



Promoting Research and Education for
Alaskans in Sustainable Development

acat.org

ZERO ENERGY HOMES: A GROWING MARKET

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Mat-Su College

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Architect and Energy Auditor

Palmer, Alaska



ALASKA CENTER FOR
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NAVIGATING YOUR PATH TO NET ZERO ENERGY

Net Zero Energy Definition

Case Studies International Alaska

Envelope Insulation Windows

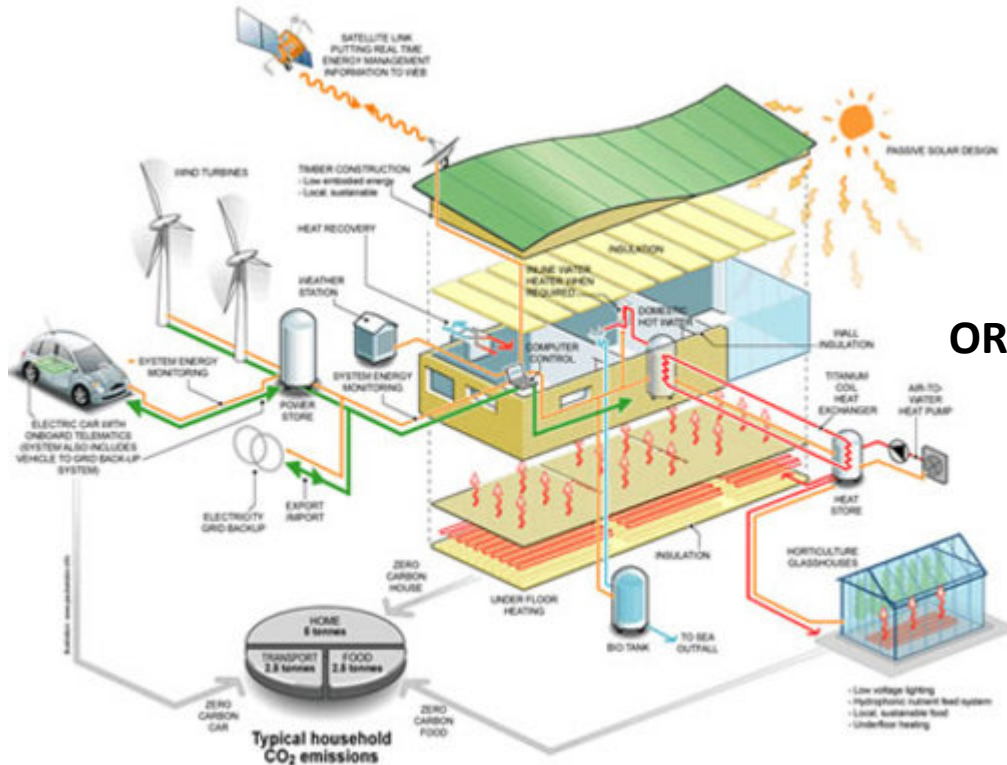
Heating Heating Methods

Electric Usage Reductions

Renewables PV Watts

Local Case Study

Overall Review



OR.



What are we thinking about when we hear Net Zero Energy?



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NET ZERO ENERGY BUILDING

Net Zero Energy Definition

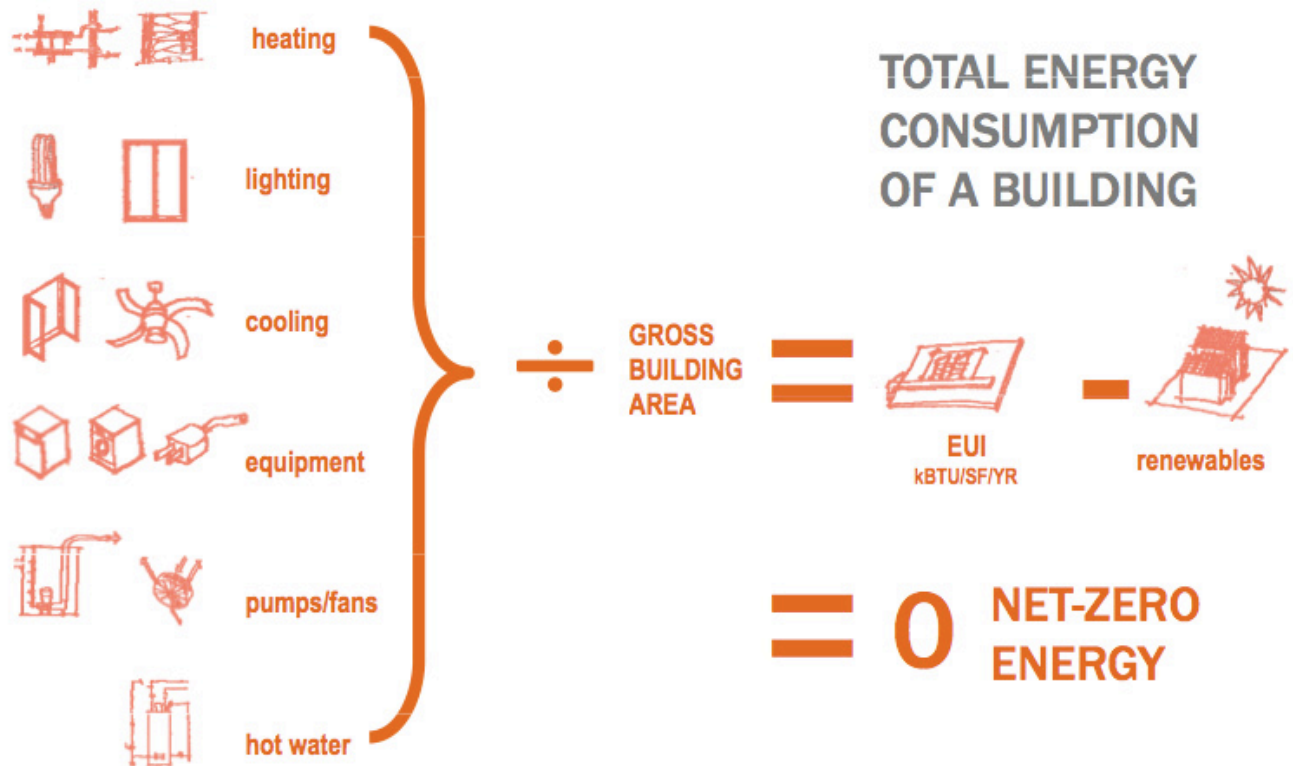
Envelope
Spreadsheet
Heat Loss
Insulation

Heating
Heating Methods
Storage

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Storage

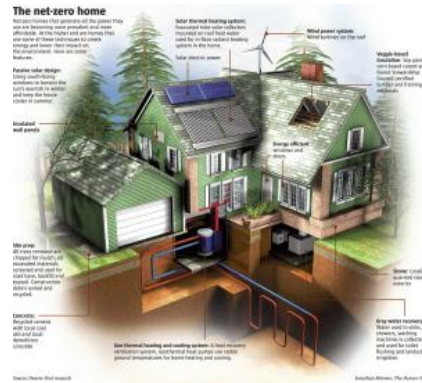
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WHAT DOES A NET ZERO ENERGY BUILDING LOOK LIKE?





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IS NET ZERO ENERGY BUILDING POSSIBLE IN ALASKA?



HAVEN'T ALASKANS BEEN DOING NET ZERO FOR YEARS?

- Is it net zero energy?
- Are you producing as much energy as you use?
- How does wood harvesting and burning enter in?
- Is it more energy intensive on the surrounding land?
- How much different is your lifestyle?



Alaska's First Net Zero Energy Homes

Thorsten Chlupp, REINA, LLC Fairbanks builder

Details:

- R70 Cellulose Walls
- Triple Pane Window
- Thermal Shutters
- R100 Roof
- Solar Thermal
- 5000ga Storage Tank
- Masonry Wood Heater



“You wouldn’t believe how many engineers have told me in the past year that it’s impossible,” Thorsten Chlupp said of the [fossil-fuel free system](#). “I already know I need to build an outdoor swimming pool because I have too much heat.”



World's Tightest Home

Tom Marsik, UAF Dillingham Renewable Energy Professor

Details:

- New (600sf)
- R90 Walls
- R100+ Roof
- Minimal glazing
- 0.05 ACH at 50Pa
- 3,700kwh annual (including heat)
- Testing an air to air heat pump



“We are certainly excited about this. The purpose of this world record attempt was to help bring attention to energy efficiency, and hopefully motivate others to be energy efficient. With this official world record, I think it really helps emphasize our message of what’s possible.”



Valley Near Net-Zero

Harvey and Sandy Bowers, Agate Inn, Wasilla

Details:

- Retrofit
- R50 Walls
- R7 Fiberglass windows
- R70 Roof
- Solar Thermal (32 tubes)
- 4 .3kw Solar PV and Tracking Array
- Water Storage Tank (2000ga)



Harvey and Sandy founded ACAT and have been working on making their home and the buildings at the Agate Inn Net Zero Energy. They are currently working on a campus solar thermal and solar photovoltaic arrays for the Agate Inn.



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Exterior Wall Retrofits

Margie Subers, Palmer

Details:

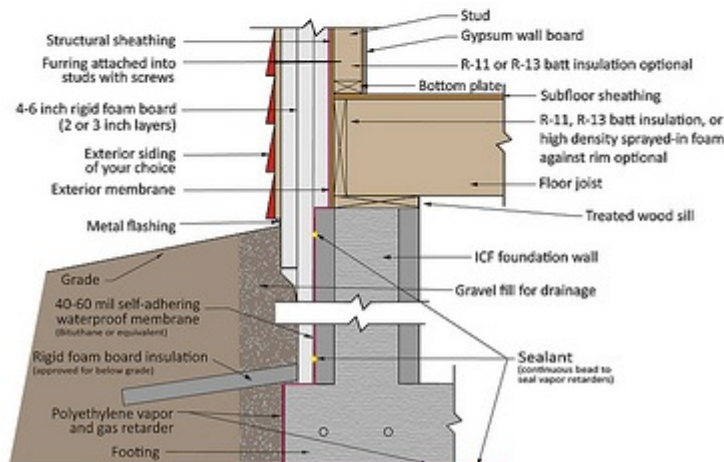
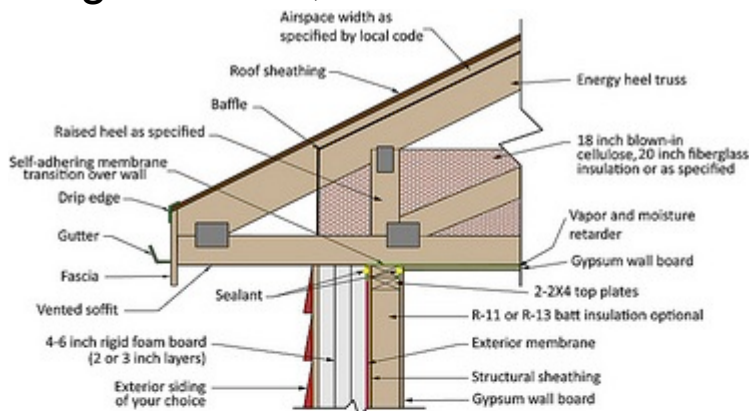
• **REMOTE Wall**
8" Foam on Walls

• **R60 Roof**

• **Triple pane windows**

• **Heat Recovery Ventilation**

• **Geothermal pre-heat loop**



Margaret built her own home using exterior insulation technology and has shared her knowledge and experience. Her workshop shared a mock up example of a wall section utilizing this technique, including some basic details for window and wall penetration techniques.



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Building Energy Use

Where does all the energy go?

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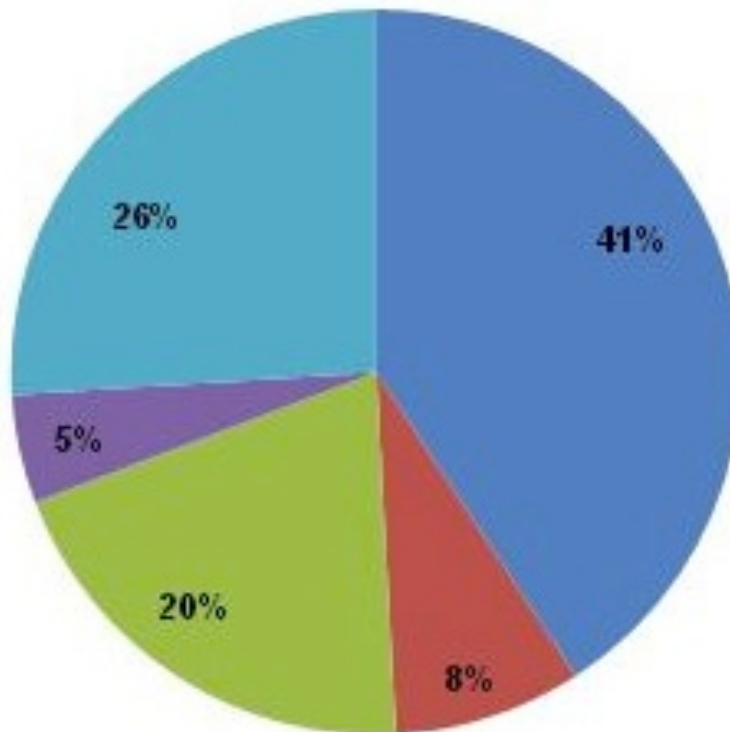
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- Space Heating
- Air-Conditioning
- Water Heating
- Refrigerators
- Other Appliances and Lighting



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Energy Audits / Energy Rating

How do we measure where energy is being used?

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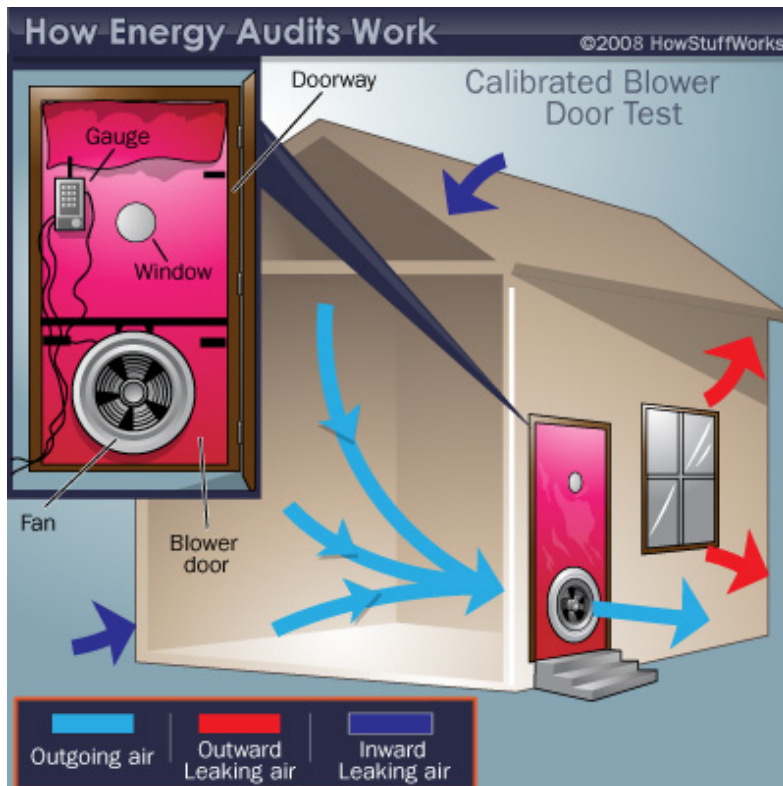
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Energy Audits

- Analyze existing utility bills
- Recommend improvements

Tools

- Measurement
- Blower Door test
- Energy Model

Residential

- Heating load typically highest
- Air sealing most cost-effective



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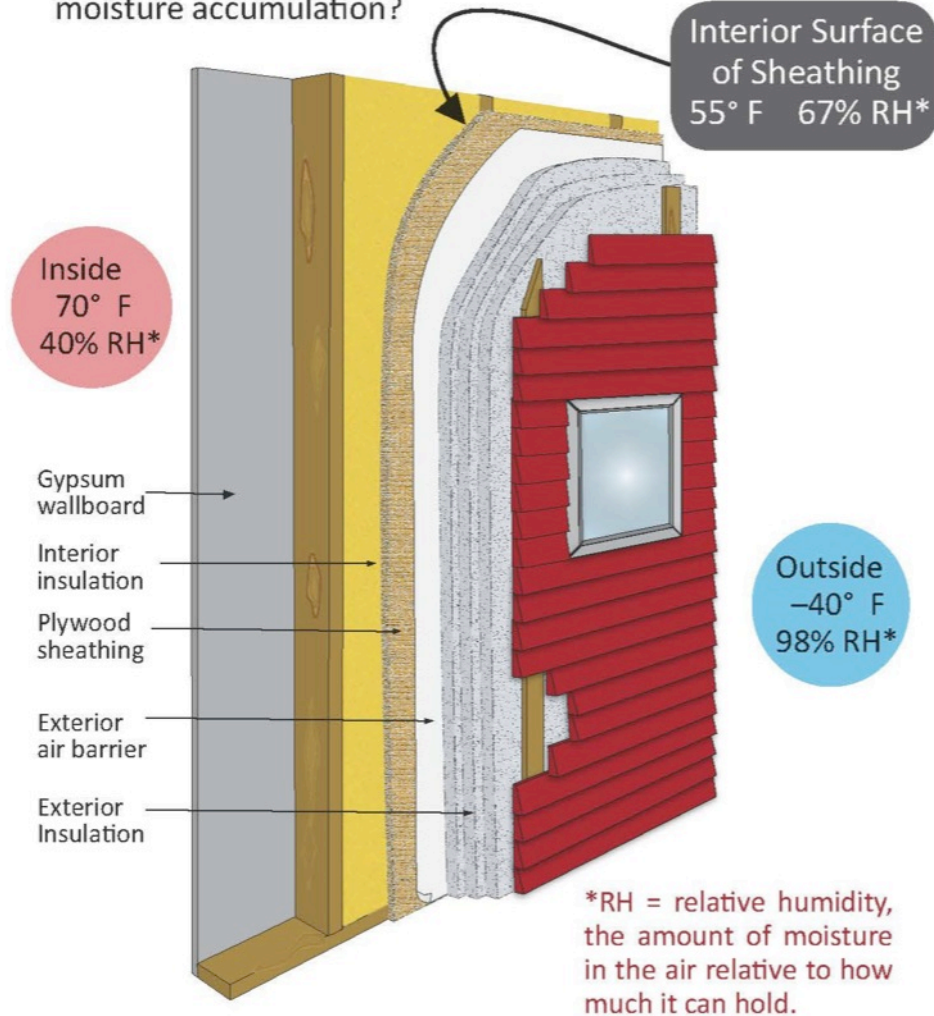
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Remote Wall - Exterior Insulation

- Does the presence of a vapor retarder and exterior foam insulation create a “double vapor barrier” that can cause moisture accumulation?



Be sure to read the CCHRC reports and studies.

See Margie Suber's 2011 Wrap It Up presentation at ACAT.org.



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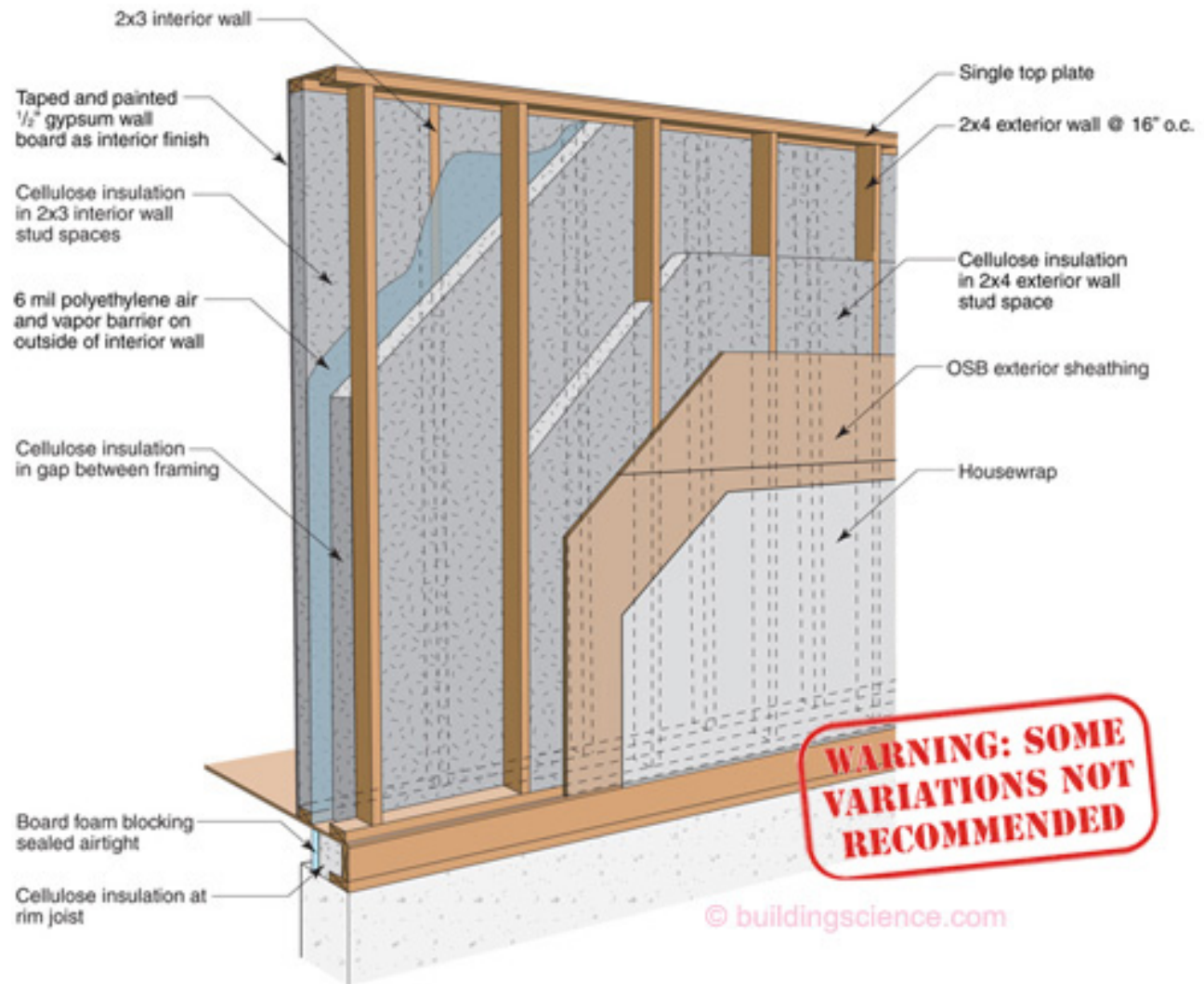
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Arctic Wall - Double Stud with Cellulose Insulation



See Thorsten and Canadian Equilibrium presentations at ACAT.org.



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 <div>World's Best Window Co. Millennium 2000+ Vinyl-Clad Wood Frame Double Glazing • Argon Fill • Low E Product Type: Vertical Slider</div>	
ENERGY PERFORMANCE RATINGS	
U-Factor (U.S./I-P) 0.35	Solar Heat Gain Coefficient 0.32
ADDITIONAL PERFORMANCE RATINGS	
Visible Transmittance 0.51	Air Leakage (U.S./I-P) 0.2
Condensation Resistance 51	_____
<small>Manufacturer declares that these ratings conform to applicable NFRC procedures for determining whole product performance. NFRC ratings are determined for a fixed set of environmental conditions and a specific product size. Consult manufacturer's literature for other product performance information. www.nfrc.org</small>	

U-factor = insulation
= 1/R-value (ie. U=0.33, R=3)

SHGC = Solar Heat Gain Coefficient
(% of solar heat allowed through glass)

VT = Visible Transmittance
(% of visible light allowed through glass)

Air Leakage – Passiv Haus requirement

See Nancy Clanton's Lighting presentation at ACAT.org.
See Bronwyn Barry's Passiv Haus Window presentation at ACAT.org.
See UAF Co-Ops Alaska Solar Guide.



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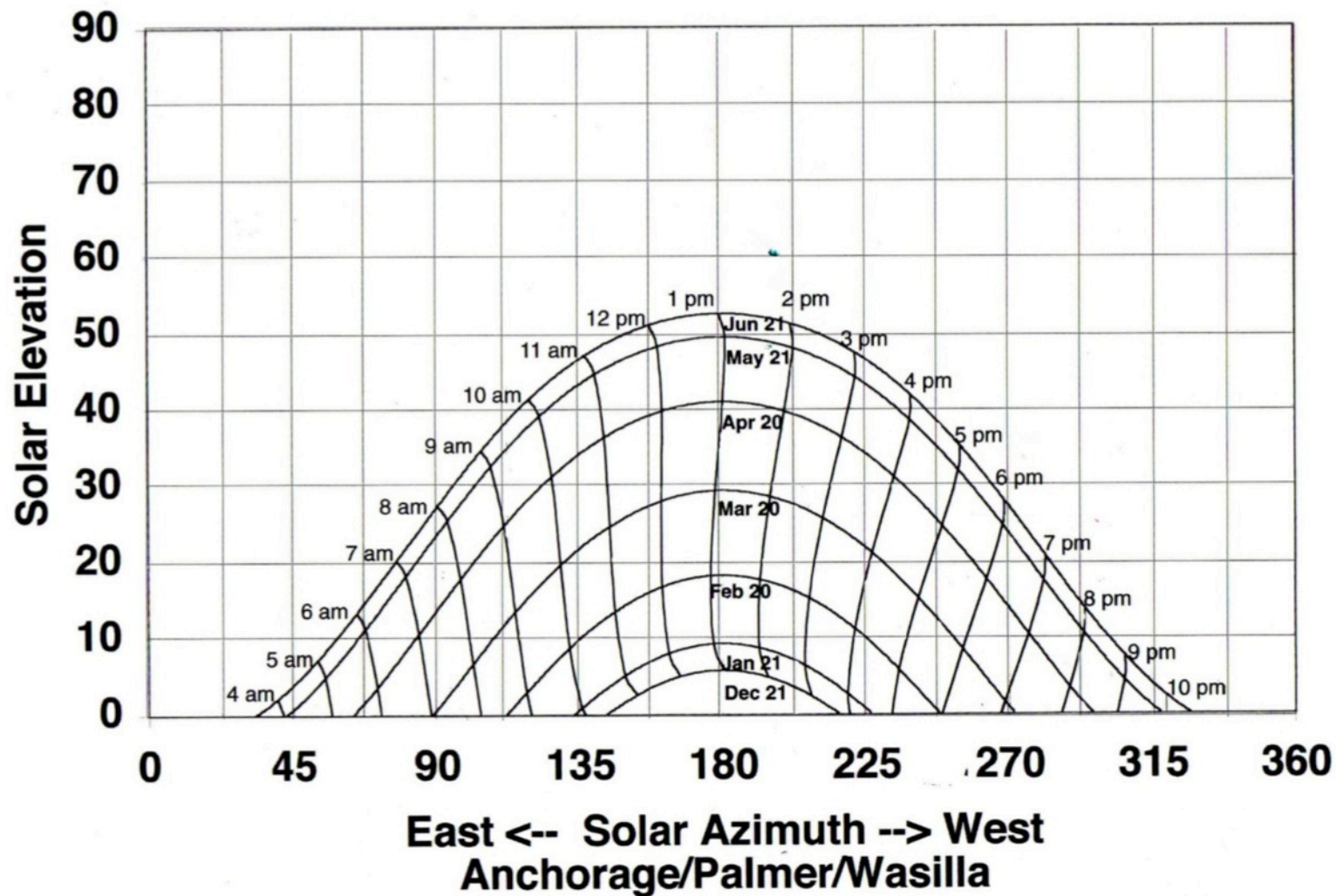
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PASSIVE SOLAR



See UAF Co-Ops Alaska Solar Guide.



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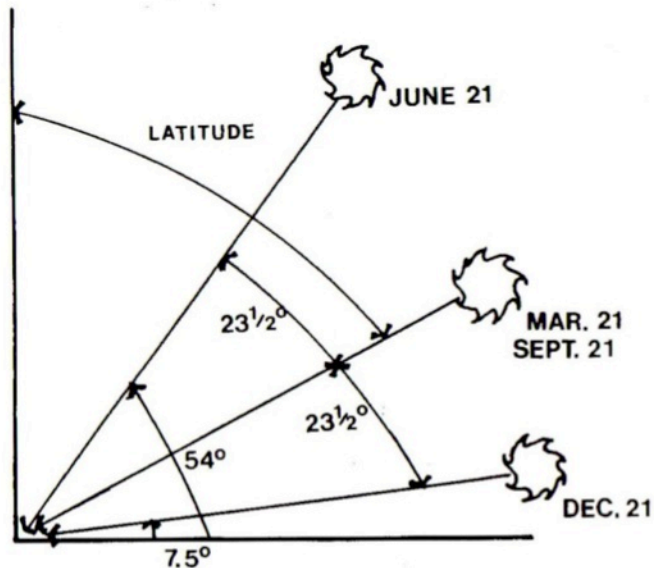


Figure 68a. The range of solar elevation angles at the latitude of Anchorage, Alaska (60°30'N). The maximum elevation is 54° on June 21, and the minimum is 7.5° on December 21.

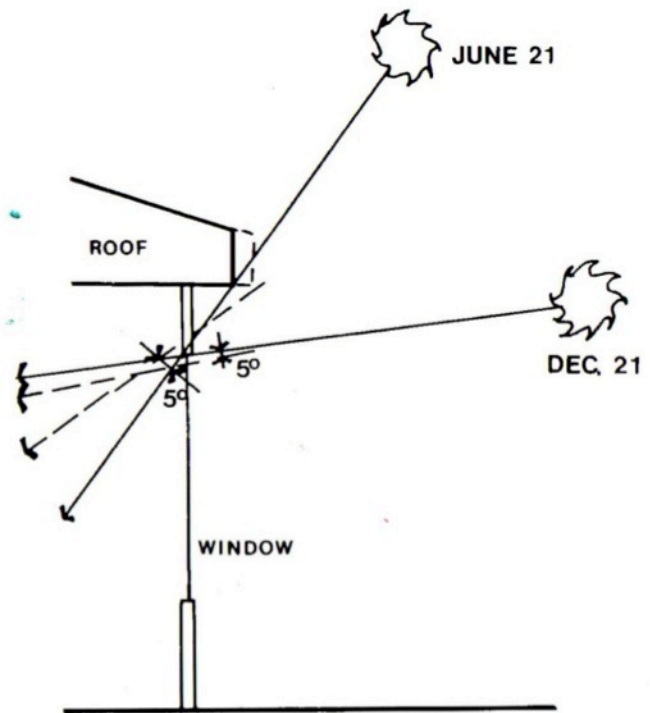


Figure 68b. Unlike the lower latitudes, a small overhang has little effect on shading the summer sun in Alaska. Larger overhangs are required in Alaska because of the lower solar elevation angles.

See UAF Co-Ops Alaska Solar Guide.

See Matt Oster's Alaska Greenhouse presentation at acat.org



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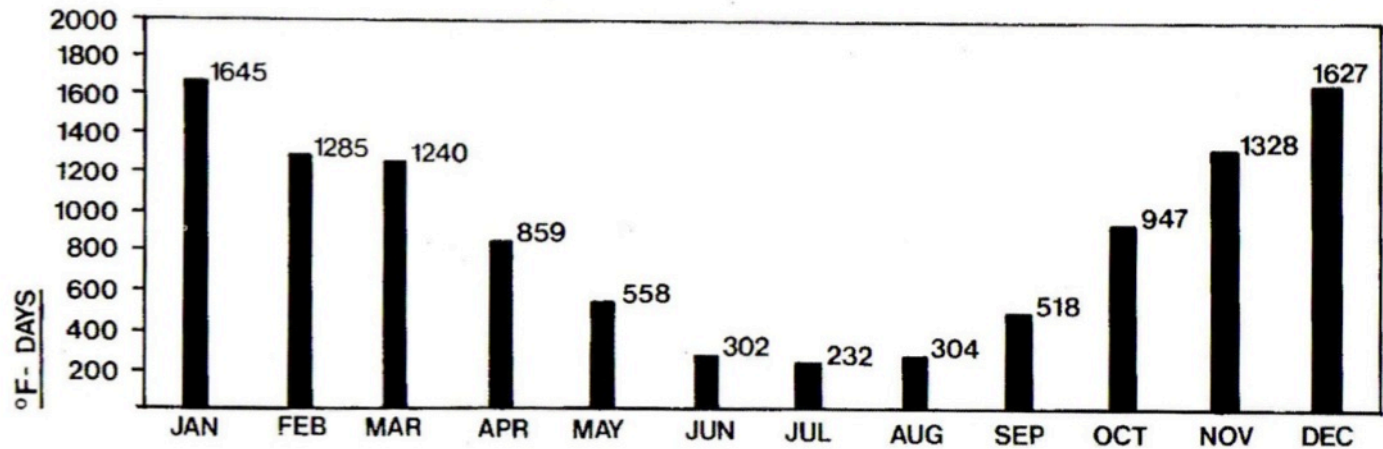
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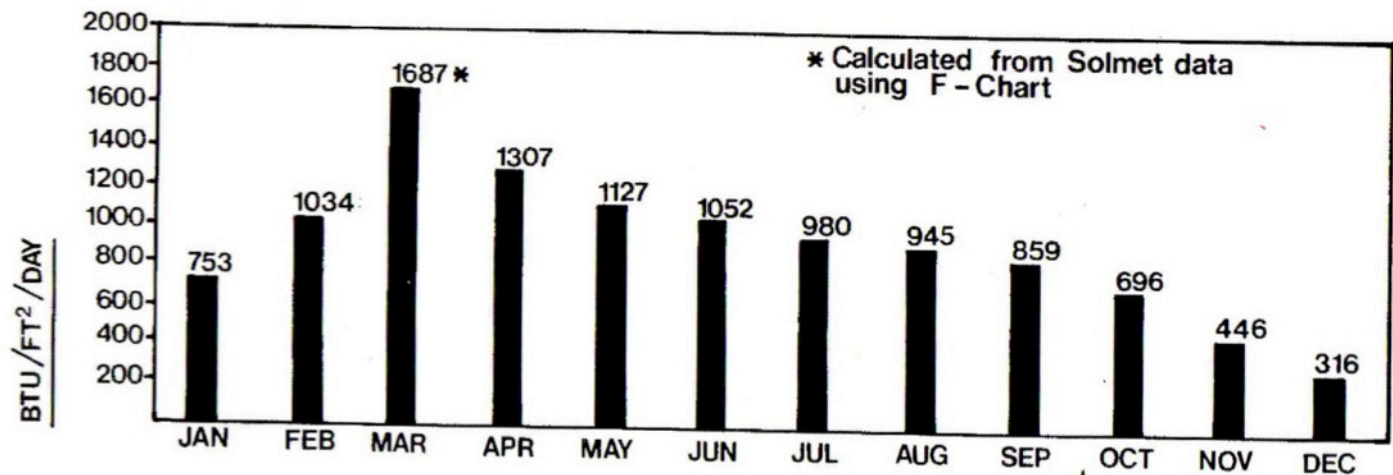
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PASSIVE SOLAR vs. HEATING DEGREE DAYS



Average Monthly Heating Degree Days

Matanuska, Alaska



Average Solar Radiation on a Vertical South Facing Surface

Matanuska, Alaska



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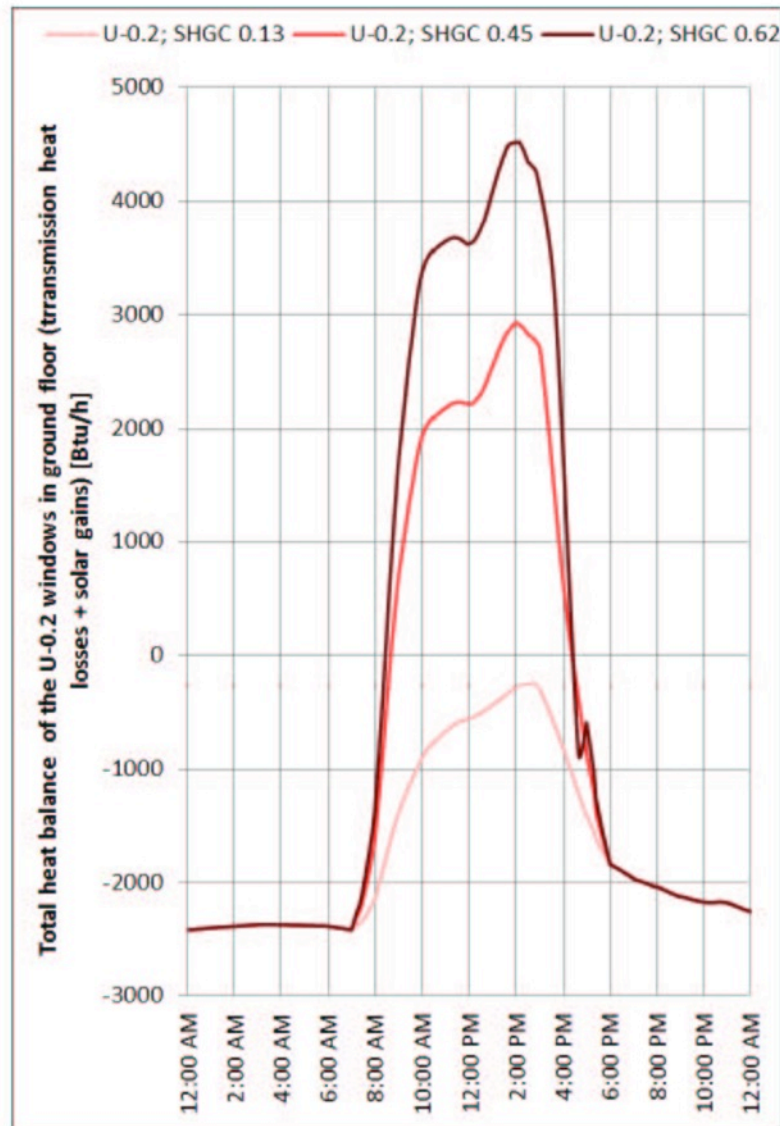


Figure 3. Heat balance of U-0.2 windows on March 1 with different SHGC.

Windows

How do we determine the balance between gains from passive solar vs. heat losses from poor R-value?

Passive Solar Gains
- $\frac{\text{Heat Losses}}{\text{Total Heat Balance}}$

Day-time: Gains depending on SHGC and orientation

Night-time: all loss

See CCHRC Martin Window Study



Windows Exterior Insulated Shutters



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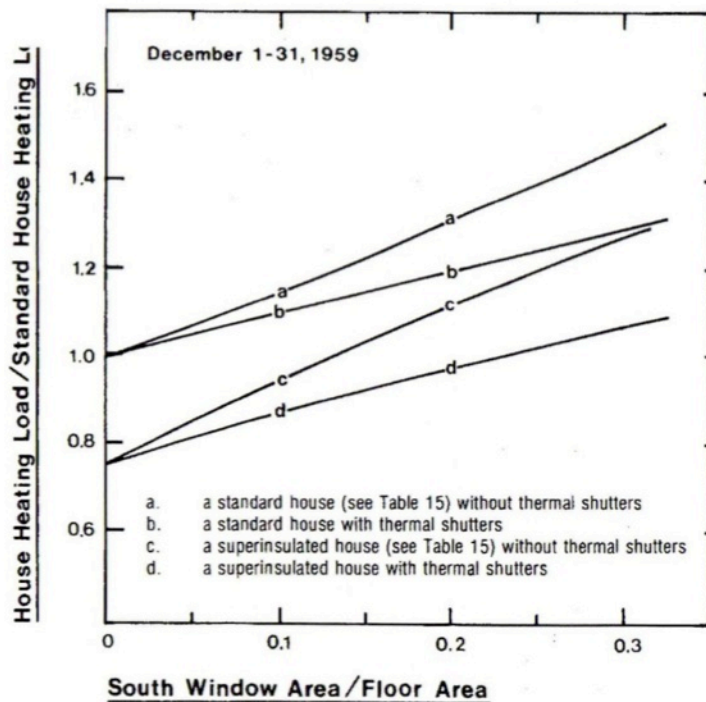


Figure 61. Increasing the window area of a structure to improve solar gain always results in increased heat loss for the month of December.

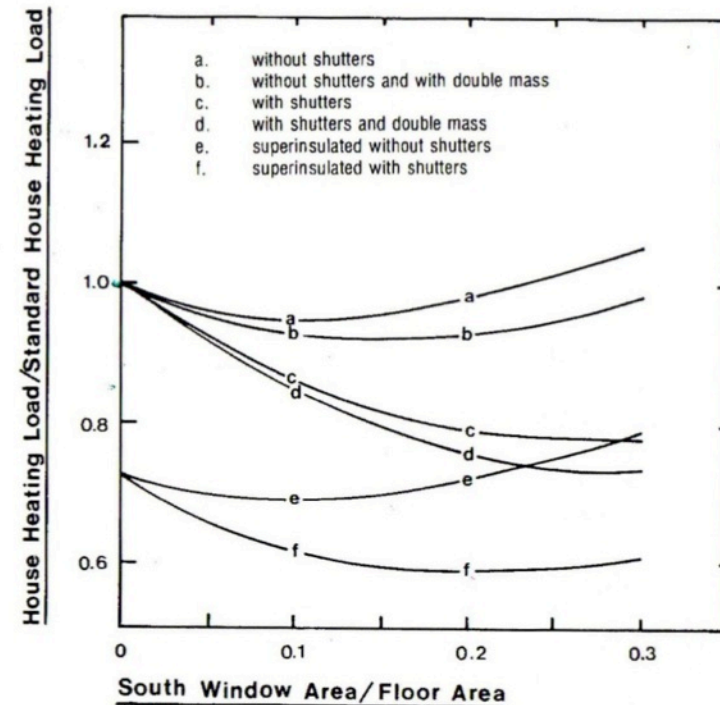


Figure 62. Annual heating requirements for houses with and without thermal shutters and various amounts of south-facing windows.

See Thorsten's presentation at ACAT.org.

See Bronwyn Barry's Passiv Haus Window presentation at ACAT.org.



Masonry Wood Heat

Mat-Su College, Wasilla & Alaska Folk School, Talkeetna

Details:

- Multiple levels of masonry
- Chambered flue manifold
- 1 Hour hot burn
- 12-24 heat radiates
- Dedicated outside air intake



Harry and Erin Aulman used 4.5 cords of wood in their masonry wood stove last winter to heat their 1600sf Talkeetna home! No oil for heating!
Mark Masteller installed one in his house in Wasilla as well.



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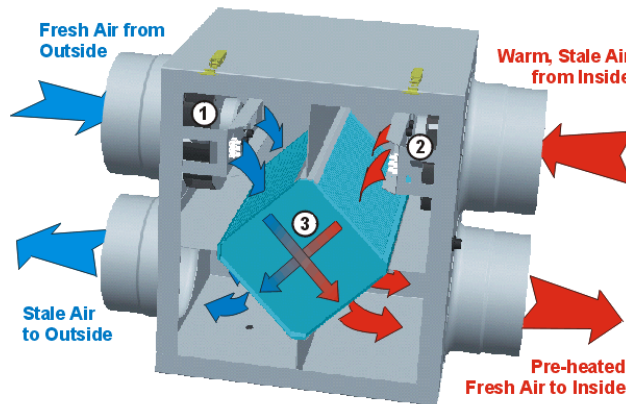
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HEAT RECOVERY VENTILATION

Build Tight, Ventilate Right... but still keep an eye on the kWh



- kW usage? kWh per day?
- HRV continuous - 35cfm Examples
 - Zehnder Focus 200 (93% Eff.) – 118cfm, 62w, 1.5kwh/day, 550kwh/year
 - Fantech 1504 (76% Eff.) – 160cfm, 72w, 1.7kwh/day, 630kwh/year
- HRV continuous use vs. 20min / hour
 - Zehnder example – 62w, 0.5kwh/day ,179 kwh/year
- Through-wall “breather” vents (paired) – 17cfm x 8 = 136cfm
 - Lunos E2 (85% Eff.) – (5.6w ea.) 45w, 1kwh/day, 365kwh/year

See Canadian Equilibrium Housing presentation at ACAT.org.
See Akenergyefficiency.org



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Electric Usage

What is your current electric usage?

- kWh per day? (Valley averages 26kWh / day)
- Summer versus winter?
- Cost per year? (Valley averages is about \$1,420 / year)
- What are the biggest contributors?
- Can you reduce it?

See Canadian Equilibrium Housing presentation at ACAT.org.
See Solar PV presentation at ACAT.org.
See Akenergyefficiency.org

MATANUSKA ELECTRIC ASSOCIATION, INC.
P.O. BOX 2929 PALMER, ALASKA 99754
(907) 761-9300, (907) 689-1111

2012090705000230

ADDRESS/TELEPHONE NUMBER CHANGE

P.O. Box/Street _____ State _____ Zip Code _____

City _____

Home Phone # () _____

Business Phone # () _____

Mobile Phone # () _____

Account Number 230336005 Member Number 101098 Name Robert B Acree

Reference: ATTRIUM BLDG

YTD Roundup Contribution \$4.02

ADJUSTMENTS

Operation Roundup Contribution

TOTAL ADJUSTMENTS

Sm Commercial Three Phase

22960 kWh @0.06592

88.000 kWh @5.340000

22960 kWh @0.0360700

22960 kWh @0.0005680

CURRENT MONTH'S CHARGES

Facility Charge

First Step

Demand Charge

WECRA

Regulatory Charge

Current Charges

3.000 % Palmer Sales Tax

TOTAL CURRENT BILLING

MESSAGES

Unless you have opted out, you have been automatically enrolled in Operation Roundup, which is the nearest whole dollar. The difference between the amount charged for electric services and the amount you have opted out of will be transferred to MEA's Charitable Foundation for charitable uses. To opt-out call 907-761-9300 or visit us at any one of our offices. Should you choose to opt-out, you will be notified by you in the prior three years are available upon request.

You will save a lot if payment is received by the 15th of the month.

Thank you for keeping your account current

HISTORICAL INFORMATION

BILL MONTH	NO OF DAYS	KILOWATT HOURS USED	AVG KWH PER DAY	KW DEMAND	AVG TEMP
AUG-12	21	22960	1093	88.000	57
JUL-12	31	30320	978	88.000	55
JUN-12	30	22320	744	80.000	46
MAY-12	31	21760	702	80.000	38
APR-12	30	22880	763	62.400	17
MAR-12	31	28080	906	56.800	22
FEB-12	28	21840	780	63.200	19
JAN-12	31	25200	813	63.200	15
DEC-11	31	33120	1068	80.000	38
NOV-11	30	29840	995	88.000	51
OCT-11	28	35280	1260	88.000	56
SEP-11	32			88.000	59



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Electric Usage - Reductions

Reductions

- Lighting – CFLs, LEDs, occupancy sensors, lighting surfaces
- Appliances – Energy Star listings
- Computer / Office – auto power strips
- Entertainment / Miscellaneous – auto power strips
- Electric (Heat Pumps or Geothermal)
- Heating system fans or pumps – efficiencies
- GFI and Weatherproof receptacles – 1w-2.5w draw



See Canadian Equilibrium Housing presentation at ACAT.org.
See Akenergyefficiency.org
See Energy Star



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Lastly... Renewables

- **Solar**
 - **Photovoltaic**
 - **Fixed, building mounted**
 - **Tracking Array**
 - **Solar Thermal**
 - **Flat Plate**
 - **Evacuated Tubes**



See presentations at acat.org

See Electric Storage – Eayrs 2011 presentation at acat.org

Not Reviewed

- **Wind**
- **Electric (Heat Pumps or Geothermal)**
- **Micro-hydro**
- **Off – Grid Systems**

See Off Grid Homes 2011 presentations at acat.org

See Electric Storage 2011 presentations at acat.org



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Solar – PV Watts2

<http://www.nrel.gov/rredc/pvwatts/grid.html>

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

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Renewable Resource Data Center

PVWatts

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[Launch Viewer](#)
[About PVWatts](#)
 [Site Specific Data \(Version 1\) Calculator](#)
 [Grid Data \(Version 2\) Calculator](#)
[Help](#)

[Printable Version](#)

PVWatts™ Grid Data Calculator (Version 2)

PVWatts™ Grid Data calculator allows users to select a photovoltaic (PV) system location in the United States from an interactive map.

The Grid Data calculator uses hourly [typical meteorological year](#) weather data and a PV performance model to estimate annual energy production and cost savings for a crystalline silicon PV system. It allows users to create estimated performance data for any location in the United States or its territories by selecting a site on a 40-km gridded map. The 40-km Grid Data calculator considers data from a climatologically similar typical meteorological year data station and site-specific solar resource and maximum temperature information to provide PV performance estimation.

In this version, performance is first calculated for the the nearest TMY2 location and then translated to the desired 40-km grid cell location. The translation process uses grid cell monthly values of solar radiation and meteorological parameters. Because the translation process uses monthly values, hourly values of PV performance are not available for the 40-km Grid Data calculator.

For more information, see [PVWatts Version 2 - Enhanced Spatial Resolution for Calculating Grid-Connected PV Performance](#).

To use the PVWatts Grid Data (Version 2) calculator, see:

- [PVWatts Frequently Asked Questions](#)
- [PVWatts Version 2 Calculator](#)
- [How to Change PVWatts Parameters](#)
- [How to Interpret PVWatts Results](#)
- [PVWatts Revision History](#)

See [nrel.gov](http://www.nrel.gov) – PV Watts 2



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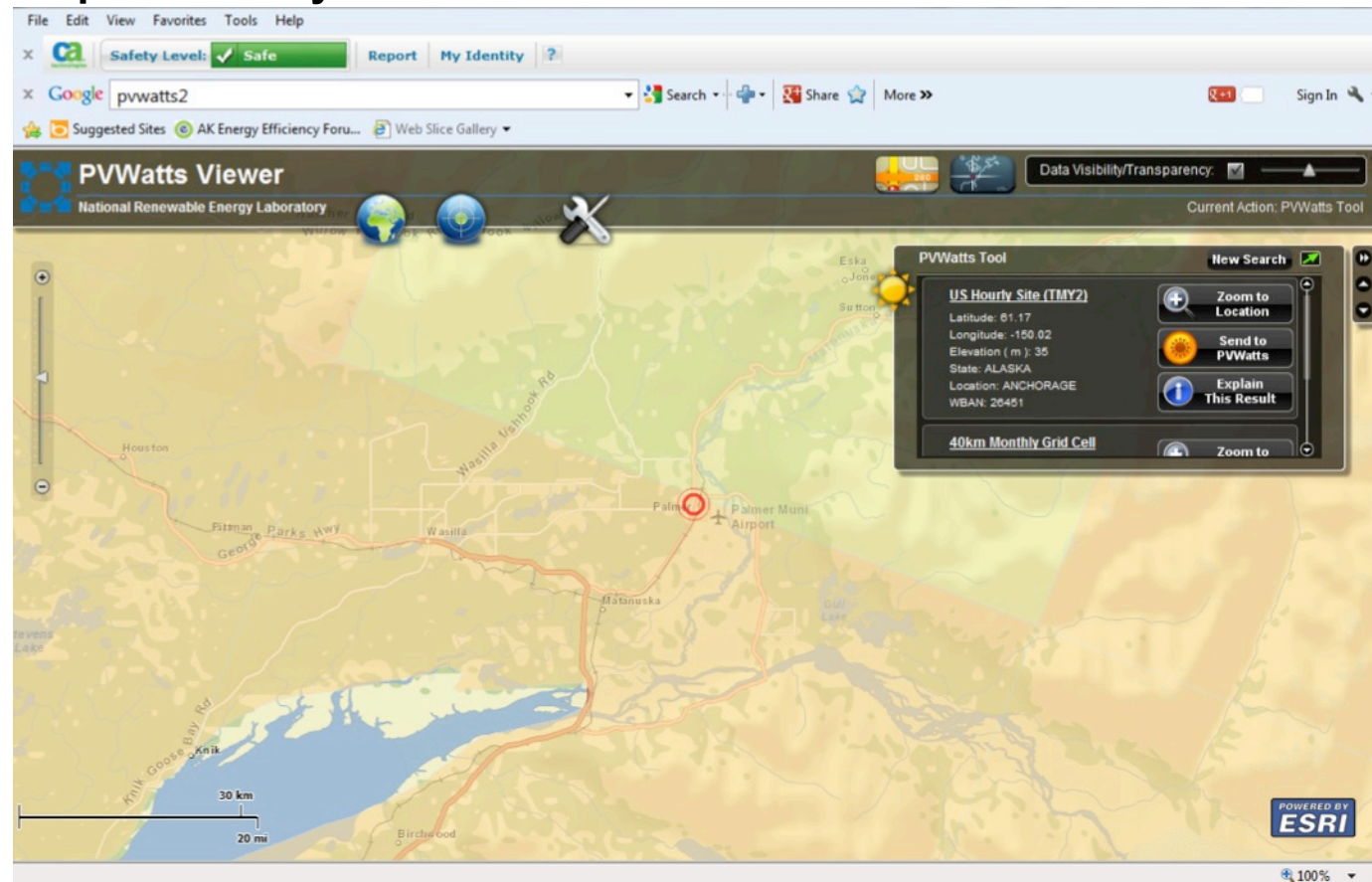
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Solar – PV Watts2

Step 2. Locate your site...



See nrel.gov – PV Watts 2



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Solar – PV Watts2

Step 3. Input PV design data...



Click on **Calculate** if default values are acceptable, or after selecting your system specifications. Click on **Help** for information about system specifications. To use a DC to AC derate factor other than the default, click on **Derate Factor Help** for information.

Site Location:

WBAN Number:	26451
City:	Anchorage
State:	Alaska
Latitude:	61.17°N
Longitude:	150.02°W
Elevation:	35 m

PV System Specifications:

DC Rating (kW):

DC to AC Derate Factor:

DERATE FACTOR
HELP

Array Type:

Fixed Tilt or 1-Axis Tracking System:

Array Tilt (degrees): (Default = Latitude)

Array Azimuth (degrees): (Default = Equator-Facing)

Energy Data:

Cents per kWh: (Default = State Average)

Solar – PV Watts2

Step 4. Output PV design data...



AC Energy
&
Cost Savings



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(Type comments here to appear on printout; maximum 1 row of 80 characters.)

Station Identification	
City:	Anchorage
State:	Alaska
Latitude:	61.17° N
Longitude:	150.02° W
Elevation:	35 m
PV System Specifications	
DC Rating:	4.0 kW
DC to AC Derate Factor:	0.770
AC Rating:	3.1 kW
Array Type:	Fixed Tilt
Array Tilt:	61.2°
Array Azimuth:	180.0°
Energy Specifications	
Cost of Electricity:	14.6 ¢/kWh

Results			
Month	Solar Radiation (kWh/m ² /day)	AC Energy (kWh)	Energy Value (\$)
1	0.83	73	10.66
2	2.16	189	27.59
3	3.77	364	53.14
4	4.35	392	57.23
5	4.88	440	64.24
6	4.74	394	57.52
7	4.50	382	55.77
8	3.77	322	47.01
9	3.28	279	40.73
10	1.88	166	24.24
11	1.39	125	18.25
12	0.61	50	7.30
Year	3.02	3177	463.84



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Navigating Your Path to Net Zero Energy

Jason Collins, Architect and Energy Auditor, Palmer

Net Zero Energy Home

Dashboard

Component	Width	Length	R Value
Building Footprint (Floor)	28	42	0
Average Floor Depth Below Grade	0.0		

Walls	Height	
Wall - crawlspace	0	30
Walls	17	30

Doors	Height	Width	#
Garage Doors	8	10	4
Doors	7	3	10

Window Areas	Area	SHGC	U-Value
Windows - South	24	0.3	0.3
Windows - East and West	10	0.3	0.3
Windows - North	0	0.35	0.3

Roof/Ceiling	
	60

Temperatures	Interior	Design
	68	-18

Air Changes per Hour	0.33 (Natural)
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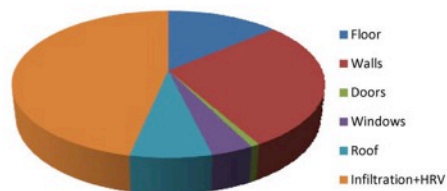
Number of Occupants	2
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Renewables	# Units
Evacuated Solar Tubes	32 # Tubes
Flat Plate Solar Collectors	0 # Flat Plates
Photovoltaic Array	7.0 kW

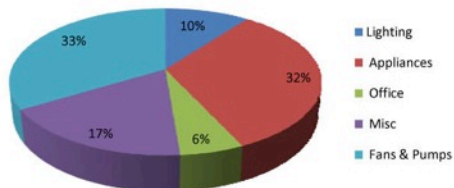
Annual Energy Usage	
Net Heat Usage	73,308,559 Btu
Net Electric Usage	-2021 kWh
NET ENERGY USAGE	72,982 kBtu
EUI (Energy Use Intensity)	31 kBtu/SF

Heating Annual Cost	\$928
Electric Annual Cost	-\$45
Total Annual Cost	\$883

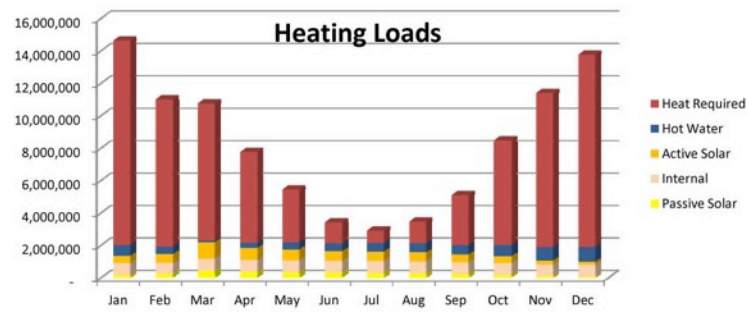
Envelope Heat Loss



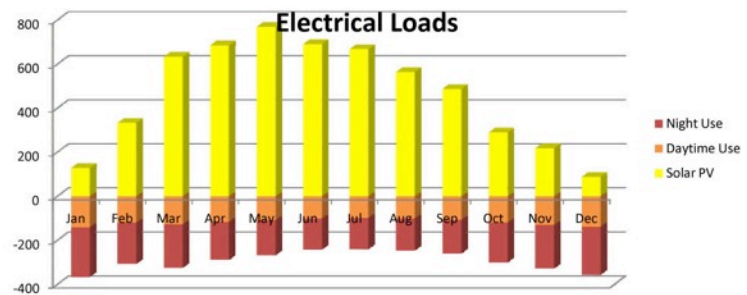
Electrical Usage



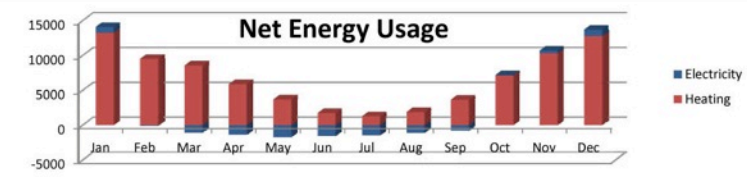
Heating Loads



Electrical Loads



Net Energy Usage



Jason Collins, architect and energy auditor, walks you through some basic steps for navigating the sometimes overwhelming process of planning for Net Zero Energy.



PATH TO NET ZERO WORKSHOP SERIES

Non-profit education outreach for Net Zero Energy

Register Online: www.ACAT.org

Full Day Workshops

- \$80 -160 General Admission
- \$40-80 Students and members
- \$225+ w/ Continuing Ed. Certificate

Lectures, Shorter Workshops

- \$20 General Admission
- \$10 Student*
- \$75 w/ Cont. Ed. Certificate

*Scholarships Available





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EUI – ENERGY USE INTENSITY BY BUILDING TYPE

Net Zero Energy
Definition

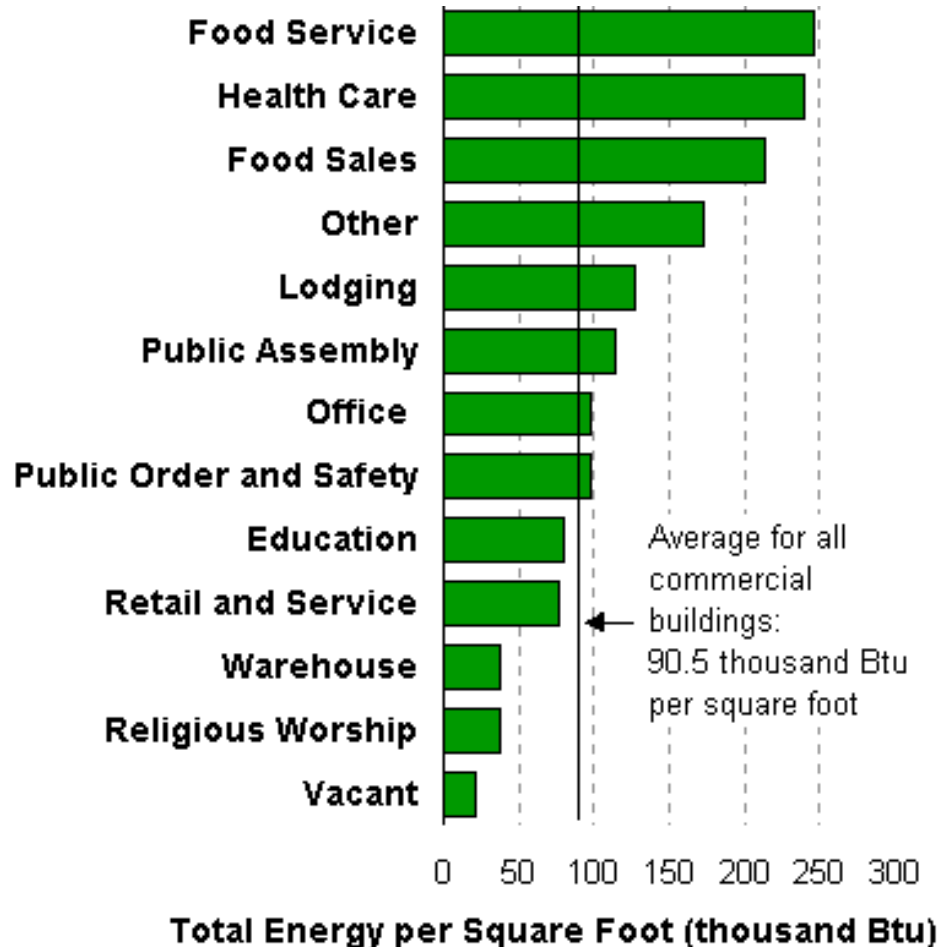
Envelope
Spreadsheet
Heat Loss
Insulation

Heating
Heating Methods
Storage

Electric Usage
Spreadsheet
Reductions

Renewables
PV Watts
Grid-tie
Storage

Overall Review



Energy Use Intensity –

- CBECS – Commercial Building Energy Consumption Survey
- Kbtu/SF/Year
- Homes – 45 kbtu
- Multi-family – 60 kbtu
- Passivhaus - 4.7 kbtu



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NET ZERO ENERGY BUILDING

Net Zero Energy Definition

Case Studies International Alaska

Envelope Insulation Windows

Heating Heating Methods

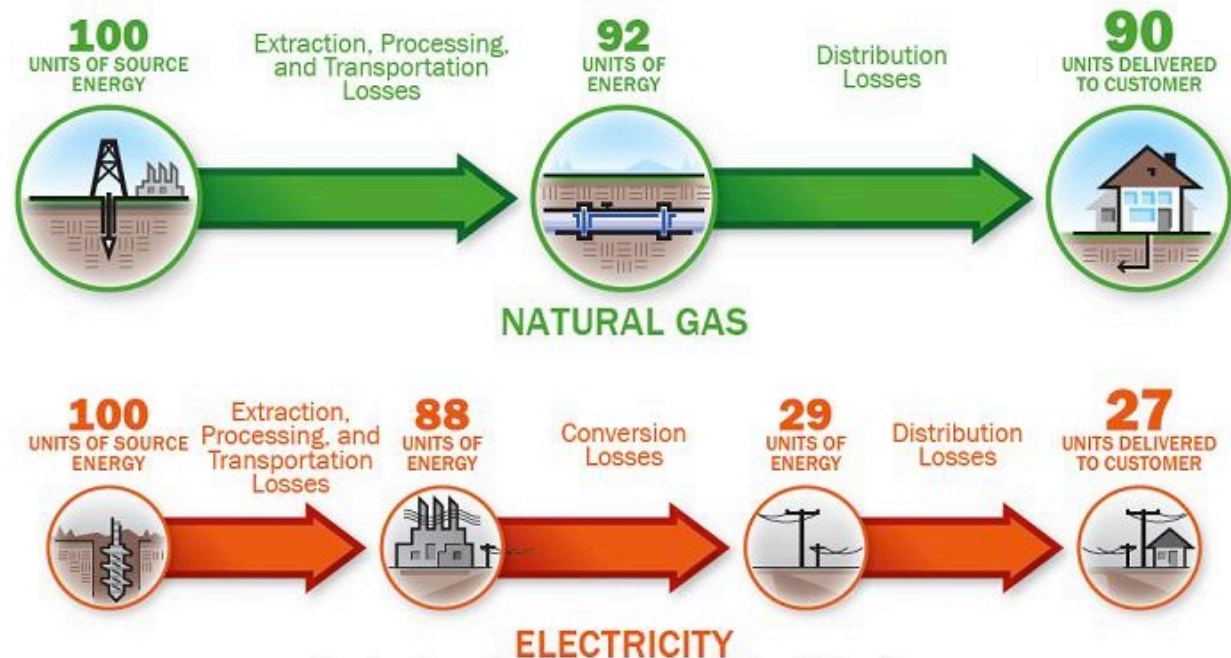
Electric Usage Reductions

Renewables PV Watts

Local Case Study

Overall Review

SOURCE ENERGY – energy that is produced off-site. This includes production and transmission losses (can be 70% energy loss from original plant usage).



So if we are grid-tied and using electricity, do we need to provide 100% of what we use on site (Site Energy)?

Or do we need to account for power production loss (Source Energy)?

If we are equaling the Source Energy, do we provide 300%?



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NET ZERO ENERGY BUILDING

Net Zero Energy Definition

NET METERING – energy produced and energy used are measured at the building location. Equal utility rates?

Case Studies International Alaska

- MEA Rates for power purchase vary quarterly.
- Power sold back into grid = \$0.04 / kwh (to \$0.07/kwh)
- Power purchased from grid = \$0.10579 / kwh plus tariffs
\$0.146408 / kwh with tariffs
- Difference in bought – sold = \$0.10 /kwh (to \$0.07/kwh)

Envelope Insulation Windows

What does this mean? If you are using the grid as a “battery” and trying to pay for your winter/evening energy usage with summer/daytime production, you’ll need to produce 3.6x more than energy than you use.

Electric Usage Reductions

FEES AND TARIFFS – utility providers have fees and tariffs isolated from actual usage cost. Even if you make as much energy as you use, you will still have a utility bill.

Renewables PV Watts

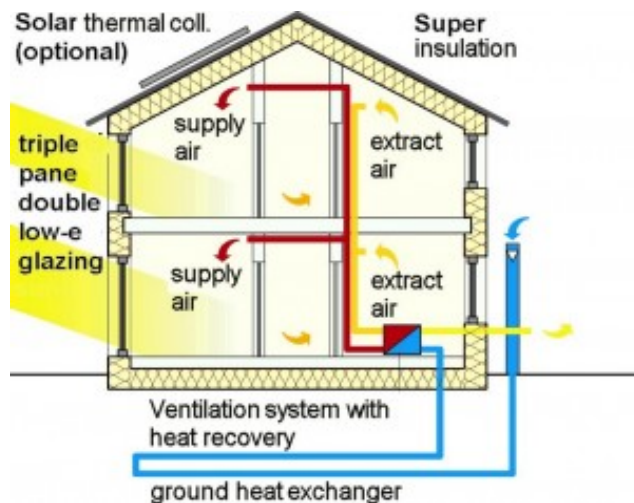
- MEA Monthly fee = \$5.65
- Annually = \$67.80

Local Case Study

Overall Review



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Passiv Haus

- German Standard, now International
 - Based on work US and Canada did back in the mid 70s
- Ultra low energy building
 - Super-insulated
 - Air tightness
 - Passive solar design
- Standards
 - 15 kwh/m² or 4.7 kbtu/sf per year heating
 - 10w/m² peak heat load
 - Total energy per year: <120kwh/m² or 37.9 kbtu/sf
 - Air Leakage: <0.6ACH 50
- Thermal Breaks – careful attention
- Ventilation – Heat Recovery Ventilator, 80%+ eff.



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Windows

Net Zero Energy
Definition

Case Studies
International
Alaska

Envelope
Insulation
Windows

Heating
Heating Methods

Electric Usage
Reductions

Renewables
PV Watts

Local Case Study

Overall Review



How many windows?

What kind of windows? (Can I afford that kind of window?)

Are there too many windows?

Overheating vs. heat loss?

Thermal mass storage?

Exhaust air strategies?

How do we calculate?

What are some good rules of thumb?

See Nancy Clanton's Lighting presentation at ACAT.org.

See Bronwyn Barry's Passiv Haus Window presentation at ACAT.org.

See UAF Co-Ops Alaska Solar Guide.