THE BASICS OF HOME ENERGY AND WATER EFFICIENCY

August 8th, 2013

When we build, let us think that we build forever.

"Let it not be for present delight nor for present use alone. Let it be such work as our descendants will thank us for; and let us think, as we lay stone on stone, that a time is to come when those stones will be held sacred because our hands have touched them, and that people will say, as they look upon the labor and wrought substance of them,

"See! This our parents did for us."

John Ruskin 1819-1900

Which House Would You Choose?

The fact is that People buying houses don't know that they want to talk about performance

- Largest Purchase
- Largest Investment
- Least knowledge


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Daily Briefing
AccuWeather.com
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Las Vegas
23°c | 9°c
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Samsung latest android
Samsung has announced the first Android 2.1 smartphone ...
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UTILITY BILL ANALYSIS
BLOWER DOOR TEST
INFRARED THERMOGRAPHY
INDOOR AIR QUALITY
HOME PERFORMANCE
DUCT TESTING
WEATHERIZATION
COMBUSTION ANALYSIS
MOISTURE ANALYSIS


Mechanical Performance
Indoor Air Quality
Moisture
Infiltration
Duct Leakage
Combustion Safety

How Have Houses Changed?

Why is this a 100 year old house?

- Drafty, uncomfortable, yet very durable houses
  - Why?
- Expectation?

Building a House Today

- What have we done to houses to meet there expectations?
  - Thermal Insulation
  - Tighter Building Envelopes
  - Heating & Cooling Systems
- Yet are our Houses are not
  - comfortable
  - Durable
  - Safe
  - Energy Efficiency
  - Environmental
- How can we meet the Expectation?
- **Applied Building Science and systems thinking**

The House as a System

(EEBA Builders Guide) www.eeba.org

"Residential Construction is a complex operation including thousands of processes by dozens of industries, bringing together hundreds of components and sub-systems into a house."

Systems Integration + Applied Building Science

Synergy

- **Two or more things working together to achieve something they could not achieve alone**
  - Man / woman
  - Democrats / Republicans
  - Aerodynamics / engine
  - Insulation / air barrier
- Look for the impact
- Logic of the process

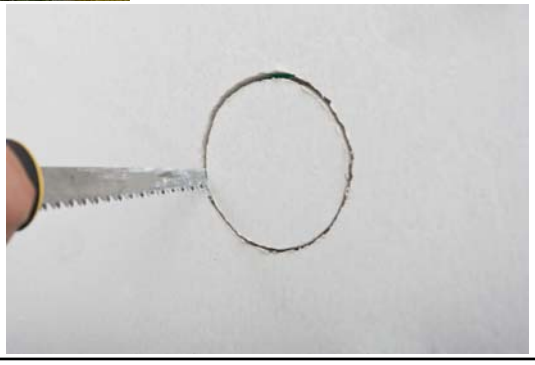
People Factors

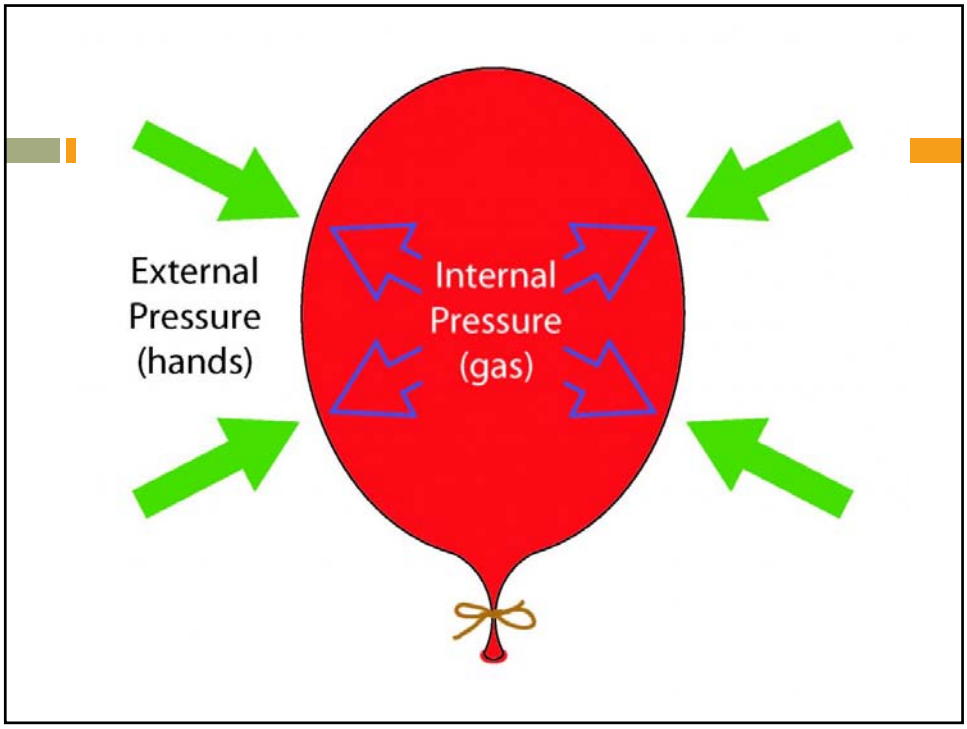
- What do they care about?
  - Aesthetics……
- Expectations
  - Safety
  - Energy Efficiency
  - Durability
  - Sustainability
  - Comfort

- People = Need for Systems Thinking

<u>How to take the people out of the equation</u>

How does air move in a house?




External
Pressure
(hands)
Internal
Pressure
(gas)


20
30
40
50
60
PRESSURE
LBS PER □ INCH

Freight Train

Moisture

Moisture = #1 enemy of most building materials

Small amount of repeated wetting can lead to:

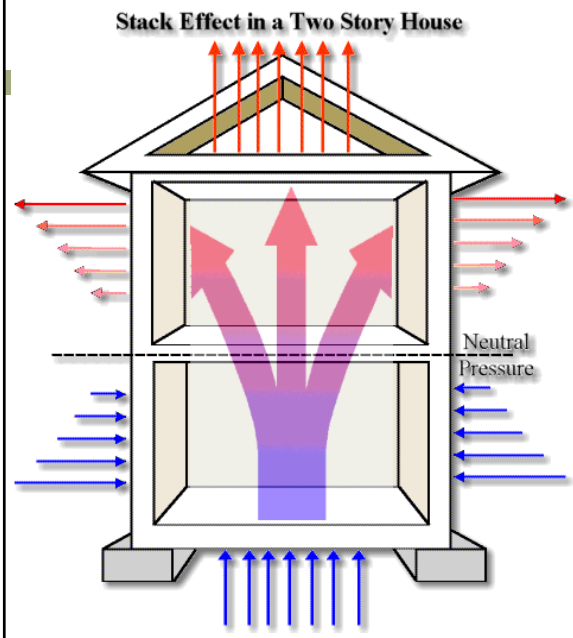
- Reduced R-value
- Mold, mildew
- Deterioration, rot

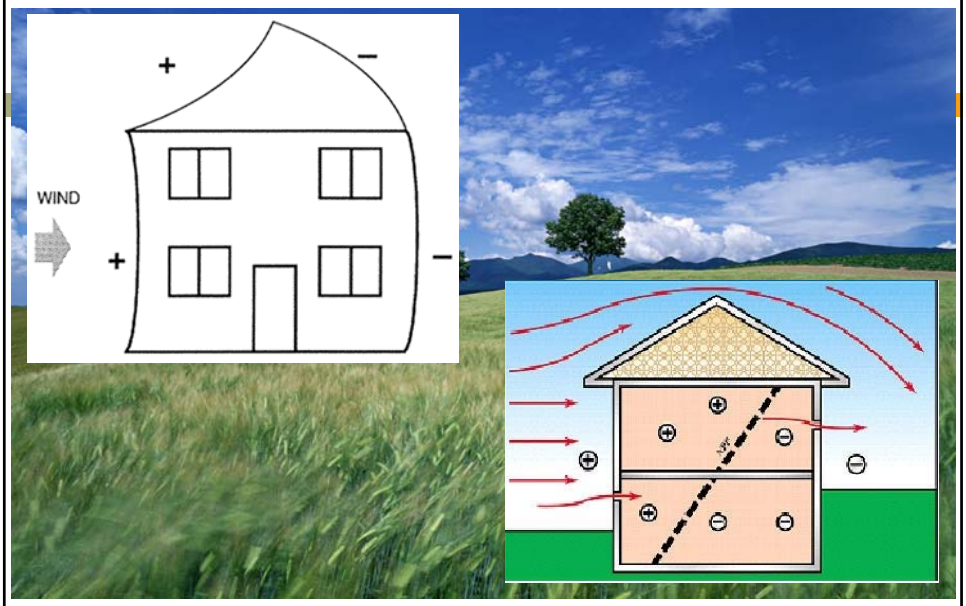
Moisture sources

- Bulk water
- Vapor diffusion
- Air movement

Courtesy of DOW Building Materials

Stack Effect

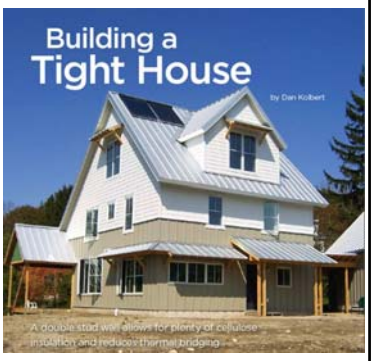




Can a House Be Too Tight?

NO!

- Wrong question
- Control **air flow**
- In order to control the air



Real question .....

- Can houses be under-ventilated?

YES!

Build Tight and Ventilate Right

Ventilation: M1507.1 General

- **Where local exhaust or whole-house** mechanical ventilation is provided, the equipment shall be designed in accordance with this section

ASHRAE
Advancing HVAC&R to serve humanity and promote a sustainable world

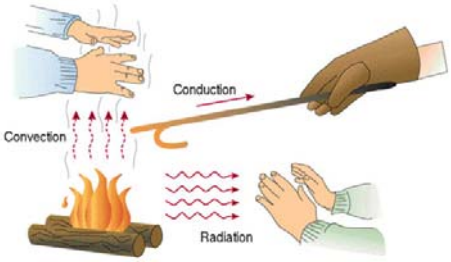
ASHRAE Standard 62.2 – 2010

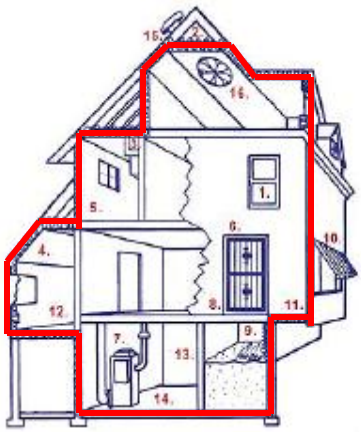
- Both Whole House **Controlled Mechanical Ventilation** and **Spot ventilation** standard
- This standard applies to spaces intended for human occupancy within **single-family houses and multifamily structures of three stories or fewer** above grade, including manufactured and modular houses

Thermal Envelope

Basic Building Science

- Basic Building Science
  - Thermal Flow
    - Define the thermal boundary
    - How systems work to control Conditioned air
      - Heat and Moisture





Insulation

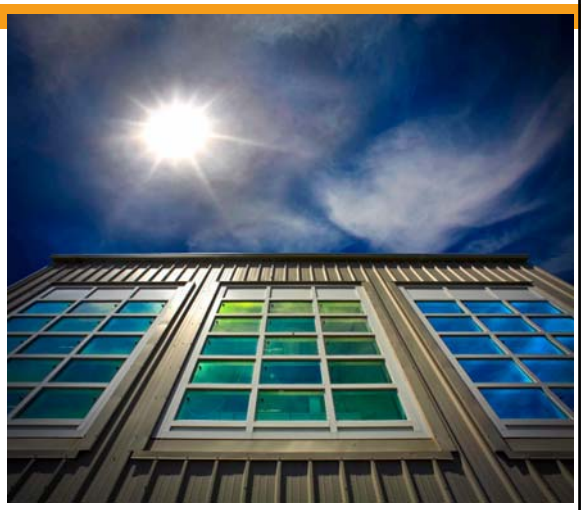
Insulation traps pockets of air

Stagnate Air Pockets create the R-value

Air Barrier

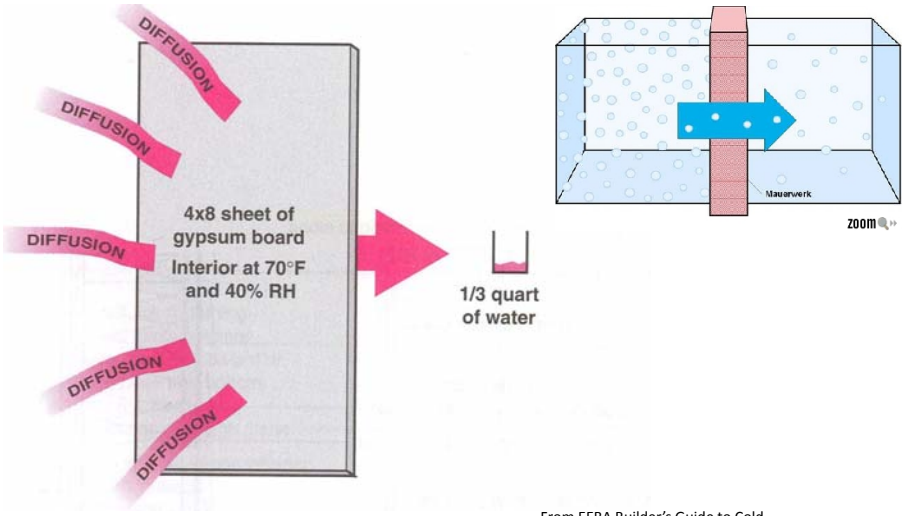
Stopping the movement of air from scrubbing away the stagnate air pocket

Now it works



http://www.efficientwindows.org

Vapor Diffusion a Slow Small Process

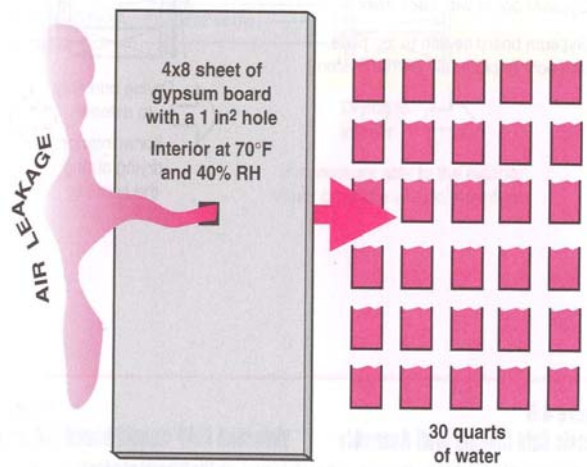


32 Square feet

From EEBA Builder's Guide to Cold Climates by Joseph Lstiburek

The Problem with Air - the 4 M's

- Much
- More
- Moisture
- Movement

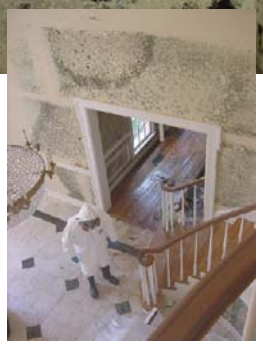


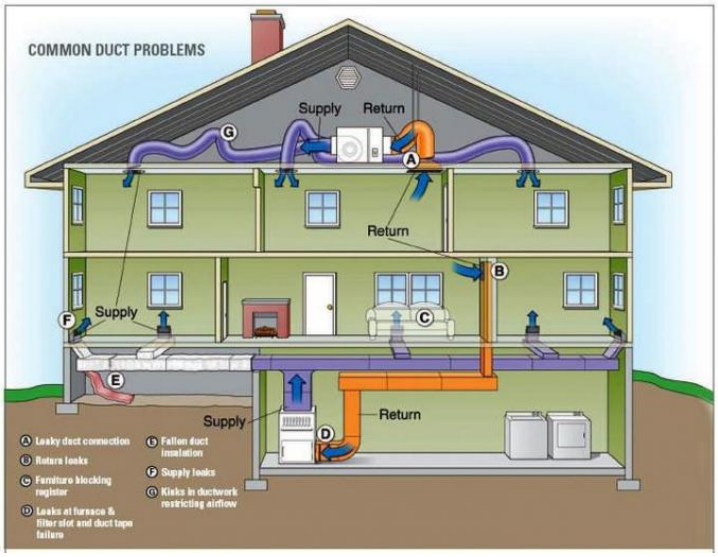
32 Square feet

From EEBA Builder's Guide to Cold Climates by Joseph Lstiburek

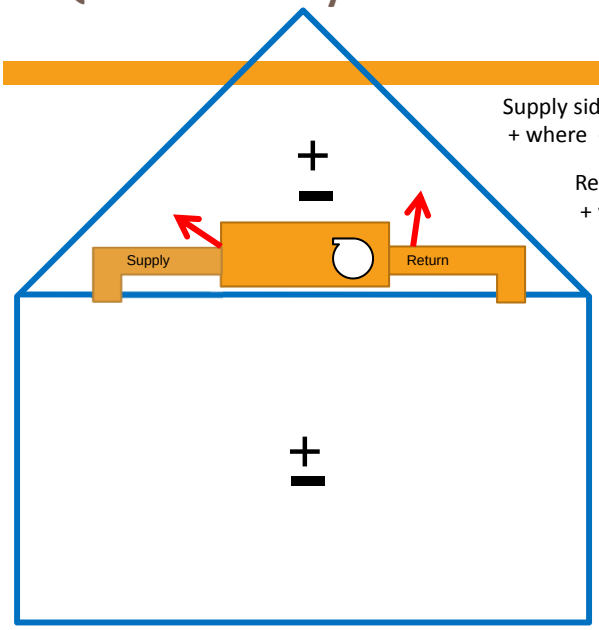
Micro Climates

- **Controlled environment**
  - **Consistent Comfort**
    - **Temperature**
    - **Humidity**
  - **Air Quality**
- **Predictability / Control**
  - **Tighter**
  - **Insulation**
  - **Mechanical Systems**
  - **Ventilation**





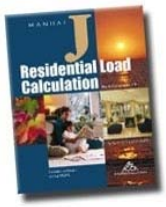
Quick Review System Effect



Supply side leak in attic
+ where - where ?

Return side leak in attic
+ where - where ?

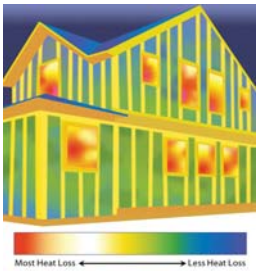
How Manual J Works



- Manual J describes every component of the thermal envelope
- Determines the Btu per hour of heat loss and heat gain through the envelope at specific design temperatures
- End result – the heating and cooling load for the house
- Room by Room load

How Manual J Works

- BTU per hour of heat loss or heat gain through an assembly U x A x ΔT = Q(Btuh)
  - U-value x Sqft x Delta T = Btu per hours
- Example
  - 500 sqft
  - R-19
  - Indoor temp at 70° and
  - Outdoor temp at 3°
- .053 x 500 x 67 = 17,755 Btu per hours



Manual D

- Determine how much flow is needed to achieve comfort in each room based on distributing the load to each room in the house

HEATING EQUIPMENT			COOLING EQUIPMENT		
Make			Make		
Trade			Trade		
Efficiency	80.0 AFUE		Efficiency	0.0 EER	
Heating input	0	Btuh	Sensible cooling	0	Btuh
Heating output	0	Btuh	Latent cooling	0	Btuh
Heating temperature rise	0	°F	Total cooling	0	Btuh
Actual heating fan	1356	cfm	Actual cooling fan	1356	cfm
Heating air flow factor	0.035	cfm/Btuh	Cooling air flow factor	0.065	cfm/Btuh
Space thermostat			Load sensible heat ratio	115	%

ROOM NAME	Area (ft²)	Htg load (Btuh)	Clg load (Btuh)	Htg AVF (cfm)	Clg AVF (cfm)
Room1	543	5881	1901	203	124
Furnace Room	40	320	72	11	5
BaseStairs	80	641	145	22	9
Base Bath	45	877	190	30	12
Family	247	3068	2393	106	156
Base Bed	156	2609	665	90	43
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Master Bed	195	1699	459	59	30
MasterCloset	42	324	68	11	4
Master Bath	90	1138	300	39	20
Bath	60	324	68	11	4
Bed 2	160	1421	367	49	24
Bed 3	180	2209	670	76	44
Loft Bath	64	997	282	34	18
Bed 4	346	4867	2120	168	138
Loft Stairs	70	1063	303	37	20
Laundry	18	0	0	0	0

Bold/italic values have been manually overridden

Printout certified by ACCA to meet all requirements of Manual J 8th Ed.

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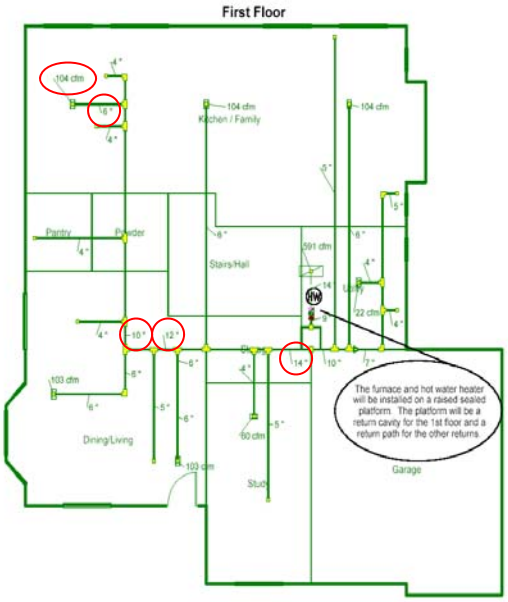
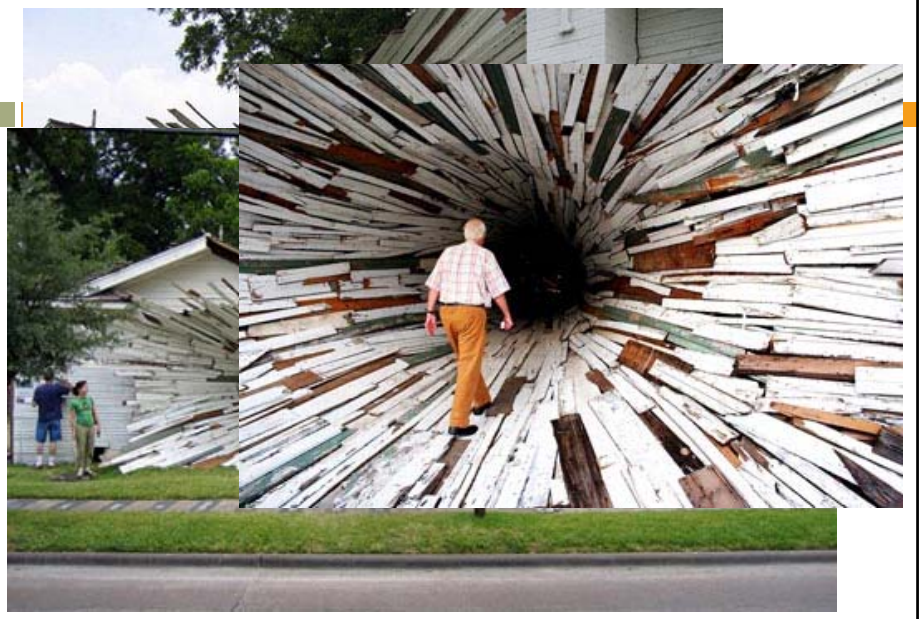
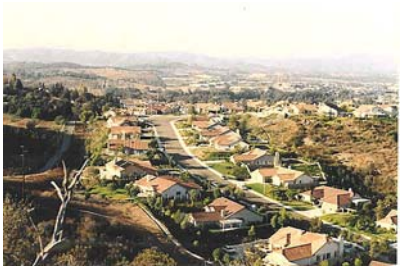
Duct Design

- Determine how to design, size, and run the duct system to ensure the proper flow and distribution of the Btu's





Tunnel House



House Built in 2004

- Avg. Energy Consumption per person 343 MMbtus
- 13,800 kWh of electricity use per year
- Avg. fridge size 20 cubic feet – 420 kWh/yr

House Built in 1970

- Avg. Energy Consumption per person 331 MMbtus
- 6300 kWh of electricity use per year
- Average fridge size 15 cubic feet – 1700 kWh/yr

House built in 1950

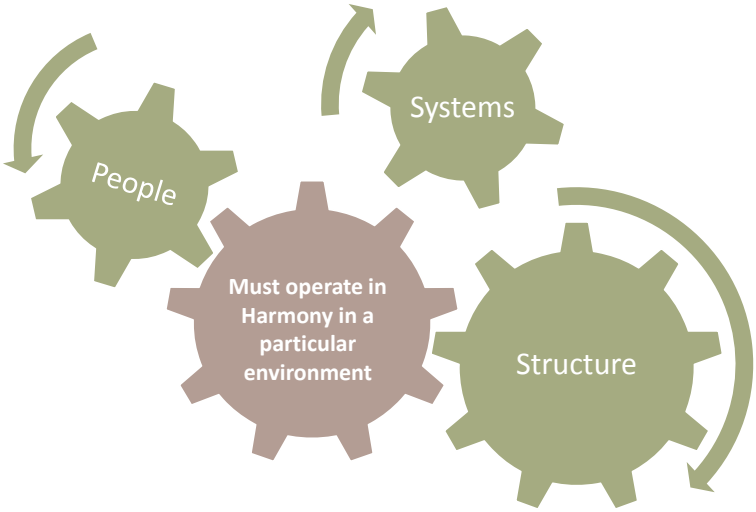
- Avg. Energy Consumption per person 227 MMbtus
- 2200 kWh of electricity use per year
- Avg. Fridge size 9 cubic feet – 360 kWh/yr

What is Energy Star?

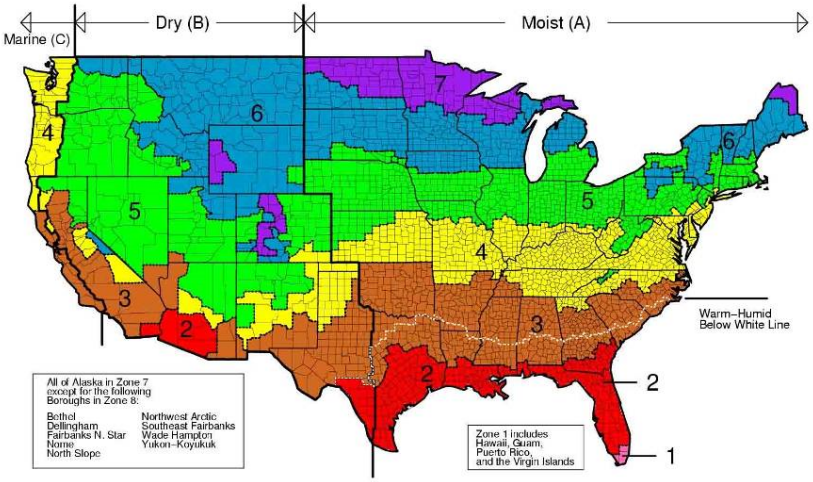
- Energy Star is a joint program of the EPA and the DOE helping us all save money and protect the environment through energy efficient products and practices

Building a House…..

System Harmony is the Goal



Climate Zones



Fundamental Questions

Is It There?

Does It Work?

Fundamental Questions

Is It There?

Does It Work?

Combustion safety

Water Efficiency

look for WaterSense Meets EPA Criteria

EAT YOUR VEGETABLES

PV is the Dessert

Applied Building Science & Systems Thinking

- Defensible space
- Conditioned attics vs. attic ventilation
- Home sprinkler systems
- Building material choices

Thank you!

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