Solar Electricity for Home, Farm & Ranch

Using The Sun To Produce Electricity

Milton Geiger, UW Extension

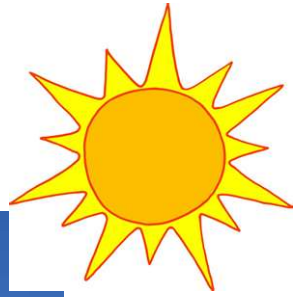
E3A Training

April 14, 2014

Credit: Susan Bilo, Montana State University Extension

Photovoltaics or "PV"

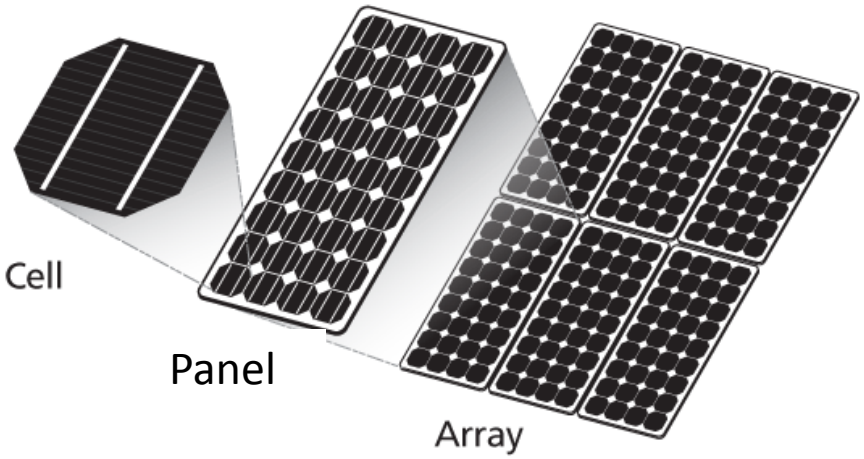
Photo = Light ; **Voltaics** = Electricity



Credit: http://www.solarplusuk.com/solar-electricity

Credit: www.flickr.com

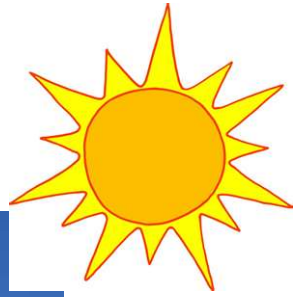
Photovoltaics



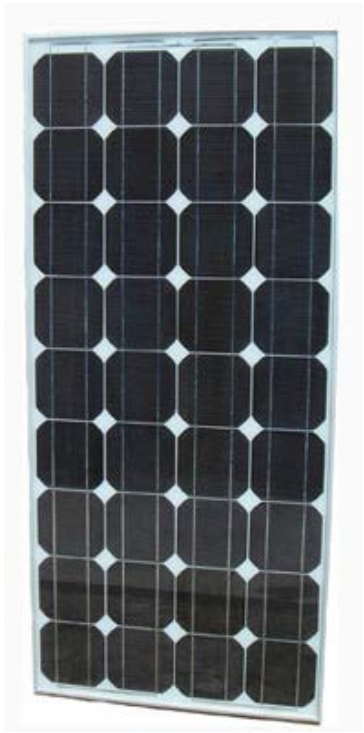
Some History

Credit: NASA

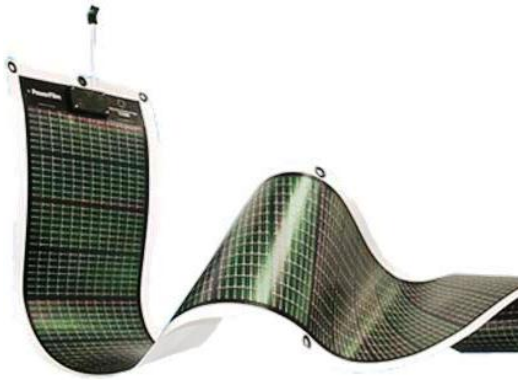
PV Materials Absorb the Sun's Light Energy



PV Materials

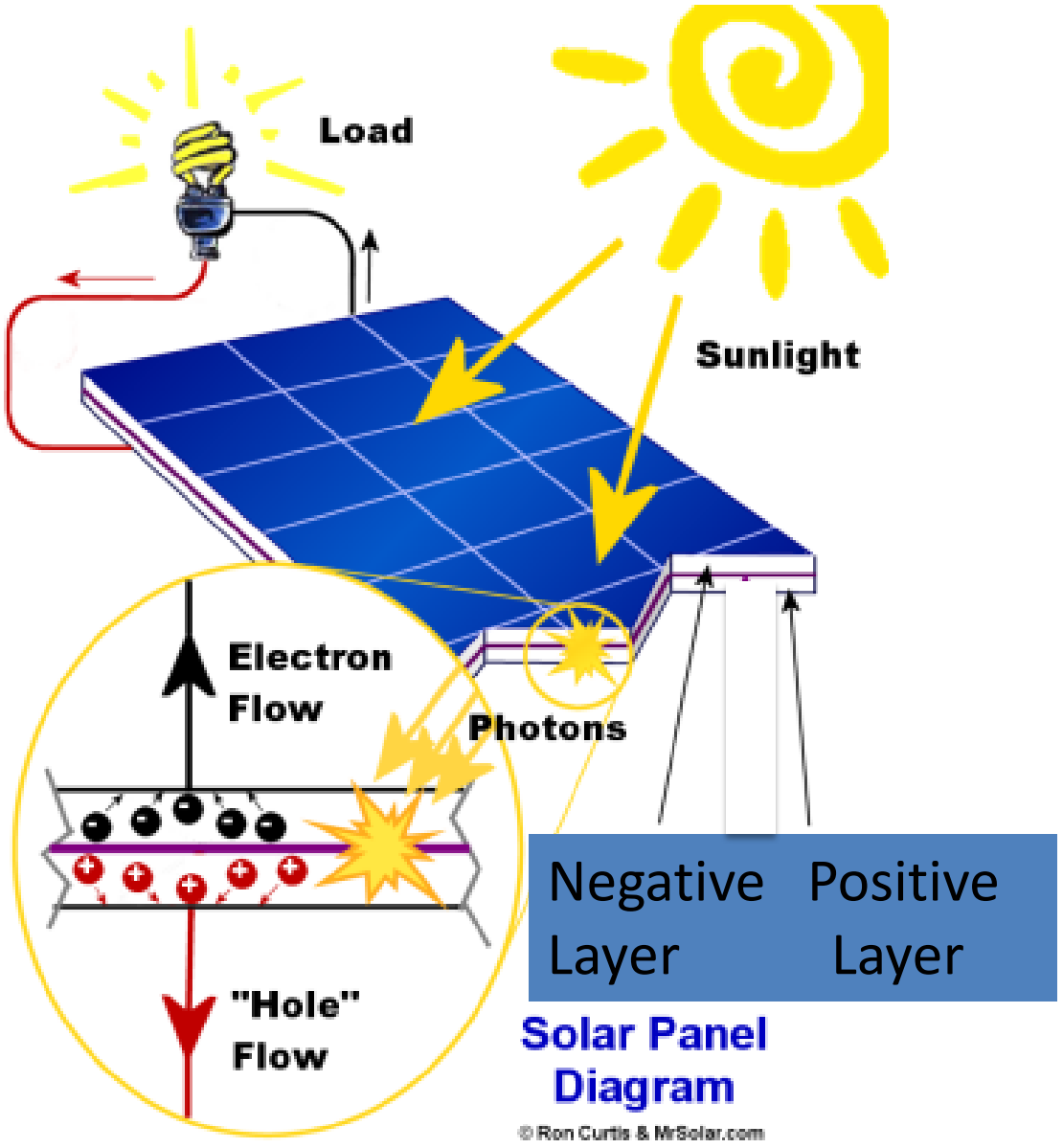


Crystalline Silicon

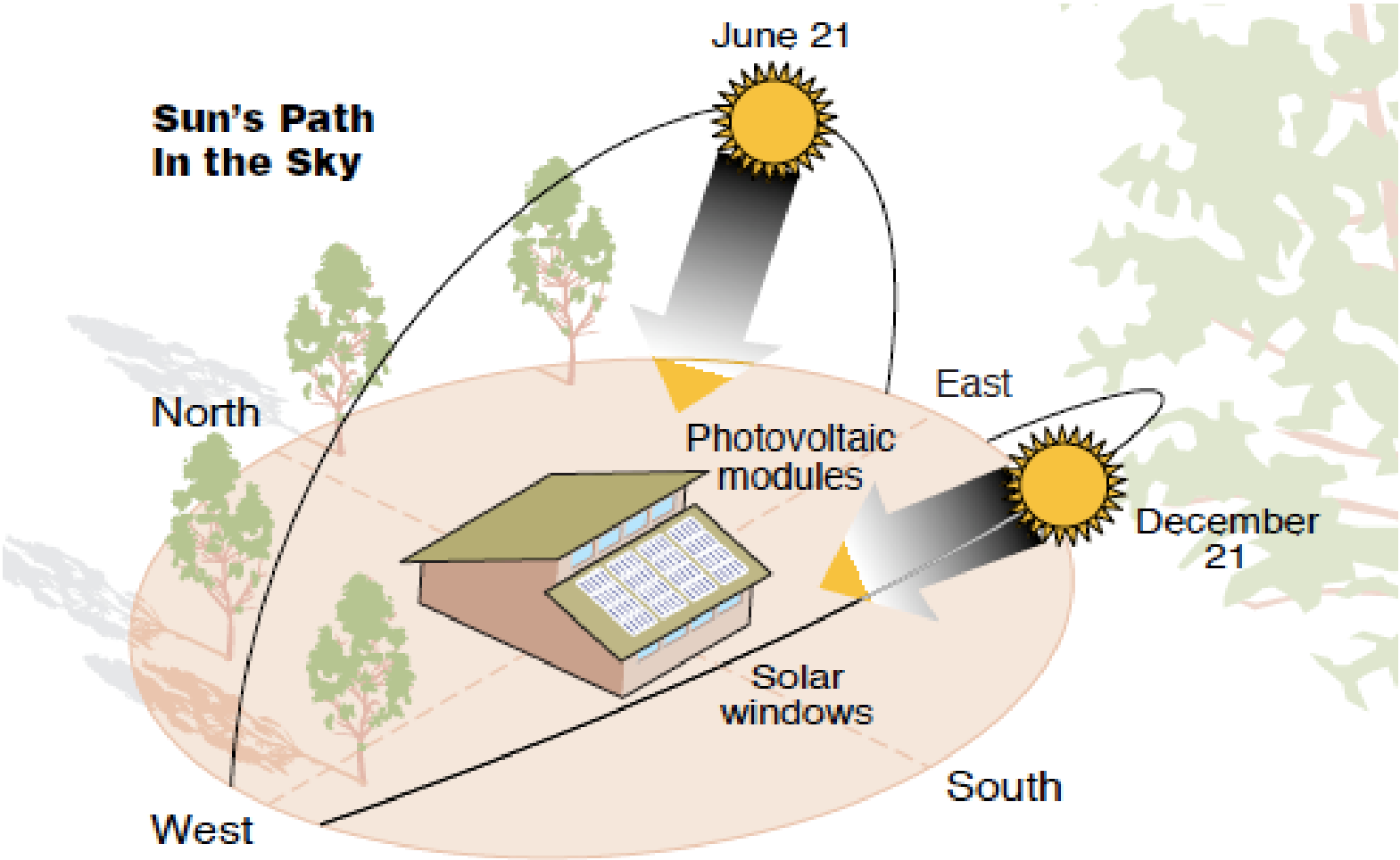


Thin-Film

How Does It Work ?



Solar Orientation



Do You Have Enough Space for Panels?

Credit: Courtesy of DOE/NREL

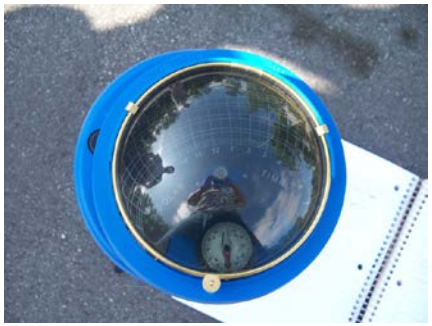
2kW system in Arlee, MT

Credit: SolarPlexus, LLC

The rule of thumb for PV panels is 100 square feet of space is needed for every kilowatt (kW) of electricity produced. For thin-film PV materials (such as solar shingles), about 175 square feet of space per kW is needed.

Got Shade?

Credit: CleanTechies.com



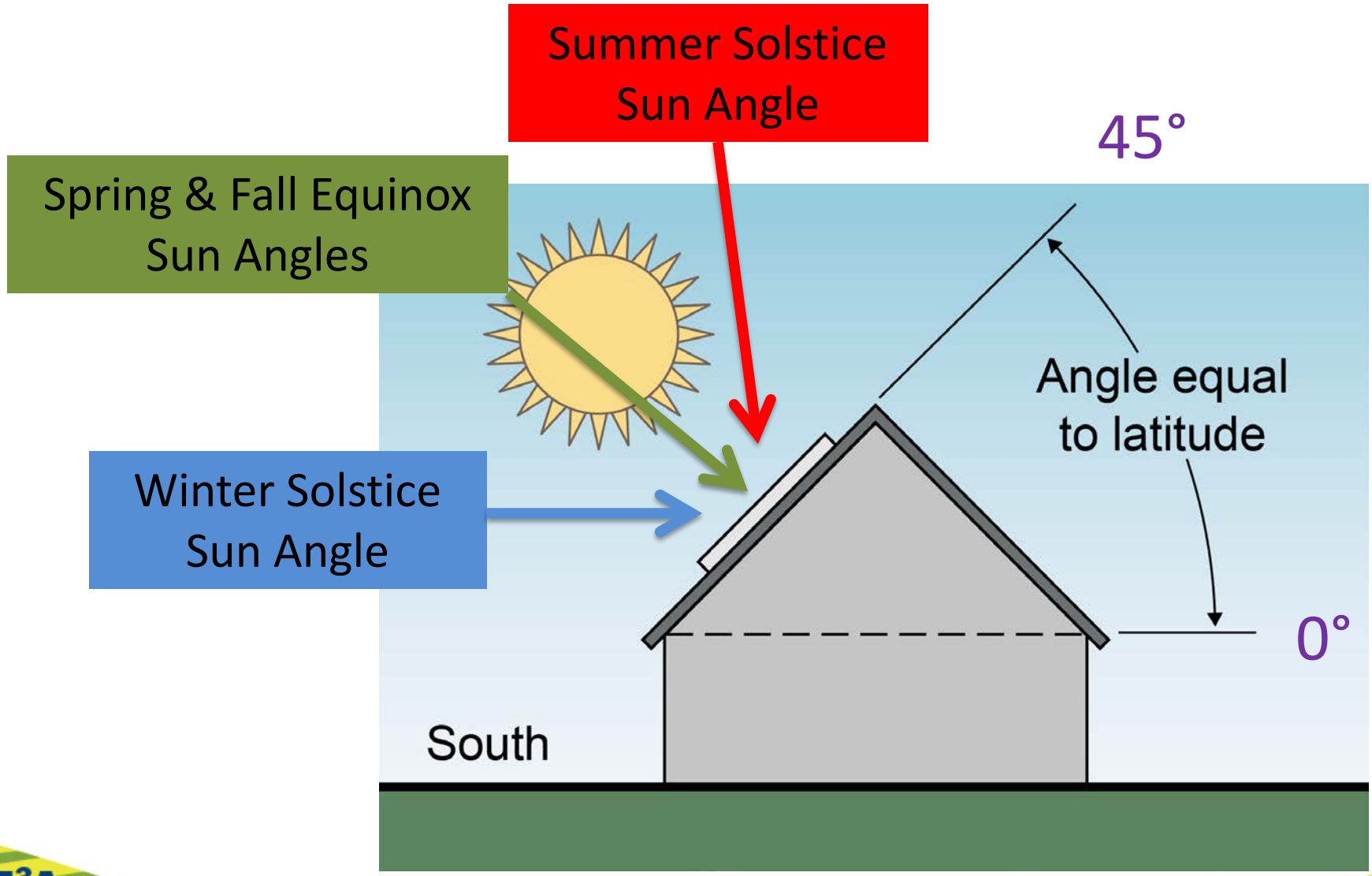
Solar PathFinder

Solmetric's SunEye

Credit: www.energyefficientheatingandcooling.com

E3A

What's Your Angle?



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 irradation on an optimally-inclined surface for the period 1981-1990.
States and countries are shown to scale, except for Alaska.

Mainland United States

Alaska United States

(Alaska Not to Scale)

Hawaii United States

Germany

Alaska USA

Hawaii USA

Germany

Spain

Mainland USA

kWh/m^2/Year

1000 1100 1200 1300 1400 1500 1600 1700 1800 1900 2000 2100 2200 2300 2400 2500

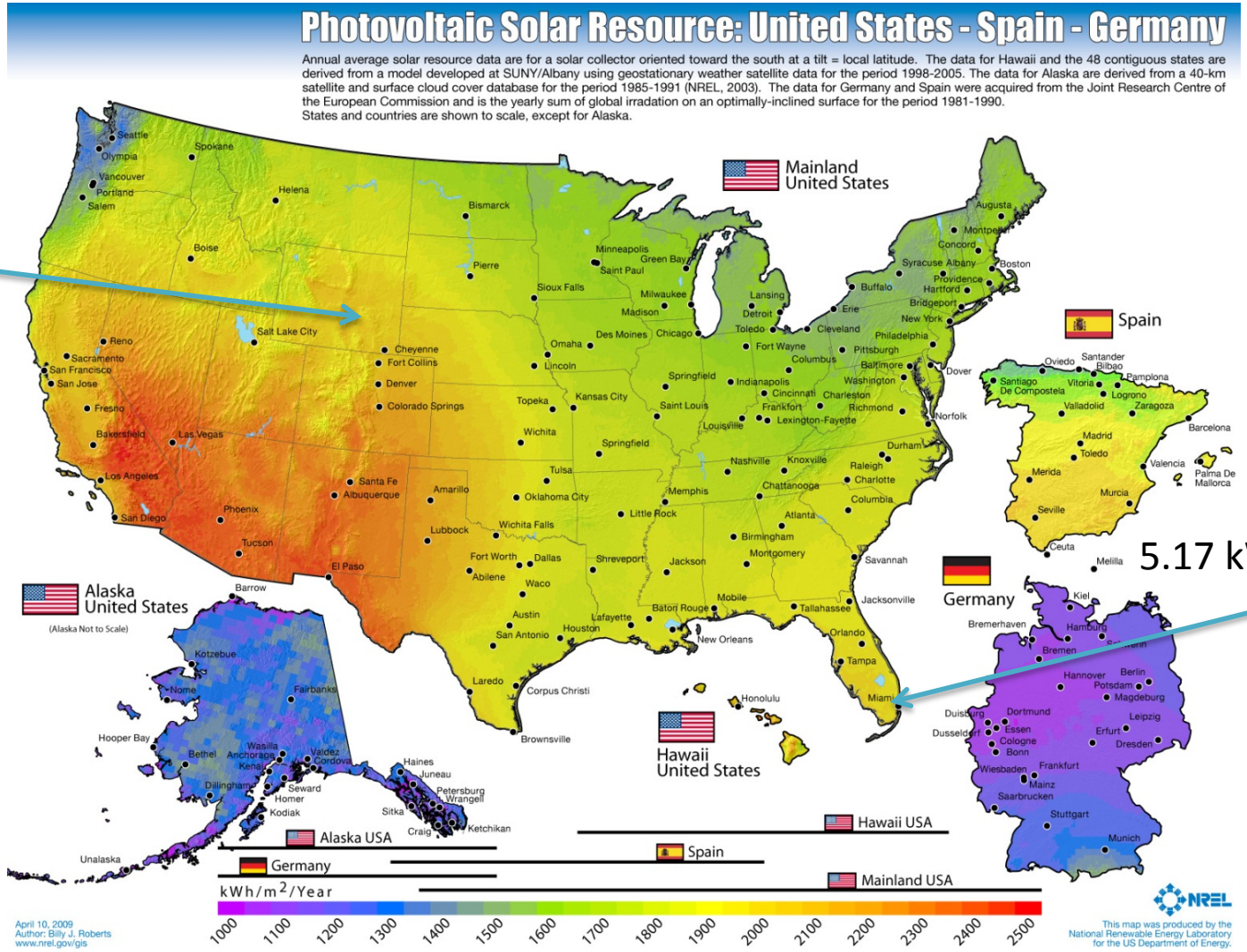
April 10, 2009
Author: Billy J. Roberts
www.nrel.gov/gis

This map was produced by the National Renewable Energy Laboratory for the US Department of Energy.

E^{3}A

Solar – WHYoming

5.35 kWh/ m2/day



5.17 kWh/m2/day

The Solar Resource

Fairbanks, AK

18, 230 watt PV panels = 4140 watts
= 4.140 kW

3810 kWh per year!

Munich, Germany

Same system

3661 kWh per year!

Grid-Connected (Tied) Solar Electric System

→ = Electricity Flow

PV Panels

Inverter

Electrical Load

Electrical Panel/Box

Utility Meter

Utility Grid System

Grid-Connected Solar Electric System With Battery Back-Up

PV Panels

Charge Controller

= Electricity Flow

Batteries

Inverter/Charger

Electrical Load

Electrical Panel/Box

Utility Meter

Utility Grid System

Off-Grid Solar Electric System

PV Panels

Charge Controller

= Electricity Flow

Batteries

DC Electrical Loads
(Optional)

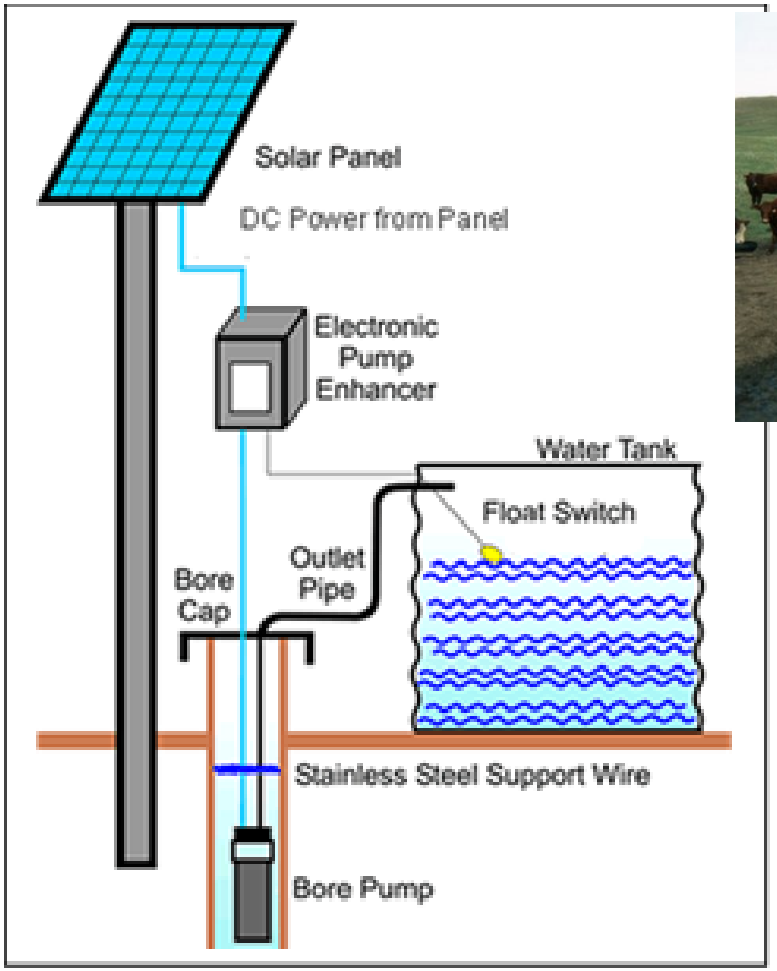
Inverter/Charger

Back-Up Generator

AC Electrical Loads

Electrical Panel/Box

PV Direct Systems



Water-pumping system

Credit: National Center for Appropriate Technology

Credit: DOE/NREL

PV-powered electric fence

Credit: SolarEnergyPros.com

So how do I teach it…

Solar electric – Why

- Reliability
  - No moving parts, long warranties
- Performance
  - Predictable production
- Scalable
  - Small technology for electro fence or utility-owned
- Rapidly declining costs

Solar – Why not

- Intermittency
  - More predictable but the sun doesn't shine at night
- And…

Solar – Why isn't it everywhere?

Cost!

Currently produce electricity at 12-16¢+/kWh!

Department of Energy SunShot Initiative has goal of $1/watt by 2020 = 6¢/kWh

<u>When will grid parity be reached?</u>

<u>In Alaska???????</u>

E3A Folder & Factsheets:

Solar Electricity for Home, Farm & Ranch

Demonstration Units…

Interactive tools…let's build something

- PVWatts v. 2

Incentives – Who you are matters…

- Commercial
  - Bountiful federal opportunities with some state and utility support
- Residential
  - Less federal opportunities with some state and utility support
- Non-profit/public
  - No direct federal opportunities with some state and utility support

Incentives – Where they come from…

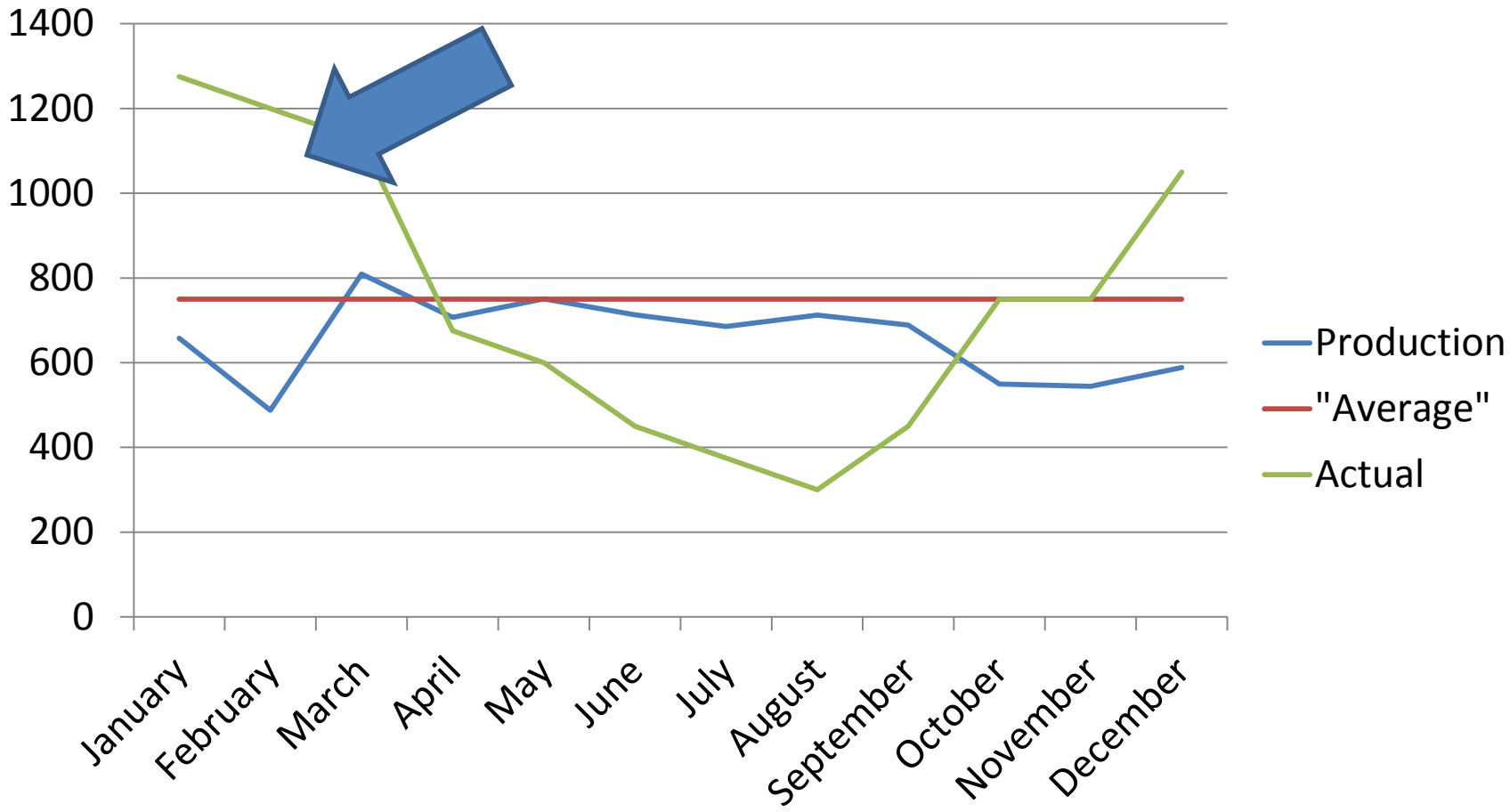
- Utility
  - Limited for solar energy (typically PV) incentives
    - Lower Valley Energy
    - Rocky Mountain Power (Blue Sky grants)
- Local
  - Limited
    - Some conservation districts and non-profits
- State
  - Net metering
- Federal
  - Tax credits
  - Accelerated depreciation
  - Grants/loans

Incentives: Net Metering

- Net metering & interconnection
  - A policy that allows the connection of electricity-producing RE systems to the grid (less than 25 kW);
  - Allows owner to use the reliability of the grid while receiving the full retail rate for production.*

*Sort of…

Incentives – Net metering example



Source: NREL IMBY 6 kW in Laramie, WY

Incentives – Federal tax credits & grants

- Tax credit
  - 30% Business Investment Tax Credit or Residential Renewable Energy Tax Credit
    - Commercial & residential
- Deductions
  - Modified Accelerated cost Recovery System (MACRS) amounts to present value of 15-22% of project cost
    - Available to commercial only
- Grants/loans
  - USDA Rural Development Rural Energy for America Program (REAP)
  - 25% of solar installations in rural areas (all but Cheyenne); $500,000 maximum award
    - Available to commercial only
  - Guaranteed loans also available

Contact Information

- Milton Geiger
  - (307) 766-3002
  - mgeiger1@uwyo.edu

University of Wyoming Extension

School of Energy Resources

E³A