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LABOR AND INDUSTRY'S STATUTE 326.0981,
SUBD. 11,**

**“THIS EDUCATIONAL OFFERING IS RECOGNIZED
BY THE MINNESOTA DEPARTMENT OF LABOR
AND INDUSTRY AS SATISFYING 1.5 HOUR OF
CREDIT TOWARD BUILDING OFFICIALS AND
RESIDENTIAL CONTRACTORS CONTINUING
EDUCATION REQUIREMENTS.”**

**FOR ADDITIONAL CONTINUING EDUCATION
APPROVALS, PLEASE SEE YOUR CREDIT
TRACKING CARD.**

INTRODUCTION TO SOLAR: TECHNOLOGY, RESOURCES, AND POLICIES

Energy Design Conference 2023

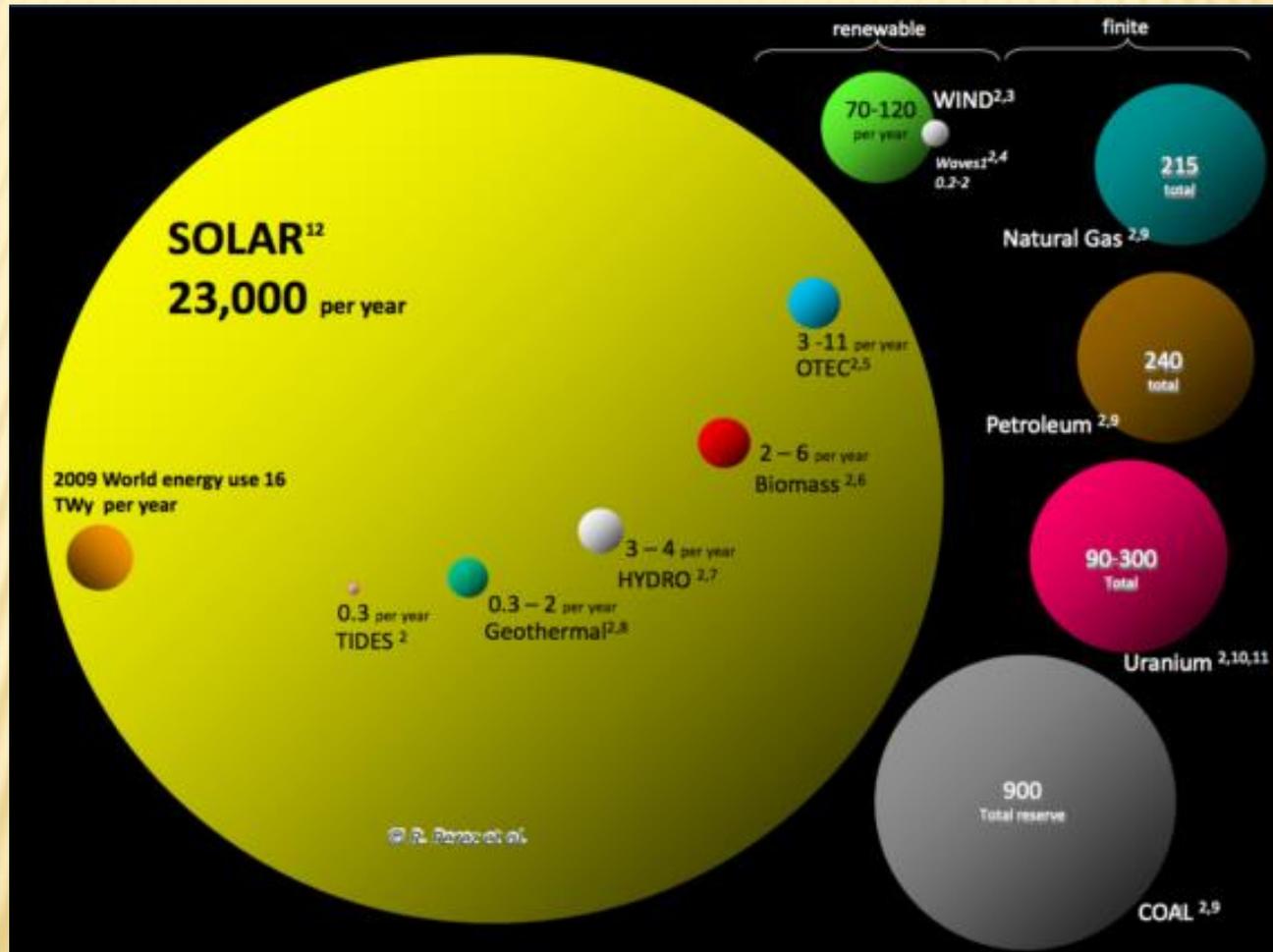
By

Paul Helstrom- Minnesota Power

AGENDA

- ✘ Introduction:
- ✘ Overview: Solar Resource, History, Policies
- ✘ Market drivers and status
- ✘ Solar Technologies
- ✘ Policies, Rules, and Regulations

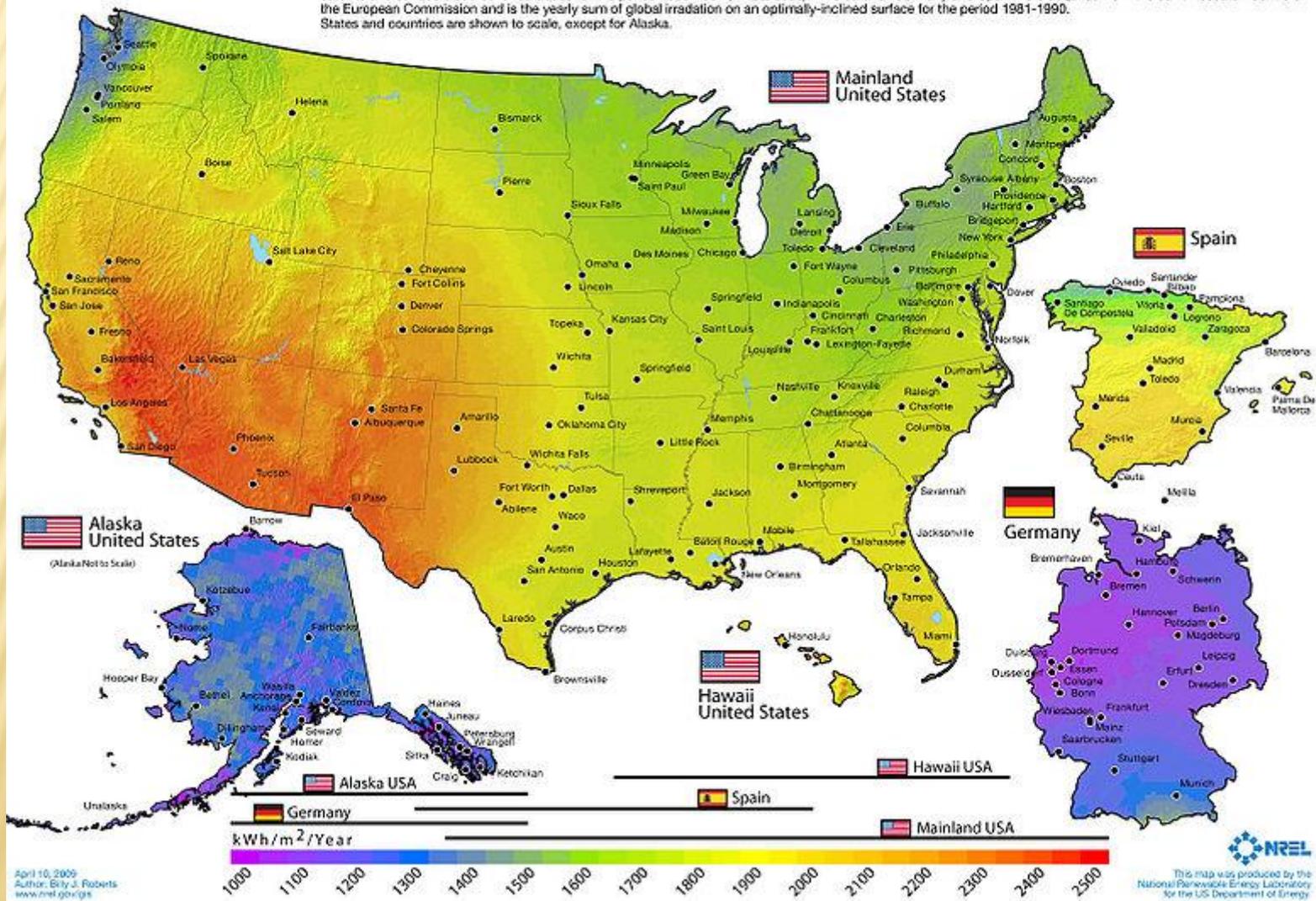
SOLAR AS A RESOURCE



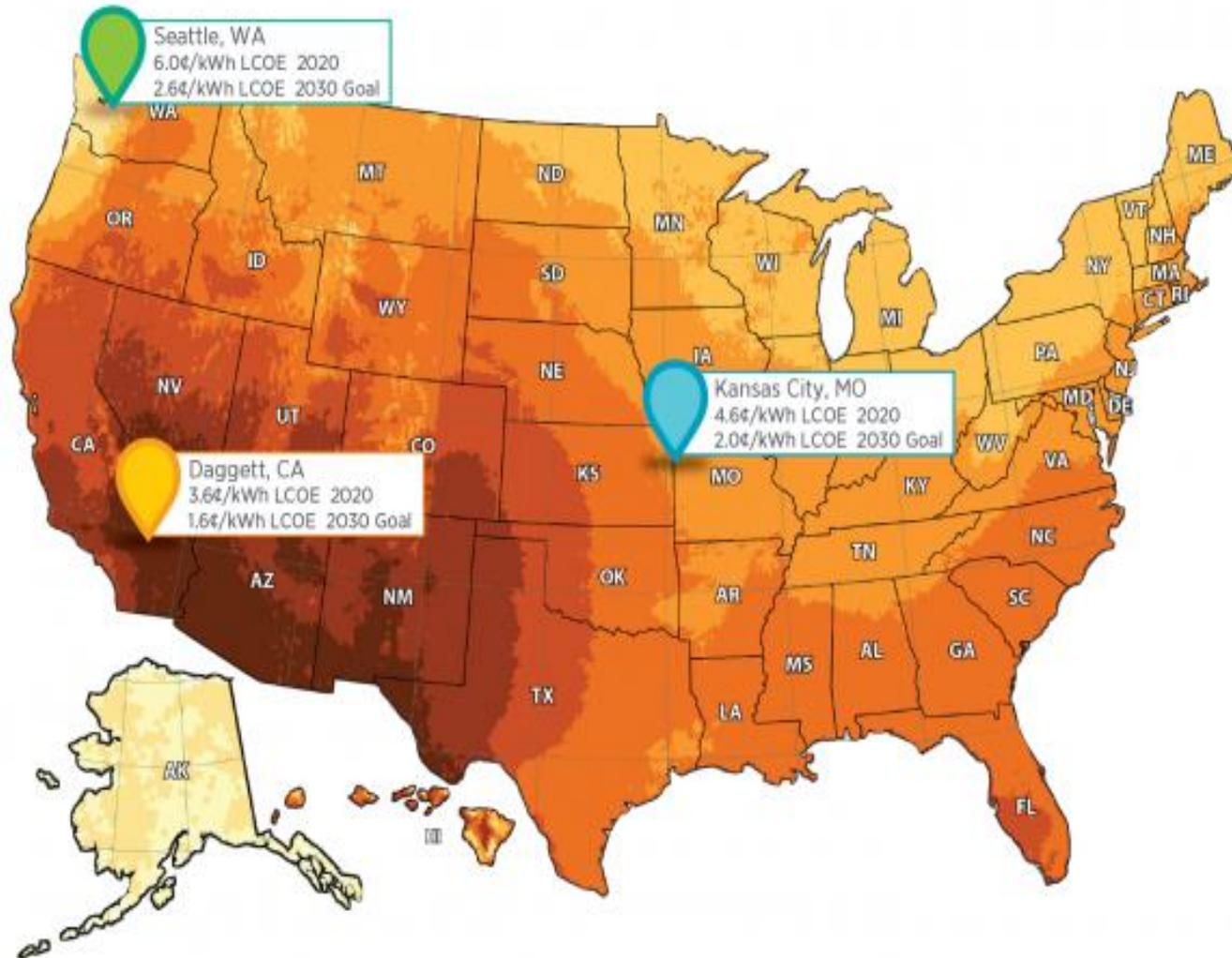
US SOLAR RESOURCE

Photovoltaic Solar Resource: United States - Spain - Germany

Annual average solar resource data are for a solar collector oriented toward the south at a tilt = local latitude. The data for Hawaii and the 48 contiguous states are derived from a model developed at SUNY/Albany using geostationary weather satellite data for the period 1998-2005. The data for Alaska are derived from a 40-km satellite and surface cloud cover database for the period 1985-1991 (NREL, 2003). The data for Germany and Spain were acquired from the Joint Research Centre of the European Commission and is the yearly sum of global irradiation on an optimally-inclined surface for the period 1981-1990. States and countries are shown to scale, except for Alaska.

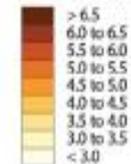


US SOLAR RESOURCE



Solar Resource Across America

kWh/m²/Day



Daggett, CA - High
Kansas City, MO - Average
Seattle, WA - Low

The amount of power that is produced by a PV system depends upon the solar resource availability (in addition to other factors like temperature and snowfall), which is location dependent. The median solar resource for the United States is represented by Kansas City, MO, while the highest solar resource is represented by Daggett, CA, and the lowest solar resource is represented by Seattle, WA.

HISTORY OF SOLAR

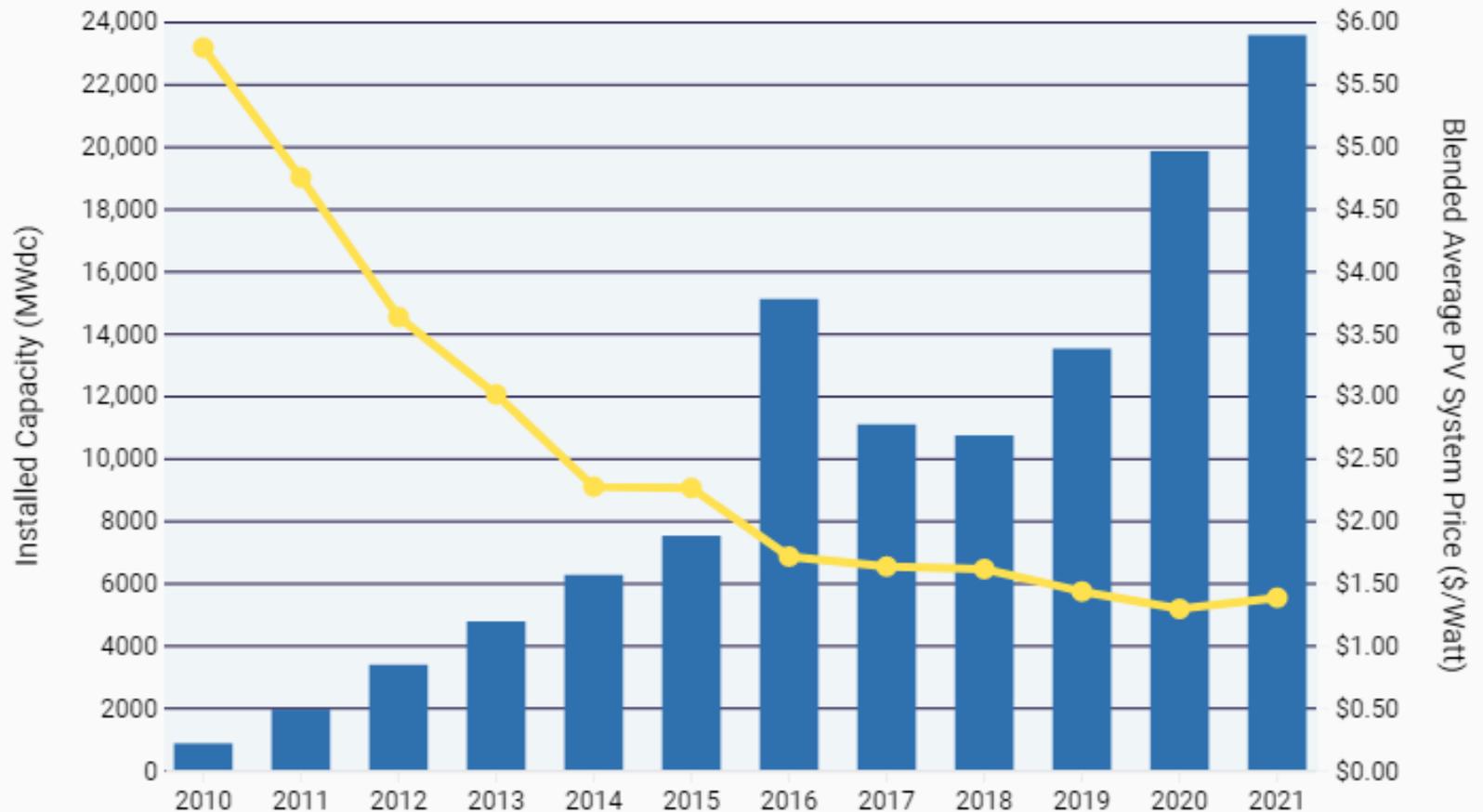
- ✘ Solar has been used for millennia – primarily for heat and fire
- ✘ Photovoltaic effect first described: 1839
 - + Edmond Becquerel
- ✘ 1954- First C-Si solar cells- Bell Labs
 - + 4% efficient- 11% achieved later
- ✘ Satellites
- ✘ 1980- Arco solar first company to produce 1 MW of solar PV cell
 - + 1983 Worldwide pv prod = 21 MW

THE SOLAR MARKETPLACE TODAY

- ✘ Global demand is growing rapidly
- ✘ US demand was about 18 GW in 2022
- ✘ Challenges of an intermittent resource
- ✘ Falling prices bringing a competitive edge
- ✘ Solar still remains higher cost energy in many areas
- ✘ Incentives are available for consumers

SOLAR IS GROWING

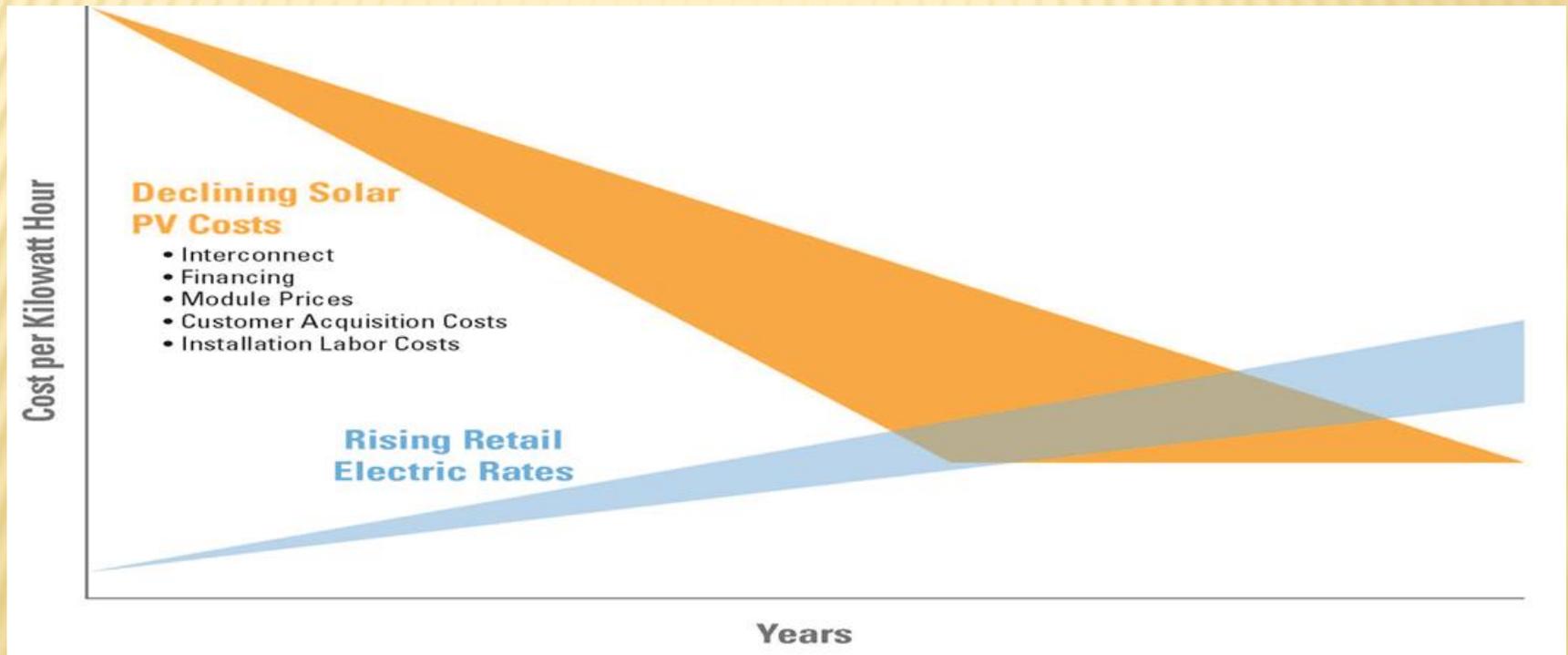
U.S. Solar PV Pricing Trends & Deployment Growth



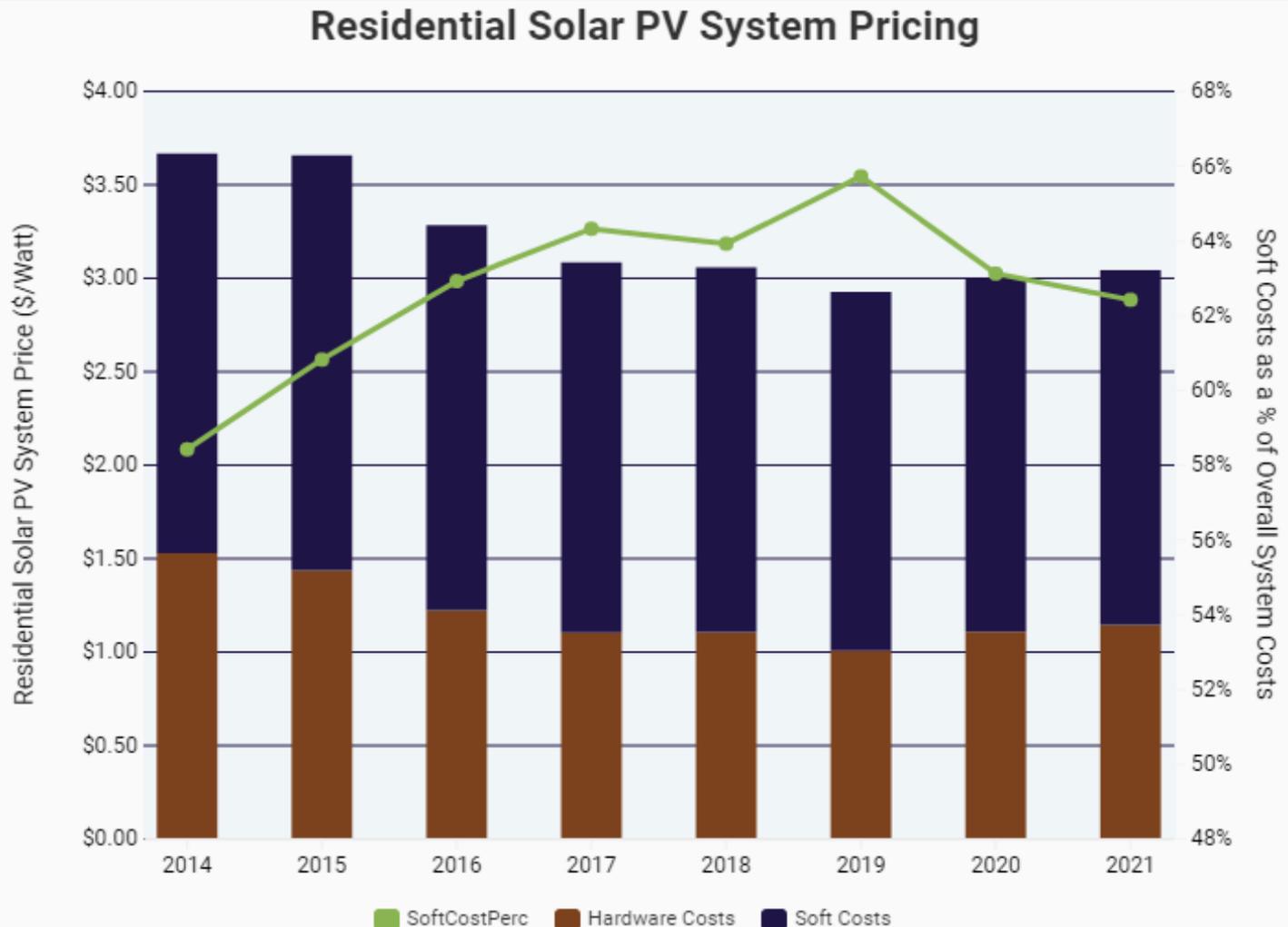
Source: [SEIA/Wood Mackenzie Power & Renewables U.S. Solar Market Insight Q3 2022](#)

COST OF SOLAR

- ✘ Historic- 1950's \$300/w, 1970's \$50/w, 1990's \$10/w, today <\$1/w



COST OF SOLAR



POLICIES DRIVING SOLAR

- ✘ Global:
 - + Germany: EnergieWende
 - + China: 5 Year plans
 - + USA: state level RPSs
 - + Others
- ✘ Public Utilities Regulatory Policies Act 1978
- ✘ Net Metering
- ✘ Community Solar Gardens
- ✘ State Mandates

MINNESOTA RENEWABLE ENERGY

- ✘ Next Generation Energy Act

 - + Passed in 2007 (§216C.05)

 - + 25% by 2025

 - + Accomplished or on target

- ✘ Solar Energy Standard

 - + 2013

- ✘ 100% by 2040

 - + Passed in 2023



2013 Minnesota Solar Legislation

Renewable Energy Standard (RES)

Unchanged

Solar Energy Standard (SES)

1.5% of Retail Sales by 2020

(excludes mining & paper industry)

Net Meter

1 MW Limit

(not to exceed 120% of usage)

Solar Value Rate

Value of Solar (VOS)

(Optional for IOU's)

Community Solar Gardens

Xcel Required, Other IOU's Optional

Made in MN Subsidy

5% of CIP\$

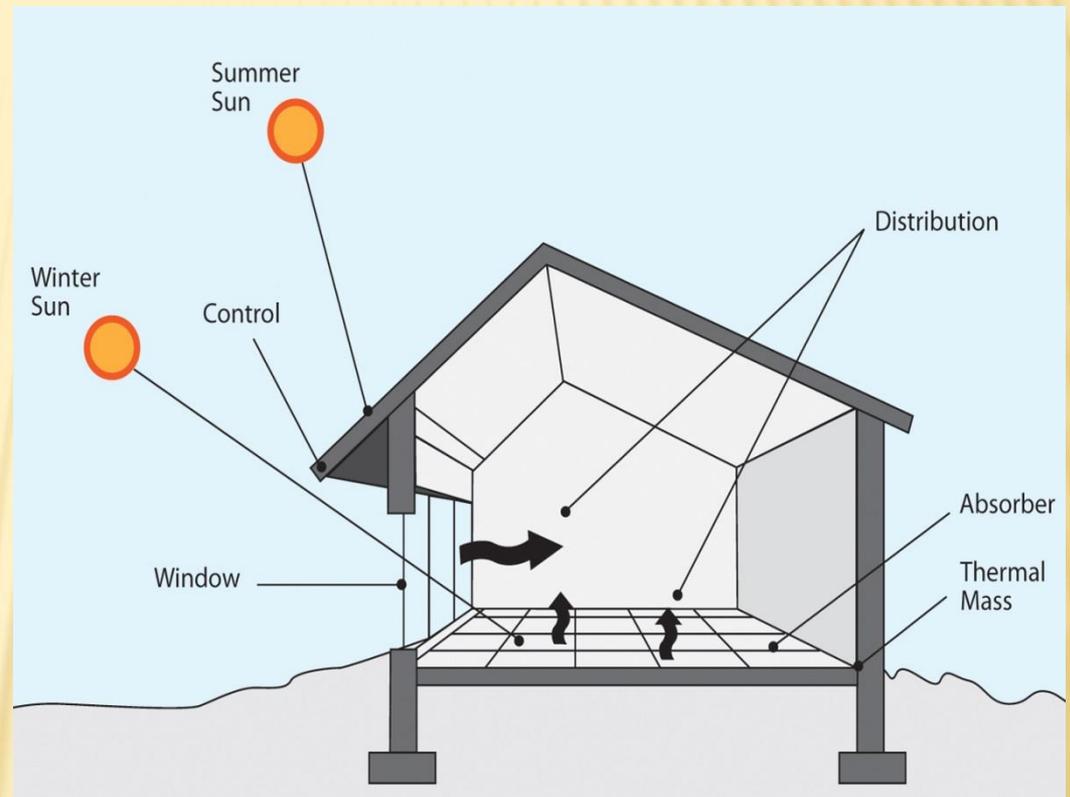


SOLAR TECHNOLOGY TYPES

- ✘ Passive
 - + Heating, cooling, Lighting
- ✘ Heating and Cooling
 - + Systems and collector types
 - + Hot water
 - + Hot air
- ✘ Electricity
 - + Thermal
 - + Photovoltaic (PV)

PASSIVE

- ✘ Using design to control energy from the sun entering the building
- ✘ Orientation, overhangs, and positioning of windows



SOLAR THERMAL- HOT WATER

- ✘ Design types
 - + Batch
 - + Pressurized
 - + Drain back
- ✘ System components
 - + Collectors
 - + Pumps
 - + Pipes
 - + Storage tanks
 - + Controls
 - + Sensors

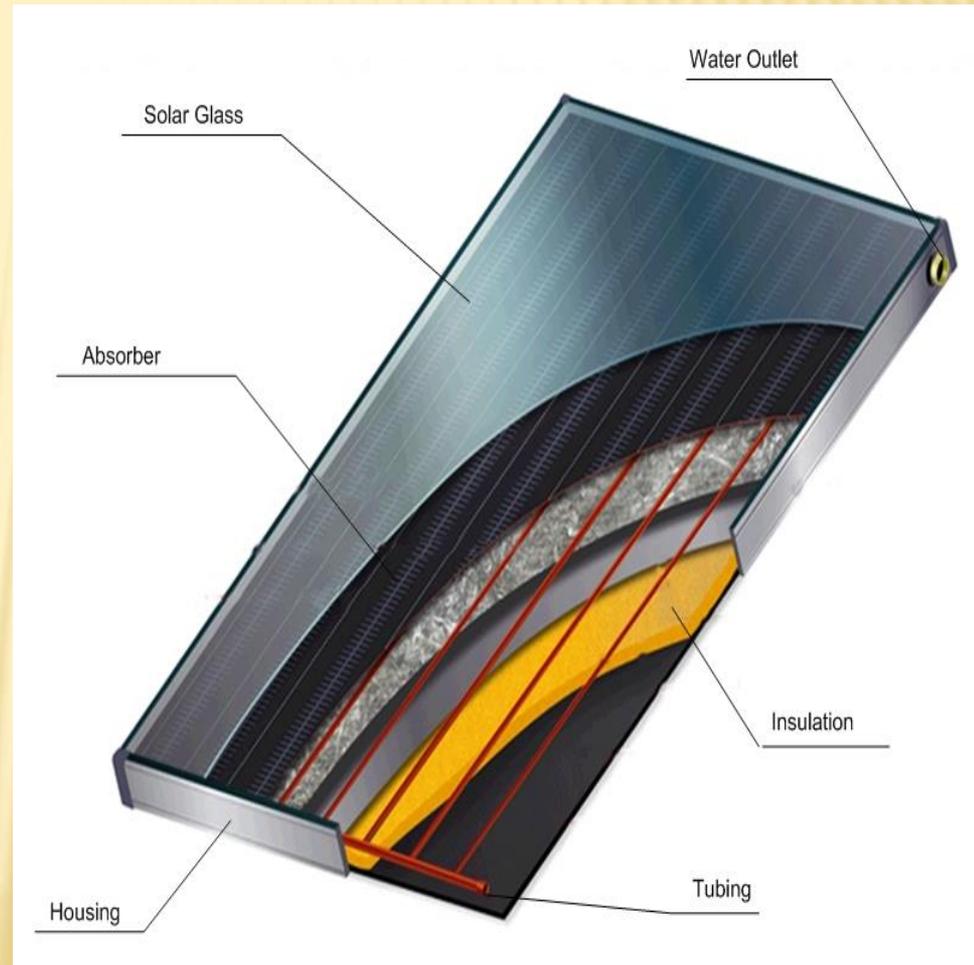
BATCH SYSTEMS

- ✘ Used in warmer climates
- ✘ Small footprint



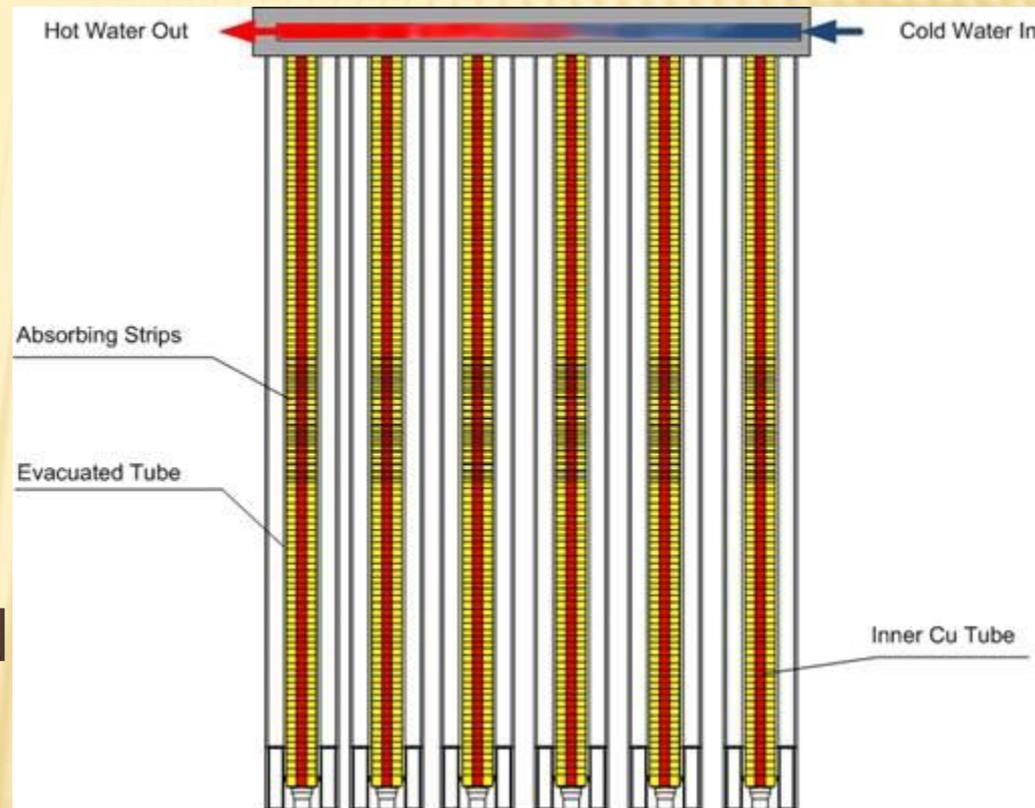
FLAT PLATE

- ✘ Flat panels
- ✘ No internal moving parts
- ✘ Collectors, tubing, insulation, glazing, frame



EVACUATED TUBES

- ✘ Vacuum sealed chamber around a specialized metal collector
- ✘ Top manifold to transfer heat to coolant loop
- ✘ Effective in very cold conditions
- ✘ Vacuum is key

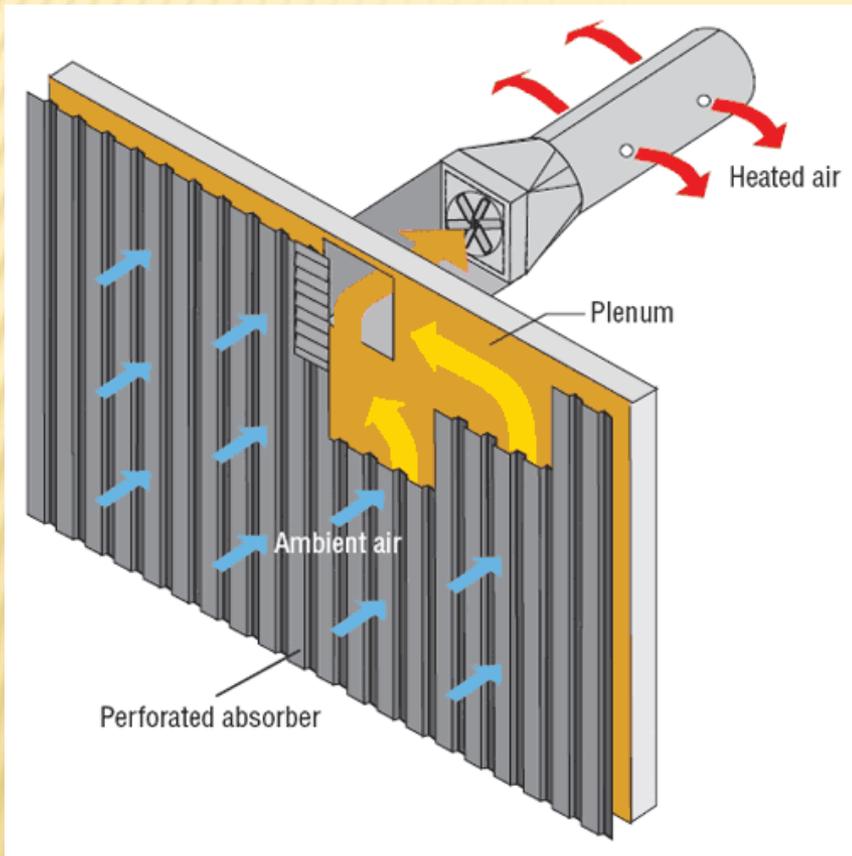




SOLAR THERMAL- HOT AIR

- ✘ Space heating
- ✘ Transpired air- pre conditioning
- ✘ Process heat
 - + Breweries

SOLAR WALLS- TRANSPIRED AIR



SOLAR THERMAL- GENERAL

- ✘ The current market is small
- ✘ Certifications for products through the Solar Rating and Certification Corporation (SRCC)



SOLAR ELECTRIC- THERMAL

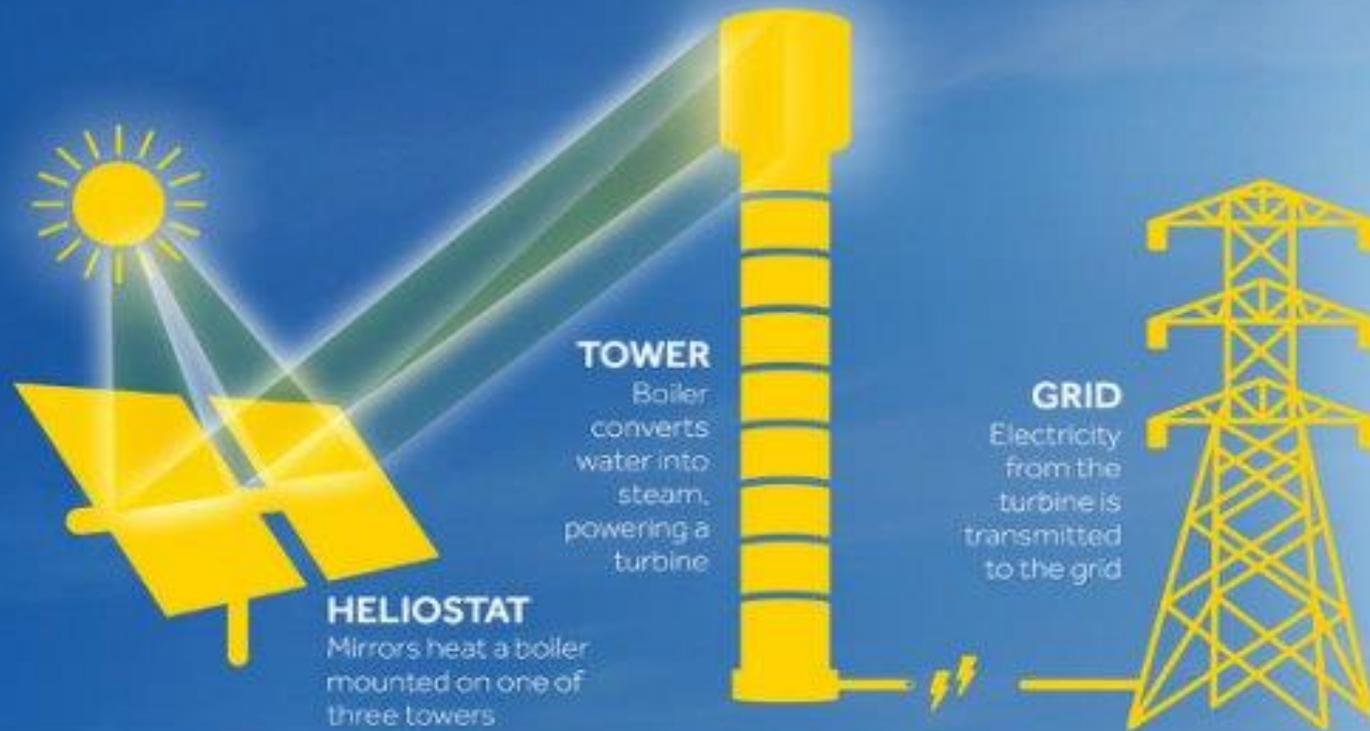
- ✘ Concentrating the sun to produce high levels of heat to create steam for power production
- ✘ Parabolic Trough and Power Towers



PO
500

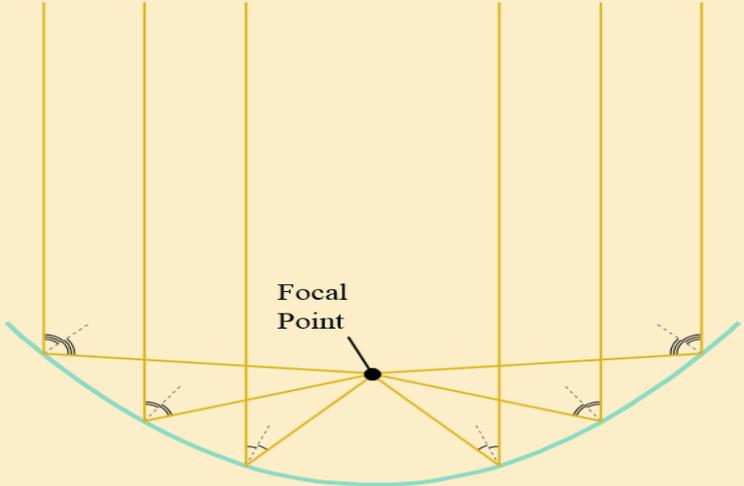
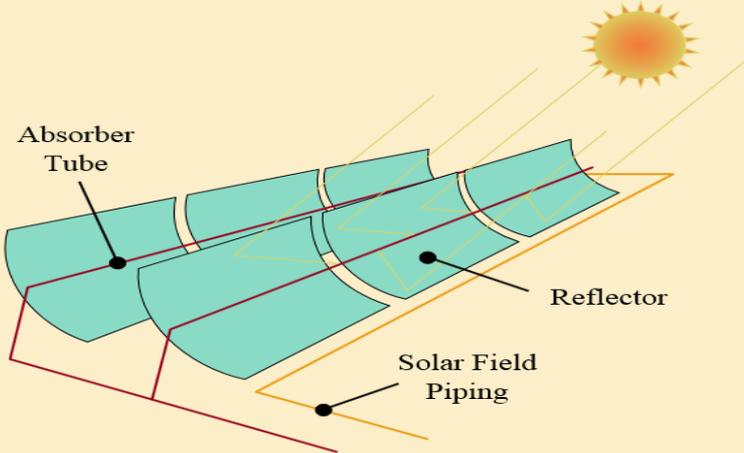
Inside the innovation

Ivanpah is three separate plants on 3,500 acres in the Mojave Desert, California. But, size alone didn't make this project a big step toward our clean energy future; it required a smarter approach. We created a state-of-the-art solar power system that generates 392 MW from 347,000 garage door-sized mirrors.



100% of the steam turbine's water is recycled

PARABOLIC TROUGH

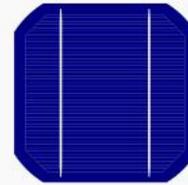


PHOTOVOLTAIC EFFECT

- ✘ Britannica: “Process in which two dissimilar materials in close contact produce an electrical voltage when struck by light or other radiant energy.”
- ✘ First observed by French physicist A.E. Becquerel in 1839
- ✘ First solar cells made of gold and selenium in 1884 by Charles Fritts

FROM CELL TO SYSTEMS

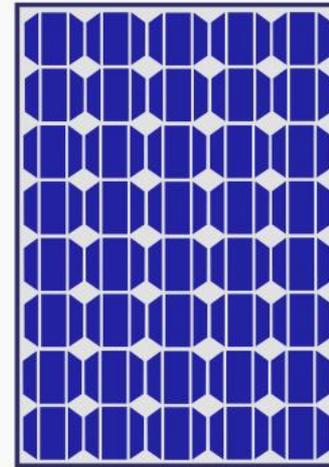
From a solar cell to a PV System



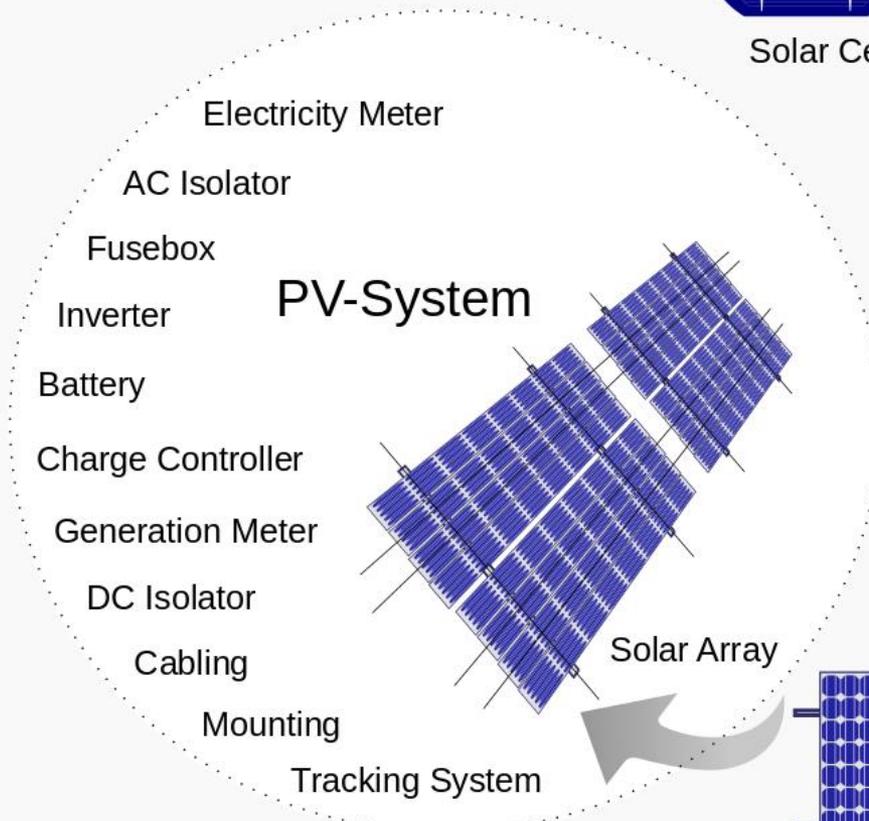
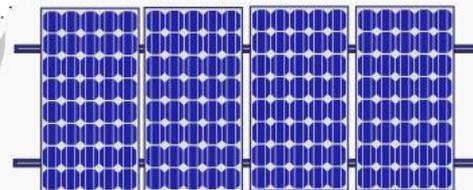
Solar Cell



Solar Module



Solar Panel



SOLAR SYSTEMS

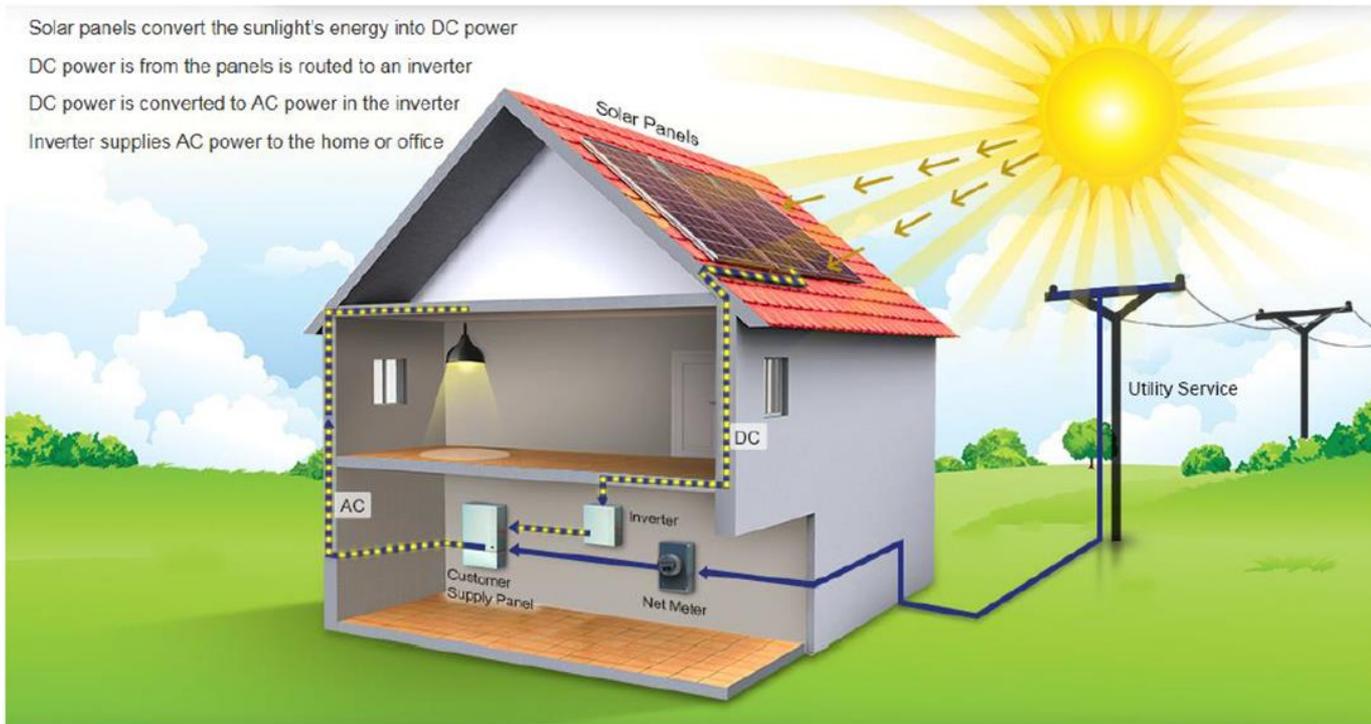
Grid Connected Solar Photovoltaic System

Solar panels convert the sunlight's energy into DC power

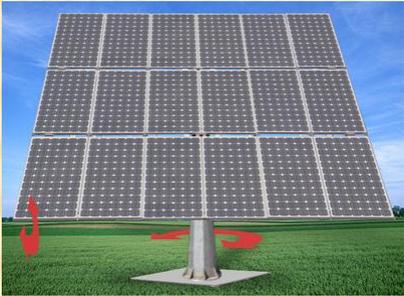
DC power from the panels is routed to an inverter

DC power is converted to AC power in the inverter

Inverter supplies AC power to the home or office



GRID TIED SYSTEM COMPONENTS



AC Disconnect
With in 10' of
utility meter



DC Disconnect

DC

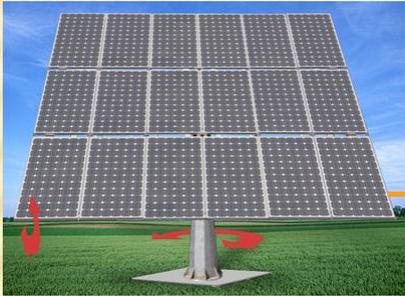


Inverter

AC



GRID TIED BATTERY BACKUP



Main Panel



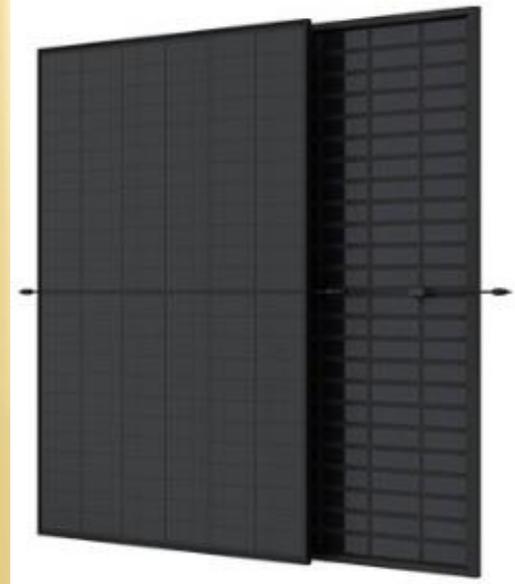
Charge Controller



Secure Loads panel

SOLAR MODULES

- ✘ 20%+ Efficiency
- ✘ Fairly standard sizes
- ✘ ~40"W x 70"H
- ✘ 350-450 watt
 - + Growing - +500watts
- ✘ Solar cell evolution
 - + Half cell, PERC, etc
- ✘ Bifacial modules



INVERTERS

Basic Elements

- Inverter
 - Similar to vehicle inverter
 - Converts DC to AC sine wave
 - Sine wave created exactly matches utility (unity PF)
 - Acts like an amperage source providing the house with kwh
 - Integrated AC-DC disconnect barrel switch on most models
 - Multiple sizes and models can be combined at one site



RACKING

- ✘ Roof
 - + Mechanical attachments
 - + Ballasted
- ✘ Ground
 - + Multiple pole
 - + Single Pole
 - + Ballasted
- ✘ Trackers
- ✘ Floating

BALLASTED

- ✘ Flat roof or ground mounts
- ✘ Weighted to hold array in place
- ✘ No penetrations/ More Weight



GROUND MOUNTS

- ✘ Need to know soil conditions
- ✘ Very flexible configurations



ATTACHED

- ✘ Mechanical fasteners into structural members
- ✘ Flashed mounting points
- ✘ Rails to attach modules
- ✘ Integrated grounding features

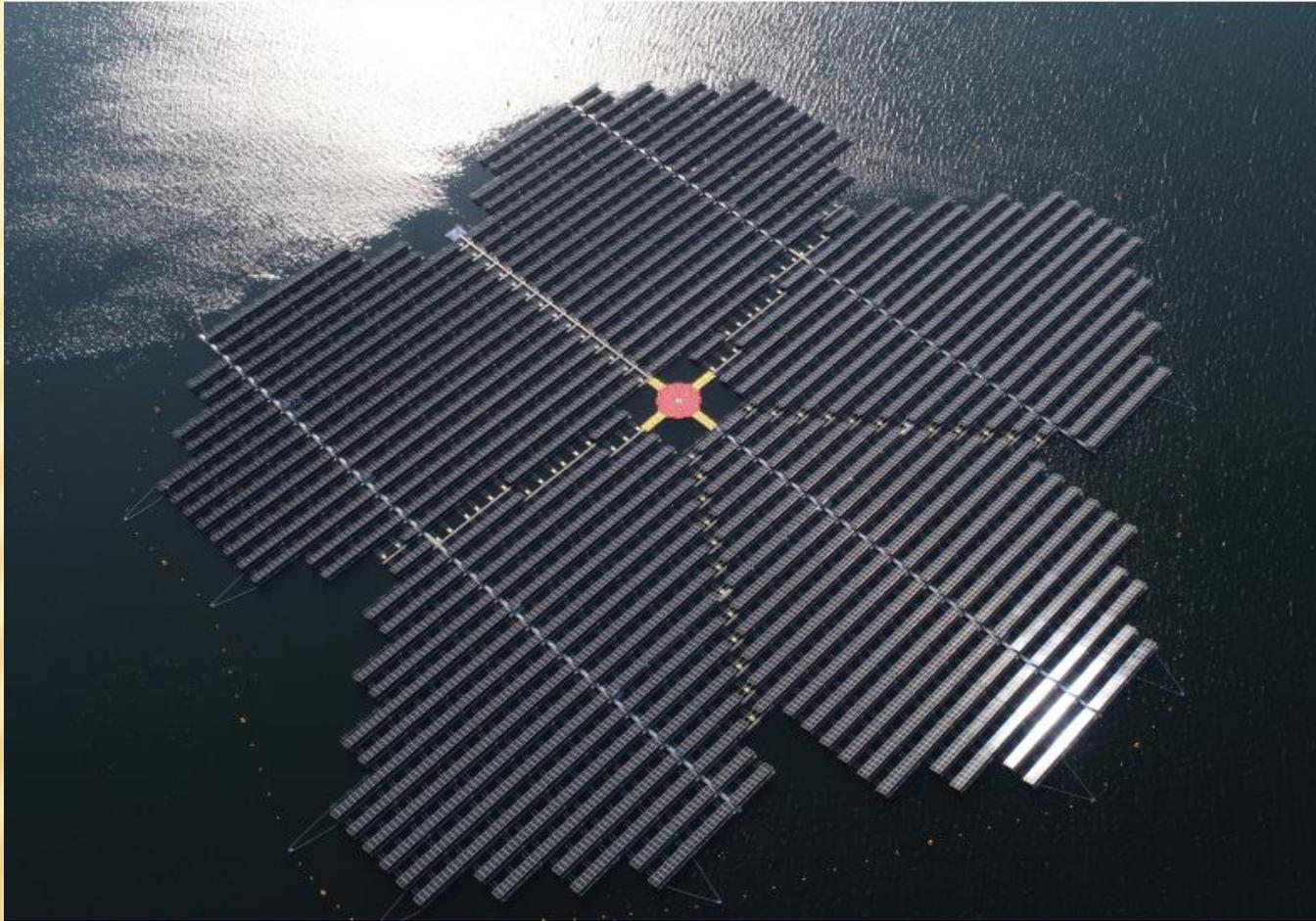


TRACKERS

- ✘ Large scale installations
- ✘ Single or Dual Axis
- ✘ Increases capacity factor



FLOATING SOLAR ARRAYS



BALANCE OF SYSTEM

- ✘ Meters
- ✘ Disconnects
- ✘ Combiners
- ✘ Conduit
- ✘ Wire
- ✘ Labels
- ✘ Etc.



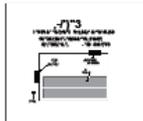
LABELS- LOTS OF LABELS

1 Enclosures / EMT Enclosures

WARNING
ELECTRICAL SHOCK HAZARD
DO NOT TOUCH TERMINALS
TERMINALS ON BOTH LINE AND
LOAD SIDES MAY BE ENERGIZED
IN THE OPEN POSITION
NEC 690.17(E) | Part No. 596-00497

WARNING
ELECTRICAL SHOCK HAZARD
THE DC CONNECTIONS OF THIS
PHOTOVOLTAIC SYSTEM ARE UNGROUNDING
AND MAY BE ENERGIZED
NEC 690.35(F) | Part No. 596-00588

2 Building / Structure



PER NEC 690.56(B) | Part No. 558-00350

WARNING
TURN OFF PHOTOVOLTAIC
AC DISCONNECT PRIOR TO
WORKING INSIDE PANEL
NEC 110.27(C) & OSHA 1910.145(f)(7)
Part No. 596-00499

3 DC Disconnect / Breaker / Recombiner Box

WARNING
ELECTRICAL SHOCK HAZARD
THE DC CONNECTIONS OF THIS
PHOTOVOLTAIC SYSTEM ARE UNGROUNDING
AND MAY BE ENERGIZED
NEC 690.35(F) | Part No. 596-00588

**PHOTOVOLTAIC
DC DISCONNECT**
IFC 605.11.3, IFC 605.11.1, NEC 690.15, NEC
690.13(B) & NEC 690.14(C)(2) | Part No. 596-00238

WARNING
ELECTRICAL SHOCK HAZARD
DO NOT TOUCH TERMINALS
TERMINALS ON BOTH LINE AND
LOAD SIDES MAY BE ENERGIZED
IN THE OPEN POSITION
DC VOLTAGE IS ALWAYS PRESENT
WHEN SOLAR MODULES
ARE EXPOSED TO SUNLIGHT
NEC 690.17(E) | Part No. 596-00496

PV SYSTEM DC DISCONNECT
OPERATING CURRENT: _____
OPERATING VOLTAGE: _____
MAXIMUM SYSTEM VOLTAGE:
5 KVA DC CABLE CURRENT: _____
NEC 690.53 | Part No. 596-00241

FOR WARNING DC BACKUP SYSTEMS
Part No. 596-00240

RATED DC OPERATING CURRENT	_____
MAX RATED DC OPERATING CURRENT	_____
RATED DC OPERATING VOLTAGE	_____
MAX RATED DC OPERATING VOLTAGE	_____
RATED SHORT-CIRCUIT CURRENT	_____
MAXIMUM SYSTEM VOLTAGE	_____

MINIMUM BACKUP POWER RATING	_____
RATED BACKUP POWER RATING	_____
BACKUP SYSTEM VOLTAGE	_____
BACKUP SYSTEM CURRENT	_____
BACKUP SYSTEM EFFICIENCY	_____
THRESHOLD VOLTAGE OF RECHARGE	_____

NEC 690.53 | Part No. 596-00253

4 EMT / Conduit Raceways **Reflective Material Required*

**WARNING: PHOTOVOLTAIC
POWER SOURCE**
NEC 690.31 | Part No. 558-00206

**WARNING
PHOTOVOLTAIC POWER SOURCE**
NEC 690.4(F) | Part No. 558-00257

5 Inverter

WARNING
ELECTRICAL SHOCK HAZARD
IF A WIRING FAULT IS INDICATED
NORMALLY ENERGIZED CONDUCTORS
MAY BE UNGROUNDING AND ENERGIZED
NEC 690.5(C) | Part No. 558-00498

6 Production / Net Meter

WARNING
ELECTRICAL SHOCK HAZARD
IF A WIRING FAULT IS INDICATED
NORMALLY ENERGIZED CONDUCTORS
MAY BE UNGROUNDING AND ENERGIZED
NEC 690.5(C) | Part No. 558-00498

WARNING
UNIDIRECTIONAL PHOTOVOLTAIC ARRAY
DISCONNECT OF NEUTRAL
OR GROUNDING CONDUCTORS
MAY RESULT IN OVERVOLTAGE
ON ARRAY OR INVERTER
NEC 690.4(G) | Part No. 596-00590

7 Production / Net Meter (Bi-directional)

**CAUTION: SOLAR ELECTRIC
SYSTEM CONNECTED**
NEC 690.15 & NEC 690.13(B) | Part No. 558-00613

**WARNING DUAL POWER SOURCE
SECOND SOURCE IS PHOTOVOLTAIC SYSTEM**
NEC 705.12(D)(4) & NEC 690.64
Part No. 558-00495

PHOTOVOLTAIC AC DISCONNECT
UNIDIRECTIONAL PHOTOVOLTAIC SYSTEM
MAXIMUM SYSTEM VOLTAGE: _____
NEC 690.54 | Part No. 596-00239

8 AC Disconnect / Breaker / Points of Connection

**UTILITY PHOTOVOLTAIC
AC DISCONNECT**
IFC 605.11.1, IFC 605.11.1.4, NEC 690.15, NEC
690.14(C)(2), NEC 690.13(B) | Part No. 596-00237

MINIMUM OPERATING VOLTAGE: _____
MINIMUM OPEN-CIRCUIT VOLTAGE: _____
MINIMUM POWER RATING: _____
MAXIMUM PERMITTED DC RATING:
FOR MODULE PROTECTION
NEC 690.52 | Part No. 558-00252

WARNING
ELECTRICAL SHOCK HAZARD
DO NOT TOUCH TERMINALS
TERMINALS ON BOTH LINE AND
LOAD SIDES MAY BE ENERGIZED
IN THE OPEN POSITION
NEC 690.17(E) | Part No. 558-00497

PHOTOVOLTAIC AC DISCONNECT
UNIDIRECTIONAL PHOTOVOLTAIC SYSTEM
MAXIMUM SYSTEM VOLTAGE: _____
NEC 690.13(B) | Part No. 558-00239

13 UTILITY PHOTOVOLTAIC PRODUCTION METER

9 Breaker Panel / Pull Boxes

WARNING
ELECTRICAL SHOCK HAZARD
IF A WIRING FAULT IS INDICATED
NORMALLY ENERGIZED CONDUCTORS
MAY BE UNGROUNDING AND ENERGIZED
NEC 690.5(C) | Part No. 558-00498

WARNING
ELECTRICAL SHOCK HAZARD
THE DC CONNECTIONS OF THIS
PHOTOVOLTAIC SYSTEM ARE UNGROUNDING
AND MAY BE ENERGIZED
NEC 690.35(F) | Part No. 558-00588

WARNING
ELECTRICAL SHOCK HAZARD
DO NOT TOUCH TERMINALS
TERMINALS ON BOTH LINE AND
LOAD SIDES MAY BE ENERGIZED
IN THE OPEN POSITION
NEC 690.17(E) | Part No. 558-00497

WARNING
SINGLE 120-VOLT SUPPLY
DO NOT CONNECT
MULTIWIRE BRANCH CIRCUITS
NEC 690.10(C) | Part No. 558-00591

WARNING
TURN OFF PHOTOVOLTAIC
AC DISCONNECT PRIOR TO
WORKING INSIDE PANEL
NEC 110.27(C) & OSHA 1910.145(f)(7)
Part No. 558-00499

**DO NOT DISCONNECT
UNDER LOAD**
NEC 690.35(E)(2) | Part No. 558-00244

PHOTOVOLTAIC AC DISCONNECT
UNIDIRECTIONAL PHOTOVOLTAIC SYSTEM
MAXIMUM SYSTEM VOLTAGE: _____
NEC 690.54 | Part No. 558-00239

CAUTION
PHOTOVOLTAIC SYSTEM CIRCUIT IS BACKUP
NEC 705.15(D)(4) & NEC 690.64
Part No. 558-00587

**WARNING DUAL POWER SOURCE
SECOND SOURCE IS PHOTOVOLTAIC SYSTEM**
NEC 705.12(D)(4) & NEC 690.64 | Part No. 558-00495

WARNING
SYSTEM CIRCUIT ENERGIZED. DO NOT
RELEASE THIS DISCONNECT PANEL.
NEC 705.12(D)(2)(C) | Part No. 558-00589

10 Main Service Disconnect

WARNING
ELECTRICAL SHOCK HAZARD
DO NOT TOUCH TERMINALS
TERMINALS ON BOTH LINE AND
LOAD SIDES MAY BE ENERGIZED
IN THE OPEN POSITION
NEC 690.17(E) | Part No. 558-00497

**MAIN PHOTOVOLTAIC
SYSTEM DISCONNECT**
NEC 690.15 & NEC 690.13(B) | Part No. 558-00243

WARNING
TURN OFF PHOTOVOLTAIC
AC DISCONNECT PRIOR TO
WORKING INSIDE PANEL.
NEC 690.5(C) | Part No. 558-00499

**CAUTION: SOLAR ELECTRIC
SYSTEM CONNECTED**
NEC 690.15 & NEC 690.13(B) | Part No. 558-00613

11 Main Service Disconnect / Utility Meter

**UTILITY PHOTOVOLTAIC
SYSTEM DISCONNECT**
NEC 690.15 & NEC 690.13(B) |

**12 PHOTOVOLTAIC SYSTEM
EQUIPPED WITH
RAPID SHUTDOWN**
NEC Article 690.56(B) | Part No. 596-00474
Reflective Material Required.

SYSTEM COMPONENTS CERTIFICATIONS

- ✘ Certifications under IEEE1547 for solar inverters
- ✘ UL1541 for inverters, and 1708 for modules
- ✘ New standards are emerging for inverters
 - + IEEE1547-2018 for MN TIIR.
 - + Allow for more advance functions
 - ✘ Low voltage ride through
 - ✘ Dynamic controlling

TRAINING, TOOLS, AND RULES

- ✘ Department of Labor and industry requires electrically trained persons to perform work associated with PV installation
- ✘ NEC codes guiding proper installation:
 - + 690
 - + 720
 - + Other associated sections
- ✘ NABCEP and UL certification
- ✘ State Interconnection Standards
 - + MnDIP Process

SOLAR INSTALLER CERTIFICATION

- ✘ NABCEP- North American Board of Certified Energy Practitioners
- ✘ UL- Underwriter Laboratories

NABCEP™

Raising Standards. Promoting Confidence.



CODE COMPLIANCE ELEMENTS

- ✘ Rapid shutdown
- ✘ Grounding
- ✘ Labeling
- ✘ Safety/isolation – Anti-islanding
- ✘ Roof set backs

SOLAR PHOTOVOLTAICS AND FIRE SAFETY



Photo Credit: Greentech Media 9/19/2013

PV SAFETY IMPROVEMENTS

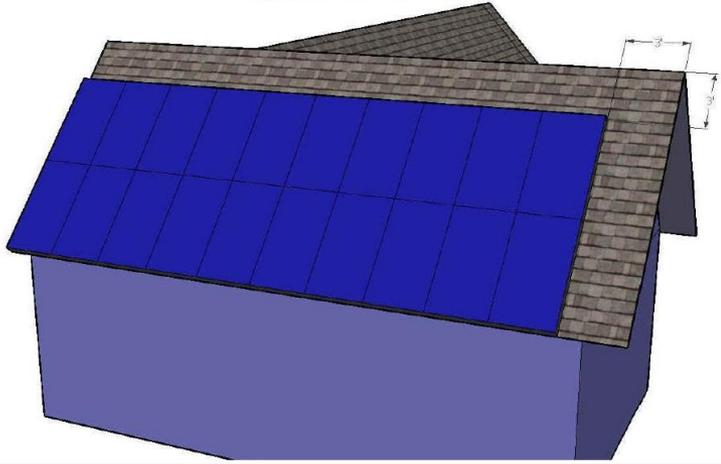
- ✘ NEC Code requirements:
 - + Conduit requirements for DC wiring
 - + Labeling requirements
 - ✘ Better information
 - ✘ More information
 - ✘ More locations on the system
 - + Rapid Shut Down systems
 - ✘ Requirement in 2015 code
 - ✘ Requires shut down within 10 seconds from time of activation to within 10' of array, or within 5' of entrance into the building.



RECOMMENDED BEST PRACTICES

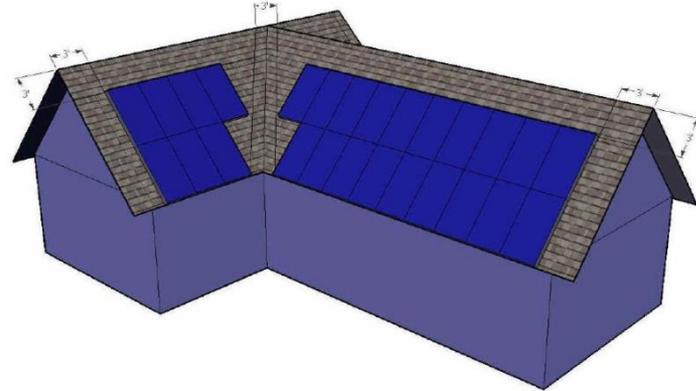
EXAMPLE 1

Diagram 1: Cross Gable Roof



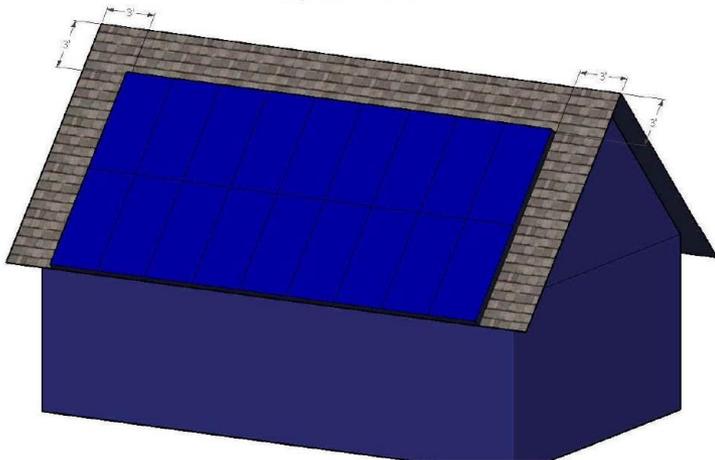
EXAMPLE 2

Diagram 2: Cross Gable with Valley



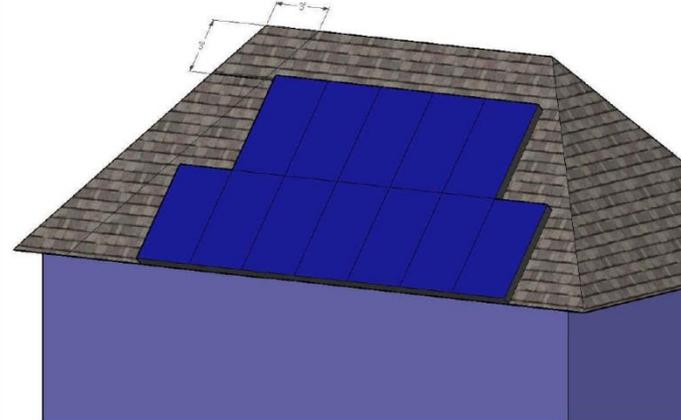
EXAMPLE 3

Diagram 3: Full Gable



EXAMPLE 4

Example 4: Full Hip Roof



INTERCONNECTION PROCESS- MN DIP

- ✘ Universal application and agreements requirements for Minnesota
- ✘ Technical stipulations vary utility to utility
 - + Technical Standard Manual- Utility specific requirements
 - + Technical Interconnection and Interoperability Requirements- TIIR – Statewide
- ✘ Interconnection Agreement:
 - + MnDIA
 - + Uniform Statewide Contract- USC

INTERCONNECTION PROCESS

- ✘ Working in different utility jurisdictions:
 - + Be aware of differing processes
 - + Be aware of different technical requirements
 - + Call and ask questions

INTERCONNECTION PROCESS

× Examples:

+ Production meters:

- × MP, CLP, ECE require them
- × Lake Country does not
- × Pay attention to how to wire them
 - ★ Line side for MP
 - ★ Load side for CLP and ECE

+ Subtractive metering

- × Not allowed with solar customers

INTERCONNECTION PROCESS- EXAMPLES

- ✘ Interconnection fees
 - + All- Application fee
 - + Commissioning fee- CLP & ECE
 - + Grid Access fees- CLP
- ✘ Commissioning procedures and expectations

APPLICATION PROCESS

- ✘ Simplified- 20 kW and less
- ✘ Fast Track- > 20 kW to 'larger'
- ✘ Study – larger systems with potential system impacts ~250 kW
- ✘ Need to submit detailed design plans
 - + One line
 - + Site Plan
 - + Insurance
 - + Application fees

SAMPLE SUBMITTALS

NOTES:

1. LOCATION OF SERVICE PANEL AND ELECTRICAL EQUIPMENT ARE SHOWN. FINAL LOCATION MAY CHANGE
2. LOCATION OF SERVICE PANEL AND ADDITIONAL ELECTRICAL EQUIPMENT NOT DRAWN TO SCALE
3. AC DISCONNECT WITHIN 10' OF MAIN SERVICE METER/BI-DIRECTIONAL METER. 24/7 UNESCORTED KEYLESS ACCESS TO BE PROVIDED FOR UTILITY AC DISCONNECT & BI-DIRECTIONAL METER.
4. PV EQUIPMENT SHALL BE INSTALLED IN ACCORDANCE WITH NEC 690 AND POSTED WITH APPLICABLE WARNINGS, SIGNAGE, AND PLAQUES PER NEC 705-10, 690-17, & 690-64 (b)(5).
5. CIRCUITS:
 - (2) CIRCUIT(S) OF 9 (20AMPS EACH)
 - (1) CIRCUIT(S) OF 10 (20AMPS EACH)

DISTANCES

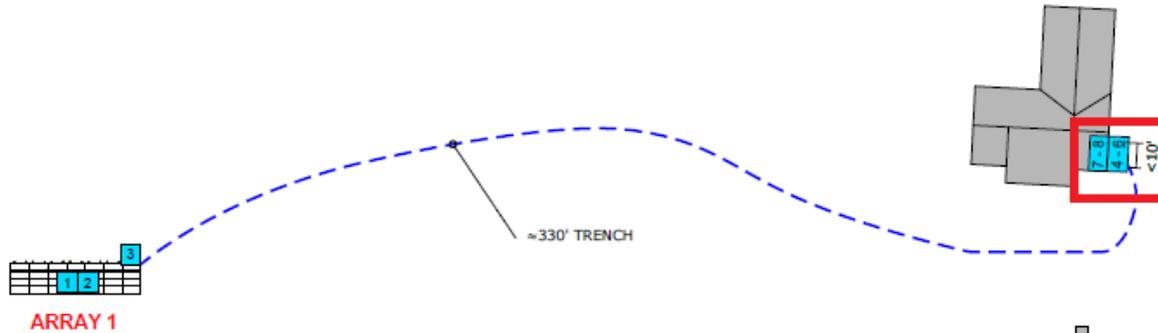
SOLAR PANELS - INVERTERS: 5' MAX
 INVERTERS - PV COMBINER PANEL: 45' MAX
 PV COMBINER PANEL - UTILITY AC DISCONNECT: 330' MAX
 UTILITY AC DISCONNECT - PV PRODUCTION METER: 2'
 PV PRODUCTION METER - MAIN SERVICE DISCONNECT 1: 2'
 MAIN SERVICE DISCONNECT 1 - BI-DIRECTIONAL METER: 5'
 MAIN SERVICE DISCONNECT 2 - BI-DIRECTIONAL METER: 5'

CALL-OUTS:

- 1: SOLAR PANELS
- 2: INVERTERS
- 3: PV COMBINER PANEL
- 4: UTILITY AC DISCONNECT
- 5: PV PRODUCTION METER
- 6: BI-DIRECTIONAL METER
- 7: MAIN SERVICE DISCONNECTION 1
- 8: MAIN SERVICE DISCONNECTION 2

LABELS LOCATED ON PV PRODUCTION METER, BI-DIRECTIONAL METER, AC DISCONNECT(S), INVERTER(S), AND APPROPRIATE LABELS ON MAIN ELECTRIC SERVICE. ALL LABELS ARE PERMANENT, WEATHERPROOF, AND DURABLE
 THERE ARE NO CLEARANCE ISSUES DUE TO OVERHEAD POWERLINES.

XXX AVE



← 20' XXX ST

COMPANY INFORMATION

CLIENT INFORMATION

SYSTEM DETAILS

- NOTES:**
1. (2) ENPHASE IQ7A INVERTER(S) = 9.772kW AC
 2. ARRAY 1: 180° AZIMUTH, 35° TILT (25) JA SOLAR 350W = 10.92kW

PREMISE: N/A

AZIMUTH



REVISIONS

PROJECT-PAGE TITLE

SITE MAP

PAGE NUMBER

A3

APPLICATION PROCESS

- ✘ Set timeline guidelines
 - + Can take up to 4 weeks for simplified
- ✘ Study process takes much longer
 - + 6 months
- ✘ Upgrade requirements may be needed

SO YOU WANT TO GO SOLAR.....

- ✘ High level expectation for solar arrays in MN:
 - + ~\$3.20/watt installed
 - + About a 10 year payback- very simple
 - + Expect about 1100-1200 kWh/kWp/yr
- ✘ Selling Solar:
 - + Customer goals
 - + Longevity in the space (home or business)
 - + Realistic expectations

SELLING SOLAR

- ✘ Solar design concerns
 - + Shade, tilt, azimuth
 - + Roof vs. Ground
 - + Roof condition
 - + Distances to meters/services
- ✘ Customer Goals
 - + Longevity
 - + Utility costs
 - + Ethical concerns
- ✘ Incentives and Financing

FEDERAL TAX CREDIT

- ✘ IRA-Inflation Reduction Act 2022
 - + 30% of the cost of installed systems through 2032
 - + Accelerated depreciation (MACRS) for commercial
 - + Storage systems also have stand alone ITC treatment.
 - + Non-Profit and Governmental- direct pay

SOLARSENSE PROGRAM

- ✘ Small Rebate dollar pool available to retail customers of MP
- ✘ \$5000 cap
- ✘ ~10% of cost
- ✘ Currently approved through 2024
- ✘ March 1-3 application period



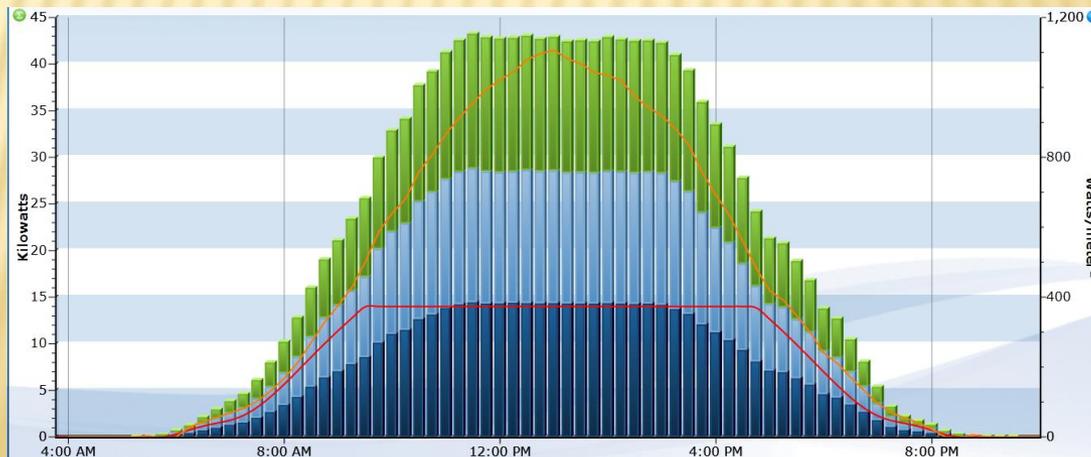
XCEL SOLAR* REWARDS

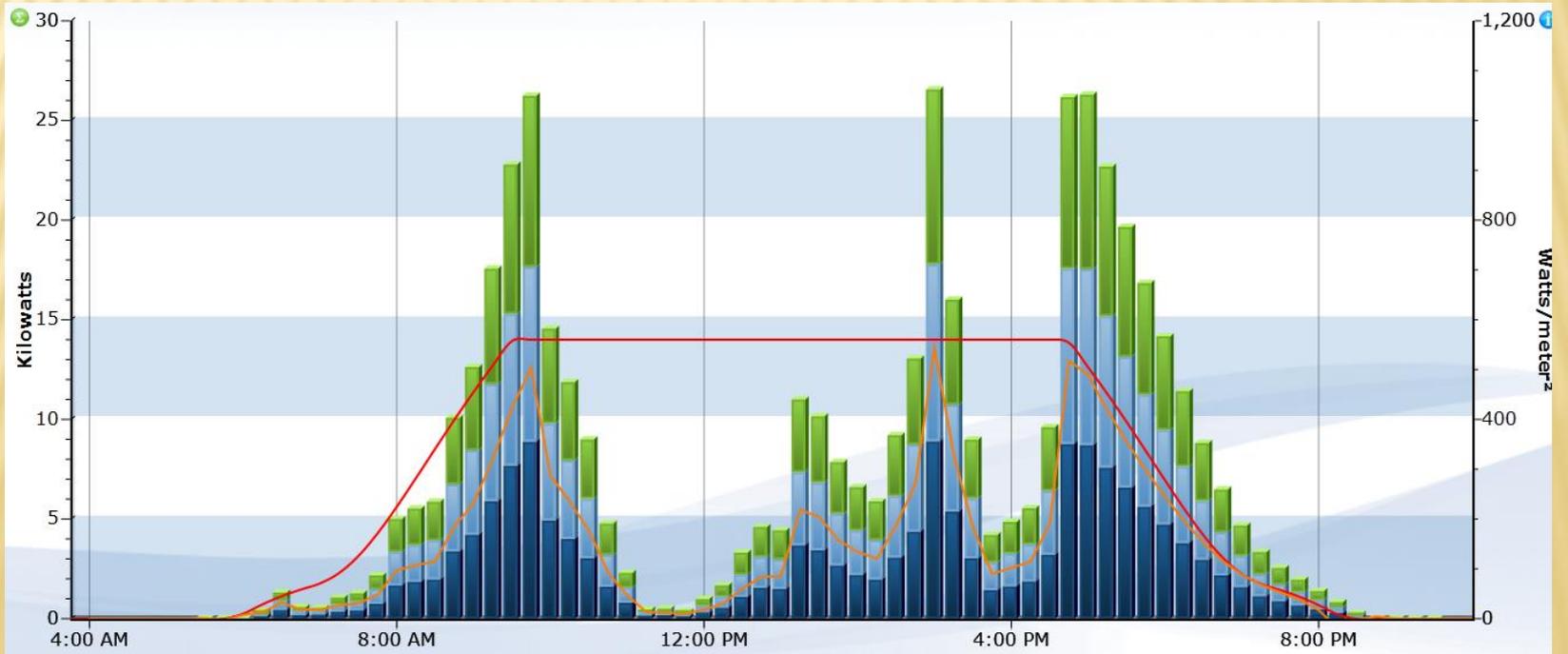
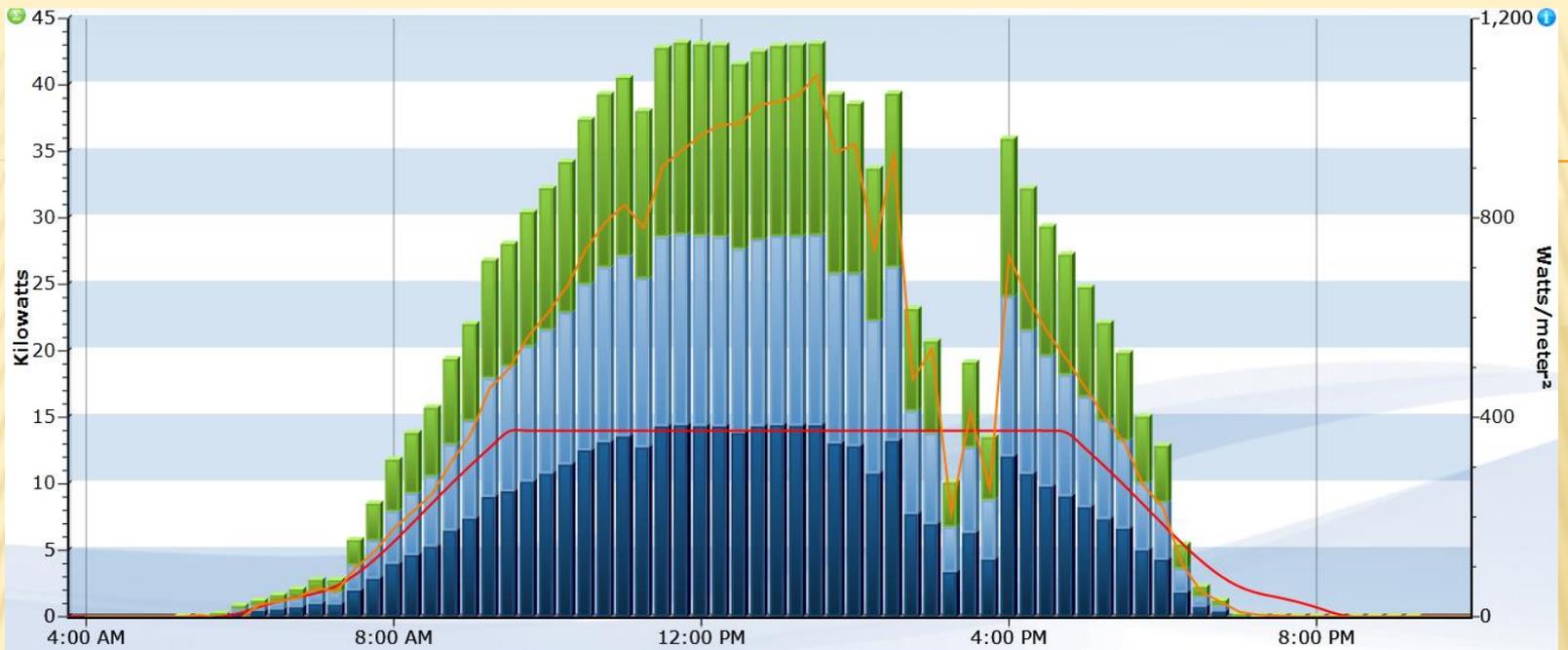
- ✘ Production based incentive: payments based on production of systems
- ✘ 10 years of annual payments
- ✘ \$0.02/kWh Residential
- ✘ Income Qualified program: +\$2/watt
- ✘ Non Prof/Gov: \$0.015 + \$1/watt
- ✘ Multi-Fam: + \$0.50/watt



INTERMITTANT RESOURCE

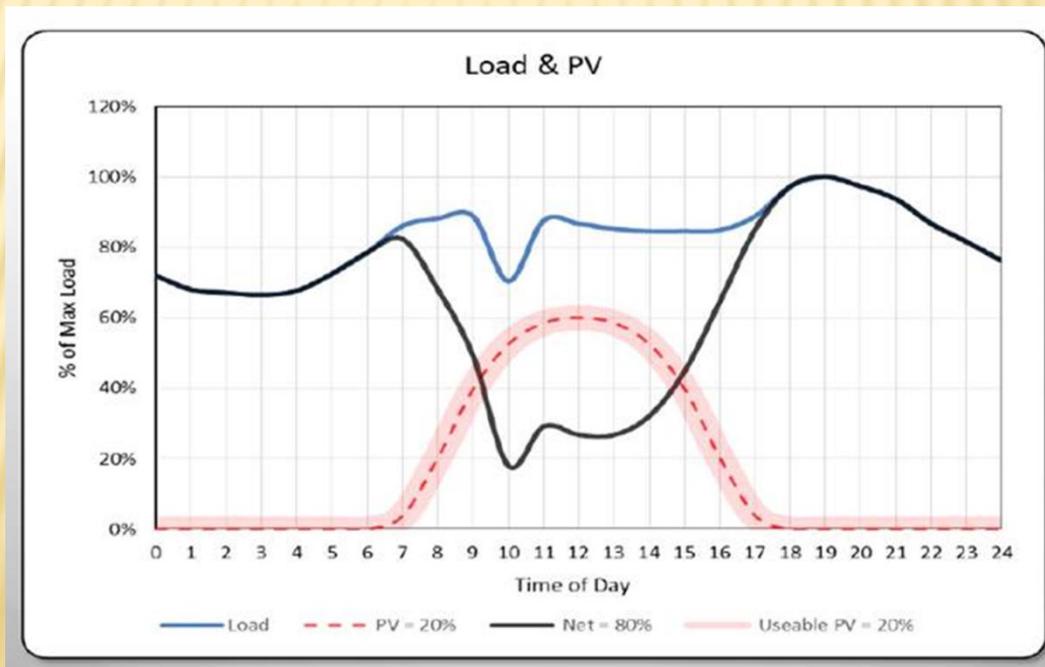
- ✘ Power is produced when the sun is up, and not when it is down
- ✘ Power curves can be erratic
- ✘ As penetration of solar increases, there can be concerning effects





PEAK POWER MATCHING

- ✘ Solar may or may not coincide with the peak power demands
- ✘ Different across states and utility territories



STORAGE AND PEAKER PLANTS

- ✘ Peaker Plants: Natural Gas can help to overcome 'Duck' curve type scenarios
- ✘ Energy storage will help alleviate intermittency issues as well.







NEXUS OF TECH- EVS - STORAGE

THANK YOU!

✘ Questions and Answers

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