


Energy Hierarchy and Building Design

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ENERGY STAR Qualified Homes
Builder Option Package Notes

2004/2006 IECC Climate Zone 1 – 5ENERGY STAR Window Zone 11 – Northern

The requirements for the ENERGY STAR Builder Option Package (BOP) are specified in the checklist below. To qualify as ENERGY STAR using this BOP, a home must meet the requirements specified and be verified and field-tested in accordance with the HERS Standards by a RESNET-accredited Provider. Note that compliance with these guidelines is not intended to imply compliance with all local code requirements that may be applicable to the home to be built.

Home Address:	City:	State:		
Building System	Inspection Guidelines	Rated Verified	Must Comply	NA
Cooling Equipment <small>(Where Provided)</small>	Right-sized ¹ ≥ 13 SEER A/C; Q/R	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Right-sized ² ≥ 14.5 SEER/ 12 EER/ 8.5 HSPF ENERGY STAR qual. HP ⁴	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Heating Equipment	≥ 90 AFUE gas furnace; Q/R	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Right-sized ² ≥ 14.5 SEER/ 12 EER/ 8.5 HSPF ENERGY STAR qual. HP ⁴ ; Q/R	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	≥ 85 AFUE boiler; Q/R	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Thermostat ⁴	≥ 85 AFUE oil furnace	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	ENERGY STAR qualified thermostat (except in zones with mass radiant heat)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Ductwork	Leakage ⁵ : ≤ 4 CFM to outdoors / 100 sq. ft.; AND	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Insulation ⁶ : ≥ R-8 insulation on ducts in unconditioned spaces	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Envelope	≤ 5 ACH50	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Infiltration ^{7,8}	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	≤ Reference UA	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	UA Alternative Approach ⁹ ; Q/R	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	≥ 38 R-Value	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Ceiling Insulation ¹⁰ ; AND (if applicable)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	≥ 30 R-Value	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Cathedral Ceiling Insulation ¹¹ ; AND (if app.)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	≥ 19 R-Value	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Wood Frame Wall Insulation ¹² ; Q/R (if app.)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Windows ^{11,12,13}	Wood Frame Wall Insulation and Sheathing ¹³ ; AND (if app.)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	≥ 13 + 5 R-Value	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Floor Over Unconditioned Space Insulation ¹⁴ ; AND (if app.)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	≥ 30 R-Value	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Crawlspace Wall Insulation Continuous ¹⁵ ; Q/R (if app.)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	≥ 10 R-Value	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Crawlspace Wall Insulation Framed ¹⁶ ; AND (if app.)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	≥ 13 R-Value	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Basement Wall Insulation Continuous ¹⁷ ; Q/R (if app.)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	≥ 13 R-Value	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Water Heater ^{14,15}	Basement Wall Insulation Framed ¹⁸ ; AND (if app.)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	≥ 10 R-Value	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Slab Insulation ¹⁹ ; AND	Completed Thermal Bypass Inspection Checklist ¹⁰	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	≤ 0.40 U-Value	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Any SHGC	Gas (EF): 40 Gal = 0.61 60 Gal = 0.57 80 Gal = 0.53	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Electric (EF): 40 Gal = 0.93 50 Gal = 0.92 80 Gal = 0.69	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Lighting and Appliances ^{17,18}	Oil or Gas ²⁰ : Integrated with space heating boiler	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Five or more ENERGY STAR qualified appliances, light fixtures, water heaters, ceiling fans equipped with lighting fixtures, and/or ventilation fans	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

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MINERGIE®

Meilleure qualité de vie, faible consommation d'énergie
Mehr Lebensqualität, tiefer Energieverbrauch



Image:
Transsolar

Building
Codes

Sustainability
Standards

Renewable
Technologies

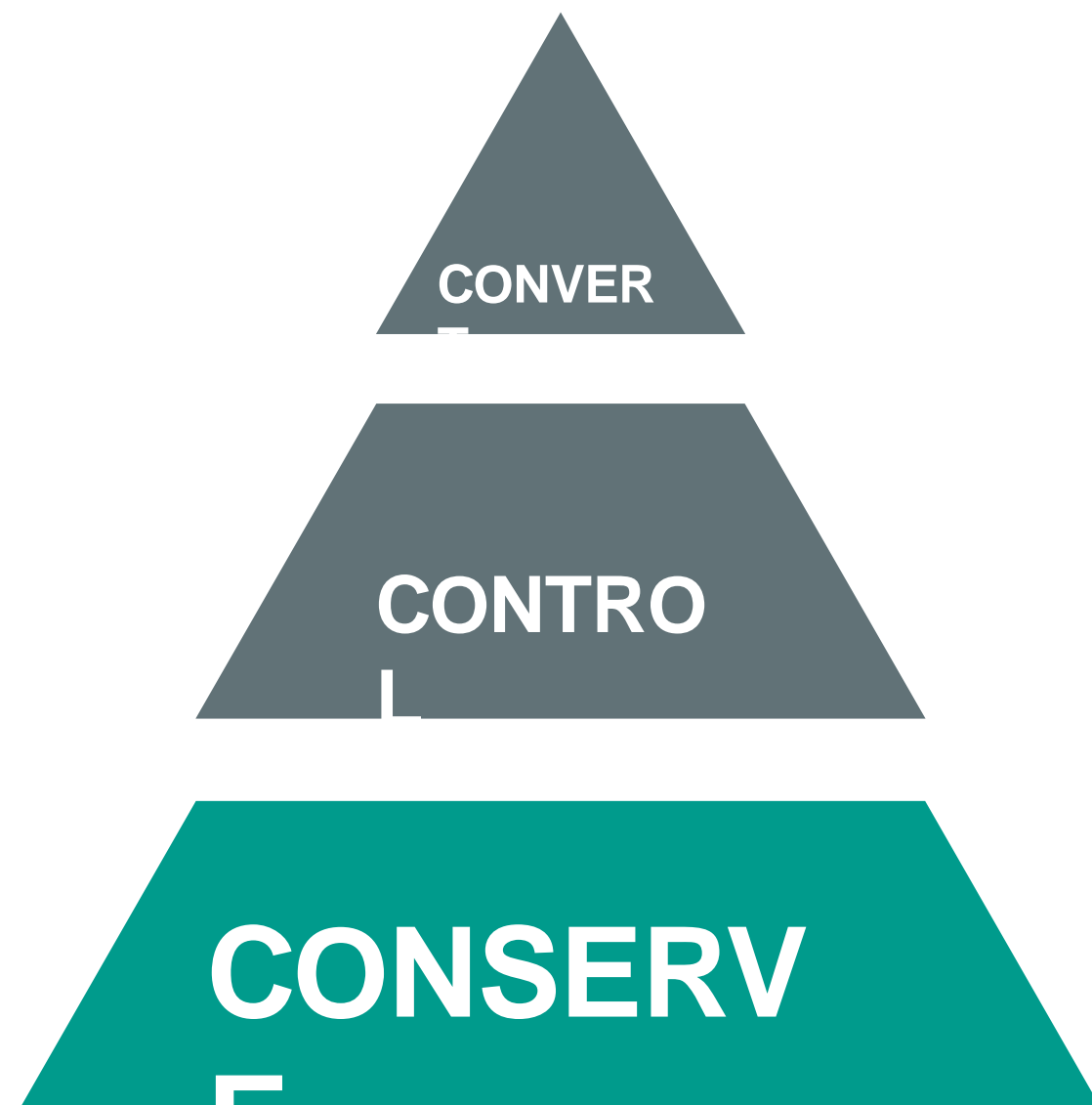




Waste Hierarchy



Waste Hierarchy



Energy Hierarchy

CONVERT

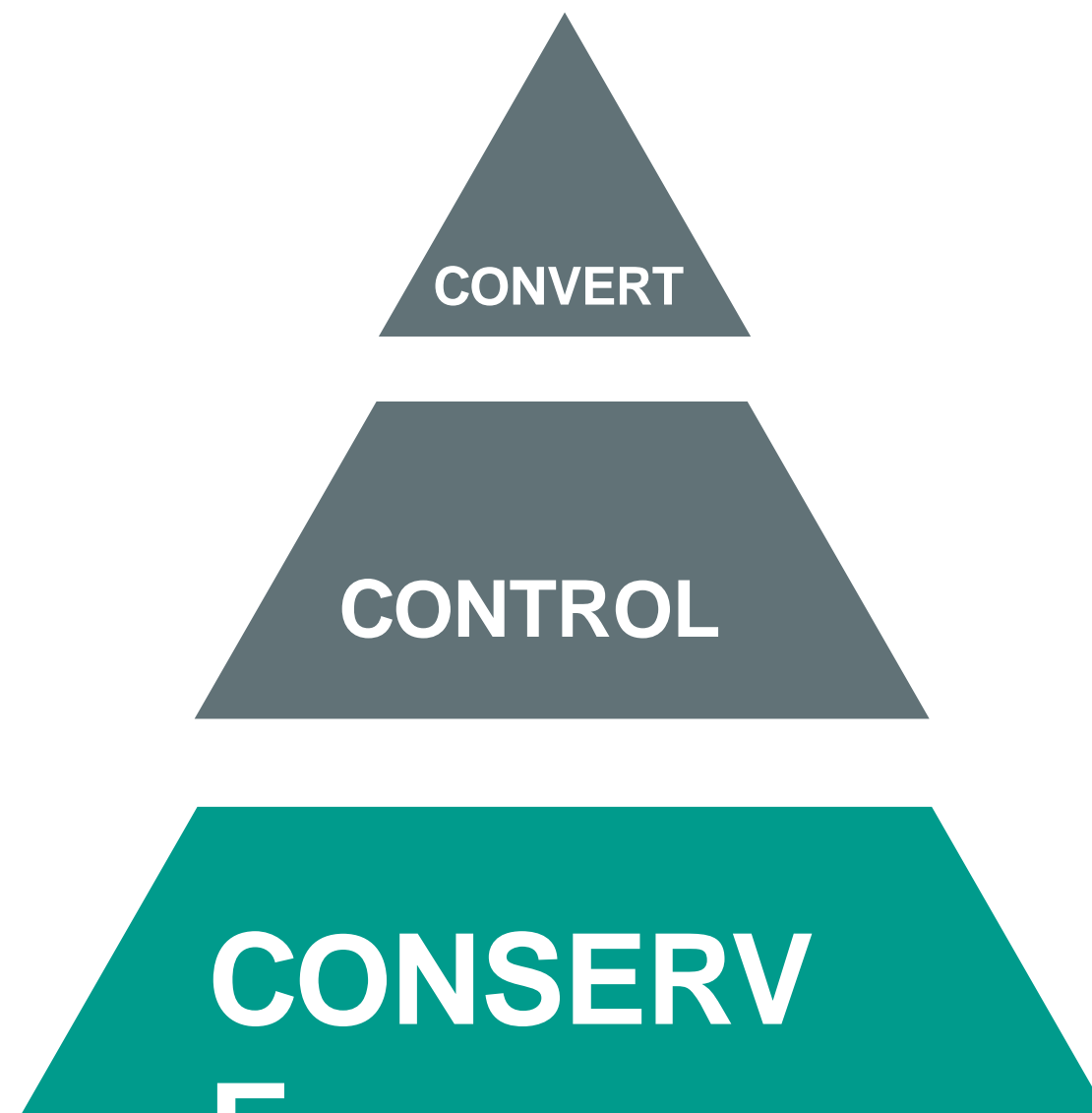
Get energy from renewable sources

CONTROL

Make sure energy that is being used is used efficiently through a review of Mechanical and Electrical Equipment

CONSERV

Prevent unnecessary energy use through Passive Climate Control Strategies and Behavioral Strategies



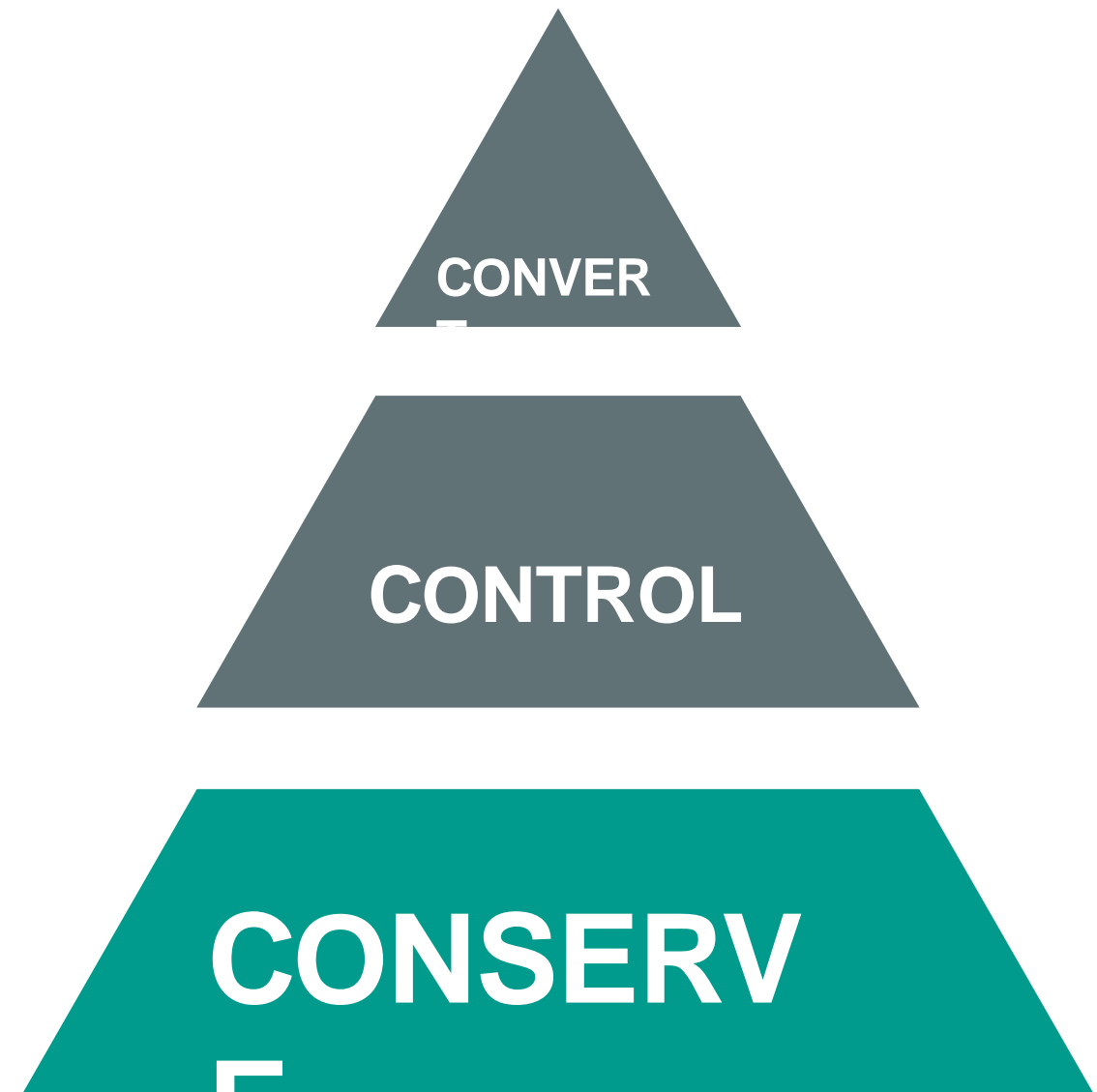
Energy Hierarchy

CONSERVE

Passive Building and Behavioral Strategies

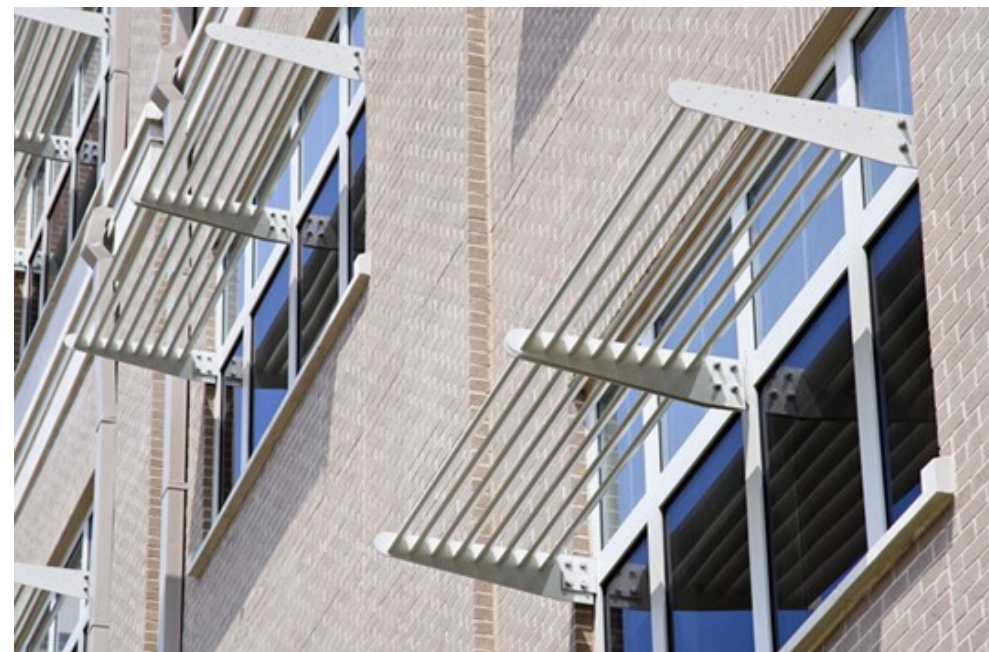
- largest impact with the least expense
- pre-schematic design choices about building siting and orientation, passive solar and ventilation options, landscape choices.
- schematic design choices about the building envelope, both opaque and transparent walls.
- building occupant education and awareness

Energy Hierarchy



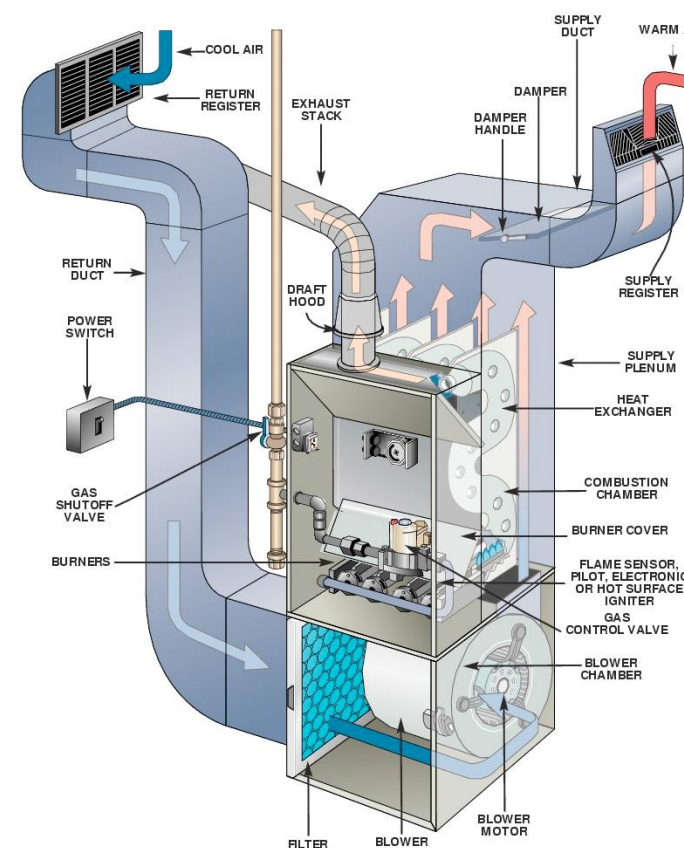
Passive Climate Control System

typically does not rely on purchased energy and uses basic elements of the building such as windows, walls, floors, etc.

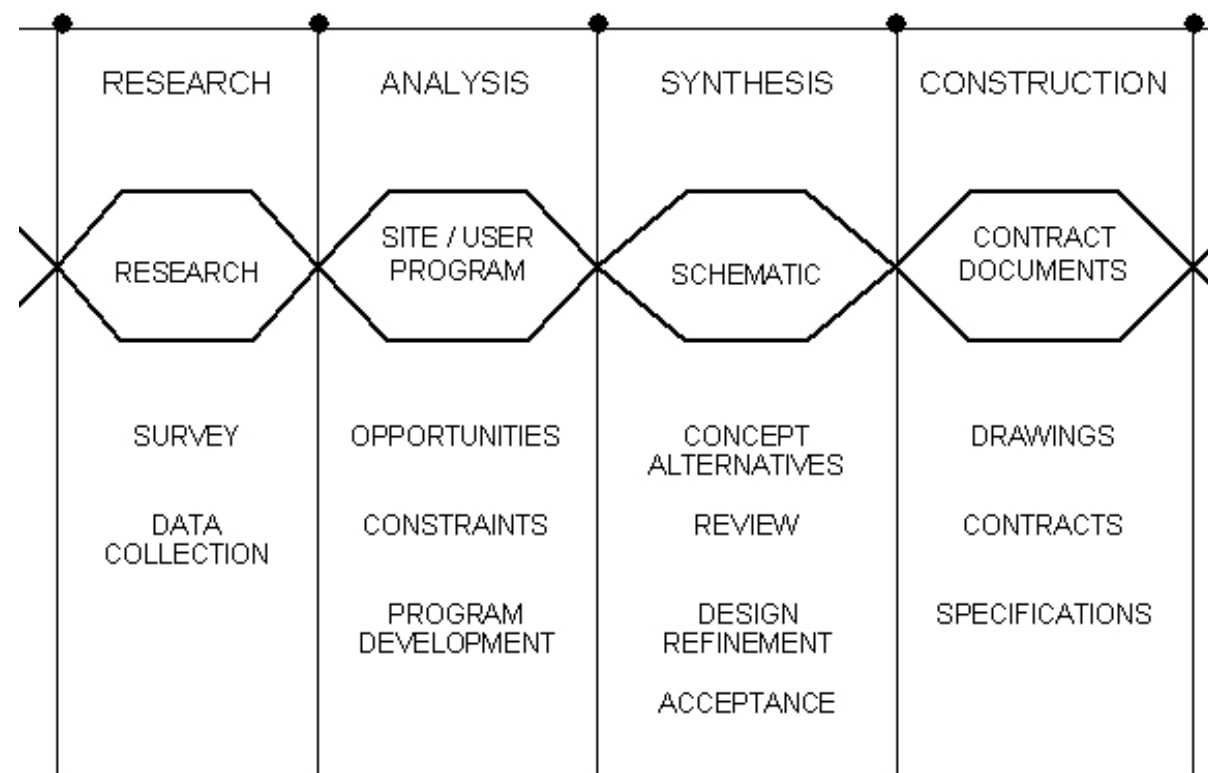


Active Climate Control Systems

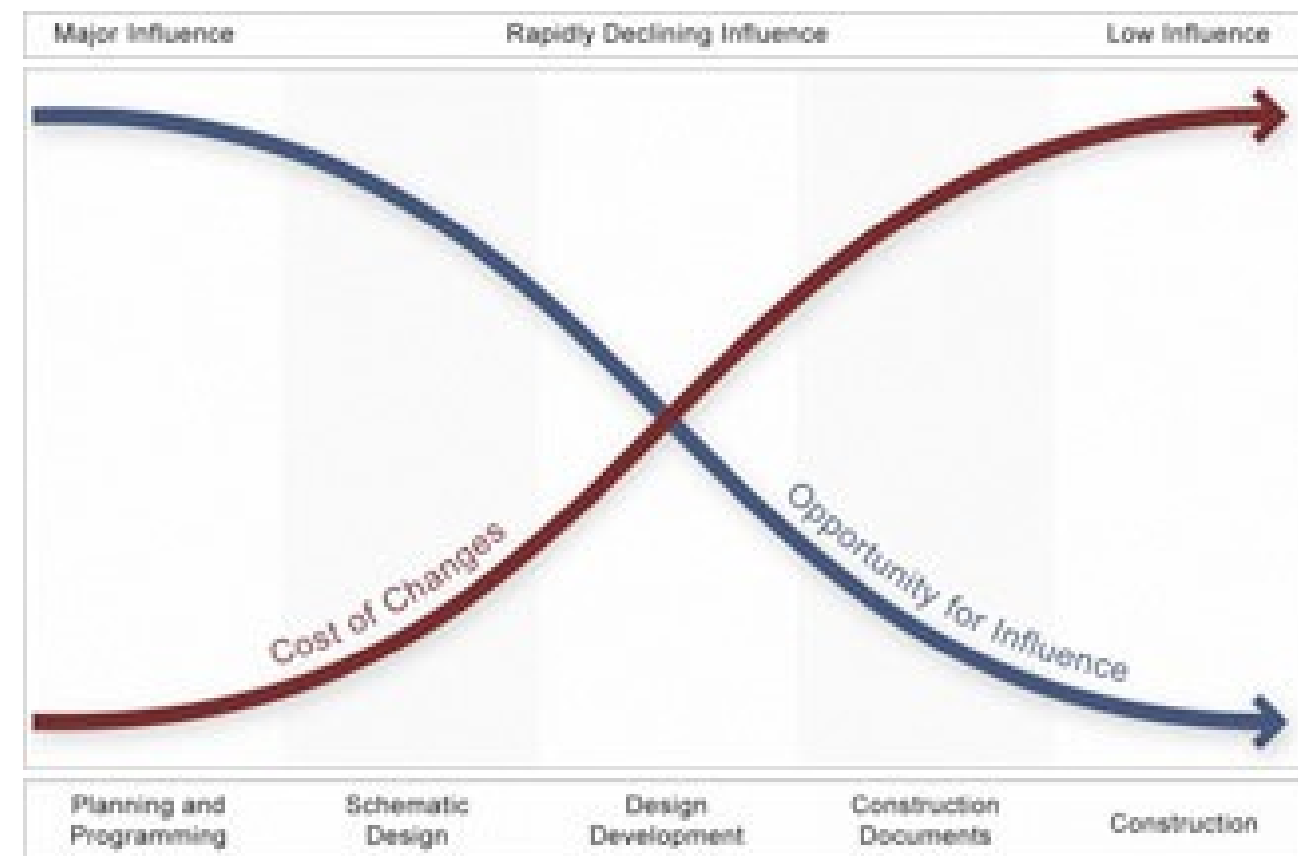
typically relies on purchased energy and dedicated equipment within the building (ducts, motors, wires, etc.)



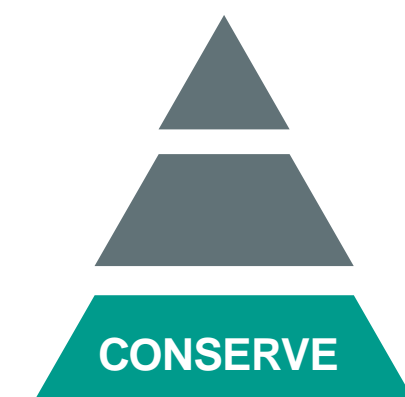
CONSERVE

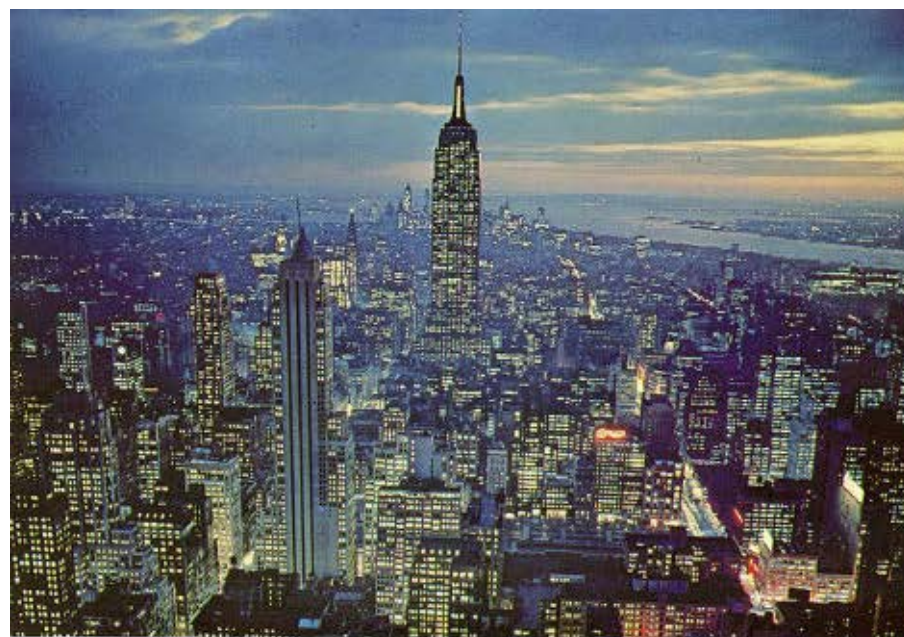


Typical Project Phases



Potential for Impact





Urban

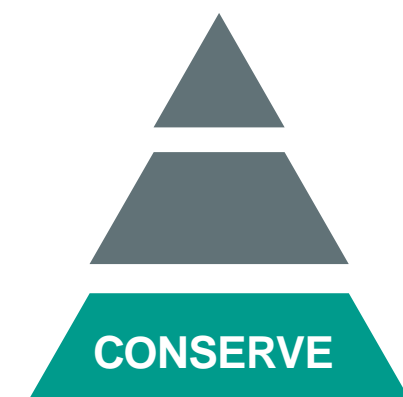


Suburban

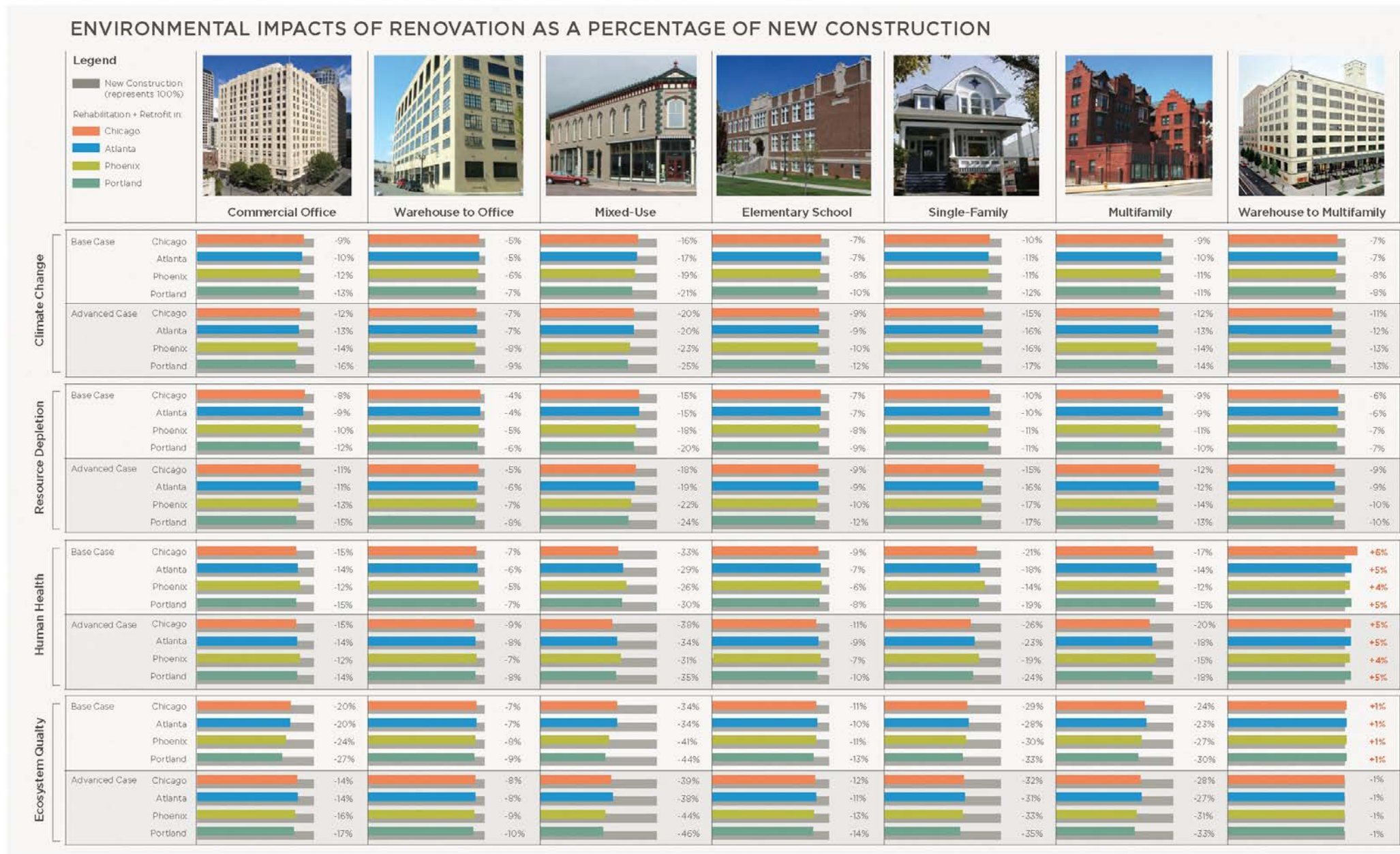


Rural

Context matters



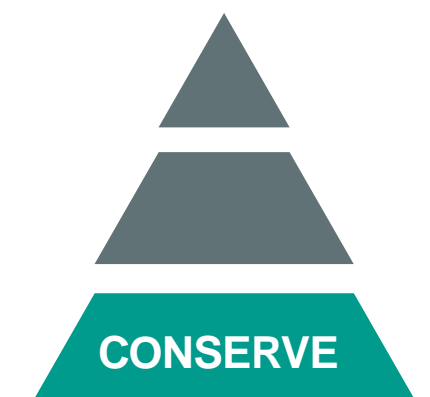
Summary of Results – The Greenest Building: Quantifying the Environmental Value of Building Reuse

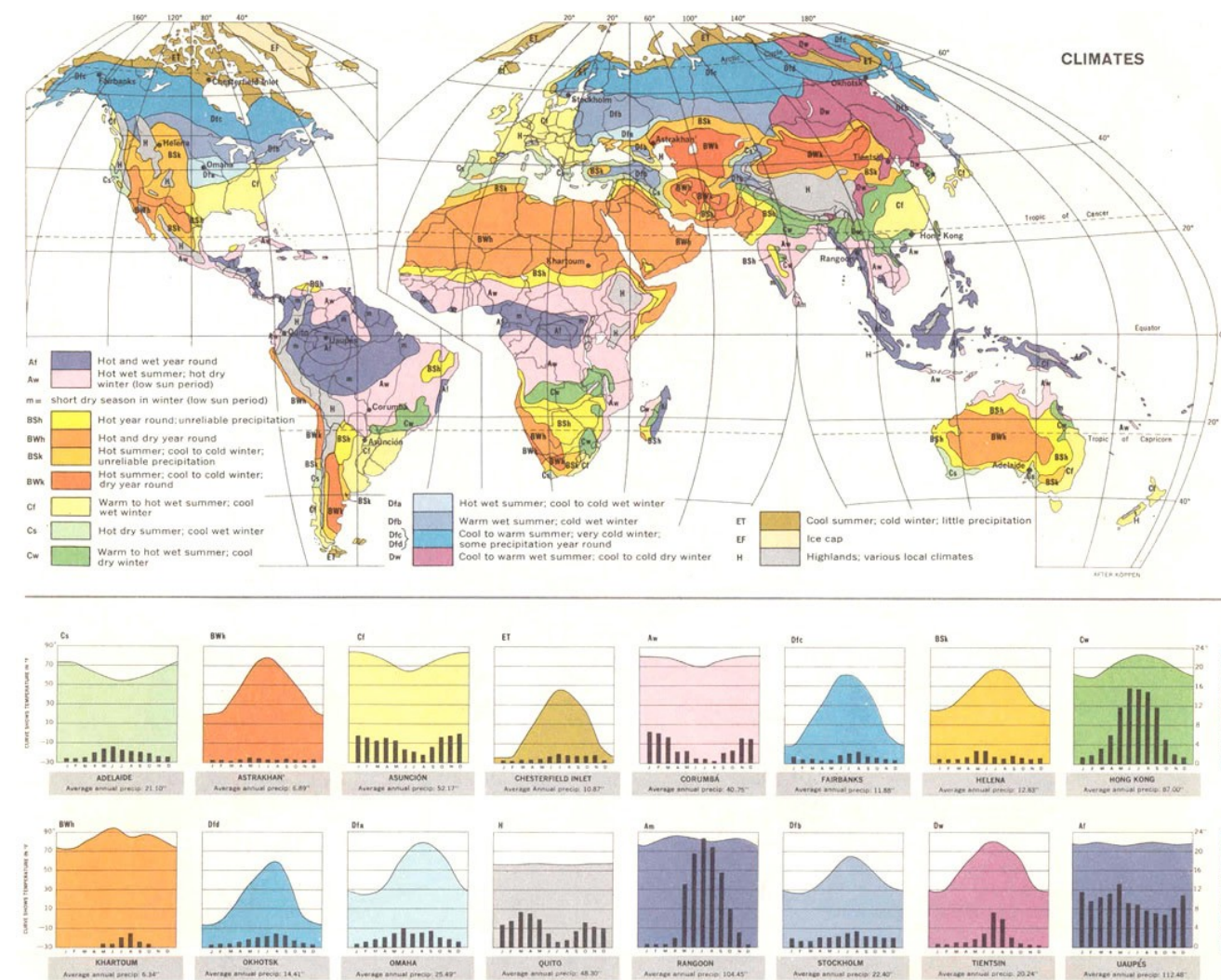


A full description of each impact category and the methods used to evaluate them is located in the *Technical Appendices*. Base Case = average energy performance, see Section 4 on methodology for determining energy use. Advanced Case = 30% more efficient than Base Case.

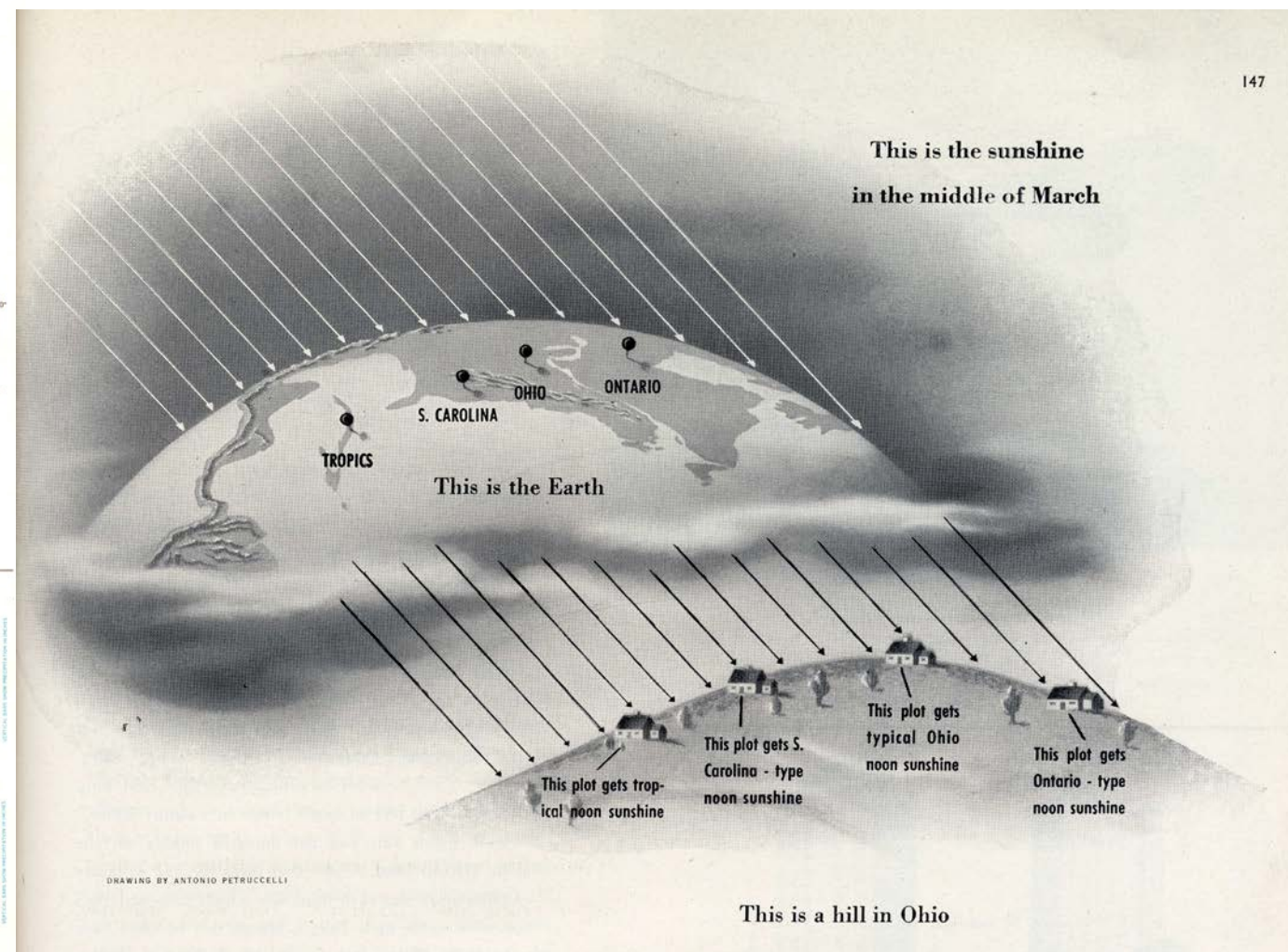
The Environmental Value of Building Reuse - National Trust for Historic Preservation

New Construction versus Rehabilitation



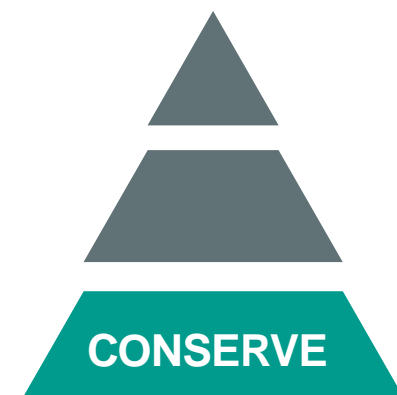


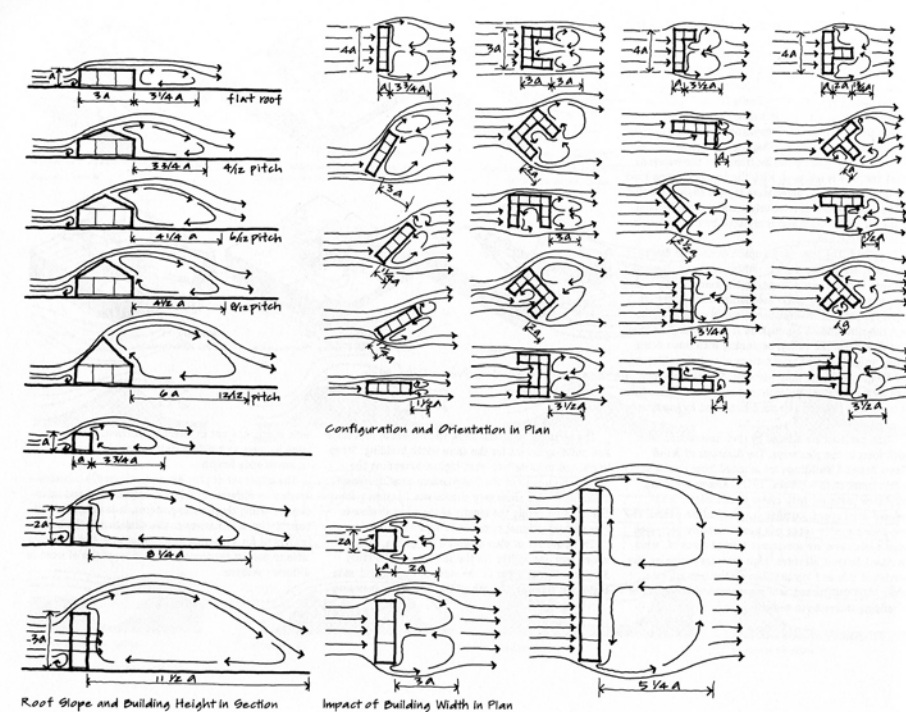
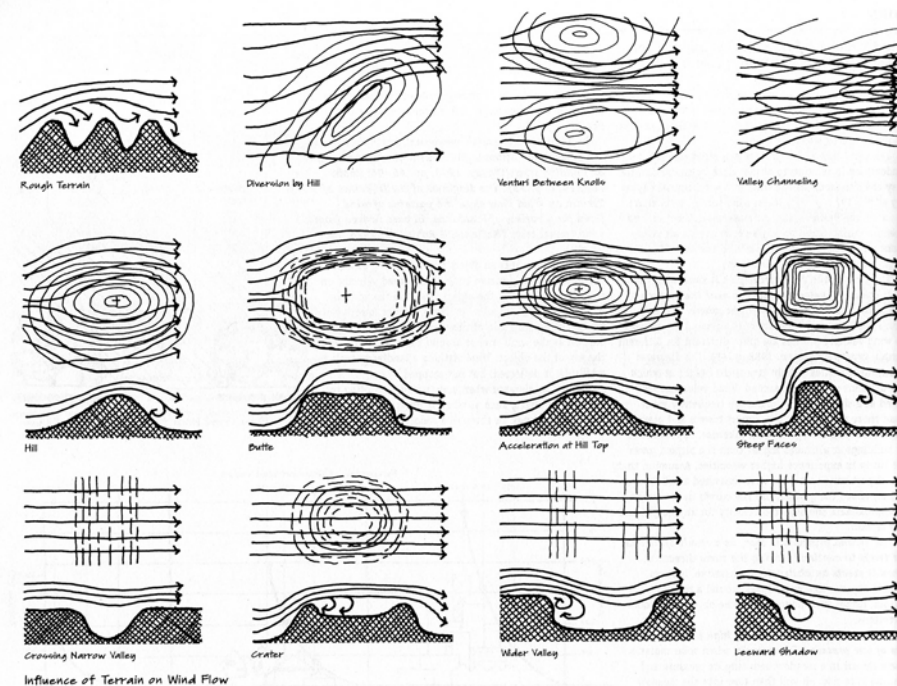
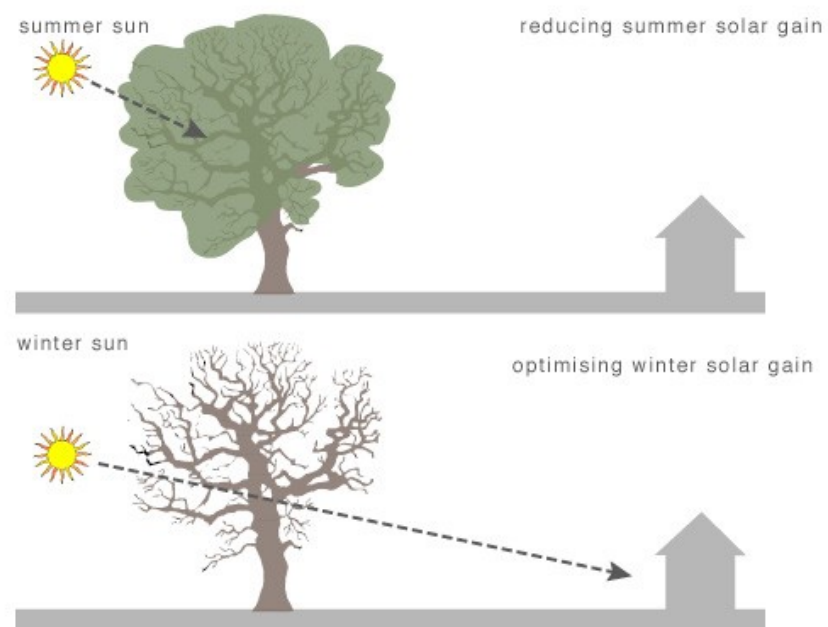
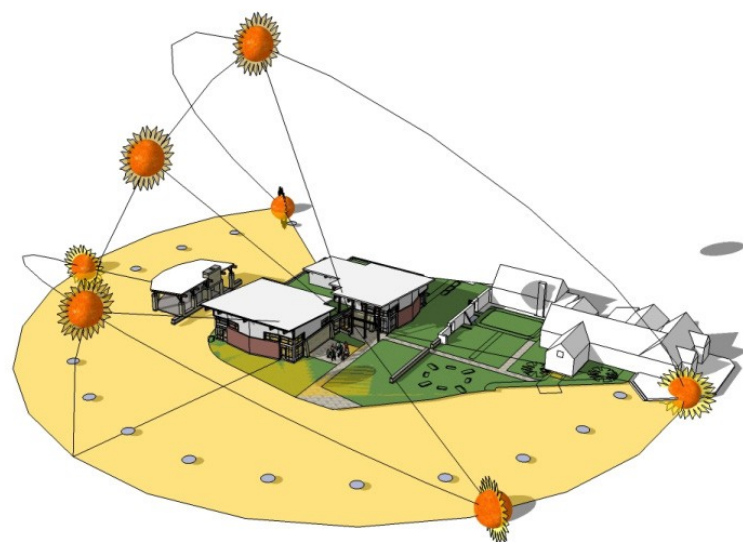
Macroclimate - Köppen Climate Classification



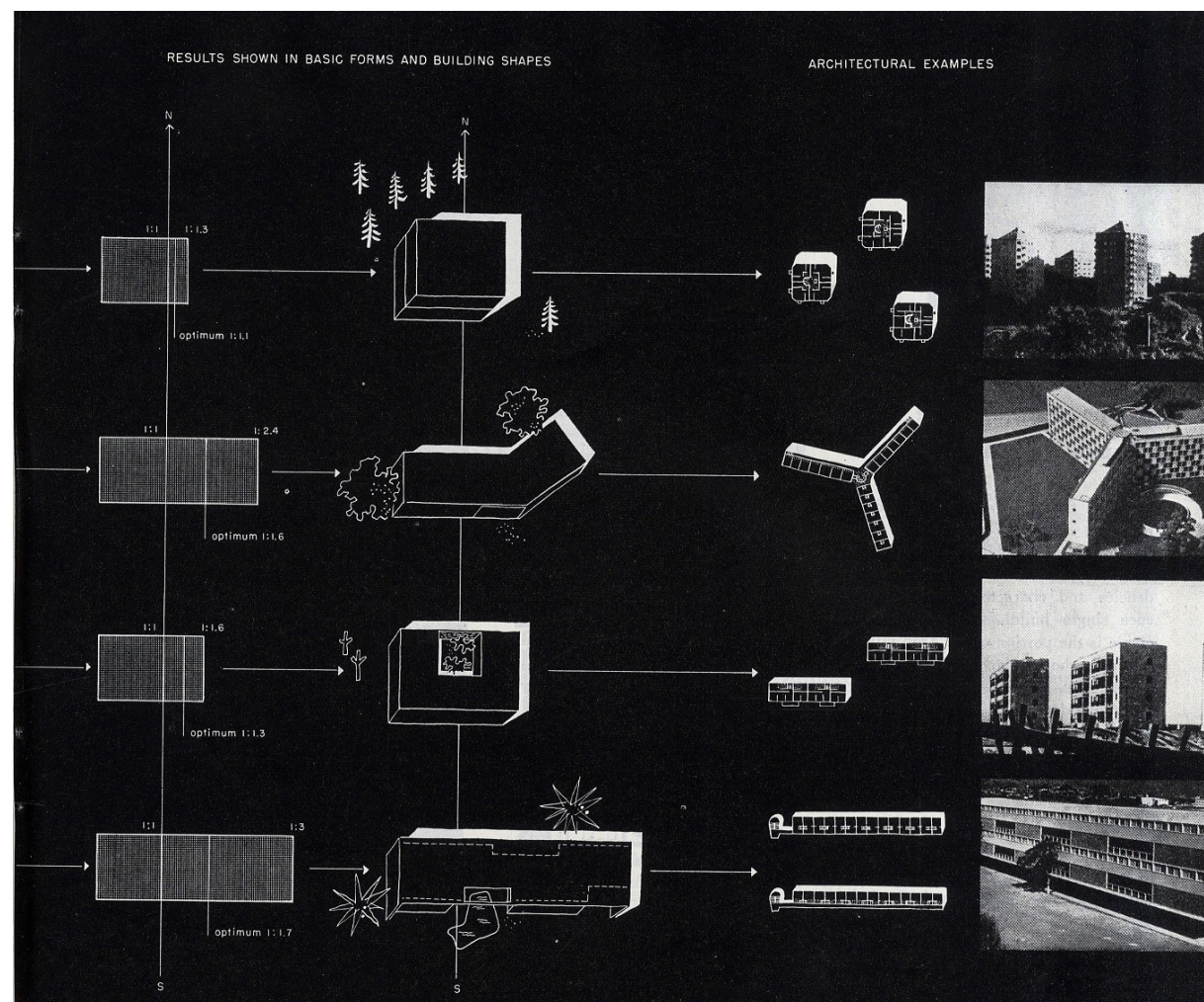
Microclimate - "This is a hill in Ohio." House Beautiful, October 1949

Climate exists at many scales - Macro to Micro



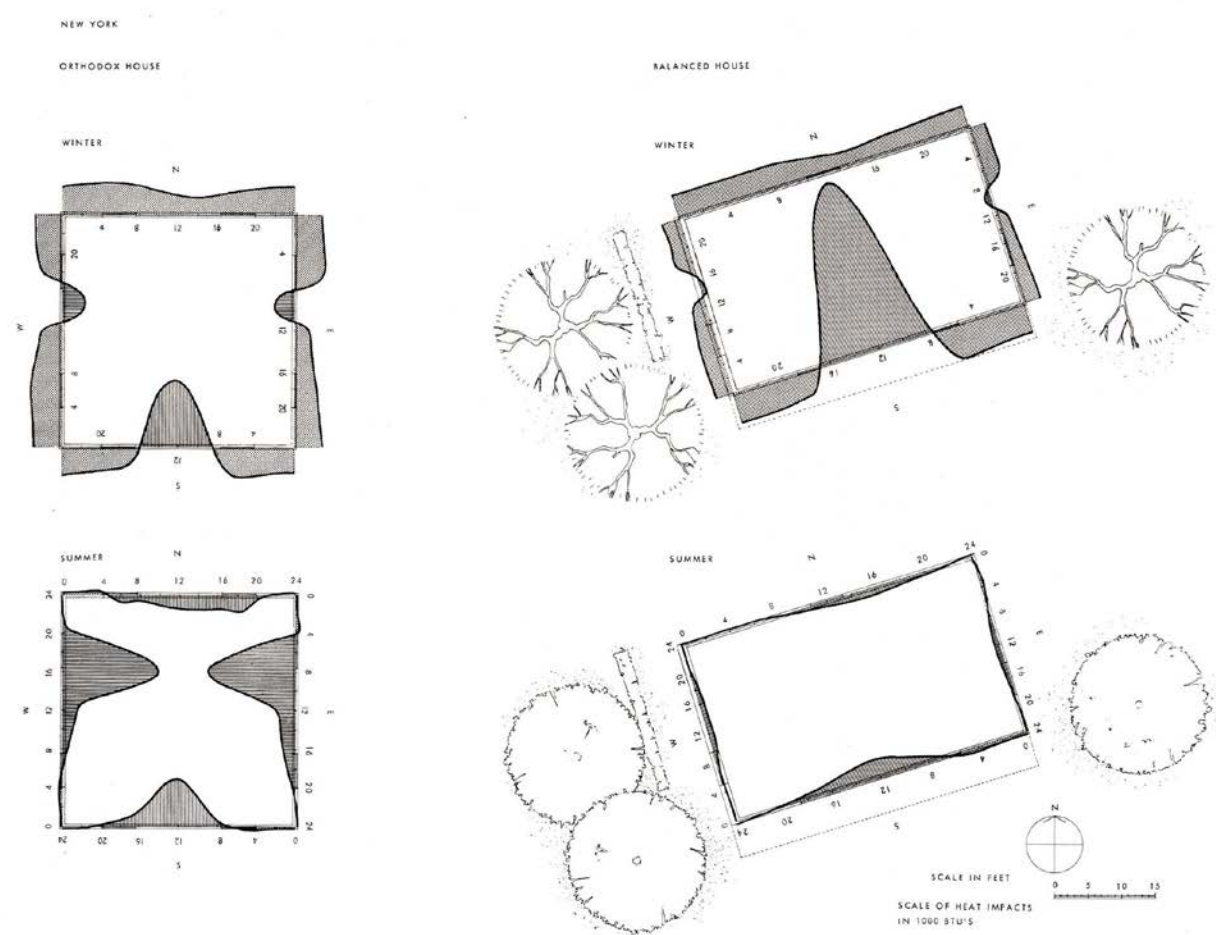


Control the site's microclimate

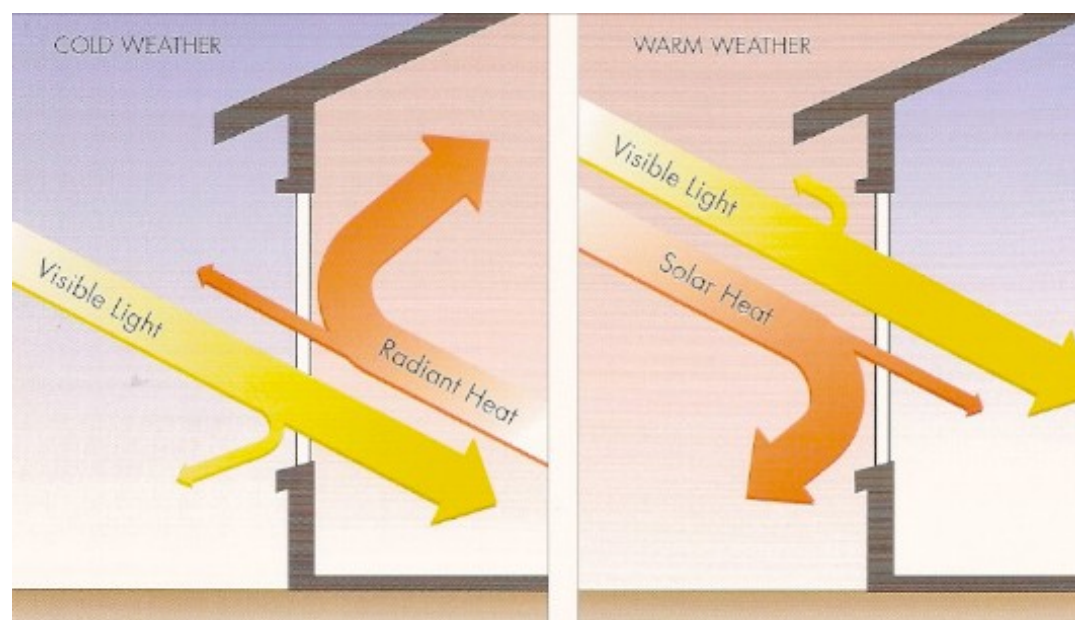


Victor Olgyay Design With Climate,
1963

Control the building's massing



CONSERVE

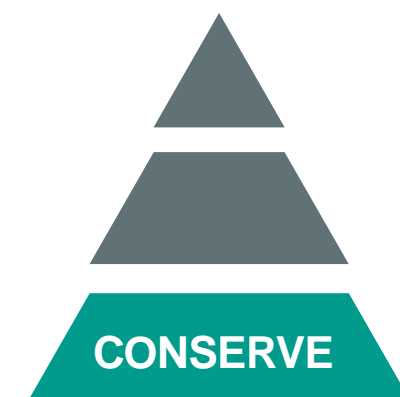


SHGC and U-value of windows



R-Value and air-tightness for Walls

Understand your house's thermal envelope



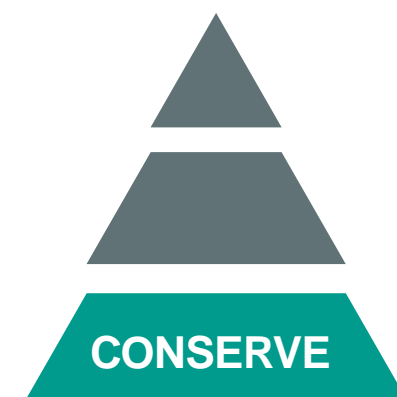
Home Energy Opportunity Check List

		Opportunity			
		Pri	Small	Medium	Large
1.	Combustion Safety Concern	C	Sealed Comb. Appl.	Natural draft Furnace	Natural Draft HW & unvented gas stove
2.	House Tightness Air Sealing	H	< 1.5 X BAS	1.5 to 2.5 X BAS	> 2.5 X BAS
3.	Attic Insulation	H	> 14" insulation	5.5" to 14"	< 5.5" insulation
4.	Wall Insulation	D	5.5" insulated	3.5" Insulated	Empty Walls
5.	Rim Joist	H	Foam Sealed & Insulated	Fiberglass only	Empty
6.	Basement Walls	D	Insulated	Partially Insulated & Sealed	Bare
7.	Heat Distribution System	D	Insulated & Sealed	Partially Insulated & Sealed	Bare
8.	Heating System	D	Condensing Furnace or Boiler	Medium Efficiency	Standing Continuous Pilot
9.	Water Heating	D	Gas Tankless or Indirect w/ HE Boiler	Electric, oil, propane 1 or 2 in household	Electric, oil, propane > 2 in household
10.	Windows & Doors	D	Double Pane & Insulated Doors	Single pane & storms Wood doors	Single pane poorly installed
11.	Lighting	D	Mostly all lights are CFL or LED	50% Incandescent	Mostly all lights are incandescents
12.	Refrigerator	D	< 500 kWh/Year	500 to 1000 kWh/Yr	>1000 kWh/Year
13.	Clothes Washer	D	2 People, cold water, line dry	2-3 people, w/ ooc. hot water, electric dry	4+ more active electric or gas dry
14.	Solar Electric (PV)	D	This area is more difficult to specify. Conserve as much electricity as possible, and if you have access to the sun install PV.		

Priority: C = Critical H = High D = Depends on a lot of things...



Energy Audit for Existing Homes

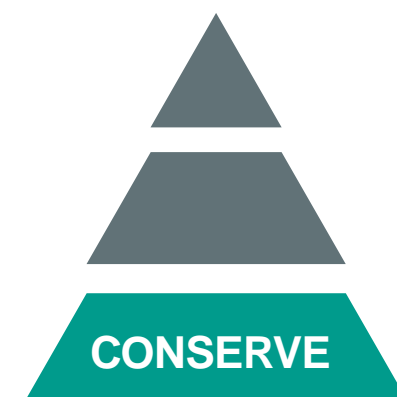




Jimmy Carter, Proposed Energy Policy, April 18, 1977



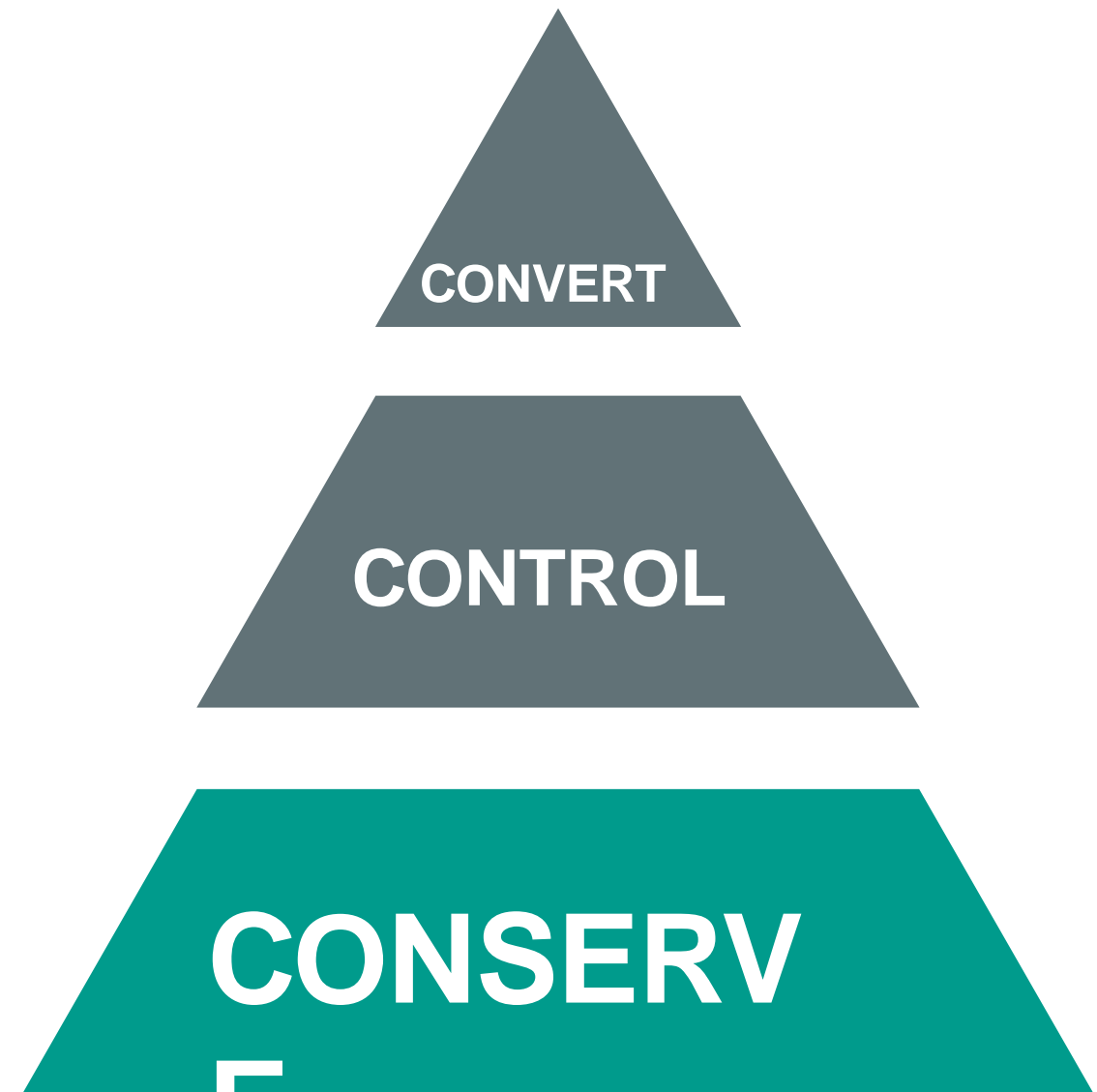
Behavioral Changes



CONTROL

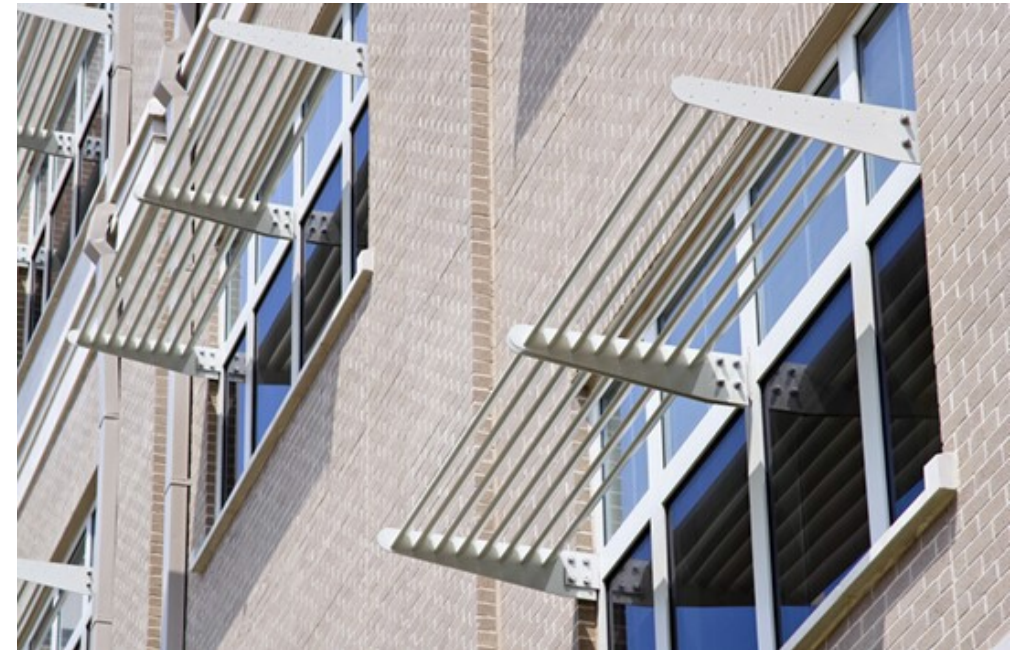
Mechanical and Electrical Equipment

- allows for reduced energy consumption without necessarily changing the behavior of building occupants
- design development or building retrofit choices
- Includes energy efficient HVAC equipment, appliances, lighting and building controls systems



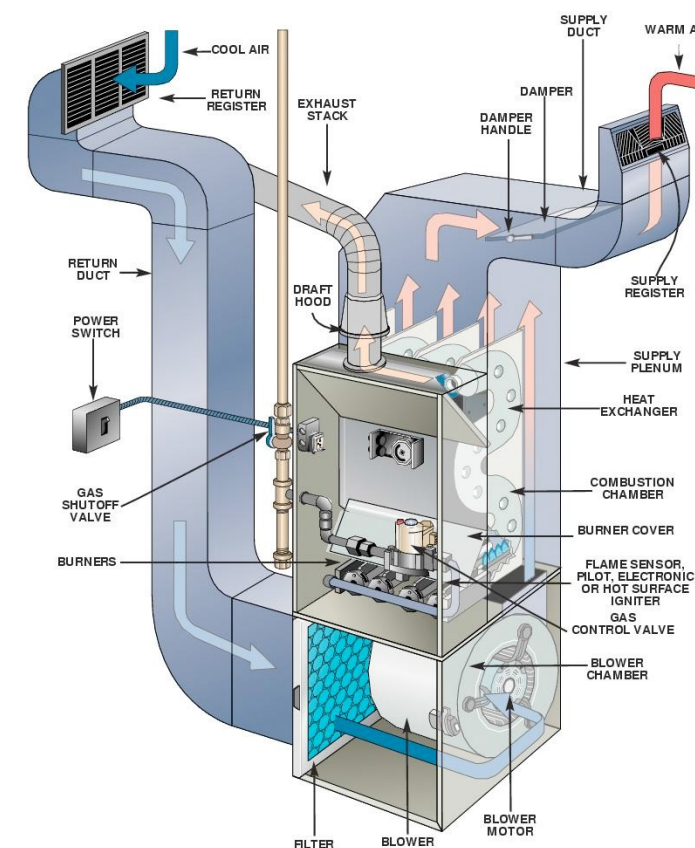
Passive Climate Control System

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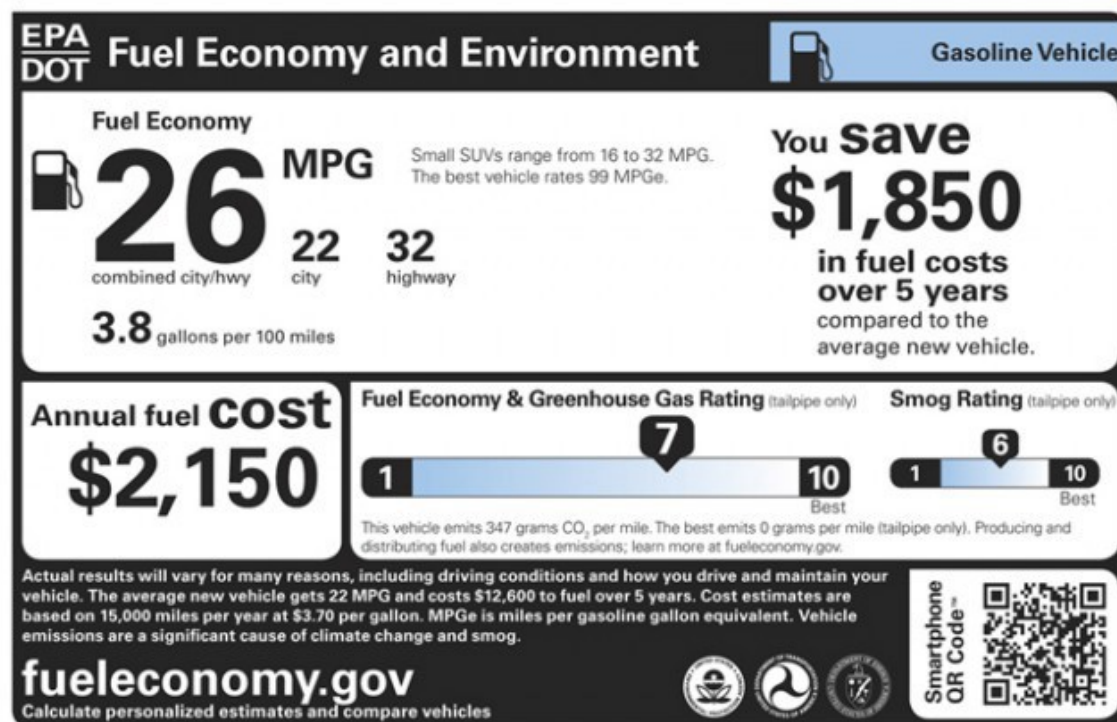


Active Climate Control Systems

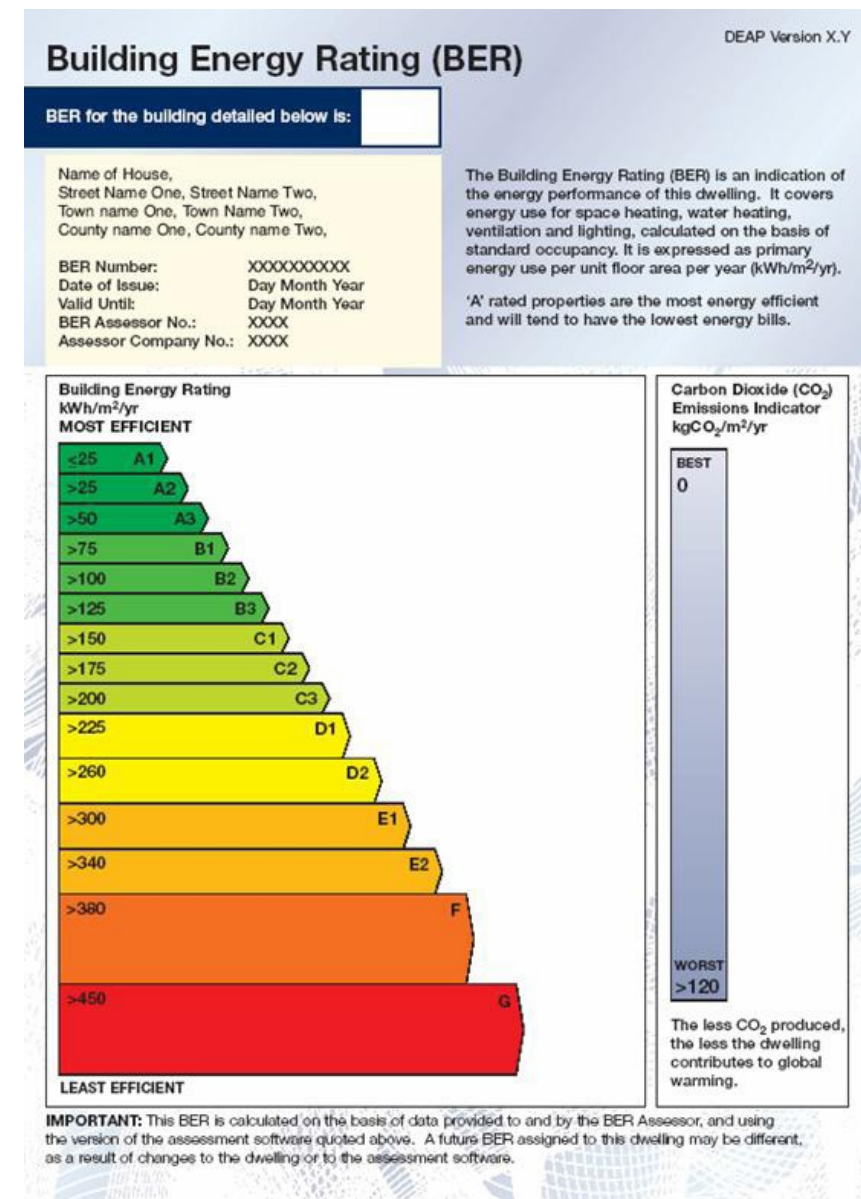
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CONTROL

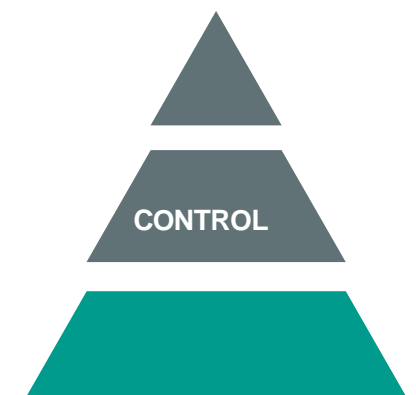


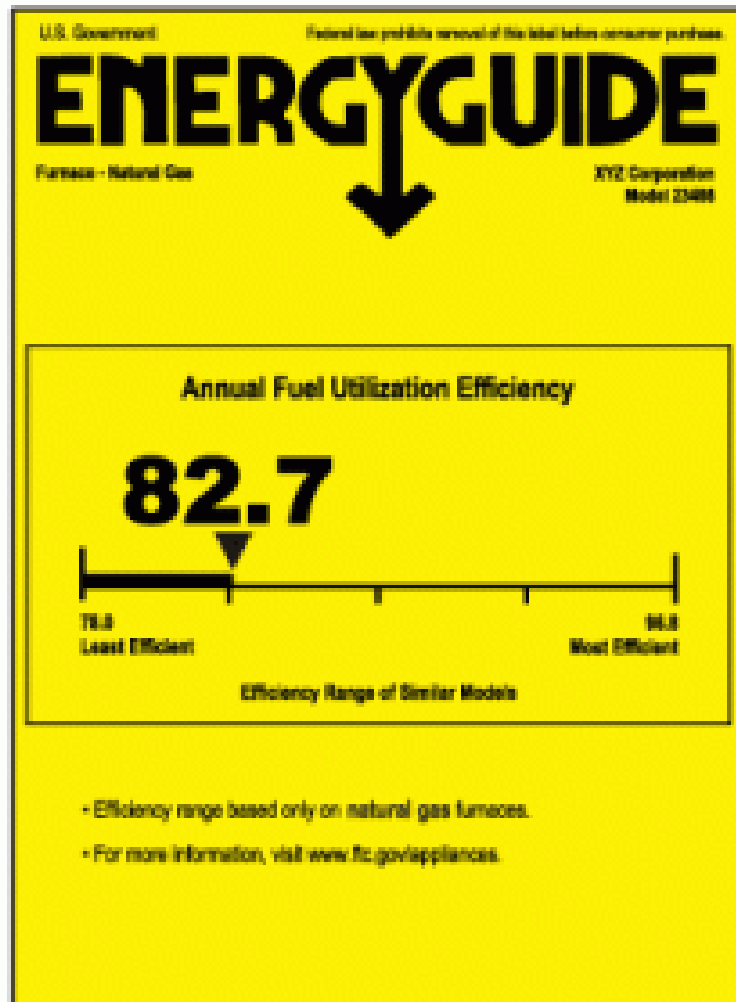
EPA Fuel Economy and Environment for Cars in the US



Building Energy Rating for buildings in the EU

Fuel Economy Guides

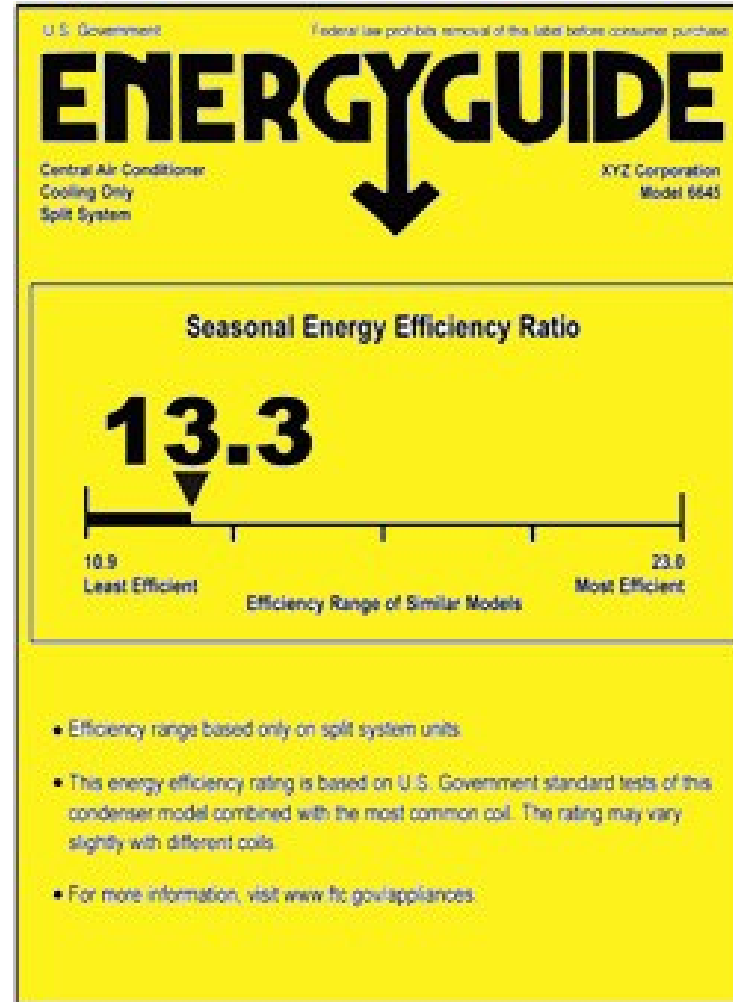




AFUE Rating

Annual Fuel Utilization
Efficiency

For combustion equipment like
furnaces, boilers and water
heaters.



SEER Rating

Seasonal Energy Efficiency
Rate

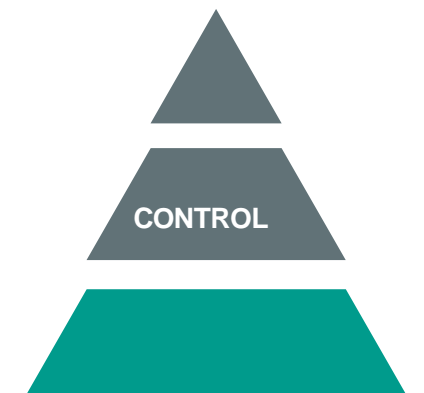
For cooling output from air
conditioning equipment.

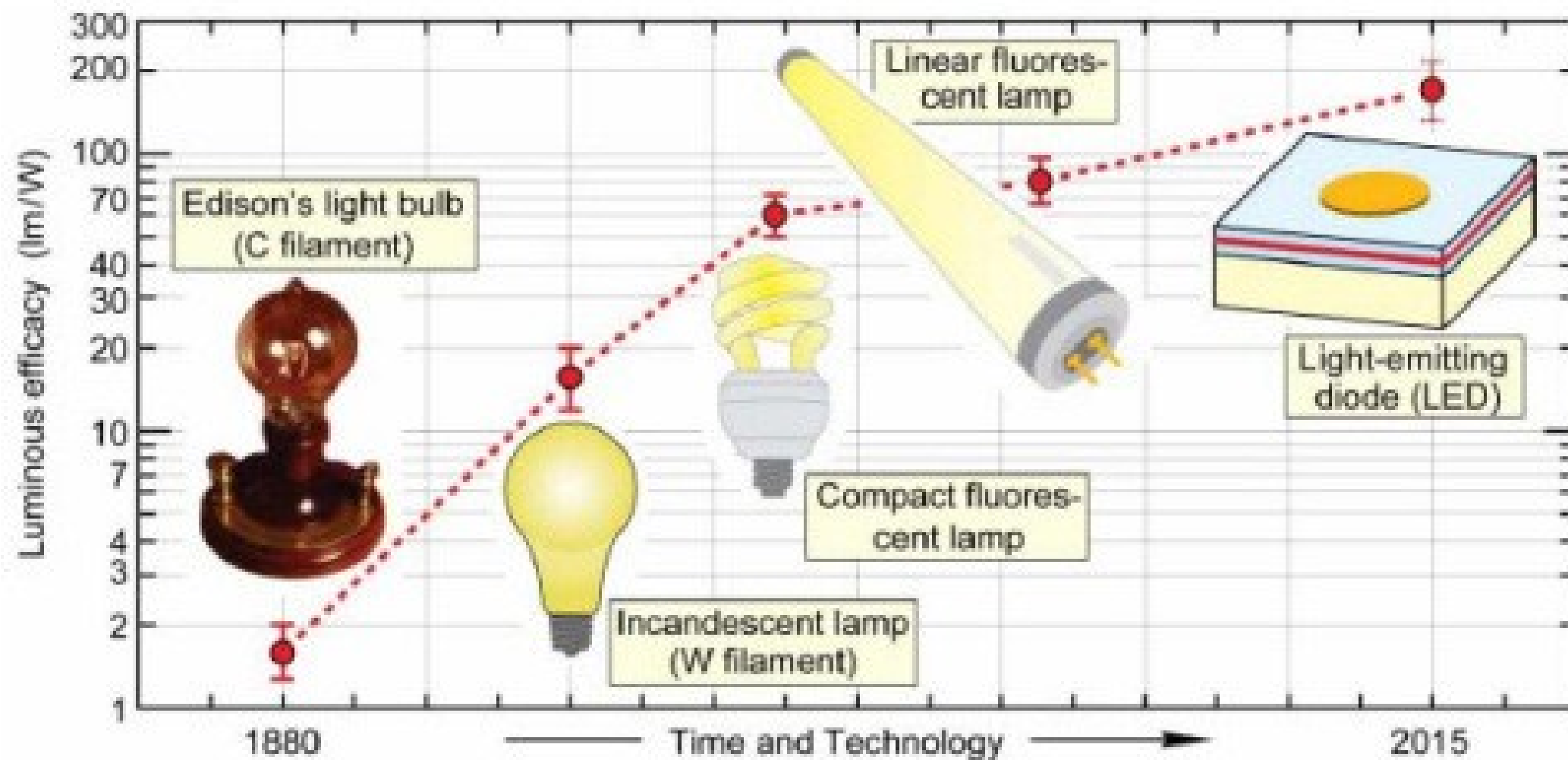


Energy Star Rating

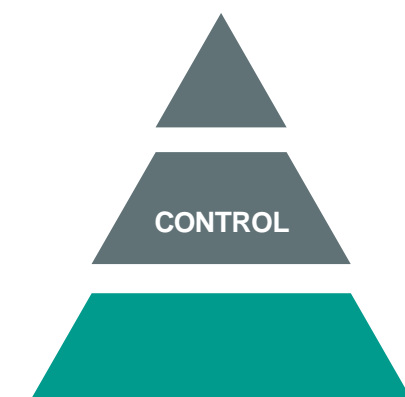
Ratings for the consumer products-such as re-
frigerators, dish washers, dryers, etc-
suggesting they use less energy than other
appliances.

HVAC Equipment & Appliances



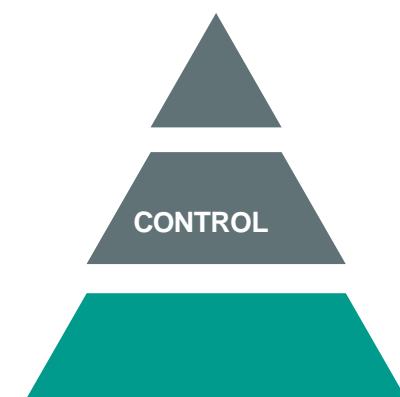


Lighting Equipment



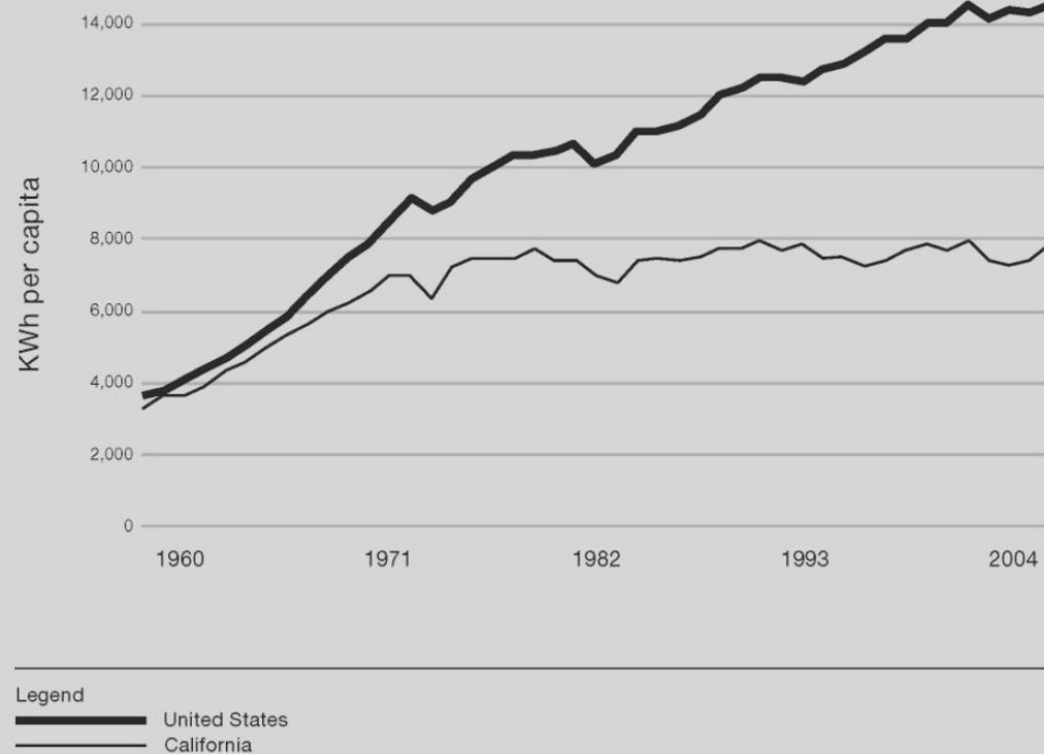


Building Controls



Energy codes do make a difference

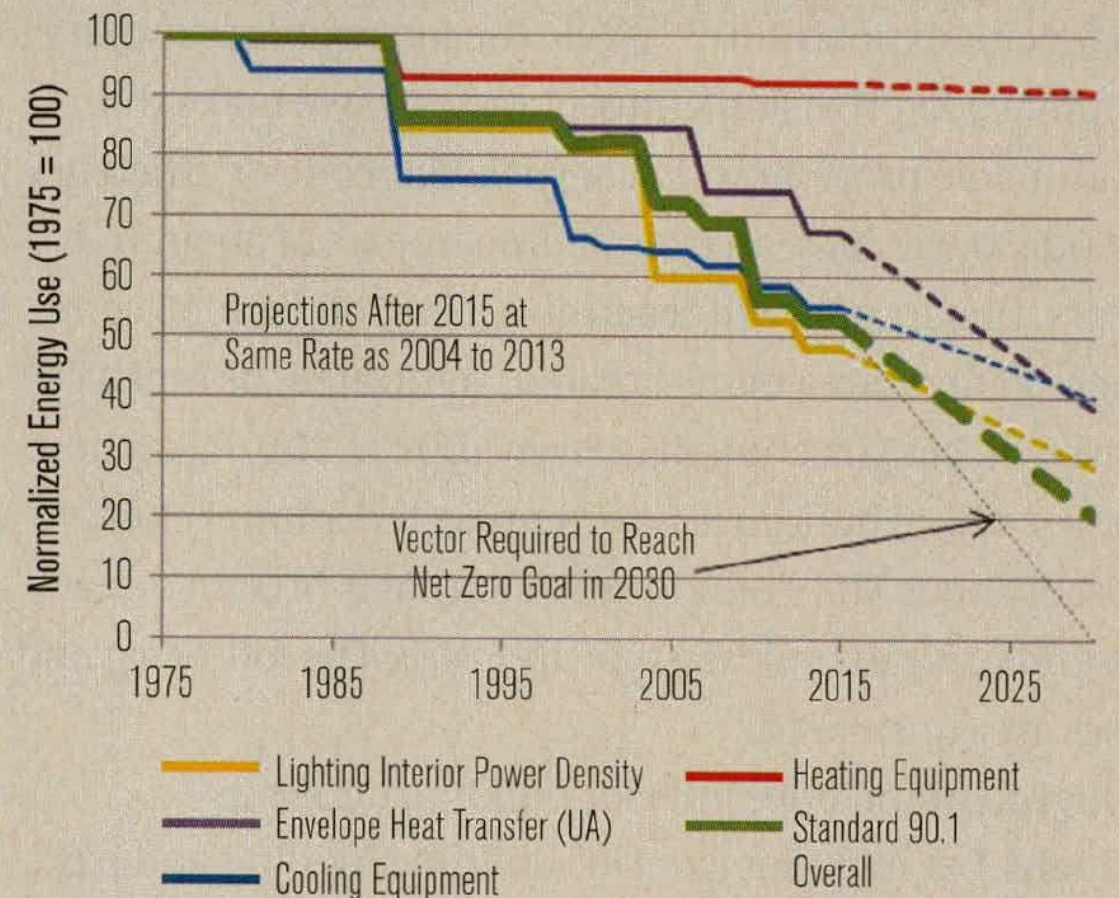
California and United States per capita electricity consumption



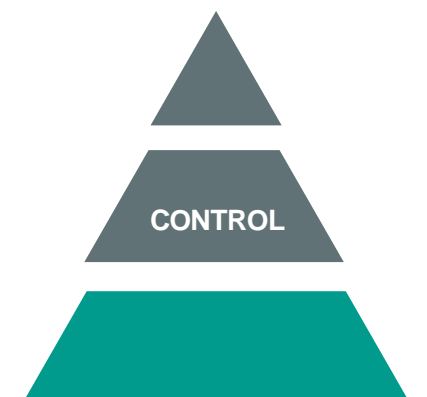
Notice the flatlining of the California figures since the early 1970s
 Source: Arup, Data: California Energy Commission, 2004

ARUP

FIGURE 1 Improvement in ASHRAE Standard 90/90.1 (1975 – 2013) with projections to 2030.



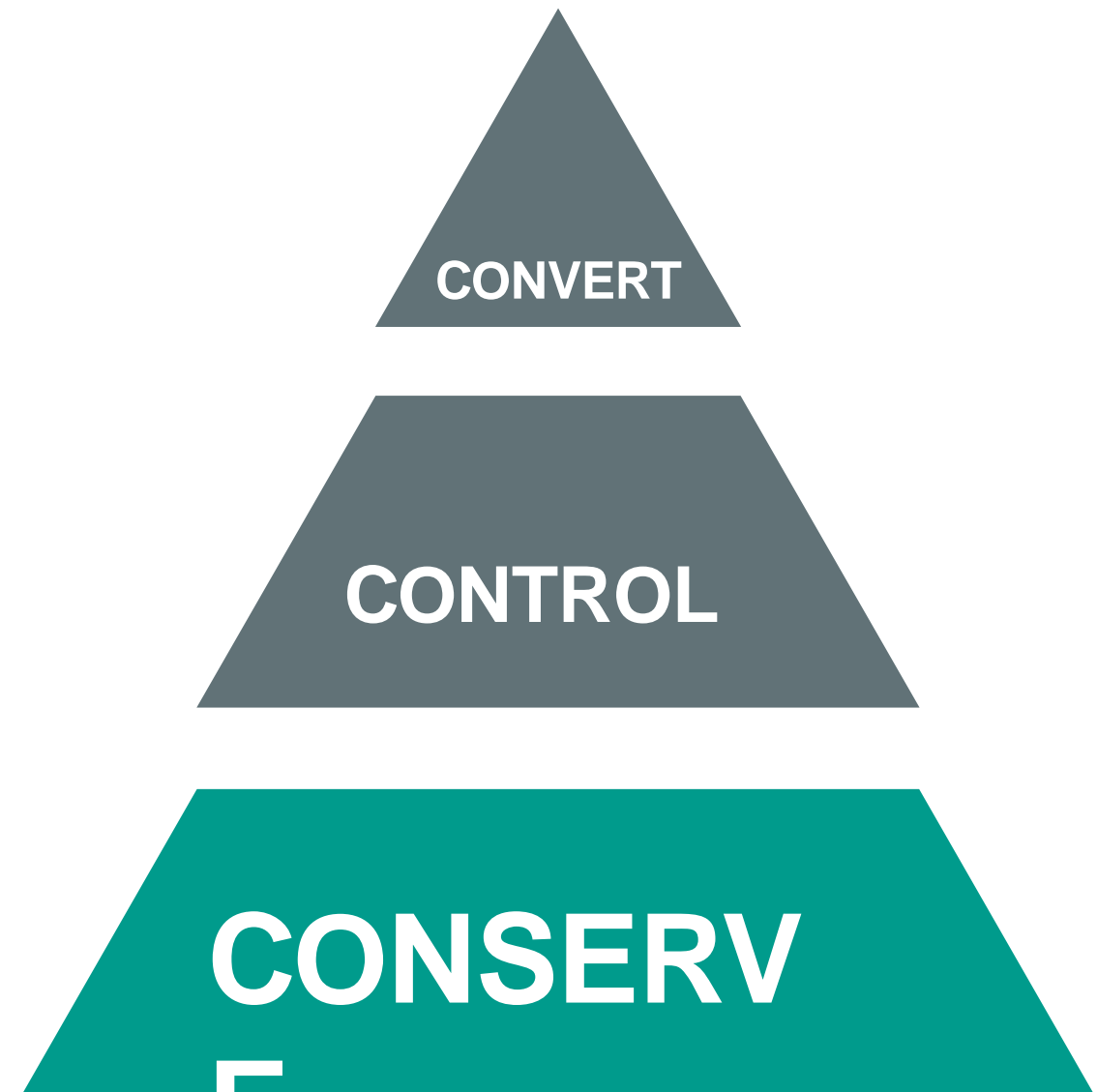
Role of Energy Codes and the Limits of Efficiency

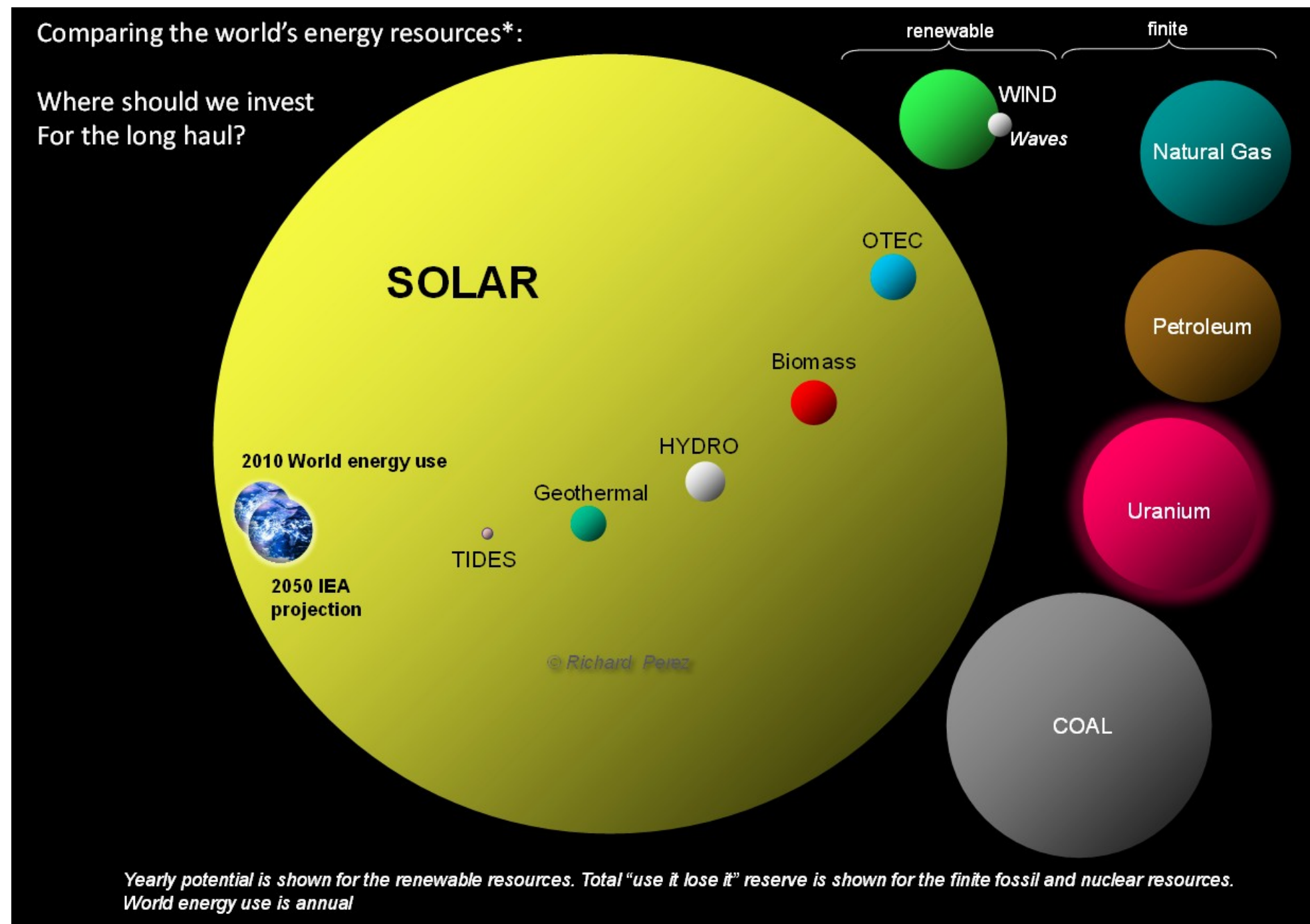


CONVERT

Renewables

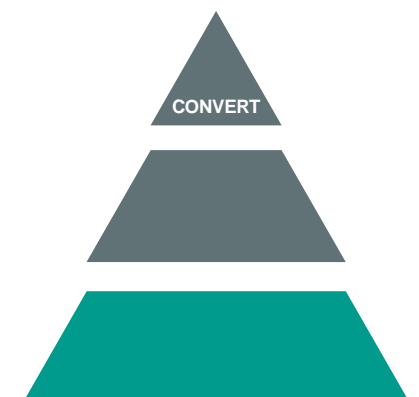
- converts natural sources into energy
- examples include PV, solar thermal and renew- able energy credits

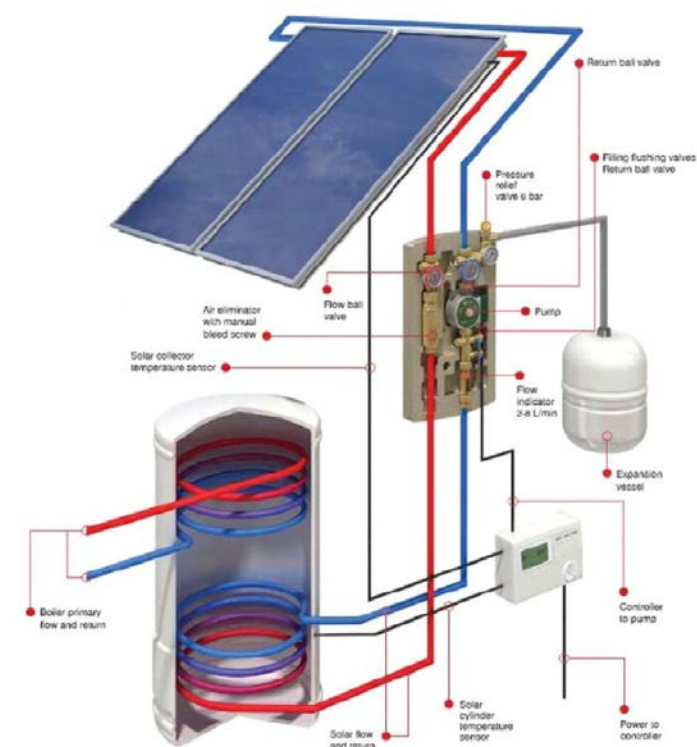
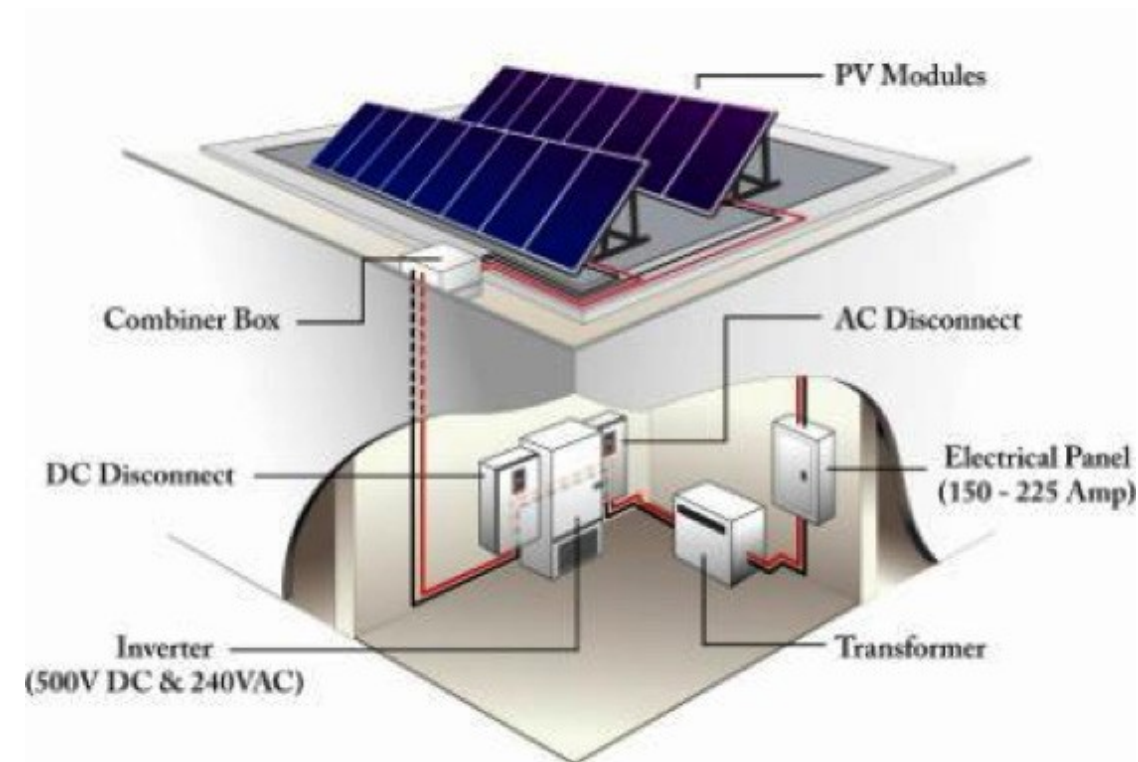




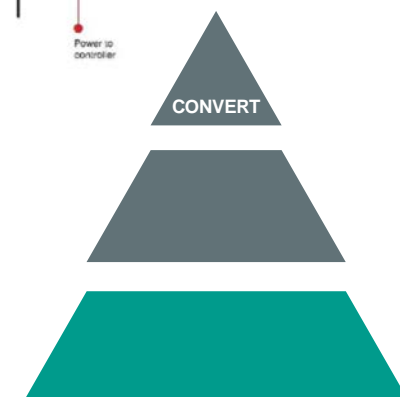
Perez et. al. A fundamental look at energy reserves for the planet,
2009

Potential of Solar Energy as an Energy Source





Photovoltaic and Solar Thermal Equipment



CONVERT

Renewables

- converts natural sources into energy
- examples include PV, solar thermal and renewable energy credits

CONTROL

Mechanical and Plumbing Equipment

- allows for reduced energy consumption without necessarily changing the behavior of building occupants
- design development or building retrofit choices
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CONSERVE

Passive Building and Behavioral Strategies

- largest impact with the least expense
- pre-schematic design choices about building siting and orientation, passive solar and ventilation options, landscape choices.
- schematic design choices about the building envelope, both opaque and transparent walls.
- building occupant education and awareness

