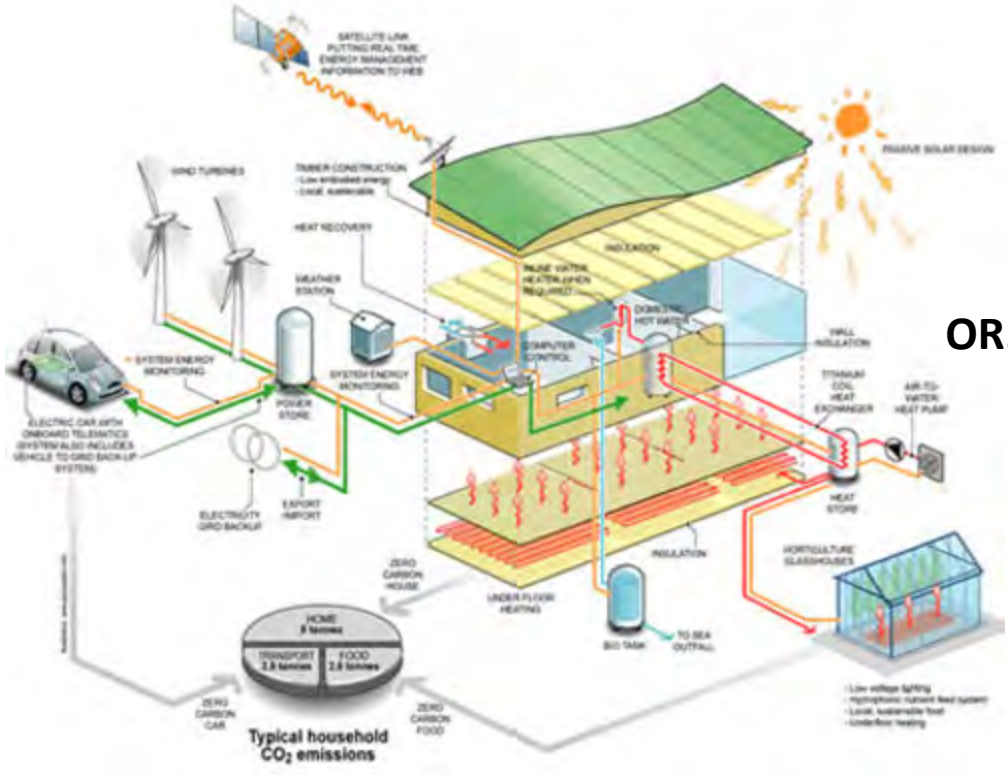
ALASKA CENTER FOR APPROPRIATE TECHNOLOGY

NAVIGATING YOUR PATH TO NET ZERO ENERGY

- 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



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?**

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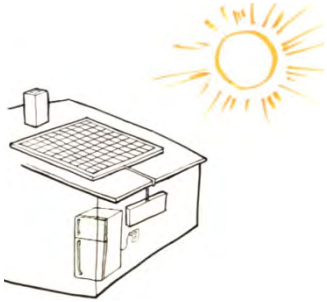

NET ZERO ENERGY BUILDING

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.

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NET ZERO ENERGY BUILDING

Net Zero Energy
Definition

Envelope
Spreadsheet
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Insulation

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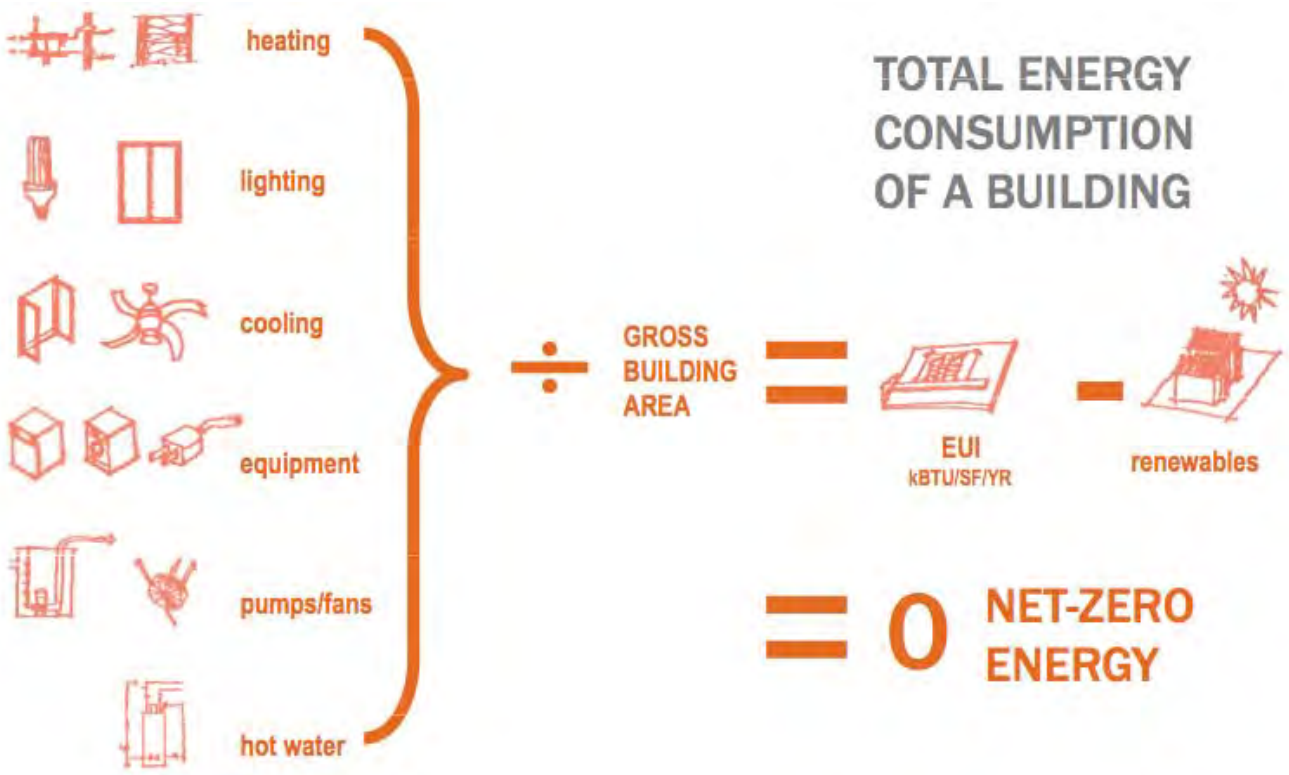
Heating Methods
Storage

Electric Usage
Spreadsheet
Reductions

Renewables
PV Watts
Grid-tie
Storage

Overall Review



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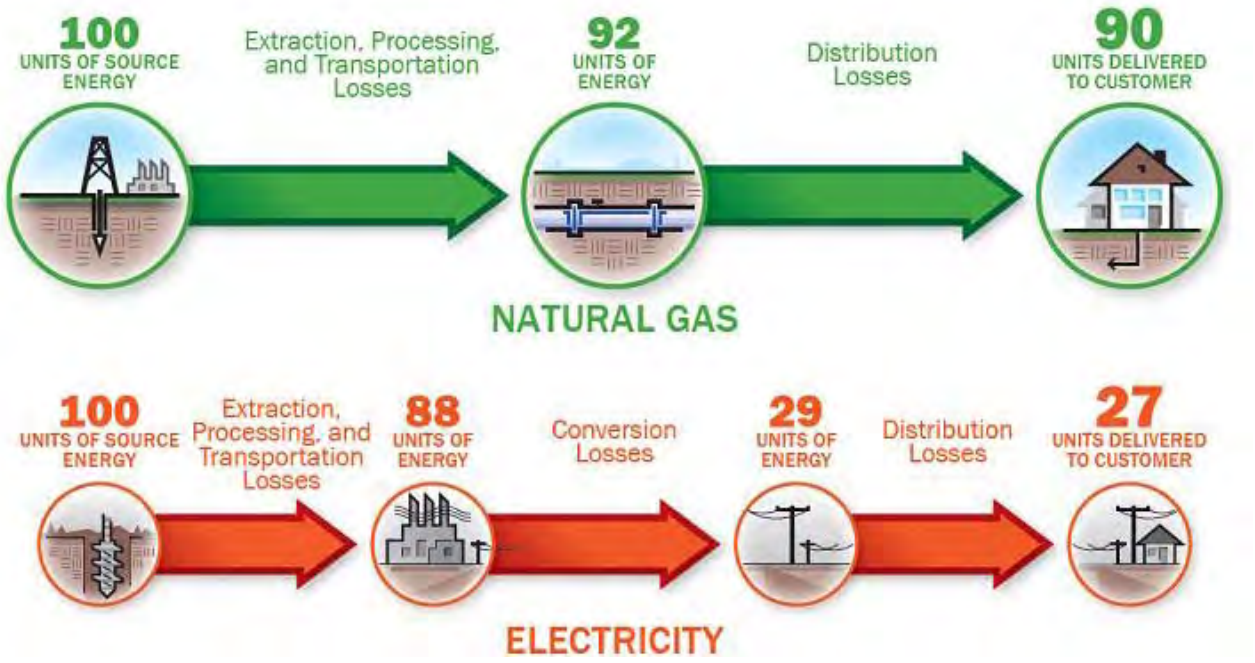
NET ZERO ENERGY BUILDING

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 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?**

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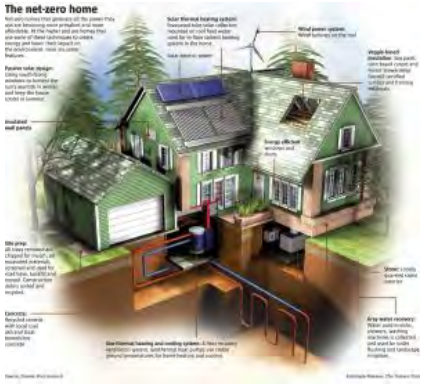
WHAT DOES A NET ZERO ENERGY BUILDING LOOK LIKE?



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IS NET ZERO ENERGY BUILDING POSSIBLE IN ALASKA?

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 MARSIK - DILLINGHAM

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

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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?**

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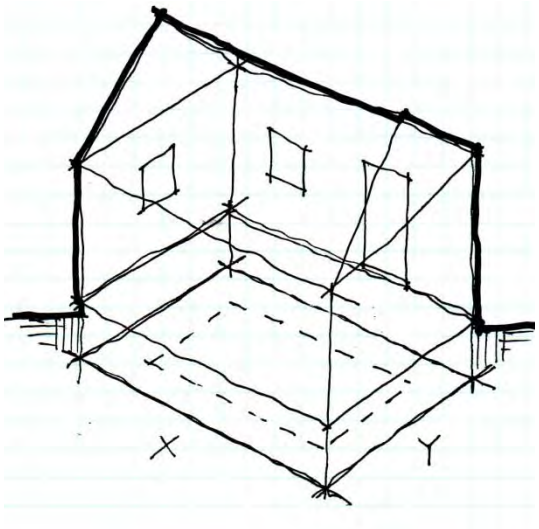

ENVELOPE

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.

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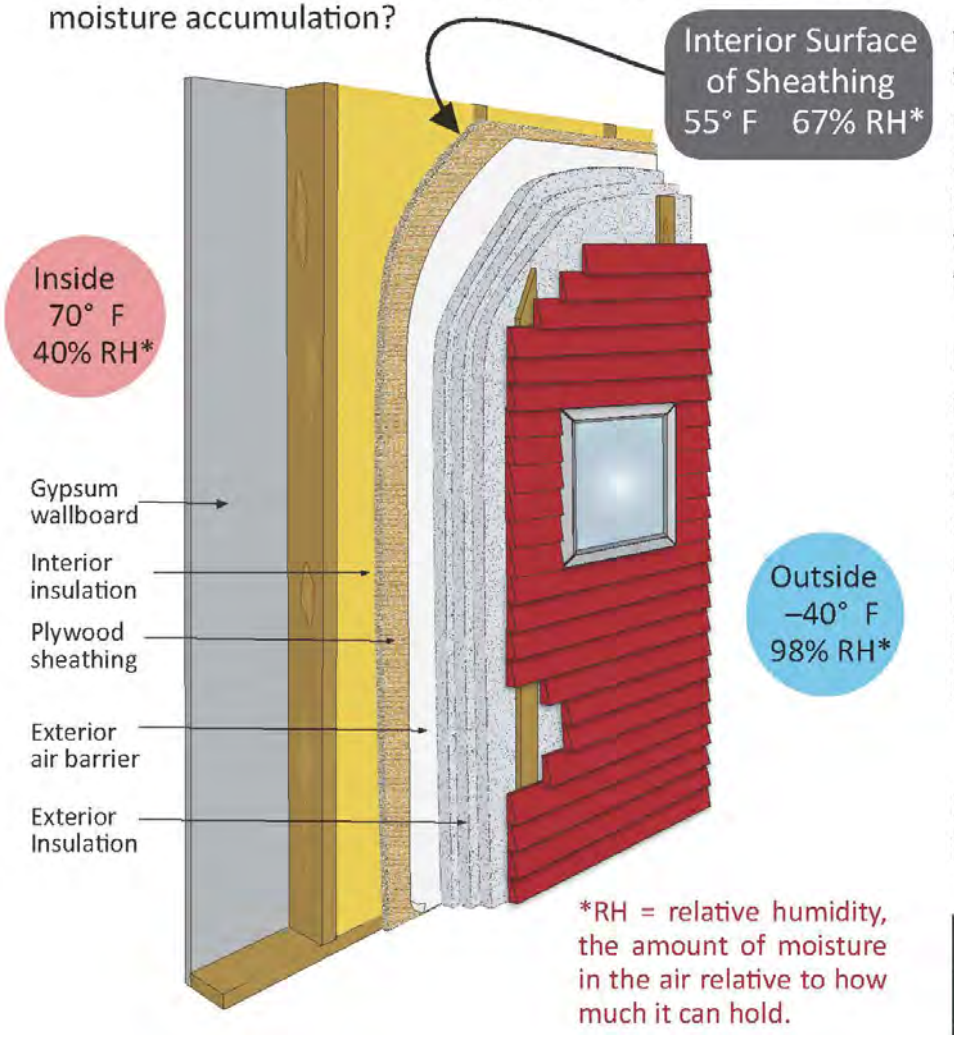
Exterior Insulation

- 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.

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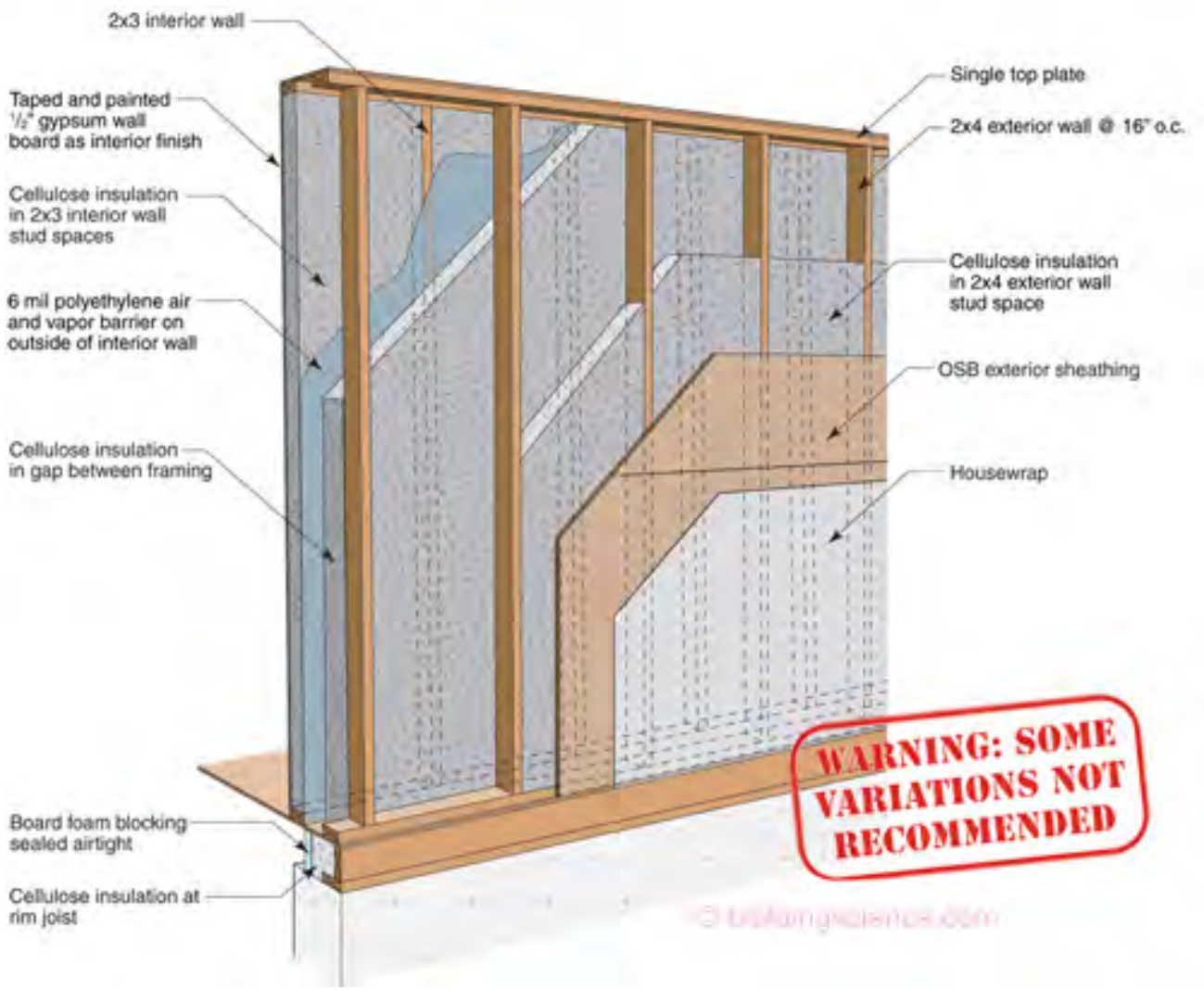
Double Stud with Cellulose Insulation



See Thorsten and Canadian Equilibrium presentations at ACAT.org.

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

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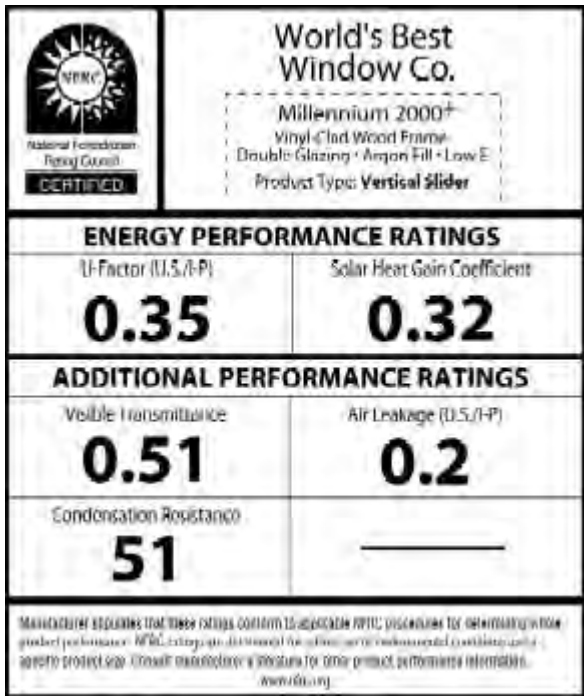
Windows



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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Windows
Exterior Insulated Shutters

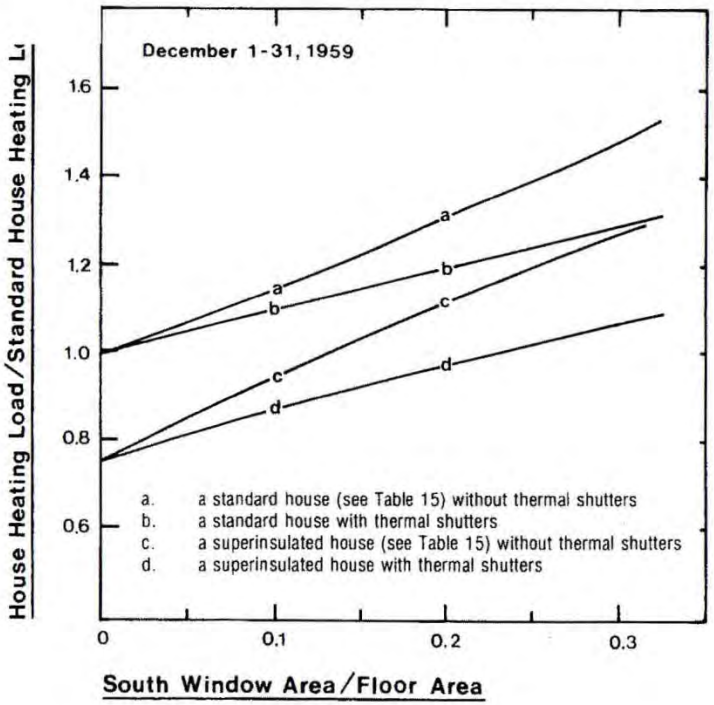

Figure 61. Increasing the window area of a structure to improve solar gain always results in increased heat loss for the month of December.

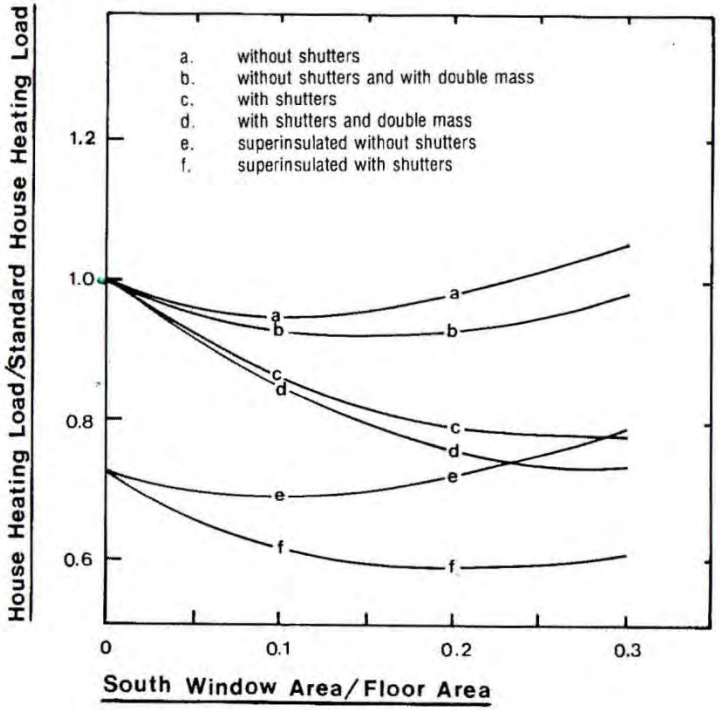

Figure 62. Annual heating requirements for houses with and without thermal shutters and various amounts of south-facing windows.

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

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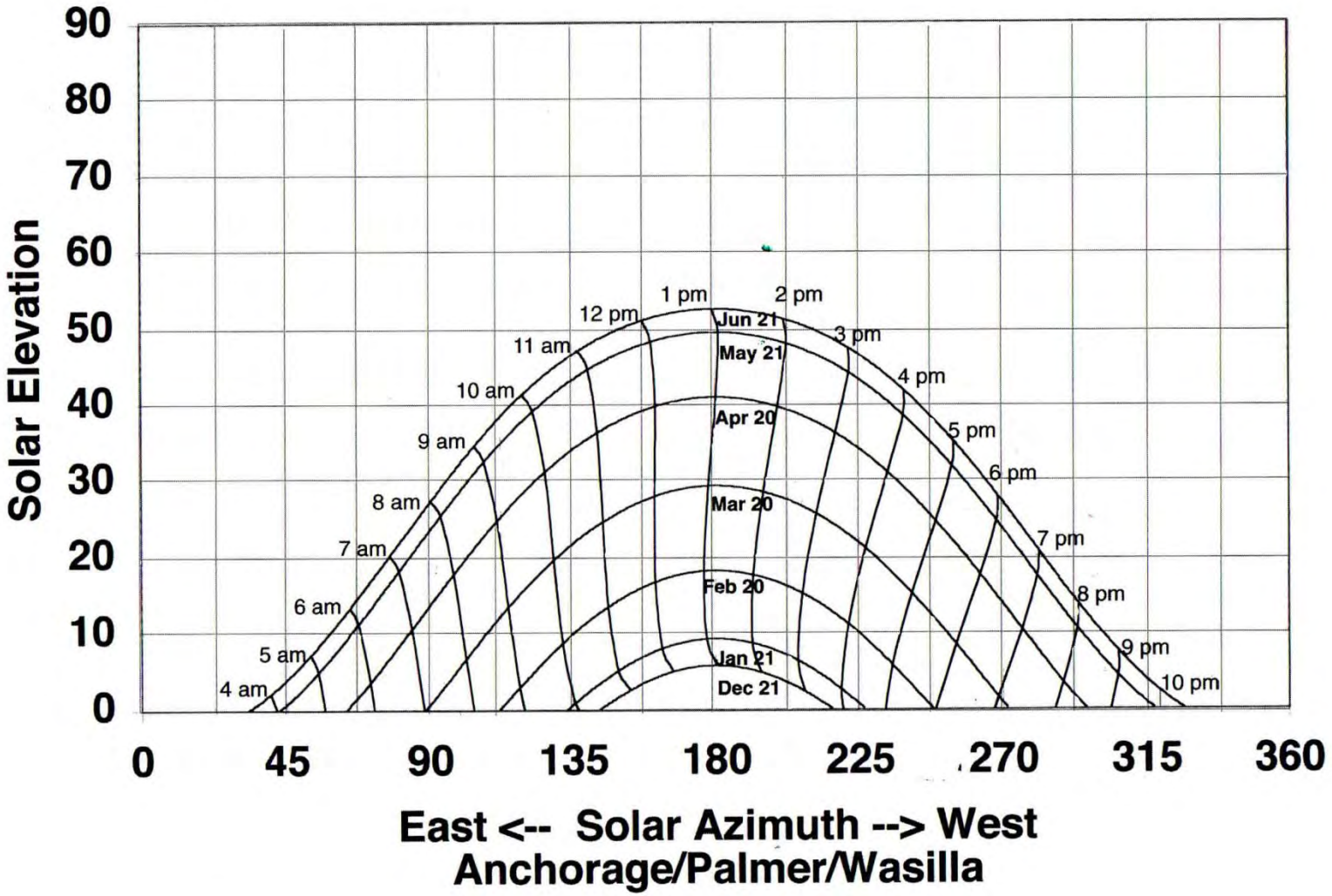
PASSIVE SOLAR



See UAF Co-Ops Alaska Solar Guide.

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PASSIVE SOLAR

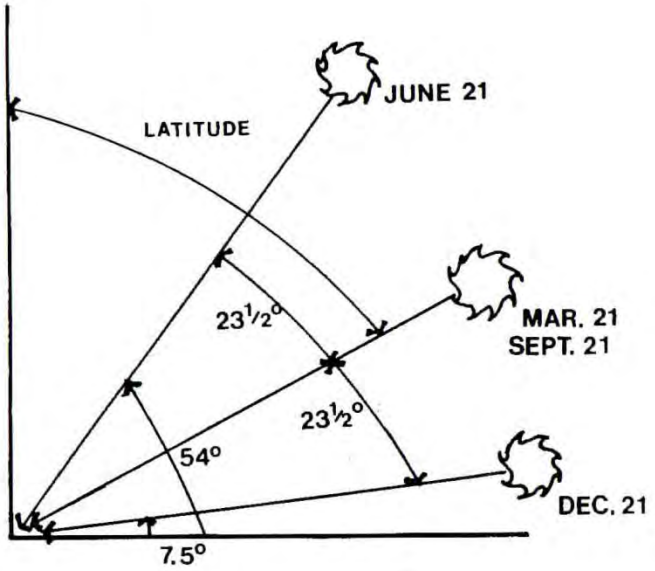

Figure 68a. The range of solar elevation angles at the latitude of Anchorage, Alaska (60°30'N). The maximum elevation is 54° on June 21, and the minimum is 7.5° on December 21.

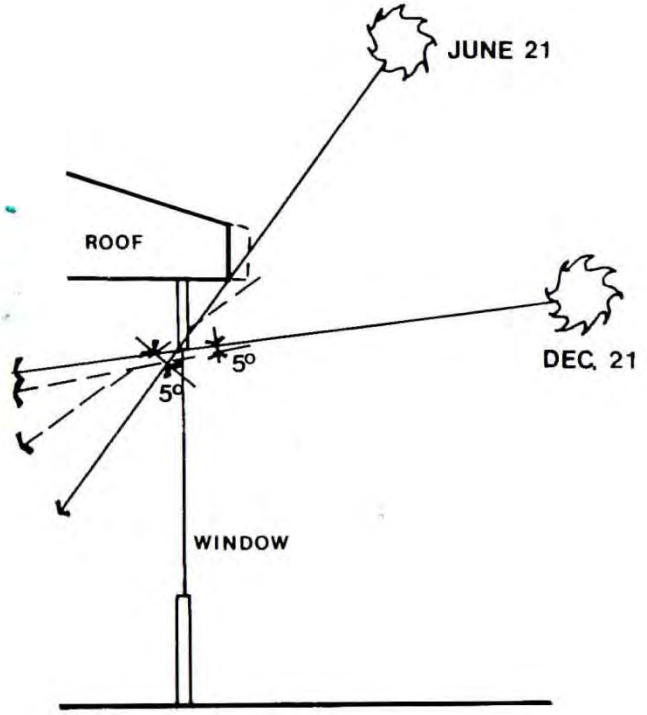

Figure 68b. Unlike the lower latitudes, a small overhang has little effect on shading the summer sun in Alaska. Larger overhangs are required in Alaska because of the lower solar elevation angles.

See UAF Co-Ops Alaska Solar Guide.
See Matt Oster's Alaska Greenhouse presentation at acat.org

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PASSIVE SOLAR

TABLE A12: MATANUSKA SOLMET DATA.

Month	Incident Solar Radiation, BTU/day·ft²				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[1]	830.1	346.5	261.9	20.9	10,847	35.0

[1]All are annual means except degree days; this value is the yearly total.

See UAF Co-Ops Alaska Solar Guide.

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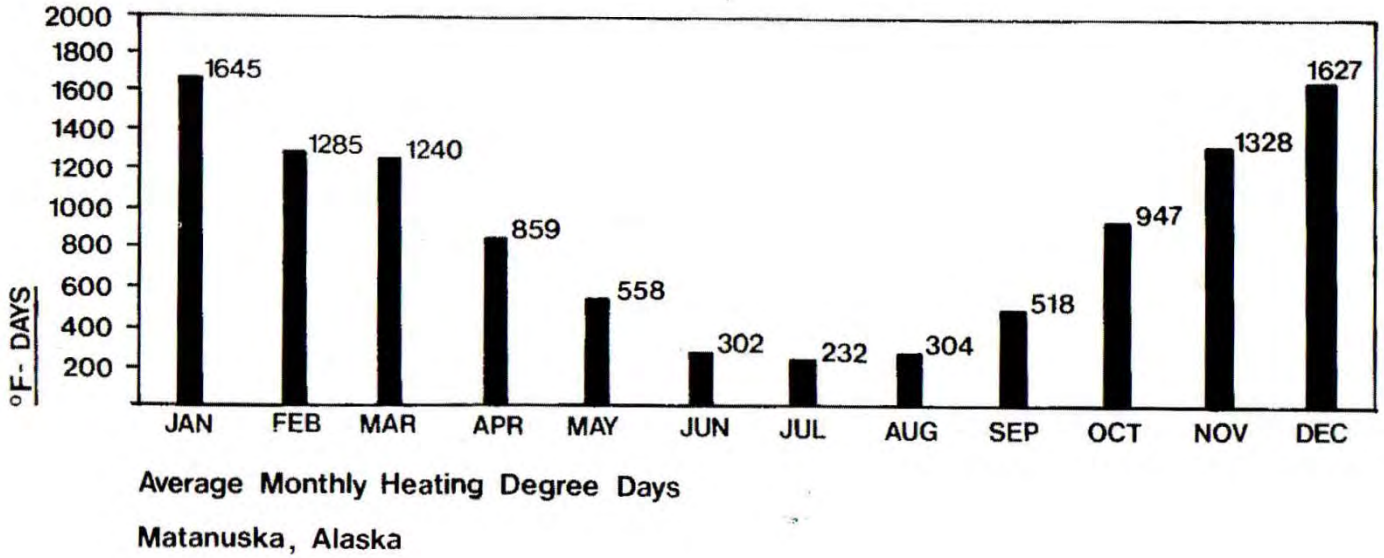
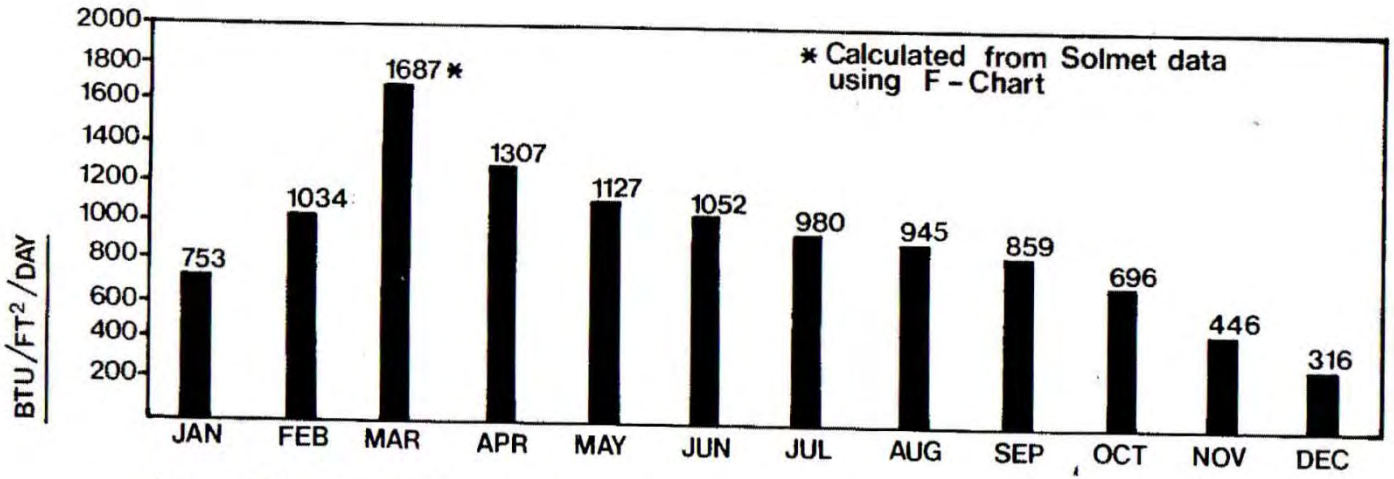
PASSIVE SOLAR



Average Monthly Heating Degree Days

Matanuska, Alaska



Average Solar Radiation on a Vertical South Facing Surface

Matanuska, Alaska

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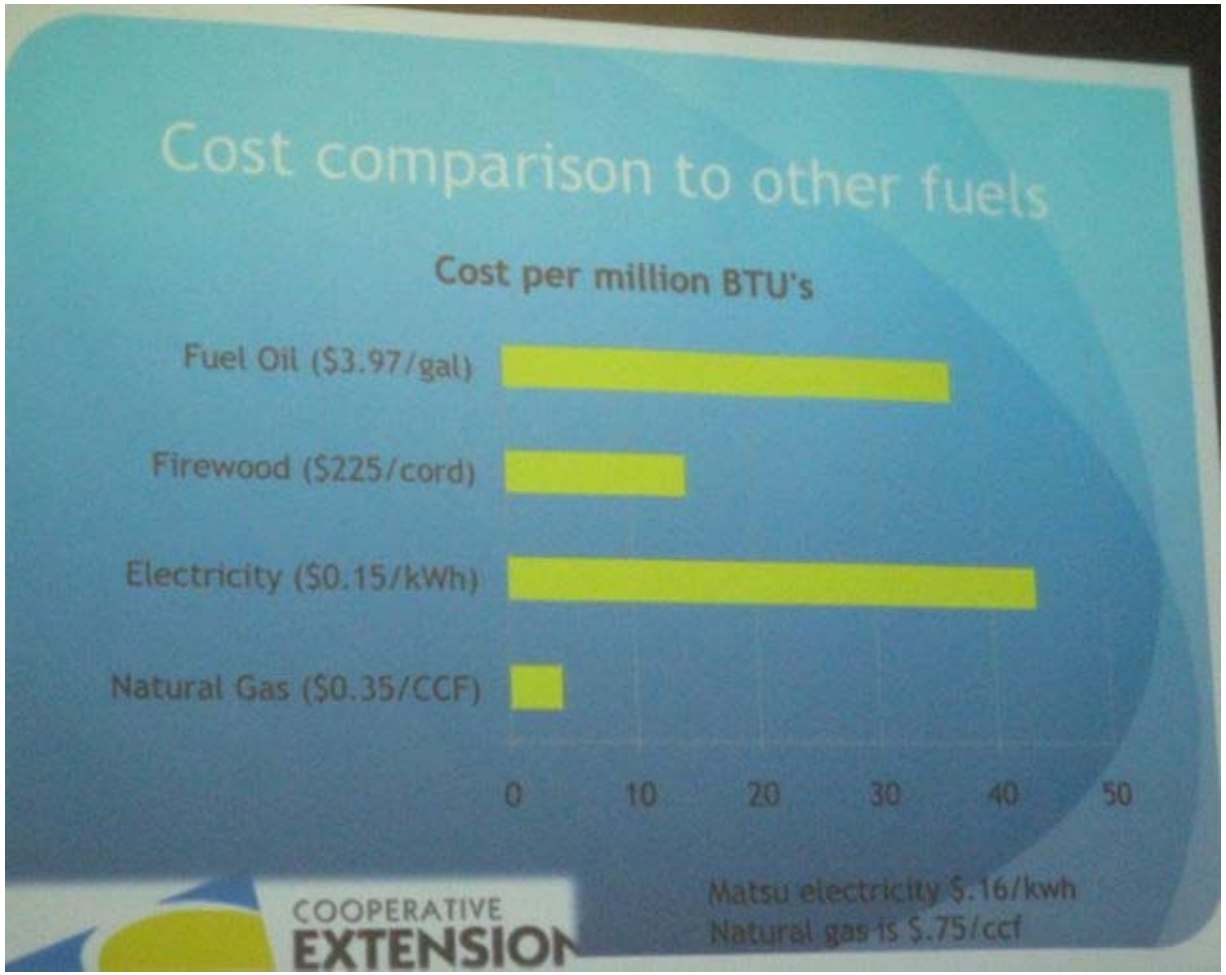
HEATING



See UAF Cooperative Extension website 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.
See Thorsten's presentation at ACAT.org.
See Serge Adamian's Solar Thermal presentation at acat.org
See UAF Co-Ops Alaska Solar Guide.

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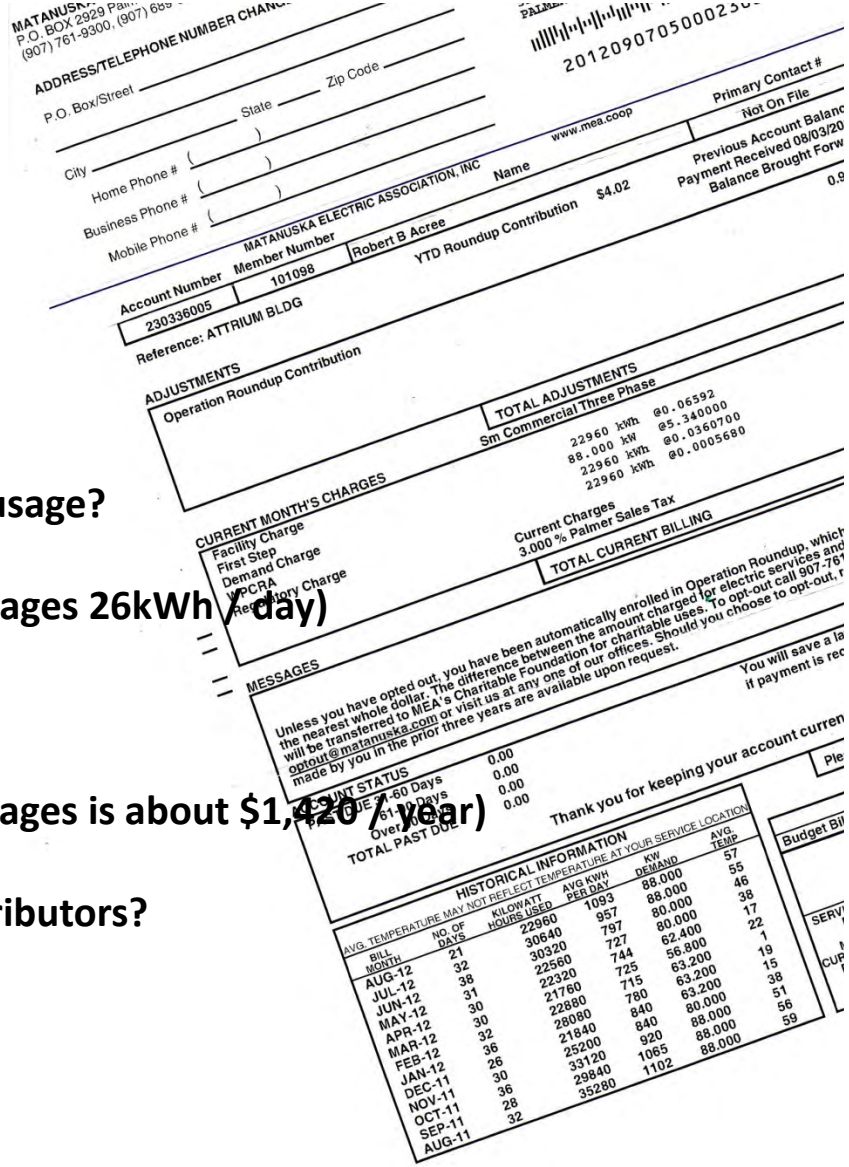
Electric Usage



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.
See Solar PV presentation at ACAT.org.
See Akenergyefficiency.org

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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.
See 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 / Miscellanious – 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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Renewables

- **Solar**
  - **Photovoltaic**
    - **Fixed, building mounted**
    - **Tracking Arrary**
  - **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

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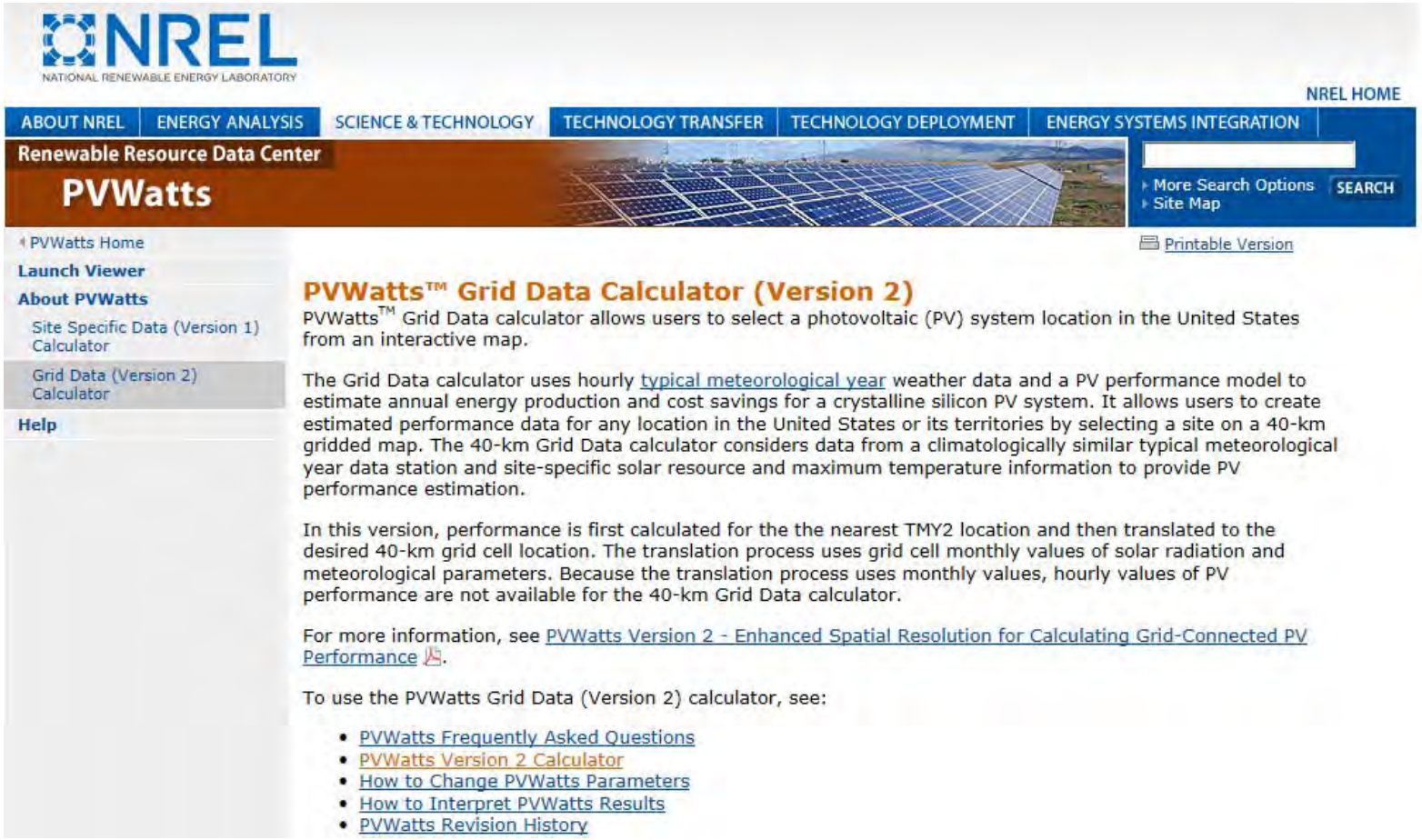

See nrel.gov – PV Watts 2

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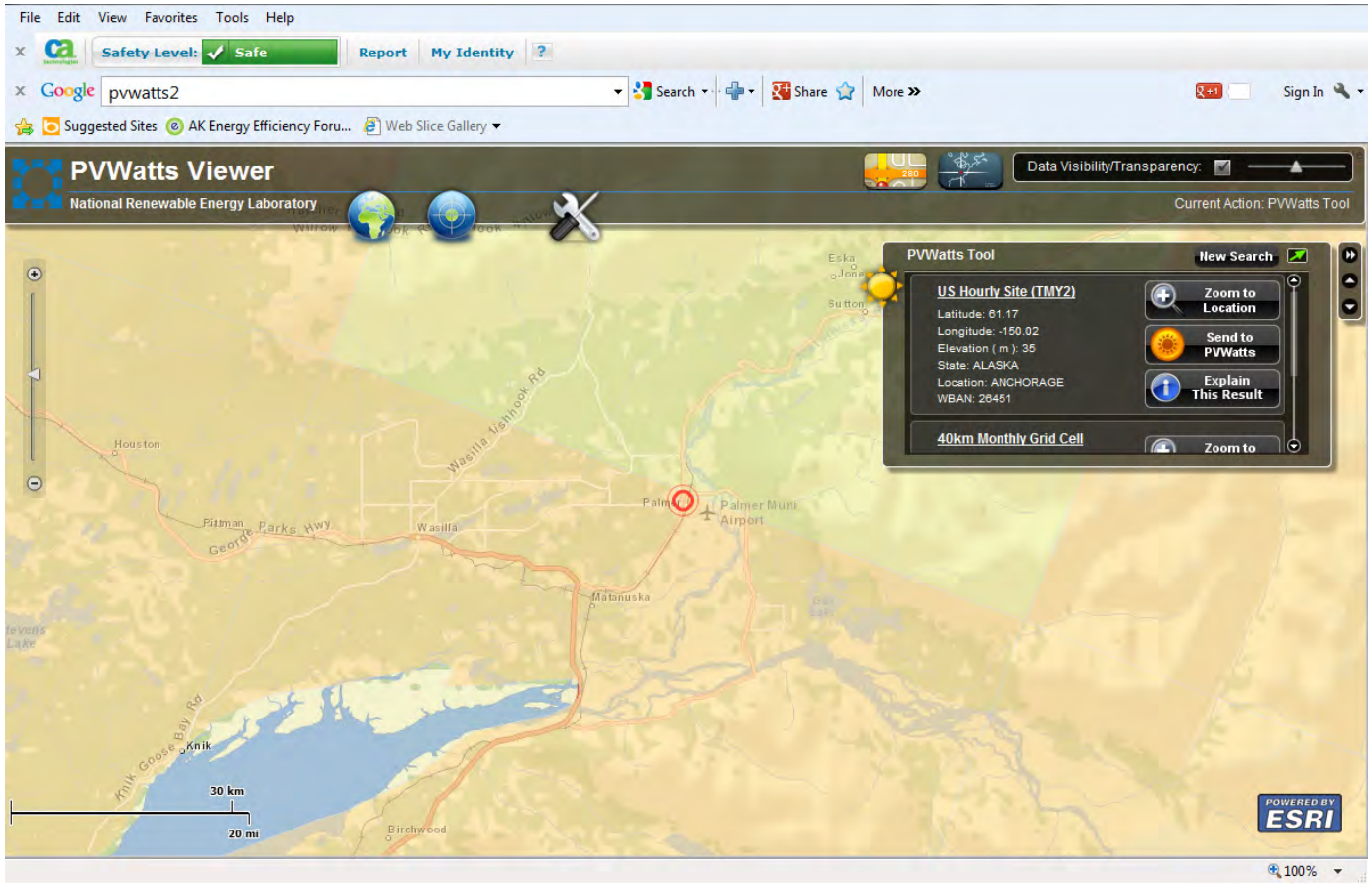
Solar – PV Watts2

Step 2. Locate your site…



See nrel.gov – PV Watts 2

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Solar – PV Watts2

Step 3. Input PV design data…

PVWatts

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):	4.0	
DC to AC Derate Factor:	0.77	DERATE FACTOR HELP
Array Type:	Fixed Tilt	

Fixed Tilt or 1-Axis Tracking System:

Array Tilt (degrees):	61.17	(Default = Latitude)
Array Azimuth (degrees):	180	(Default = Equator-Facing)

Energy Data:

Cents per kWh:	.146	(Default = State Average)

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Solar – PV Watts2

Step 4. Output PV design data…

PVWatts

AC Energy & Cost Savings

Cautions for Interpreting the Results

(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/m²/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 for presentations!