DOE OFFICE OF INDIAN ENERGY

Overview of Energy Technologies and Energy Efficiency (solar, wind, net metering, and energy efficient buildings and infrastructure)

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U.S. DEPARTMENT OF ENERGY

Energy Efficiency then Renewable Energy (EERE)

- All new buildings should be as efficient as possible with the goal of net zero annual energy.
- Determine the energy use and energy cost of existing buildings and infrastructure
- Reduce energy use by installing EE lighting, HVAC and controls and reducing plug loads
- Install RE (Solar, Wind, Biofuels) to meet remaining energy needs

Step 1 – Compile monthly electricity and heating fuel bills

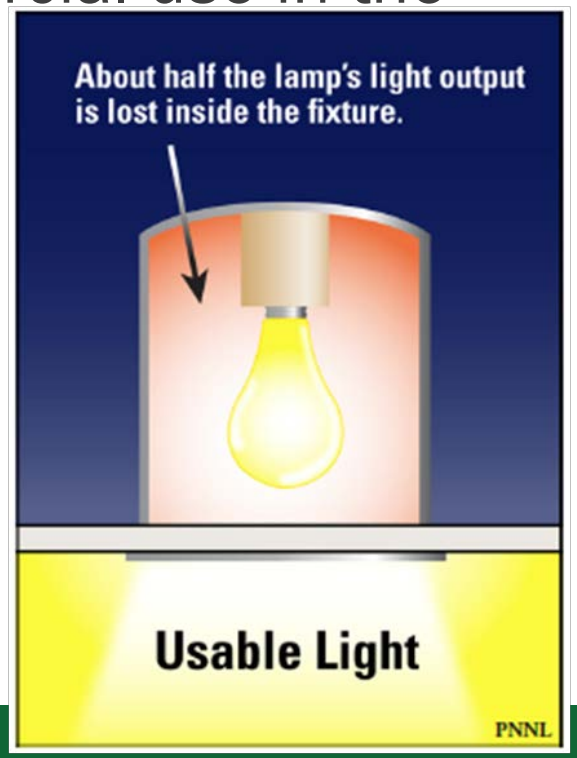
- Where do you go for the data?
  - Finance department
  - Facilities reports
  - Environmental Management Systems
  - Leases
- What are you looking for?
  - Electricity consumption (kWh) and rates ($/kWh)
  - Natural Gas consumption (CCF, Therms, Btu or MMBtu) and rates ($/unit)
  - On-peak and off-peak rates
  - On-peak start time and stop time
  - Utility provider
- Not sure how to read the bills?
  - Ask the finance department
  - Contact the Utility company directly (they're often really helpful)

Background

- Lighting accounts for 25% of the total electricity used in the federal sector
- Electric lighting accounts for more than a third of all electricity consumed for commercial use in the United States

General Energy Saving Strategies

1. Optimize use of natural daylight
2. Replace lamps and ballasts with modern, efficient lamps / ballasts
3. Replace incandescent lamps with compact fluorescent lamps (CFLs)
4. Implement task lighting
5. Install state-of-the-art lighting controls

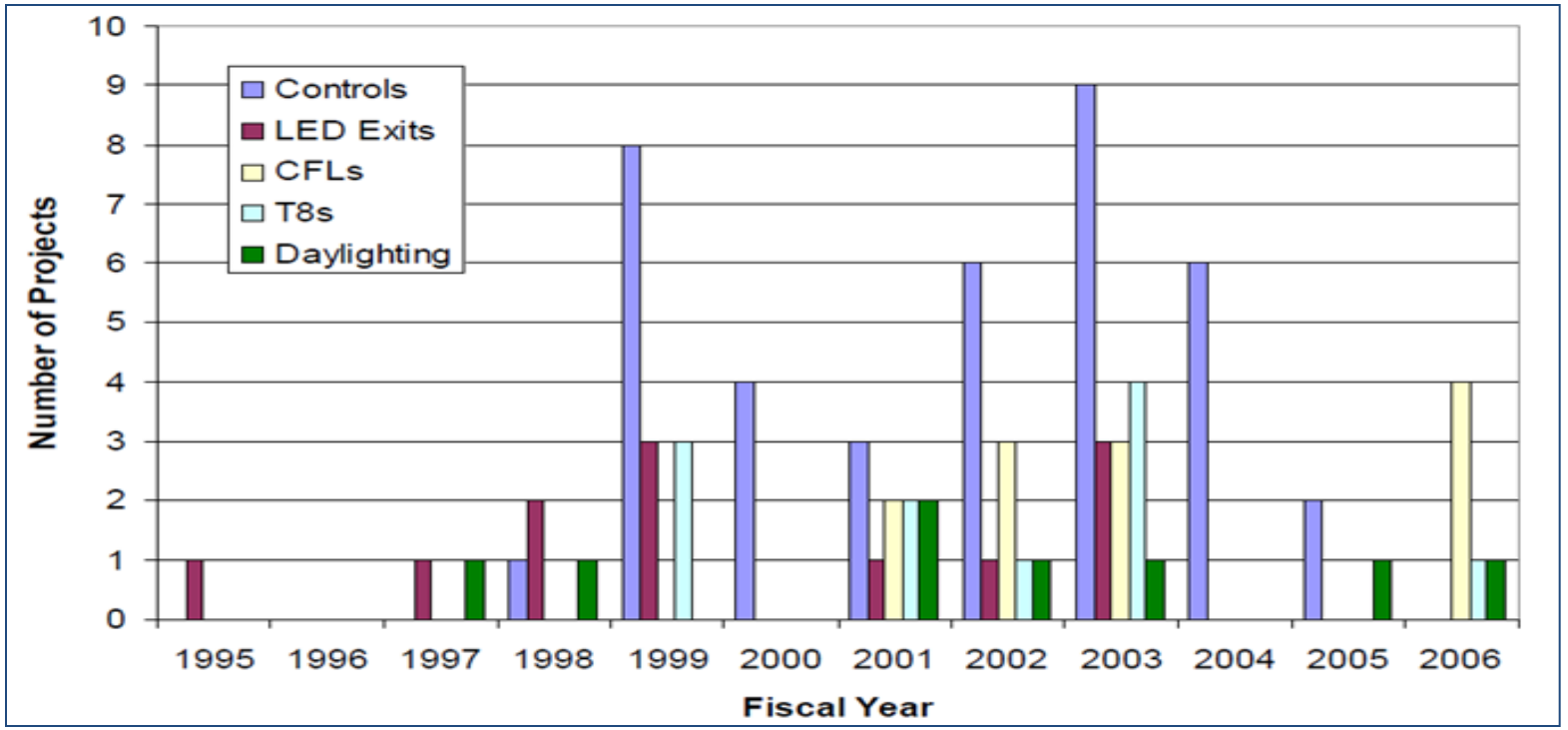


Energy Conservation Measures (ECM's)

- **Fluorescent Lights and Electronic Ballasts**
  - Replace T-12 lamps and Magnetic Ballasts with Low Wattage T-8 Lamps and Electronic Ballasts
  - Replace Standard T-8 Lamps with Low Wattage T-8 Lamps and Low Ballast Factor Ballasts
  - Install Perimeter Dimming Ballasts
  - Optimize Interior Security Lighting
- **Compact Fluorescent Lights (CFL)**
  - Screw-in Lamp Retrofit
- **Light Emitting Diodes (LED)**
  - Replace Standard Exit Signs with LED Exit Signs
  - Install LED Task Lighting
  - Replace Incandescent and HID/HPS Fixtures with LED Fixtures

ECM's - Continued

- Lighting Controls
  - Install Occupancy Sensors in Bathrooms, Conference Rooms and Private Offices
  - Install Central Lighting Controls



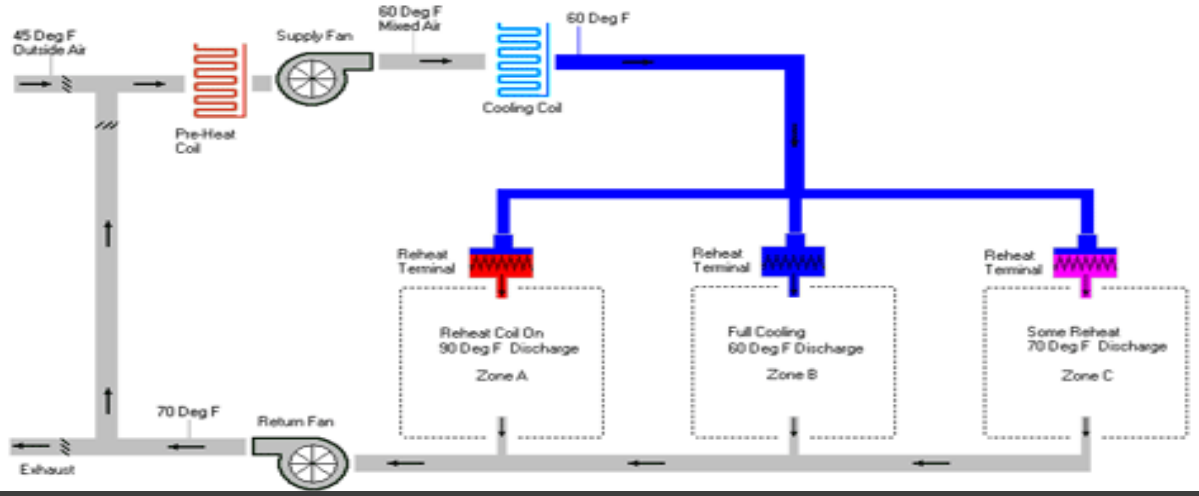
Lighting Projects by Year and Type

HVAC Overview

- Convert CV to VAV
- Convert 3 Way Valves to 2 Way Valves w/ VFDs
- Install Dedicated OA AHU
- Install Static Pressure Sensor and VFD on Small CV AHU
- Install Energy Recovery

Convert CV to VAV

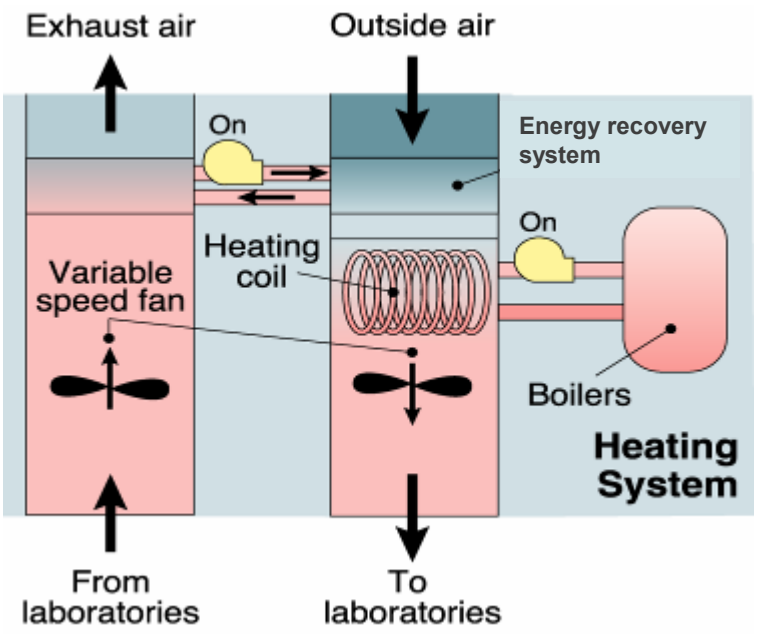
- Constant Volume Configurations:
  - Most constant volume systems have electric or hot water heating elements serving as terminal units
- Variable Air Volume System Components:
  - Each VAV system will have a central air handling unit with a variable speed supply fan (VFD on supply fan)
  - The AHU will contain a cooling coil, controls, mixing box, possibly a return air fan
  - AHU's should be located as close to end loads as possible
  - Existing AHU can be used or it might need to be replaced



http://www.betterbricks.com/graphics/assets/images/Building_Ops/BOpTIsCmnOps_3W.png

Energy Recovery

- Factors that improve energy recovery economics include:
  - Colder climates (e.g. more than 3,000 heating degree-days)
  - High exhaust rates
  - High utility rates
- Consider impact of increase pressure drop due to energy recovery devices in airflow.



Heating Background

- Space heating and water heating accounts for 45% of the energy used in commercial buildings.[1]

General Energy Saving Strategies

1. Install high efficiency equipment
2. Turn equipment down or off as load decreases
3. Install biofuel (typ wood) heating systems

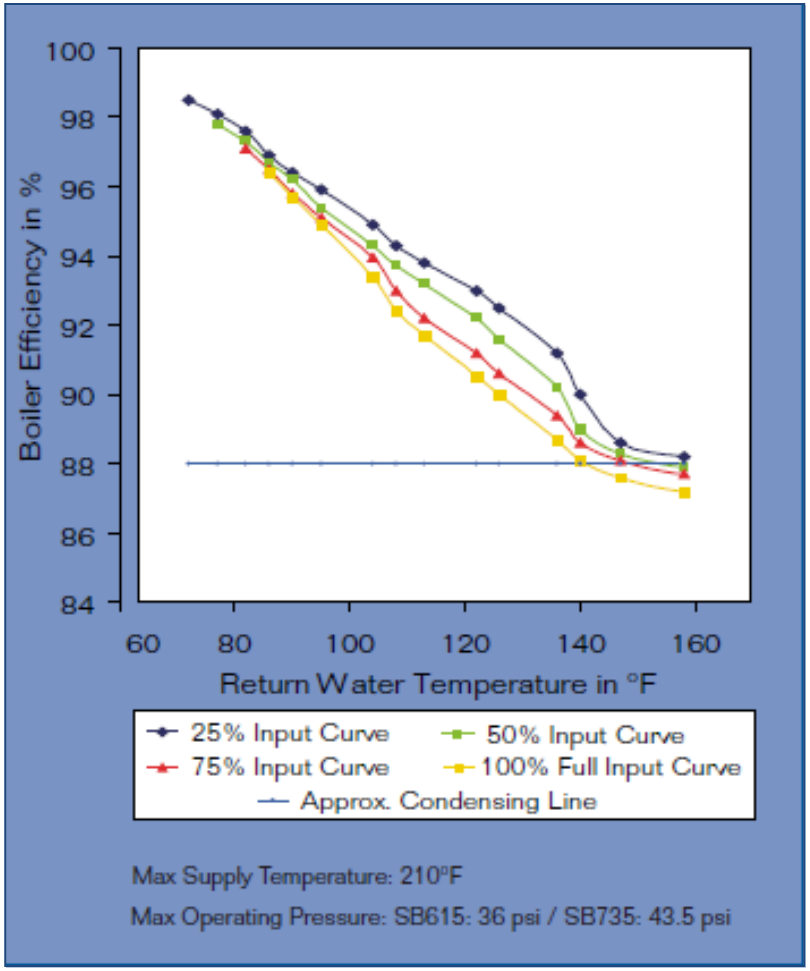
Reference: 2005 Buildings Energy Data Book, EIA/DOE

Install Condensing Gas Furnace

- Small condensing furnaces have efficiencies 92% - 96%
- Great application for smaller facilities
- PVC exhaust stack reduces installed cost

Consider Installing Condensing Boilers

- Condensing boiler benefits:
  - High efficiencies ~ 98%, low Nox
  - Good part load efficiencies
- Condensing boiler issues:
  - Most common problem is high return water temperatures
  - Typical heating coils are 180 F/ 150 F
  - Won't work if the building is heated with only perimeter baseboard heaters
- Condensing remedies:
  - Install 180/120 F cooling coils (60 deg delta) w/ supply water temp reset
  - Set them up with two return water steams



HVAC Control Overview

- Install Programmable Thermostats
- Replace Pneumatic Sensors with Electronic Sensors
- Reduce OA and EA Flow Rates per ASHRAE 62
- Enable Air-side Enthalpy Economizer Operation
- Optimize Supply and Exhaust Air Duct Work Static Pressure

Background

- HVAC Control system improvements typically produce considerable energy savings with minimal capital investments

General Energy Saving Strategies

1. Match HVAC schedules to occupancy schedules
2. Optimize current control strategies for improved efficiency and comfort

Install Programmable Thermostats

- Programmable Thermostat Applications:
  - Control of zone
  - Control of system such as a packaged air handling unit
- Programmable Thermostat Requirements:
  - Commercial building unit
  - Minimum of 7 day scheduling capability
  - EASY TO PROGRAM
  - Able to turn zone or unit on-off based on time and temperature
  - Adjustable dead-band (differential where thermostat remains neutral – no heating or cooling)
- Programmable Thermostat Optional:
  - Occupied/unoccupied control
  - Heating only
  - Cooling only
  - Ventilation only

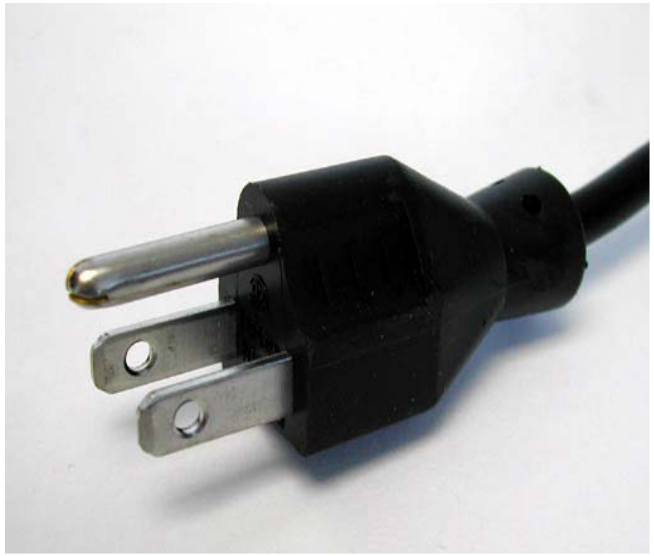
http://yourhome.honeywell.com/Consumer/Cultures/en-US/Products/Thermostats/Do-It-Yourself/Default.htm

Plug Loads Overview

- Definition of Plug Loads
- Energy conservation measures to reduce plug loads
  - Activate power management on computers and monitors
  - Replace desktop computers with laptop computers and a docking station
  - Replace desktop computers with low energy desktop computers or thin clients
  - Replace CRT monitors with LCD monitors
  - Install vending machine misers on refrigerated vending machines and de-lamp advertising lighting
  - Install occupancy sensor controlled surge protectors in offices
  - Replace appliances with Energy Star appliances
  - Others
    - Network printers to reduce the number of personal printers
    - Replace task lighting with LED task lighting
    - Replace office equipment with Energy Star models

Plug Loads

- Plug loads are devices that plug into a building's electrical system. They include:
  - Office equipment (fax machines, computers, printers, and copiers)
  - Appliances
  - Soda machines
  - Drinking fountains
  - TVs
  - VCRs

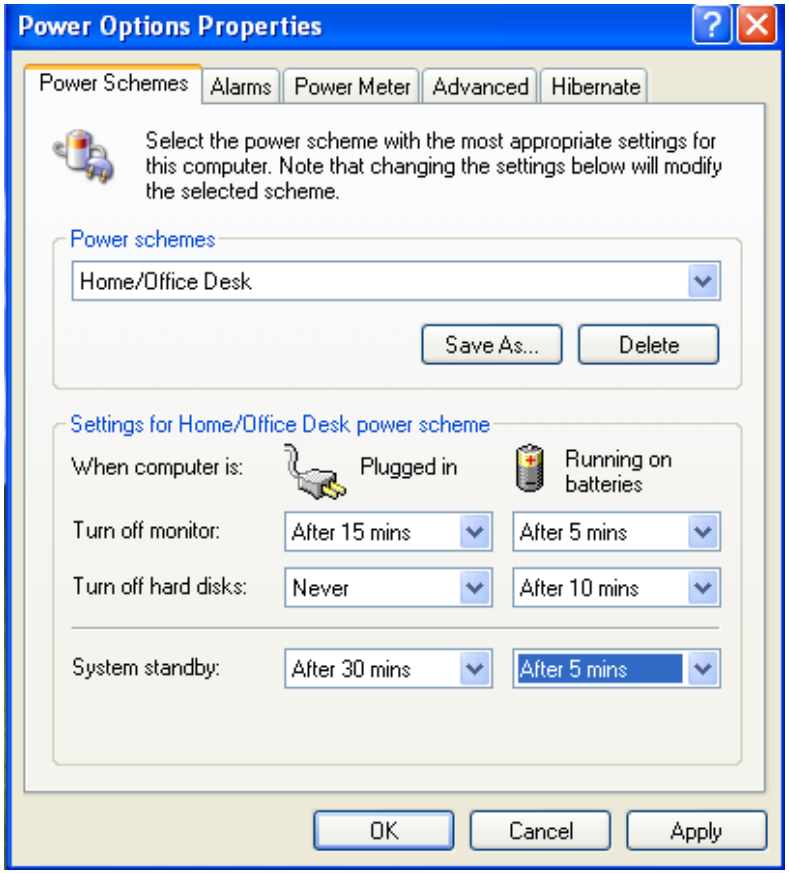


- Plug loads account for 9% of a building's total electrical use

ECM: Activate Power Management on Computers and Monitors

- Technical Specifications
  - Activate power management settings on all computers through built-in Windows tools
    - "Turn off monitor" set to **15** minutes
    - "System Standby" set to **30** minutes
    - "Hibernation" set to **45** minutes
  - Limit screen-saver use

- Cost Guidelines
  - Power management settings are already built in to Windows at no additional cost
  - Average labor time per computer should be 15 minutes

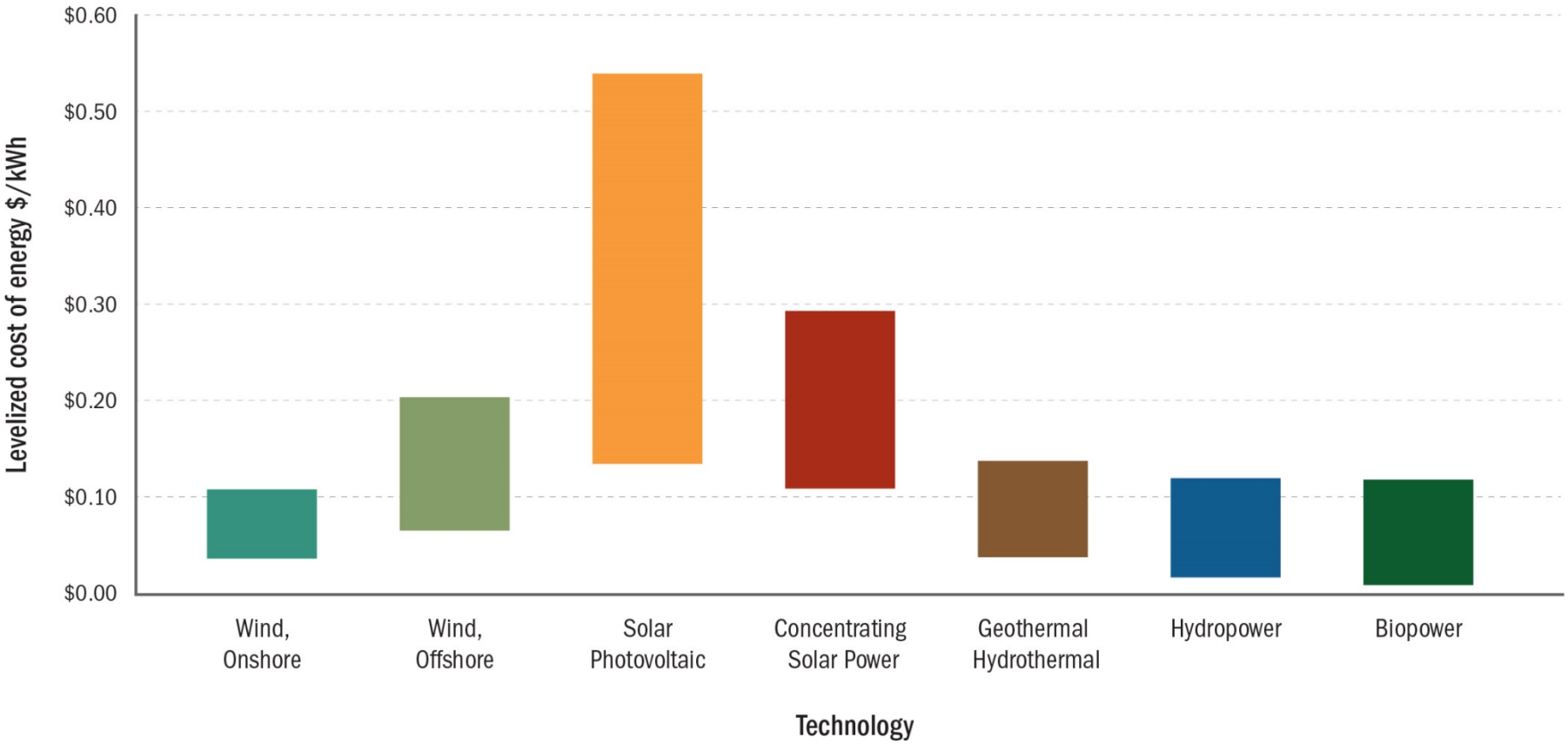


ECM: Replace Appliances with Energy Star Appliances

- Refrigerators
  - Specify refrigerators at least 20% more energy efficient than the minimum federal government standard (NAECA)
- Clothes washers
  - Specify modified energy factor (MEF) ≥1.72
    - MEF equals washer capacity divided by total energy consumption per cycle
  - Specify water factor (WF) ≤8.0
    - WF is the water consumption per cycle divided by the washer capacity
- See *http://www.energystar.gov/index.cfm?c=appliances.pr_appliances* for Energy Star specifications on other appliances

LCOE

Lifetime or Levelized Costs of Renewables



DSIRE™
Database of State Incentives for Renewables & Efficiency

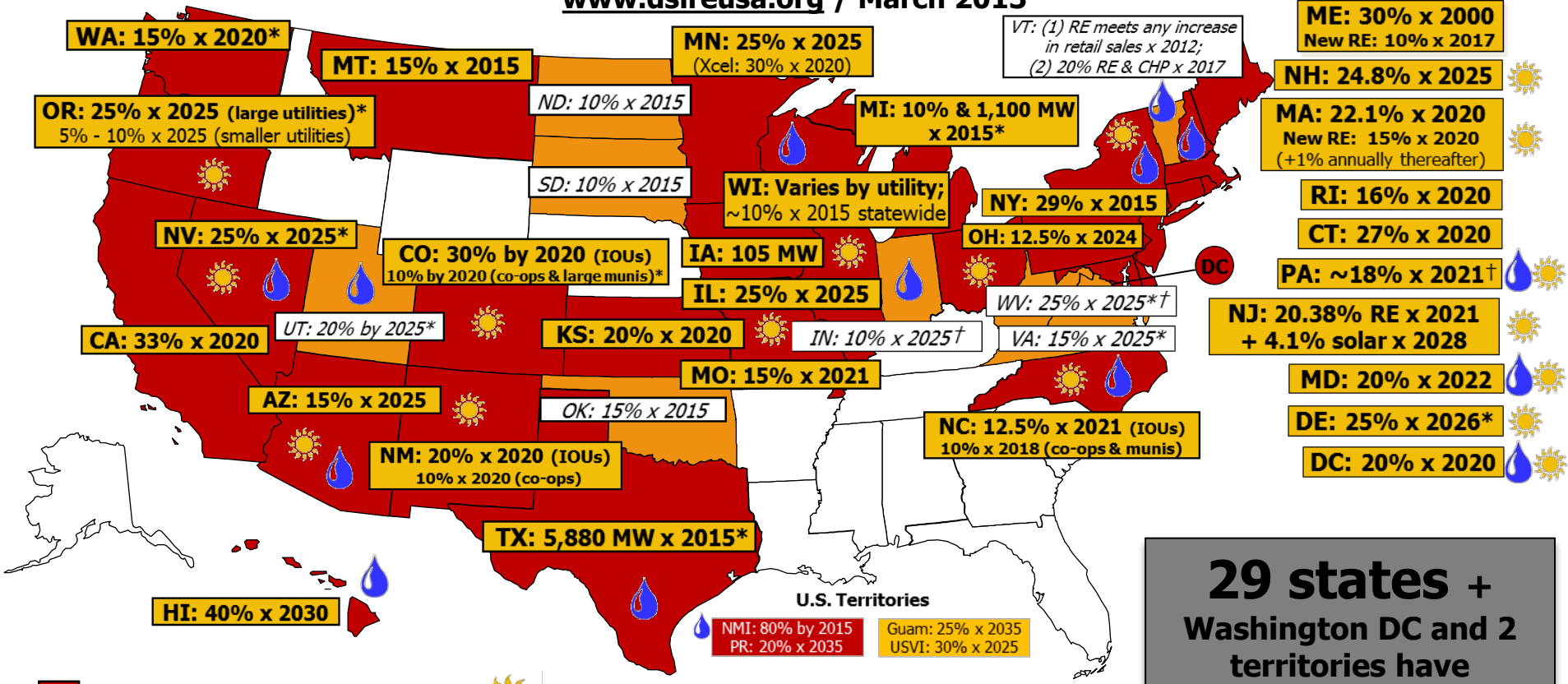
U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

IREC Interstate Renewable Energy Council

NORTH CAROLINA Solar Center

Renewable Portfolio Standard Policies

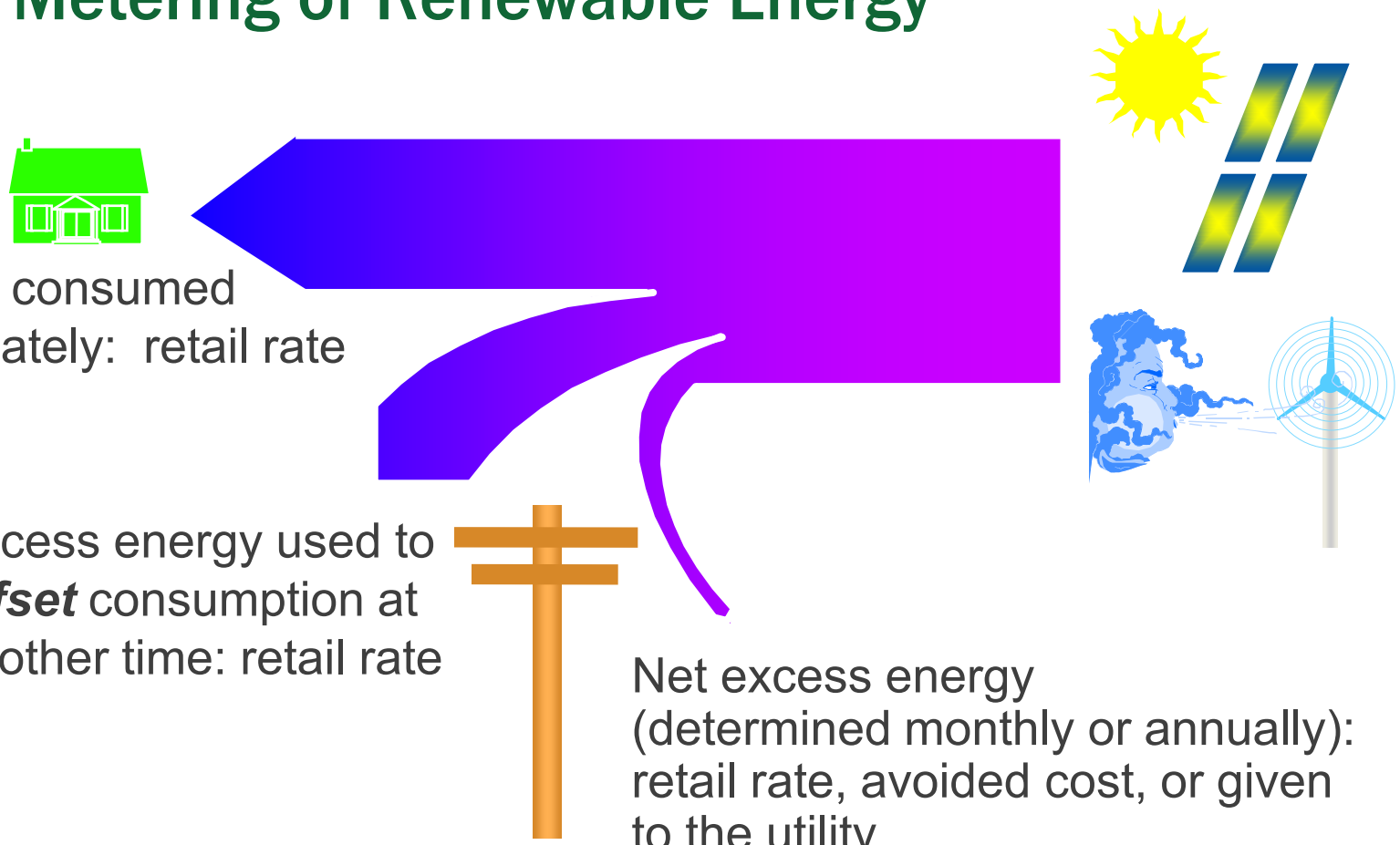
www.dsireusa.org / March 2013



29 states +
Washington DC and 2 territories have Renewable Portfolio Standards
(8 states and 2 territories have renewable portfolio goals)

- Renewable portfolio standard
- Renewable portfolio goal
- Solar water heating eligible
- Minimum solar or customer-sited requirement
- * Extra credit for solar or customer-sited renewables
- † Includes non-renewable alternative resources

Net Metering of Renewable Energy



Energy consumed immediately: retail rate

Excess energy used to ***offset*** consumption at another time: retail rate

Net excess energy (determined monthly or annually): retail rate, avoided cost, or given to the utility

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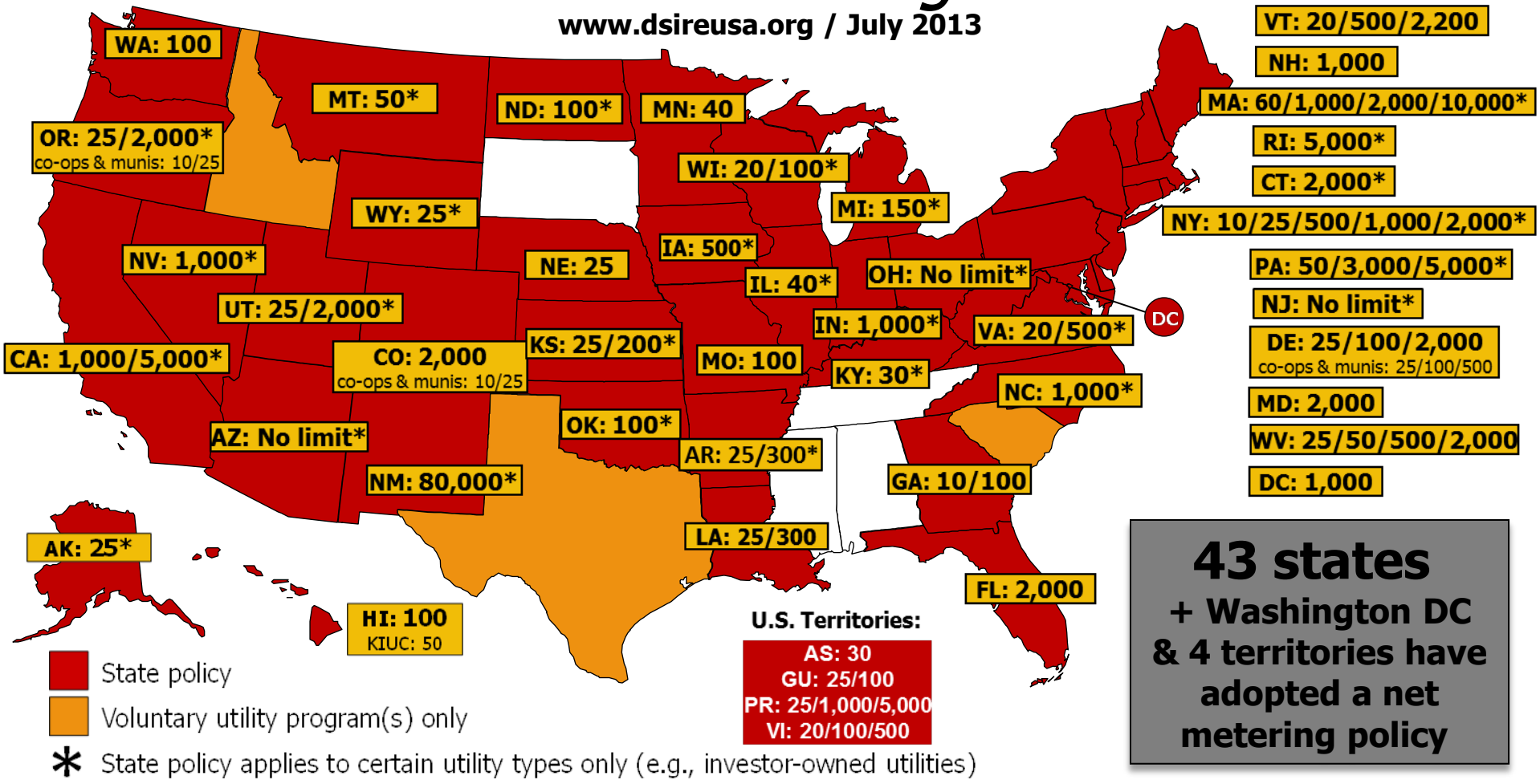
Net Metering

www.dsireusa.org / July 2013



U.S. Territories:

AS: 30
GU: 25/100
PR: 25/1,000/5,000
VI: 20/100/500

State policy

Voluntary utility program(s) only

* State policy applies to certain utility types only (e.g., investor-owned utilities)

43 states
+ Washington DC & 4 territories have adopted a net metering policy

Note: Numbers indicate individual system capacity limit in kilowatts. Some limits vary by customer type, technology and/or application. Other limits might also apply. This map generally does not address statutory changes until administrative rules have been adopted to implement such changes.

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Database of State Incentives for Renewables & Efficiency

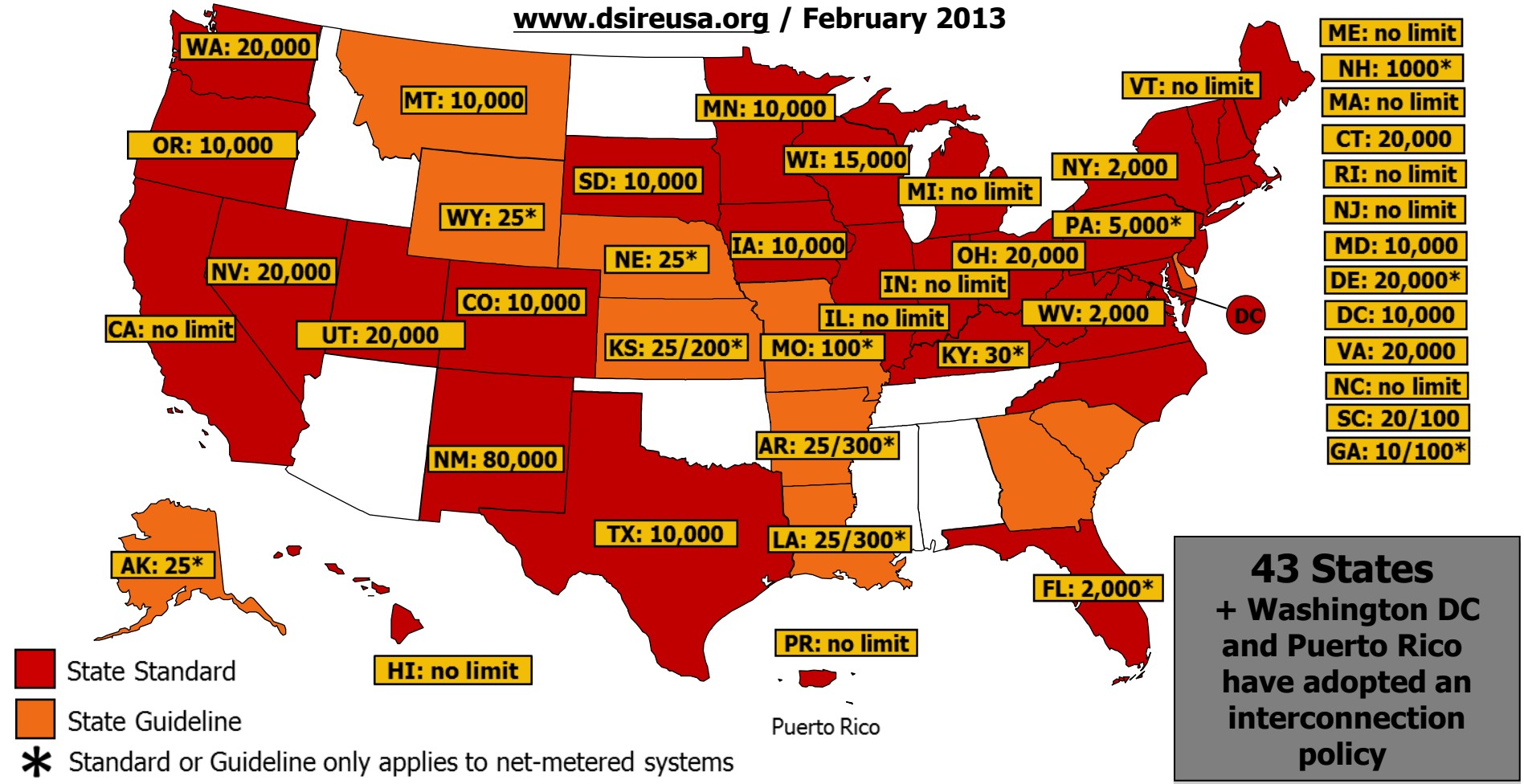
U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

IREC Interstate Renewable Energy Council

North Carolina Solar Center

Interconnection Policies

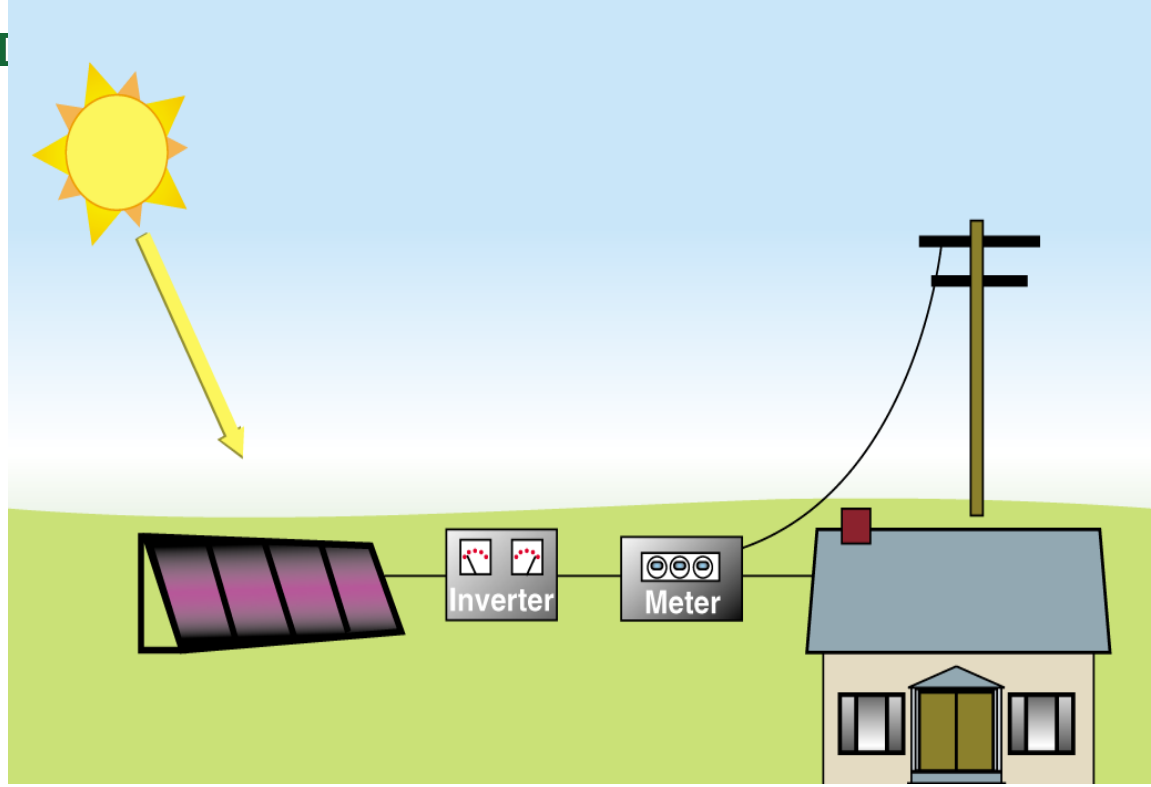
www.dsireusa.org / February 2013



43 States
+ Washington DC and Puerto Rico have adopted an interconnection policy

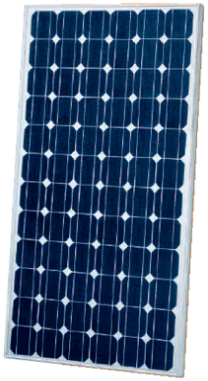
Notes: Numbers indicate system capacity limit in kW. Some state limits vary by customer type (e.g., residential versus non-residential). "No limit" means that there is no stated maximum size for individual systems. Other limits may apply. Generally, state interconnection standards apply only to investor-owned utilities.

PV Technology Overview



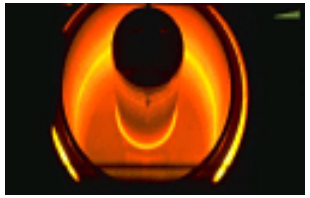
- Direct conversion of sunlight into DC electricity
- DC converted to AC by inverter
- Solid-state electronics, no-moving parts
- High reliability, warranties of 20 years or more
- PV modules are wired in series and parallel to meet voltage and current requirements

Common PV Technologies



Single Crystal
14 to 23%

Notes: Most efficient. Rigid.



Multi-Crystal
13 to 17%

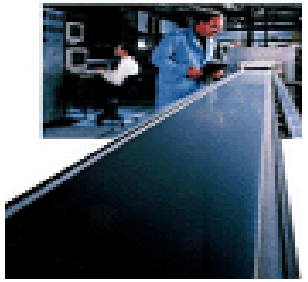
Notes: Efficient. Most Common. Less area per watt. Rigid.

CIGS
12% to 14%

Notes: Uses no Silicon. Can be made flexible.

Cadmium Telluride
10% to 11%

Notes: Uses no Silicon. Rigid.

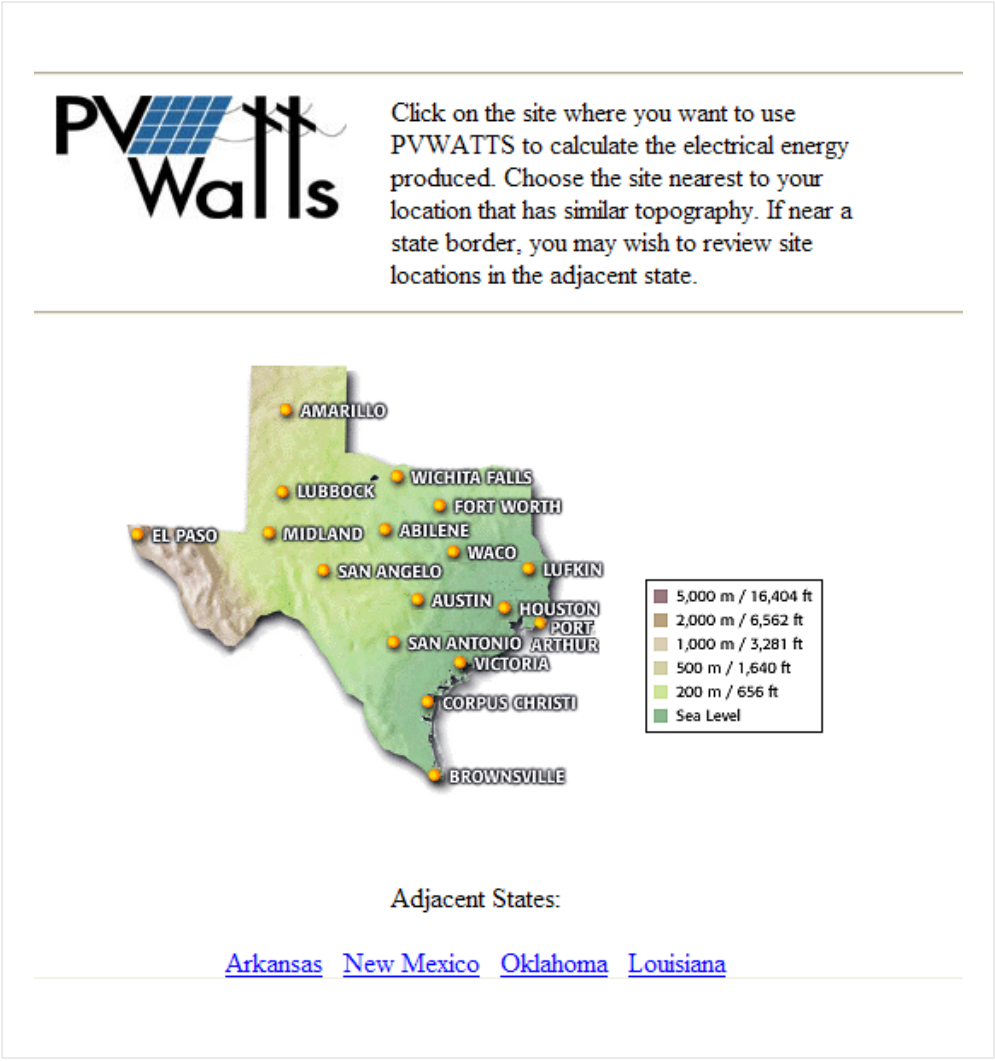


Thin Film Si
6 to 11%

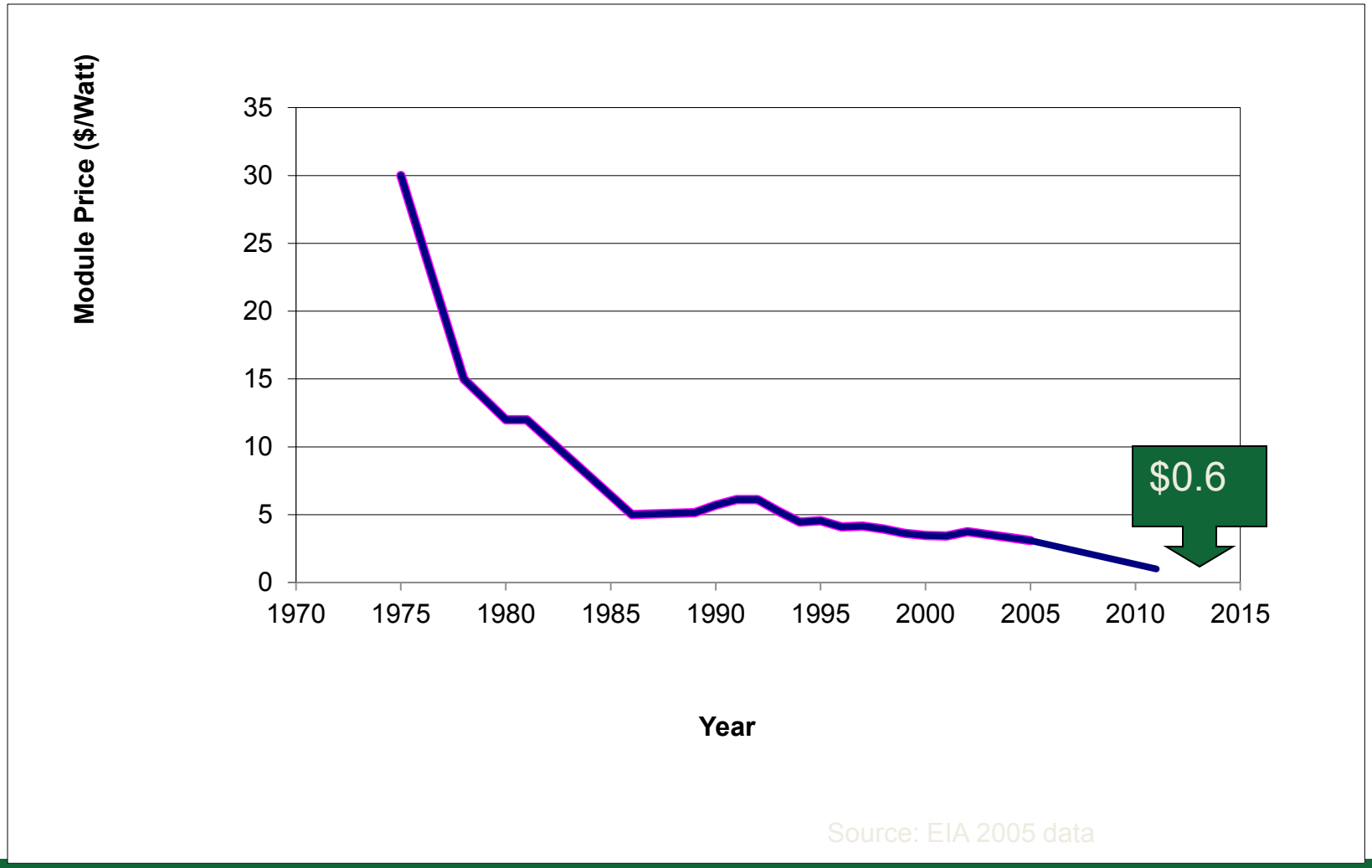
Notes: Uses relatively little Silicon. Can be made flexible.

PV Watts

- **PV Watts** Photovoltaic Analysis
  - Select default values *or* input customized system parameters for size, electric cost, array type, tilt angle, and azimuth angle
  - Typical Meteorological Year weather data for the selected location (TMY files) used to calculate incident solar radiation and PV cell temperature for each hour of the year
- **Benefits**
  - Easy to use
  - Very Quick
  - Useful for users of all technical levels
  - Widely accepted tool



Price of PV Modules



Source: EIA 2005 data

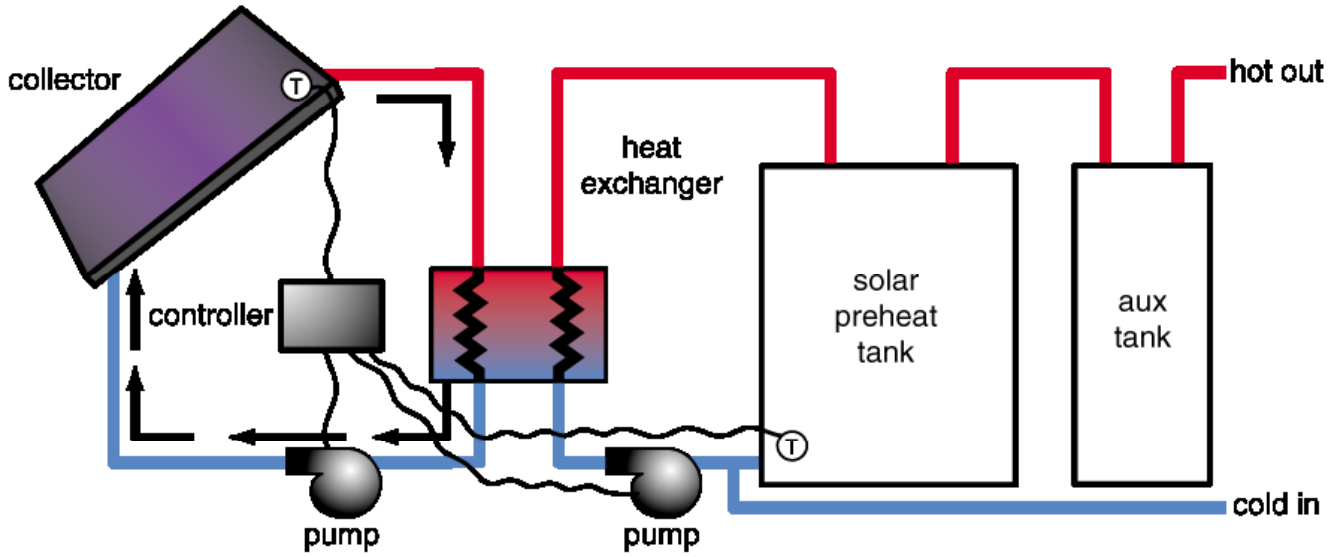
Costs

- **Use PPA or PERFORMANCE SPECS (kWh/year) not specific manufacture or kW.**
- **Provide clear requirements and evaluation criteria**
- **Costs depend on:**
  - Size – bigger is better:
  - Balance of system costs including structures, inverters, electrical and interconnection.
- **Lowest cost is large (5 MW+) ground mount, $2/W (6-14)**
- **Ballasted or Direct roof attachment such as standing seam metal roof – Installed approx. $3/Wdc for 100kW**
- **Single axis tracking (over 300 kW in SW) – add $0.1/W**
- **Carports – add $0.6/W (careful w/ snow and ice)**
- **High efficiency modules (GT 17%) add $0.3/W**

PV Net Zero Energy Home Example in Boulder, CO

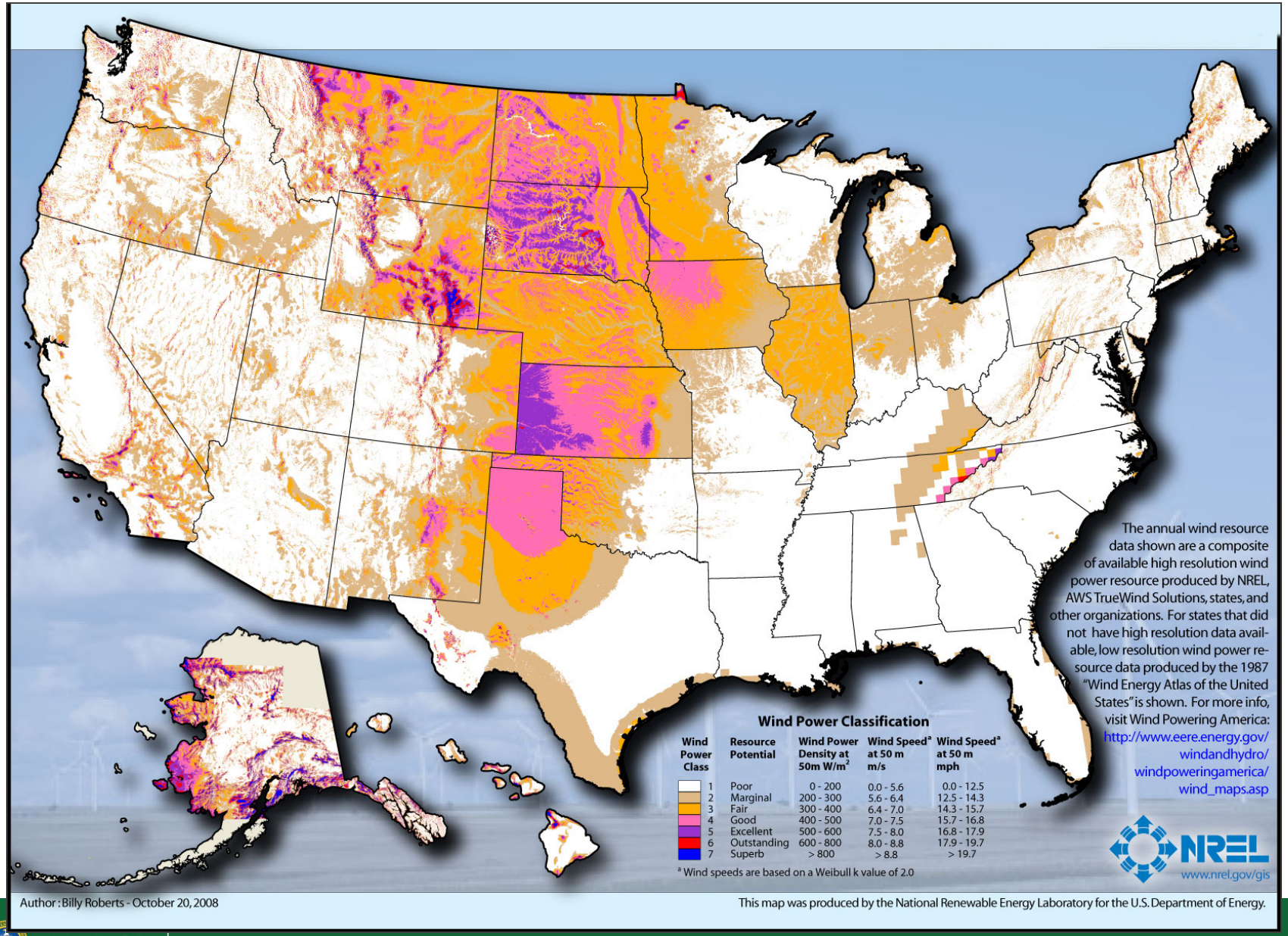
- **Annual Energy use = 6000 kWh**
- **PV on south facing roof sloped at 20 degrees produces 1458 kWh/kW Annual with 0.8 derate factor**
- **6000 kWh/1458kWh/kW = 4.1 kW**
- **Expected cost at $4/W = $16.4K before incentives**
- **Area required = 4100 W/11W/sq ft = 373 sq ft.**

SHW - Active, Closed-loop (antifreeze), Indirect System



- Excellent freeze protection
- Good hard water tolerance
- High maintenance requirements

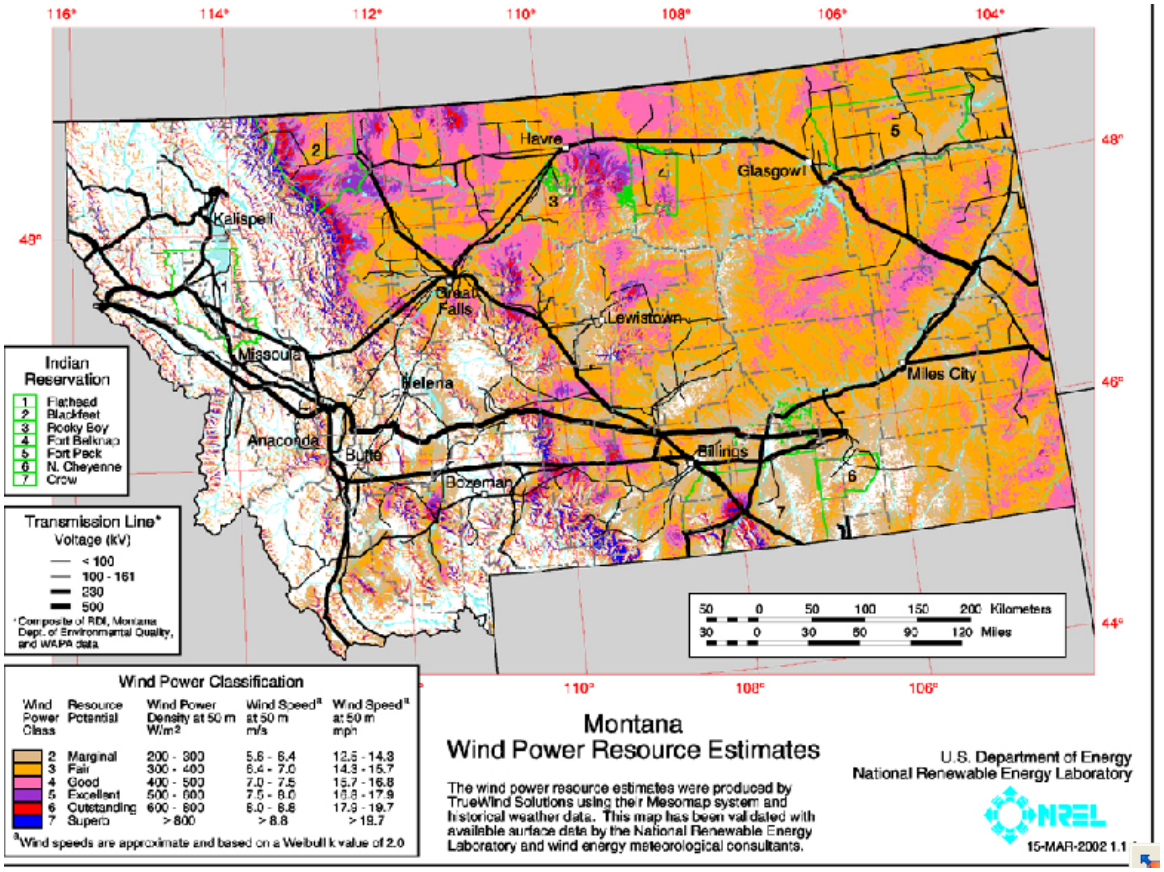
Resource Assessment



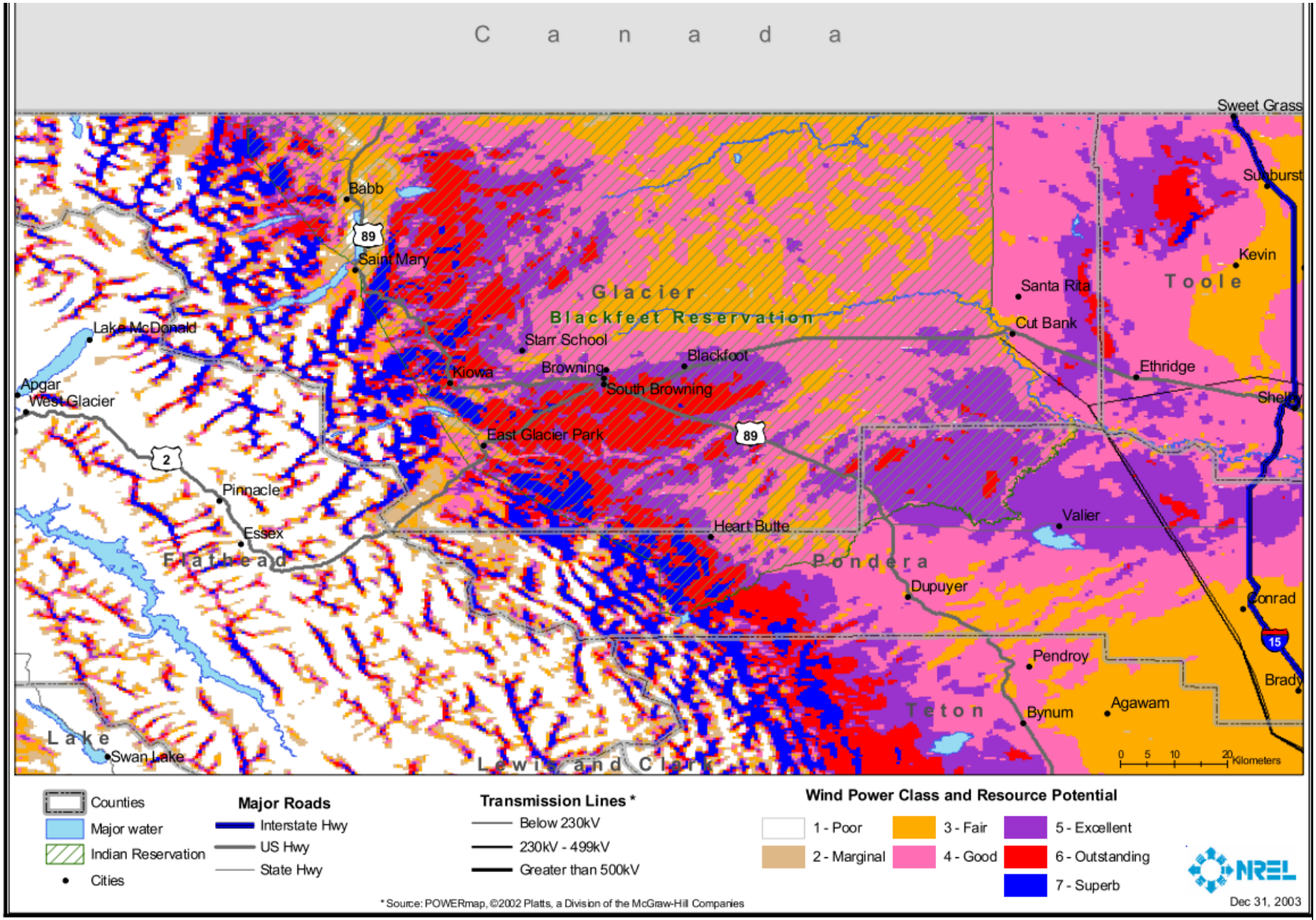
Locating Windy Sites

- Wind maps – check for updated state maps
- Regional wind atlases
- Biological indicators
- Environmental monitoring data
- Local knowledge
- Geographic/social references
- Proprietary localized wind maps

- **Measure, measure, measure!**
  - Essential for large investments
  - 1yr. dataset is typical
  - "It's really windy here" isn't bankable



http://www1.eere.energy.gov/tribalenergy/guide/pdfs/wind_montana_2.pdf



Sizes and Applications

Small (≤10 kW)

- Homes
- Farms
- Remote Applications

(e.g. water pumping, telecom sites, icemaking)

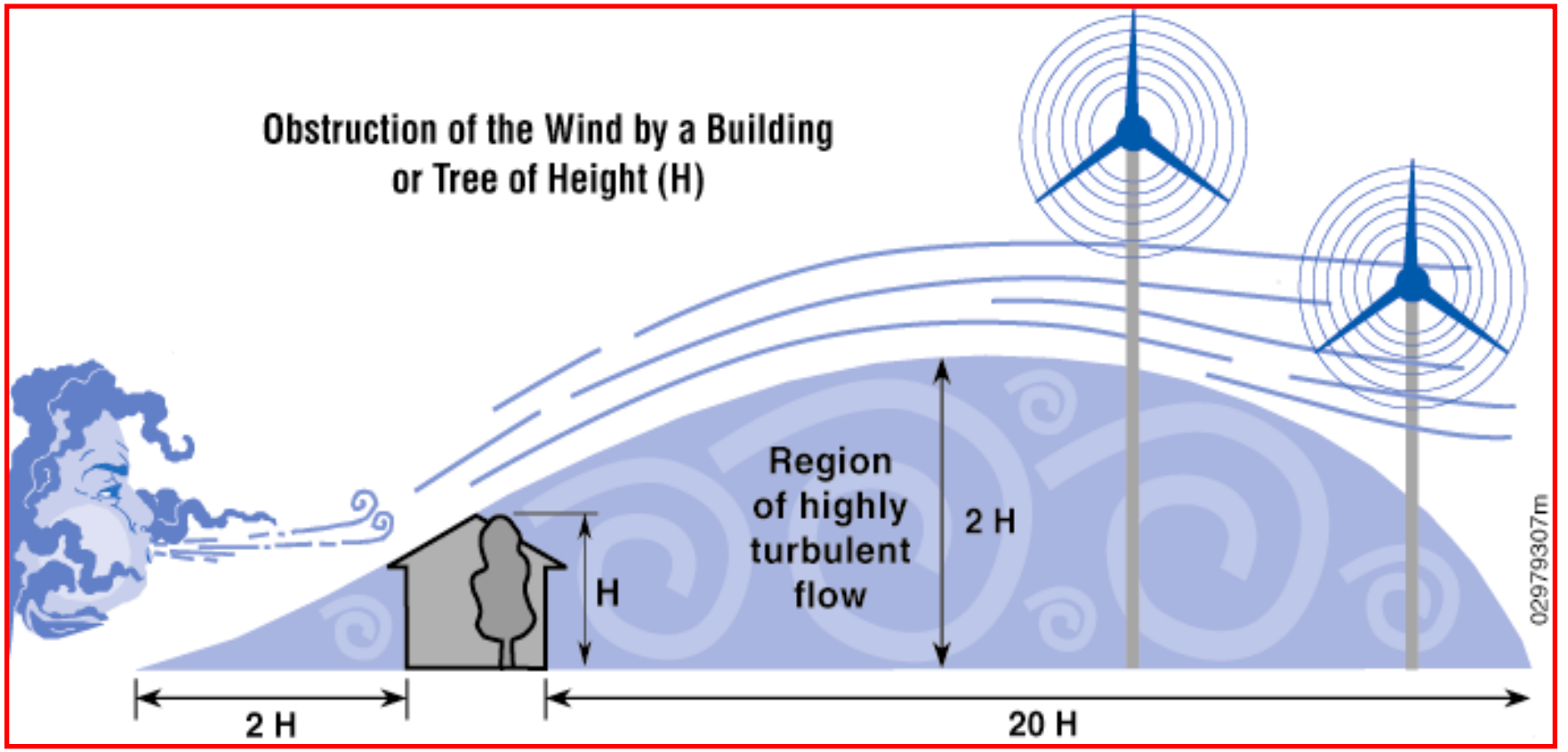
Intermediate (10-250 kW)

- Village Power
- Schools, businesses
- Hybrid Systems
- Distributed Power

Large (660 kW - 2+MW)

- Central Station Wind Farms
- Distributed Power
- Community Wind

Importance of “Micro-Siting”



Questions?

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