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Alaskans in Sustainable Development

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How to Zero Your Electric Bill

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



INTRODUCTIONS

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

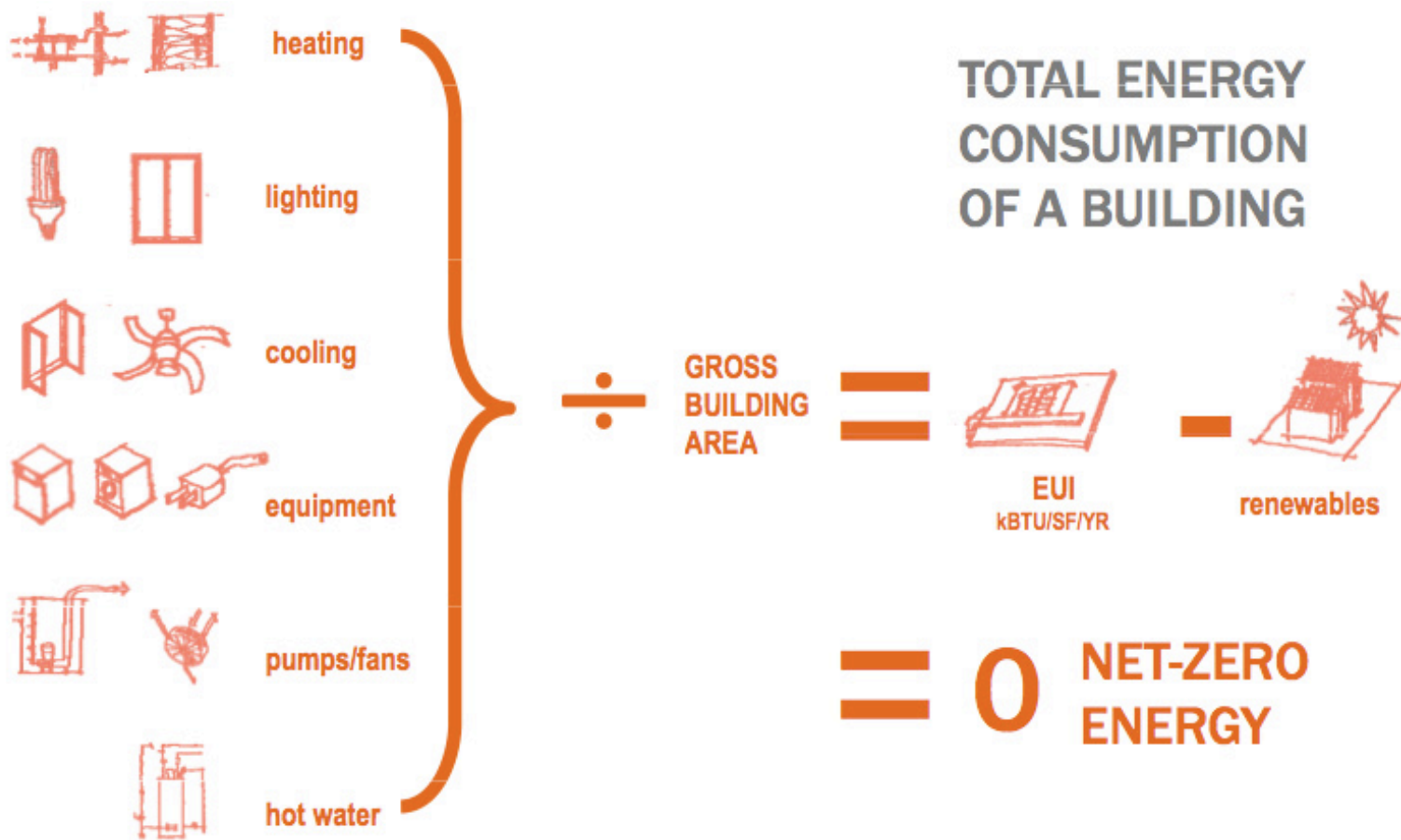
Notes for everyone to Share:

- Name
- Where do you live?
- Did you bring a copy of your electric bill?
- What is your average daily electric usage in kwh?
- What's your average monthly bill?
- Total annual cost?



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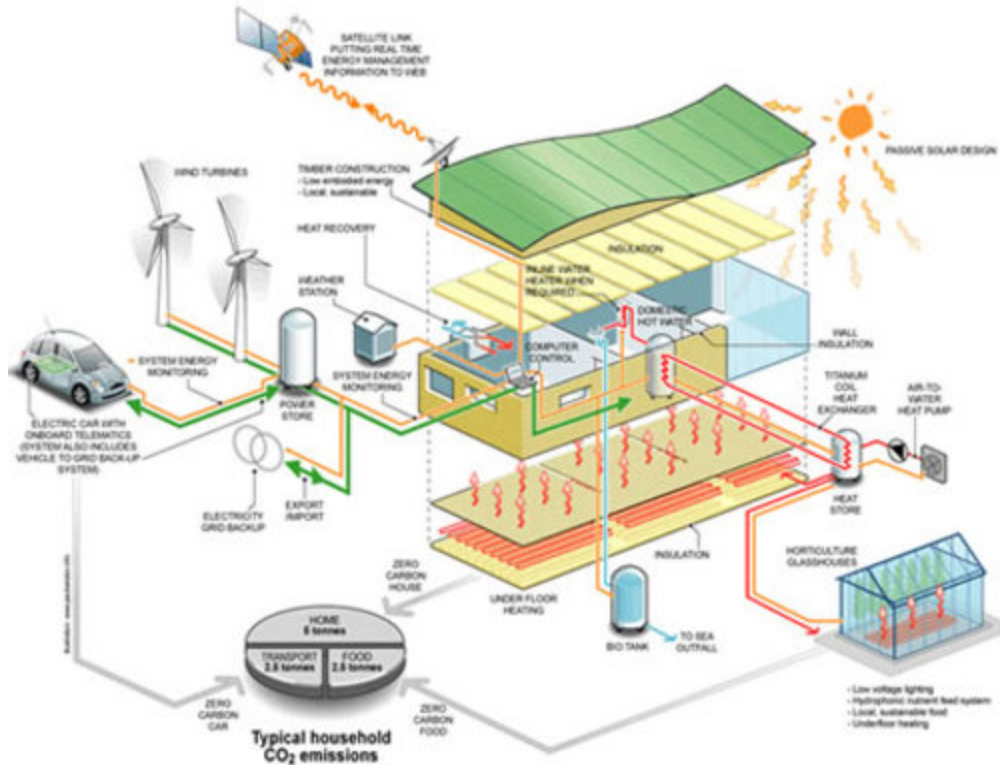
NET ZERO ENERGY BUILDING





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WHAT DOES NET ZERO ENERGY LOOK LIKE?



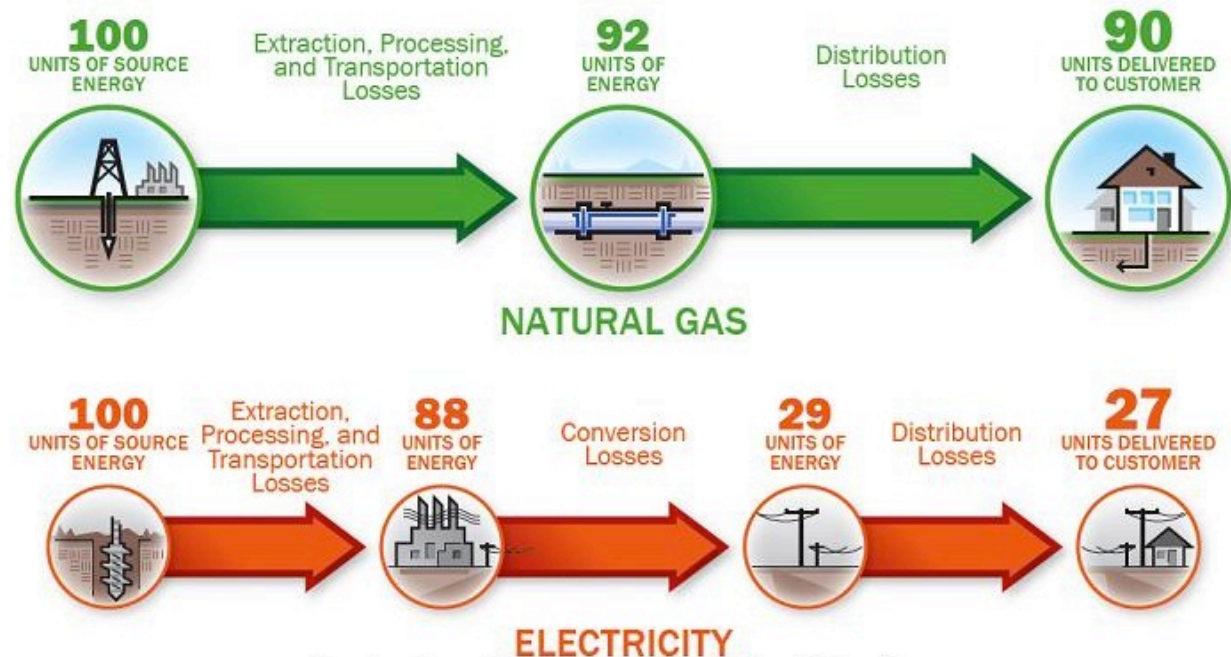
OR.



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

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)?

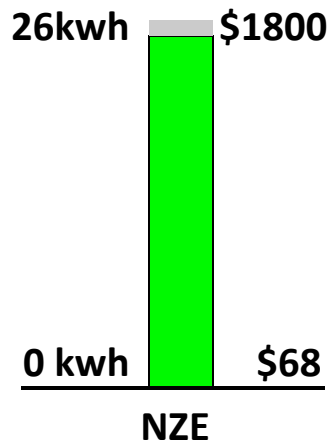
If we are equaling the Source Energy, do we provide 300%?



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 \$1,800 / year)
- What are the biggest contributors?
- Can you reduce it?



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

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

ADJUSTMENTS
Operation Roundup Contribution \$4.02

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
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 will be transferred to MEA's Charitable Foundation for charitable uses. To opt-out call 907-761-9300 or email optout@matanuska.com or visit us at any one of our offices. Should you choose to opt-out, you will be responsible for the amount you owe by you in the prior three years are available upon request.

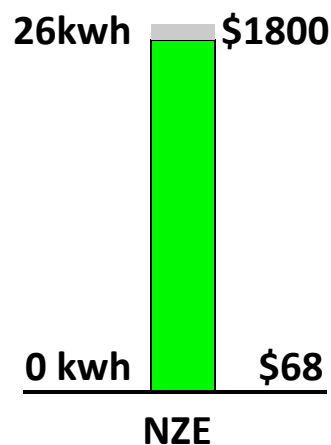
Thank you for keeping your account current

| 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 | 88.000 | 46 |
| MAY-12 | 31 | 21760 | 702 | 80.000 | 38 |
| APR-12 | 30 | 22880 | 763 | 80.000 | 17 |
| MAR-12 | 31 | 28080 | 906 | 80.000 | 22 |
| FEB-12 | 28 | 21840 | 780 | 80.000 | 19 |
| JAN-12 | 31 | 25200 | 813 | 80.000 | 15 |
| DEC-11 | 31 | 33120 | 1068 | 80.000 | 38 |
| NOV-11 | 30 | 29840 | 995 | 80.000 | 51 |
| OCT-11 | 31 | 35280 | 1140 | 88.000 | 56 |
| AUG-11 | 31 | | | 88.000 | 59 |

Electric Usage - Reductions

Reductions – order of ease and cost payback

- Computer / Office – auto power strips
- Entertainment / Miscellaneous – auto power strips
- Lighting – CFLs, LEDs, occupancy sensors, lighting surfaces
- Appliances – Energy Star listings
- Heating system fans or pumps – efficiencies
- GFI and Weatherproof receptacles – 1w-5w draw
- Other Miscellaneous



Unplugging, Plug Loads and Phantom Loads

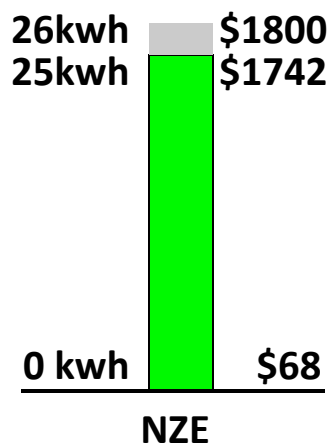
Plug Loads and Phantom Loads are the things that we plug into the wall outlets and forget about. They are easy to forget about. But just because they aren't "on" doesn't mean they're using no energy.

- Anything with a remote (TV, DVD, DVR, Stereo)
- Anything with a transformer or "wall-wart" (Phones, chargers)
- Power Strips
- Chargers

How do we reduce these loads?

- Unplug chargers
- Power Strips
- Turn off wifi when not being used

Simply unplugging chargers and turning items off when not in use is an easy way to see electrical savings. The example house saw a 1kwh per day reduction from this and about \$58 savings per year.



Plug Loads and Phantom Loads



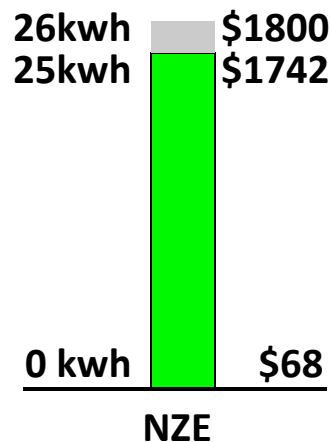
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Member household phantom load example¹

| Product type | Total phantom loads ² | Monthly phantom load - energy use (kWh) and cost | | Annual phantom load - energy use (kWh) and cost | |
|--|----------------------------------|--|---------------|---|----------------|
| Plasma TV (<40") | 3 Watts | 2.19 | \$0.20 | 26.28 | \$2.37 |
| DVR | 37 Watts | 27.01 | \$2.43 | 324.12 | \$29.17 |
| DVD player | 1 Watt | 0.73 | \$0.07 | 8.76 | \$0.79 |
| Audio system | 8 Watts | 5.84 | \$0.53 | 70.08 | \$6.31 |
| Cordless phone | 2 Watts | 1.46 | \$0.13 | 17.52 | \$1.58 |
| Desktop Computer, monitor and speakers | 8 Watts | 5.84 | \$0.53 | 70.08 | \$6.31 |
| Computer modem | 5 Watts | 3.65 | \$0.33 | 43.80 | \$3.94 |
| Multi-function printer | 6 Watts | 4.38 | \$0.39 | 52.56 | \$4.73 |
| Power tool charger | 4 Watts | 2.94 | \$0.26 | 35.04 | \$3.15 |
| Totals | 74 Watts | 54.04 kWh | \$4.87 | 648 kWh | \$58.35 |

Totals shown only reflect the device's use when turned off. Many electronic devices use significantly more energy when on, and on but not running. The above scenario is just an example, your actual phantom loads and total electronics use may be more or less depending on the amount of electronics in your home and how often they are used. If you have more than one of any device, multiply the monthly or yearly totals by the amount of your devices to get your totals.

¹Costs based on an average rate of 9 cents per kilowatt-hour



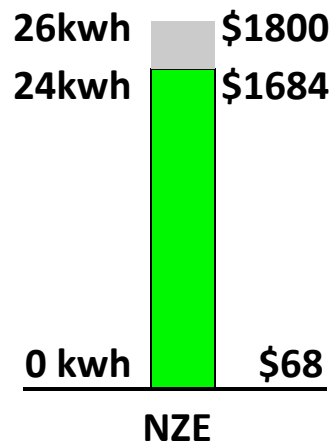
Plug Loads and Phantom Loads

Here's what we had in the example case:

- DVD - 1w
- Stereo - 8w
- Phone - 2w
- Computer 8w
- Modem 5w
- Printer 6w
- TV 5w

Subtotal = 35w x 24hrs = 840w x 365days = 306kwh (1kwh/day) = \$58

In order to avoid these loads, we used a power strip at the entertainment center and another at the office computer. The auto-off power strip is used at the office.



Lighting

Lighting is essential to our living and working environments. Depending on how much light comes in from windows and what time of year it is, lights can be on 8hrs a day. For our example, we'll assume some daylighting and use 4hrs a day.



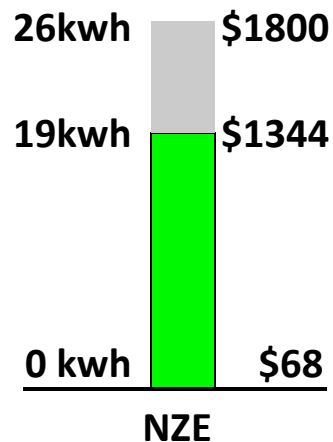
- Incandescent – $100\text{w} \times 4\text{hrs} \times 365\text{days} = 146\text{kwh/year} \times \$0.19 = \$28$
- CFL – Fluorescent - $23\text{w} \times 4\text{hrs} \times 365\text{days} = 33.6\text{kwh/year} \times \$0.19 = \$6$
- LEDs - $14\text{w} \times 4\text{hrs} \times 365\text{days} = 20.4\text{kwh/year} \times \$0.19 = \$3.88$

That's either \$24 or \$2.12 savings per year, depending on bulb type.

LED 100w equivalent bulb is \$4.57. So, the LED will pay back in 2 years.

For our example house, we have about 50 lightbulbs and let's assume 10 of those are still incandescent. So that saves us:

- 1788 kwh (or 5 kwh per day)
- \$340 /year
- Total bulb cost: \$228



Lighting – Exterior Lights

Similar to interior lighting, exterior lighting use can be dependent on time of the year. During the winter, it is not uncommon to see folks turn on exterior lights when they leave in the morning and then leave them on for when they come home at night (10-12hrs).

- Incandescent – $100\text{w} \times 12\text{hrs} \times 365\text{days} = 438\text{kwh/year} \times \$0.19 = \$83$
- CFL – Fluorescent - $23\text{w} \times 12\text{hrs} \times 365\text{days} = 100\text{kwh/year} \times \$0.19 = \$19$
- LEDs - $14\text{w} \times 12\text{hrs} \times 365\text{days} = 61\text{kwh/year} \times \$0.19 = \$12$

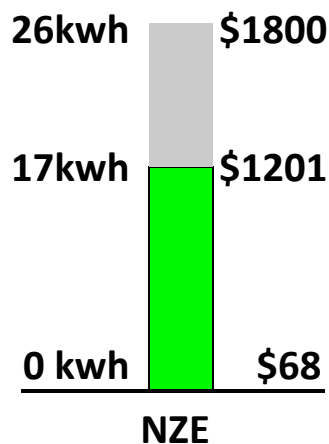
That's either \$64 or \$6 savings per year, depending on bulb type.

If we use a photocell to turn the light off when there is enough daylight:

- LED w/ Photocell - $14\text{w} \times 6\text{hrs} \times 365\text{days} = 30\text{kwh/year} \times \$0.19 = \$6$

For our example, we have about 2 lights on photocells. So that saves us:

- 754 kwh (or 2 kwh per day)
- \$143 /year
- Total bulb/photocell cost: \$20

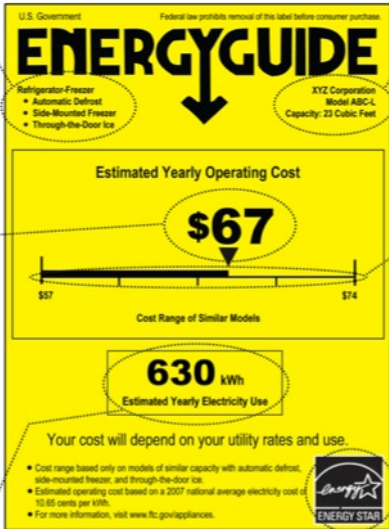




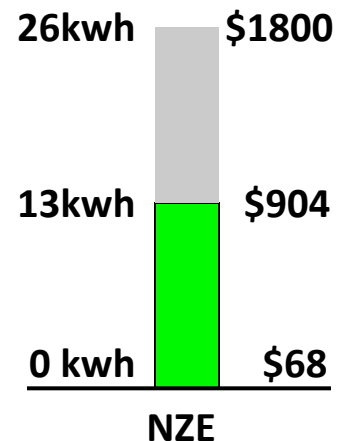
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Appliances

Energy Star provides ratings for many household appliances. They are available in viewable spreadsheets comparing similar size and types. They are typically rated with an estimated average annual usage.



| Appliance | Average | E-Star | Savings | \$/Year |
|------------------|---------|--------|---------|--------------|
| • Refrigerator | 1000kwh | 725kwh | 275kwh | \$52 |
| • Freezer | 329kwh | 218kwh | 111kwh | \$21 |
| • Dishwasher | 833kwh | 315kwh | 518kwh | \$98 |
| • Washer | 590kwh | 95kwh | 495kwh | \$94 |
| • Dryer | 769kwh | 607kwh | 162kwh | \$31 |
| Subtotal=1561kwh | | | | \$297 |
| | | | | (4.2kwh/day) |



Appliances that are not Energy Star rated:

- Microwave (700-1500w)
- Oven/Range (oven typically 4000w)
 - Induction 2,800w, 84%
 - Elect Smooth Top 2,500w, 74%
 - Elect Coils 2,000w, 55%

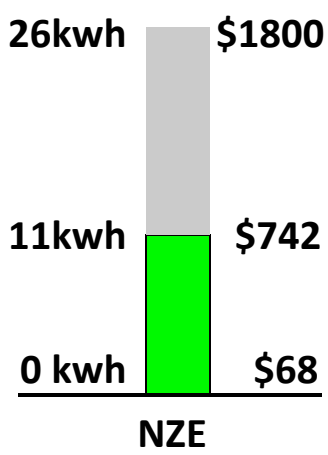


Other Energy Star Items

Energy Star provides ratings for a number of other household items and equipment. Many of these are also tested for low phantom load use.



| <u>Appliance</u> | <u>Average</u> | <u>E-Star</u> | <u>Savings</u> | <u>\$/Year</u> |
|-------------------|----------------|---------------|----------------|----------------|
| •Humidifiers | 125kwh | 70kwh | 55kwh | \$11 |
| •Air Cleaners | 408kwh | 183kwh | 225kwh | \$43 |
| •TVs | 150kwh | 38kwh | 112kwh | \$22 |
| •Audio/Video | 164kwh | 24kwh | 140kwh | \$27 |
| •Telephones | 131kwh | 1kwh | 130kwh | \$25 |
| •Fans | 120kwh | 87kwh | 33kwh | \$6 |
| •Computer | 150kwh | 72kwh | 78kwh | \$15 |
| •Monitor | 75kwh | 20kwh | 55kwh | \$11 |
| •UPS/Backup | 50kwh | 25kwh | <u>25kwh</u> | <u>\$5</u> |
| Subtotal = 853kwh | | | | \$162 |
| | | | | (2.3kwh/day) |

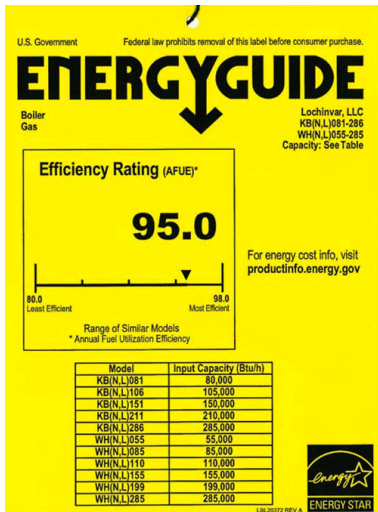




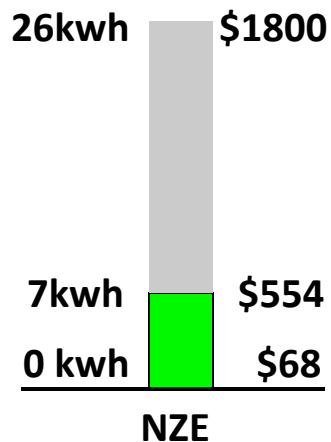
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Heating and Hot Water

Typically in our area, this equipment is natural gas or fuel-oil fired. But most of the heating appliances still have electrical fans, pumps or controls associated with them. Newer equipment should have lower electrical use, but it's good to check on it if you're replacing a heater.



| Equipment | Average | E-Star | Savings | \$/Year |
|-------------------|---------|---------|---------|-------------------|
| •Furnace | 2285kwh | 1371kwh | 914kwh | \$174 |
| •Boiler | 1705kwh | 1021kwh | 684kwh | \$130 (or) |
| •Unit Heater | 209kwh | 156kwh | 52kwh | \$10 (turned off) |
| •Hot Water Heater | NA | | | |
| •Bathroom Fans | 25kwh | 5kwh | 20kwh | \$4 |
| Subtotal = | | | | 986kwh \$188 |
| | | | | (3kwh per day) |

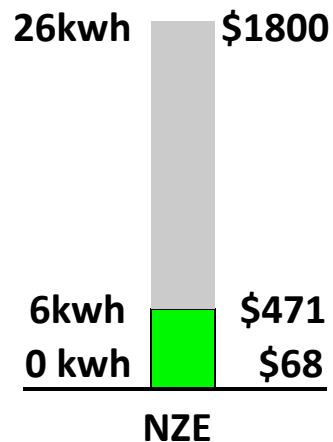


Phantom Loads - Advanced

Similar to the Plug Loads and Phantom Loads that we talked about earlier, there are a number of items in our houses that are “always on”. These items are more involved to modify to eliminate their phantom load.



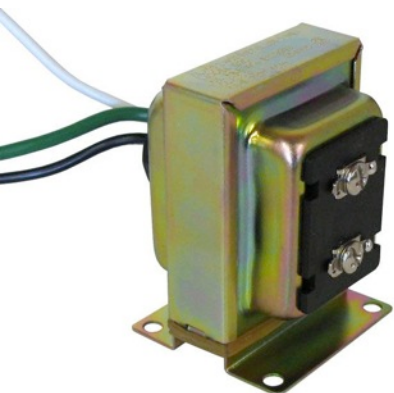
- **GFCI Outlets (and Weatherproof receptacles) – 1w-5w draw**
 - $1\text{w} \times 24 \text{ hrs} \times 365 \text{ days} = 8760 \text{ wh}$ or 8.7 kwh per year
 - $5\text{w} \times 24 \text{ hrs} \times 365 \text{ days} = 42,800 \text{ wh}$ or 42.8 kwh per year
 - \$1.66 - \$8.32 per year
 - Assuming 10 outlets, that’s 87-428kwh and \$16 - \$83 per year (about 1kwh per day)



- **What’s a good solution?**
 - GFCI’s are important as a protection device in wet locations
 - Limit # of locations
 - GFCI Breaker still has a constant draw
 - Put GFCI Outlets on a switch, LED switch to show it’s on

Phantom Loads - Advanced

Similar to the Plug Loads and Phantom Loads that we talked about earlier, there are a number of items in our houses that are “always on”. These items are more involved to modify to eliminate their phantom load.



- **Doorbell – 7w**

- Doorbells are low voltage and use a transformer to change from AC to DC. The transformer is always on.
- $7\text{w} \times 24 \text{ hrs} \times 365 \text{ days} = 61,320 \text{ wh}$ or 61 kwh per year
- \$11.65 per year

- **Garage Door – 5-7w**

- Garage Doors have remote controls, right?
- In order to engage the remote, the unit is always on.

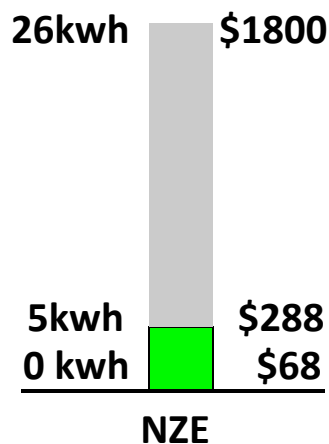
- **HRV Controls – 5-7w**

- The low voltage control panel has a constant draw.

$7\text{w} \times 24 \text{ hrs} \times 365 \text{ days} = 61,320 \text{ wh}$ or 61 kwh per year

\$11.65 per year

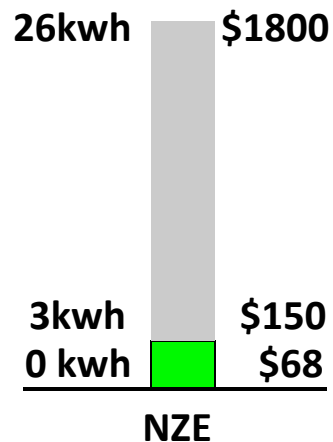
If you have all 3 of these, that's \$35 or 183kwh/year. (0.5kwh/day)



Phantom Loads - Advanced

Similar to the Plug Loads and Phantom Loads that we talked about earlier, there are a number of items in our houses that are “always on”. These items are more involved to modify to eliminate their phantom load.

- Dimmer Switches – many of these cool looking devices have a phantom load of 1w plus. Imagine all your switches = 219kwh, \$42/year.
- Occupancy Sensors
- Heat Exchanger Water Heaters
- Geothermal Heat Pumps

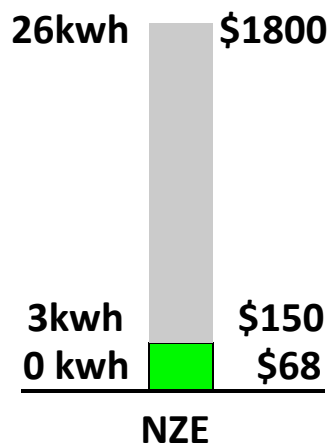


Daylighting and passive strategies also play a big part. During the summer and shoulder seasons, the electrical use drops another 2kwh per day. This is mostly due to natural daylighting being used rather than the lighting.

Lastly... Renewables

Solar Photovoltaic

- Type of system
 - Fixed, building mounted
 - Tracking Array
- How big a system? (kw)
 - How many kwh per year are you using?
 - What's your budget?
- What area is available for solar panels?
 - Building or ground mount
 - Is it partially shaded?



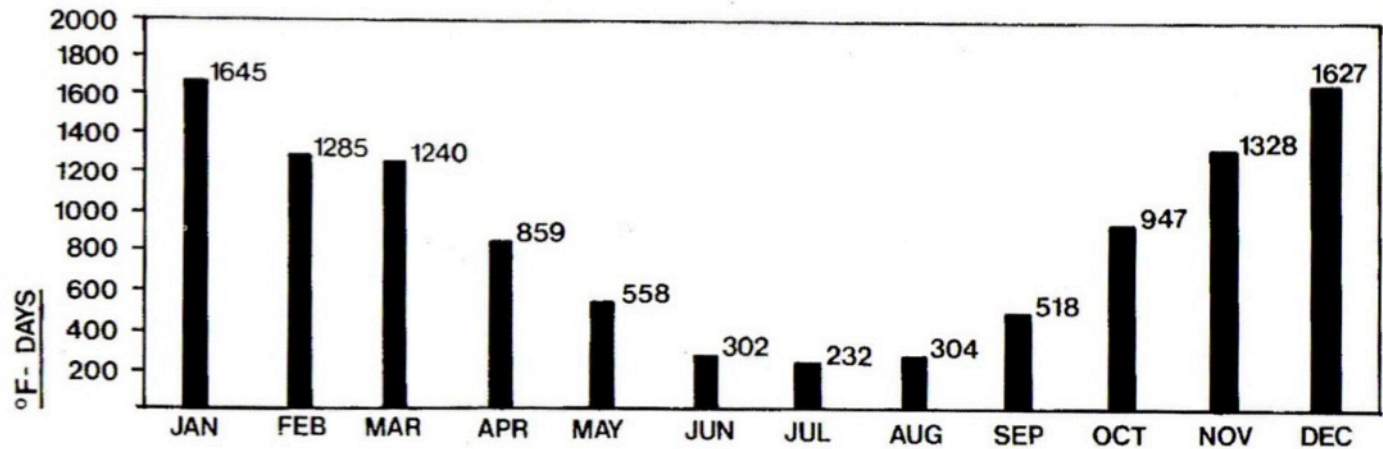
See presentations at acat.org

See Electric Storage – Eayrs 2011 presentation at acat.org



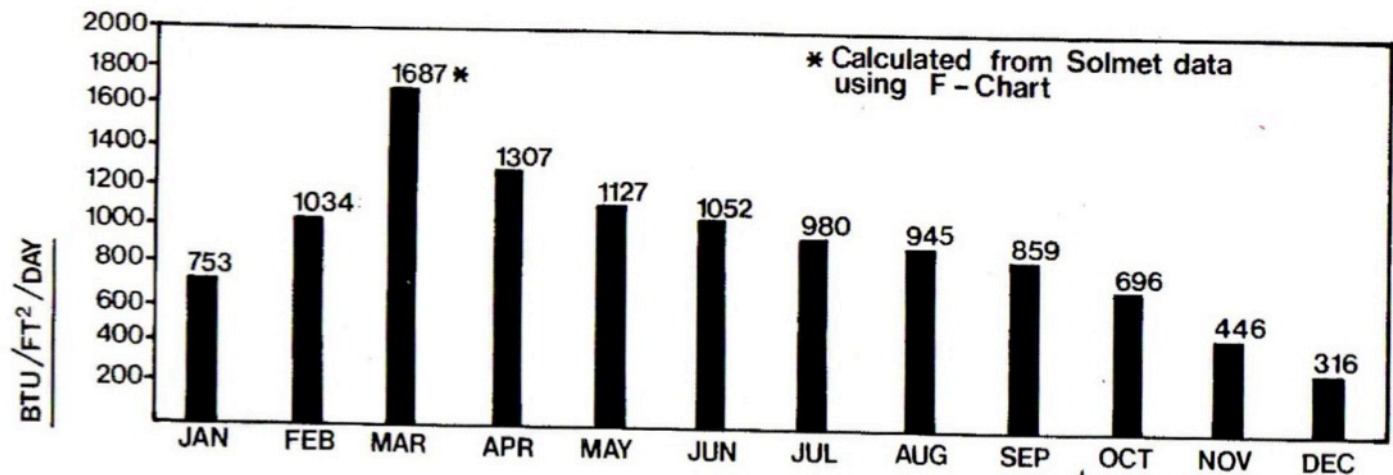
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PASSIVE SOLAR vs. HEATING DEGREE DAYS



Average Monthly Heating Degree Days

Matanuska, Alaska



Average Solar Radiation on a Vertical South Facing Surface


Matanuska, Alaska



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Solar – PV Watts2

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



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[Grid Data \(Version 2\) Calculator](#)


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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](#) .

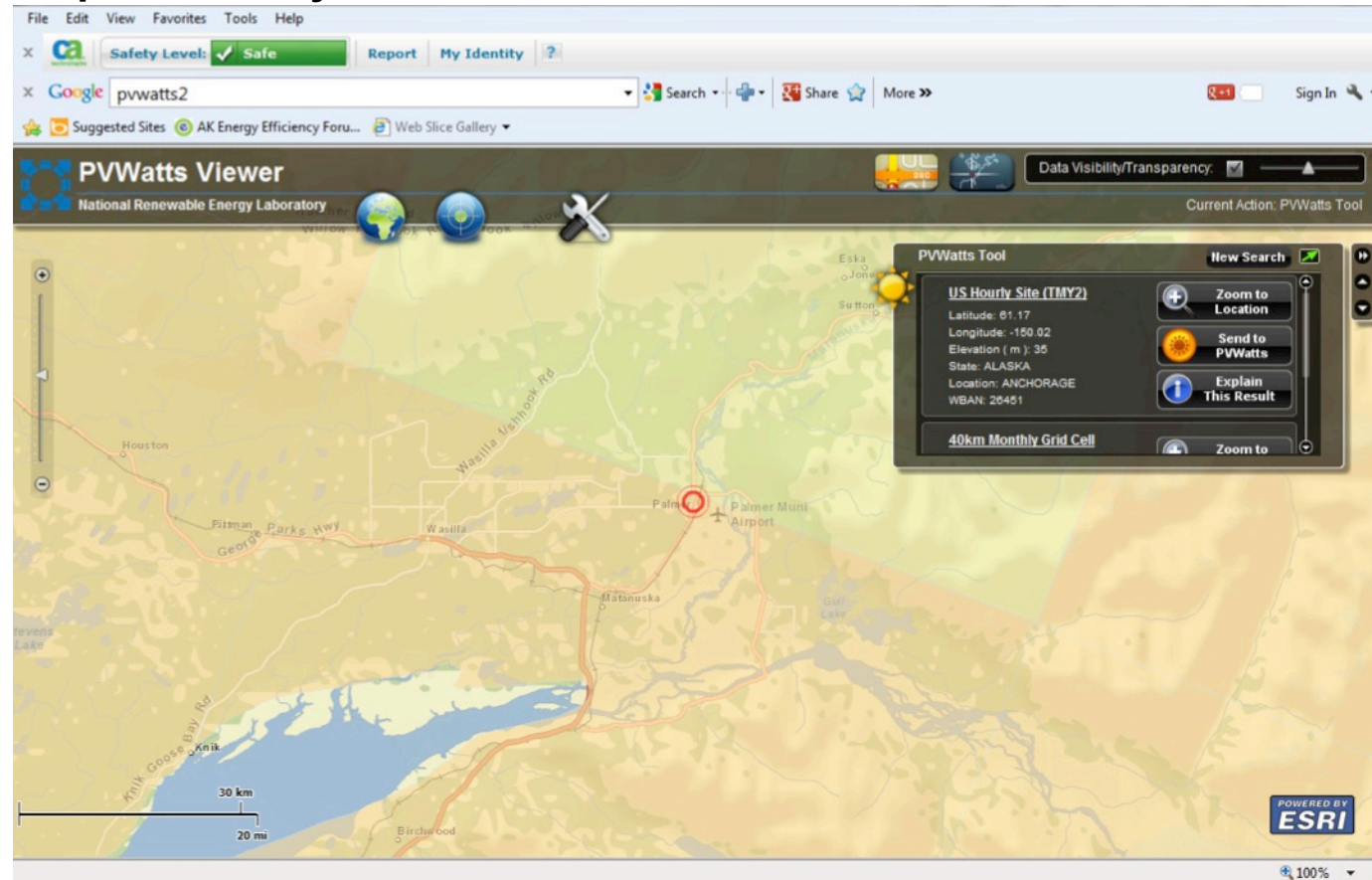
To use the PVWatts Grid Data (Version 2) calculator, see:

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

See nrel.gov – PV Watts 2

Solar – PV Watts2

Step 2. Locate your site...



See nrel.gov – PV Watts 2

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



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

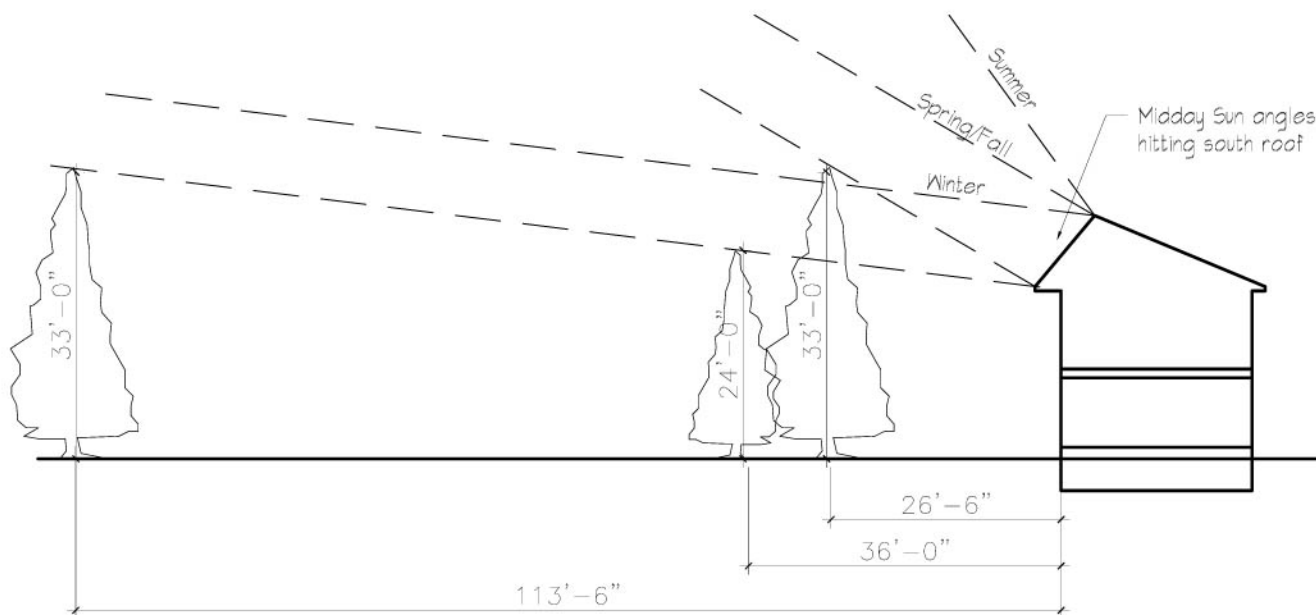
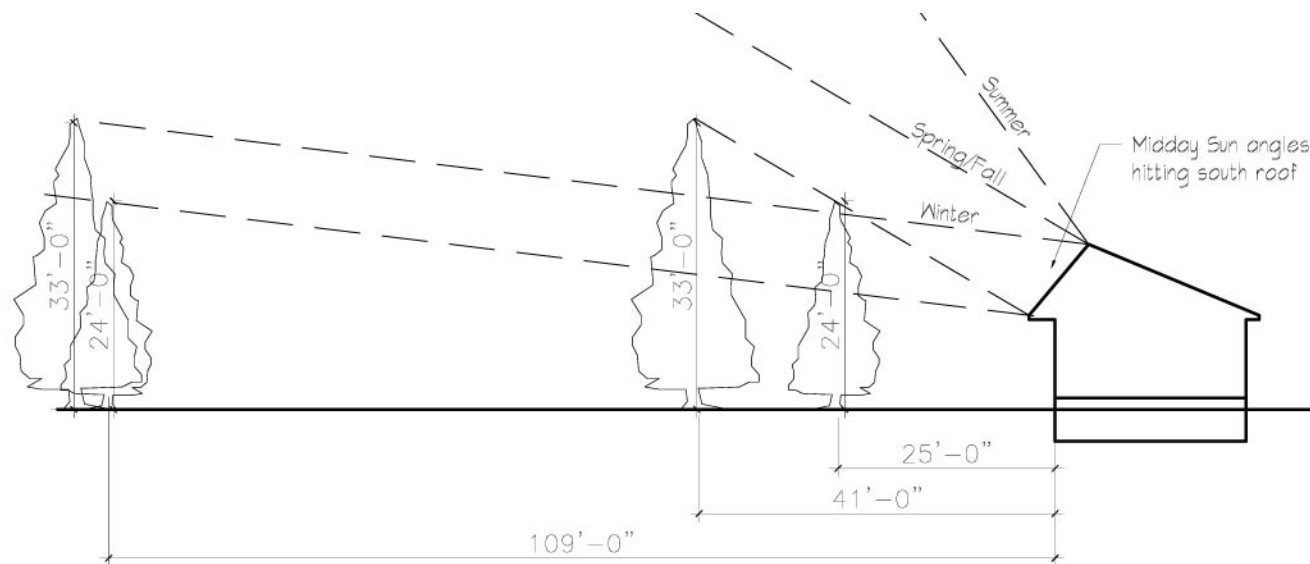
| Station Identification | |
|--------------------------|------------|
| City: | Anchorage |
| State: | Alaska |
| Latitude: | 61.17° N |
| Longitude: | 150.02° W |
| Elevation: | 35 m |
| PV System Specifications | |
| DC Rating: | 4.0 kW |
| DC to AC Derate Factor: | 0.770 |
| AC Rating: | 3.1 kW |
| 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 |

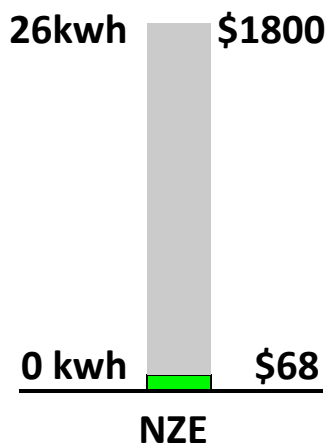


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Solar PV seasonal site angles



Solar PV Array



My Solar PV System

- 13 x 280w panels = 3655watt
- Power Optimizers to control voltage during shading
- Central Inverter

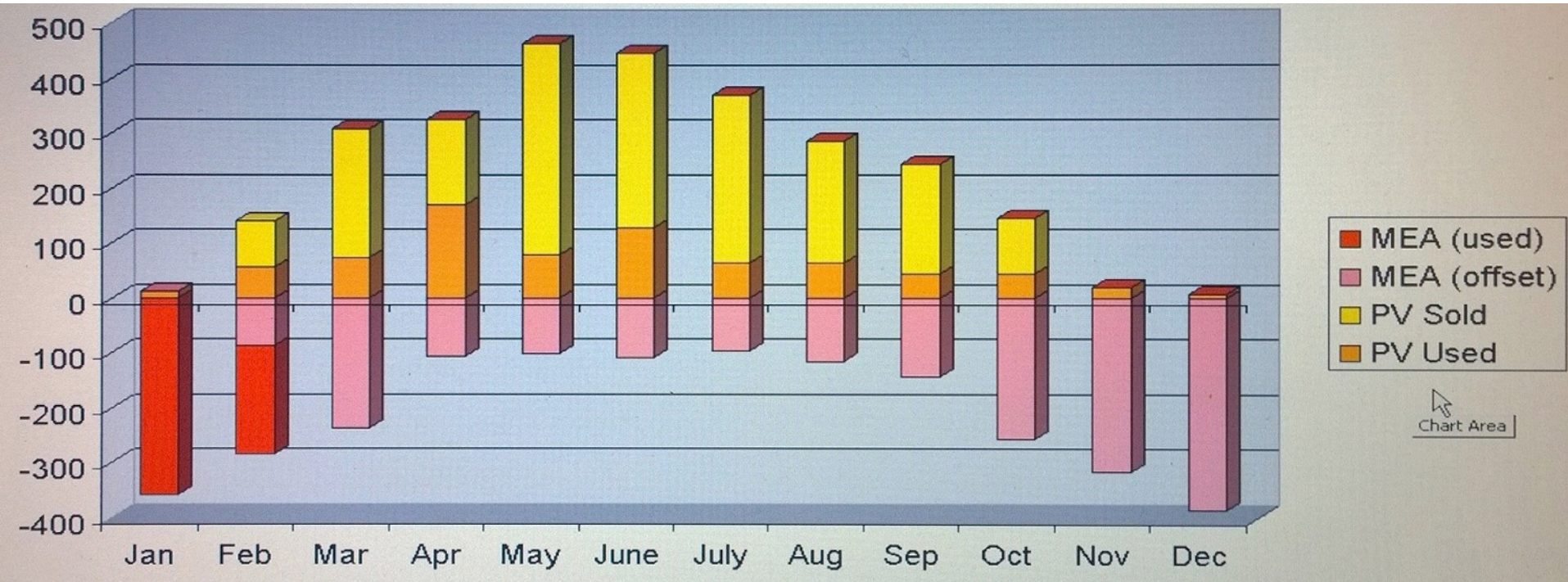
Results - what I am seeing with my system (and other similar systems)

- Total Array wattage = about # of kwh per year
- Payback 12-15 years, DIY with Tax Credit
- 5% (simple) Return on Investment
- NZE for electrical only for year?
- PV Watts calcs 50 degrees as most output



ALASKA CENTER FOR
APPROPRIATE TECHNOLOGY

Solar PV Array



At the end of the year, any remaining additional production is paid out for a zero balance.

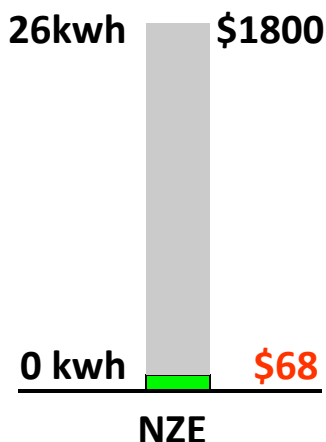
NET ZERO ELECTRICAL METERING

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 = \$0.0825 / kwh
- Power purchased from grid = \$0.11455 / kwh plus tariffs
\$0.191174 / 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 more than energy than you use.

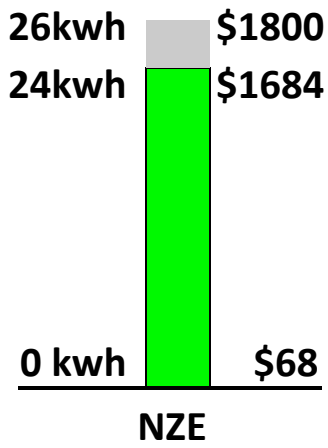
FEES AND TARIFFS – utility providers have fees and tariffs isolated from actual usage cost. Even if you make as much energy as you use, you will still have a utility bill.



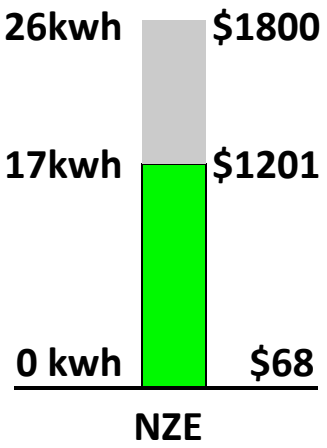
- MEA Monthly fee = \$5.65
- Annually = \$67.80

SUMMARY – IN REVIEW

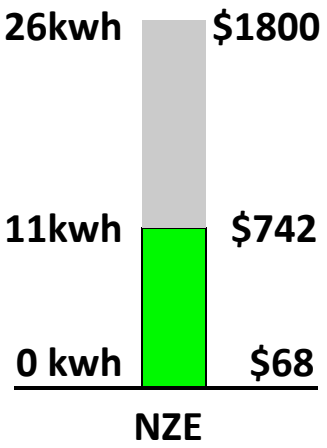
Step 1: Phantom Loads



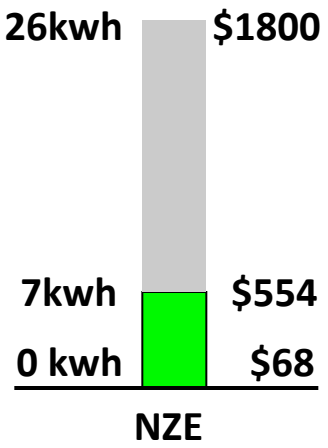
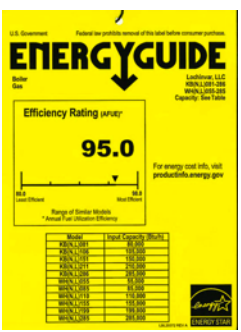
Step 2: Lighting



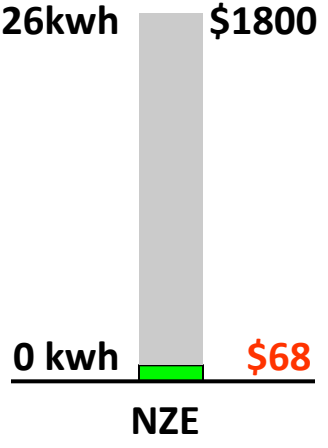
Step 3: Appliances



Step 4: HVAC Equipment



Step 5: Solar Panels





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

