

## NAVIGATING YOUR PATH TO NET ZERO ENERGY

Net Zero Energy  
Definition

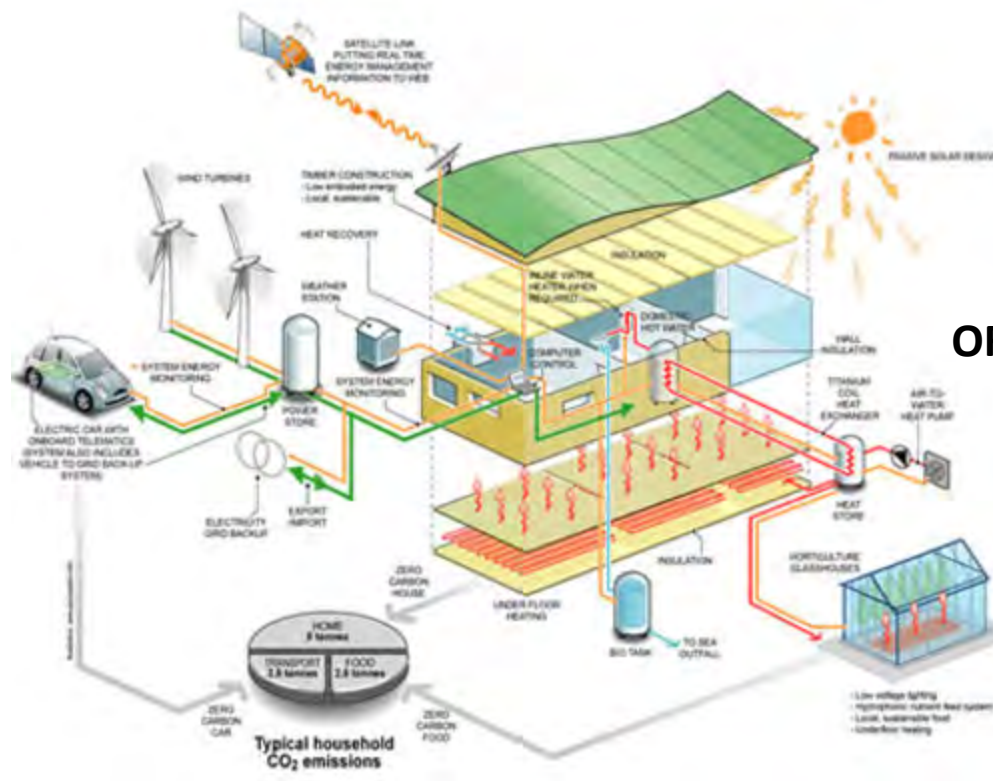
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Insulation

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Heating Methods  
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OR.



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



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## **INTRODUCTIONS**



**Jason Collins AIA LEED AP CEA  
Architect and Energy Auditor, Palmer, AK**

### **Notes for everyone to Share:**

- **Name**
- **Where do you live?**
- **Interest in Net Zero Energy**
- **What is your Project? (Your house, cabin, retrofit, someone else's?)  
(It's ok if you don't have a project in mind.)**
- **How big is it? (square feet)**
- **Goals with Net Zero Energy / Renewables?**



## Net Zero Energy Definition

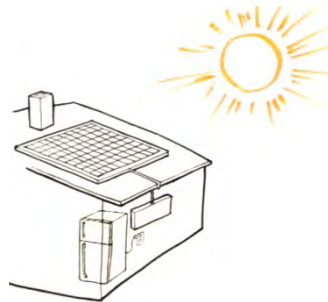
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## NET ZERO ENERGY BUILDING

**NET ZERO ENERGY BUILDING** – a building that produces as much energy as it uses over the course of a year.

**SITE ENERGY** – energy that is produced or used at the building location.

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

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

**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.

**NET ZERO CARBON** – zero carbon emissions annually.

## NET ZERO ENERGY BUILDING

### Net Zero Energy Definition

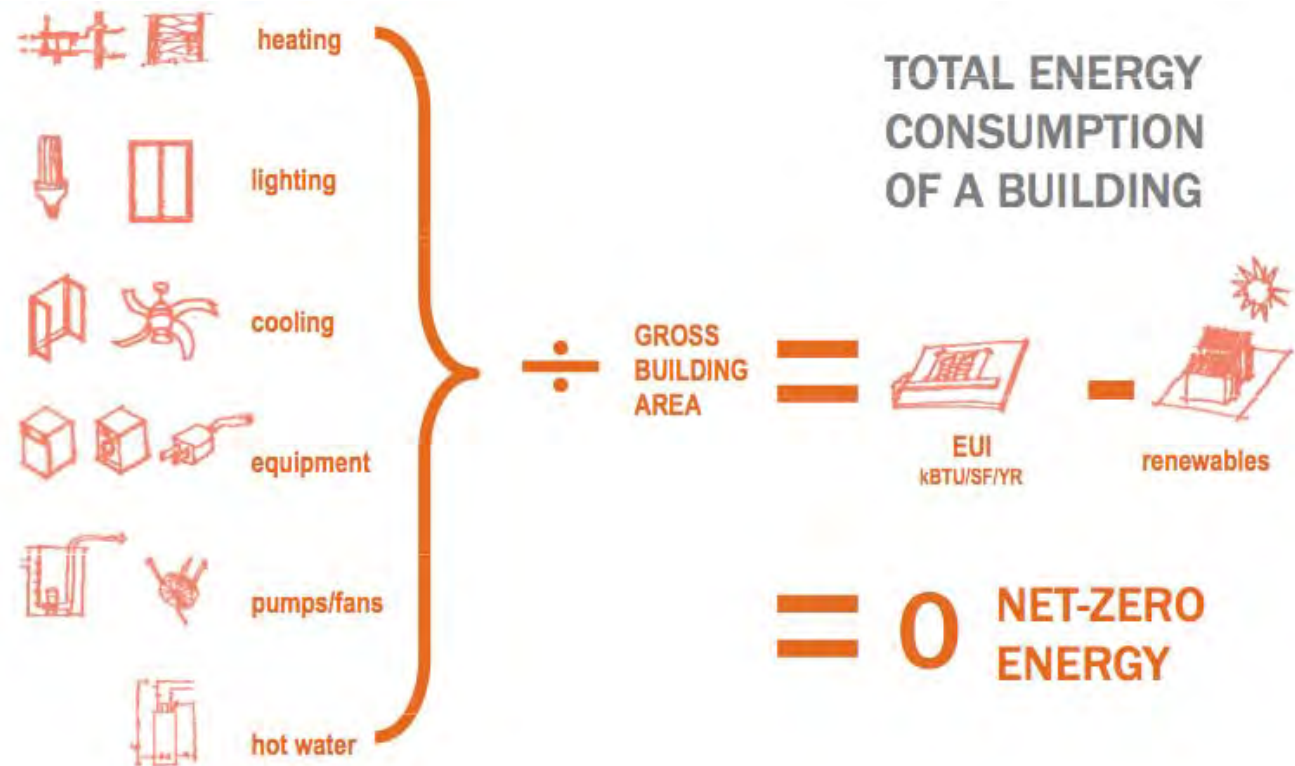
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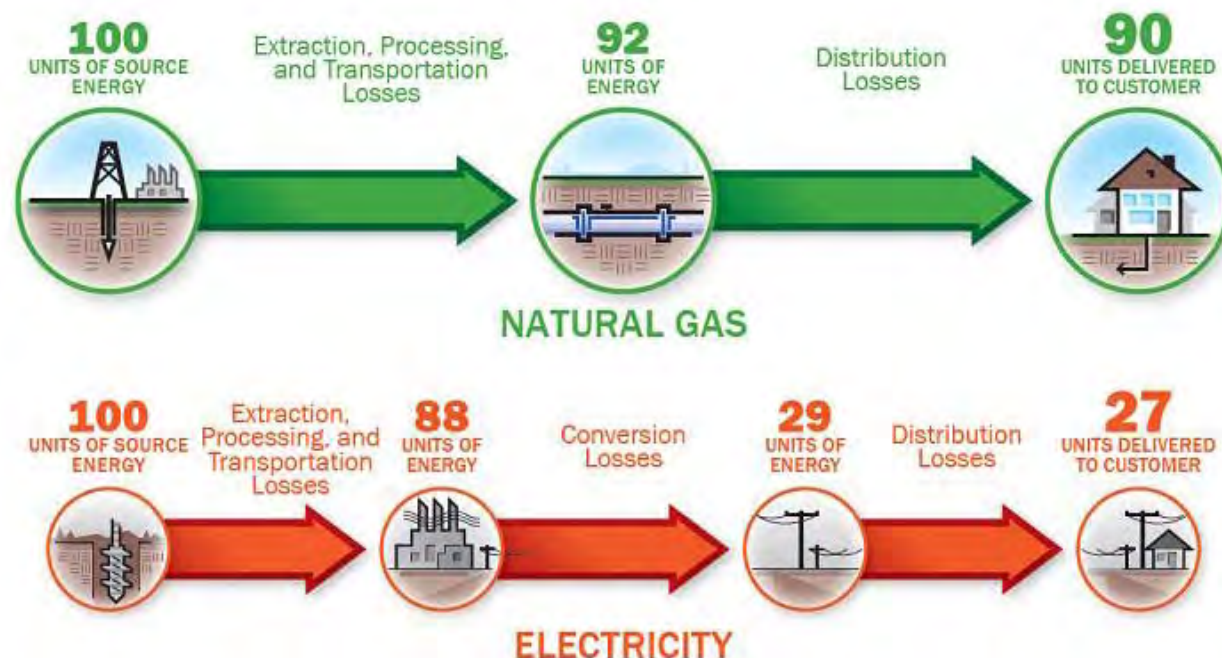
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**SOURCE ENERGY** – energy that is produced off-site. This includes production and transmission losses (can be 70% energy loss from original plant usage).



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%?





## **NET ZERO ENERGY BUILDING**

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

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

**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.**

**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.**

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



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## NET ZERO ENERGY BUILDING

**NET ZERO CARBON – zero carbon emissions annually.**

- Is this possible if you are grid-tied?
- Is this possible if you are off grid?
- What about the up-front carbon footprint? (PV?)

## HEATING DEMANDS IN ALASKA

- When our demands are highest, our solar production is lowest.
- How do we store heat if we make it? Can we make that much heat?
- Can wood heat be used in net zero? To supplement?
- Is wood renewable? Is it carbon zero?



## WHAT DOES A NET ZERO ENERGY BUILDING LOOK LIKE?







## IS NET ZERO ENERGY BUILDING POSSIBLE IN ALASKA?



### THORSTEN CHLUPP - FAIRBANKS

- R70 Walls, Thermal Shutters
- R100 Roof
- Solar Thermal
- Masonry Wood Heater
- 1000ga Storage Tank



### HARVEY BOWERS - WASILLA

- Retrofit
- R50 Walls, R7 Fiberglass windows
- R70 Roof
- Solar Thermal (32 tubes)
- Solar PV and Tracking Array (4.3kw)
- Water Storage Tank (2000ga)



### TOM MARIK - DILLINGHAM

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



## 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?



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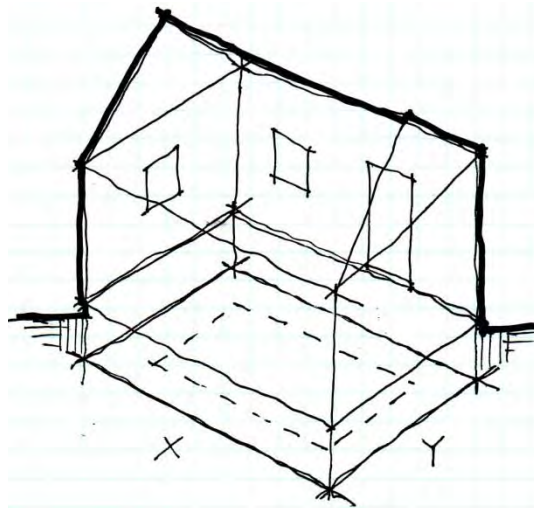
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## ENVELOPE

### SPREADSHEET FUN!

- What is the size of the footprint? W x L
- Is there a crawlspace or a slab?
- What is the height of the wall(s)?
- How many doors?
- How many windows and on what orientation?
- What type of roof? Cathedral or truss?
- How tight can you build the house?

See Bob Lefevre's 2009 presentation at [ACAT.org](http://ACAT.org).



ALASKA CENTER FOR  
APPROPRIATE TECHNOLOGY

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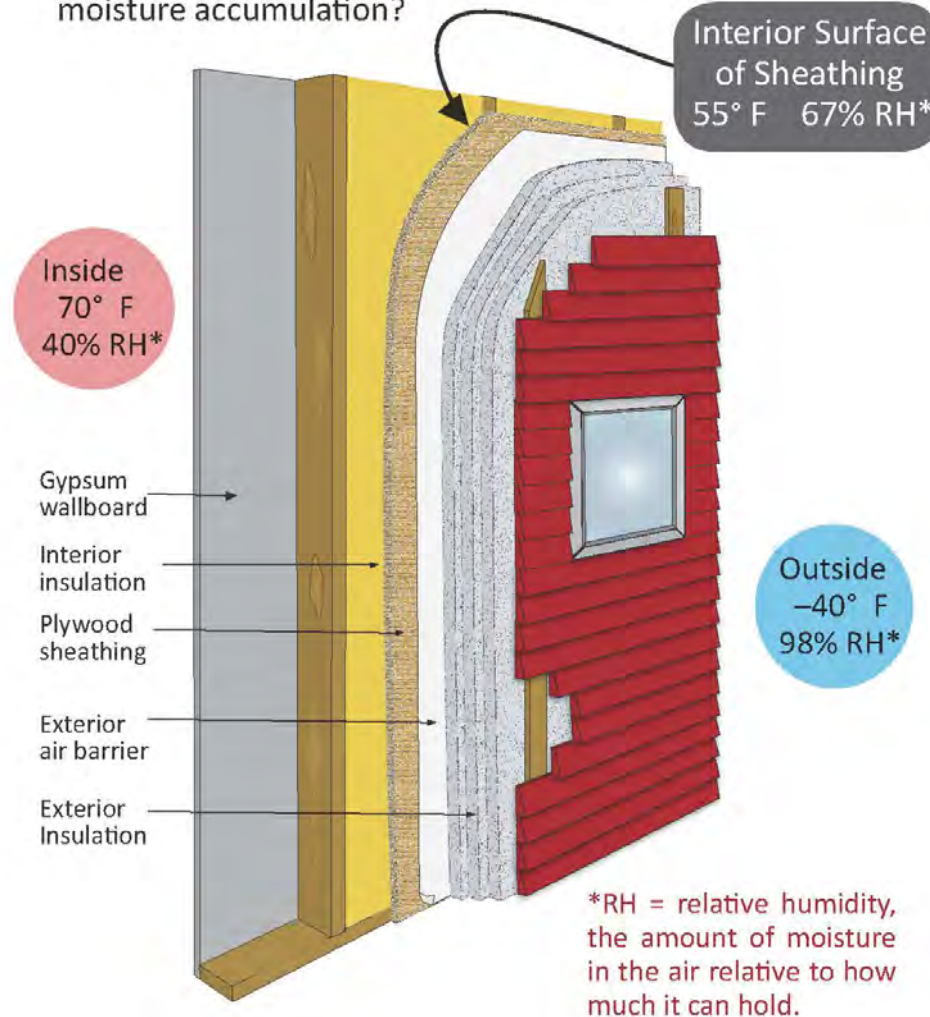
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## Exterior Insulation

- 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](http://ACAT.org).**





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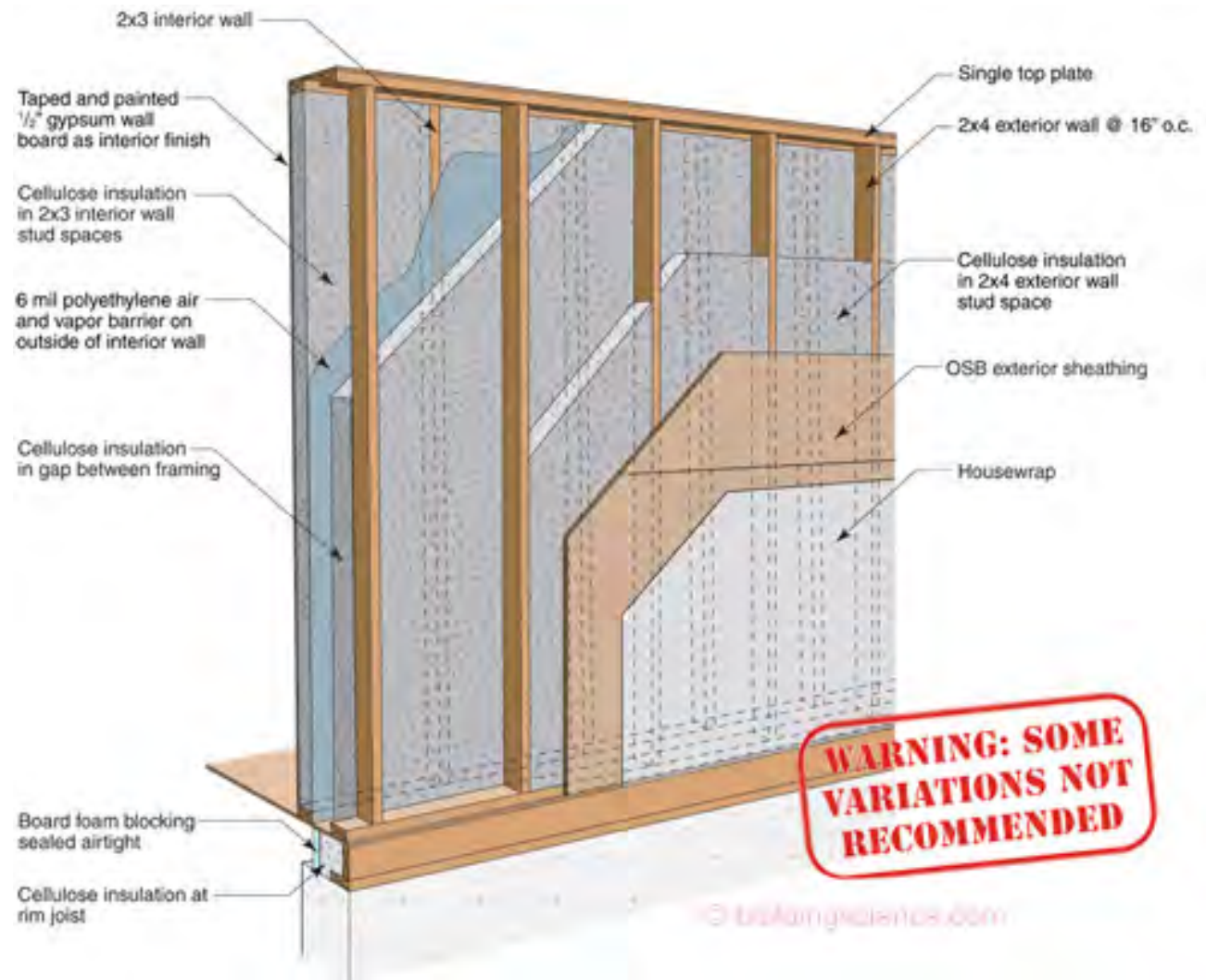
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## Double Stud with Cellulose Insulation



See Thorsten and Canadian Equilibrium presentations at [ACAT.org](http://ACAT.org).

## Windows

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**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](http://ACAT.org).**

**See Bronwyn Barry's Passiv Haus Window presentation at [ACAT.org](http://ACAT.org).**

**See UAF Co-Ops Alaska Solar Guide.**



## Windows

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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)	Solar Heat Gain Coefficient
<b>0.35</b>	<b>0.32</b>
ADDITIONAL PERFORMANCE RATINGS	
Visible Transmittance	Air Leakage (U.S./I-P)
<b>0.51</b>	<b>0.2</b>
Condensation Resistance	
<b>51</b>	—
<small>MANUFACTURER'S EXPLANATION OF FACTORS AFFECTING ENERGY PERFORMANCE: U-Factor is based on standard test conditions. Visible Transmittance is based on standard test conditions. Air Leakage is based on standard test conditions. Condensation Resistance is based on standard test conditions. For more information, visit <a href="http://www.nfrc.org">www.nfrc.org</a>.</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.**



## Windows

### Exterior Insulated Shutters

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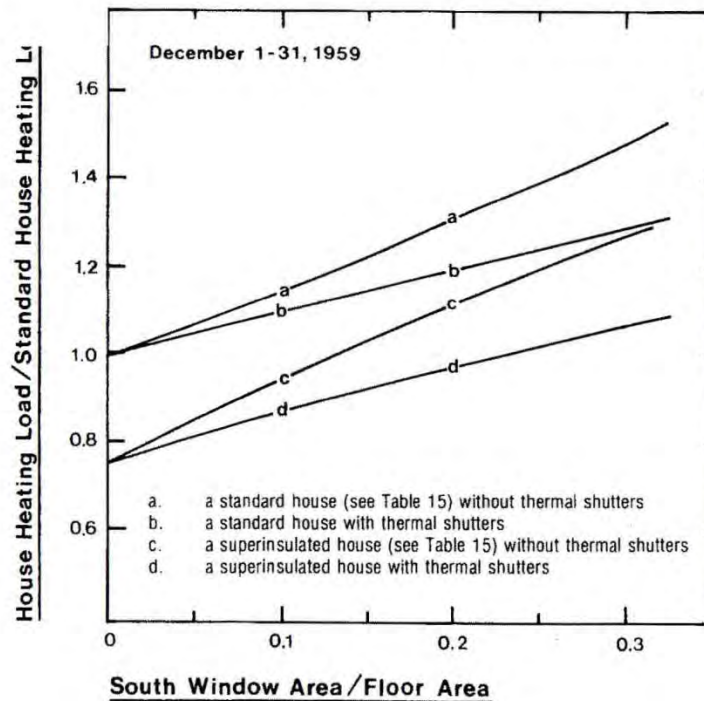
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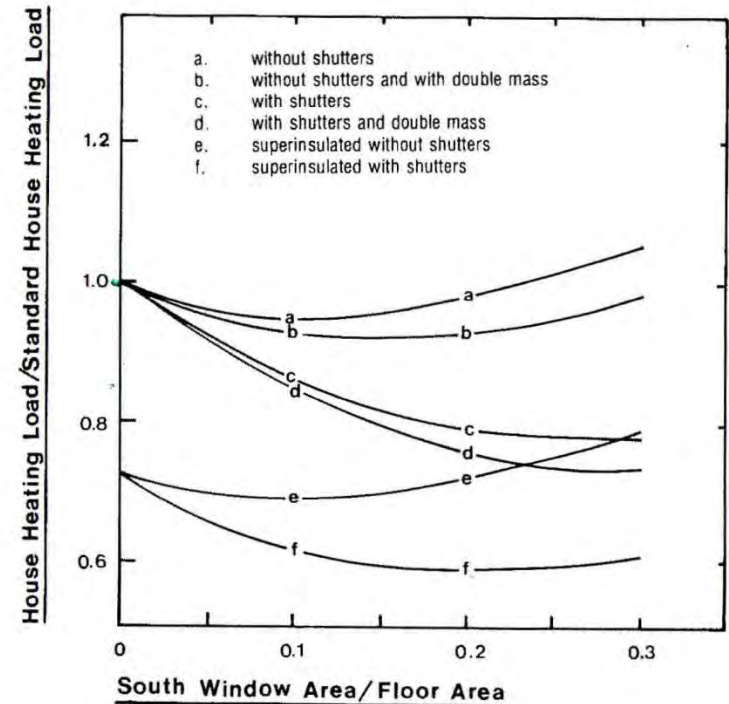
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**Figure 61.** Increasing the window area of a structure to improve solar gain always results in increased heat loss for the month of December.



**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](http://ACAT.org).**

**See Bronwyn Barry's Passiv Haus Window presentation at [ACAT.org](http://ACAT.org).**





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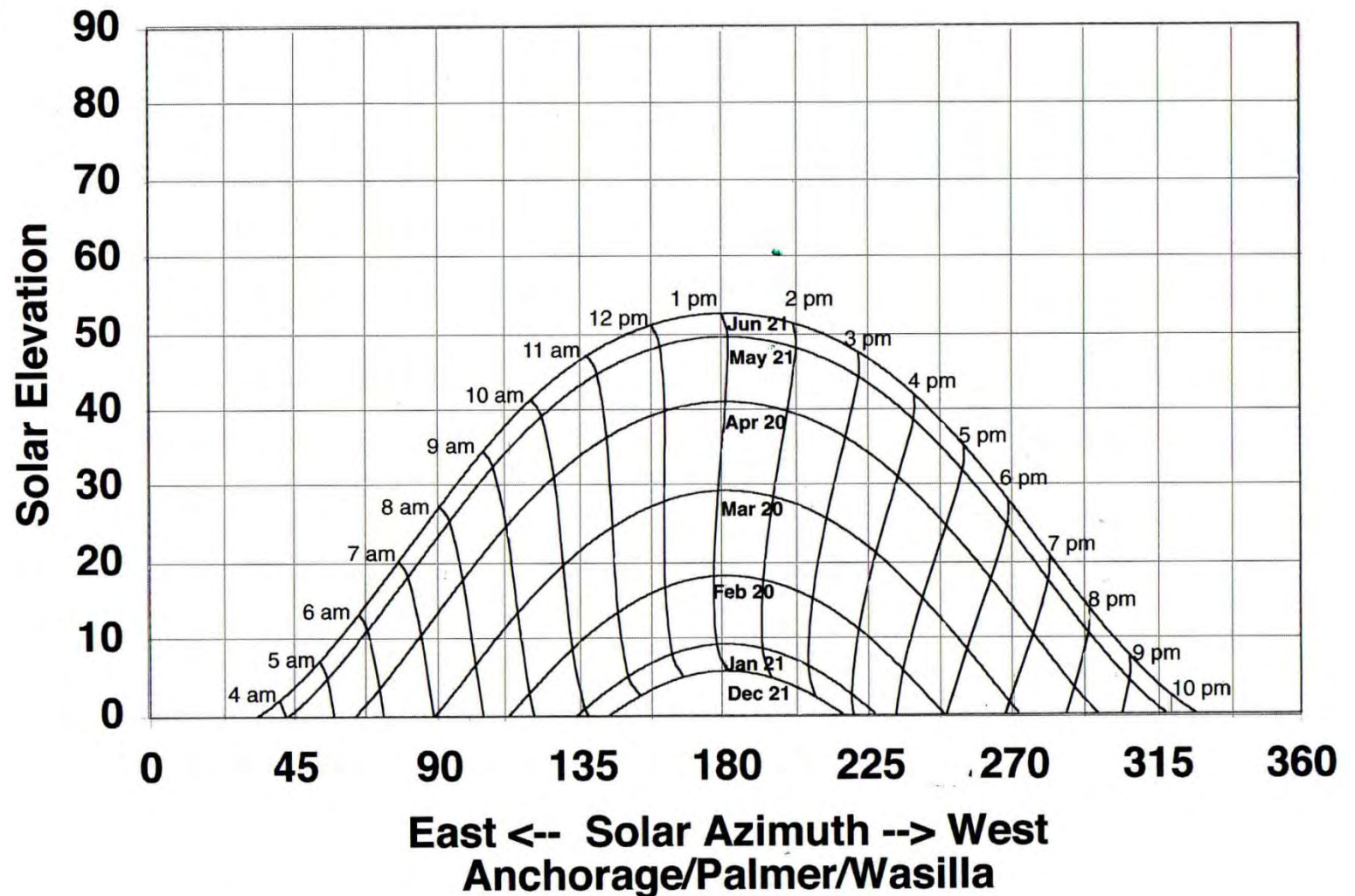
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## PASSIVE SOLAR



See UAF Co-Ops Alaska Solar Guide.

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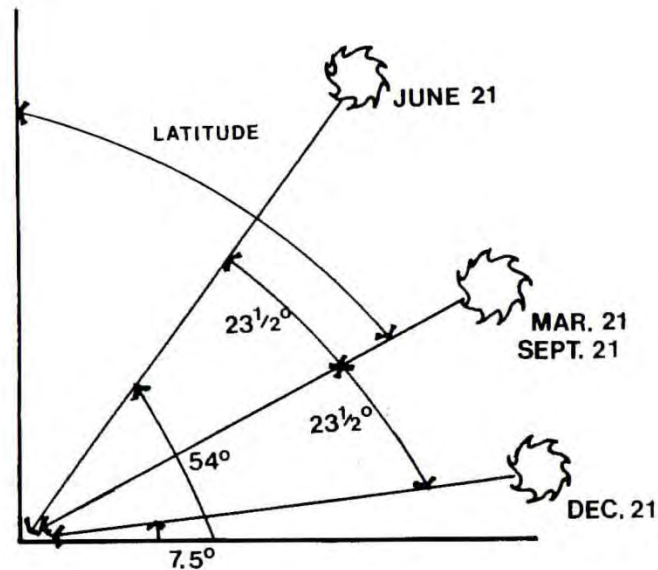
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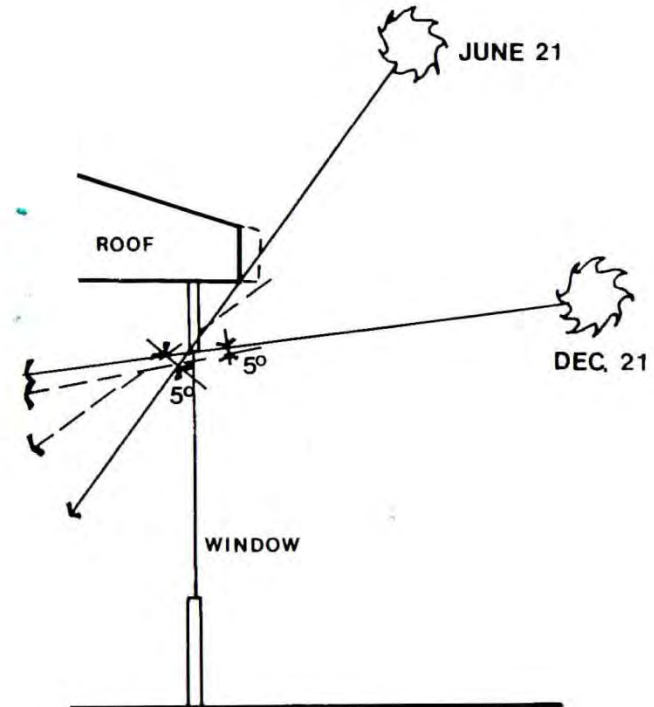
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**Figure 68a.** The range of solar elevation angles at the latitude of Anchorage, Alaska (60°30'N). The maximum elevation is 54° on June 21, and the minimum is 7.5° on December 21.



**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](http://acat.org)**



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**TABLE A12: MATANUSKA SOLMET DATA.**

Month	Incident Solar Radiation, BTU/day-ft <sup>2</sup>				Degree Days °F·day	Mean Temperature °F
	Horizontal Surface	Vertical Surface				
		South	East/West	North		
Jan	119.3	777.4	193.5	-0	1,645	12.2
Feb	339.3	1,053.6	435.7	0	1,285	19.4
Mar	893.5	1,748.4	1,058.1	0	1,240	26.6
Apr	1,313.0	1,306.7	1,186.7	0	859	35.6
May	1,606.5	1,071.0	1,222.6	0	558	46.4
Jun	1,703.3	1,003.3	1,236.7	126.7	302	53.6
Jul	1,506.5	932.3	1,096.8	119.4	232	57.2
Aug	1,158.1	883.9	890.3	0	304	53.6
Sep	730.0	823.3	616.7	0	518	46.4
Oct	367.7	774.2	380.6	0	947	33.8
Nov	140.0	620.0	186.7	0	1,328	21.2
Dec	54.8	403.2	87.1	0	1,627	14.0
Annual <sup>1</sup>	830.1	346.5	261.9	20.9	10,847	35.0

<sup>1</sup>All are annual means except degree days; this value is the yearly total.

**See UAF Co-Ops Alaska Solar Guide.**





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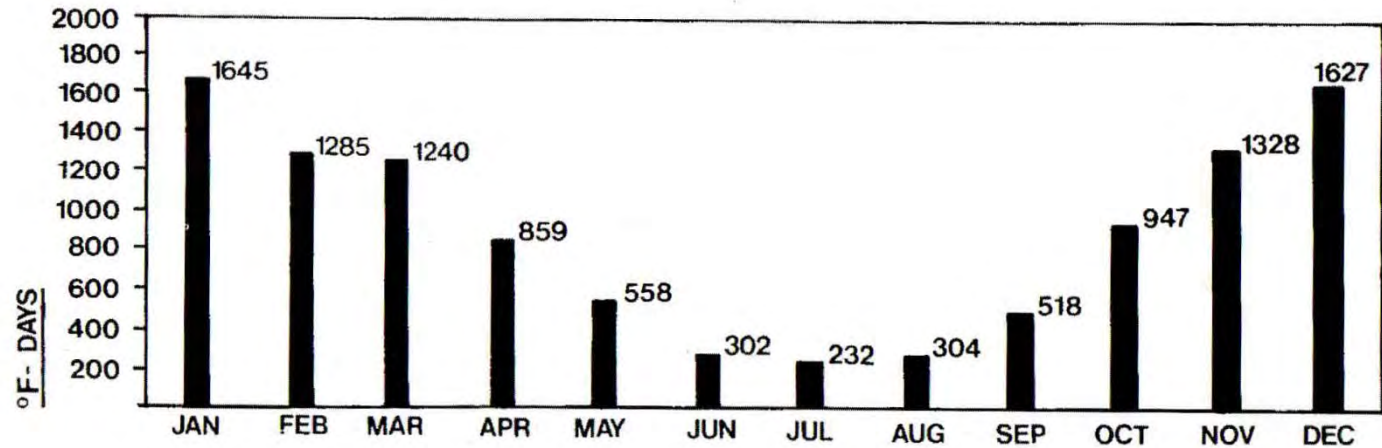
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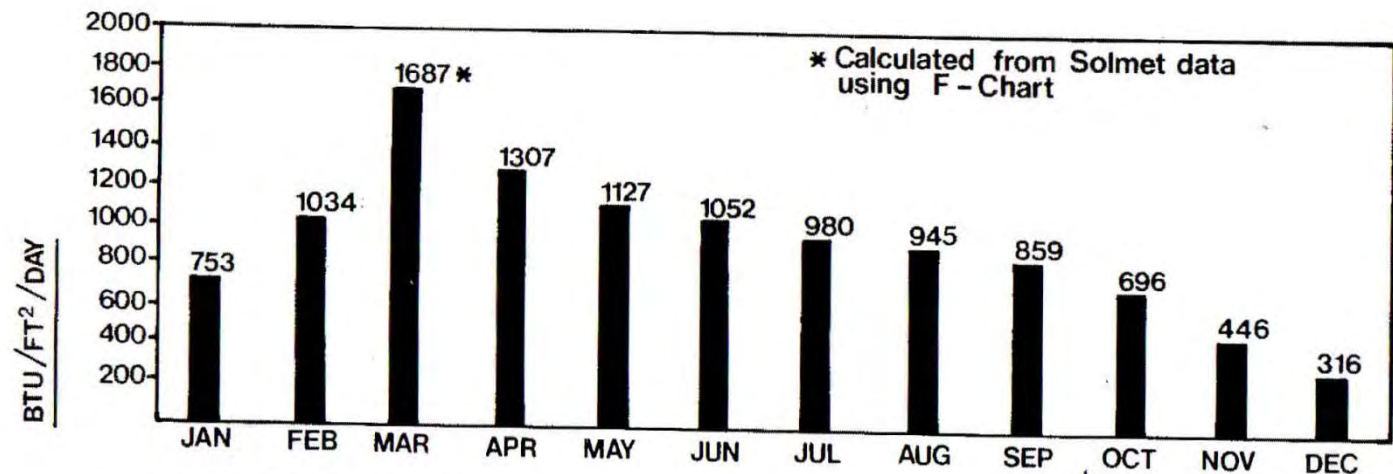
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## PASSIVE SOLAR



Average Monthly Heating Degree Days

Matanuska, Alaska



Average Solar Radiation on a Vertical South Facing Surface

Matanuska, Alaska





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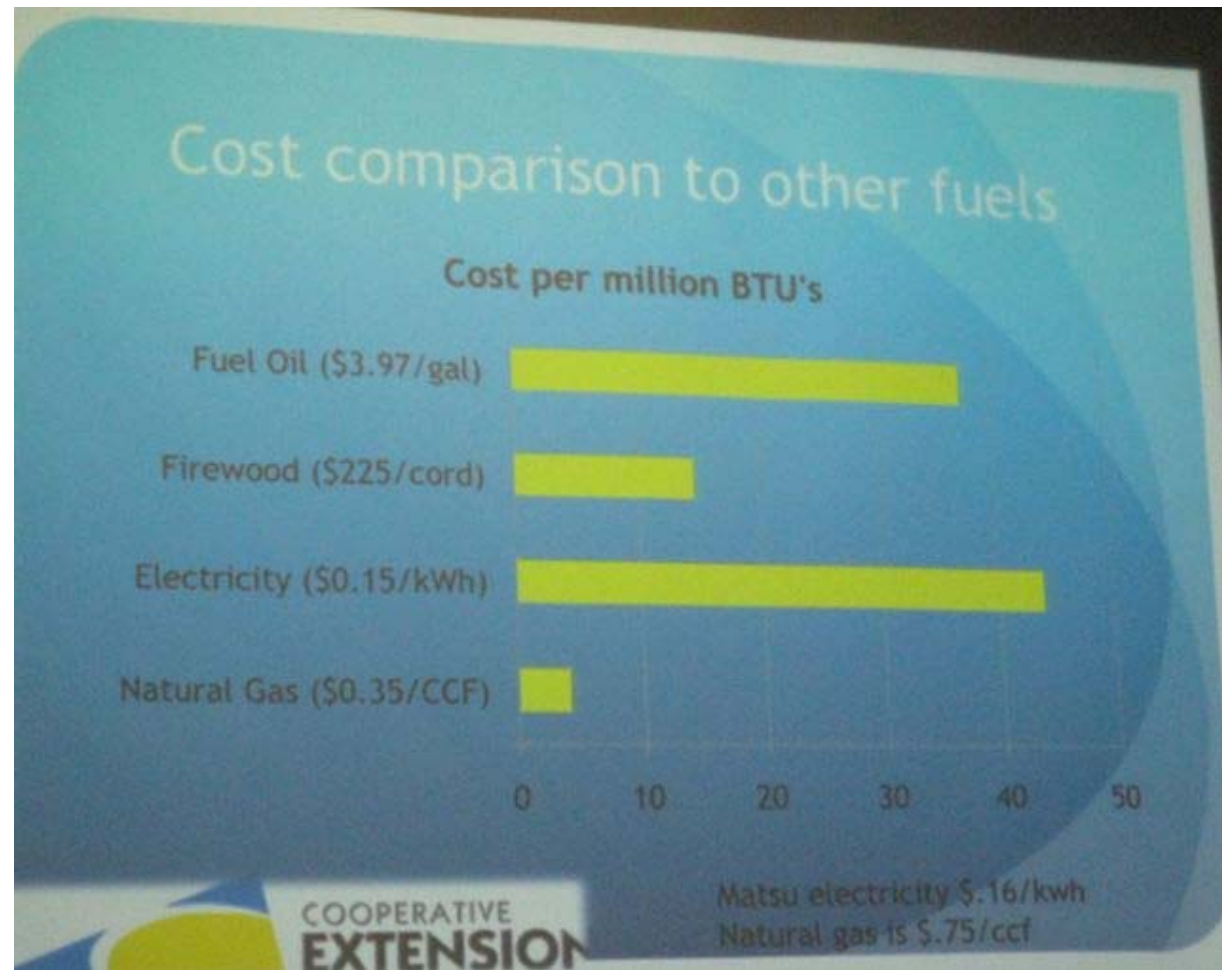
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## HEATING



See UAF Cooperative Extension website [www.uaf.edu](http://www.uaf.edu).



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## **HEATING AND PASSIVE SOLAR**

### **More Spreadsheet Fun!**

- **Passive Solar**
- **Wood**
- **Electric (Heat Pumps or Geothermal)**
- **Oil or gas back-up or supplement**
- **Solar thermal**
  - **Domestic Hot Water and Heating?**
  - **How do we store it for when it's needed?**

**See Canadian Equilibrium Housing presentation at [ACAT.org](http://ACAT.org).**

**See Thorsten's presentation at [ACAT.org](http://ACAT.org).**

**See Serge Adamian's Solar Thermal presentation at [acat.org](http://acat.org)**

**See UAF Co-Ops Alaska Solar Guide.**



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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](http://ACAT.org).

See Solar PV presentation at [ACAT.org](http://ACAT.org).

See [Akenergyefficiency.org](http://Akenergyefficiency.org)

MATANUSKA ELECTRIC ASSOCIATION, INC.  
P.O. BOX 2929 Palmer, Alaska 99757  
(907) 761-9300, (907) 665-1111

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

Primary Contact # Not On File  
Previous Account Balance Payment Received 08/03/20 Balance Brought Forward 0.9

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  
WPCRA  
Recycling 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 save a lot if payment is received by you in the prior three years are available upon request.

ACCOUNT STATUS  
Due 1-60 Days 0.00  
Due 61-90 Days 0.00  
Over 91 Days 0.00  
TOTAL PAST DUE 0.00

Thank you for keeping your account current

HISTORICAL INFORMATION  
AVG TEMPERATURE MAY NOT REFLECT TEMPERATURE AT YOUR SERVICE LOCATION

BILL MONTH	NO OF DAYS	KILOWATT HOURS USED	AVG KWH PER DAY	KW DEMAND	AVG TEMP
AUG-12	31	22960	744	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	29	21840	753	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	31	35280	1138	88,000	56
SEP-11	30				59

Budget Bill



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## Electric Usage

### More Spreadsheet Fun!

Consider how you live in your house now. How might that change?

- **Lighting**
- **Appliances**
- **Computer / Office**
- **Entertainment / Miscellaneous**
- **Electric (Heat Pumps or Geothermal)**
- **Heating system fans or pumps**

See Canadian Equilibrium Housing presentation at [ACAT.org](http://ACAT.org).

See [Akenergyefficiency.org](http://Akenergyefficiency.org)

See Energy Star





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## Electric Usage - Reductions

### Reductions

- **Lighting – CFLs, LEDs, occupancy sensors, lighting surfaces**
- **Appliances – Energy Star**
- **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](http://ACAT.org).

See [Akenergyefficiency.org](http://Akenergyefficiency.org)

See Energy Star



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## Renewables

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



**See presentations at [acat.org](http://acat.org)**

**See Electric Storage – Eayrs 2011 presentation at [acat.org](http://acat.org)**

## Not Reviewed

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

**See Off Grid Homes 2011 presentations at [acat.org](http://acat.org)**

**See Electric Storage 2011 presentations at [acat.org](http://acat.org)**



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## Solar – PV Watts2

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

The screenshot shows the NREL PVWatts Grid Data Calculator (Version 2) web interface. The header includes the NREL logo and navigation links: ABOUT NREL, ENERGY ANALYSIS, SCIENCE & TECHNOLOGY, TECHNOLOGY TRANSFER, TECHNOLOGY DEPLOYMENT, and ENERGY SYSTEMS INTEGRATION. The main title is "Renewable Resource Data Center PVWatts". The left sidebar contains links: PVWatts Home, Launch Viewer, About PVWatts (Site Specific Data (Version 1) Calculator, Grid Data (Version 2) Calculator), and Help. The main content area is titled "PVWatts™ Grid Data Calculator (Version 2)" and describes the tool's purpose: "PVWatts™ Grid Data calculator allows users to select a photovoltaic (PV) system location in the United States from an interactive map." It explains that the 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. It notes that in this version, performance is first calculated for 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, it directs users to "PVWatts Version 2 - Enhanced Spatial Resolution for Calculating Grid-Connected PV Performance". It also provides a link to "To use the PVWatts Grid Data (Version 2) calculator, see:" followed by a list of links: PVWatts Frequently Asked Questions, PVWatts Version 2 Calculator, How to Change PVWatts Parameters, How to Interpret PVWatts Results, and PVWatts Revision History.

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



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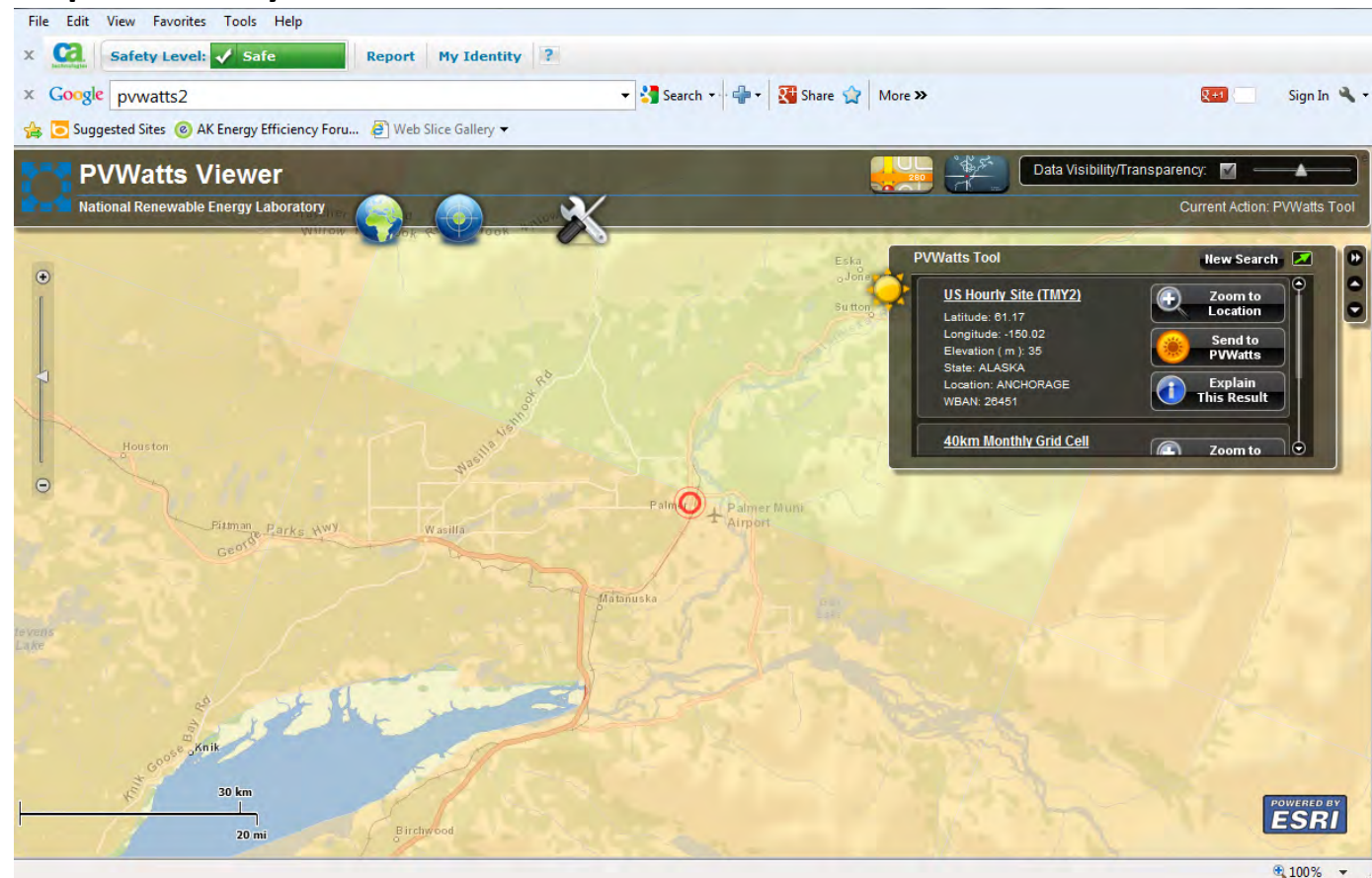
Electric Usage  
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### Step 2. Locate your site...



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





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### 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):	<input type="text" value="4.0"/>	
DC to AC Derate Factor:	<input type="text" value="0.77"/>	<a href="#">DERATE FACTOR HELP</a>
Array Type:	<input type="text" value="Fixed Tilt"/>	
Fixed Tilt or 1-Axis Tracking System:		
Array Tilt (degrees):	<input type="text" value="61.17"/>	(Default = Latitude)
Array Azimuth (degrees):	<input type="text" value="180"/>	(Default = Equator-Facing)

#### Energy Data:

Cents per kWh:	<input type="text" value=".146"/>	(Default = State Average)
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## 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 <sup>2</sup> /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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## Overall Review

- **Definition of a Net Zero Energy building**
  - **Envelope heat loss calculation**
    - **Super-Insulation**
  - **Heating methods**
    - **System sizing**
    - **Passive Solar**
    - **Annual Usage**
    - **Heating Systems**
      - **Solar Thermal**
  - **Electric Usage**
    - **Spreadsheet**
    - **Reductions**
  - **Renewables**
    - **Solar PV Watts**
- How much does it cost? Up front? In the long run?**

**Go to [acat.org](http://acat.org) for presentations!**