SOLAR TECHNOLOGY

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SOLAR TECHNOLOGY

Photovoltaics

Funding Options

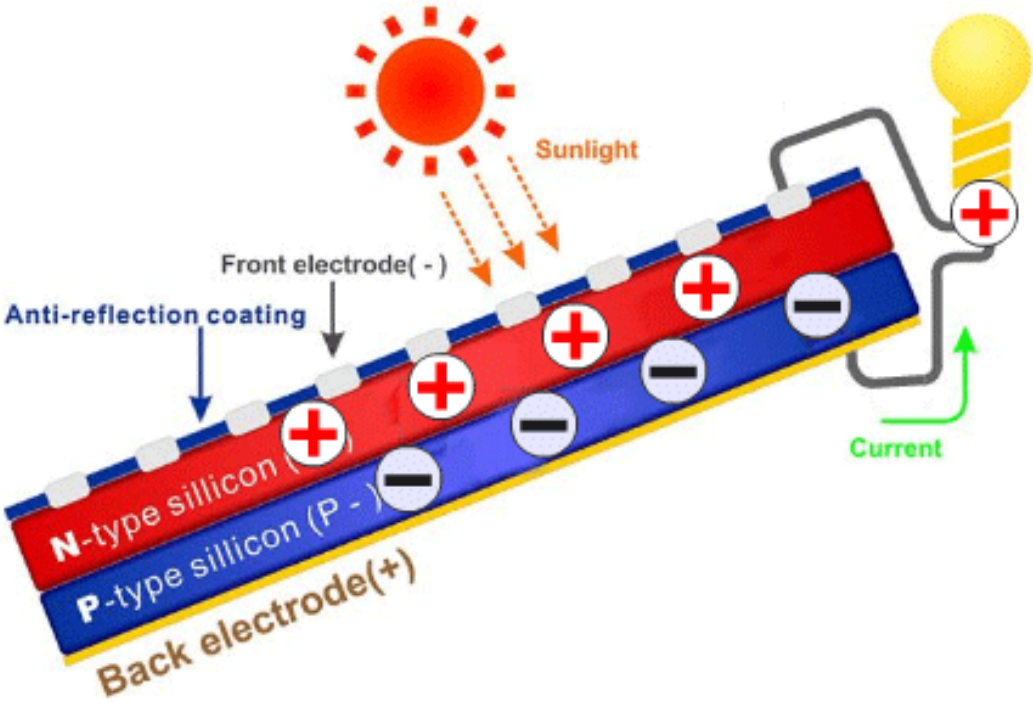
Solar Thermal

Photovoltaics

1. What are they and how do they work?
2. The Solar Resource - Understanding, measuring and using data
3. Site Analysis
4. Types of Systems
5. Mechanical Attachment Options
6. Inverters & Balance of System

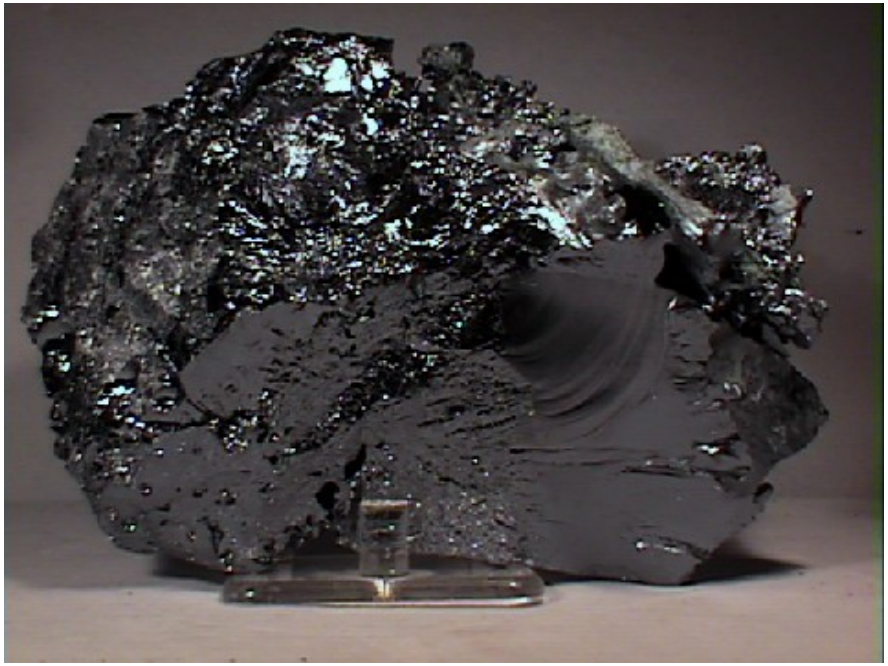
Photovoltaics - What are they and how do they work?

Photovoltaic Effect



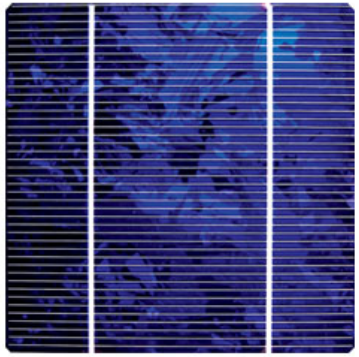
Photovoltaics - What are they and how do they work?

- Modules or panel cells are made of silicon.



Photovoltaics - What are they and how do they work?

Cell

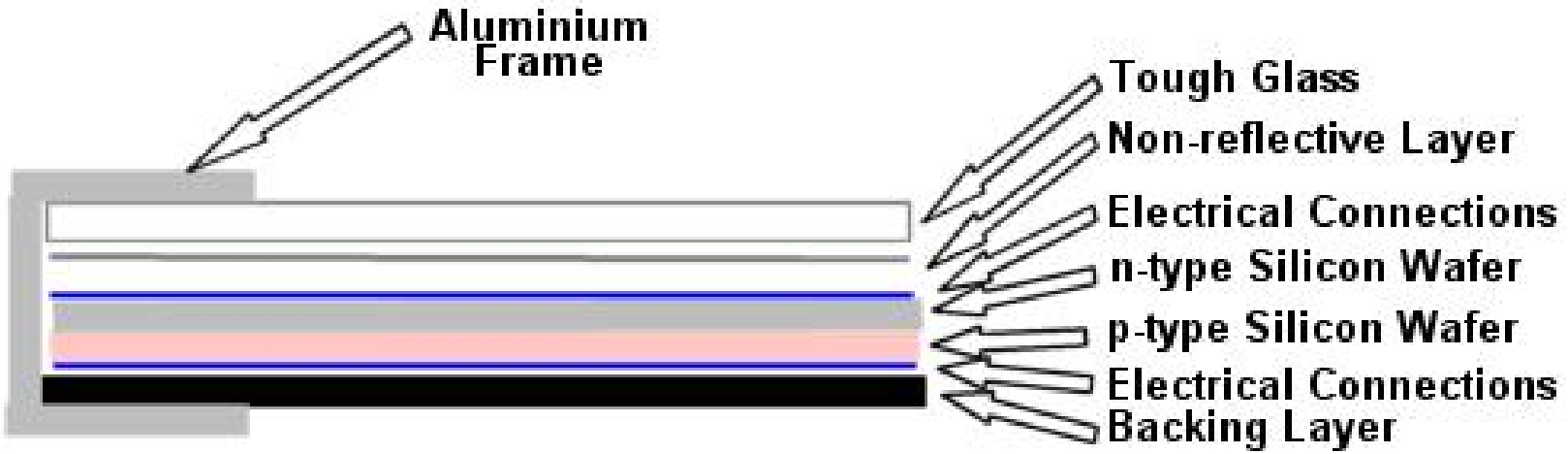


Module

Array

Photovoltaics - What are they and how do they work?

Solar Module Construction



Photovoltaics - What are they and how do they work?

Mono Crystaline

Poly Crystaline

Photovoltaics - What are they and how do they work?

- Mono Crystaline
  - Single silicon cell is grown
  - Individual cells are cut in thin wafers
  - Round wafers are squared off and corners are cut
  - Current efficiency is 14-17%
  - Characteristic diamond shape between cells
  - More expensive than Poly crystaline

Photovoltaics - What are they and how do they work?

- Poly Crystaline
  - Molten silicon is poured into a mold and individual cells are cut from ingot
  - Current efficiency 11-14%
  - Cheaper to manufacturer than Mono crystaline

Photovoltaics - What are they and how do they work?

- Doesn’t matter what it is made of 200W output is 200W.
- Modules degrade about 1%/year
- Output varies +/- 5%
- As temperature decreases output increases
- Every panel has a “sweet spot” where it produces the most electricity

Photovoltaics - What are they and how do they work?

Warranty

Manufacturer's

- Typical 5-10 year warranty on manufacturer's defects and workmanship

Power

- Typically a 90% 10 year limited & 80% 25 year limited

Example: A 200W module

After 10 years 90% of 200W = 180W

After 25 years 80% of 200W = 160W

SOLAR ENERGY

The Solar Resource - Understanding, measuring and using data

The Solar Resource - Understanding, measuring and using data

Effects on PV Output

- Location on the Earth
- Atmospheric Conditions
- Site Specific Conditions
- RETScreen
- Earth's Energy Budget

The Solar Resource - Understanding, measuring and using data

Location on the Earth

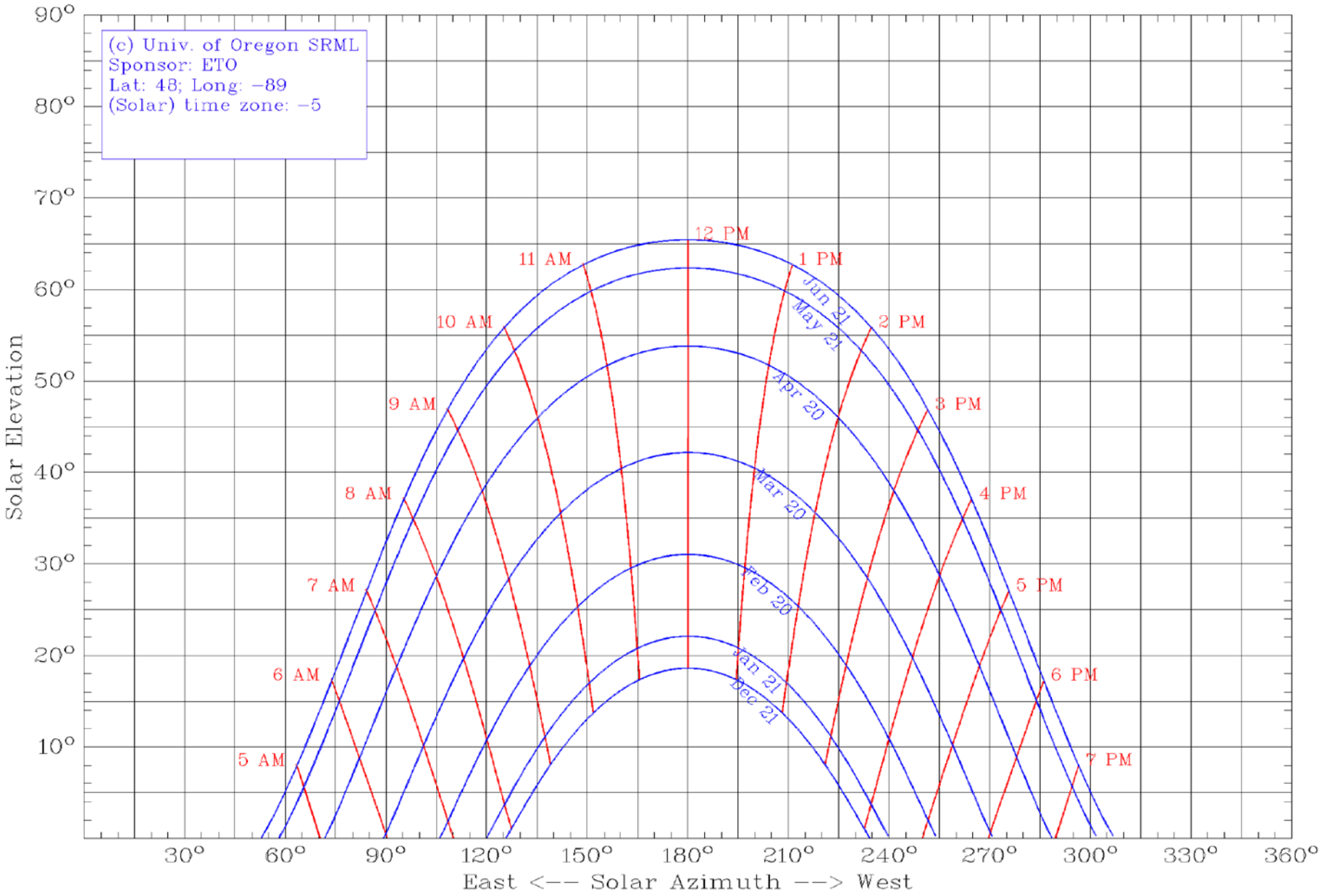
The sun has a specific path in the sky for a location on the earth!

The Solar Resource - Understanding, measuring and using data

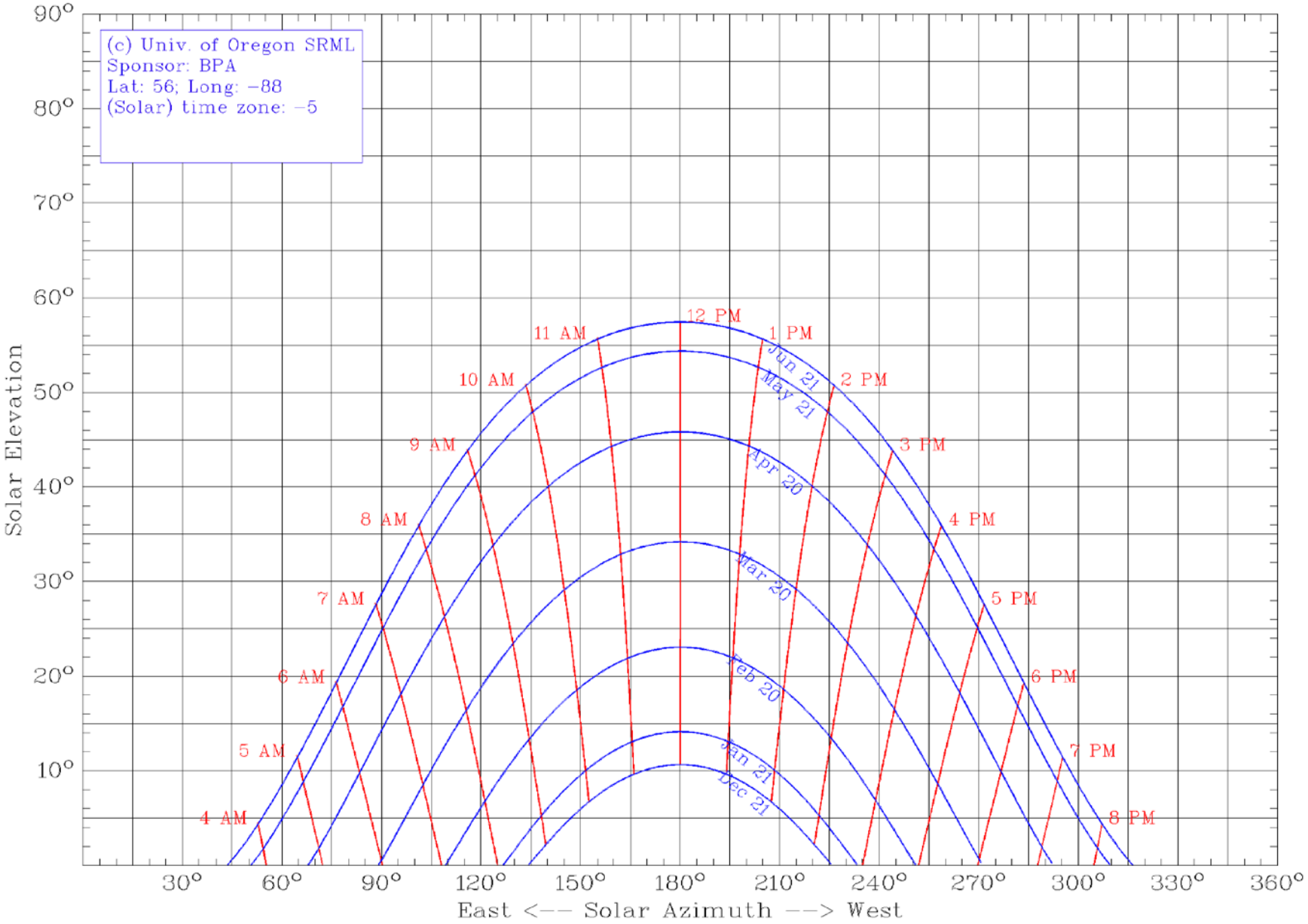
Sun path chart picture

http://solardat.uoregon.edu/SunChartProgram.html

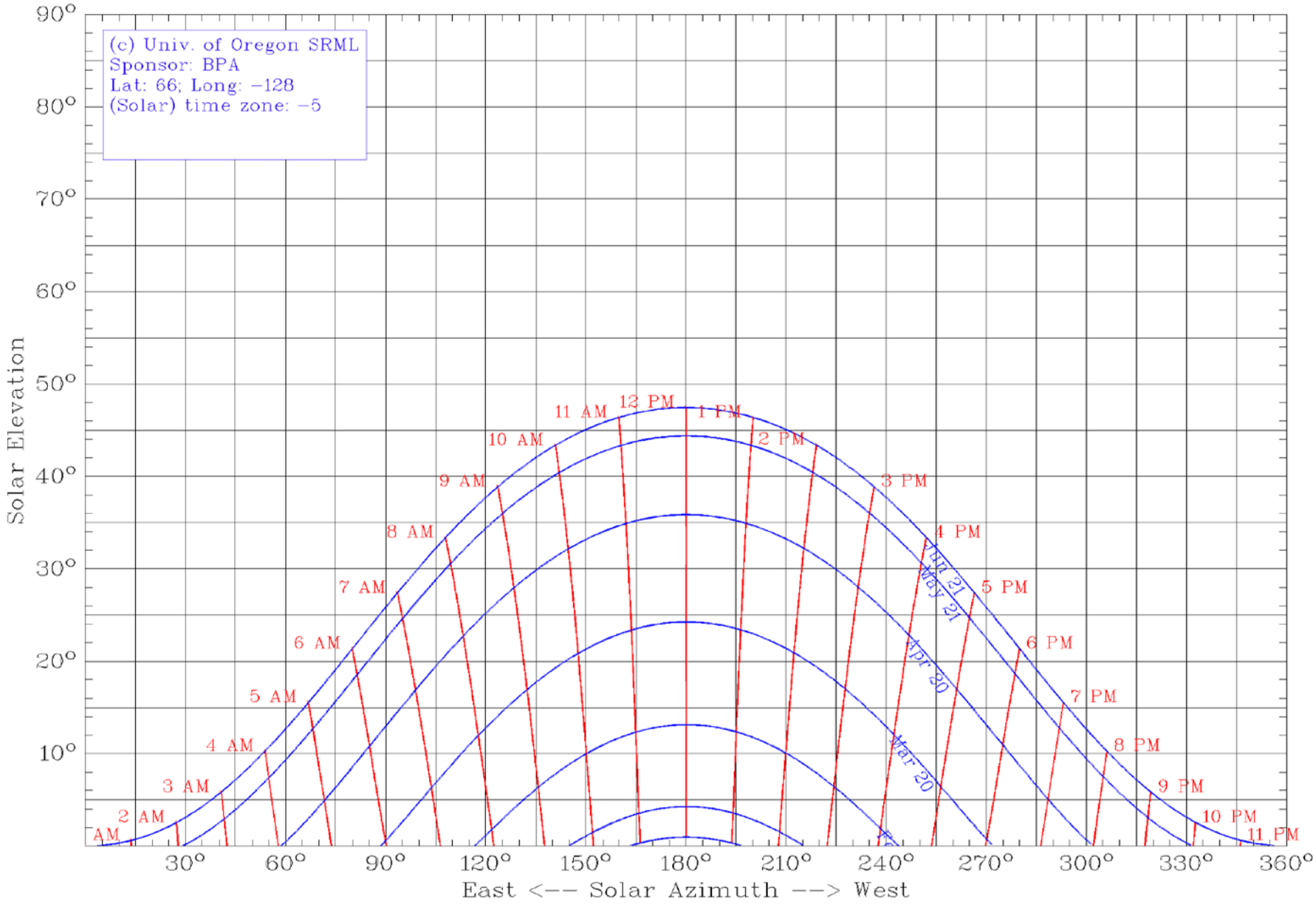
Thunder Bay, Ontario



Fort Severn First Nation, Ontario



Fort Good Hope First Nation, Yukon



The Solar Resource - Understanding, measuring and using data

Location on the Earth

Latitude greatly affects the amount of energy received from the sun.

The further north you go summer days become longer but the sun stays lower on the horizon.

Hours of sunlight in the winter are much less the further north you go. With the sun even lower on the horizon.

The Solar Resource - Understanding, measuring and using data

Location on the Earth

The sun intensity is greatest due south at noon.

This is “SOLAR NOON”

The Solar Resource - Understanding, measuring and using data

Atmospheric Conditions

- Direct Radiation – Water vapour, dust & airborne particles
- Diffuse Radiation – Scattering of sunlight from clouds, pollution and airborne particles
- Air Mass – As the sun gets closer to the horizon the light passes through more atmosphere

The Solar Resource - Understanding, measuring and using data

Site Specific Conditions

- Latitude
- Temperature – As temp. decreases output increases
- Terrain – Shading from trees, buildings and grass.

The Solar Resource - Understanding, measuring and using data

Site Specific Conditions

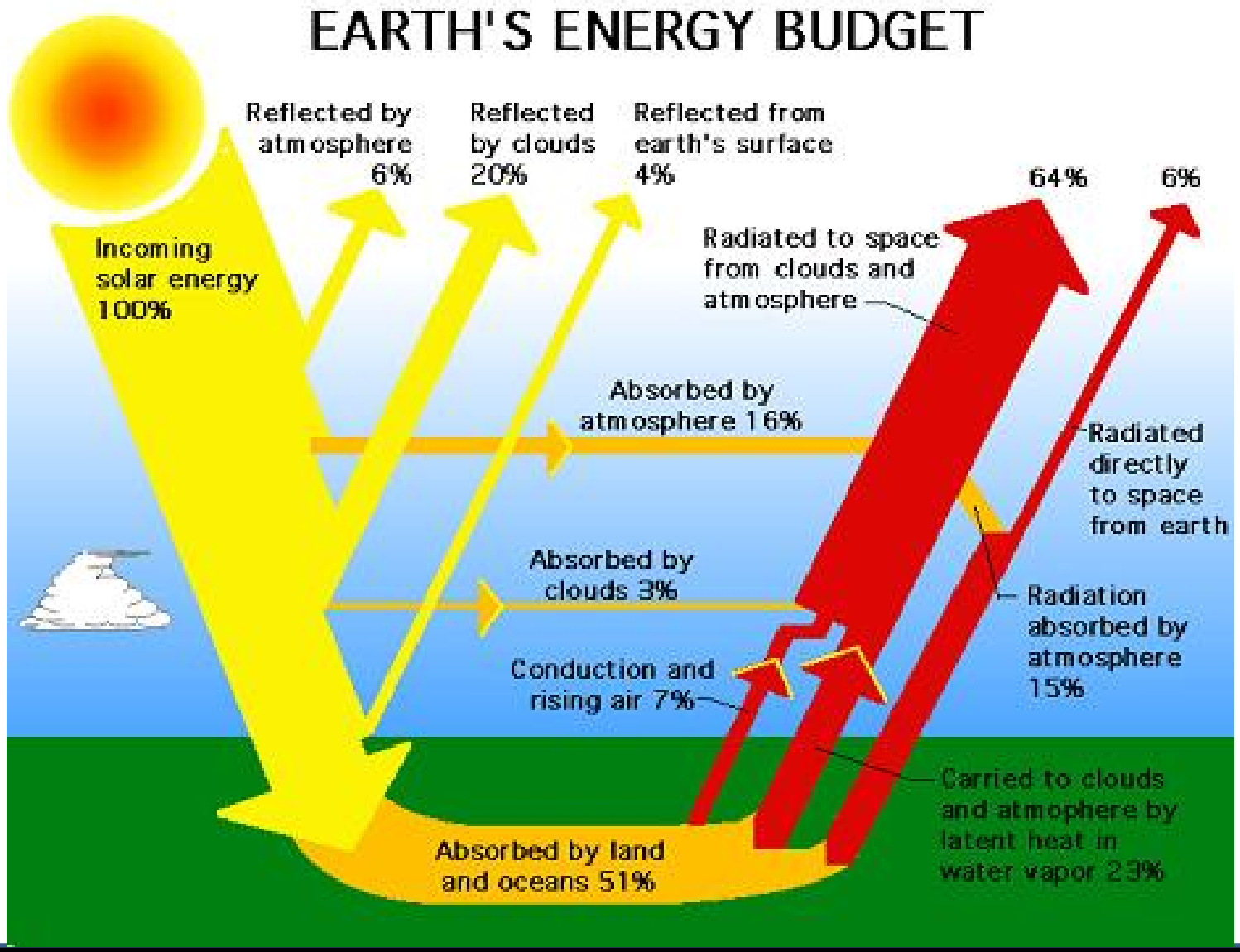
- Latitude
- Temperature – As temp. decreases output increases
- Terrain – Shading from trees, buildings and grass.

The Solar Resource - Understanding, measuring and using data

RETScreen

- Natural Resources Canada (NRCan) software that can produce/provide, environmental information, system parameters and payback period for all types of renewable energy projects.

The Solar Resource - Understanding, measuring and using data



The Solar Resource - Understanding, measuring and using data

Solar Potential

The sun's power received over a given area of a given time is:

INSOLATION

Measured in: $kWh/m^2/day$

The Solar Resource - Understanding, measuring and using data

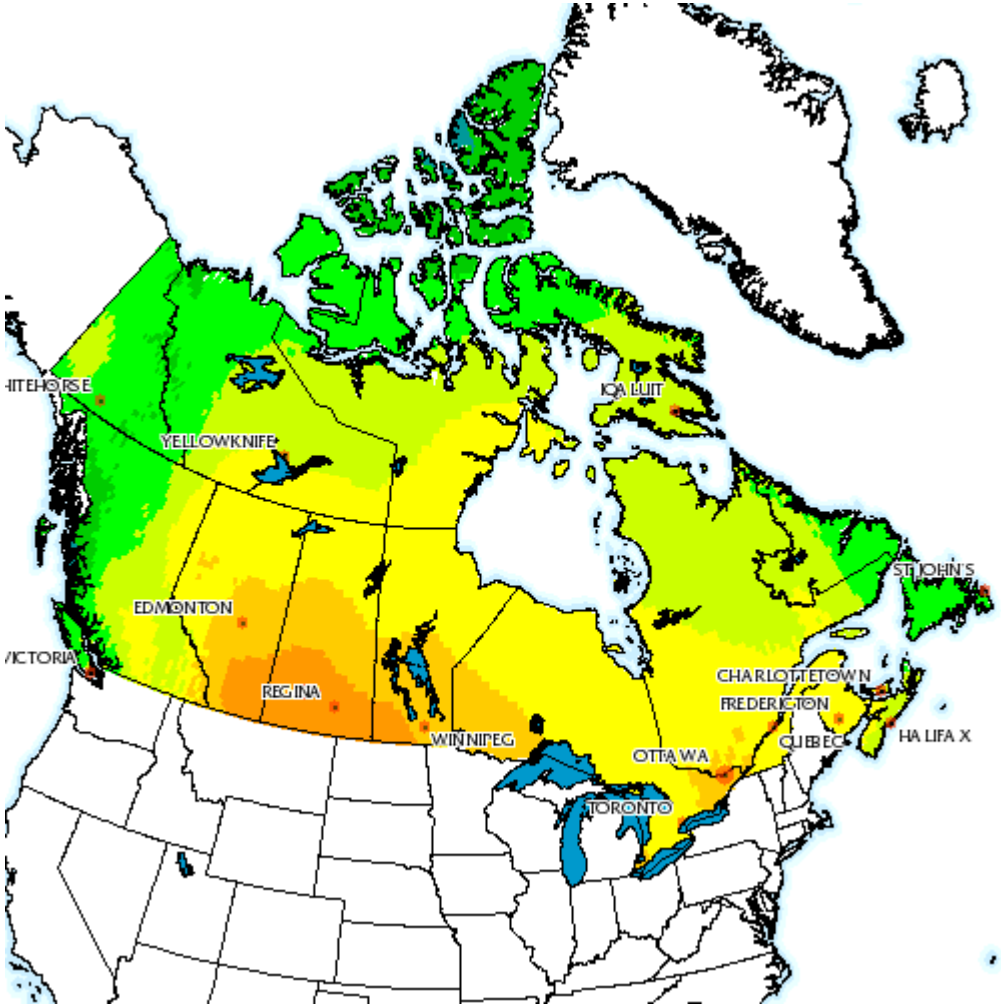
Solar Potential

The sun provides the earth on average 84TW of Power each day!!

That's 84,000,000,000,000W of Power

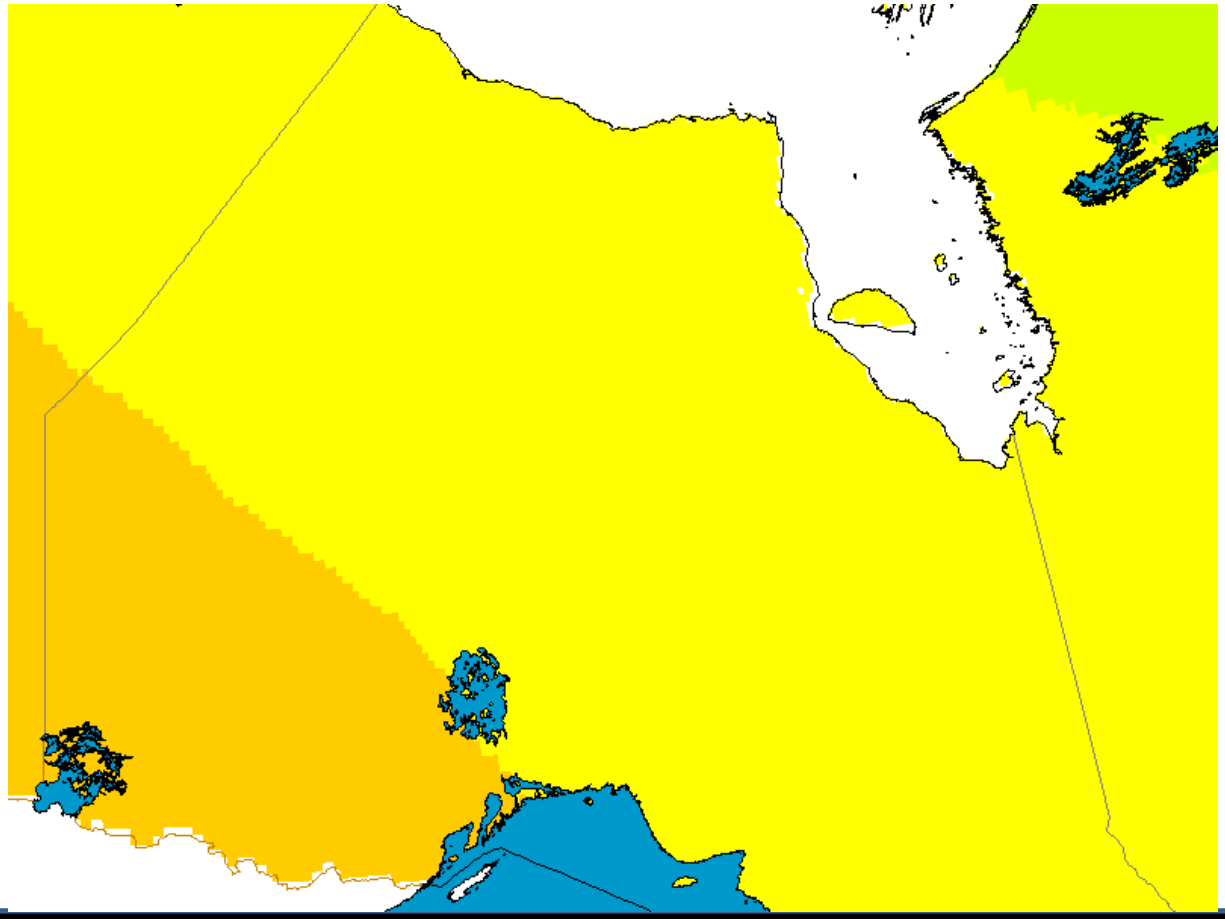
An average home uses 6000W of Power each day that's 14 billion homes.

The Solar Resource - Understanding, measuring and using data



The Solar Resource - Understanding, measuring and using data

Solar Potential



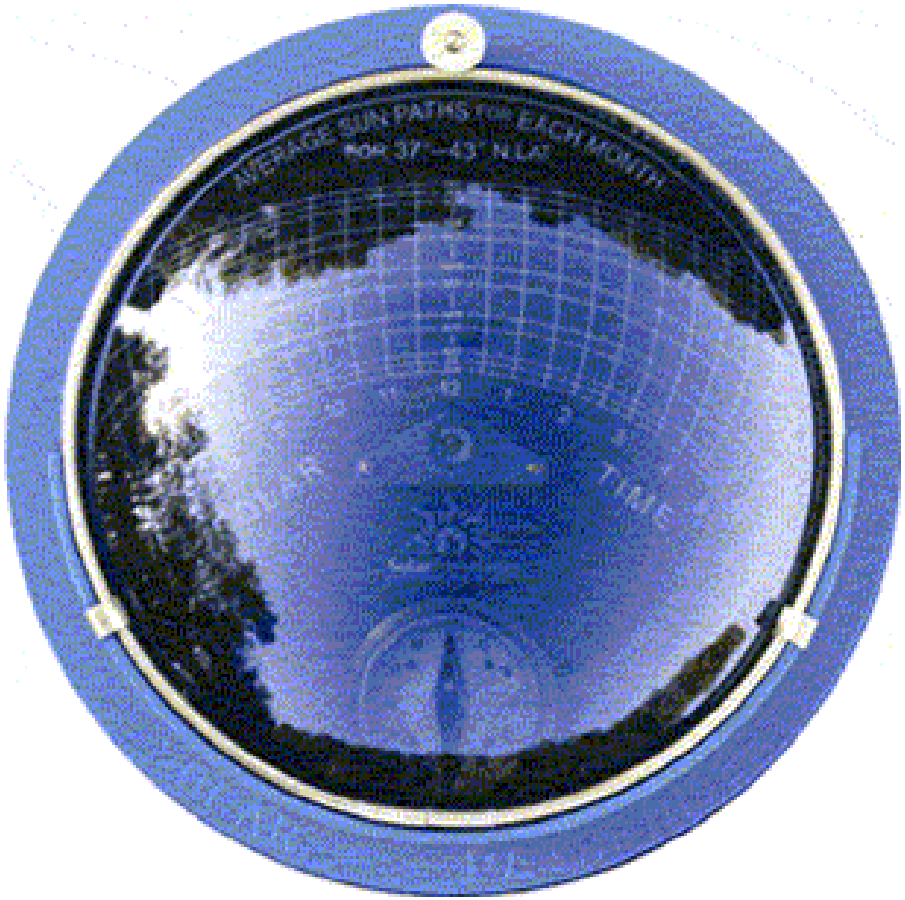
Site Analysis

- Determine EXACT location of the module or array
- Shading analysis
- Can be done for free by a solar company but only if you have a system installed

Site Analysis

Solar pathfinder

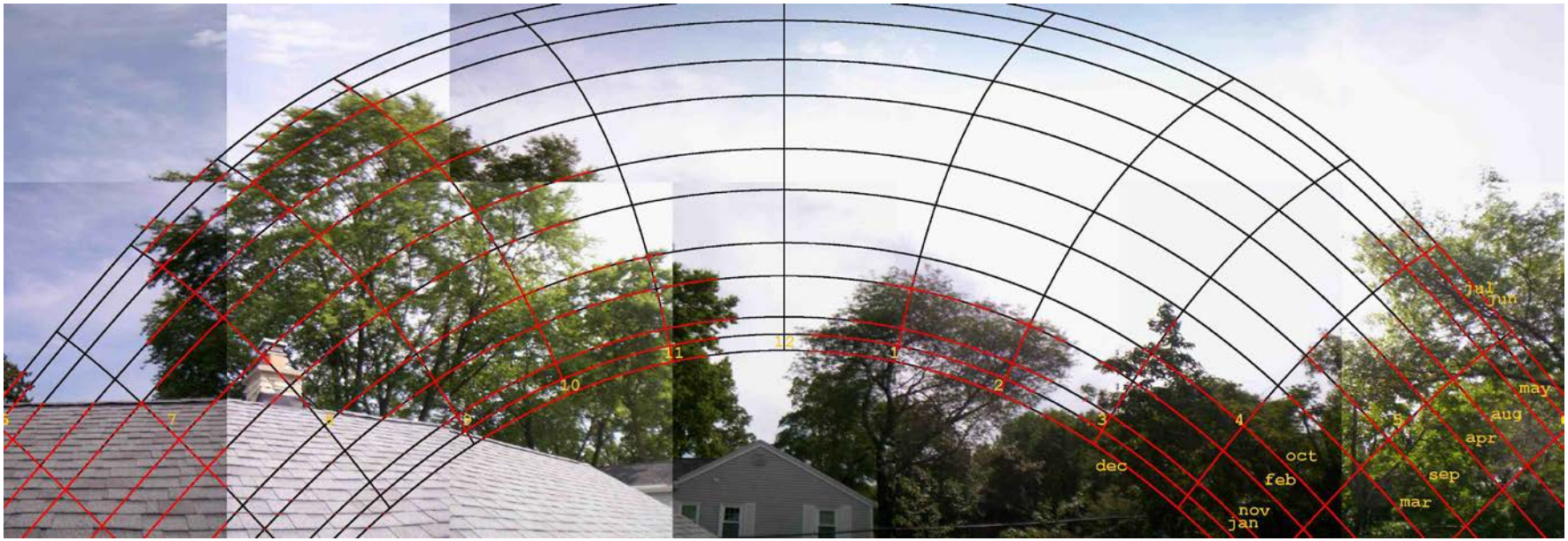
Site Analysis



Site Analysis

Acme Solar Site Evaluation Tool - ASSET

Site Analysis



Site Analysis
Shading

- Remember that trees and grass grow.
- Consider future development for buildings and houses.
- Don’t forget about features on the building such as hips/valleys, chimneys, TV dishes and vent stacks.
- Solar panels need sun to produce electricity so the more shade = less production.
- Chain link fencing casts a shadow too.

Site Analysis
Shading

Site Analysis
Shading

BAD

VERY BAD

DO NOT DO!!!!!

Types of Photovoltaic Systems

Grid Tie

- Connected to the Electrical Grid

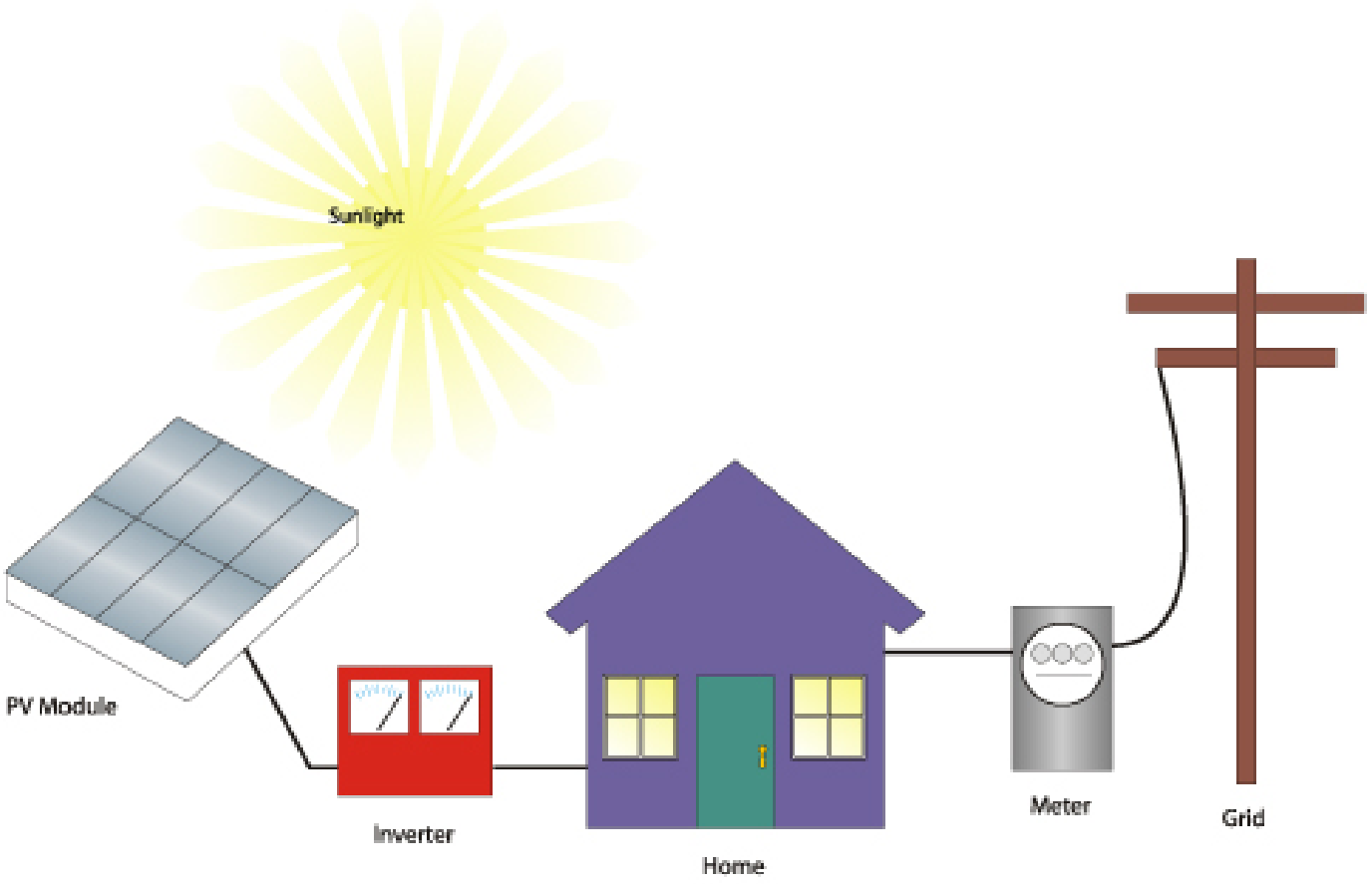
Modules-Inverter-Meter

Off Grid

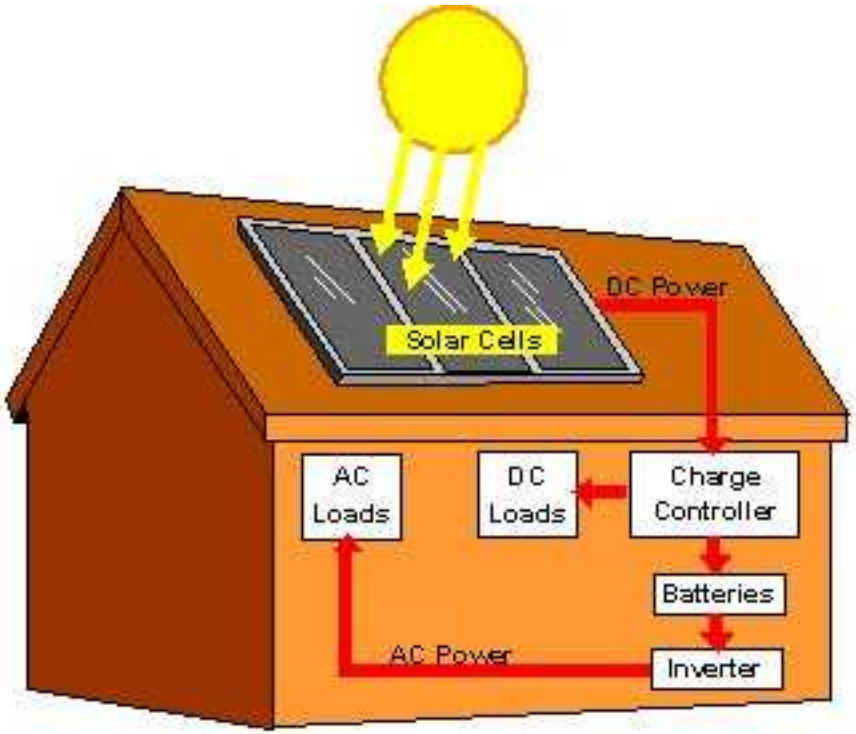
- Not Connected to the Electrical Grid

Modules-Charge Controller-Batteries-Inverter-AC use

Types of Photovoltaic Systems
Grid Tie



Types of Photovoltaic Systems
Off Grid



Mechanical Attachment Options

Roof Mount

Ground Mount

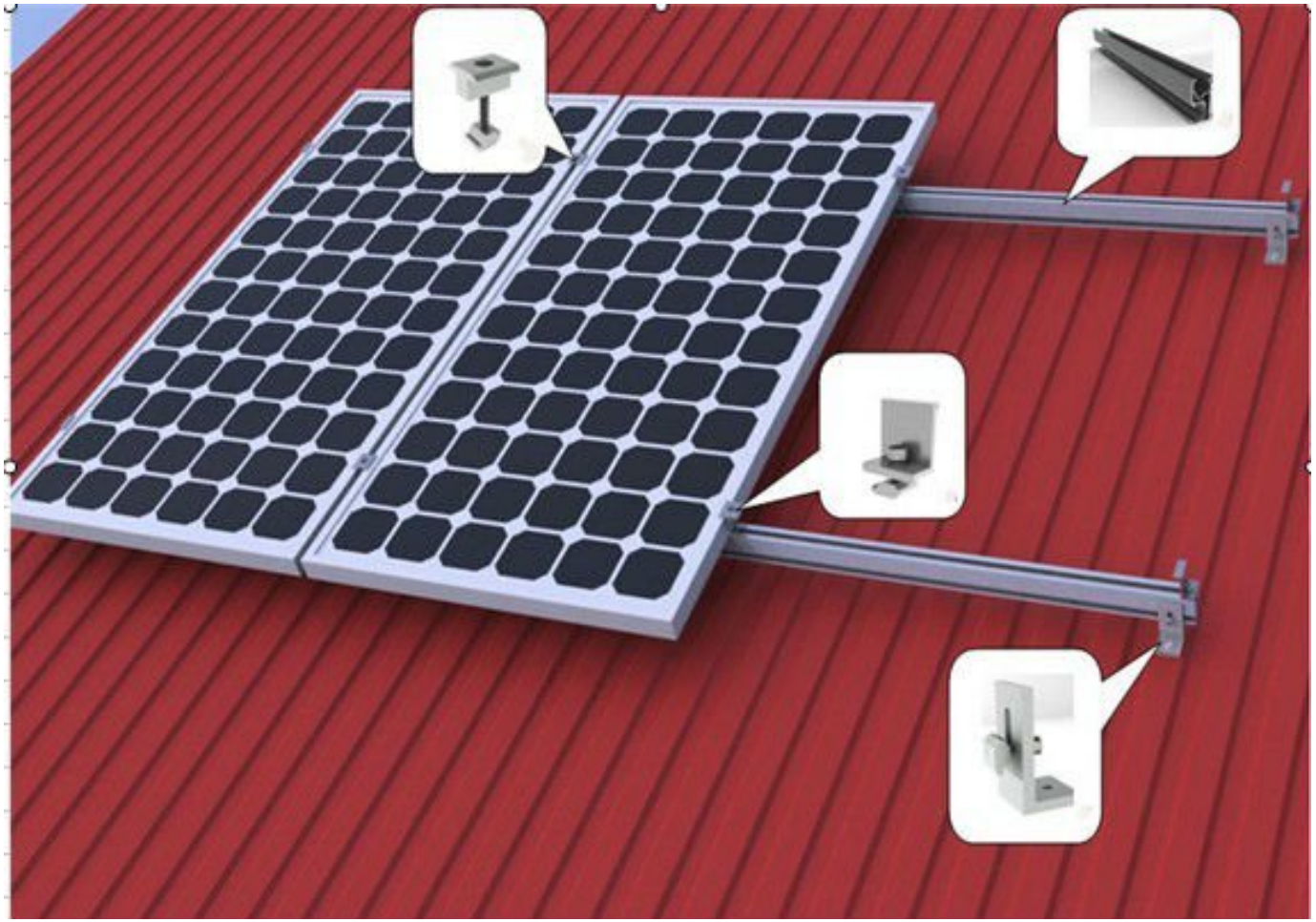
Mechanical Attachment Options
Roof Mount

1. Sloped Roof Mount

2. Flat Roof Mount

Mechanical Attachment Options

Sloped Roof Mount



Mechanical Attachment Options

Sloped Roof Mount

Manufactured in: Ontario

K-Rack System

Mechanical Attachment Options

Flat Roof Mount

Ballast Mount System

- No punctures in the roofing membrane
- Weight is added to rail system to prevent wind uplift

Mechanical Attachment Options

Flat Roof Mount

"Foot" or Standoff Mount System

- Must be integrated at time of construction

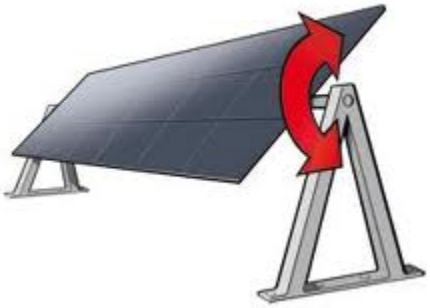
Mechanical Attachment Options

Ground Mount

Rail of Fixed System

Mechanical Attachment Options

Ground Mount



Single Axis Tracker

- Manual or Motorized Operation
- May Increase Output by up to 20%

Mechanical Attachment Options

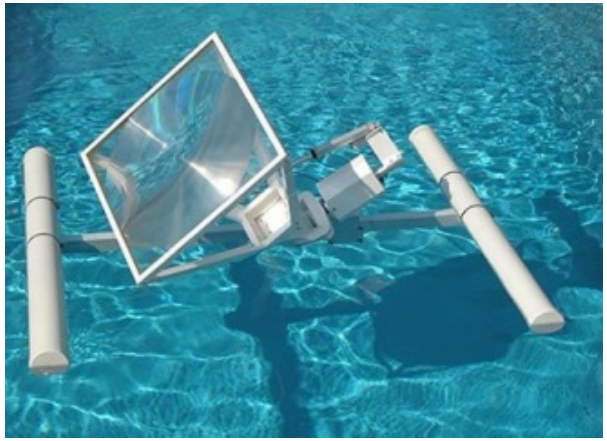
Ground Mount

Dual Axis Tracker

- Motorized computer software or “sun spot”
  - May increase output by 40%
  - Large foundations needed for mast

Mechanical Attachment Options

Car Mount System



Liquid Solar Array

Attachment Options
Roof Mount

8,844 Modules!!!

Inverters and Balance of System - BOS

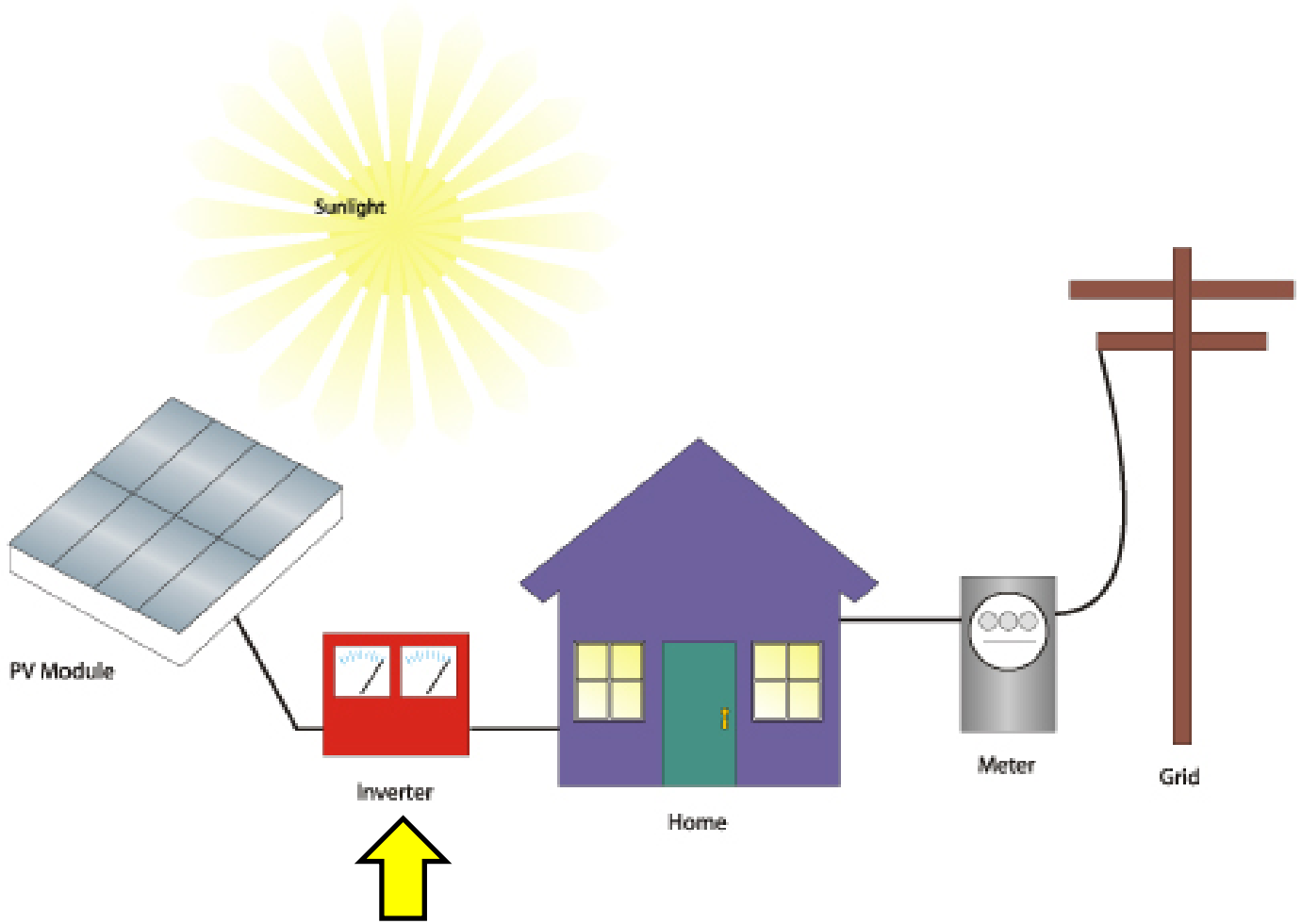
Inverter

Grid-Tie

- Panels produce DC power, the grid is AC, an Inverter Converts DC power from the modules to AC to supply to the grid.

Inverters and Balance of System - BOS

Inverter – Grid Tie



Inverters and Balance of System (BOS)

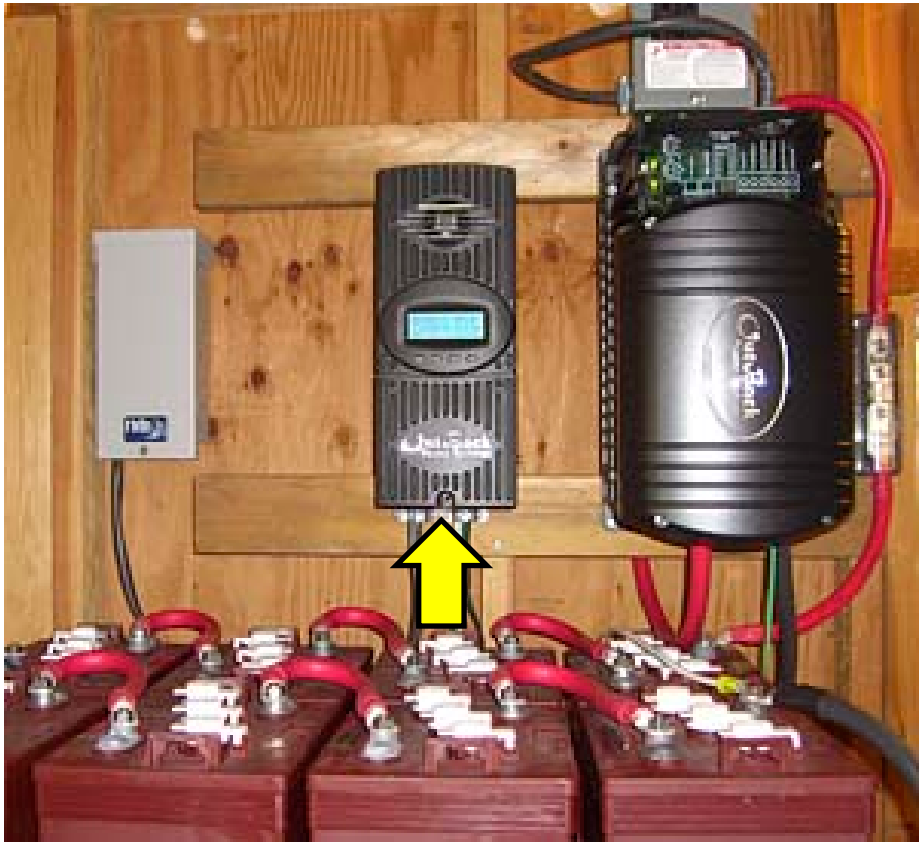
Inverter

Off Grid

- Panels produce DC power, the house or building wiring is AC, an Inverter Converts DC power from the battery bank or generator to supply the house or building.

Inverters and Balance of System - BOS

Inverter – Off Grid



Inverters and Balance of System (BOS)

Balance of System (BOS)

- Everything else you will need besides modules and inverters.

<u>Grid Tie</u>

- Fuses & Breakers
- Disconnects
- Junction Boxes
- All Typically done by certified electrician

<u>Off Grid</u>

- Everything for Grid Tie Plus
- Charge Controller
- Batteries
- Some sort of back up

Feed In Tariff - FIT

ONTARIO POWER AUTHORITY

Generating renewable energy and selling for a guaranteed price for a 20 year term.

http://fit.powerauthority.on.ca/

Feed In Tariff - FIT

FIT

Greater than 10 kilowatts – 10,000W up to 10MW – 10,000,000W

microFIT

Less than 10kW

52 modules

Feed In Tariff - FIT

PRICING

ROOF TOP SOLAR	< 10kW	54.9 c/kwh
	> 10 < 100kW	54.8
	> 100 < 500kW	53.9
	> 500 kW	48.7
GROUND MOUNT SOLAR	< 10kW	44.5
	> 10 < 100kW	38.8
	> 100 < 500kW	35.0
	> 500 kW	34.7

Feed In Tariff - FIT

PRICING

Kenora Area - $4-5/W installed

+/- 6 Year Pay Back

Remote Community - $12-14/W installed

+/- 10 Year Pay Back

Feed In Tariff - FIT

PRICING - EXAMPLE

Kenora Area – Rooftop

10,000W @ $5/W = $50,000

OPA Rate = 54.9 c/kWh

Generate = +/- $8,700/year

Payback = 5.7 Years

Income = $124,410

Feed In Tariff - FIT

PRICING - EXAMPLE

Big Trout Lake – Ground Mount Single Axis

10,000W @ $12/W = $120,000

OPA Rate = 56.4 c/kWh*

+1.5c Aboriginal Incentive for non-rooftop

Generate = +/- $11,000/year

Payback = 10.9 Years

Income = $100,100

Feed In Tariff - FIT

Aboriginal Projects

One of the core goals of the FIT Program is to encourage the development of Aboriginal renewable energy projects. This is done through reduced security payments, additional price incentives and the creation of the “Aboriginal Energy Partnerships Program”.

Feed In Tariff - FIT

Aboriginal Energy Partnerships Program

The Aboriginal Energy Partnerships Program seeks to maximize First Nations and Métis participation in renewable energy development while helping to build the province's energy supply. The program will provide funding for many of the key developmental stages needed to bring projects on stream, including:

- feasibility studies
- resource assessment

Feed In Tariff - FIT

Aboriginal Energy Partnerships Program

- technical research
- developing business cases
- regulatory approval studies
- engineering activities
- community energy plans
- creation of an Aboriginal Renewable Energy Network.

Feed In Tariff - FIT

Aboriginal Energy Partnerships Program

Visit www.aboriginalenergy.ca for more information, including details on the Aboriginal Renewable Energy Fund.

Funding Opportunities

AANDC – EcoEnergy

Funding for northern communities for clean energy projects.

-$250,000 per project for hydroelectricity, residual heat recovery, and wind.

-$100,000 per project for solar photovoltaics, passive solar heating systems, and geothermal that produce heat.

http://www.aadnc-aandc.gc.ca/eng/1100100034258/1100100034259#ch1

Funding Opportunities

Hydro One Remotes – REINDEER

Contact Lori Rice

Lori.Rice@hydroone.com

(807) 343-2018

Funding Opportunities

FIT Contract Capacity Set Aside Projects

- A solar company needs 50.1% Aboriginal Content
- A solar array is in place somewhere in Ontario
- An agreement is made at time of FIT application
- $0 Initial Investment
- Community can enter only ONE agreement
- Income is dependent on type of agreement may not be 50.1% of the profit.

Funding Opportunities

Net Metering

-Provide electricity generated from renewable sources to the electrical grid for a credit toward your energy costs

-Less than 500kW

-If you supply power that is worth more than what you take from the grid over the billing period, you'll receive a credit up to 12 months

Solar Thermal

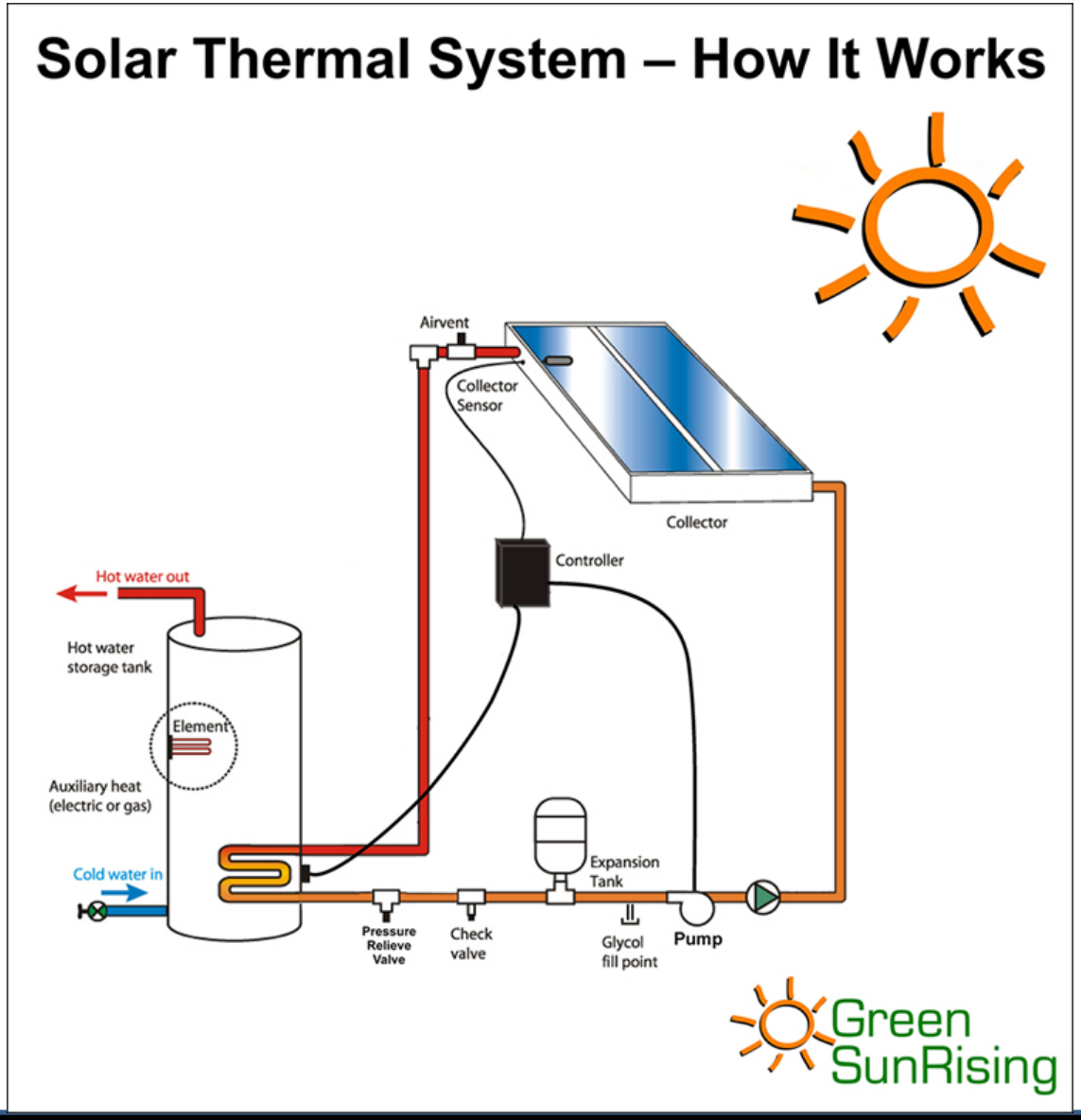
Heat from the sun's rays is collected and used to heat a fluid.

Can offset the energy from conventional gas and/or electric hot water and space heating equipment.

Solar Thermal

In a closed-loop system, a pump moves a non-toxic heat transfer fluid through the solar collectors where it is heated. After the heat transfer fluid exits the solar collectors, it passes through a heat exchanger where the solar heat is transferred from the solar fluid to the domestic water supply inside your solar storage tank.

Solar Thermal



Solar Thermal

What Can You Do With All That Hot Water?

Domestic Hot Water
Heating Loads