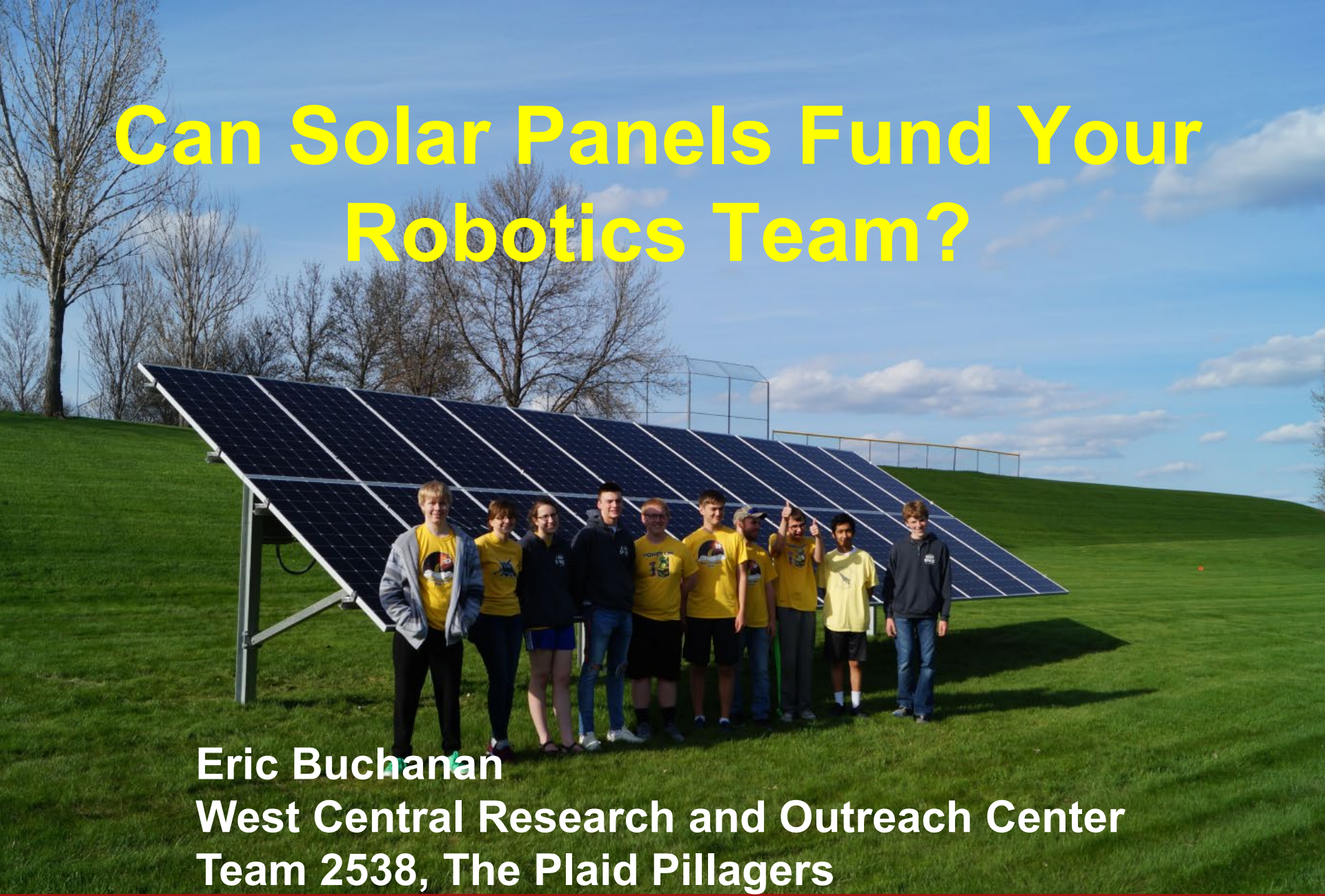
Can Solar Panels Fund Your Robotics Team?



Eric Buchanan
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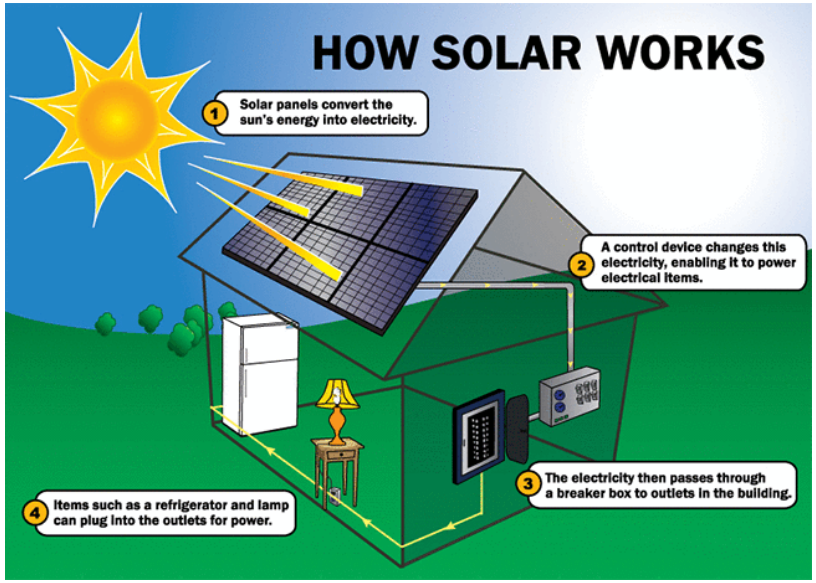
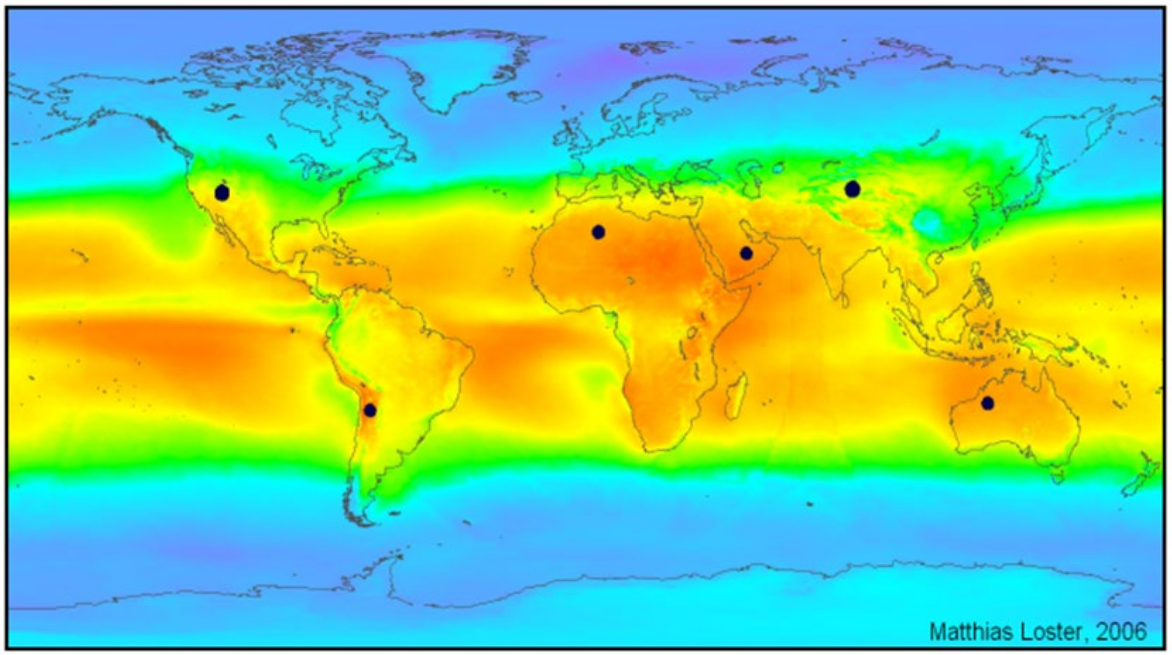
Team 2538, The Plaid Pillagers



1. How does solar PV work?
2. How do I install it?
3. The Morris experience

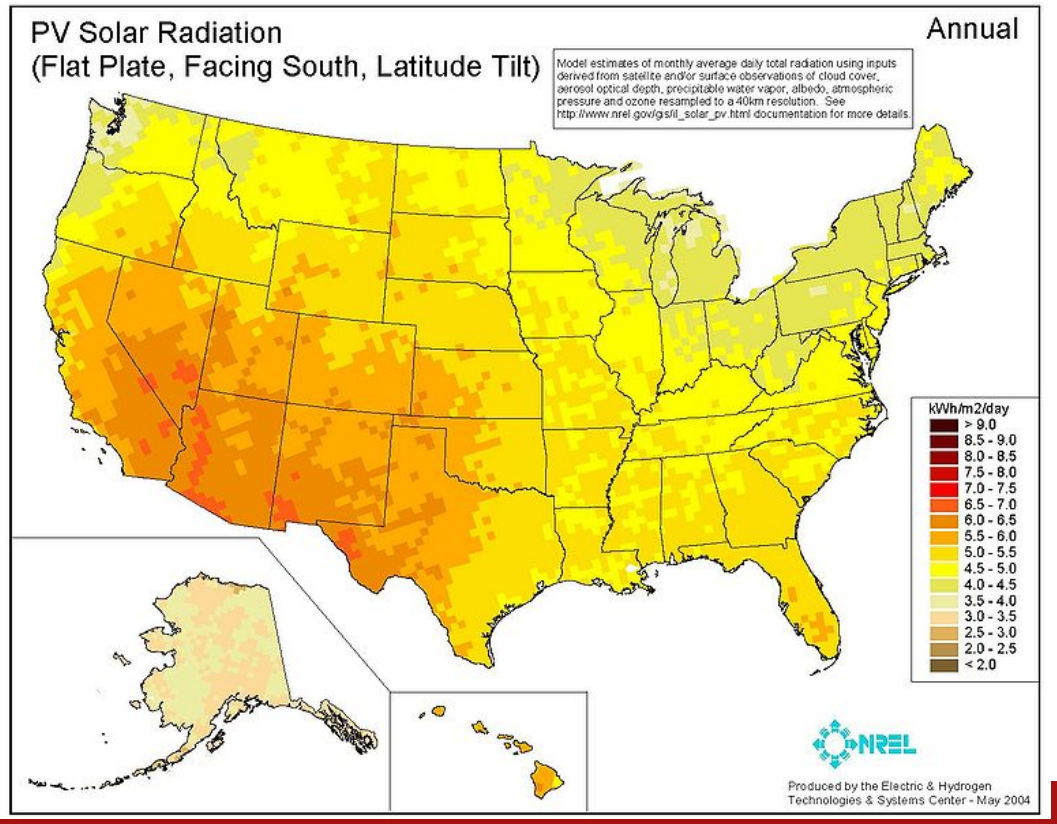
How Does Solar PV Work?

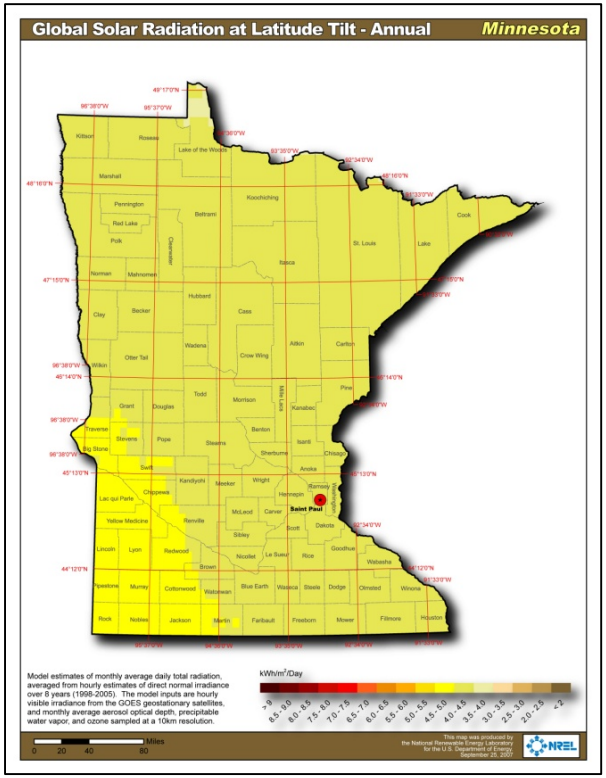


The sun provides more energy in one hour than the human race uses in a year!

How Does Solar PV Work?

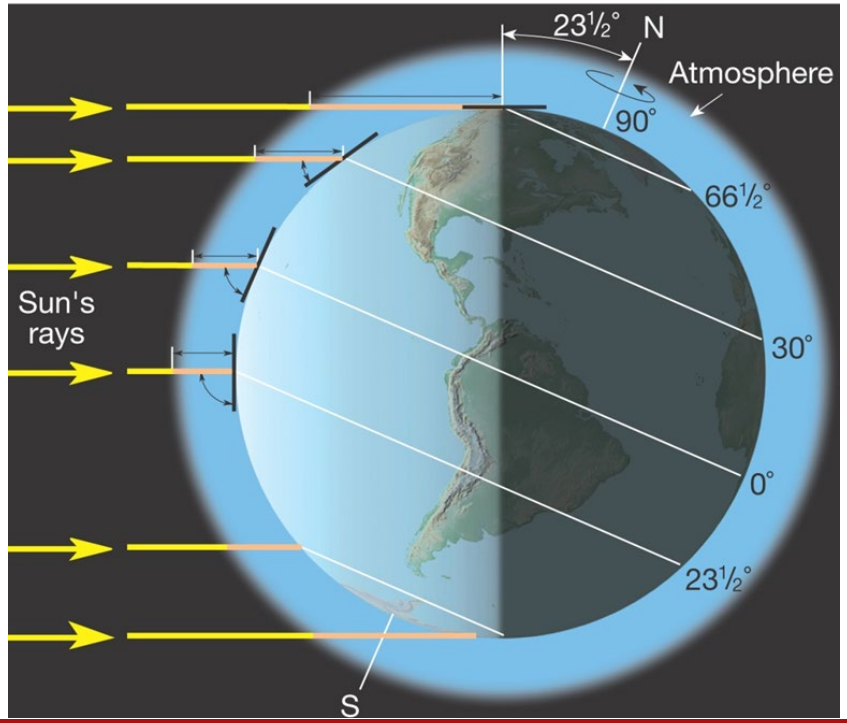
- The US and MN have good solar resources

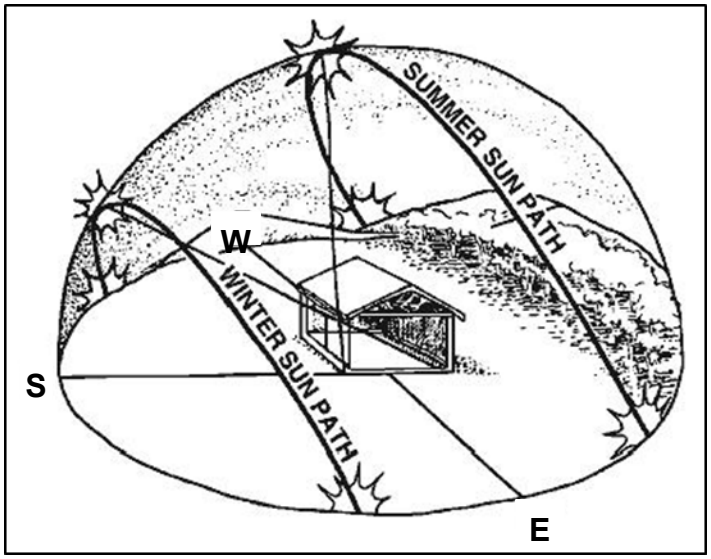




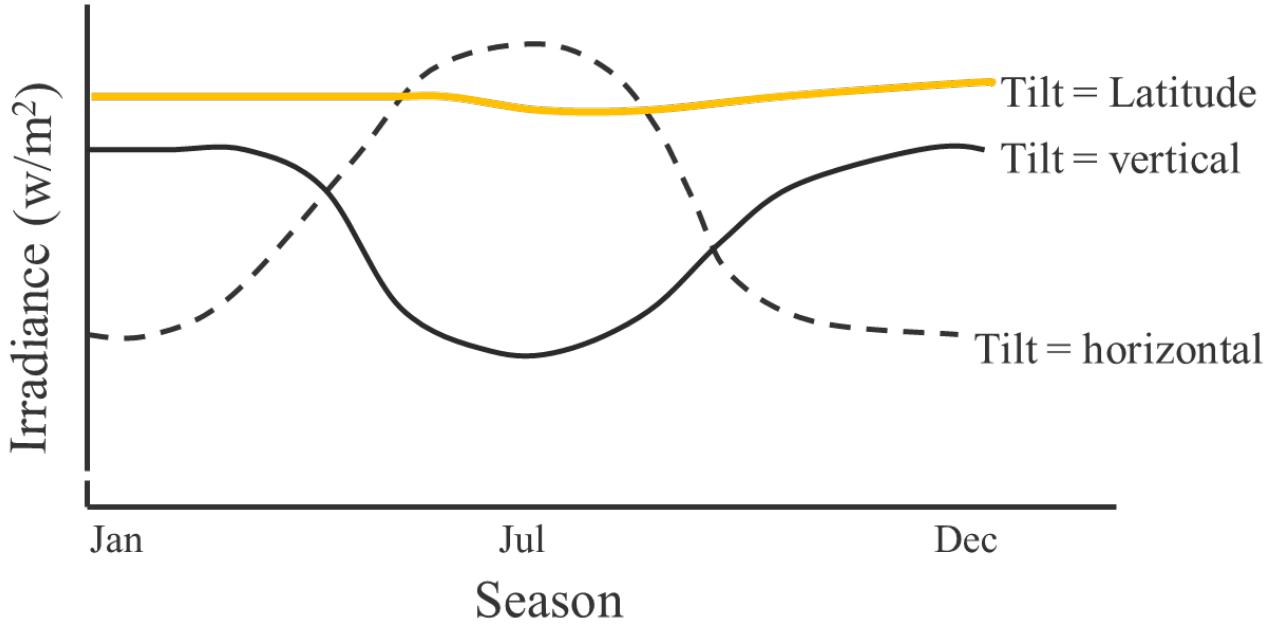
How Does Solar PV Work?

- Irradiance from the sun varies with location, weather, and time of year





How Does Solar PV Work?

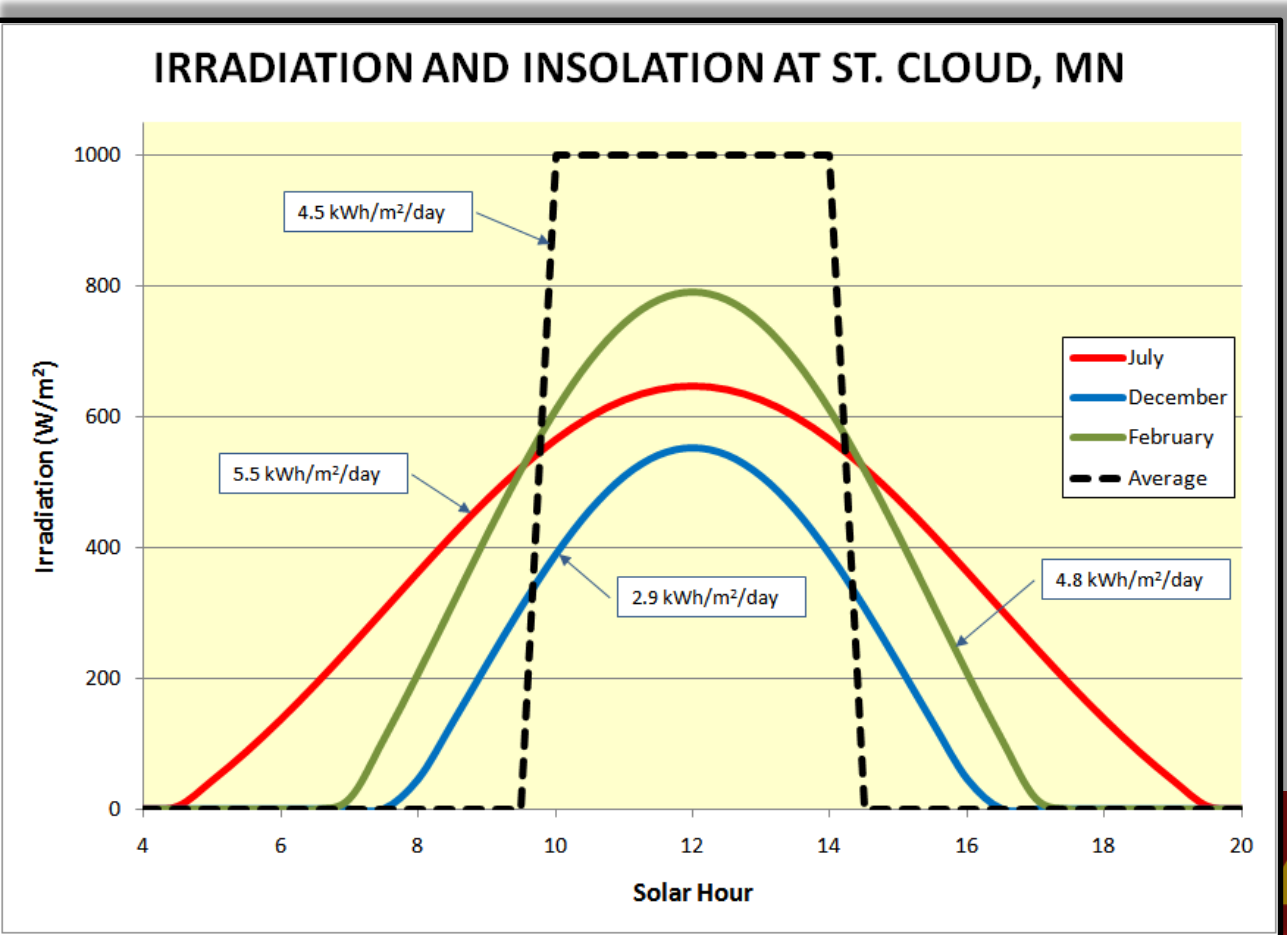


Panels are tilted to the latitude angle and face south

- **A tilt angle between about 15˚ and 55˚ with panels facing anywhere between SE to SW will collect 95% of possible solar energy**
- **Panels can track the sun (+32% energy), but may not be worth the cost**

How Does Solar PV Work?

- How much sunlight do we get in MN?

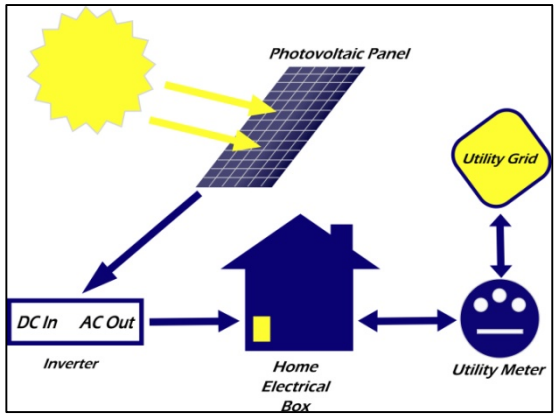


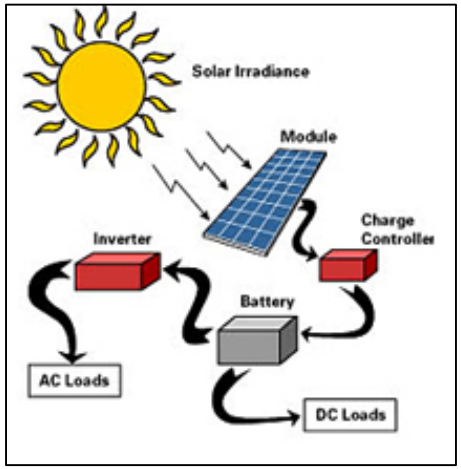
4.5 kWh/m²/day

This means a PV panel will produce its rated power output for 4.5 hours on average every day of the year

How Does Solar PV Work?

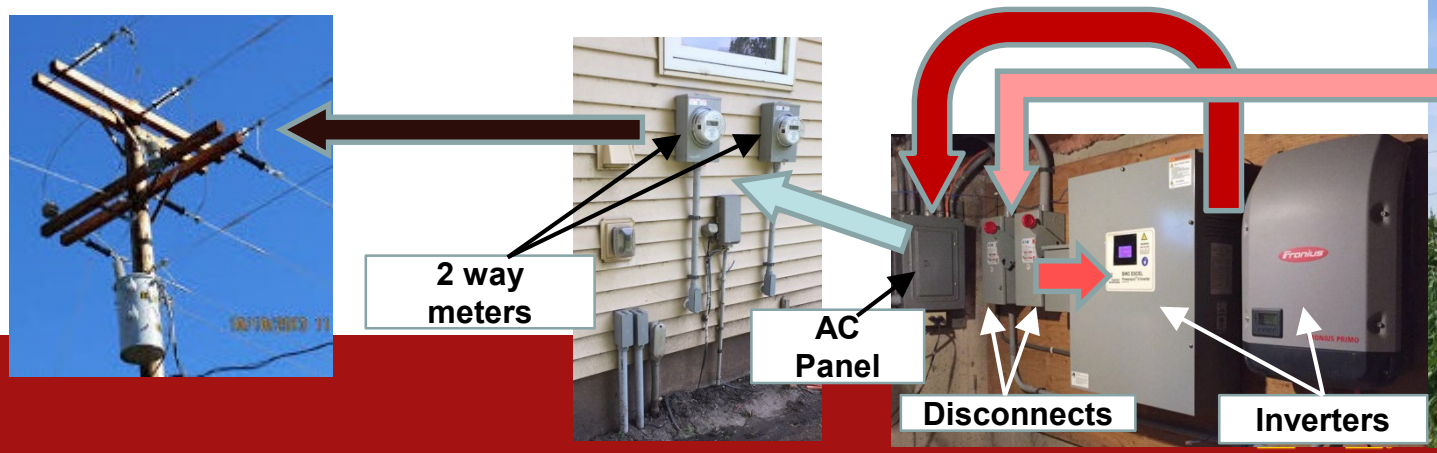
- There are 2 basic ways to install a solar PV system
  - Grid tied – Excess electricity is sold to a utility company (net metering <40 kW)
  - Stand alone – Uses batteries to store electricity for dark times





How Does Solar PV Work?

- **Grid-tie system components:**
  - **DC electricity (solar) and wild AC (wind) have a disconnect switch near the installation site**
  - **Electricity travels to a disconnect in or on building**
  - **Then to power inverters to be converted to AC**
  - **Then to AC panel**
  - **On to the utility meters (2 way)**
  - **Finally to the utility electric grid**



How Does Solar PV Work?

- Longevity and Maintenance
  - Most equipment is warrantied for 25 years
    - Performance warranty (80%) - should last 50 yrs
    - Must monitor to claim
  - Snow will degrade winter performance
    - Lost revenue is probably not significant
  - No moving parts! (unless tracking)

2 days after storm

How Do I Install Solar PV?

1. Figure out how much solar you need
2. Determine PV array size
3. Find a contractor
4. Determine the best site
5. Interconnect to your utility

How Do I Install Solar PV?

- Step 1: How much solar do I need?
  - How much do you use? Check elec. Bill
    - **kWh** - charge for energy (~10¢ per kWh)
    - **kW** – demand charge for power (~$10 per kW)
      - Commercial & industrial accounts

Service Address: 46209 STATE HWY 320 OFFICE BUILDING, MOR

Electric Service 49.31.01(53) Usage Period 06/01/19 to 07/01/19 -- 30 Days

Meter #	Pres Rdg	Prev Rdg	Multiplier							
58942	610	557	600.0	Fixed Charge					$	60.00
58942	610	557	600.0	Energy - Main Meter	29381	kWh	@ $	.07900	$	2,321.10
58942	0.228		600.0	Demand Charge	126.90	kW	@ $	10.00000	$	1,269.08
9943282	53678	51259	1.0	WPCA	29381	kWh	@ $	.0023900	$	70.22 CR
				Generation & Transmission Reservation Fee					$	412.74
				Distribution Reservation Fee					$	60.88
				Current Electric					$	4,053.58

How Do I Install Solar PV?

- Step 2: How much electricity will I make?
  - NREL free online prediction tool
    - https://pvwatts.nrel.gov/
  - Simple rule of thumb for MN – **1.2**
    - Array size (watts) times 1.2 = production (kWh/yr)
  - Example: 30 kW solar PV array
    - 30,000 X 1.2 = 36,000 kWh per year

How Do I Install Solar PV?

- Step 3: Find a contractor (get bids)
  - A good contractor will help you with all the following steps
  - MN Solar Energy Industry Association
    - https://www.mnseia.org/find-installer
  - CERTs
    - https://www.cleanenergyresourceteams.org/
  - NABCEP certification

How Do I Install Solar PV?

Step 4: On the ground or on the roof?

Ground mounted solar

PRO's

- generally simpler
- Allows mounting angle choice
- Probably less expensive
- Easy access for snow removal

Con's

- Takes up valuable space
- In path of debris (mowing/blowing)
- Ground cover/landscaping/fencing

Roof mounted solar

PRO's

- Out of sight
- Panels are close to the load
- Less chance of damage/vandalism

Con's

- May require engineering study
- May require roof enhancements
- Need to remove panels to re-roof




How Do I Install Solar PV?

- Step 5: Interconnection
  - Talk to your utility company early!
    - Must fill out interconnection application & pay fee
      - <20kW: $100, <250 kW: $500, >250 kW: $1,500
      - 2 way or production meter needed ($200 - $600)
  - Will need building & electrical permits
  - Islanding test
  - Additional monthly fees
    - Grid access fee, Demand reservation fees

Pillager Goals for Solar Array

1. Permanent funding for our team
2. Another real-world learning experience for students
3. Data and facility for bringing renewable energy into classrooms
4. Work with a community collaboration to meet community adopted climate goals

How to Pillage Solar

- Do your homework before talking to administrators
  - Decide how much revenue you want to get
  - Calculate solar array size
    - Annual funding x 10 = # kWh/yr (@10¢/kWh)
    - Array size (W) = # kWh/yr ÷ 1.2
  - Morris example:
    - $1000 x 10 ÷ 1.2 = 8,333 W (8.3 kW)

How to Pillage Solar

- Find a couple suitable site locations
  - Want areas open to the south and close to electrical service entrance
    - Further away costs more
    - Fire code requires a disconnect near the service entrance
    - Ground mount provides access for science labs

- For roof mounting, check with facilities manager about roof age

How to Pillage Solar

- Talk to the superintendent/facilities manager about your plan and ask for permission to get contractor bids
- Get bids and choose a contractor
  - This will give you some real numbers and site preferences
- Have a student present proposal to school board

How to Pillage Solar

- Raise money!
  - Find grants
    - CERTs
    - RDP
  - Check for incentives
    - Otter Tail Power POP
      - $ 1,250/kW
  - Ask your sponsors
  - Hold public fund raisers

Morris Experience

Array Size	7.9 kW
Total Cost	$ 30,900
Cost per Watt	$ 3.90
POP Benefit	($ 9,900)
Funding Goal	**$ 21,000**

Funding Plan	
CERTs grant	$ 7,300
SWRDP grant	$ 2,500
IATP grant	$ 3,000
Team Raised	$ 8,200

How to Pillage Solar


Thank you!
Eric Buchanan
Team 2538, The Plaid Pillagers