







#### Insulation Values

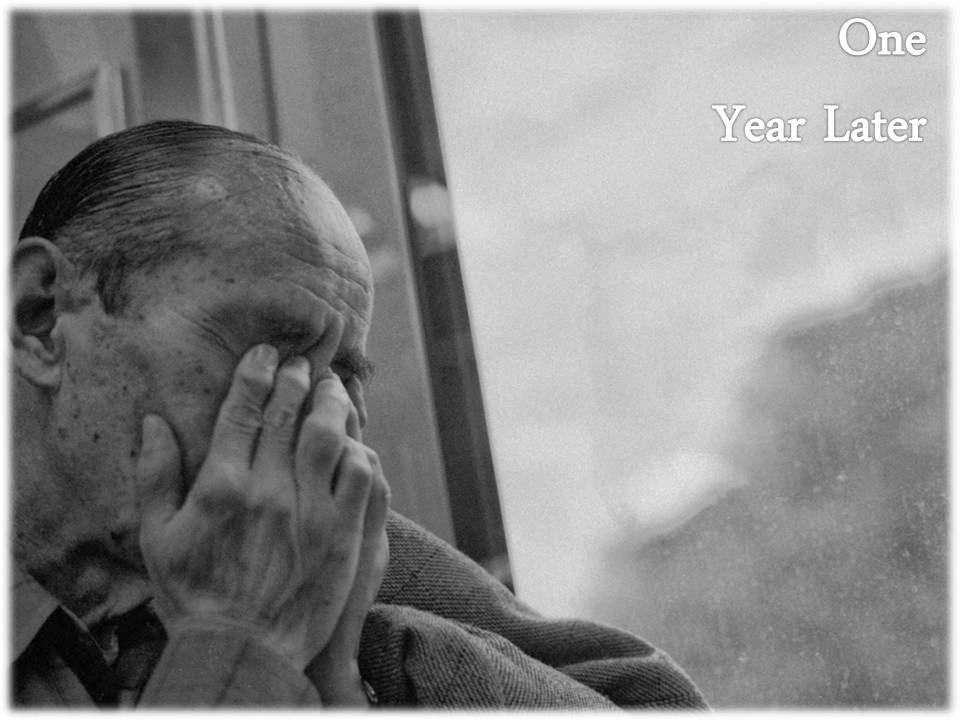
Walls R-75 or U-0.073 W(m<sup>2</sup>/K)

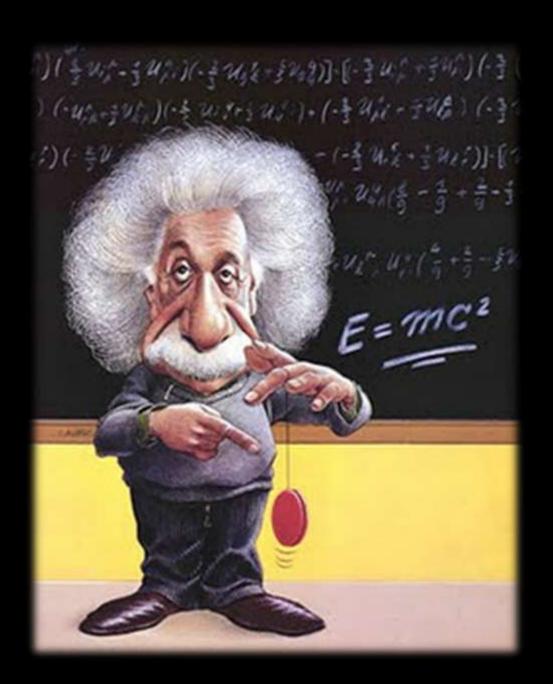
Roof R-115 or U-0.049 W(m<sup>2</sup>/K)

Slab R-63 or U-0.090 W(m<sup>2</sup>/K)

1084 Bags of cellulose ~12 tons of insulation







# Facts

OT

# Fiction



#### (or ~ wishful thinking)

|  |                 |                   |              |                       |                      |                | -         |                      |                        |                      |      |      |
|--|-----------------|-------------------|--------------|-----------------------|----------------------|----------------|-----------|----------------------|------------------------|----------------------|------|------|
| Building   | Chlupp Resid    | dence             |              |                       |                      |                |           |                      |                        |                      |      |      |
| Location and Climate   |                 |                   | Fairbe       | unks, Alaska          |                      |                |           | No Standard Climat   | e:                     |                      |      |      |
| Street Address   | 2595 Allen      | Adale Road        |              |                       |                      |                |           |                      |                        |                      |      |      |
| City, State, Zip:  | Pairbanks,      | Alaska, 99709     |              |                       |                      |                |           |                      |                        |                      |      |      |
| Country  | USA             |                   |              |                       |                      |                |           |                      |                        |                      |      |      |
| Building Type:   | Single Fami     | ly                |              |                       |                      |                |           |                      |                        |                      |      |      |
| Home Owner(s) / Client(s):   | Thorsten Ch     | lupp              |              |                       |                      |                |           |                      |                        |                      |      |      |
| Street Address   | PO Box 7479     | 8                 |              |                       |                      |                |           |                      |                        |                      |      |      |
| City, State, Zip   | Fairbanks,      | Alaska 99709      |              |                       |                      |                |           |                      |                        |                      |      |      |
| Architect.   | REINA, LLC      | Thorsten Chlupp   |              |                       |                      |                |           |                      |                        |                      |      |      |
| Street   |                 |                   |              |                       |                      |                |           |                      |                        |                      |      |      |
| City, State, Zip.  |                 |                   |              |                       |                      |                |           | Calculation Electric | ity / Internal Heat 6  | iains                |      |      |
| Mechanical System.   |                 |                   |              |                       |                      |                |           | Building Type:       | Flexidential           |                      |      |      |
| Street Address   |                 |                   |              |                       |                      |                | -         |                      |                        |                      |      |      |
| City: State, Zip:  |                 |                   |              |                       |                      |                |           | Internal Heat Gains  |                        |                      |      |      |
| Year of Construction   | 2010            |                   |              |                       |                      |                |           | Utilization Pattern  | Dveling                | -                    |      |      |
| Number of Dwelling Units:  | 1               | - 0               | nterior Tern | perature              | 68.0                 | 'F             |           | Type of Yalues Used  | Standard               | -                    |      |      |
| Gross Enclosed Volume V <sub>2</sub>   | 26093           | n <sup>3</sup>    | Internal He  | at Gains:             | 0.7                  | BTU/hr.ft      |           |                      |                        |                      |      |      |
| Number of Occupants  | 4.0             |                   |              | -                     |                      |                |           | Planned Number of    | Occupants:             |                      |      |      |
|  |                 | 13.6              | 5 kV         | Vh/m2a                |                      |                |           | 4                    | Design                 | ×                    |      |      |
| energy Demands with Reference to the Tre   | eated Floor Are | a                 |              |                       |                      |                |           |                      |                        |                      |      |      |
| Treated Floor Area   | 2210            | R <sup>2</sup>    |              |                       |                      |                |           |                      |                        |                      |      |      |
|  | Applied:        | Monthly Method    |              | PH Cer                | tificate:            | Fi             | ulfilled? | Verification:        | Monthly Method         |                      |      |      |
| Specific Space Heat Demand:  | 4.33            | kBTU/(ft°yr)      |              | 4.75 kBTU             | /(ft°yr)             | Y              | es        |                      | Specific Space Heat De | mand, Annual Method  | 3.08 |      |
| Pressurization Test Result:  | 0.48            | ACH <sub>50</sub> |              | 0.6 ACH <sub>50</sub> |                      | Y              | es        |                      | Specific Space Heat De | mand, Monthly Method | 4.33 |      |
| Specific Primary Energy Demand<br>(DHV, Heating, Cooling, Ausiliary and Household<br>Electricity): | 14.9            | kBTU/(ft²yr)      |              | 38.0 kBTU/            | (ft <sup>e</sup> yr) | Y              | es        |                      |                        |                      | 100  | - 23 |
| Specific Primary Energy Demand<br>(DRIV, Heating and Auxiliary Electricity):                       | 6.9             | kBTU/(ft²yr)      |              |                       |                      | : <del>.</del> |           |                      |                        |                      |      |      |
| Specific Primary Energy Demand<br>Energy Conservation by Solar Electricity:                        |                 | kBTU/(ft²yr)      |              |                       |                      |                |           |                      |                        |                      |      |      |
| Heating Load:  | 3.54            | BTU/(ft²hr)       |              |                       |                      |                |           |                      |                        |                      |      |      |
| Frequency of Overheating:  |                 | %                 | over         | 77.0 'F               |                      |                |           |                      |                        |                      |      |      |
| Specific Useful Cooling Energy Demand:   | 0.00            | kBTU/(ft²vr)      |              | 4 75 kBTU/            | (B²ur)               |                | Vo.       |                      |                        |                      |      |      |

We confirm that the values given herein have been determined following the PHPP methodology and based on the characteristic values of the building. The calculations with PHPP are attached to this application.

Cooling Load:

BTU/(ft2hr)

0.00

issued on:

signed:



#### HOME ENERGY RATING CERTIFICATE

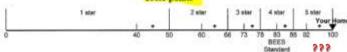
The Home Located At: 2595 Allenadale Fairbanks, Alaska

Has Been Energy-Rated As:

\*\*\*\* +

Five Star Plus

Overall Efficiency of Home 100.0 points



Projected Annual Energy Costs \$2,484 per year

Amount of CO2 Produced by the Home

21,632 pounds per year

#### BREAKDOWN OF HEATING COSTS, \$ PER YEAR

| Floor       | \$29 |
|-------------|------|
| Wall/Door   | \$58 |
| Window      | \$45 |
| Ceiling     | \$18 |
| Air/Vent    | \$64 |
| System Loss | \$59 |
| Hot Water   | *    |

Client: Reina Properties Rater: Lynn A Kuhl, Kuhl Inspection Date: 1/19/2011

Rater's City: Fairbanks, Alaska 99709 Contact: 907-452-5601, kuhlsütgei ner

ver. 2.0.6.1, library: 3/24/2010, file: RP2595.hm2, Rating Type: BEES

Htg

I certify that this Rating is true and correct, to the best of my knowledge and belief:

#### ENERGY COST AND FEATURES REPORT

Property: Reina Properties

2595 Allenadale Fairbanks, Alaska Rater:

Lynn A Kuhl

Kuhl Inspection 5151 Electra Ave

Fairbanks, Alaska 99709

House: Single Family

ID: 81

Rating: BEES Living Floor Area: 2,548 square feet No Attached Garage

VENTILATION WARNING: The recountred six tightness of this home indicates that it may not provide sufficient ventilation six (for acceptable indoor quality) as defined by ASHRAS 62.2 2004, without adequate mechanical ventilation equipment. If whole house esochanical ventilation equipment has been installed, it is recommended that it be properly maintained and operated. If no whole house mechanical ventilation equipment has been installed, it is strongly recommended that the homoewner consider an investment in this improvement. (A test of the building's ventilation air rate would help determine the importance of a mechanical vestilation system in this home.)

**Envelope Efficiency** 

Floor insulation R-76.2\* Wat/Door Insulation R-68.3 \*

R-119.1 Ceiling Insulation 0.48 ACH<sup>50</sup> Window R-Value R-8.33

Window to Wall Ratio, Living Space 18.7%

South Facing Window Area 245 aquare feet

Air Leakage 0.5 Air Changes per Hour at 50 Pascals. 0.03 Air Changes per Hour Natural

\* Includes the insulating value of the ground in contact with these envelope components.

Space Heating System

System Efficiency 82%

Spruge Wood Fuel Type Supplemental Fuel None Thermostat Setting 70.0 degrees F

Setback Thermostat Yes. Controls Entire Home

Water Heater

Efficiency

Conditioned Space Location Fuel Type Spruce Wood

None Present Space Cooling System

Ventilation Heat Recovery Ventilator

Other

Number of Occupants

Clothes Dryer Fuel Electricity Gooking Range Fuel Electricity Miscellaneous Lights/Appliance Use Average

ESTIMATED ANNUAL ENERGY COST

Lights and Appliances V//

| Space Heating | \$272 |
|---------------|-------|
| Water Heating | \$296 |
| Space Cooling | 50    |

62 kWh of Electricity, 1.40 cords of Spruce Wood Space Heating

Water Heating 1.62 cords of Spruce Wood

Space Cooling Lights and Appliances 9,426 kWh of Electricity

Actual use and costs may vary from these estimates depending upon weather conditions, occupant life styles and utility rates currently in effect.

ver. 2.0.6.1, library: 3/24/2010, file: RP2595.htm2

# Actual usage & bills



(907) 452-1151 or 1-800-770-4832 mww.gvea.com

GOLDEN VALLEY ELECTRIC ASSOCIATION, INC.

P.O. Box 71249. Folitbanks. Alaska 99707-1249.

Rate Schedule: Residential Meter No.: 48266

District: 2

| ACCOUNT NUMBER<br>234078     | CUSTOMER NAME<br>REINA PROPERTIES CORP |                       |  |  |
|------------------------------|--|-----------------------|--|--|
| SERVICE LOC<br>2595 Allen Ad |  | BILL DATE<br>11/10/11 |  |  |
| 10/11/11 11/09/11            | 12/05/11                               | \$109.41              |  |  |
| Electronic Voting#:          |  |                       |  |  |



(907) 452-1151 or 1-800-770-4832 www.gvea.com

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P.O. Box 71249, Fairbanks, Alaska 99707-1249

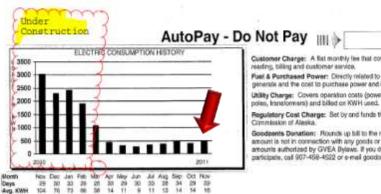
Rate Schedule: Residential

Meter No.: 48266 District: 2

| ACCOUNT NUMBER<br>234078        | CUSTOMER NAME<br>REINA PROPERTIES CORP |                       |  |
|---------------------------------|--|-----------------------|--|
| SERVICE LOCA<br>2595 Allen Adal | 0.000                                  | BILL DATE<br>12/09/11 |  |
|                                 | COMMENT CHANGES WET BAT                | AMOUNT DUE            |  |
| 11/09/11 12/08/11               | 01/03/12                               | \$200.26              |  |
| Tectronic Voting#               | +                                      |                       |  |

| READ DATE  | KWH   | KVAR | KW                                 | CHARGE DESCRIPTION   | AMOUNT   |
|--|---|------|------------------------------------|--|--|
| 11/09/11 CURN READ<br>10/11/11 PREV READ<br>MULTIPLIE<br>KWH USED<br>GVEA scholarship appli<br>now. Visit gwes.com h | 52695<br>R I<br>465<br>cations are or<br>or scholarsh |      | TOTA BALA Cust fuel Util Regu CURR | PREVIOUS BALANCE TOTAL PAYMENTS BALANCE FORMARD Customer Charge Fuel & Purchased Power 465 kwh @ 0.10924 Utility Charge 465 kwh @ 0.08791 Regulatory Cost Charge 465 kwh @ 0.00049 CURRENT CHARGES | 96.56<br>-96.56<br>0.00<br>17.50<br>50.80<br>40.88<br>0.23<br>109.41 |
| information and applic   | ations.   |      |                                    | Total Due<br>Goodeents Donation  | 109.41   |
|  |   |      |                                    |  |  |

| ì | READ DATE   | KWH                            | KVAR | KW. | CHARGE DESCRIPTION  | AMOUNT  |
|---|---|--------------------------------|------|-----|---|---|
|   | 12/08/11 CURR READ<br>11/09/11 PREV READ<br>MULTIPLIER<br>KMH USED<br>GVEA scholarship applic<br>available now. Visit gve | 847<br>ations are<br>a.com for |      |     | PREVIOUS BALANCE<br>TOTAL PAYMENTS<br>BALANCE FORMARD<br>Customer Charge<br>Fuel & Purchased Power 847 kwh @ 0.12737<br>Utility Charge 847 kwh @ 0.08791<br>Regulatory Cost Charge 847 kwh @ 0.00049<br>CURRENT CHARGES | 109.41<br>-109.41<br>0.00<br>17.50<br>107.88<br>74.46<br>0.42<br>200.26 |
|   | information and applica   | tions.                         |      |     | Total Due<br>Goodgents Donation   | 200.26  |



Customer Charge: A flat monthly lee that covers costs for mater reading, billing and customer service.

Fuel & Purchased Power: Directly related to the price of fuel to generate and the cost to purchase power and is calculated quarterly. Utility Charge: Covers operation costs (power plants, substations,

Regulatory Cost Charge: Set by and funds the Regulatory Commission of Alaska.

Goodcents Donation: Flounds up bill to the nearest dollar. This amount is not in connection with any goods or services. Collection amounts authorized by GVEA Bylaws. If you do not wish to participate, call 907-468-4622 or e-mail goodcents @gvsa.com.



Dad Jan Feb Mar Apr May Jun Jul Aug Bep Oot New Dec 30 33 29 26 33 29 30 30 30 28 34 29 29 29 26 23 66 36 14 11 9 11 13 14 14 16 29

\$200.26 Customer Charge: A flat monthly lee that covers costs for meter

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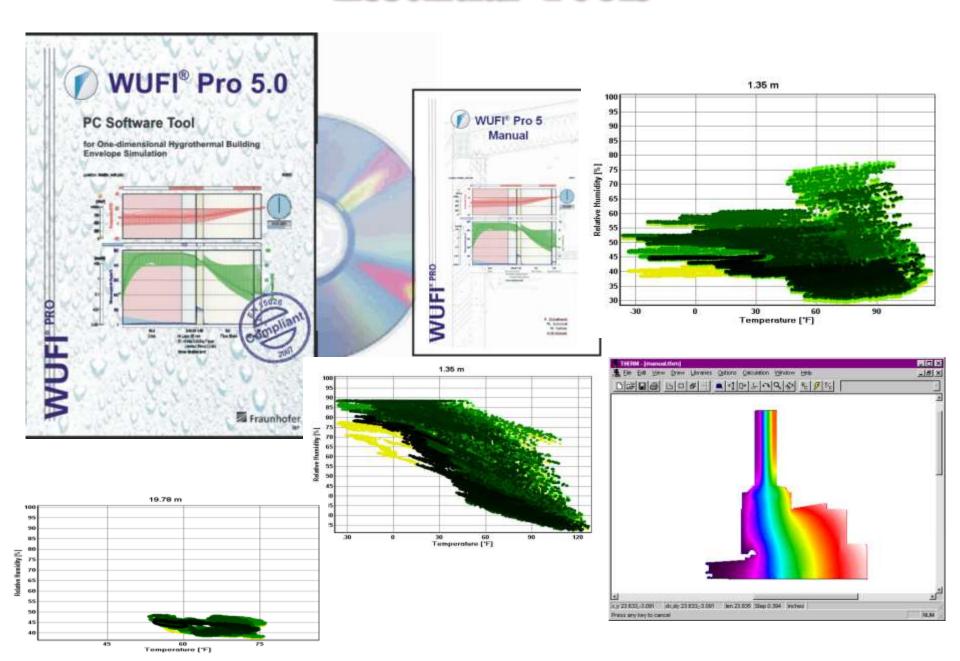
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1st Year ~ 6480kWh

\$109.41

(improvements needed)

### **Essential Tools**











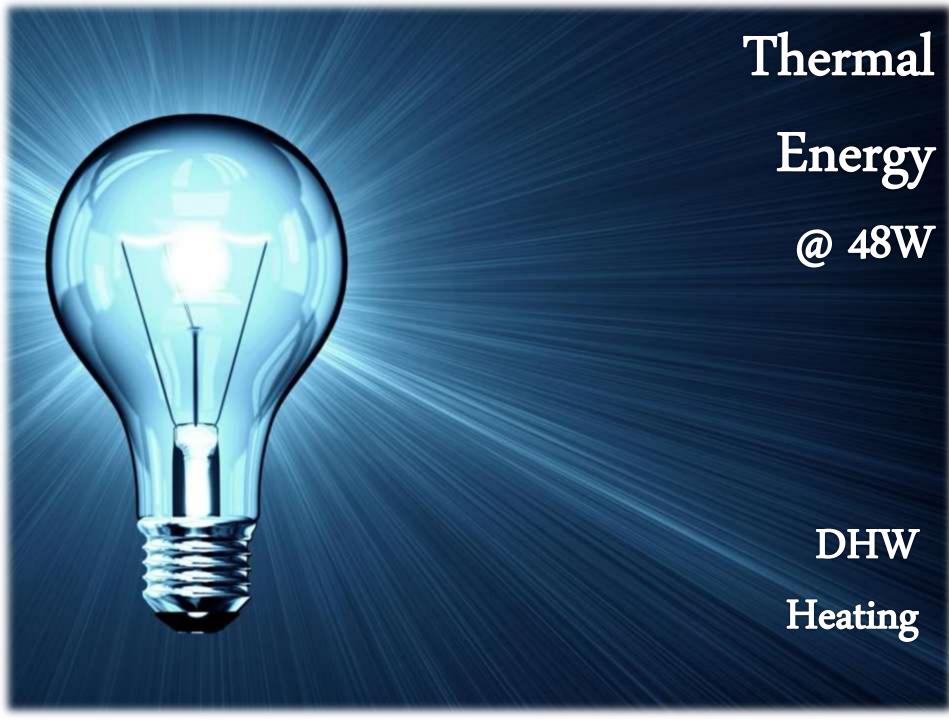


# 275 days

#### 100% Solar

2<sup>nd</sup> Febr. – 3<sup>rd</sup> Nov.2011







# 98 days

# 100% Wood+Solar

3rd Nov.2011- 9th Febr.



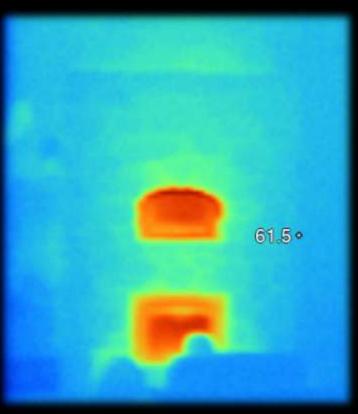
# 1-1/2 cords of wood

=22.5 mbtu

180 Gallons or 680 L oil

= \$ 720



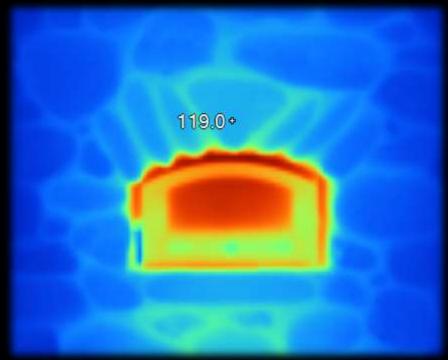




98 days, 3 Girls, 1 Geek, 2210 SF TFA Heating + DHW @ 40 below 14,000 HDD

 $\pm 4.32$  BTU/HR

=1.26 Watts





#### HOME ENERGY RATING CERTIFICATE

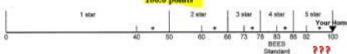
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| System Loss | \$59  |
| Hot Water   | \$299 |
|             |       |

Client: Reina Properties Rater: Lynn A Kuhl, Kuhl Inspection Date: 1/19/2011

Rater's City: Fairbanks, Alaska 99709 Contact: 907-452-5601, kuhlsütgei net ver. 2.0.6.1, library: 3/24/2010, file: RP2595.hm2, Rating Type: BEES

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ID: 81

 $0.48 \, \mathrm{n}50$ 

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System Efficiency 82%

Spruge Wood Fuel Type Supplemental Fuel None Thermostat Setting 70.0 degrees F

Setback Thermostat Yes. Controls Entire Home

Water Heater

Efficiency

Conditioned Space Location Spruce Wood Fuel Type None Present Space Cooling System

Ventilation Heat Recovery Ventilator

Other

Number of Occupants

Clothes Dryer Fuel Electricity Cooking Range Fuel Electricity Miscellaneous Lights/Appliance Use Average

ESTIMATED ANNUAL ENERGY COST

Lights and Appliances

| Space Heating \$272 | 3 cords vs | 1-1/2 |
|---------------------|------------|-------|
| Water Heating \$299 |            |       |
| Space Cooling 50    |            |       |

62 kWh of Electricity, 1.40 cords of Spruce Wood Space Heating Water Heating 1.62 cords of Spruce Wood

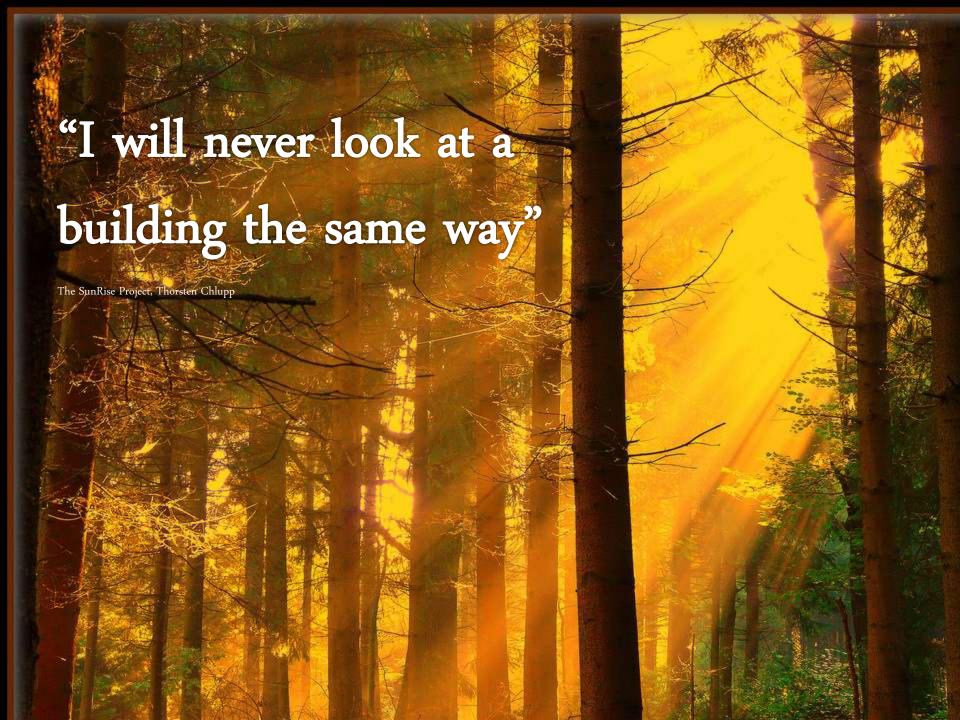
Space Cooling Lights and Appliances 9,426 kWh of Electricity

Actual use and costs may vary from these estimates depending upon weather conditions, occupant life styles and utility rates currently in effect.

ver. 2.0.6.1, Horary: 3/24/109, 4262 Wh vs 6480kWh)

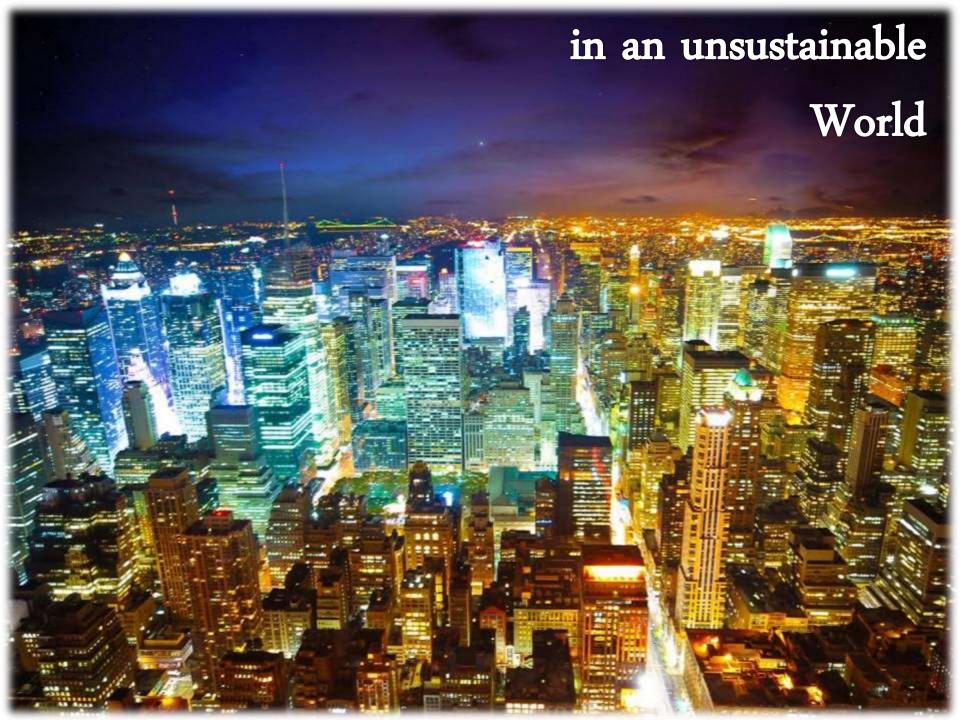














# "evolution"



# Where are we Going?







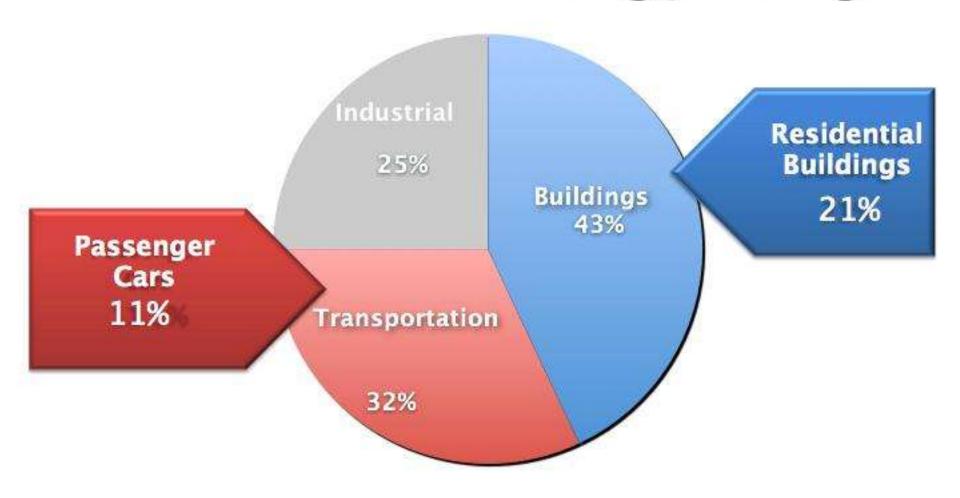




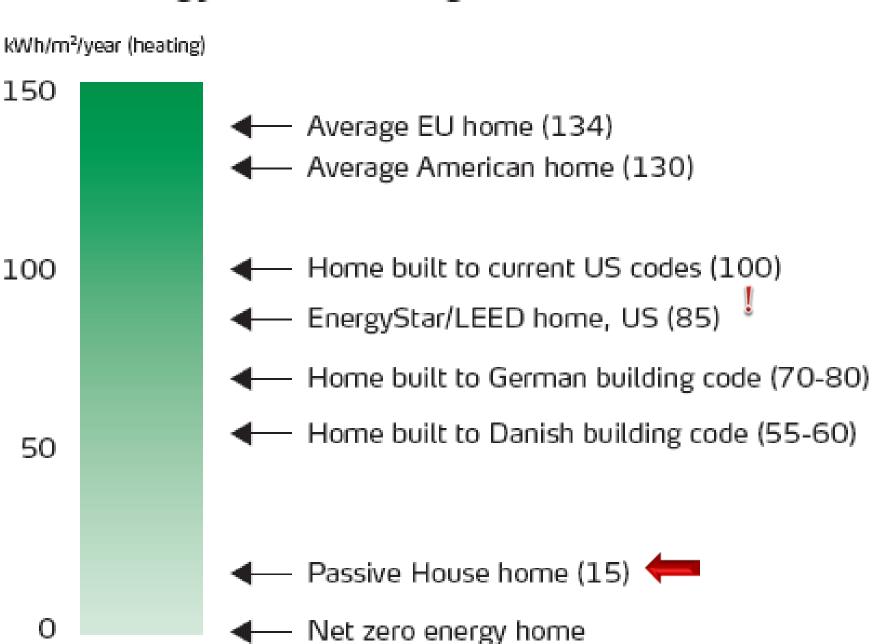




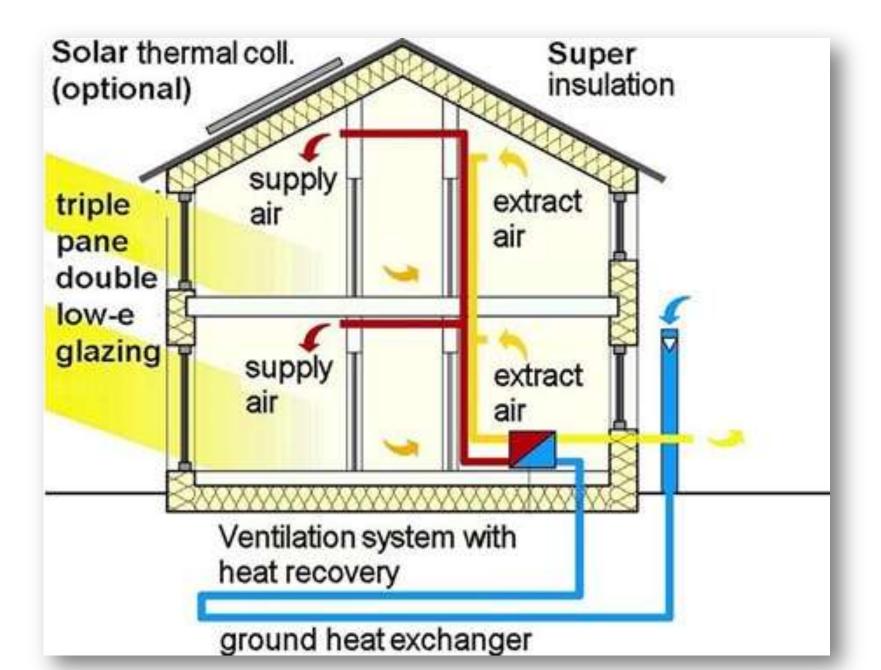
# United States Energy Usage

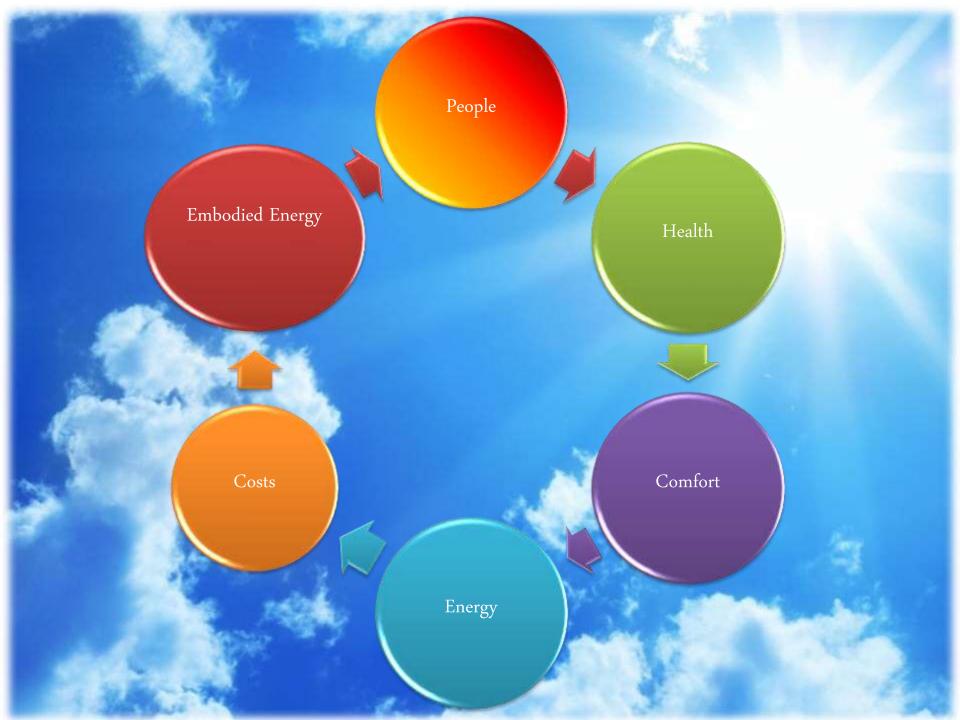


#### How energy low can we go?

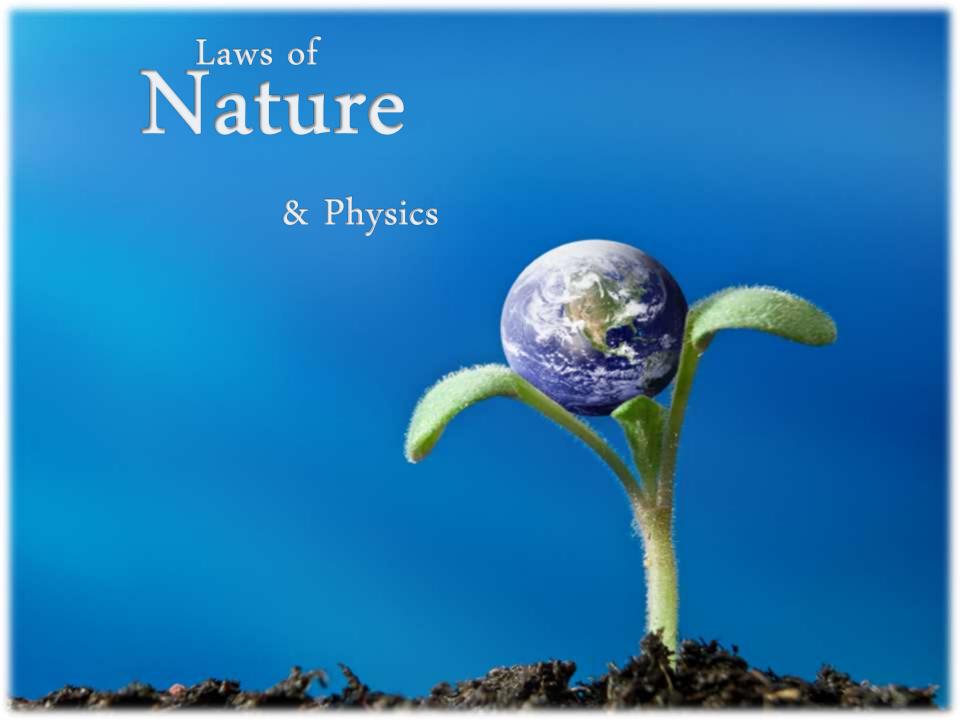


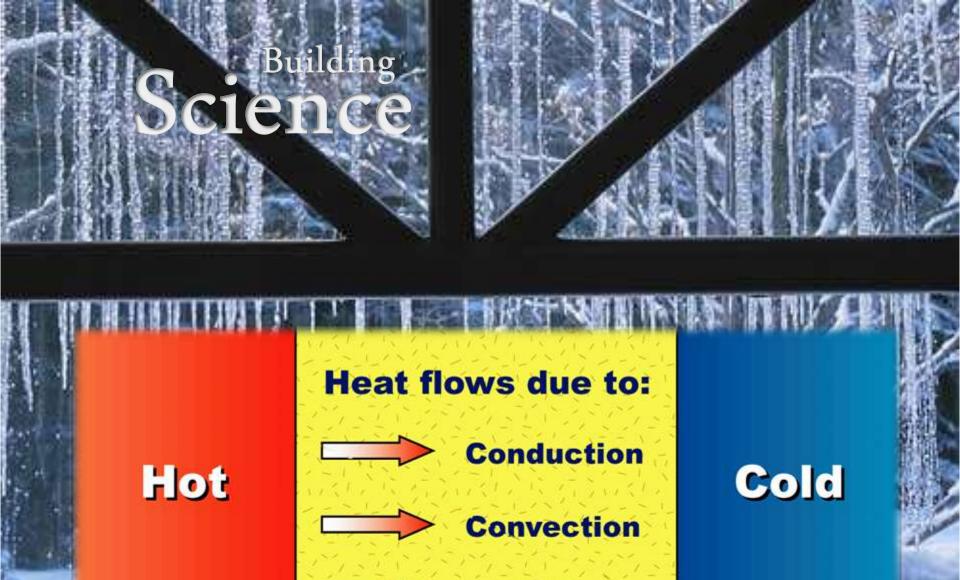
#### Passiv Haus



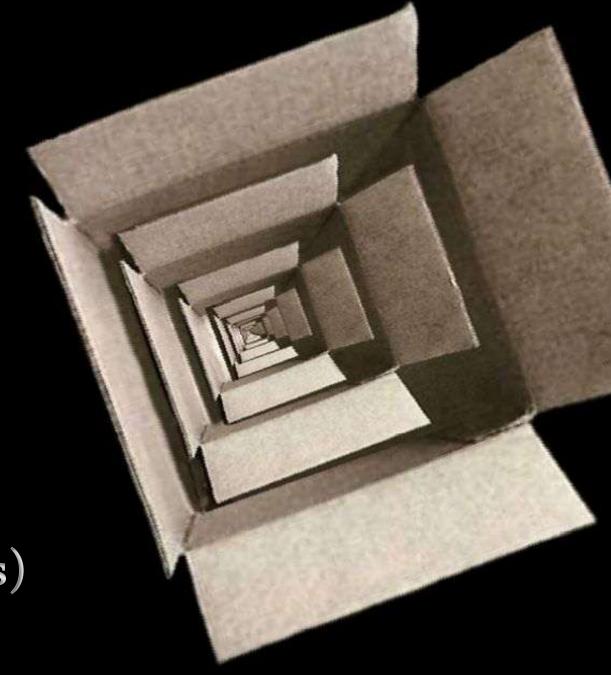








Radiation



Think
Outside the

Box(es)

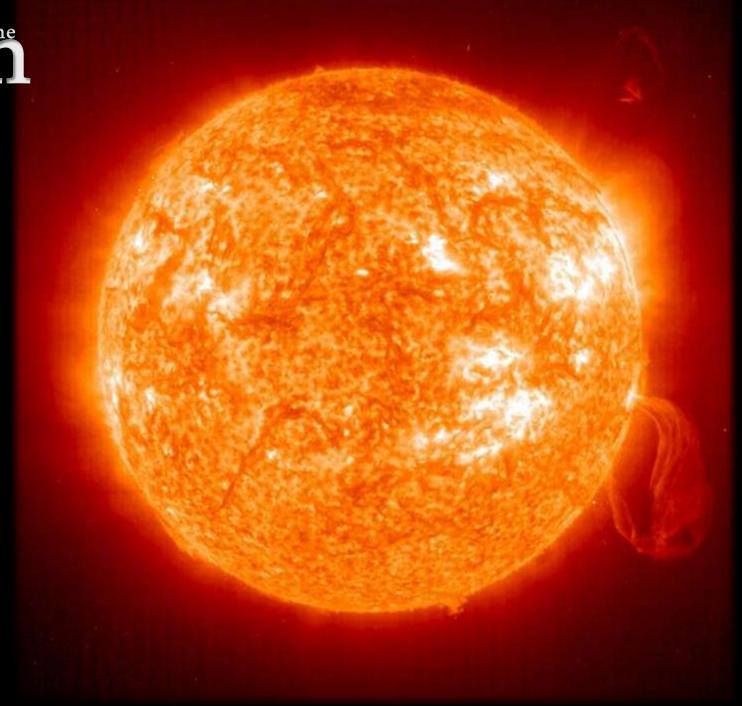




# Human What makes us

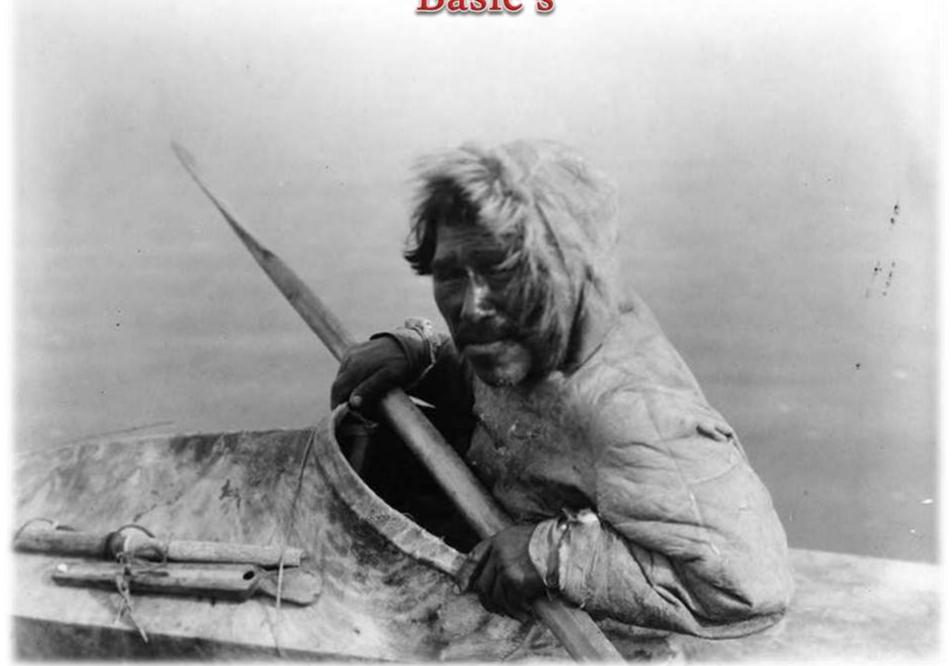


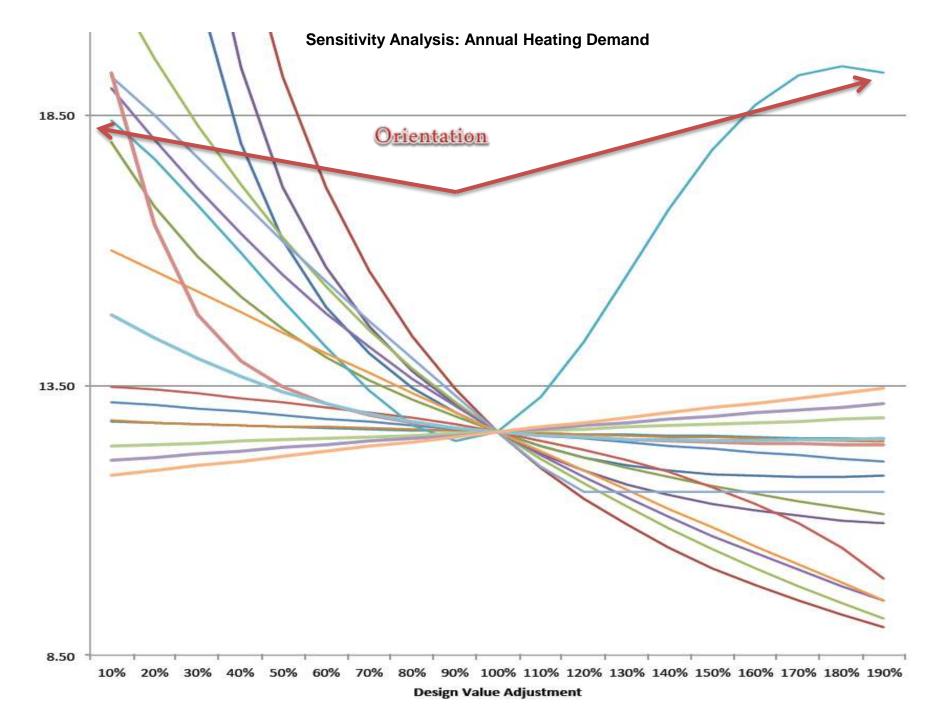
Sun

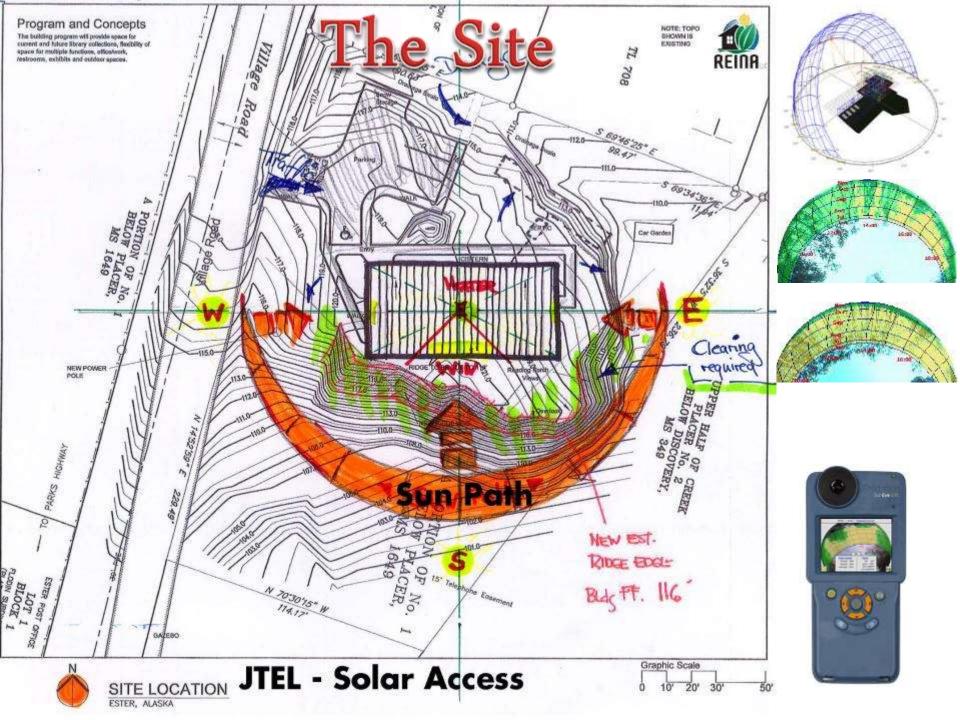


ANDERE THERE MUST BE
A SOURCE OF ENERGY
DOWN THERE

# "Basic's"

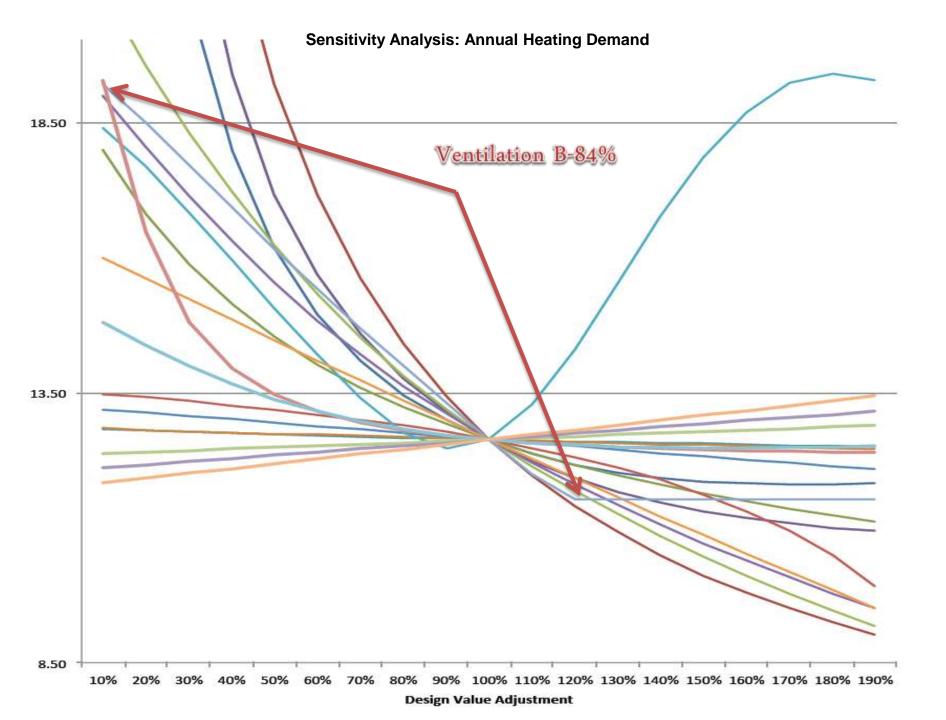








# "Ventilation"





### Zehnder ComfoAir 350 @84%

+ ComfoFond

400 FT Ground loop

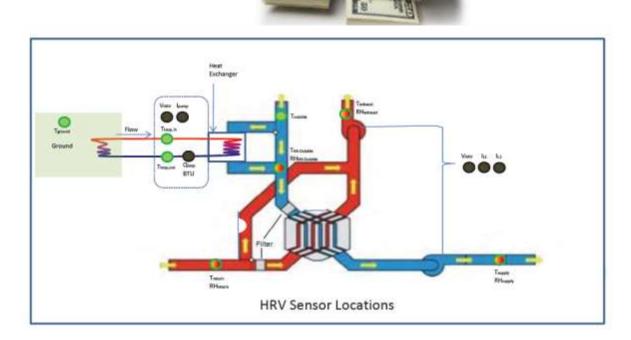
Heat exchanger @ 12 foot depth

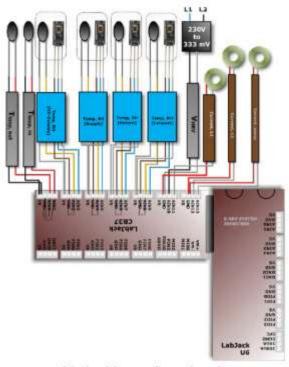


#### HRV maintained

2-3°F differential Supply/Return

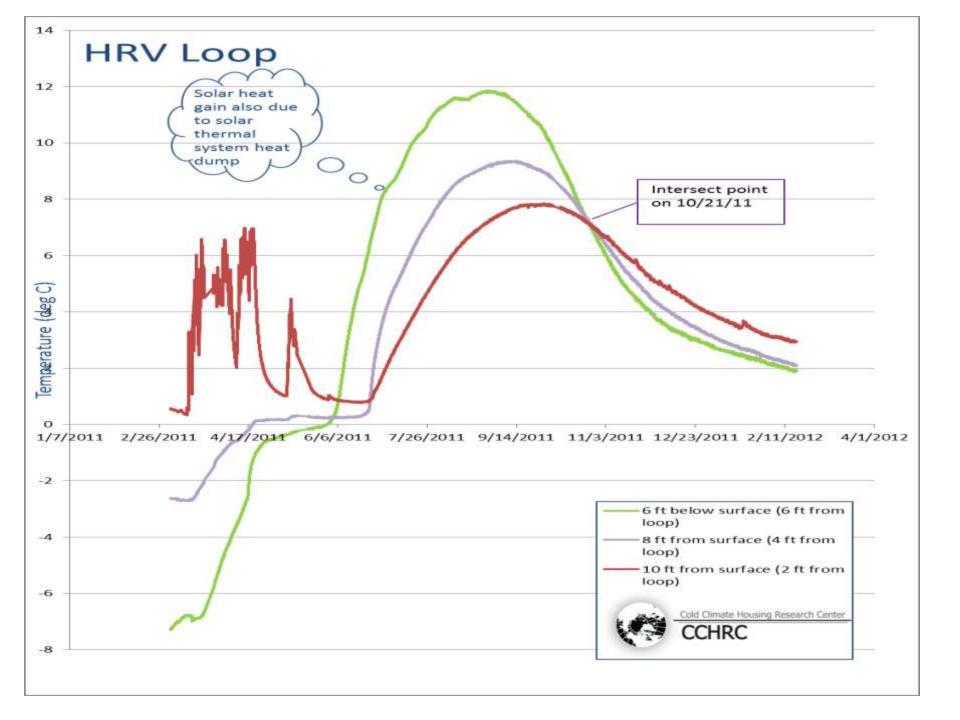
@ -49°F





Labjack Wiring Configuration Diagram 8CG 9-21-11





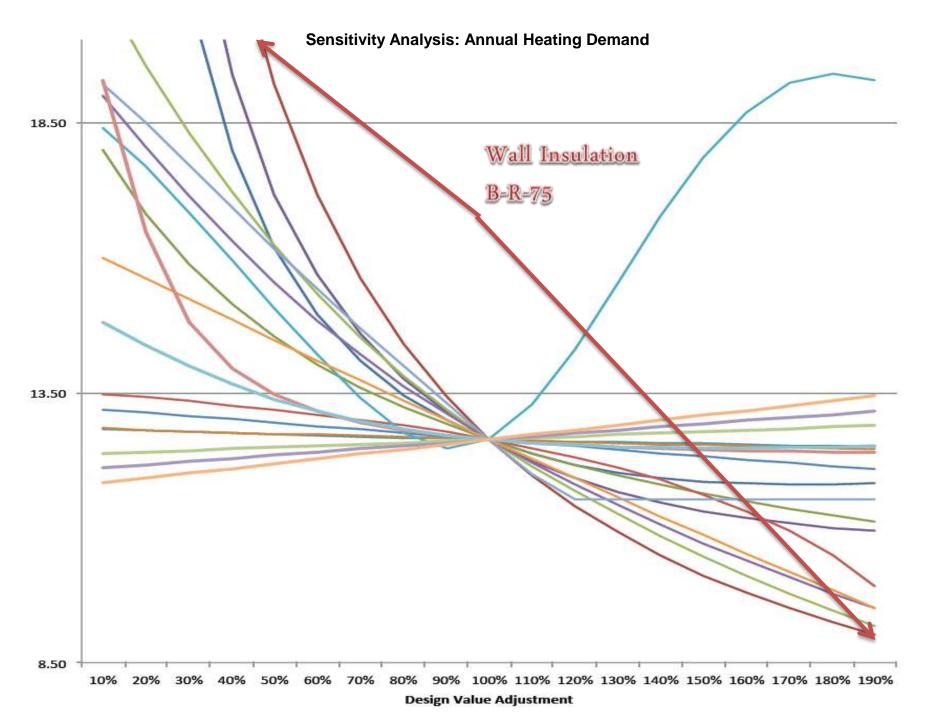


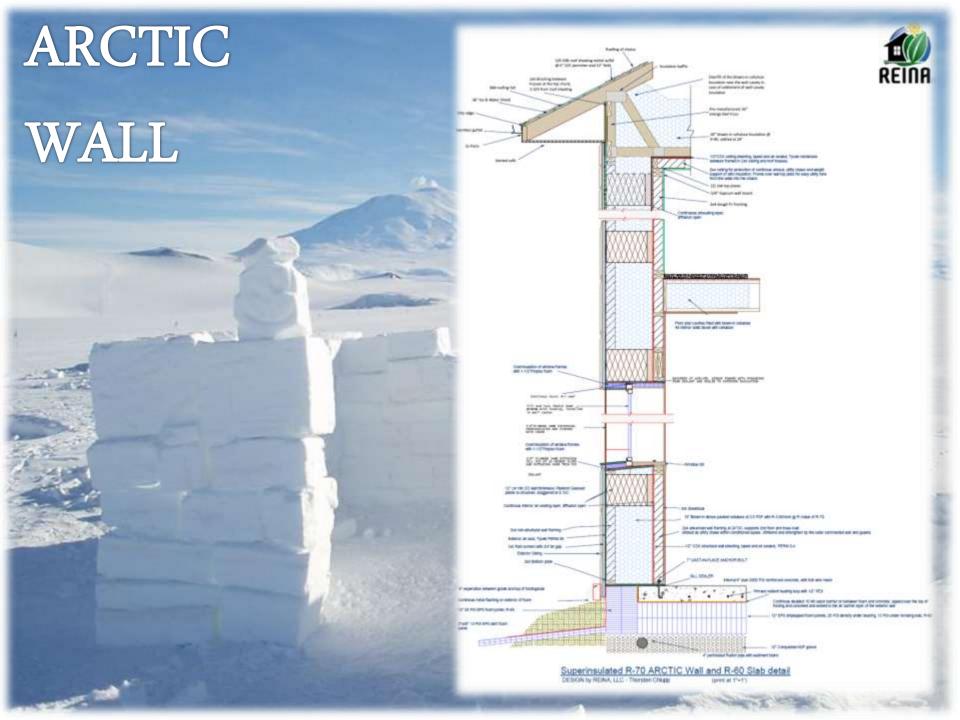


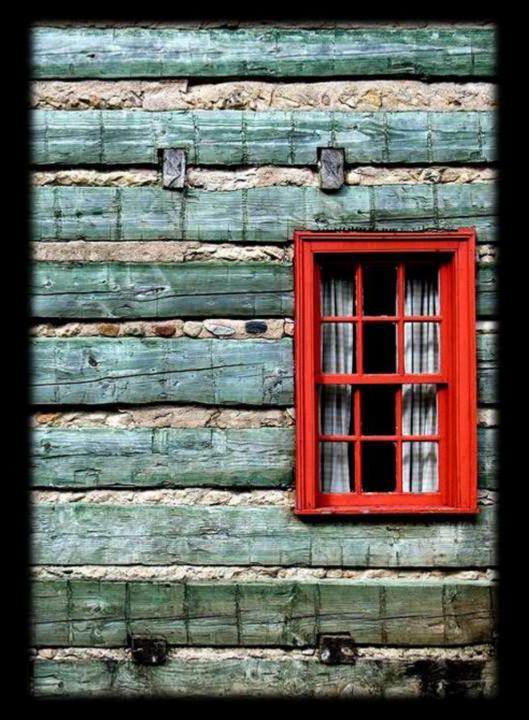


# "Wall Insulation"









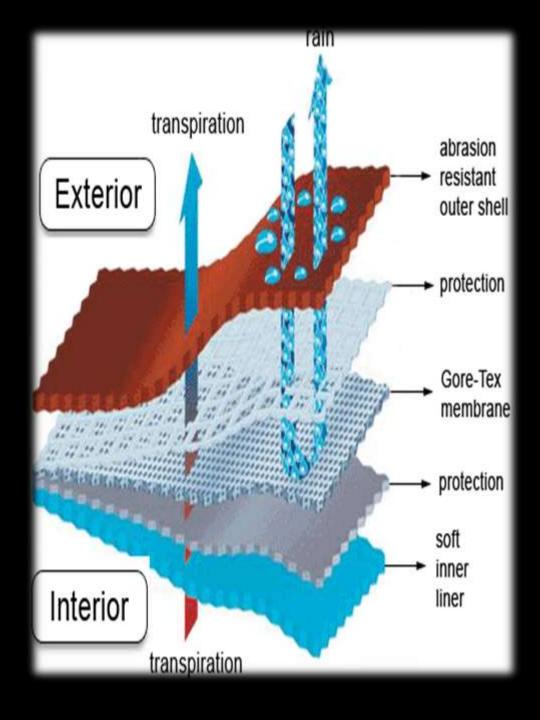
# Diffusion

open

wall

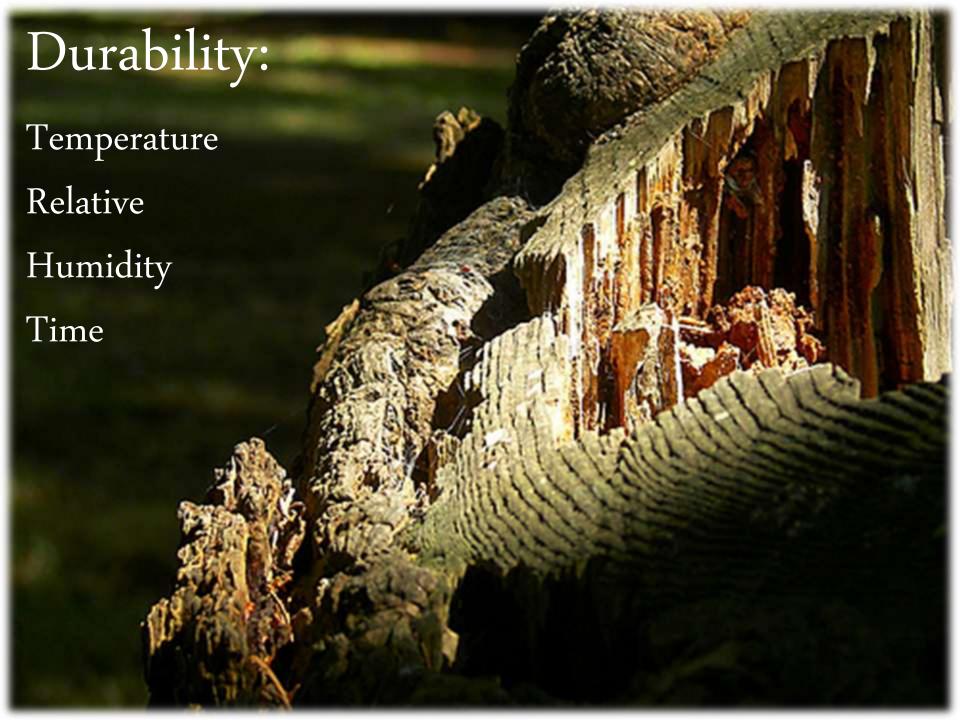


Dryingpotentialin anydirection



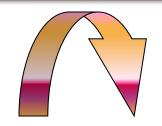
Diffusion
open
= Think
Gore Tex





## Air Transport of Water Vapor

# AR LEAKAGE



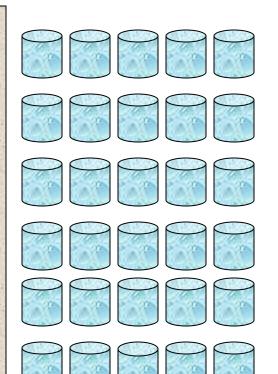
Air leakage

-Moisture flow 4 x 8 Drywall 70 F 40 % RH 1 square inch hole

Flow quantity
-30 Quarts of
water

4 X 8 sheet of gypsum board with a 1 inch square hole

Interior at 70 F and 40 % RH one heating season

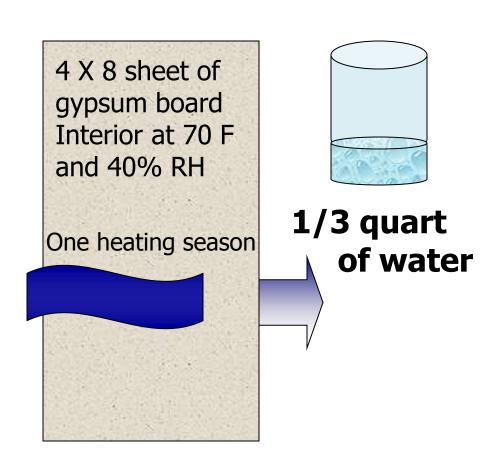


30 quarts of water

#### **Diffusion Transport of Moisture**

#### Diffusion

- -Migration of moisture by means of vapor pressure differential.
- -Occurs in either direction based on climate conditions and interior levels of humidity.
- -1/3 quart of water!!



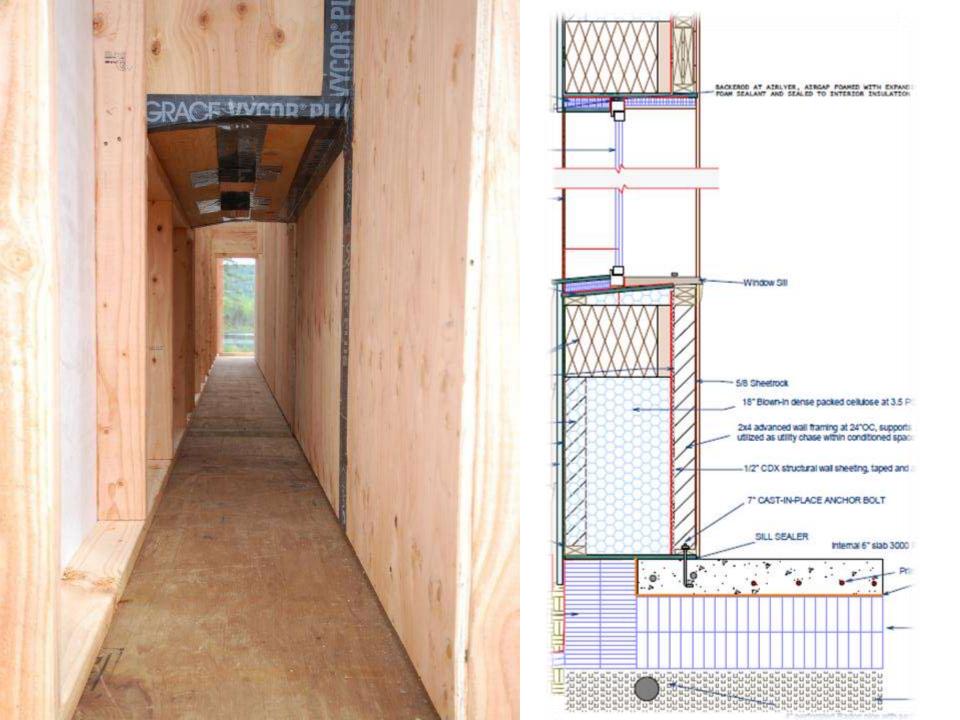


# Lambda value

High density, high heat capacity
- phase displacement

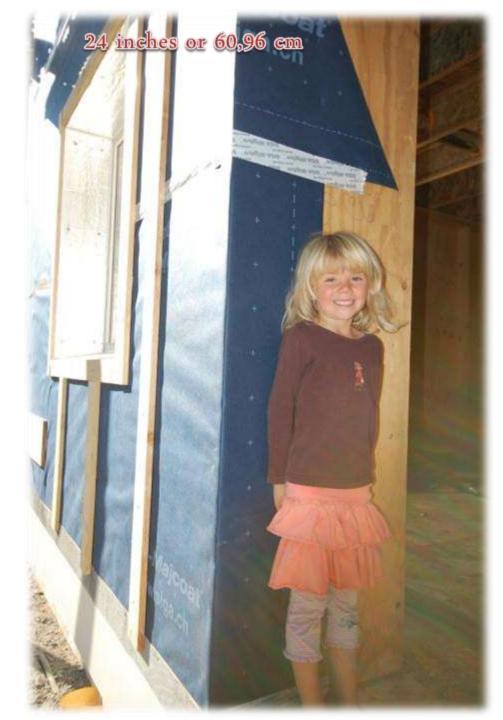
| Construction material       | Bulk density      | Thermal conductivity | Specific thermal capacity | Temperature guide number |
|-----------------------------|-------------------|----------------------|---------------------------|--------------------------|
| Construction material       | · _               | ?<br>[W/(mK)]        | c<br>J/(kg·K)             | a <sup>2</sup> /m        |
|                             | kg/m <sup>3</sup> |                      |                           |                          |
| Oriented Strand Board (OSB) | 650               | 0,13                 | 2100                      | 3                        |
| Cement bound Particleboard  | 1200              | 0,23                 | 2100                      | 3                        |
| Spruce, pine, fir           | 600               | 0,13                 | 2100                      | 4                        |
| Particleboards              | 600               | 0,14                 | 2100                      | 4                        |
| Softboard                   | 250               | 0,07                 | 2100                      | 4                        |
| Paroc                       | 220               | 0,035                | 2100                      | 4                        |
| Cellulose Insulation        | 70                | 0,04                 | 2000                      | 10                       |
| Woodwool                    | 55                | 0,04                 | 2000                      | 13                       |
| Concrete                    | 2000              | 1,35                 | 1000                      | 24                       |
| Polyurethane foam           | 30                | 0,035                | 1500                      | 28                       |
| Flax                        | 30                | 0,04                 | 1300                      | 37                       |
| Hemp                        | 30                | 0,045                | 1300                      | 4                        |
| Polystyrene foam            | 20                | 0,035                | 1500                      | 42                       |
| Glass wool                  | 20                | 0,035                | 1000                      | 63                       |
| sheep wool                  | 15                | 0,04                 | 1300                      | 74                       |
| Steel                       | 7800              | 50,00                | 400                       | 577                      |

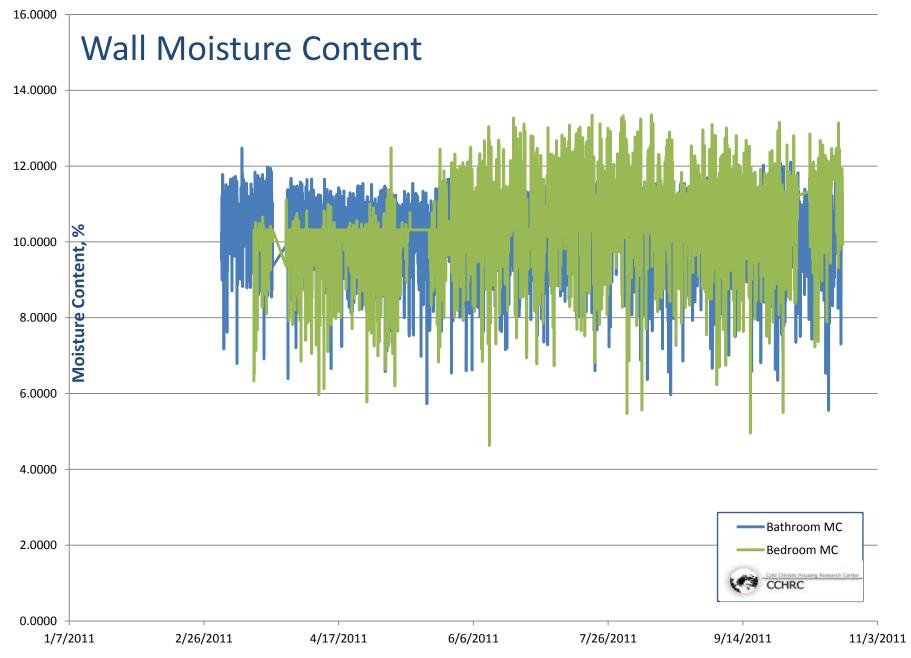


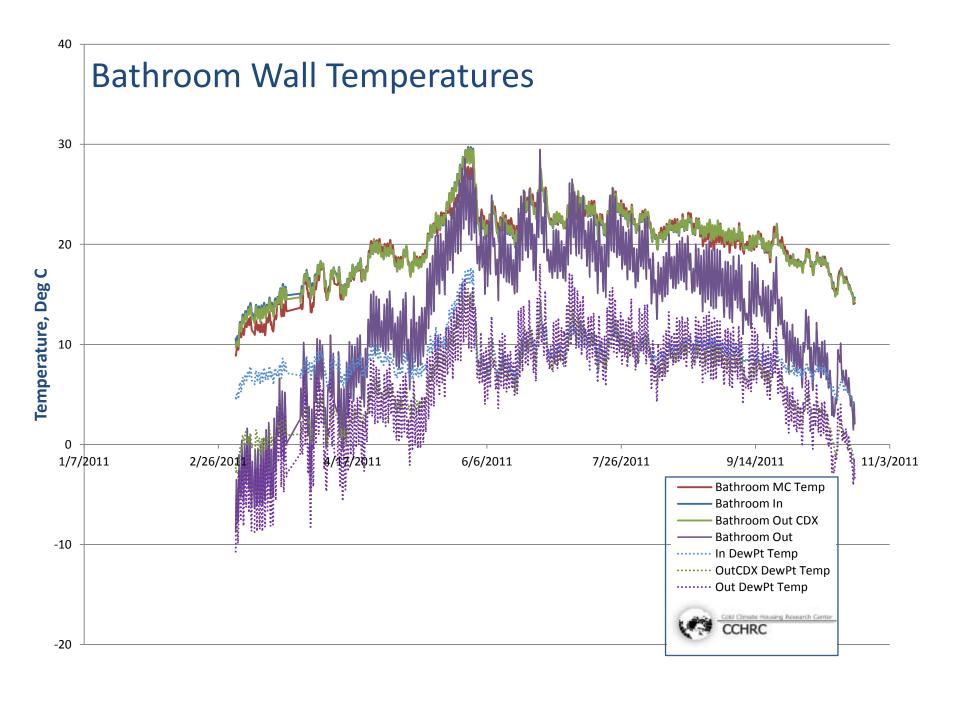


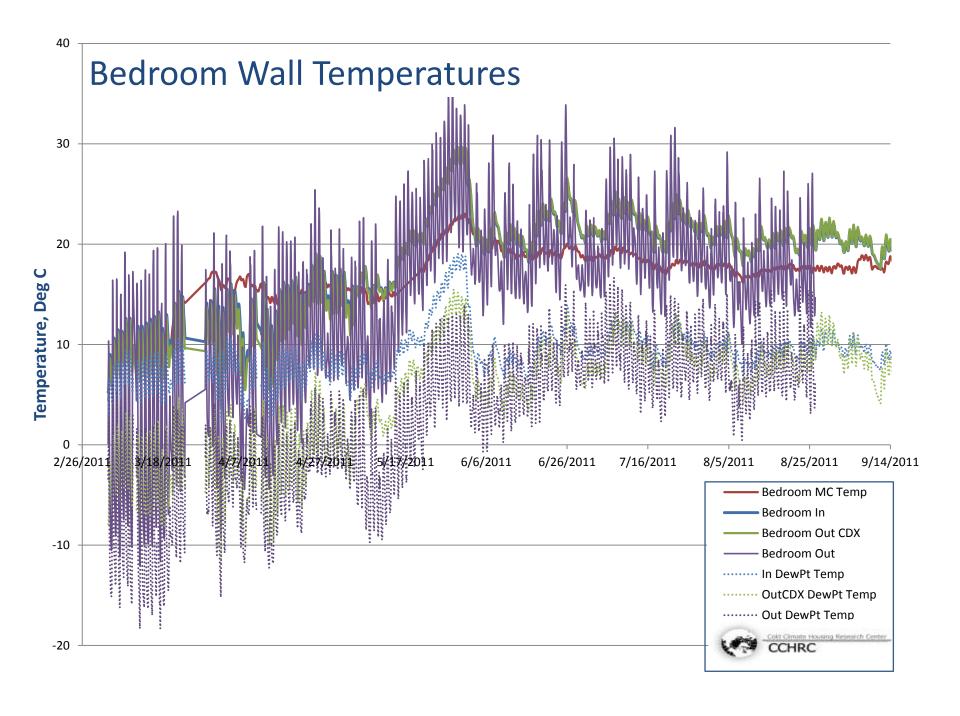




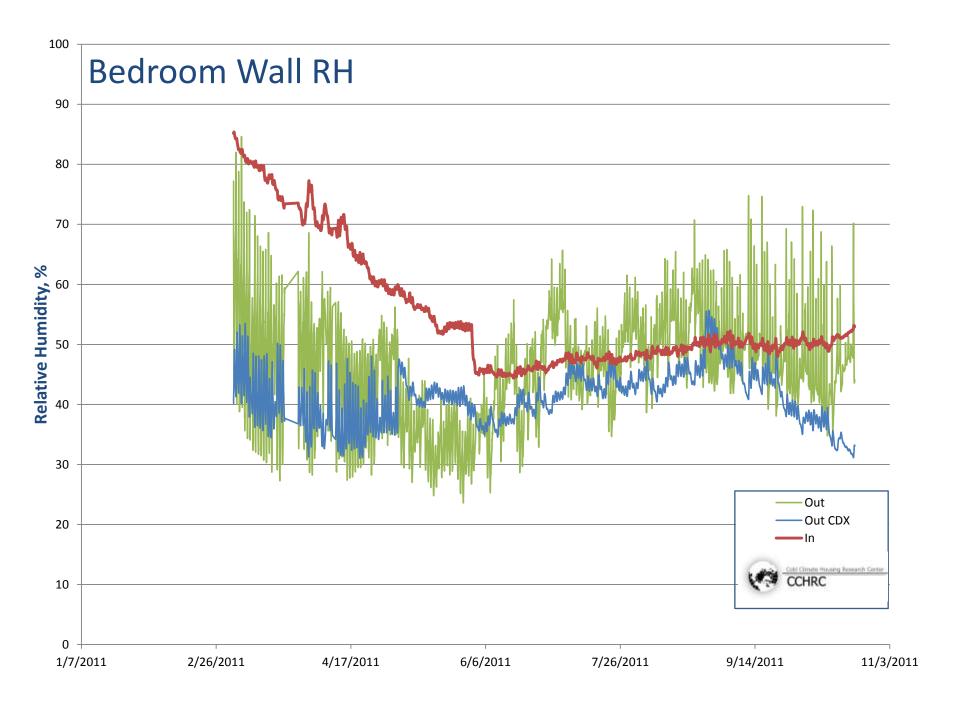






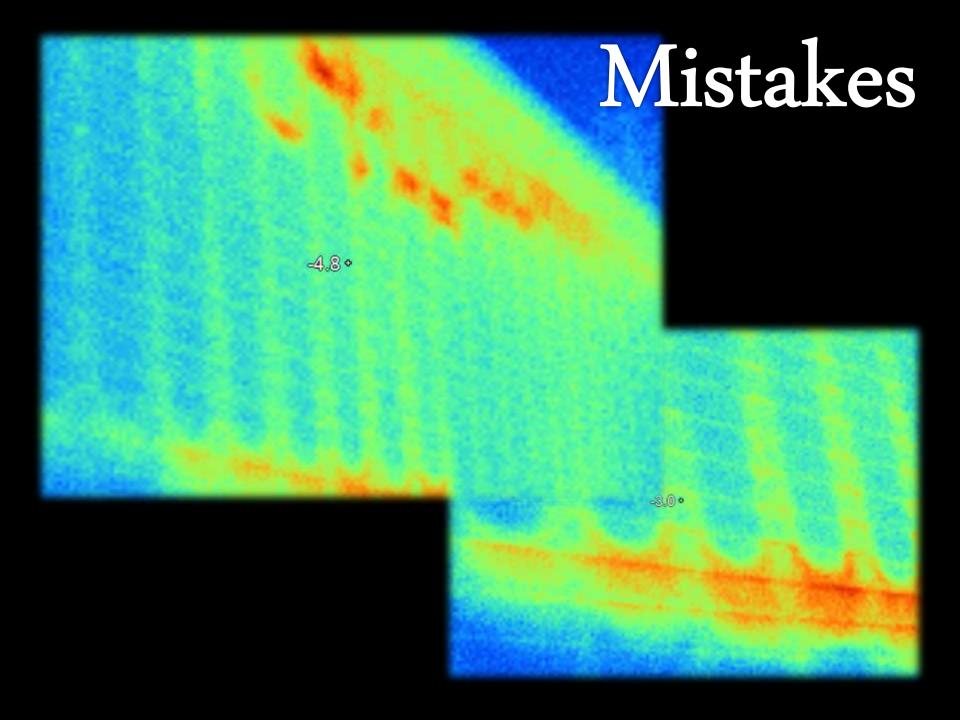




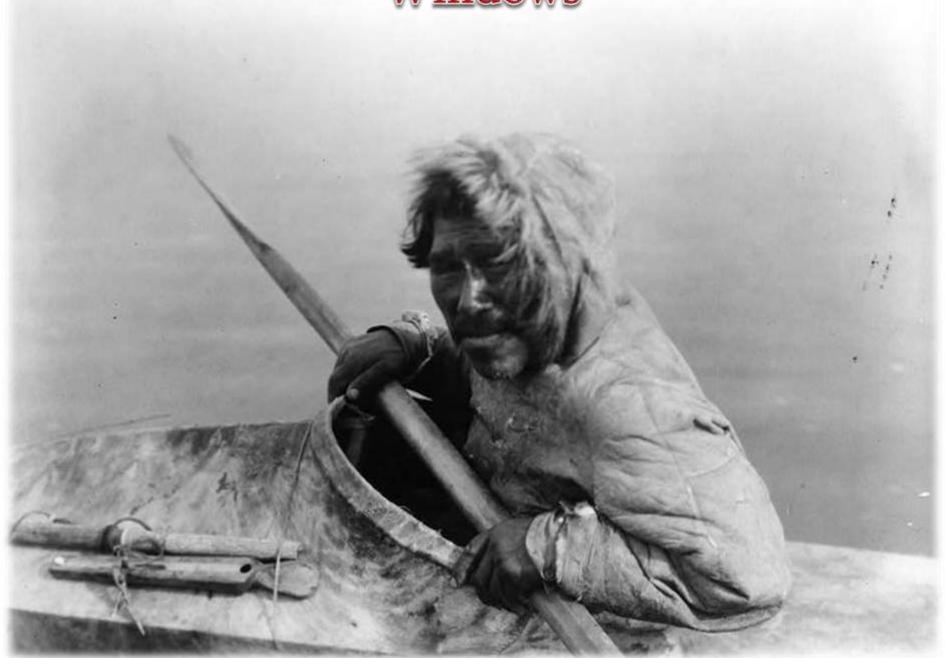








### "Windows"





#### **Passive House Planning**

#### REDUCTION FACTOR SOLAR RADIATION, WINDOW U-VALUE

Annual Heat Demand:

4.33 ABTU/[FI:qe]

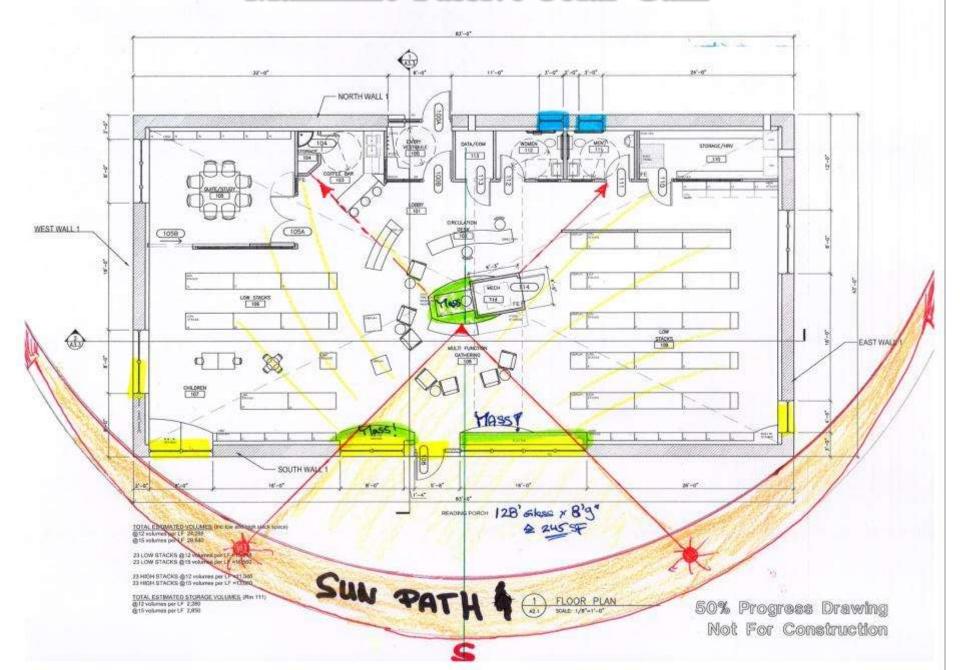
Heating Degree Days:

| raction | SHGC | Reduction<br>Factor for<br>Solar<br>Radiation | Window<br>Area | Window<br>U-Value         | Window<br>R-Value | Glazing<br>Area | Area as | Average<br>Global<br>Radiatio |
|---------|------|---|----------------|---------------------------|-------------------|-----------------|---------|-------------------------------|
|         |      |   | ei,            | DT0/64-61 <sup>2</sup> .F | s.ees².F/BTU      | er'             |         | LDTE/fl-q.                    |
| 00      | 0.00 | 0.00  | 0.0            | 0.00                      | 0.0               | 0.0             | 0.0%    | 17                            |
| 28      | 0.63 | 0.43  | 48.3           | 0.18                      | 5.7               | 35.2            | 2.7%    | 70                            |
| 50      | 0.63 | 0.66  | 242.1          | 0.12                      | 8.4               | 205.8           | 15.9%   | 174                           |
| 08      | 0.63 | 0.50  | 105.9          | 0.14                      | 7.3               | 85.6            | 6.6%    | 87                            |
| 00      | 0.00 | 0.00  | 0.0            | 0.00                      | 0.0               | 0.0             | 0.0%    | 93                            |
|         | 0.62 | 0.50  | 200.2          | 0.12                      | 7.0               | 220.0           | 1       |                               |

| 12056        |           |
|--------------|-----------|
| <b>.</b>     | Heat      |
| Transmission | Gains     |
| Losses       | Solar     |
|              | Radiation |
| kBTU/yr      | kBTU/yr   |
| 0            | 0         |
| 2470         | 921       |
| 8301         | 17645     |
| 4221         | 2878      |
| 0            | 0         |
| 14992        | 21443     |



#### Maximize Passive Solar Gain

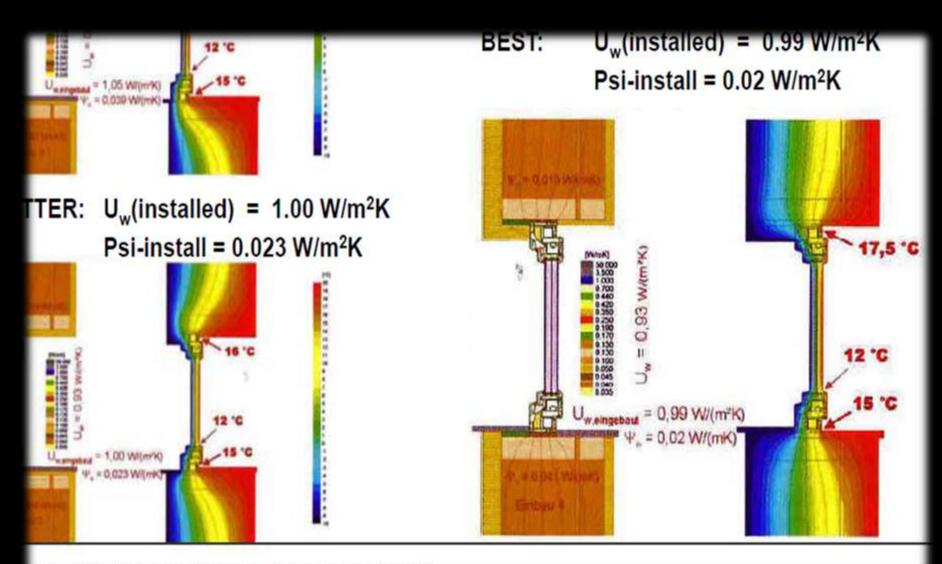






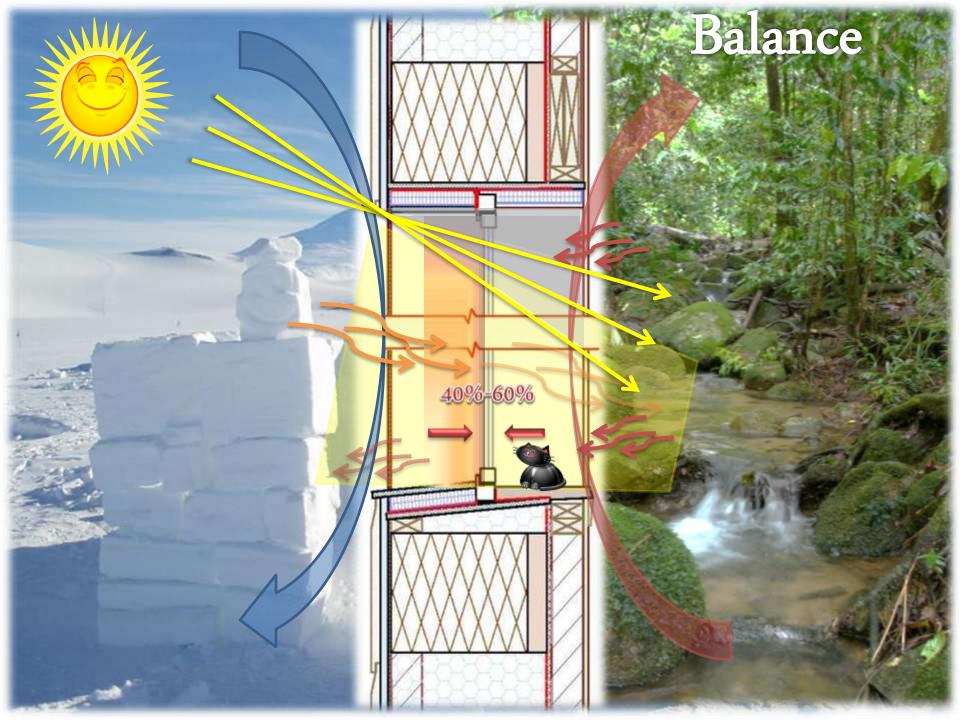


### Position









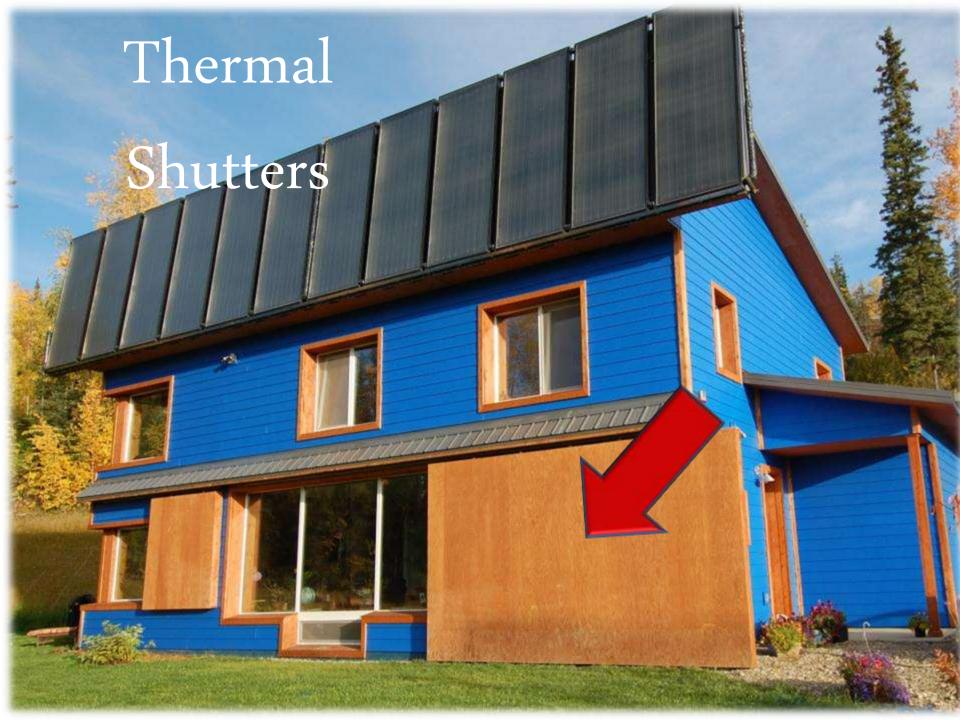


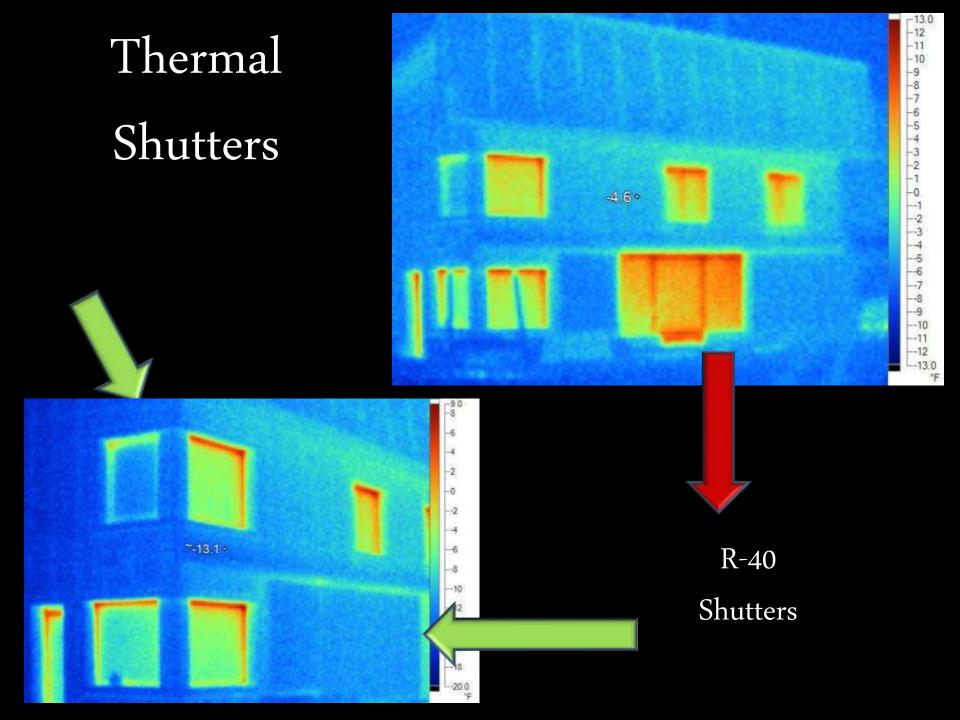


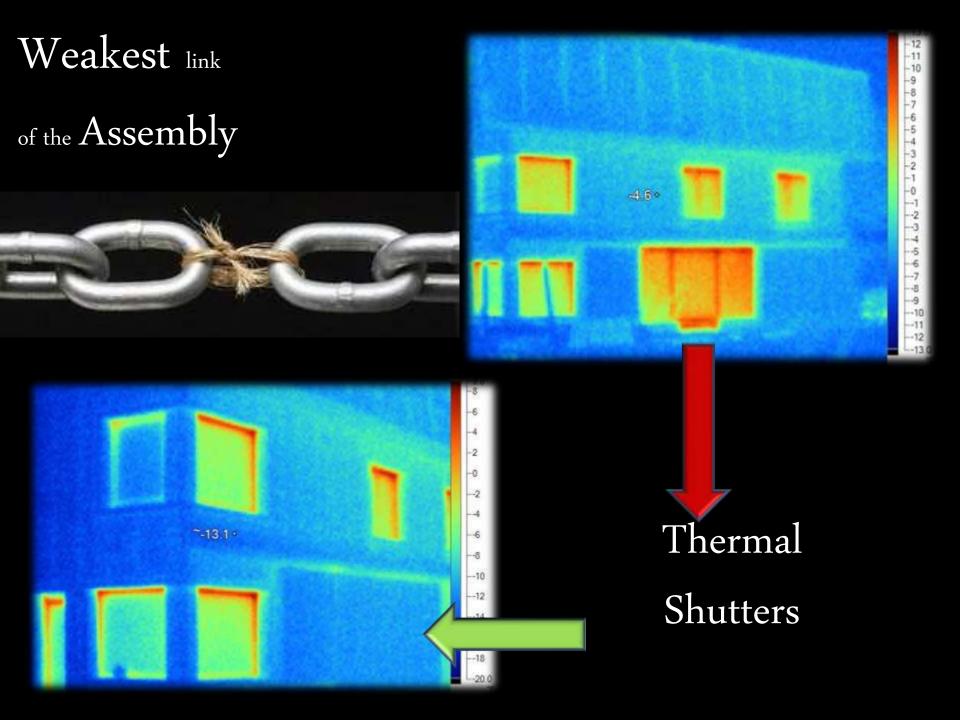




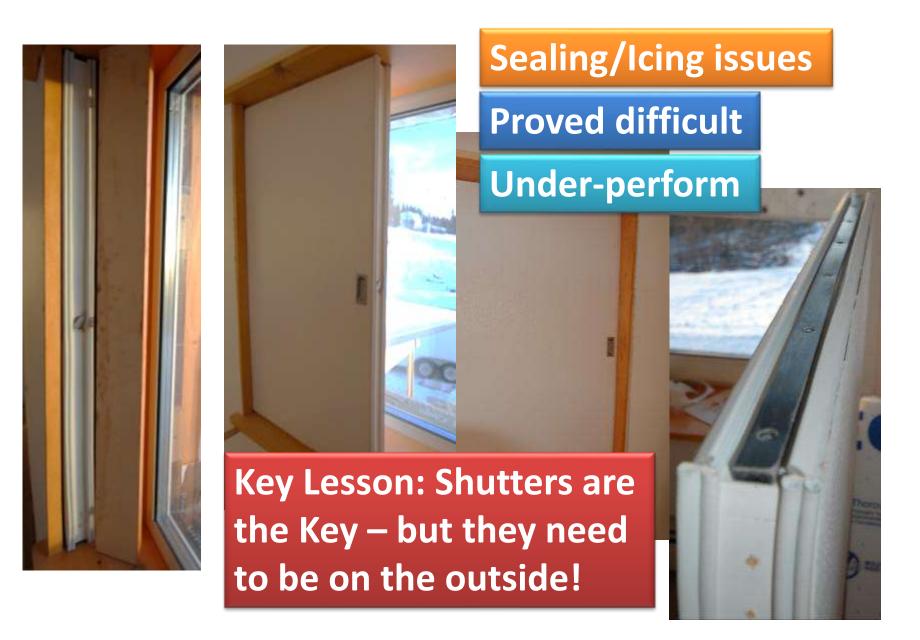


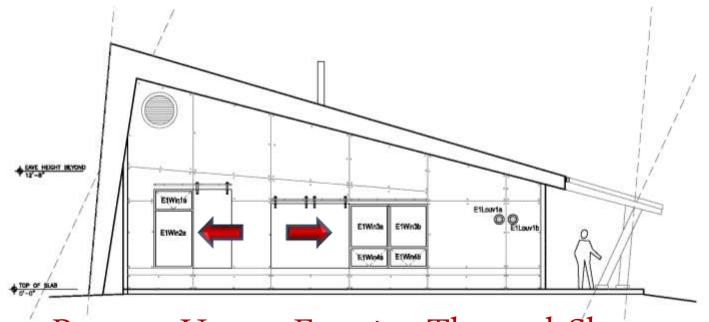




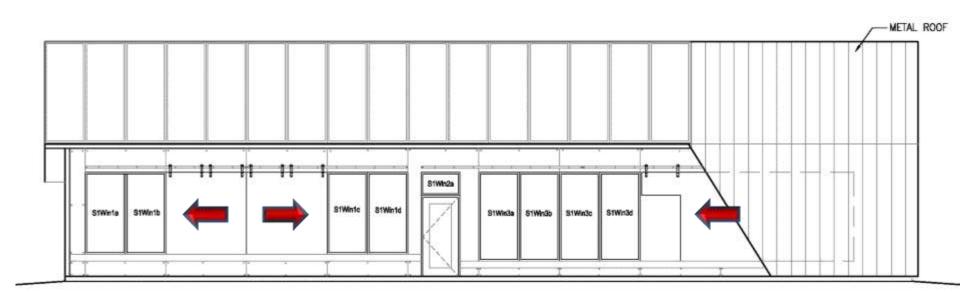


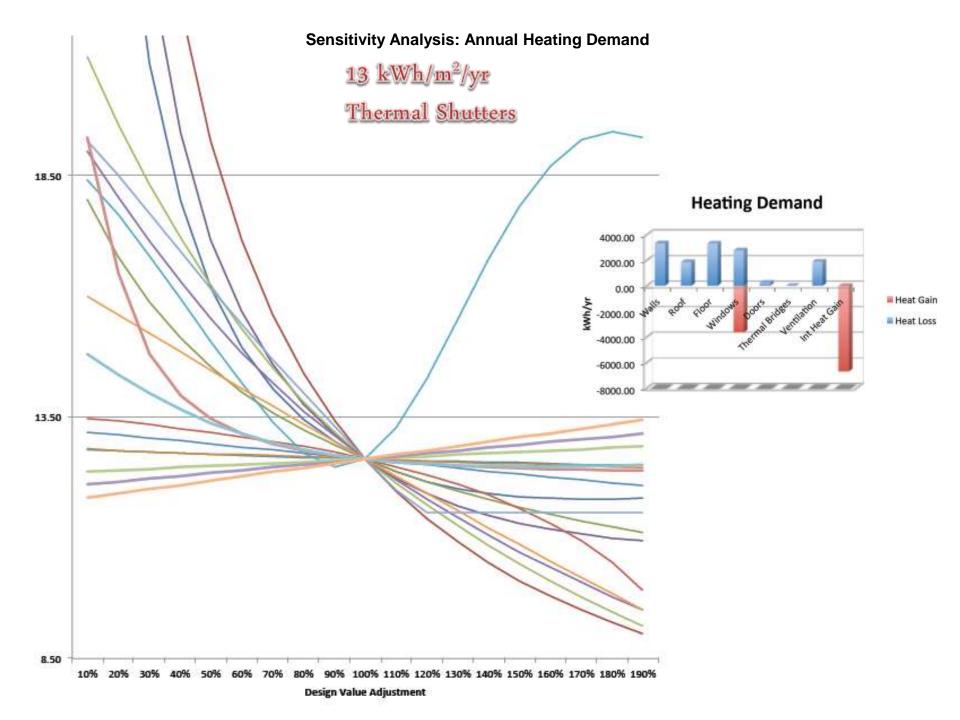
#### Interior Thermal Shutters function BUT:

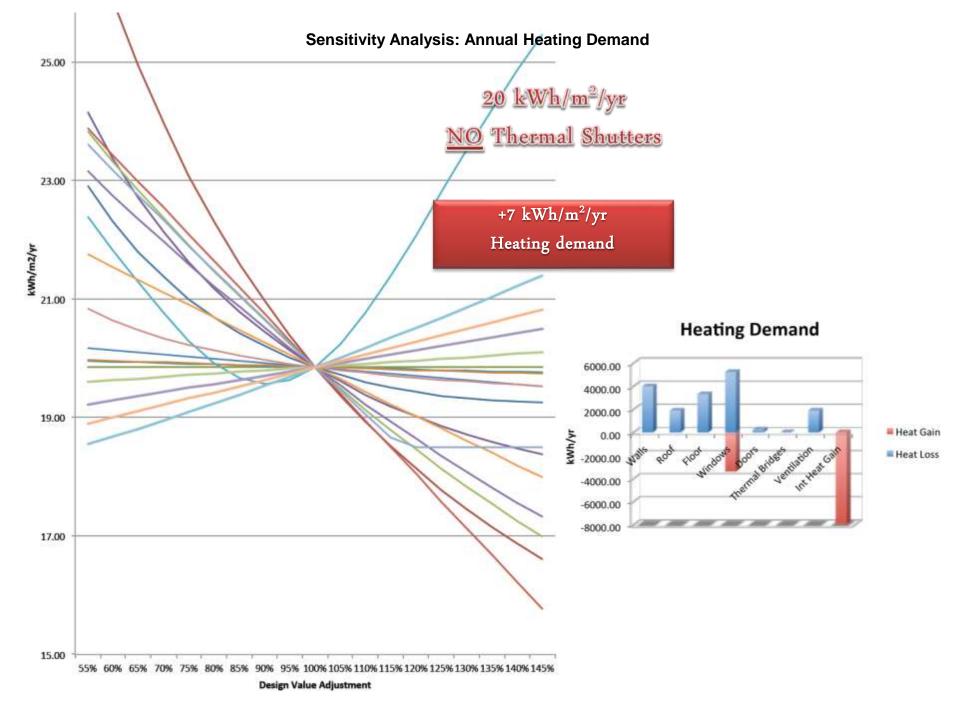




R-20 or U-0.05 Exterior Thermal Shutters





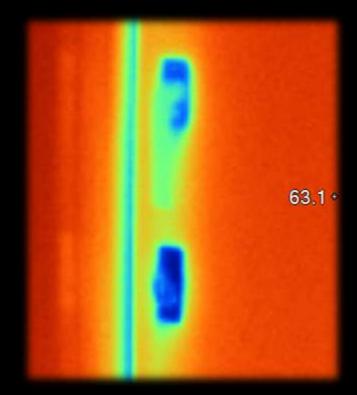


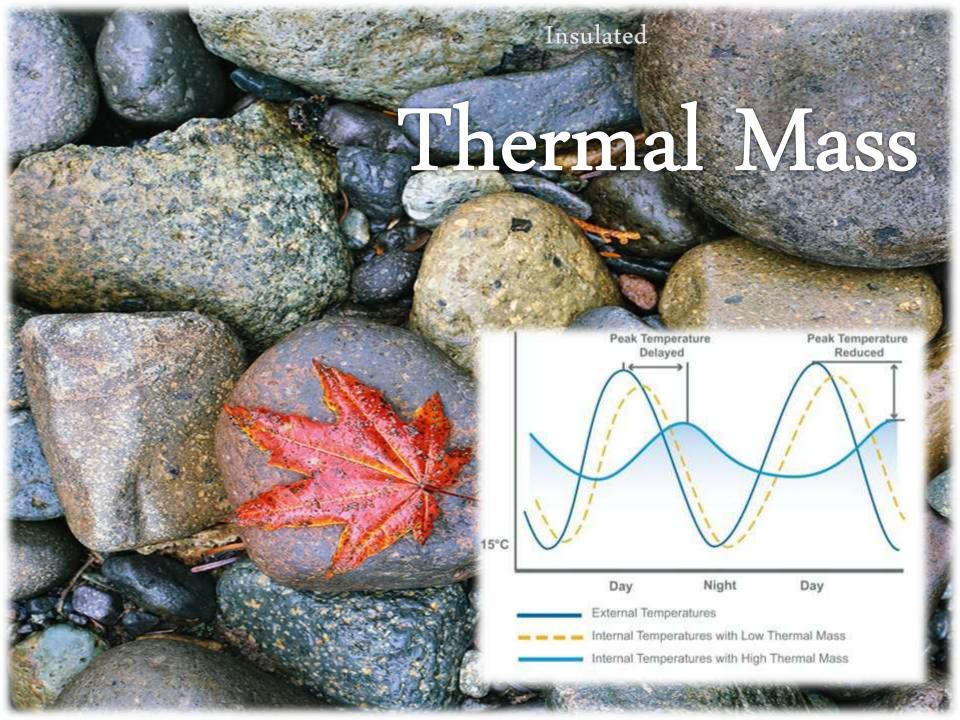


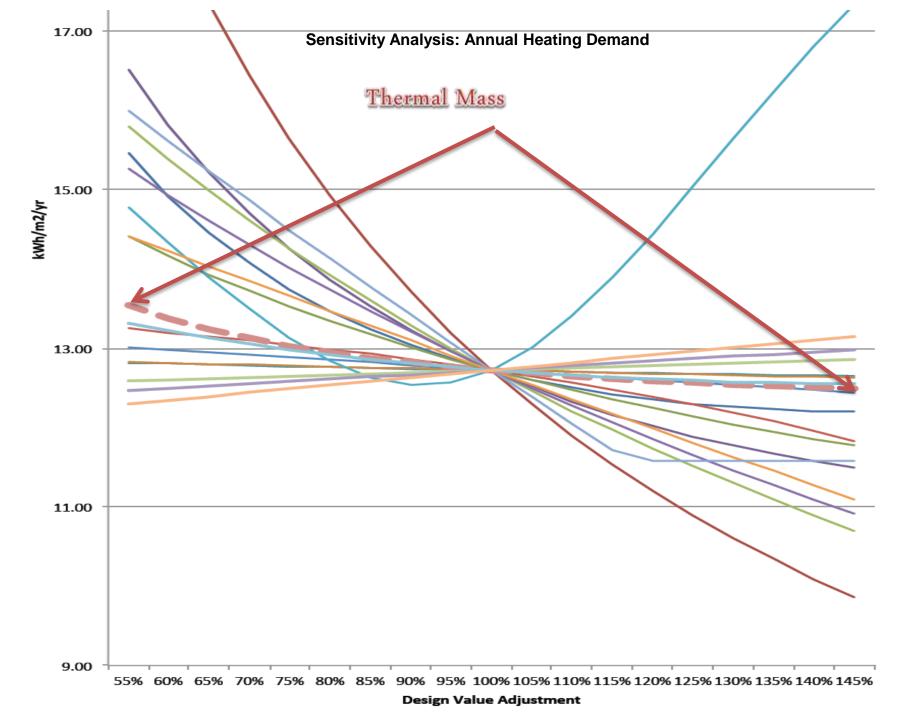
Hidden

# Thermal

@ 40 Below

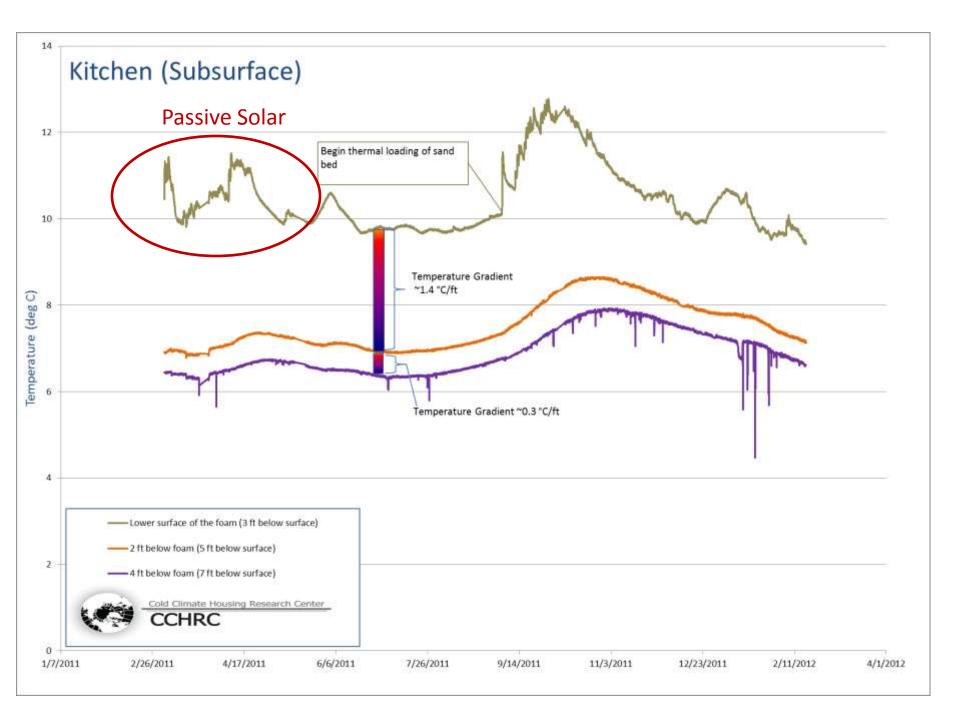












## "Annual Heat Storage"





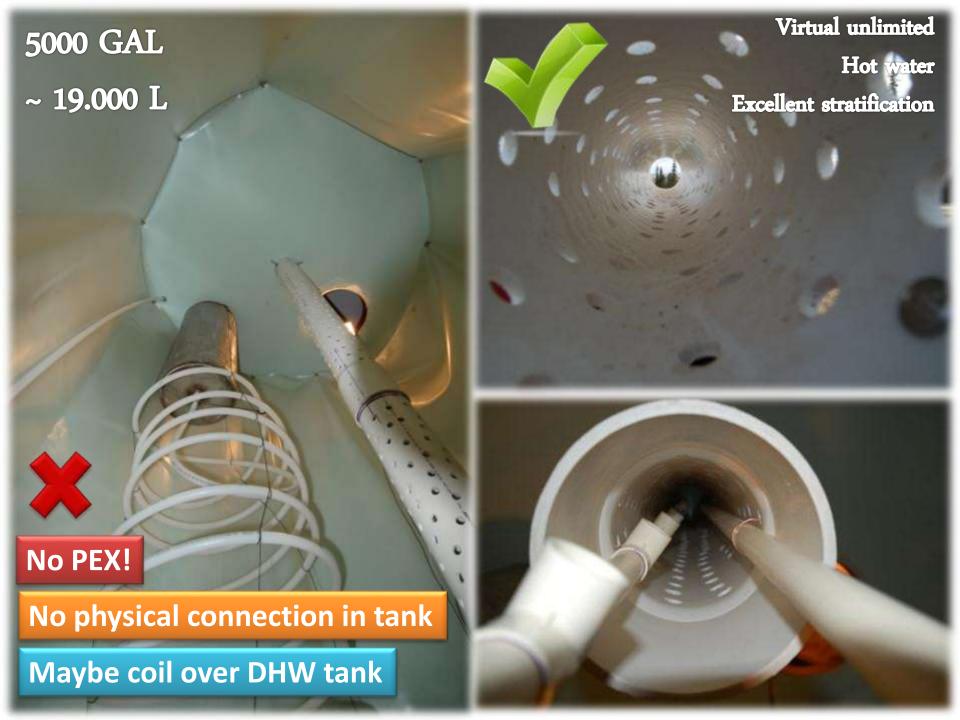
## 3 months without Sun



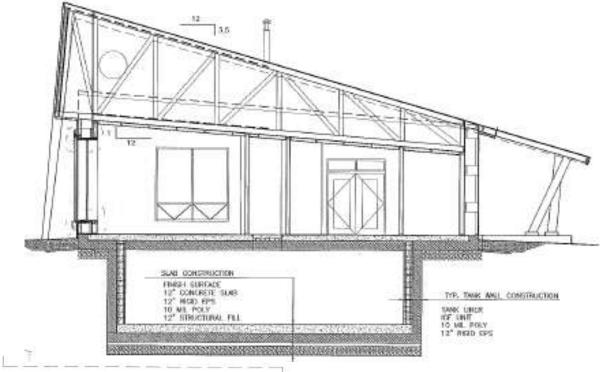


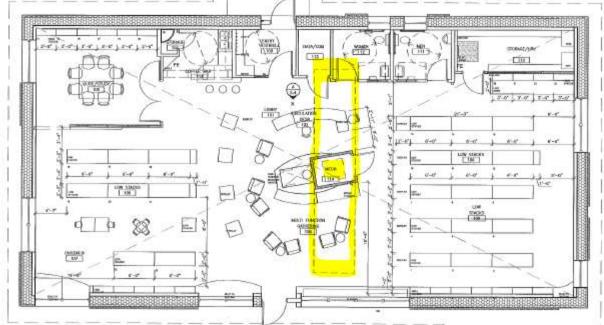




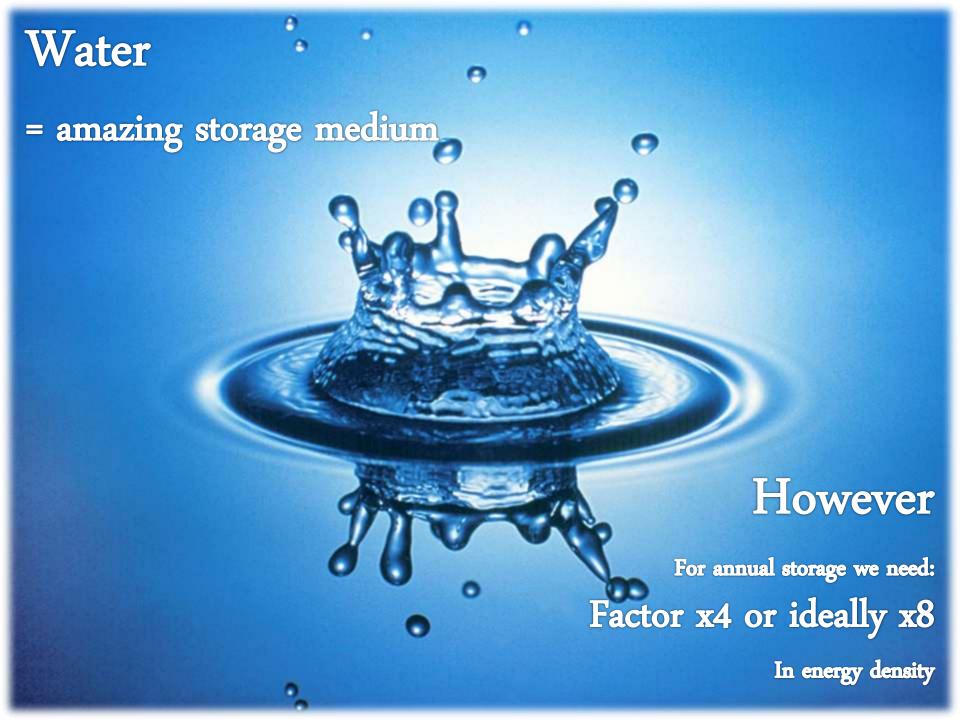


Heating
dominated
minimal DHW
needs





14,000 Gal seasonal storage



## What is it going to be?



**Opportunity** 

Liability

