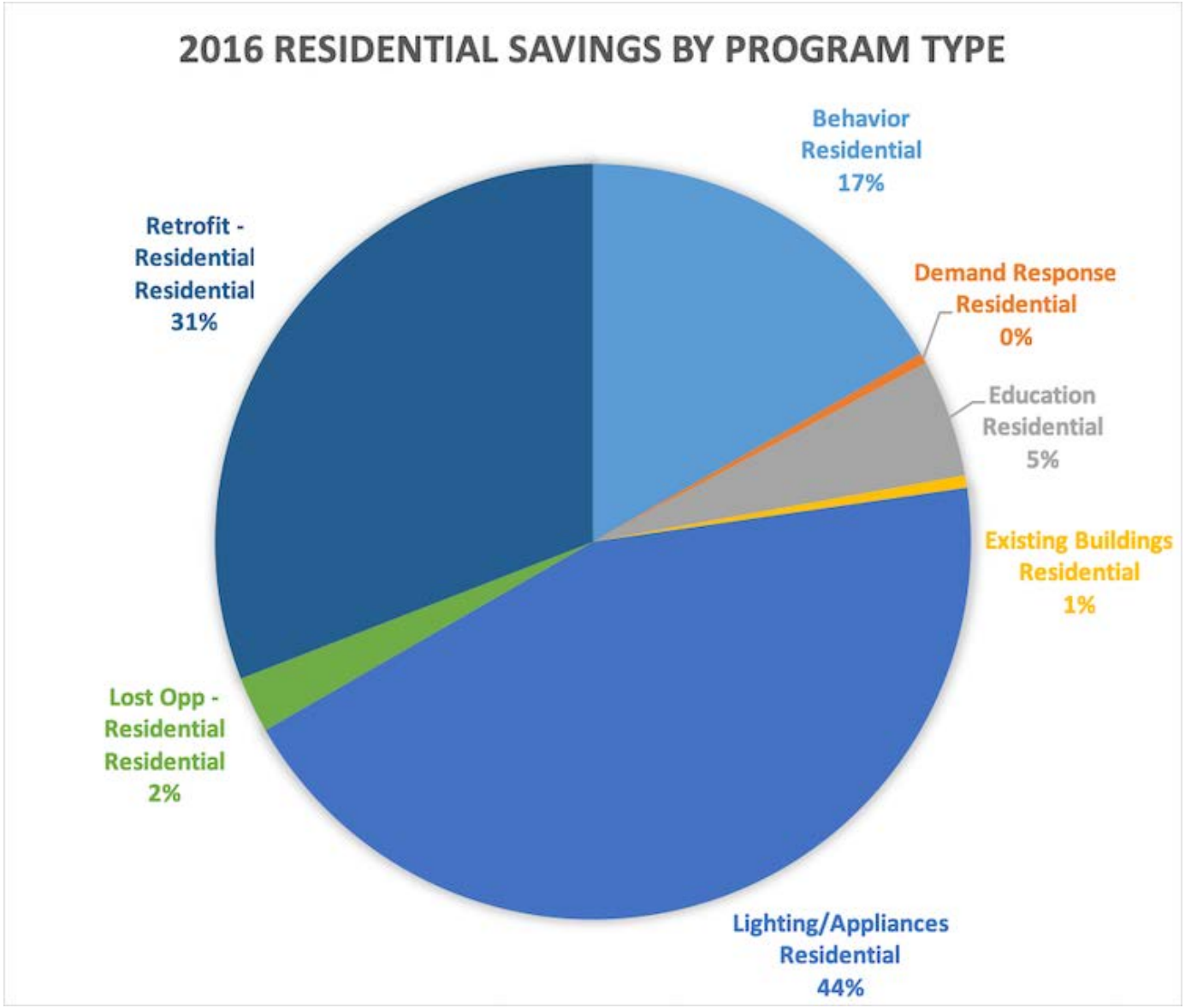
*Notes: Energy efficiency program portfolio data from Molina and Relf 2018. Represents costs to utilities or program administrators only, including shareholder performance incentives if applicable. All other data from Lazard 2018 Unsubsidized Levelized Cost of Energy Comparison.

ACEEE research published this summer shows that energy efficiency programs cost utilities, on average, about 3.1 cents per kilowatt-hour nationally. It examines program costs and performance incentives for the 49 largest US electricity utilities in the 2015 program year (the data do not include additional participant costs). Lawrence Berkeley National Laboratory (LBNL) has found similar results in an analysis of 2009-2015 program year data (with a few differences in approach). It has also examined the total cost of efficiency programs, including participant costs... 12/17/2018)

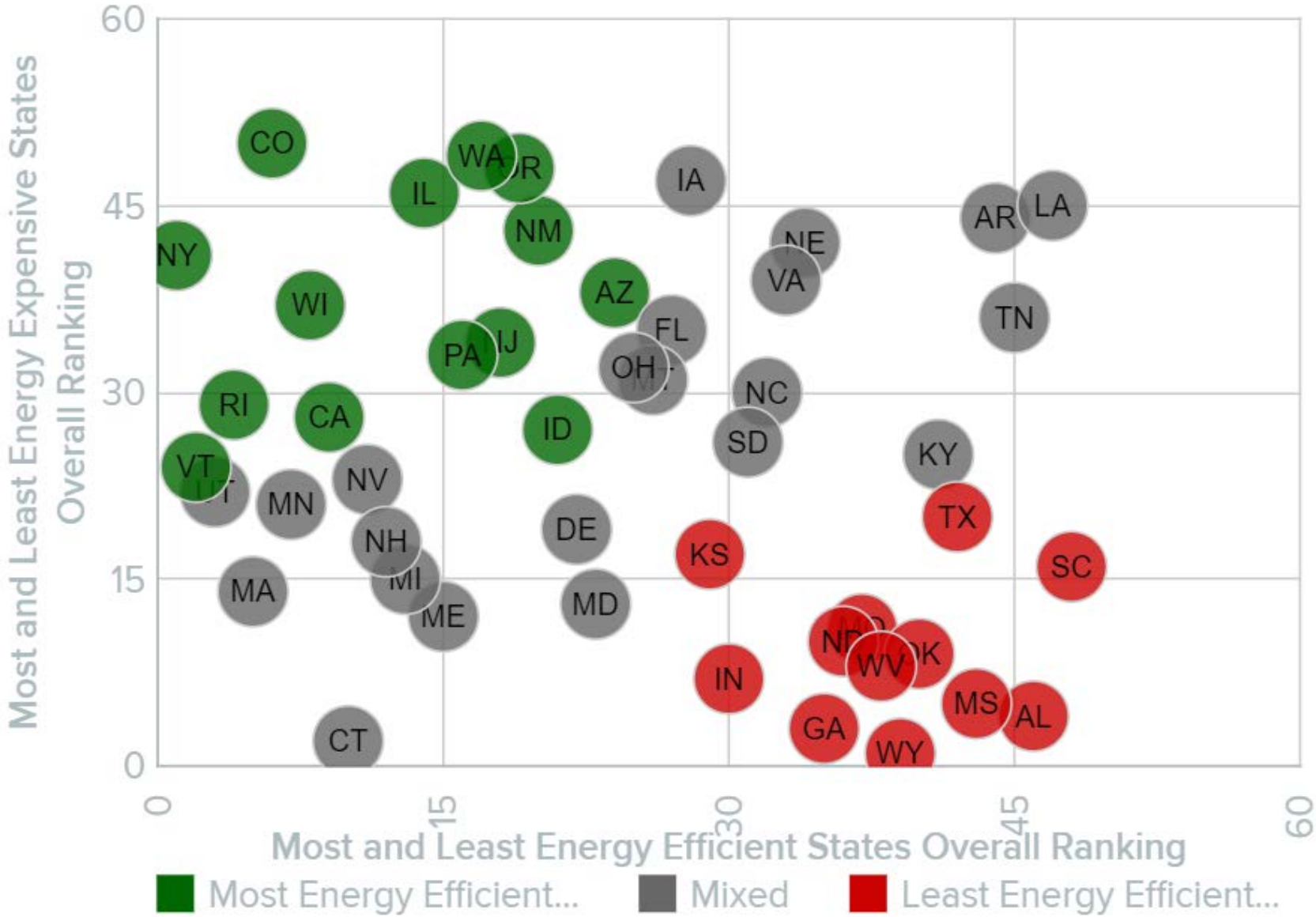
To continue reading the blog post, visit: http://www2.aceee.org/e/310911/les-are-getting-cheaper-energy/5b64t6/266255393?h=Q_UVT4utmjHevy-AYRZIWZ_G7WOItviW_21bX4qhJ4c



https://www.iea.org/newsroom/news/2017/may/commentary-the-untapped-potential-of-energy-efficiency-.html

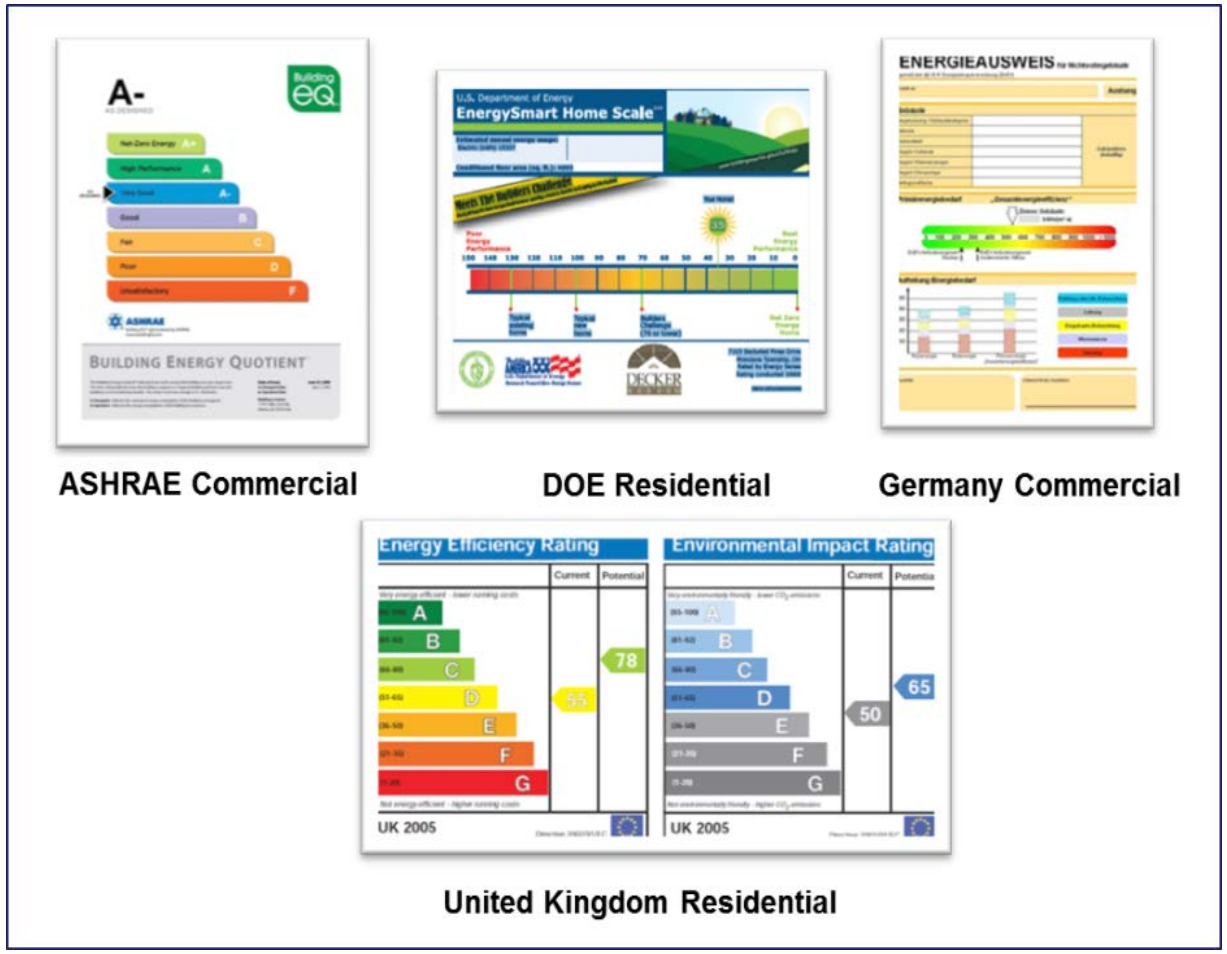


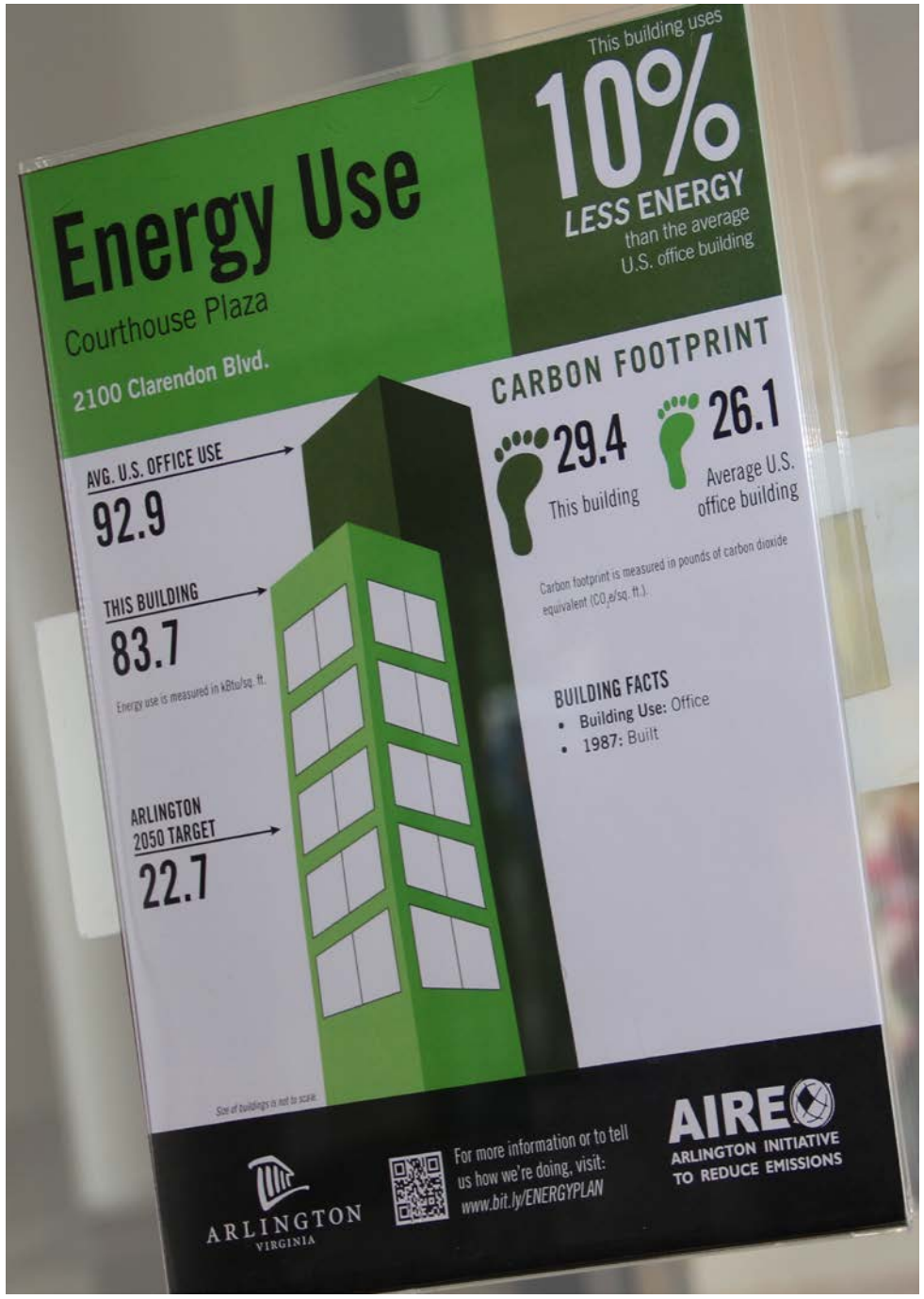
https://neep.org/blog/reed-rendering-12-transforming-markets?utm_source=NEEP+Master+List&utm_campaign=1e7abbe7de-EMAIL_CAMPAIGN_2018_02_07_COPY_01&utm_medium=email&utm_term=0_d09b004d10-1e7abbe7de-224806629


Most and Least Energy Expensive States Overall Ranking
60
45
30
15
0
CO
WA
IL
IA
NM
NY
AR
LA
NE
VA
AZ
WI
TN
FL
PA
OH
NC
RI
CA
ID
SD
KY
VT
NV
MN
TX
DE
NH
KS
SC
MA
MD
ME
IN
WV
MS
AL
GA
WY
CT
0
15
30
45
60
Most and Least Energy Efficient States Overall Ranking
Most Energy Efficient...
Mixed
Least Energy Efficient...

Buildings

- S2– Energy Performance Labels




Energy Use
Courthouse Plaza
2100 Clarendon Blvd.
This building uses
10%
LESS ENERGY
than the average
U.S. office building
AVG. U.S. OFFICE USE
92.9
THIS BUILDING
83.7
Energy use is measured in kBtu/sq. ft.
ARLINGTON
2050 TARGET
22.7
Size of buildings is not to scale.
CARBON FOOTPRINT
29.4
This building
26.1
Average U.S.
office building
Carbon footprint is measured in pounds of carbon dioxide equivalent (CO_2e/sq. ft.).
BUILDING FACTS
Building Use: Office
1987: Built
ARLINGTON
VIRGINIA
For more information or to tell
us how we're doing, visit:
www.bit.ly/ENERGYPLAN
AIRE
ARLINGTON INITIATIVE
TO REDUCE EMISSIONS

“R – VALUE”. Higher the resistance number, the better.

Smart Windows: What You Need to Know

SEPTEMBER 19TH, 2019

Windows are incredibly important in the design of a home. They are important for the home's aesthetics, they allow exterior light to enter the home, can be opened for ventilation, and solar energy entering through southern facing windows can help offset home heating costs in the winter. On the down side, according to the U.S Department of Energy, older, inefficient windows can be responsible for over 25 percent of energy costs of heating/cooling a home. For these reasons and more, many homeowners are opting for smart windows. Windows, like everything else, don't last forever. The average lifespan of a window is around 20 years. This means there are many homes that could benefit from replacement of windows. The down side of this is that replacing windows isn't cheap. According to Home Advisor, the cost of replacing windows in an average U.S. home is between $3,000 and $10,000. The good

Smart Window Options

If you are replacing your windows, or building a new home where you have input on the windows being used, there are high tech options you may want to consider.

1. Low-emissivity (low-E) glass has a microscopic layer of metallic particles adhered to the glass. These particles reflect infrared radiation so solar energy from the sun is reflected back, keeping a home cooler in the summer. The coating also reflects infrared radiation within a home helping to keep it warmer in the winter. In addition, the coating blocks UV rays, protecting furnishings within a home from damage from sunlight.

2. Smart Window Film

An alternative are smart window films. While this might not be the best aesthetic choice for a classic Victorian home, smart window films remove the need for window treatments by using a window film that can be adjusted from clear to fully opaque through the application of a voltage to the film. The most common technology for smart window films is PDLC (Particle Displaced Liquid Crystal) where a voltage applied to the film causes it to be clear. When the voltage is removed the film becomes opaque. By varying the voltage the amount of opacity can be infinitely adjusted.

The good news for consumers and smart home integrators is that PDLC-based smart window films can be retrofit onto any window. Applying smart window film to a window is no more complicated than the application of any other window film with the exception of the wiring.

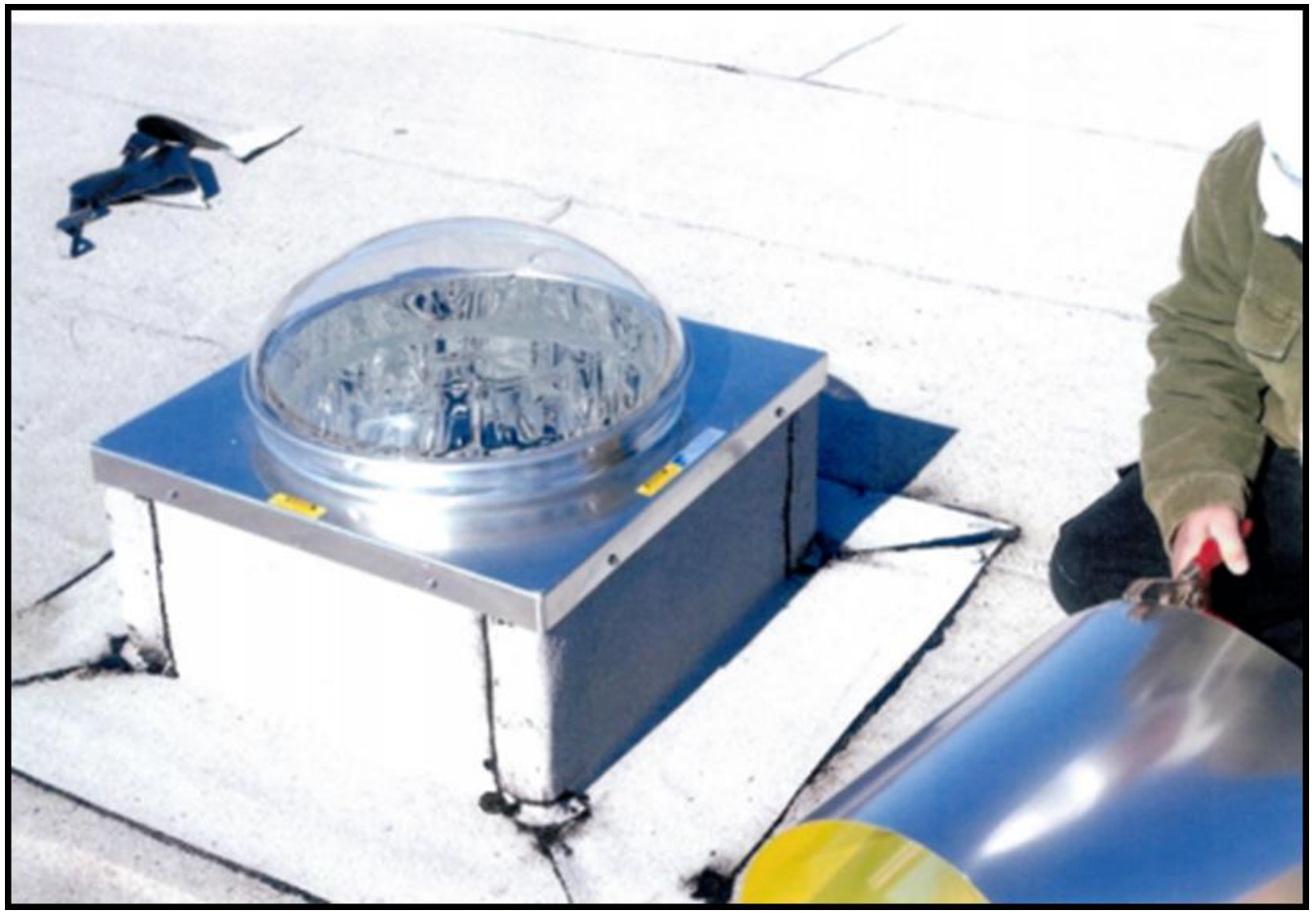
SOURCE: https://restechtoday.com/smart-windows/

Lowest Watt Lights: Low Energy Out, Better Lumens Out

18 watts dimmable
cold cathode cfl 72 watt output

LED dimmable
flood 60 watt output

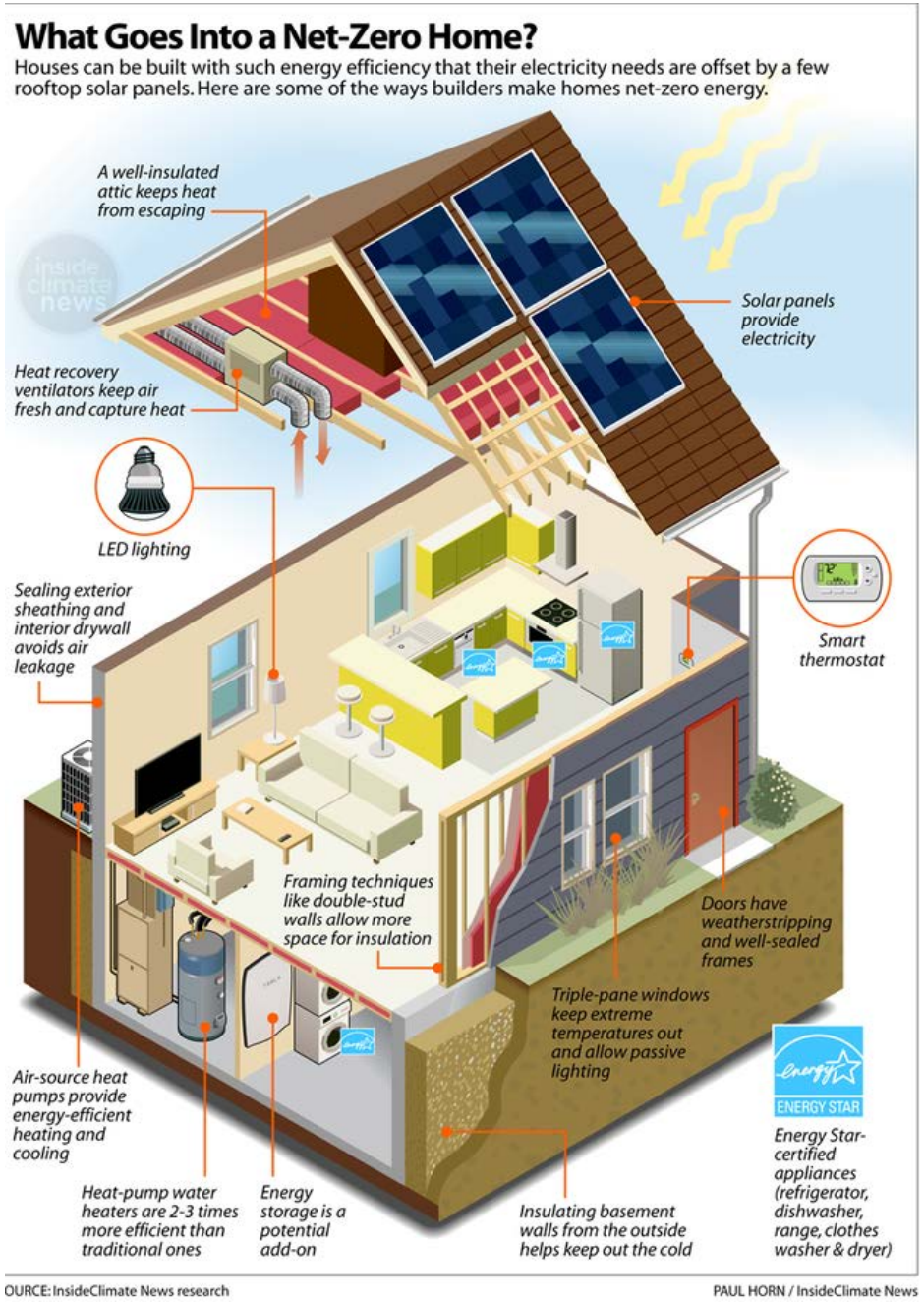
HUVCO Daylighting Solutions™



NSA Visitors Center, Ft. Meade, MD

Use of 21” tubular skylights, with 2’x2’ diffuser to bring free, pure, healthy natural light into the space.

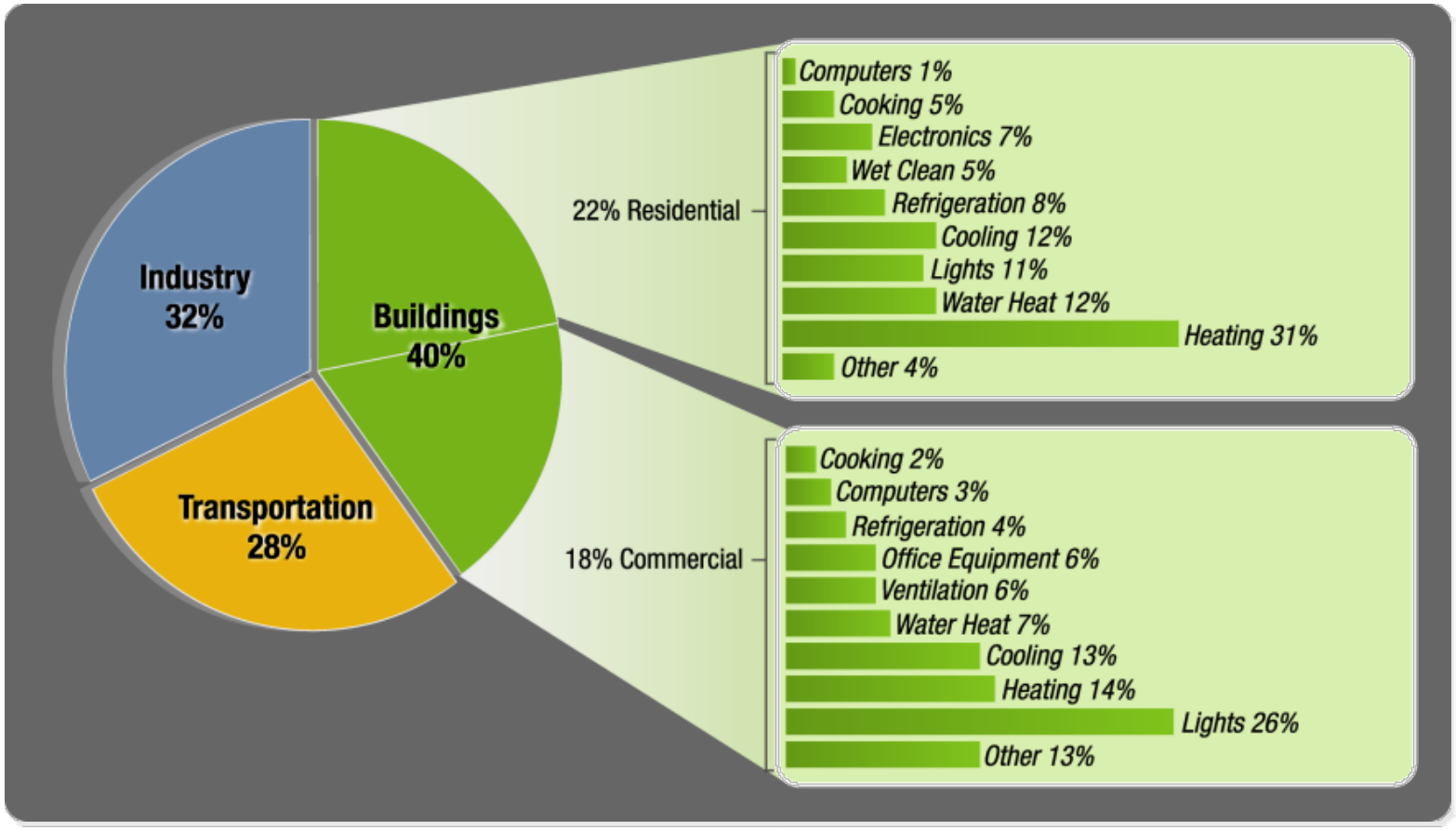
The Stella Group, Ltd. zero energy office (Arlington, VA)
UniSolar PV, SW Windpower Turbine, ReliOn Fuel Cell, Gridpoint Battery Bank



https://insideclimatenews.org/news/10122018/net-zero-energy-efficiency-home-infographic-solar-pay-off-years-midwest-detroit-chicago-columbus?utm_source=InsideClimate+News&utm_campaign=f32d6f74ec-&utm_medium=email&utm_term=0_29c928ffb5-f32d6f74ec-327493849

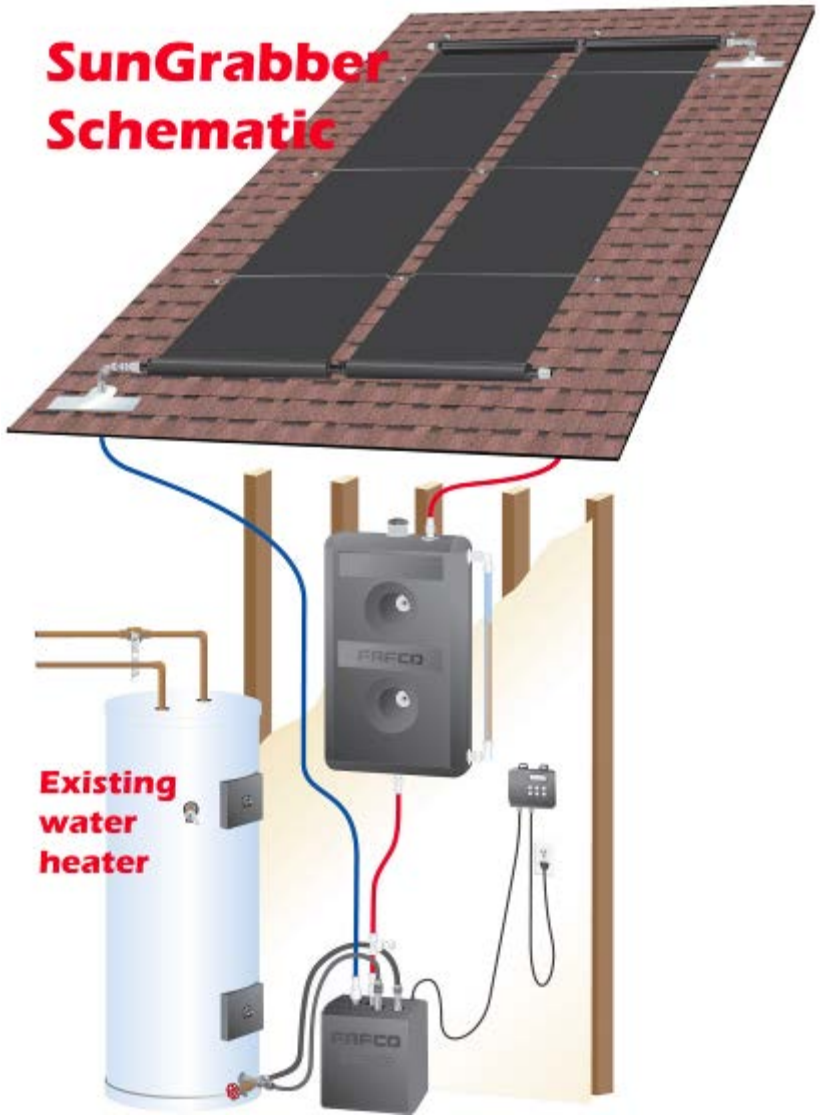
Why Net Zero is Important

- Buildings are the Largest Energy Consumer in the U.S.
  - 40% of primary energy, 72% of electricity, 55% of natural gas



EAST SIDE

Drainback unglazed solar water heating system



www.fafco.com

Build-Up of Residential Solar Water Heating Value In California

	¢/therm
Other Values	TBD
Value of Lower NG & Elec Prices	TBD
Value of Increased Energy Security	TBD
Value of Job Creation Potential	4.75 – 5.79
Health Benefits of Avoided Emissions	28.25 – 32.10
Value of Avoided SO_2 Emissions	0.03 – 0.16
Value of Avoided PM2.5 Emissions	1.11 – 3.79
Value of Avoided NO_x Emissions	4.34 – 34.55
Value of Avoided Methane (CH_4) Emissions	0.54 – 1.56
Value of Avoided CO_2-Equivalent Emissions	4.93 – 19.10
Value of Avoided or Deferred Natural Gas Pipeline Capacity	3.12 – 9.99
Value of Avoided Natural Gas Distribution-Related Losses	1.02 – 2.51
Value of Solar Water Heating as a Natural Gas Price Hedge	6.22 – 10.65
Value of Indirect Natural Gas Savings from Avoided Efficiency Losses	10.49 – 53.90
Value of Direct Natural Gas Savings from Solar Water Heating (Compared to a Natural Gas-Fired Boiler)	29.65 – 110.62

CAL SEIA RES 1/15/09 R4

RANGE OF TOTAL VALUE OF RESIDENTIAL SOLAR WATER HEATING: 94 – 285 ¢/therm

How will this collector perform?

SOLAR COLLECTOR CERTIFICATION AND RATING

SRCC OG-100

CERTIFIED SOLAR COLLECTOR

SUPPLIER:	**Heliodyne, Inc.** 4910 Seaport Avenue Richmond, CA 94804 USA
MODEL:	336 013
COLLECTOR TYPE:	Gobi Glazed Flat-Plate
CERTIFICATION#:	2007026A

COLLECTOR THERMAL PERFORMANCE RATING

Megajoules Per Panel Per Day				Thousands of BTU Per Panel Per Day			
CATEGORY (Ti-Ta)	CLEAR DAY	MILDLY CLOUDY	CLOUDY DAY	CATEGORY (Ti-Ta)	CLEAR DAY	MILDLY CLOUDY	CLOUDY DAY
A (-5 °C)	36.8	27.8	18.9	A (-9 °F)	34.9	26.4	17.9
B (5 °C)	33.1	24.1	15.2	B (9 °F)	31.4	22.9	14.4
C (20 °C)	27.6	18.8	10.1	C (36 °F)	26.2	17.8	9.6
D (50 °C)	17.3	9.3	2.1	D (90 °F)	16.4	8.8	2.0
E (80 °C)	7.8	1.7	0.0	E (144 °F)	7.4	1.6	0.0

For solar water heating in Chicago, in the summer, one might expect this collector to convert about 17,800 BTU/day.

Source: http://www.solar-rating.org/

How will this collector perform?

SOLAR COLLECTOR CERTIFICATION AND RATING

SRCC OG-100

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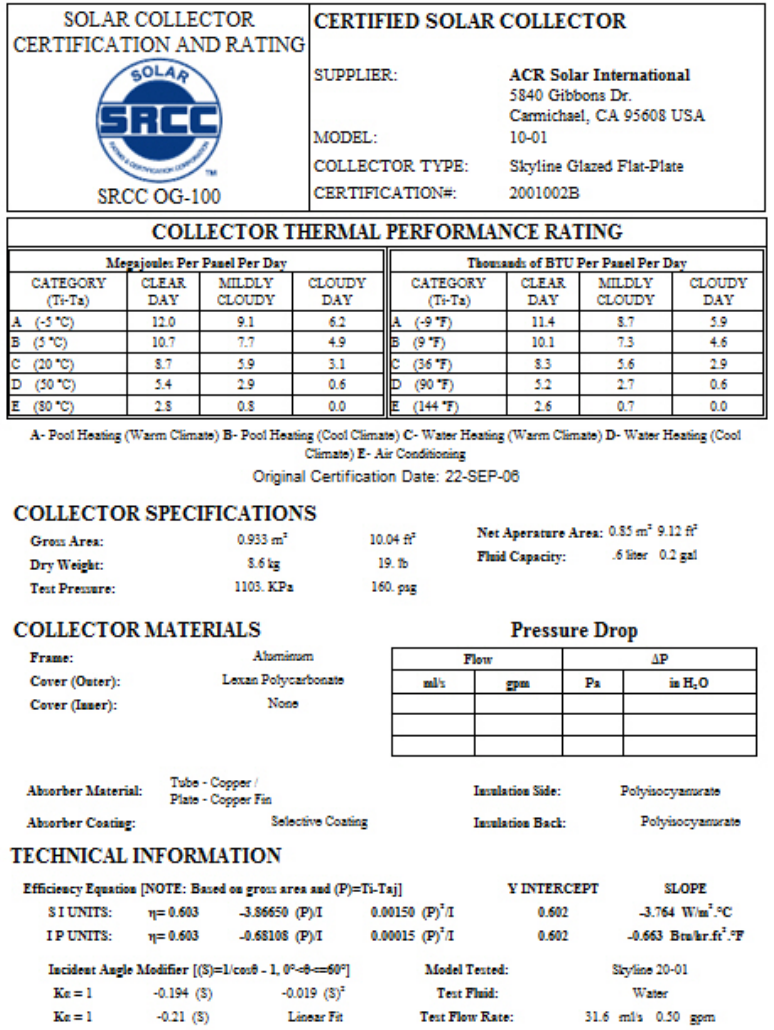
C (20 °C)	27.6	18.8	10.1	C (36 °F)	26.2	17.8	9.6
D (50 °C)	17.3	9.3	2.1	D (90 °F)	16.4	8.8	2.0
E (80 °C)	7.8	1.7	0.0	E (144 °F)	7.4	1.6	0.0

For solar water heating in Chicago, in the summer, one might expect this collector to convert about 17,800 BTU/day.

Source: http://www.solar-rating.org/

Each listed collector has a data page…



SOLAR COLLECTOR CERTIFICATION AND RATING

SRCC OG-100

CERTIFIED SOLAR COLLECTOR

SUPPLIER: **ACR Solar International**
5840 Gibbons Dr.
Carmichael, CA 95608 USA

MODEL: 10-01

COLLECTOR TYPE: Skyline Glazed Flat-Plate

CERTIFICATION#: 2001002B

COLLECTOR THERMAL PERFORMANCE RATING

Megajoules Per Panel Per Day				Thousands of BTU Per Panel Per Day			
CATEGORY (Ti-Ta)	CLEAR DAY	MILDLY CLOUDY	CLOUDY DAY	CATEGORY (Ti-Ta)	CLEAR DAY	MILDLY CLOUDY	CLOUDY DAY
A (-5 °C)	12.0	9.1	6.2	A (-9 °F)	11.4	8.7	5.9
B (5 °C)	10.7	7.7	4.9	B (9 °F)	10.1	7.3	4.6
C (20 °C)	8.7	5.9	3.1	C (36 °F)	8.3	5.6	2.9
D (50 °C)	5.4	2.9	0.6	D (90 °F)	5.2	2.7	0.6
E (80 °C)	2.8	0.8	0.0	E (144 °F)	2.6	0.7	0.0

A- Pool Heating (Warm Climate) **B**- Pool Heating (Cool Climate) **C**- Water Heating (Warm Climate) **D**- Water Heating (Cool Climate) **E**- Air Conditioning

Original Certification Date: 22-SEP-06

COLLECTOR SPECIFICATIONS

Gross Area:	0.933 m^2	10.04 ft^2
Dry Weight:	8.6 kg	19. lb
Test Pressure:	1103. KPa	160. psig

Net Aperature Area: 0.85 m^2 9.12 ft^2

Fluid Capacity: .6 liter 0.2 gal

COLLECTOR MATERIALS

Frame:	Aluminum
Cover (Outer):	Lexan Polycarbonate
Cover (Inner):	None

Pressure Drop

Flow		ΔP	
ml/s	gpm	Pa	in H_2O

Absorber Material: Tube - Copper / Plate - Copper Fin

Absorber Coating: Selective Coating

Insulation Side: Polyisocyanurate

Insulation Back: Polyisocyanurate

TECHNICAL INFORMATION

Efficiency Equation [NOTE: Based on gross area and (P)=Ti-Ta]				Y INTERCEPT	SLOPE
S I UNITS:	η= 0.603	-3.86650 (P)/I	0.00150 $(P)^2/I$	0.602	-3.764 $W/m^2 \cdot °C$
I P UNITS:	η= 0.603	-0.68108 (P)/I	0.00015 $(P)^2/I$	0.602	-0.663 $Btu/hr.ft^2 \cdot °F$

Incident Angle Modifier [(S)=1/cosθ - 1, 0°<θ<=60°]

Kα = 1	-0.194 (S)	-0.019 $(S)^2$	
Kα = 1	-0.21 (S)	Linear Fit	

Model Tested: Skyline 20-01

Test Fluid: Water

Test Flow Rate: 31.6 ml/s 0.50 gpm

http://securedb.fsec.ucf.edu/srcc/coll_detail?srcc_id=2001002B

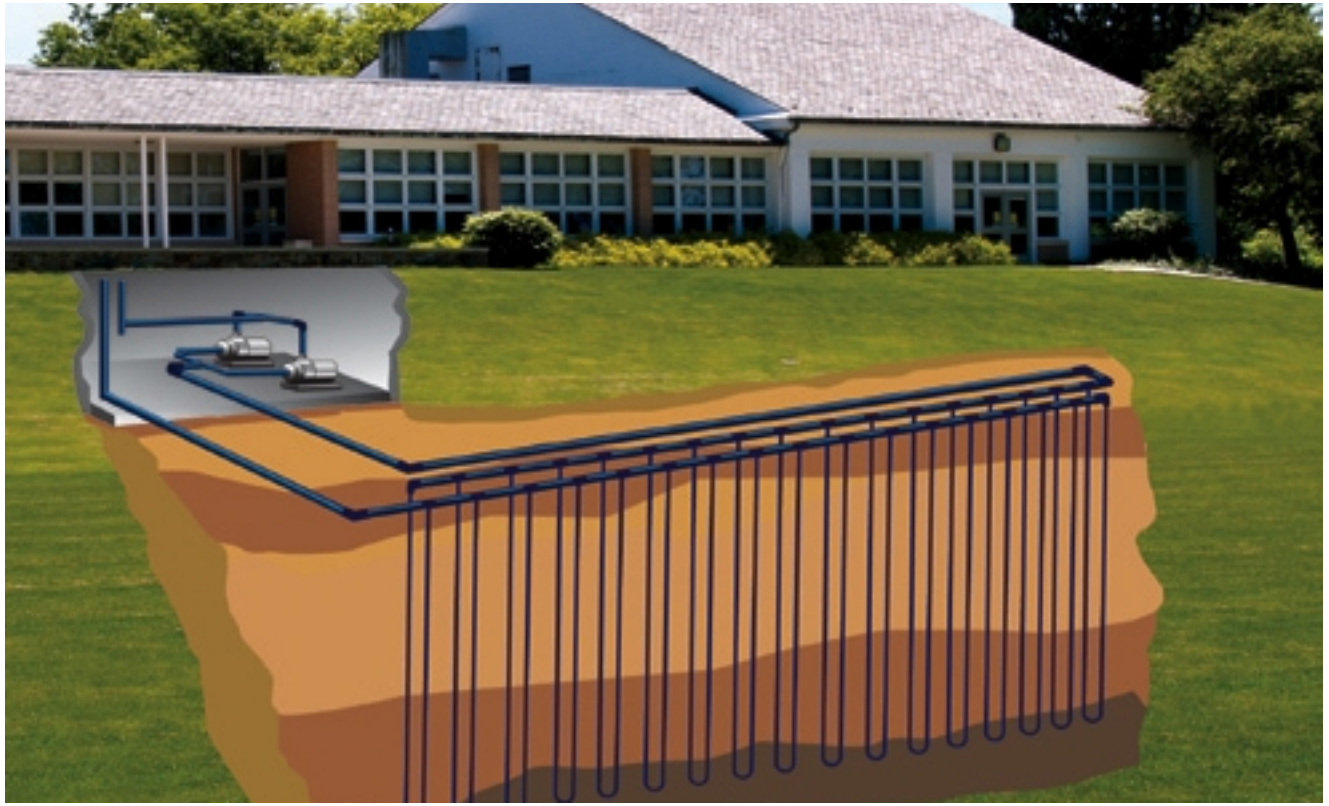
Efficiency Requirements for Residential Central AC and Heat Pumps to Rise in 2023:
U.S. Energy Information Administration, July 30, 2019

https://www.eia.gov/todayinenergy/detail.php?id=40232

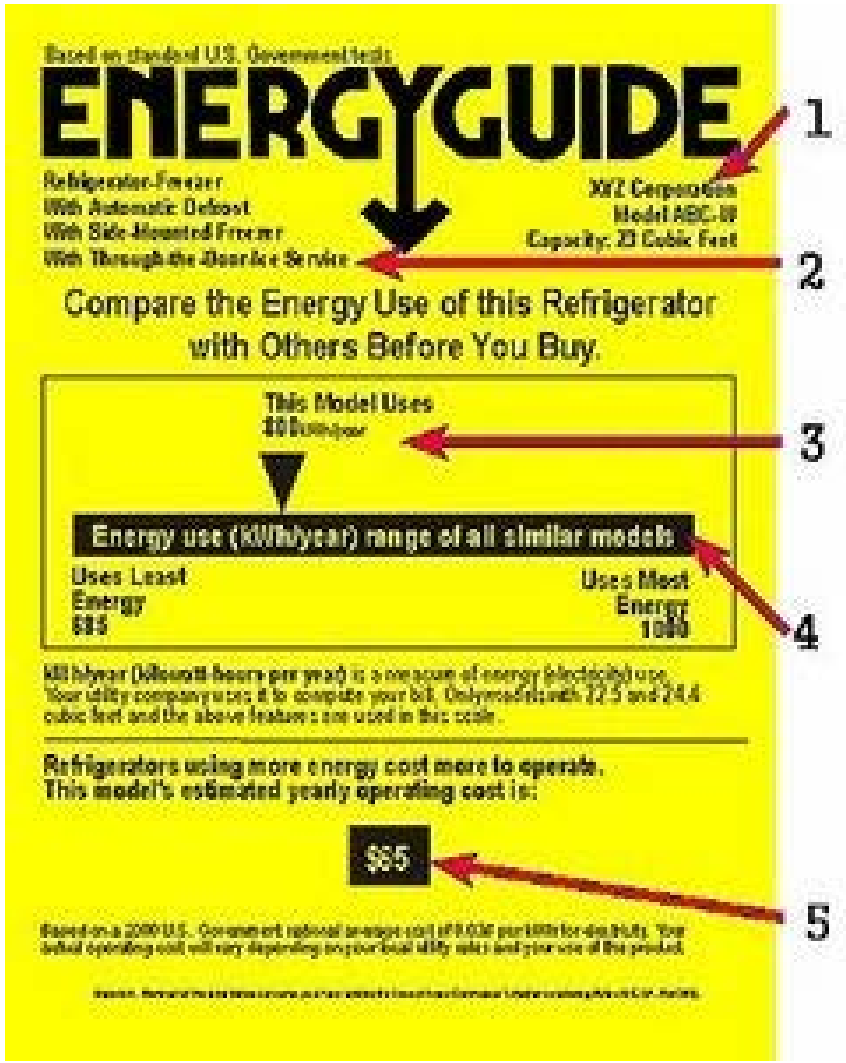
Beginning in 2023, all new residential central air-conditioning and air-source heat pump systems sold in the U.S. will be required to meet new minimum energy efficiency standards. The most recent minimum energy efficiency standards for these equipment types went into effect in 2015, and for the first time, separate standards were set for cooling central air conditioners sold in the northern parts of the United States and those sold in the southern parts. The new standards will require a seasonal energy efficiency ratio (SEER) of no less than 14 SEER for residential systems in the northern part of the U.S. and 15 SEER in the southern part of the U.S., where cooling loads are a larger share of home energy use. Higher SEER ratings indicate more energy-efficient equipment. In addition, the new standards require an increase in the heating efficiency of air-source heat pumps—measured by the equipment's heating seasonal performance factor (HSPF). The minimum HSPF will be 8.8 HSPF compared with the 8.2 HSPF required by the current standard.

Direct-Exchange GCHP at Sklar House

GEOEXCHANGE FOR SCHOOLS: HEATING & COOLING



LABEL PRODUCTS, VEHICLES, GENERATORS IN LIFECYLE COSTS PER MONTH EVERWHERE



What You Should Know about SEER

The efficiency of central air conditioning systems is rated by a Seasonal Energy Efficiency Ratio (SEER). In general, the higher the SEER, the less electricity the system needs to do its job. SEER is a mathematically determined ratio of the total cooling capacity during normal periods of operation (not to exceed 12 months) divided by the total electric energy input during the same time period. More detail on the SEER calculation can be obtained in **AHRI Standard 210/240-2008**

Great strides have been made in the last 10 years to increase the efficiency of new air conditioners and heat pumps. SEER ratings for air conditioning and air-source heat pump systems manufactured today range from 13 SEER to 24 SEER, with the highest numbers indicating the most efficient units that offer the most energy savings year after year.

The government in 1992 established the minimum seasonal energy efficiency standard for units manufactured in the United States at 10 SEER. The minimum SEER value changed again on January 23, 2006 to 13 SEER. AHRI lists the certified energy efficiency ratings for specific equipment in its online **AHRI Directory of Certified Product Performance**. To obtain that certified efficiency rating, though, it is important that a contractor install a system properly. Only **certified matched systems** are listed in the directory. Ask your contractor for either an AHRI Certified Reference Number or a AHRI Certificate of Product Ratings to confirm that the system being installed in your home is properly matched to achieve its certified efficiency rating. Central air conditioners that are in the top 25 percent of efficient models may carry the ENERGY STAR® label. To qualify, they must have a minimum SEER efficiency level of 14. Consumers can identify whether their system is ENERGY STAR® qualified in the **CEE/AHRI HVAC Directory**.

http://www.ahrinet.org/Homeowners/Save-Energy/Seasonal-Energy-Efficiency-Ratio

SEER Ratings Explained

SEER stands for Seasonal Energy Efficiency Ratio and was defined by the Air Conditioning, Heating, and Refrigeration Institute. The SEER rating of a unit is the cooling output of the system during a typical cooling season divided by the total electric energy used in that same period. In the United States, we measure cooling by British thermal units or BTU's. What you need to know about SEER ratings: a consumer needs to take away from this is that the higher the SEER rating, the more efficient the unit is. Let's compare a 13 SEER and 16 SEER 2 ton air conditioning units. By dividing the BTU's per hour by the SEER rating we can get the Watts per hour used by each unit. **13 SEER: 24,000 BTU's per Hour / 13 = 1,846 Watts per Hour 16 SEER: 24,000 BTU's per Hour / 16 = 1,500 Watts per Hour**

Now that we have our Watts per hour, we can calculate our costs per hour by multiplying our Watts per hour by our electricity cost. Let's assume that our electricity costs 20 cents per kilowatt hour. **13 SEER: 1.846 kW x 20 cents per kw = 36.92 cents per hour 16 SEER: 1.500 kW x 20 cents per kw = 30 cents per hour**

We now have the operating cost per hour, but let us compare the yearly usage savings between the two units. Lets assume that the air conditioner will run 14 hours a day for 125 days a year will run for 1750 hours a year and multiply that by the cost 36.92 per hour to operate the unit - $647.50 per year.

https://hvacdirect.com/info/seer-ratings-explained/

Relationship of SEER to EER and COP
The energy efficiency ratio (EER) of a particular cooling device is the ratio of *output* cooling energy (in BTU/hr) to *input* electrical energy (in Watts) at a given operating point. EER is generally calculated using a 95 °F outside temp and an inside (actually return air) temp of 80 °F and 50% relative humidity.

The EER is related to the coefficient of performance (COP) commonly used in thermodynamics, with the primary difference being that the COP of a cooling device is unit-less, because the numerator and denominator are expressed in the same units. The EER uses mixed units, so it doesn't have an immediate physical sense and is obtained by multiplying the COP (or EER) by the conversion factor from BTU/h to Watts: EER = 3.41214 × COP (see British thermal unit).

The seasonal energy efficiency ratio (SEER) is also the COP (or EER) expressed in BTU/hr/W, but instead of being evaluated at a single operating condition, it represents the expected overall performance for a typical year's weather in a given location. The SEER is thus calculated with the same indoor temperature, but over a range of outside temperatures from 65 °F (18 °C) to 104 °F (40 °C), with a certain specified percentage of time in each of 8 bins spanning 5 °F (2.8 °C). There is no allowance for different climates in this rating, which is intended to give an indication of how the EER is affected by a range of outside temperatures over the course of a cooling season.

Typical EER for residential central cooling units = 0.875 × SEER. SEER is a higher value than EER for the same equipment.[1] A more detailed method for converting SEER to EER uses this formula:
$EER = -0.02 \times SEER^2 + 1.12 \times SEER$[2] Note that this method is used for benchmark modeling only and is not appropriate for all climate conditions.[2]

A SEER of 13 is approximately equivalent to an EER of 11, and a COP of 3.2, which means that 3.2 units of heat are removed from indoors per unit of energy used to run the air conditioner.

https://en.wikipedia.org/wiki/Seasonal_energy_efficiency_ratio

THERE ARE NO DUMB QUESTIONS –

Any questions ???

Need reports, contacts ???

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Thank you!

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