

MONTANA WEATHERIZATION TRAINING CENTER

Importance of Shell Work for Electrification

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MONTANA
STATE UNIVERSITY

EXTENSION

**MONTANA WEATHERIZATION
TRAINING CENTER**

The Weatherization Assistance Program (WAP) and The Weatherization Training Center's (WTC's)



What is the Weatherization Assistance Program?

Federally funded program that was started in the 1970's as a reaction to the oil crisis.

Administered by the Department of Energy (DOE)



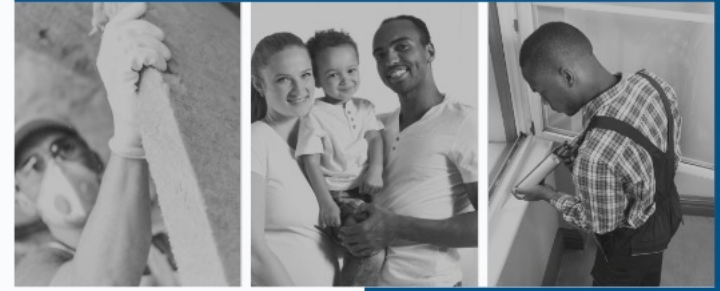
Mission:

To reduce energy costs for low-income families, particularly for the elderly, people with disabilities, and children, while ensuring their health and safety.



- Supports 8,500 jobs
- 35,000 homes every year
- \$372 anual energy savings per home, every year
- 7 million families since 1976

ENERGY AWARENESS MONTH



WEATHERIZATION WORKS

Families benefit from energy efficiency when less of their household incomes go to utilities.



Who does the Weatherization Work?

Community Action Agencies in all States



Weatherization Work Done at Houses

- Blower door-directed air sealing
- Attic insulation
- Dense-pack
- Sidewall insulation
- Heating and cooling equipment
- repair and replacement
- Duct sealing and modification
- Electric base load measures
 - CFLs
 - Refrigerator replacement
 - Water heater modification & replacement



To get the work done correctly it was recognized by the DOE that they needed a comprehensive training program so in the 1990's the DOE started setting up Weatherization Training Centers, WTC's

MONTANA WEATHERIZATION TRAINING CENTER



The Montana Weatherization Training Center

- Follow the DOE's standard curriculum
- IREC Certified Training Center (Interstate Renewable Energy Council)
- EPA Training provider
 - Renovation Repair and Painting Certifications (RRP)
 - Lead Inspector Certifications
 - Lead Risk Assessor Certifications
- OSHA Outreach Training Provider
 - OSHA 10 Certifications
 - OSHA 30 Certifications
- BPI Test Center
 - Energy Auditor Certifications
 - Building Analyst Technician Certifications
 - Building Analyst Professional Certifications
 - Quality Control Inspector Certifications



Who Attends courses at the WTC

Weatherization crews that perform shell retrofit work on homes. 95%

- Crew workers (Residential Installer Technicians)
- Crew leaders
- Energy Auditors
- Quality Control Inspectors

Other building trades 5%

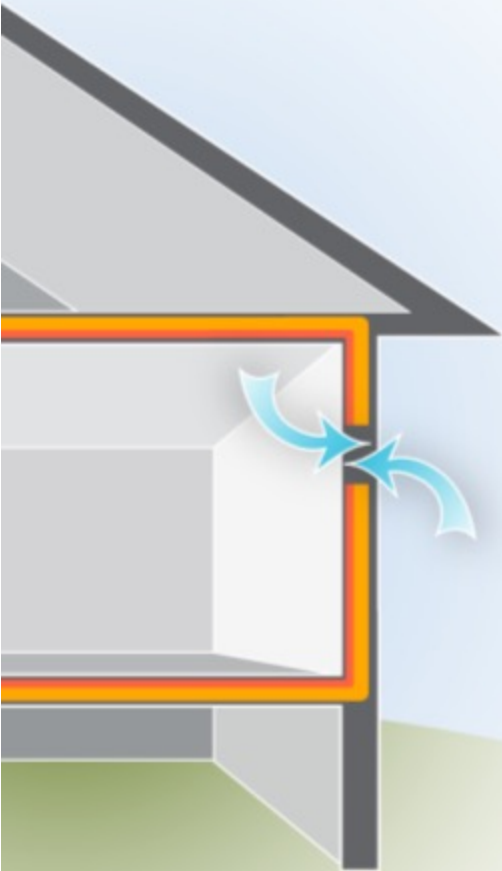
- Construction workers (OSHA courses, Lead Safety - RRP)
- Environmental Technicians (Lead Inspectors and Lead Risk Assessors)



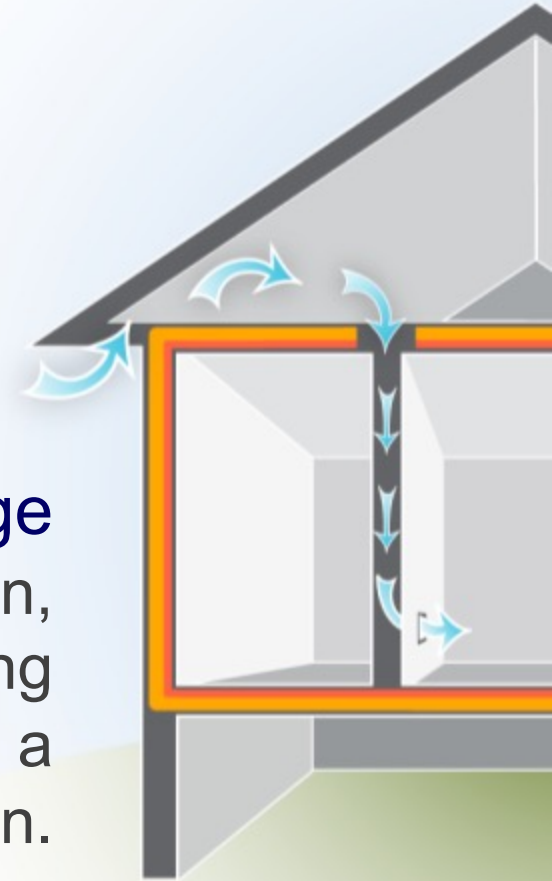
Improving the shell of homes
(weatherizing) is the first step in
the electrification process

Air Leakage

Direct leakage
occurs at direct
openings to outdoors.
Leakage enters or exits
the building envelope
directly at this location.



Indirect leakage
enters at one location,
moves through building
cavities, and exits at a
different location.



Driving Forces of Air Leakage

Driving Forces of Air Leakage

Temperature and pressure differences—
usually between inside and outside the house.

The bigger the temperature or pressure difference,
the greater the air and heat flow.

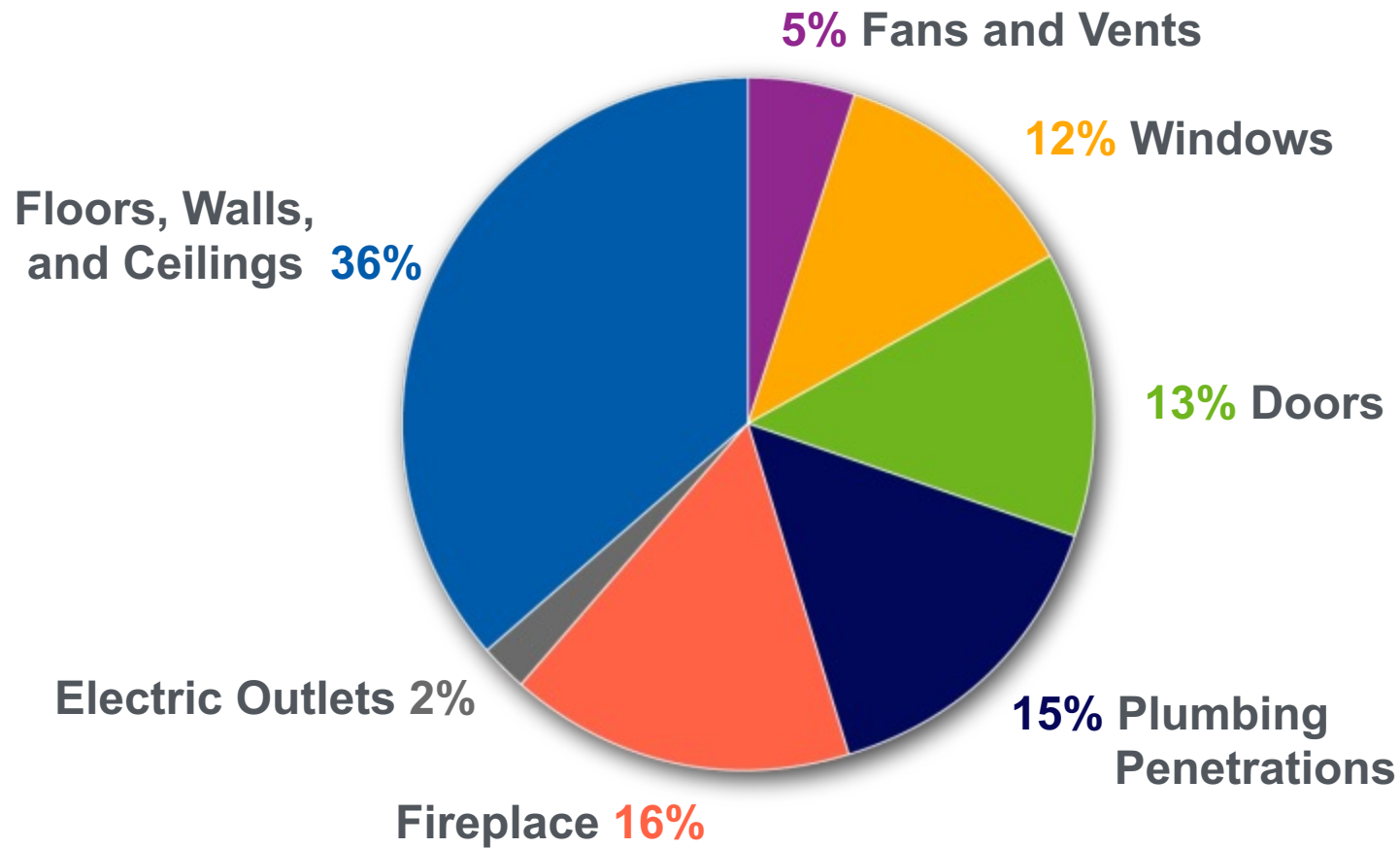
Quantifying Envelope Energy Loss

Where does the heat go?



Photo courtesy of ENERGY STAR; http://www.energystar.gov/index.cfm?c=behind_the_walls.btw_airsealing

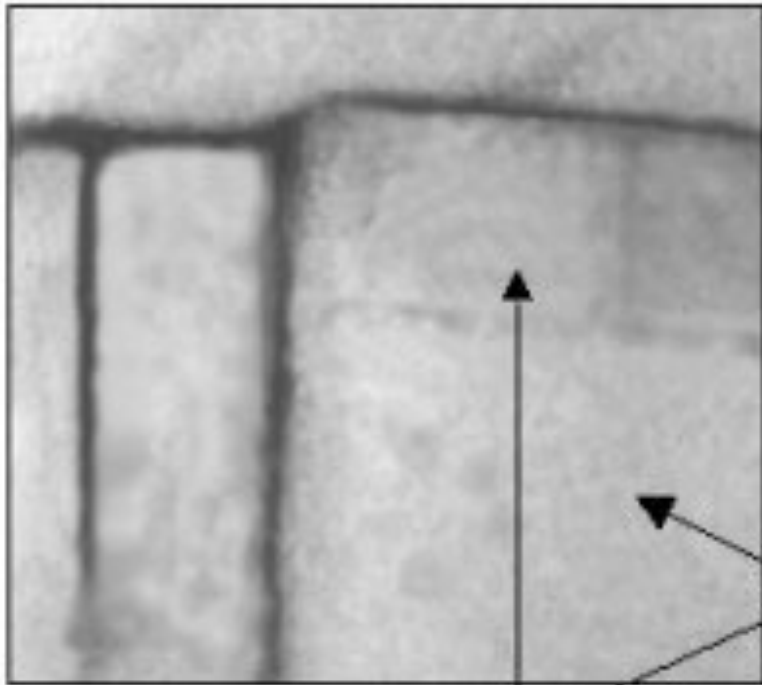
Primary Air Infiltration Sites



Data courtesy of California Energy Commission

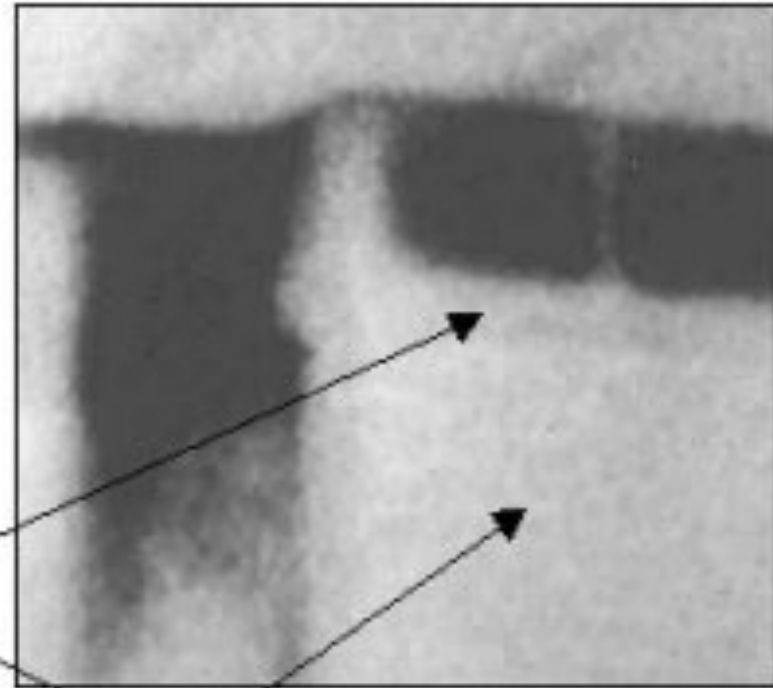
IR and the Blower Door

Without Blower Door



Kitchen Soffit

With Blower Door Running



Cabinets

Blower Door Driven Infiltration

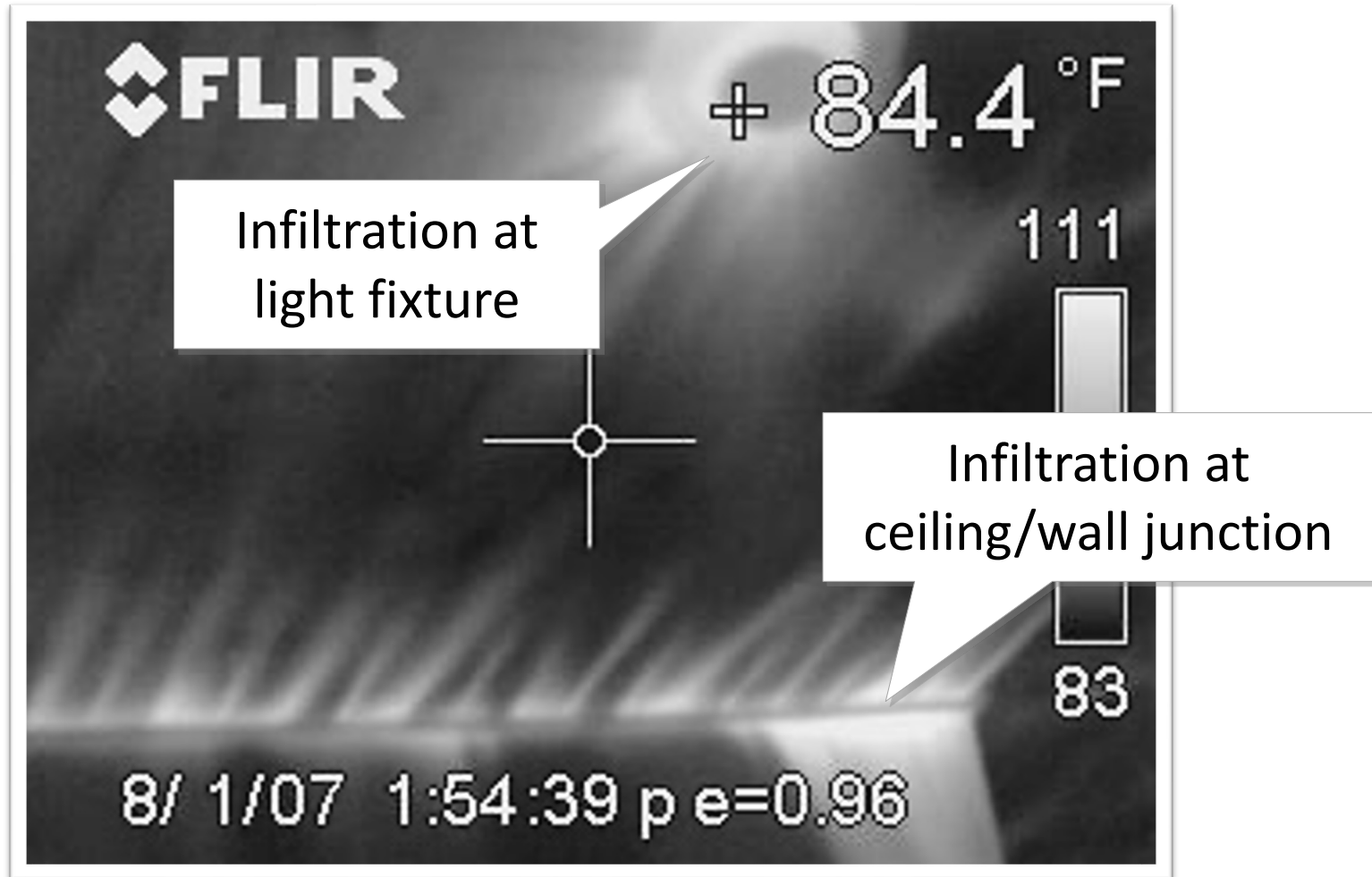
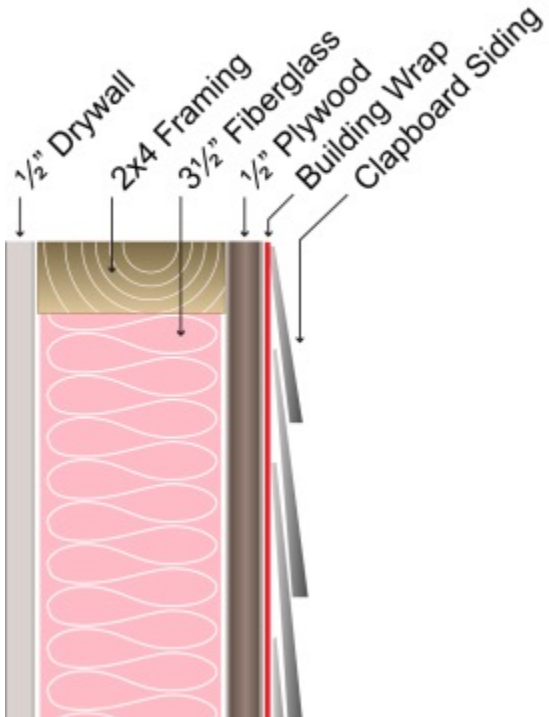


Photo courtesy of Tony Gill

Assembly R-Values

- Building envelopes generally consist of layers of materials, each of which resists heat flow.
- In addition, each layer—not in physical contact with another layer—has an air film that also resists heat flow.



- The assembly has $\frac{1}{2}$ in. drywall, $3\frac{1}{2}$ in. fiberglass, 2 in. x 4 in. framing, $\frac{1}{2}$ in. plywood, building wrap and clapboard siding.¹
- The assembly has a total theoretical R of ≈ 14 . In reality it will test $\approx 20\%$ lower; $\approx R-10$.²

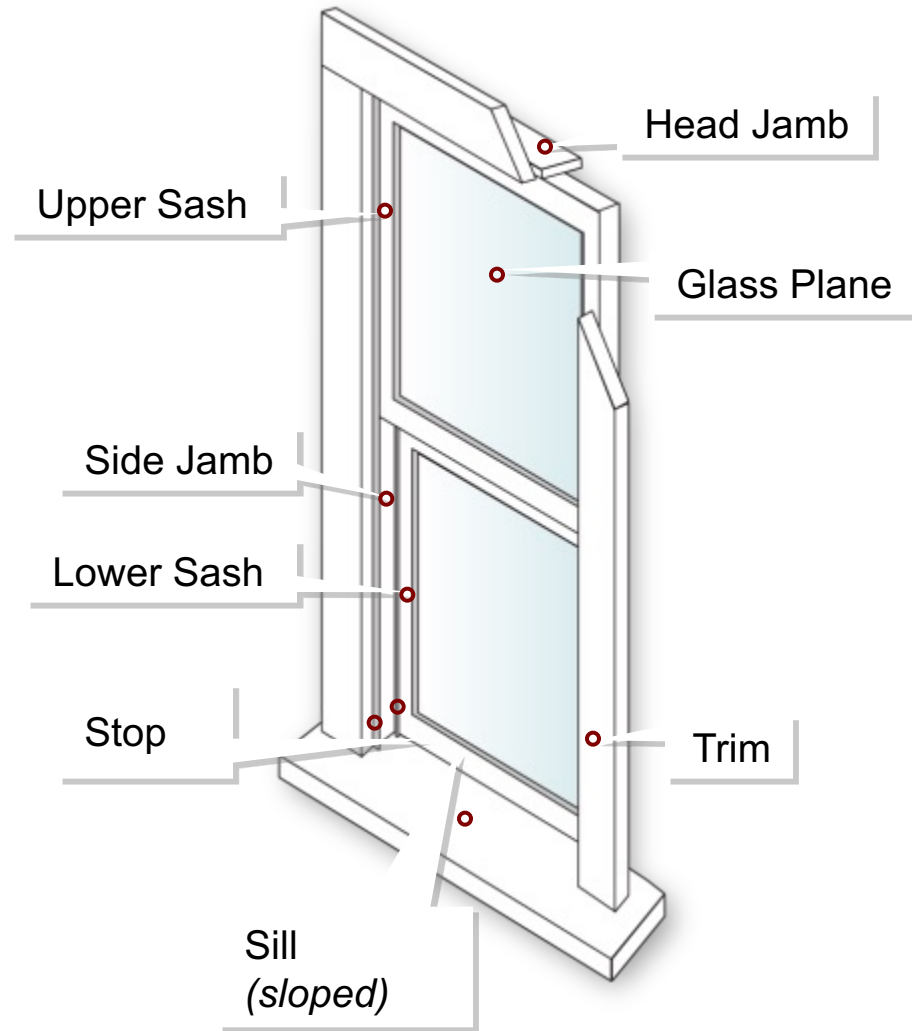
¹ Krigger, page 67. ² Krigger, page 272.

Sample Single-Family Home Priority List

BUILDING SHELL RETROFITS			
Air Seal as per blower door and zone pressure diagnostic protocols			
Duct Sealing as per blower door guided and duct diagnostic protocols			
Insulation Components	No Insulation	R-11 Existing	R-19 Existing
Open Attic Ceilings	add R-38 blown	Add R-19 blown	Add R-11 blown
Closed Floor Cavities (adjacent to unconditioned spaces)	fill to 3.5 lbs/ft ² with loose-fill insulation where dimensions allow		
Open Wall Cavities (adjacent to unconditioned spaces)	add R-13 batt and cover with air barrier	NA	NA
Closed Wall Cavities (adjacent to unconditioned spaces)	fill to 3.5 lbs/ft ² with loose-fill insulation	NA	NA
Open Floor Cavities (in unconditioned basements and crawl spaces)	add R-19 batt	NA	NA
Sill Box and Foundation Walls (in conditioned basements or crawl spaces)	seal penetrations and add R-13 batt or two-part spray foam	NA	NA
Deteriorated Windows and Doors Beyond Repair	Replace		

Window Terminology

Typical Wood Window Exterior



Window Treatments

Where applicable specify:

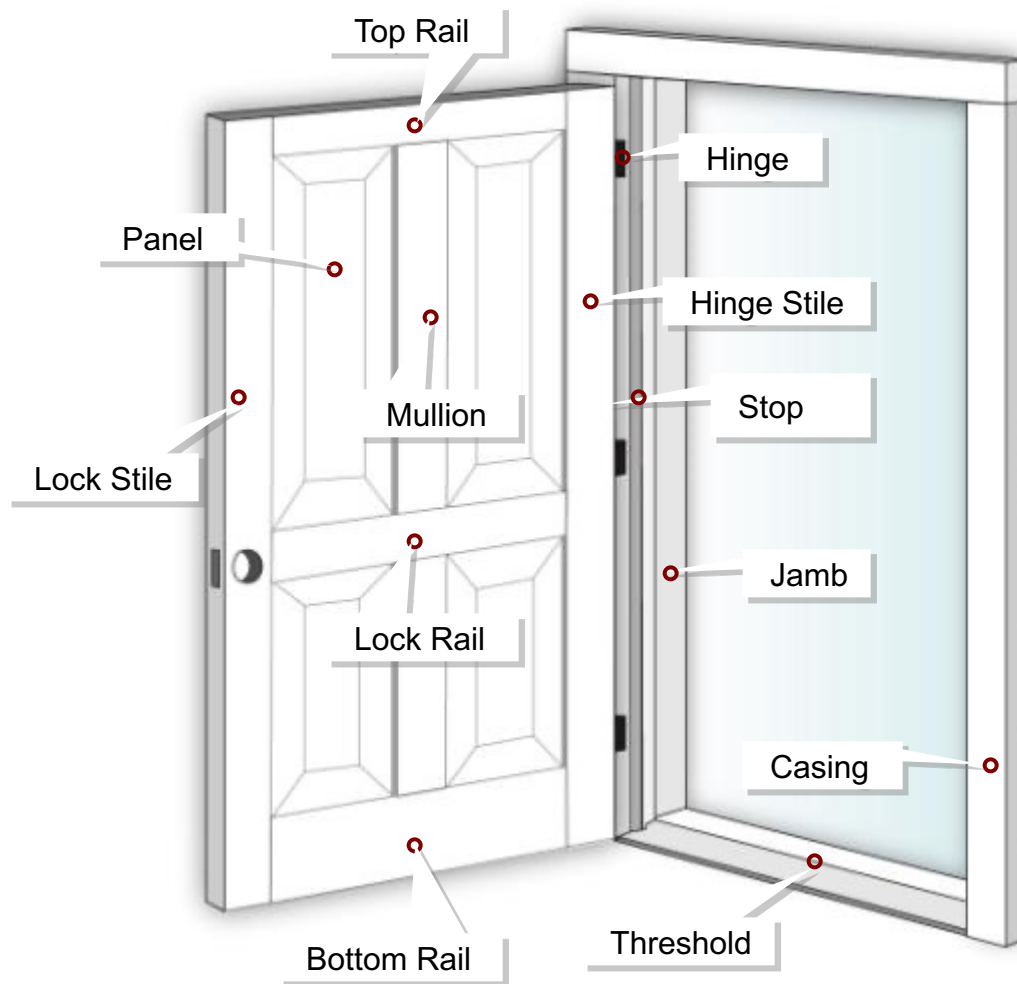
- Replace broken glass.
- Replace broken sash locks.
- Weatherstrip meeting rails and sliding surfaces.
- Install pulley seals.
- Caulk interior trim.



Photo courtesy of the U.S. Department of Energy

Repairing the broken pane will reduce air leakage significantly for much lower cost than window replacement.

Door Terminology



Door Fixes

- Specify weatherstripping, door stops, door sweeps or thresholds.
- Specify repair or replacement of locksets, latches and hinges.
- Specify a replacement door only when:
 - Existing door creates a hazard to health, safety, or building durability.
 - Existing door is damaged or weathered beyond repair and the replacement material and labor cost is less than cost of repair.



Base Load Defined

Base Load:

The energy used by electric or gas appliances in a home that is not used for space conditioning, thus it is not a seasonal load.

Typical measures include:

- Lighting retrofits.
- Water heater modification.
- Low-flow fixtures.

Occupant Impacts

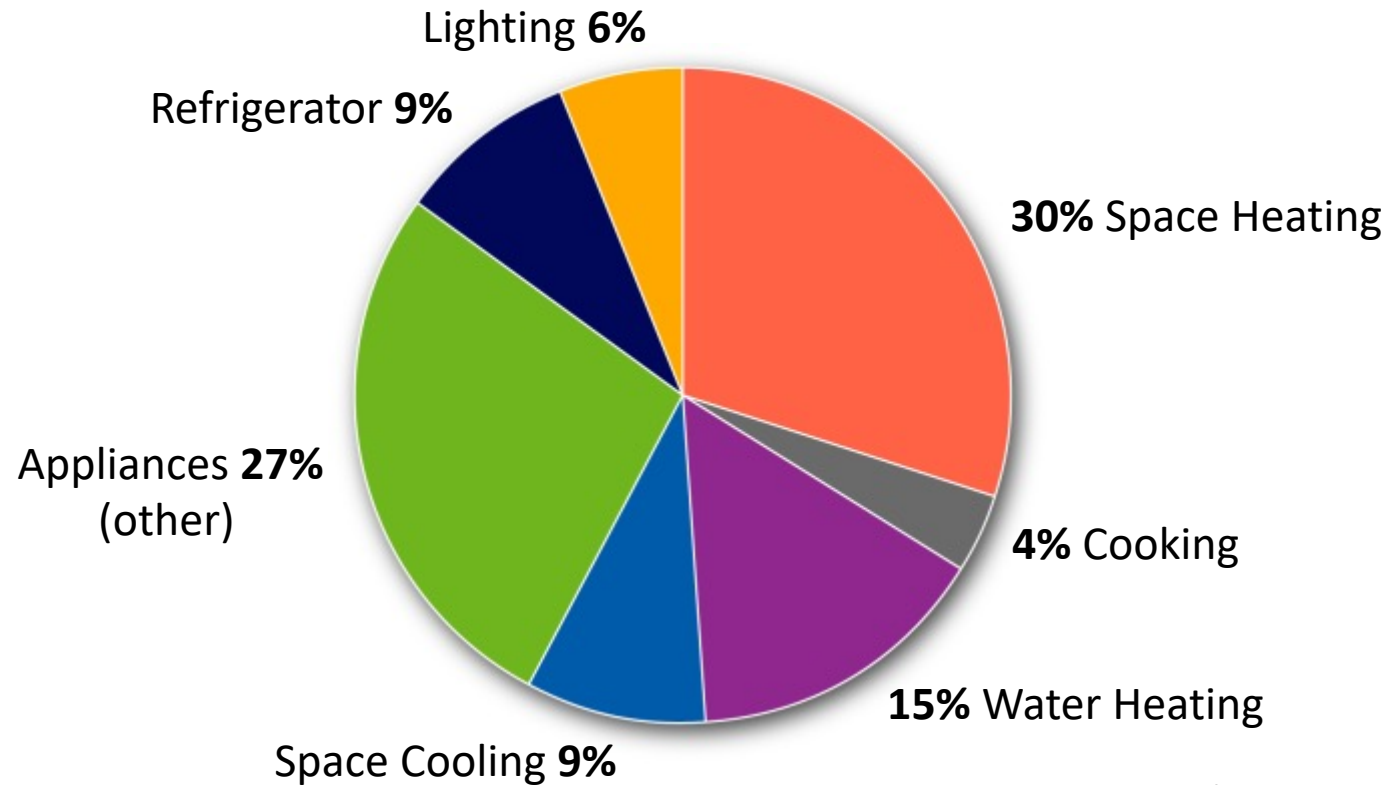
Base load use is affected by:

- Number of occupants.
- Size and efficiency of equipment.
- Habits of occupants.

Client education is key to effectively reducing base-load energy use.

Why Target Electric Base Loads?

Percent of Total Energy Costs by End Use in Income Eligible Households



*Source: Energy Information Administration, U.S.
Department of Energy*

Domestic Water Heaters

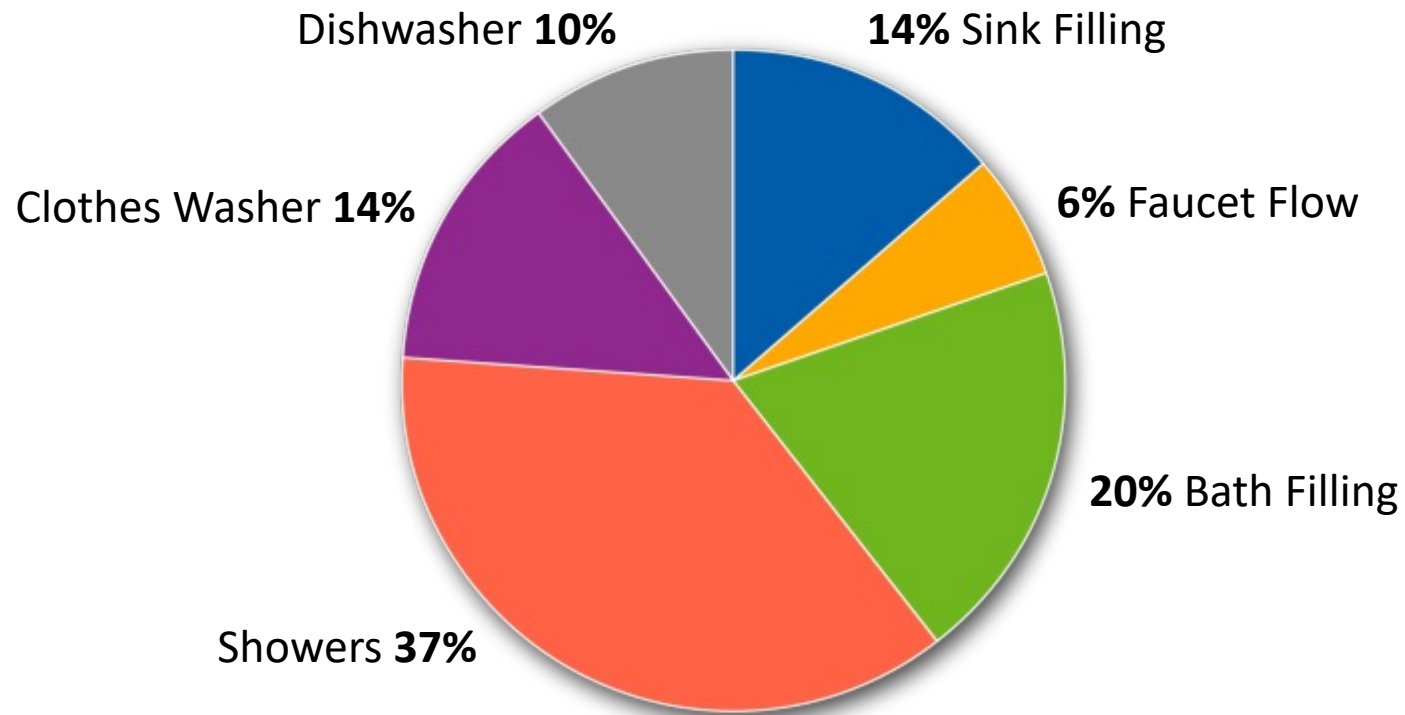
Reduce Setting from 140°F to 120°F

	Average	High
Energy Savings	343 kWh/yr	974 kWh/yr
\$ Savings*	\$37.73/yr	\$107.14/yr
Existing DHW Use	4,500 kWh/yr	6,500 kWh/yr

** Savings based on \$0.11/kWh*

Hot Water Use

Cut down on hot water use by repairing leaks and installing low-flow fixtures.



Source: 2008 Buildings Energy Databook. US DOE

Refrigerator Replacement

- Older models are typically energy hogs.
- Worn gaskets make the unit run more often.
- Insulation can be guessed by pushing on door.
 - Pushes in easily – likely fiberglass
 - Does not push in easily – likely solid foam
- If Coppertone brown, avocado green, or harvest gold, replacements can be cost-effective.



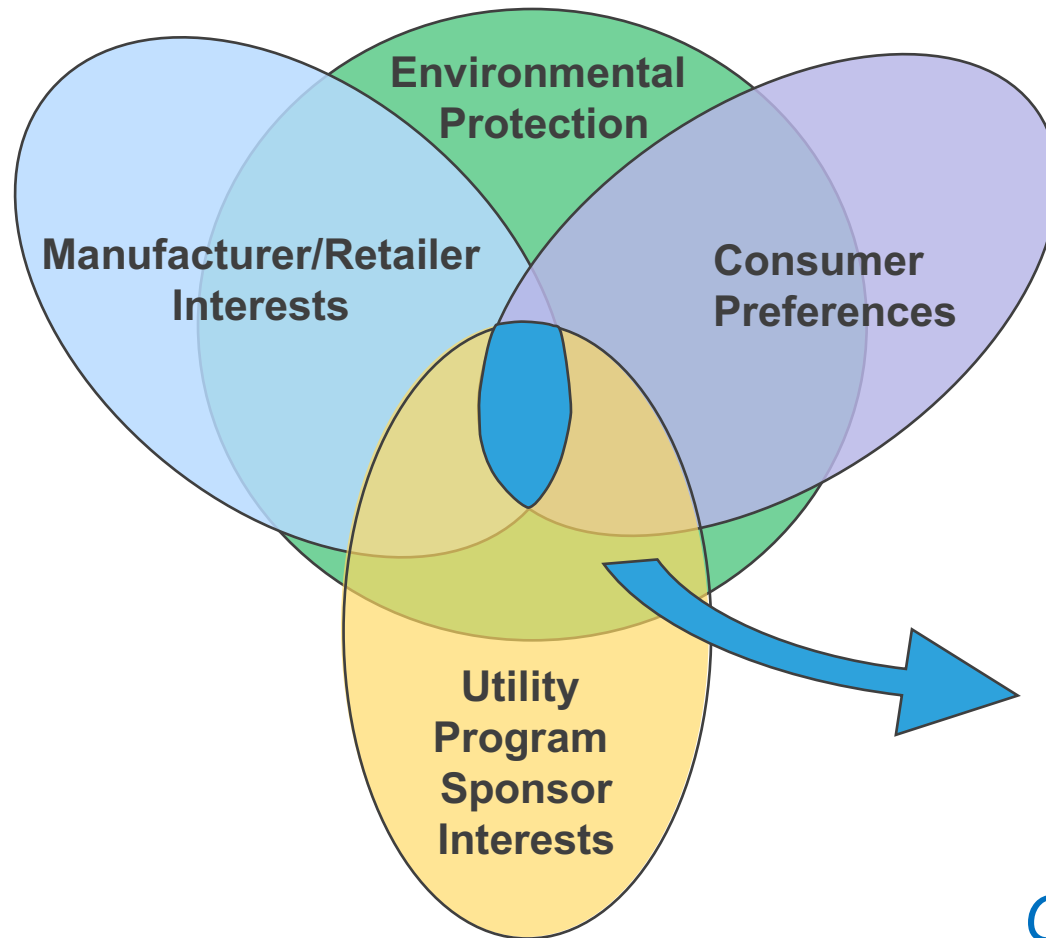
Photo courtesy of US Department of Energy

Lighting

- Lighting accounts for up to **10%** of total home energy use.
- With Compact Fluorescent Lighting (LED) retrofits, can cut that by **85%**.
- Overall energy reduction of **8.5%** for the home.



Builds Upon Intersection of Interests



- Cost-effective
- No sacrifice in performance

Consumer is key!

ENERGY STAR Strategies



Residential

Certified Products as of 2014

- 70+ product categories
- 50,000+ certified products
- 10–60% more efficient

Certified New Homes

- 20–30% more efficient

Home Improvement Services

- Beyond products
- Ducts / home sealing
- Whole home retrofits

International partnerships: Canada, EU, Japan, etc.



Commercial & Industrial

Corporate Energy Management

- Benchmarking, goals, upgrades
 - Management & systems – not widgets
- Indicates whole-building excellence
 - Technical assistance

Certified Products

- For plug-load, not system components

Industrial

Small Business Initiative

Strategy: EDUCATE and ACTIVATE

Goal:

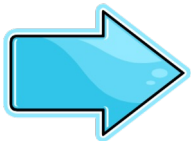
- Raise awareness to help Americans save energy and fight global warming

Audiences:

- Consumers & Employees (create demand)
- Corporate Level Executives (drive strategy and progress)
- Energy & Facility Managers (direct and implement)

Desired Results:

- Increased consumer/employee awareness of energy saving actions they can take where they work, shop, play, and learn
- Increased consumer/employee demand for energy efficiency where they work, shop, play, and learn
- Increased awareness of your organization's efforts, in partnership with ENERGY STAR, to save energy and fight global warming

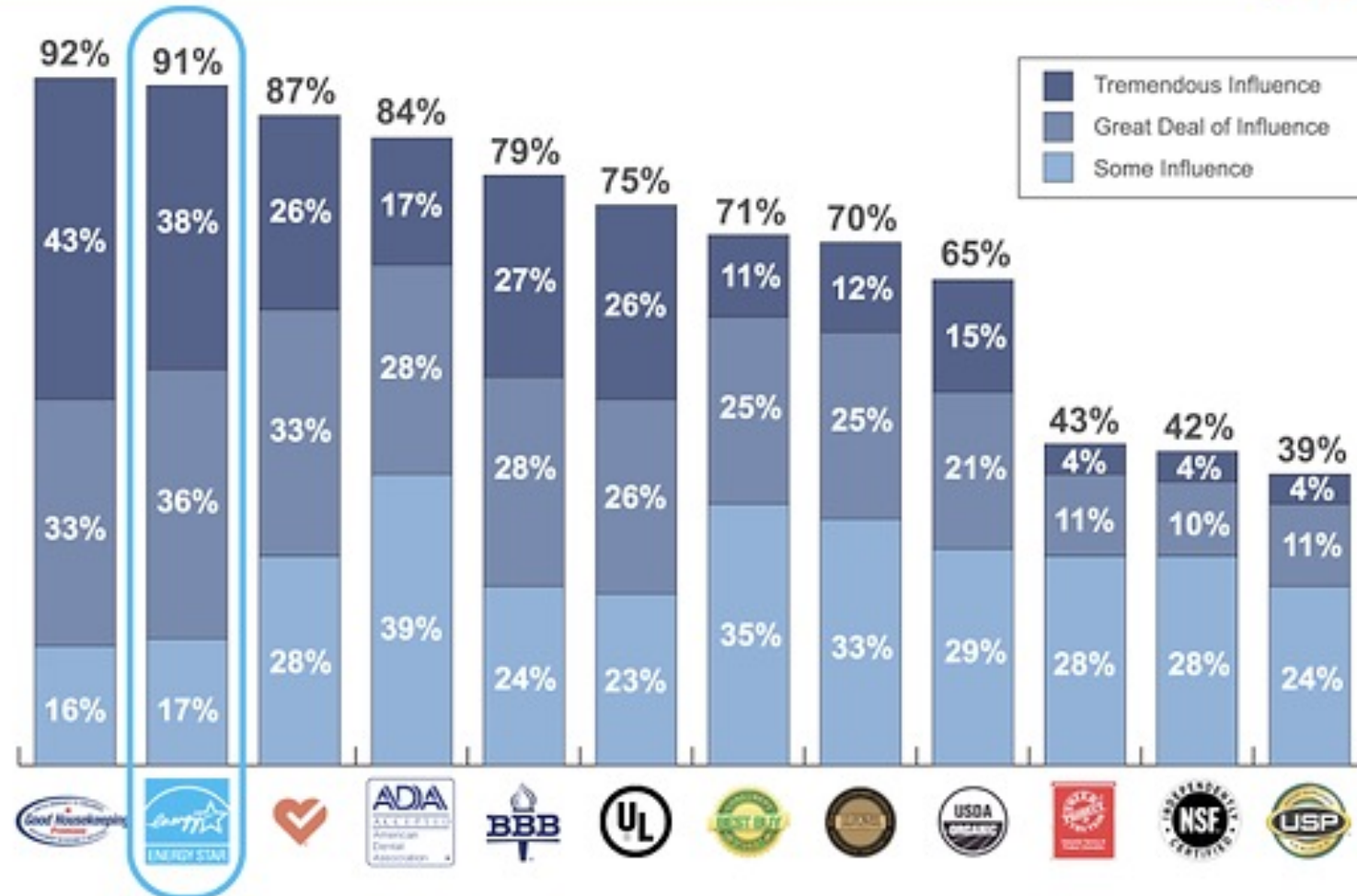


Ultimate Result: Decrease greenhouse gas emissions

Change Consumer Behavior

- Not just changing preferences—changing behavior
- Educate consumer
 - Second price tag (life-cycle costs)
 - Environmental choice
 - Credible source
 - Tools/ advice/ unbiased information
 - Information at transaction points
- Link to measurement/performance
 - Measured performance incents behavior change
- Link to quality services

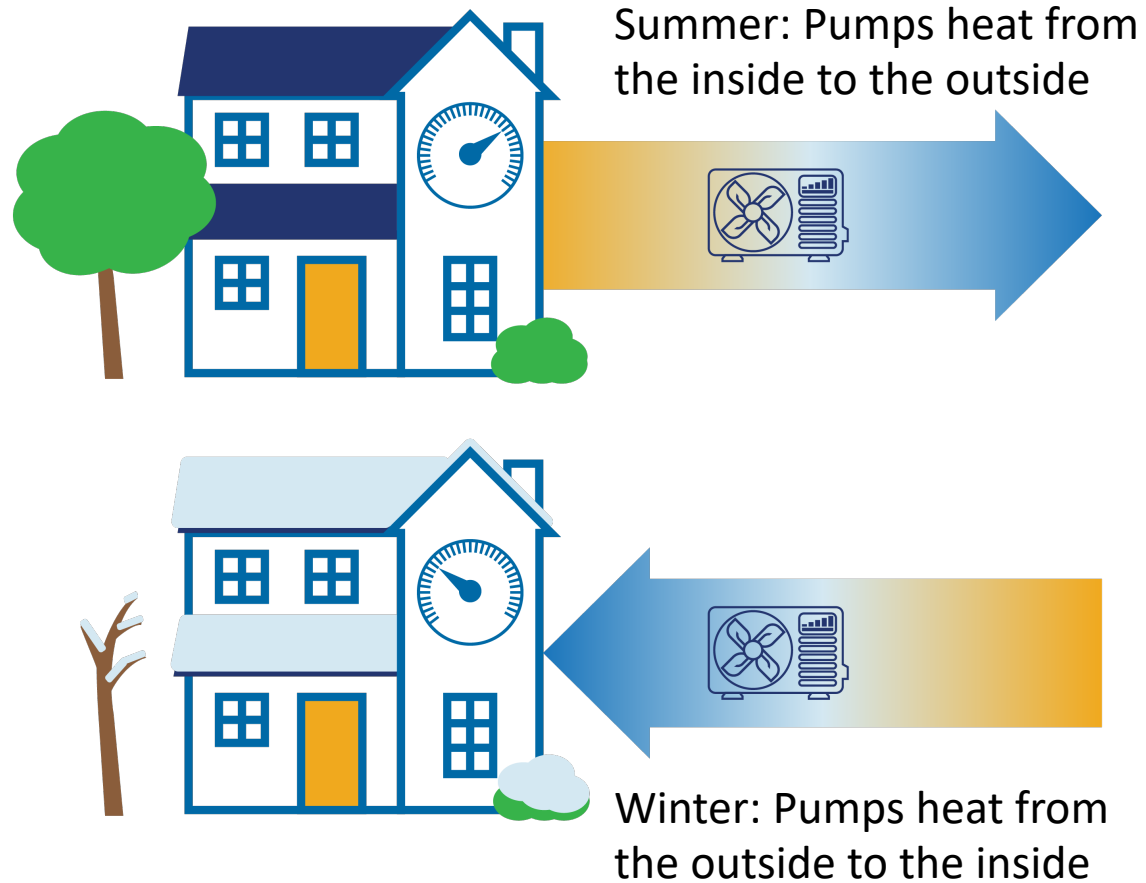
Brand Influences Product Purchases



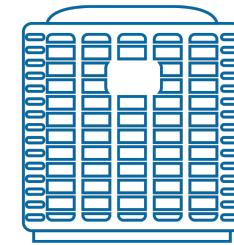
Source: Fairfield Research, July 2009

<https://www.energystar.gov/>

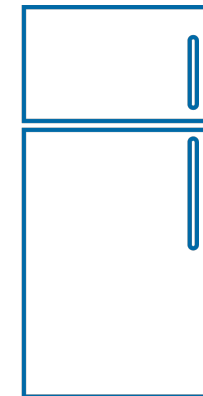
What is a heat pump?



Same technology as:



Air-conditioner



Refrigerator

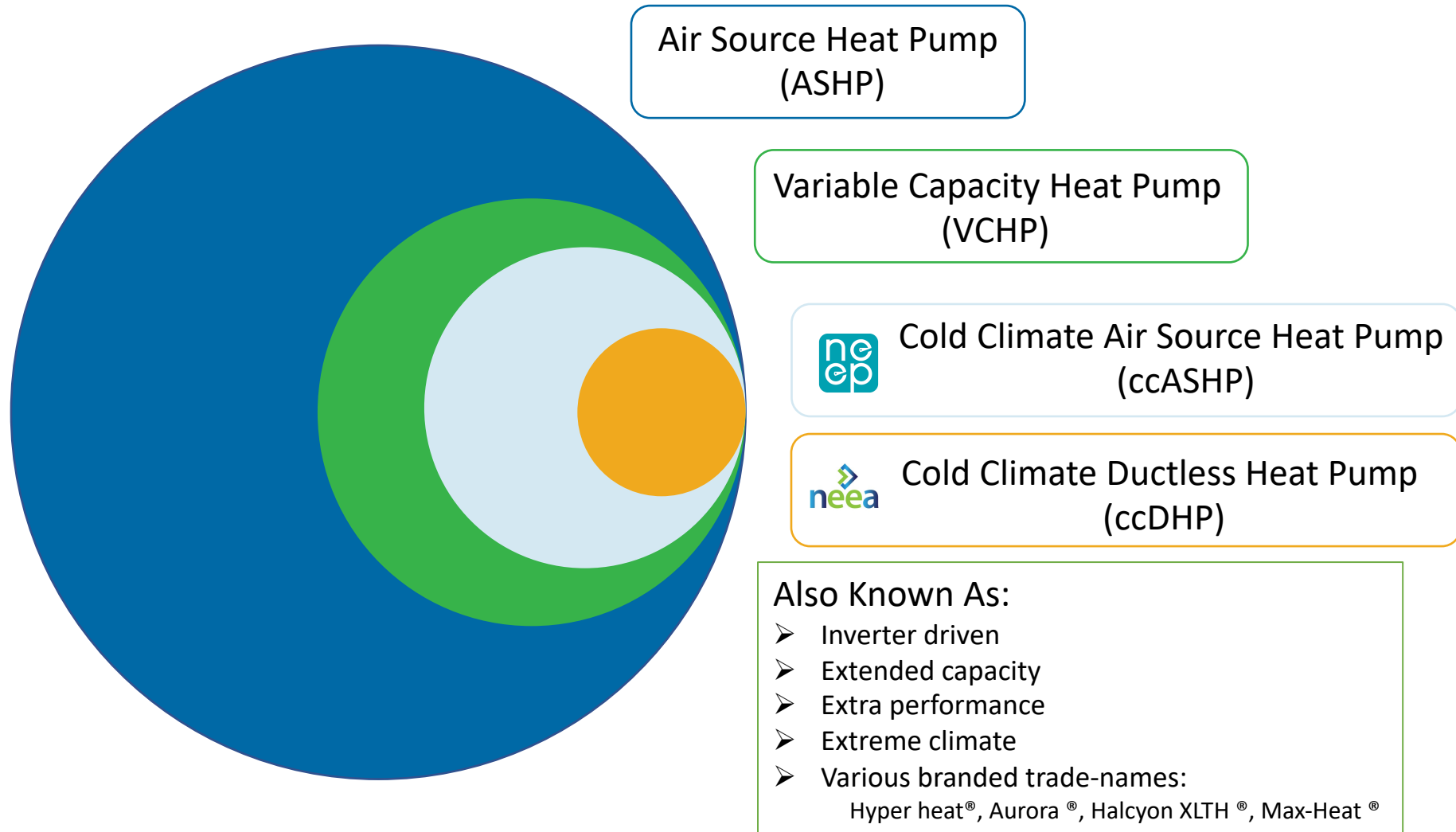
Where does the heat come from?

Heating mode: From the outside air, heated by the sun. Even when it is cold outside, heat energy can be extracted from the air and pumped inside.

Cooling mode: From the inside air. It is not bringing in cold, it is pumping heat out of the building.



The many names of a heat pump



Heat Pump Efficiency Ratings Defined

Acronym	Name	Description	Range
HSPF	Heating Seasonal Performance Factor	Overall heating efficiency; Heating output (Btu) during a typical heating season divided by total electric energy (watt-hours) used during the same period	7 – 18+
SEER	Seasonal Energy Efficiency Ratio	Overall cooling efficiency; Cooling output (Btu) during a typical cooling-season divided by the total electric energy (Watt-hours) used during the same period	14 – 25
COP	Coefficient of Performance	Instantaneous efficiency (heating or cooling); Units of energy IN divided by energy OUT	2 – 5

Customer Benefits from Heat Pumps

- Cost savings or fuel cost stabilization
- Adding cooling to spaces with heating only
- Provide increased capacity or control with supplemental equipment
- Avoiding risks from combustion heating
- Interest in slowing climate change through electrification and efficiency improvements

How Modulation Helps – Capacity

- Traditional heat pumps cannot perform at low temperatures and therefore require supplemental heat
- Cold climate heat pumps require less supplemental heat

