Energy and Agriculture: A Pyramid for Action

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Sheridan, WY
September 3, 2014

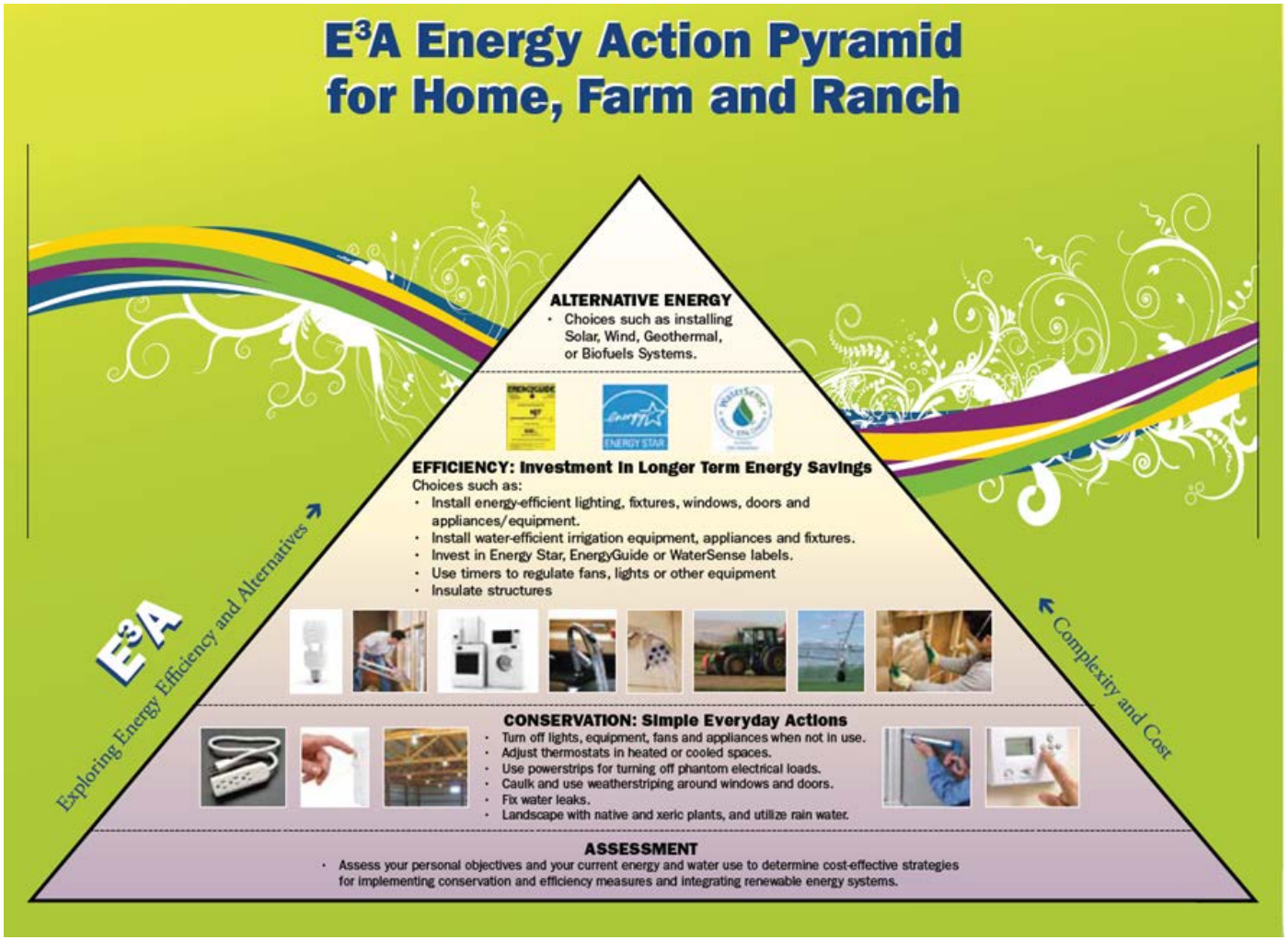
University of Wyoming Extension

School of Energy Resources

Outline

- Framework
- We have options…
- Understanding your use…
- Actionable information…

Basic Framework



You have choices…

Utility Monopoly

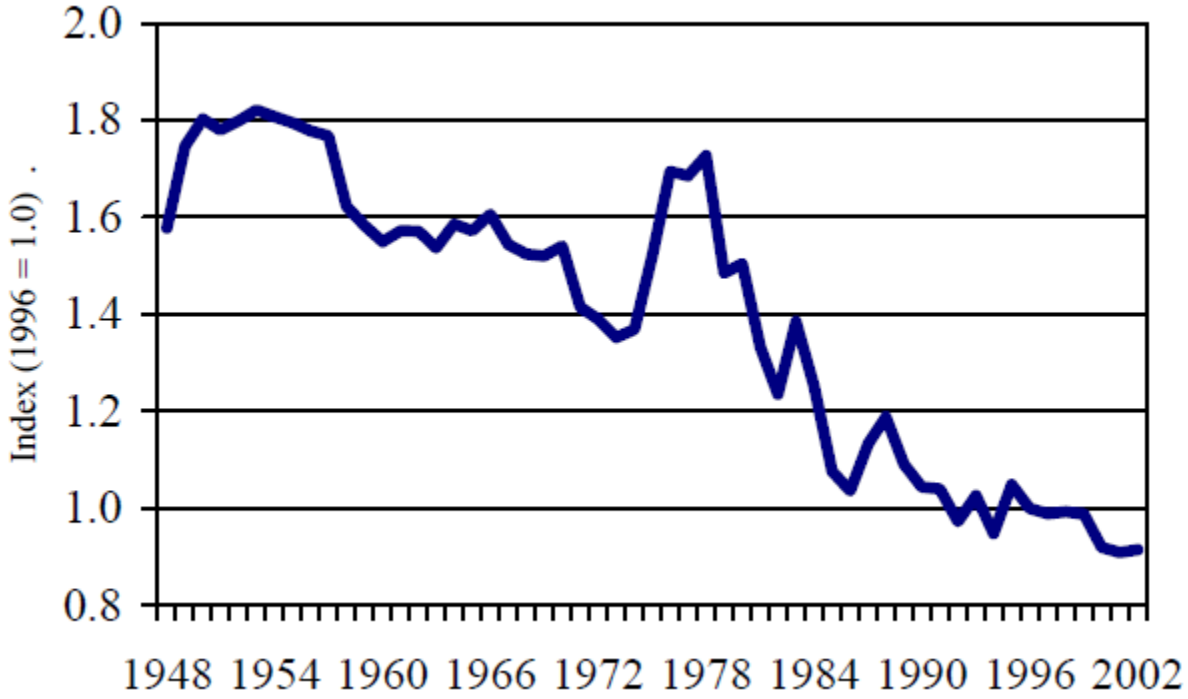
You have choices…

Context: Agriculture's energy use – National context

14.4%

Source: USDA ERS Energy Use in the U.S. Food System: 2010

Context: Agriculture's energy use – Declining energy intensity



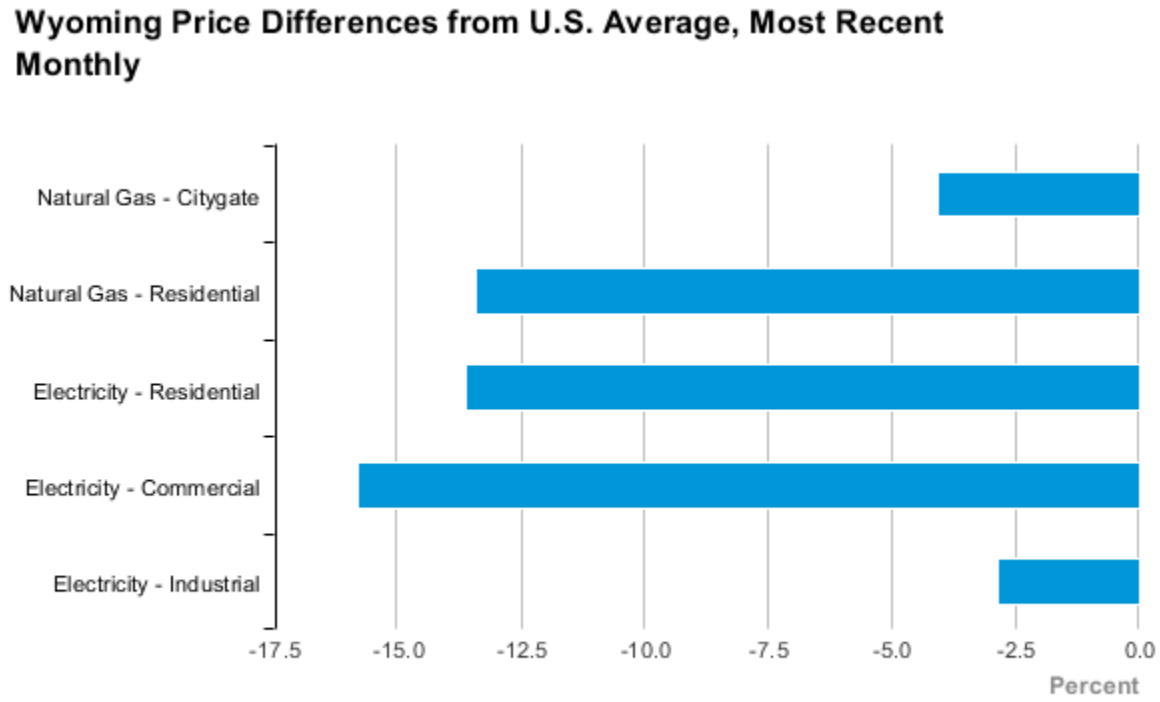
Source: USDA 2007 Farmbill Theme Paper –
Energy and Agriculture: August 2006

Context: Agriculture's energy use – Impact on expenses

15%

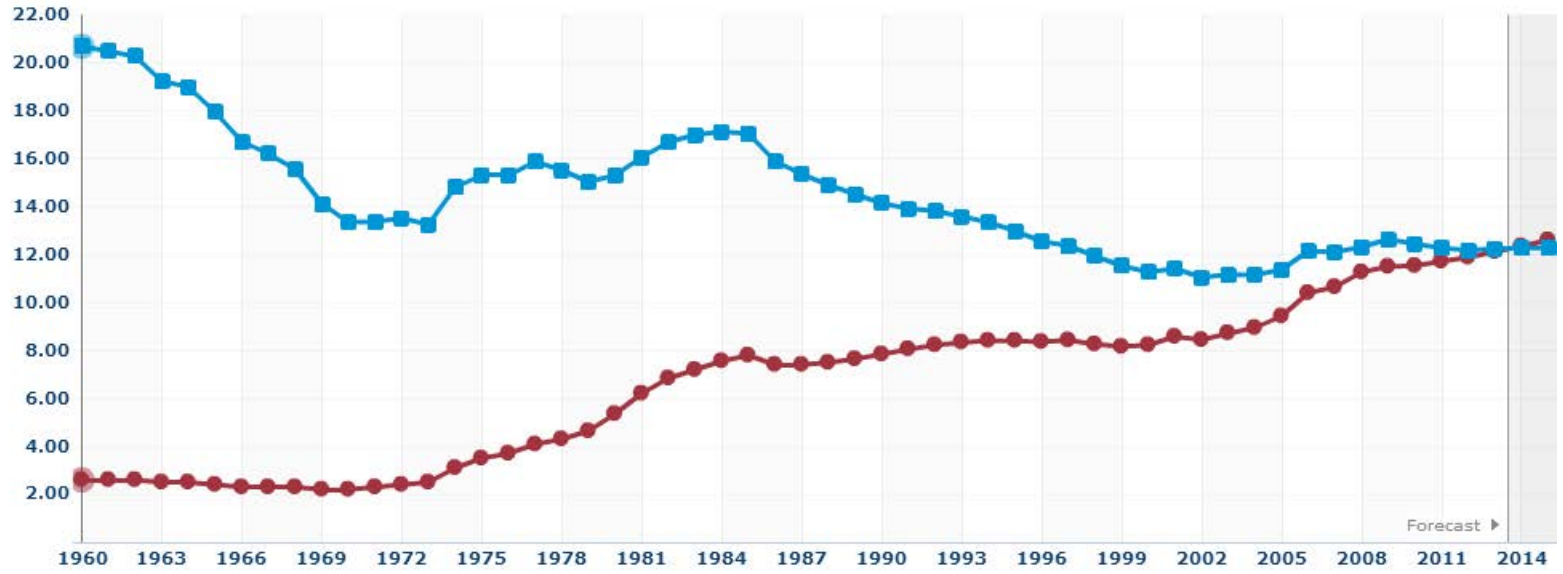
Source: USDA 2007 Farmbill Report: Agriculture and Energy

Context: The alternative to the “alternative” is relatively cheap…



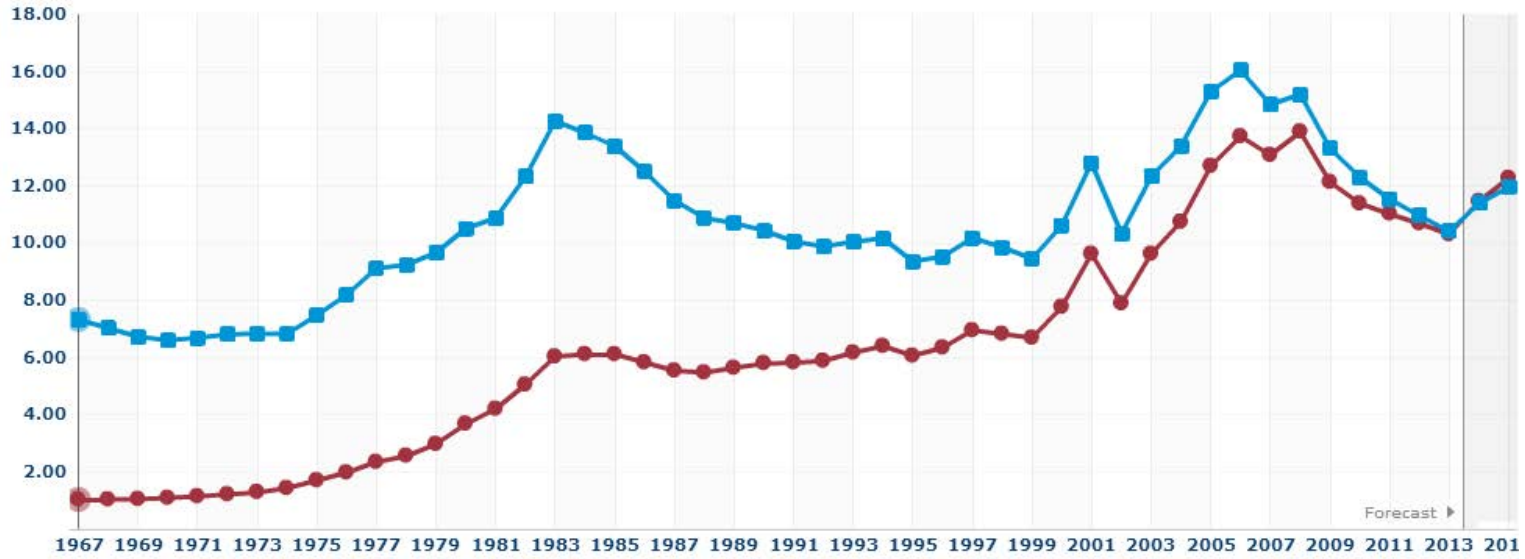
Source: Energy Information Administration, Petroleum Marketing Monthly; Natural Gas Monthly; Electric Power Monthly

Prices Change: Residential Electricity Prices



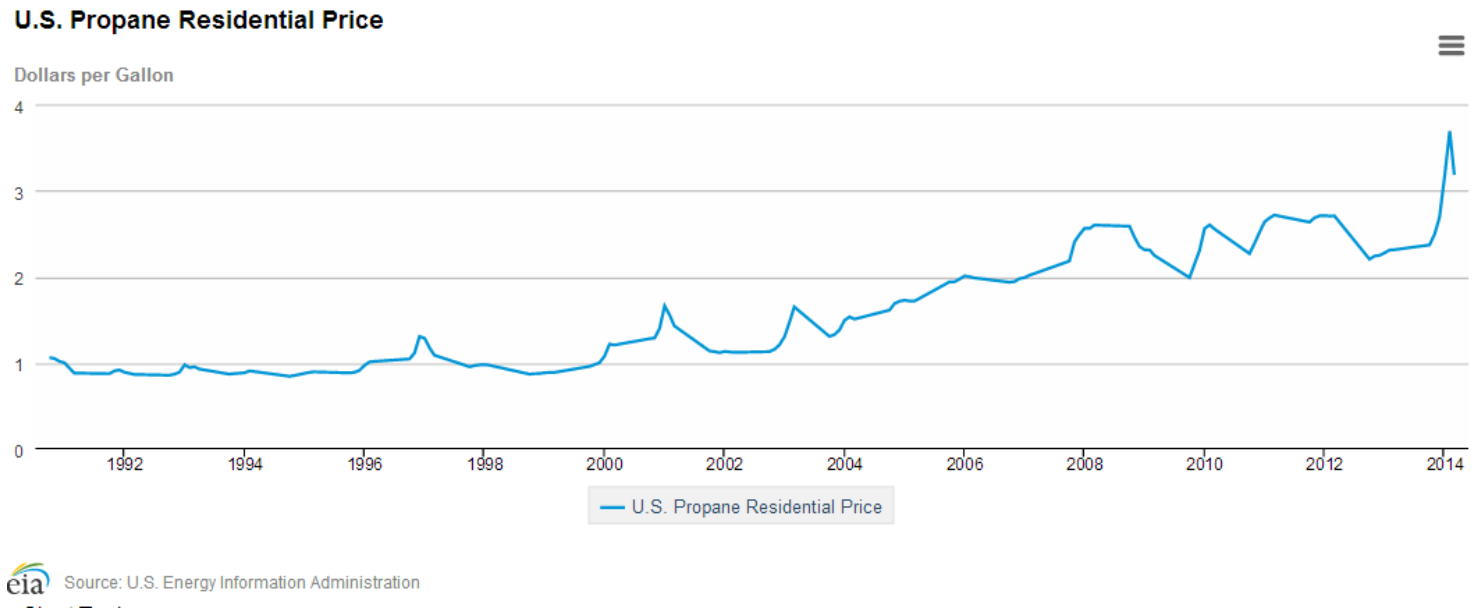
Source: EIA http://www.eia.gov/forecasts/steo/realprices/

Prices Change: Residential Natural Gas Prices



Source: EIA http://www.eia.gov/forecasts/steo/realprices/

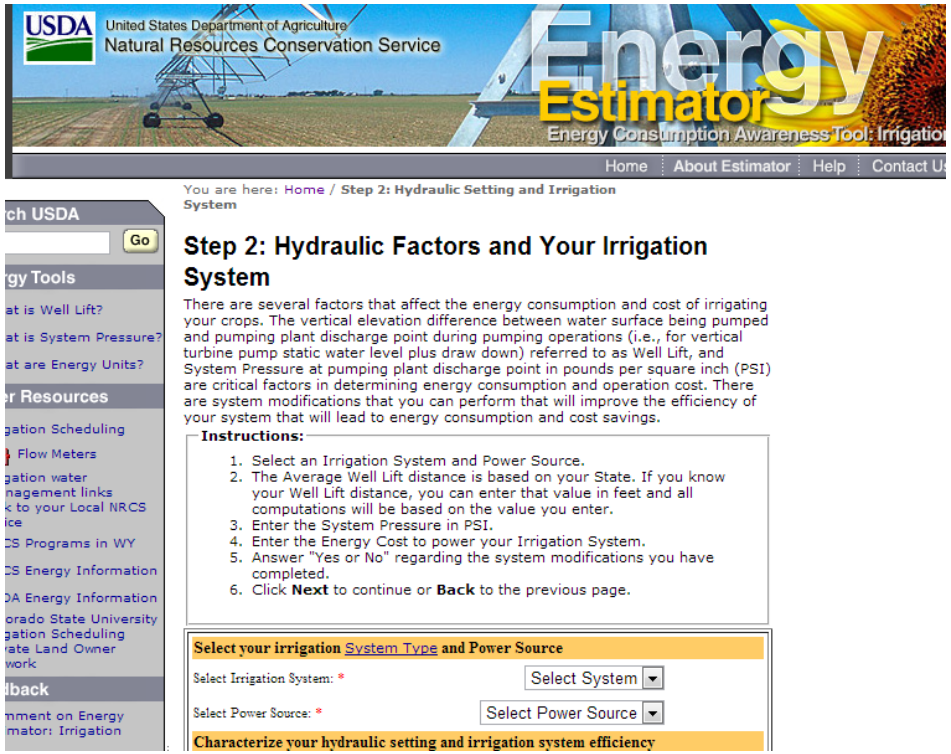
Prices Change: Residential Propane Prices



Source: EIA http://www.eia.gov/forecasts/steo/realprices/

Assess!

1. Find the data
2. Self-evaluate
3. Call in the professionals



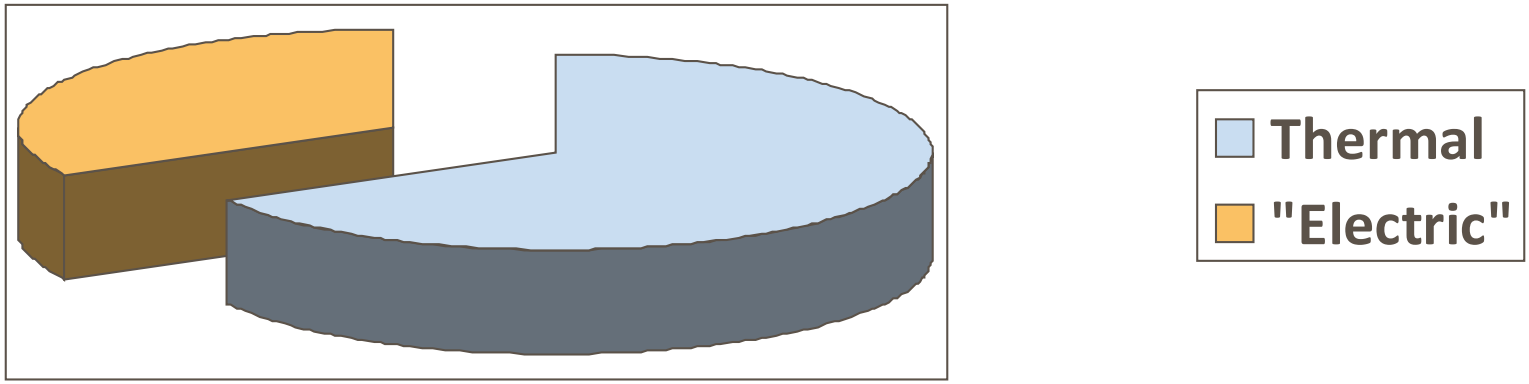
Conservation vs. Efficiency

Conservation

Efficiency

Eat the bigger part of the pie…

Thermal vs. "Electric" - Household Use 2012



Source: EIA http://www.eia.gov/consumption/residential/data/2009/index.cfm?view=consumption#end-use

Conservation / Efficiency Discussion

What are the typical renewable energy systems?

- Biomass
  - Heat, power, and transportation fuels
- Geothermal
  - Direct use and heat pumps
- Hydroelectric
- Solar
  - Thermal
  - Photovoltaic (PV)
- Wind

Terms and definitions – Where

- On-grid
  - Uses existing utilities (e.g. electric or natural gas) to back-up
- Off-grid
  - Battery-based
  - Stock water

Terms and definitions – Size

- "Large-scale"
  - Selling electricity (thermal energy) into the market
- "Small-scale"
  - Designed to principally offset personal electricity or thermal consumption
    - Net metered (25 kW or less) for electricity

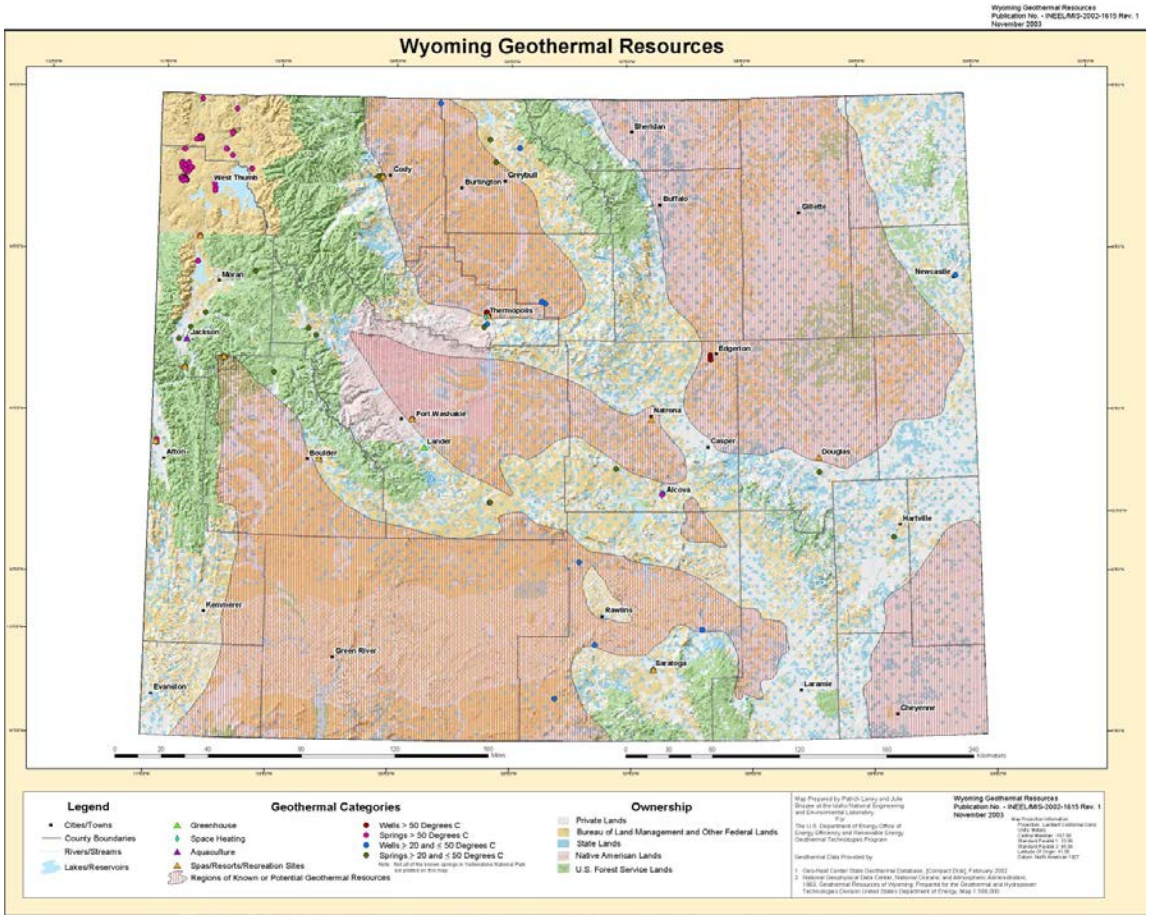
Terms and definitions – Net metered

- Net metering & interconnection
  - A policy that allows the connection of electricity-producing RE systems to the grid;
  - Allows owner to use the reliability of the grid while receiving the full retail rate for production*;
  - Serves as an incentive that varies by state.

Biomass

NEXT GENERATION
WoodStove
DesignChallenge

Geothermal


Wyoming Geothermal Resources
Publication No. - INEEL/MIS-2002-1615 Rev. 1
November 2003
Sheridan
Cody
Greybull
Burlington
West Thumb
Buffalo
Gillette
Moran
Newcastle
Thermopolis
Jackson
Edgerton
Fort Washakie
Natrona
Lander
Casper
Afton
Boulder
Douglas
Alcova
Hartville
Kemmerer
Rawlins
Green River
Saratoga
Evanston
Laramie
Cheyenne
Legend
Cities/Towns
County Boundaries
Rivers/Streams
Lakes/Reservoirs
Geothermal Categories
Greenhouse
Space Heating
Aquaculture
Spas/Resorts/Recreation Sites
Regions of Known or Potential Geothermal Resources
Wells > 50 Degrees C
Springs > 50 Degrees C
Wells > 20 and ≤ 50 Degrees C
Springs > 20 and ≤ 50 Degrees C
Ownership
Private Lands
Bureau of Land Management and Other Federal Lands
State Lands
Native American Lands
U.S. Forest Service Lands
Wyoming Geothermal Resources
Publication No. - INEEL/MIS-2002-1615 Rev. 1
November 2003

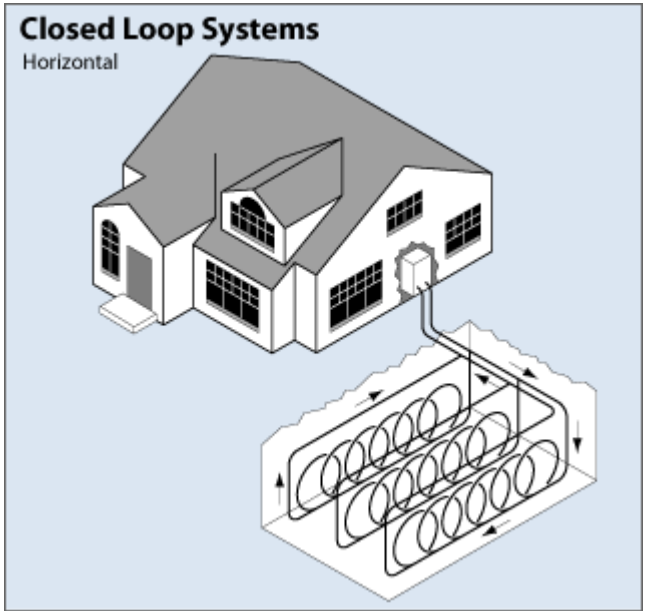
Geothermal Heat Pump – How

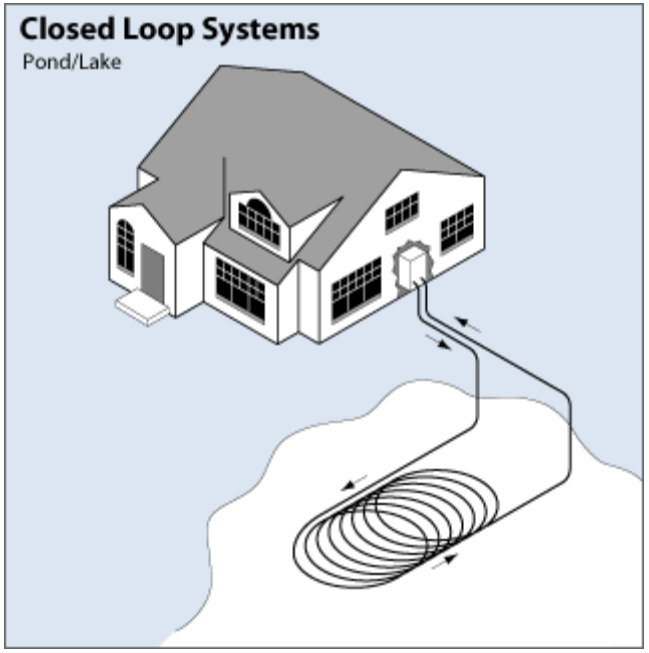
- Uses relatively constant temperature of sub-surface to heat and cool buildings
  - Like a cave
- Use stored solar heat
  - Mostly…
- Fluid circulated to exchange heat
  - Like a refrigerator

Geothermal Heat Pump - What

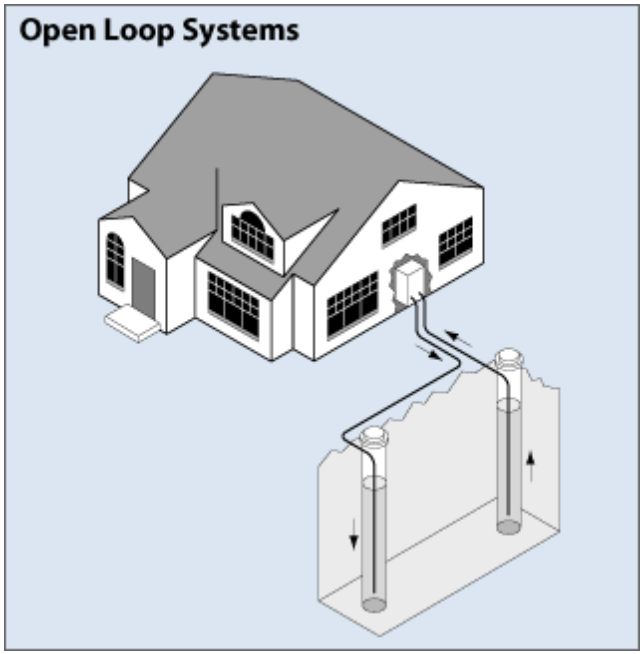
- Space heating, cooling, and potentially water heating system for buildings
  - Heats fluid – typically air – to 90-110°F (winter)
  - Cools fluid by using ground as heat sink (summer)
  - Can be equipped with a “desuperheater” to supply hot water
    - Uses waste heating in summer
    - Increases load in winter, although does use waste heat from exchanger
- Works nearly everywhere
  - No special resource (e.g. hot springs needed)

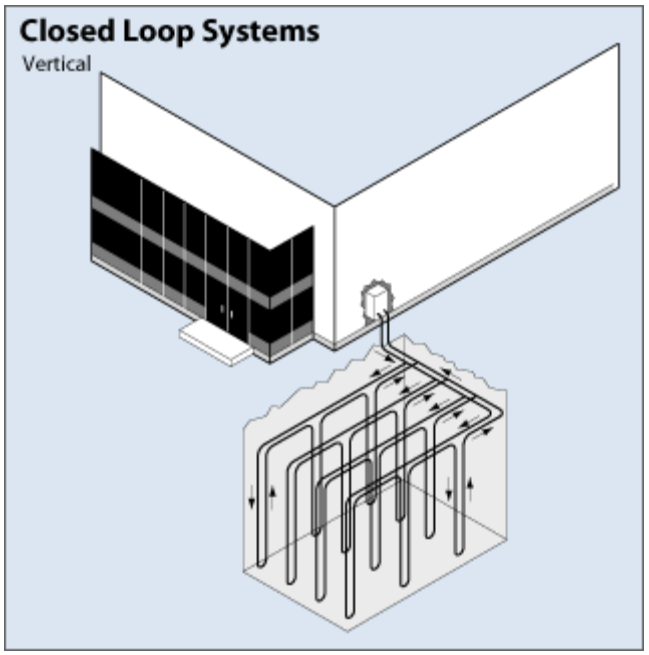
Geothermal Heat Pump – Design





Geothermal Heat Pump - Design





Geothermal Heat Pump - Where

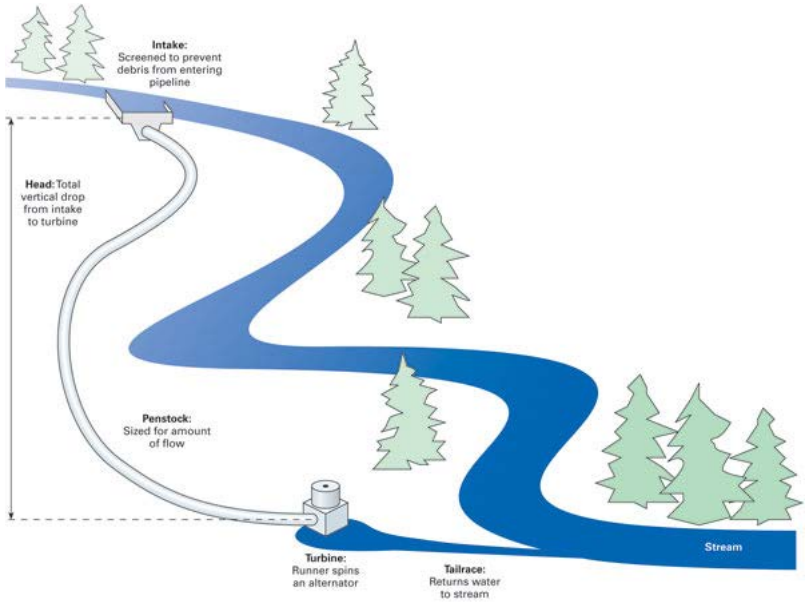
- Requirements
  - Adequate space for loop field
    - More for horizontal
  - Existing duct work or hydronic system
  - Some soils (wet, clays, etc.) are better than others (sands)
- Best applications
  - Locations with high heating costs
    - Propane, electric, etc.
  - Need to replace existing HVAC system
  - New construction

Small Hydroelectric

- Micro hydro
  - Under 100 kW
    - Effectively under 25 kW in WY (net metering)
- Small Hydro
  - 100 kW-20MW
- Large Hydro
  - 20MW+

Hydro – Basic Principles

- Head
  - Vertical distance between intake and turbine
- Flow
  - Amount of water in pipeline
- Friction loss
  - Pipeline length and design



Courtesy: Home Power Magazine

Hydro – Where

- Existing structures
  - Dams
  - Canals
  - Pipelines
  - Center pivots
  - Municipal water supply and wastewater
- In-stream – No new storage capacity required

Much easier if new infrastructure is not required!

Solar – Heat or Electricity

Solar Thermal – What for

- Solar hot water
  - Heat domestic or commercial hot water
- Solar heating
  - Liquid
    - Larger hot water system
  - Air
    - Dedicated heating system

Don’t forget about passive solar!

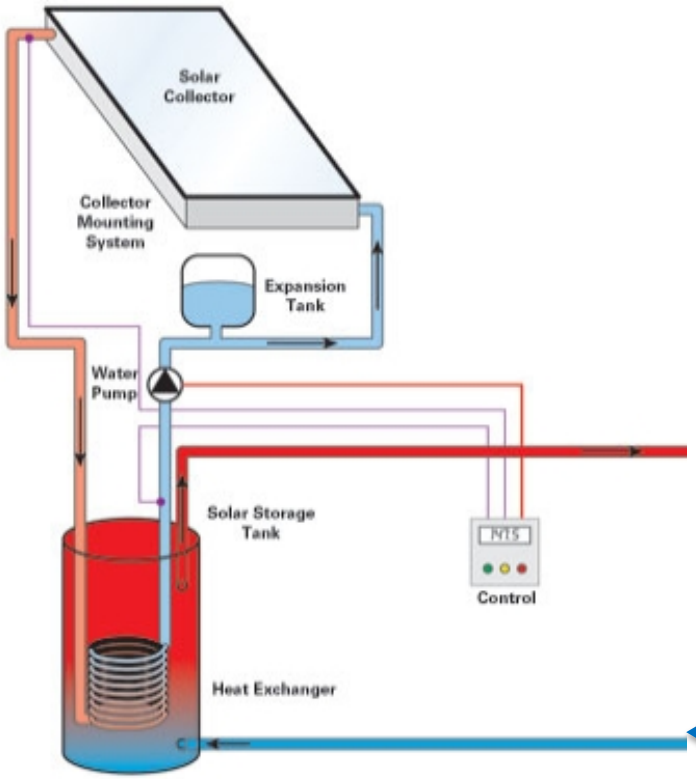
Solar thermal – Type

Flat-plate
solar hot water collectors

Evacuated tube
solar hot water collectors

Credit: http://switchsource.co.uk/solarthermal.html

Solar thermal – Antifreeze system

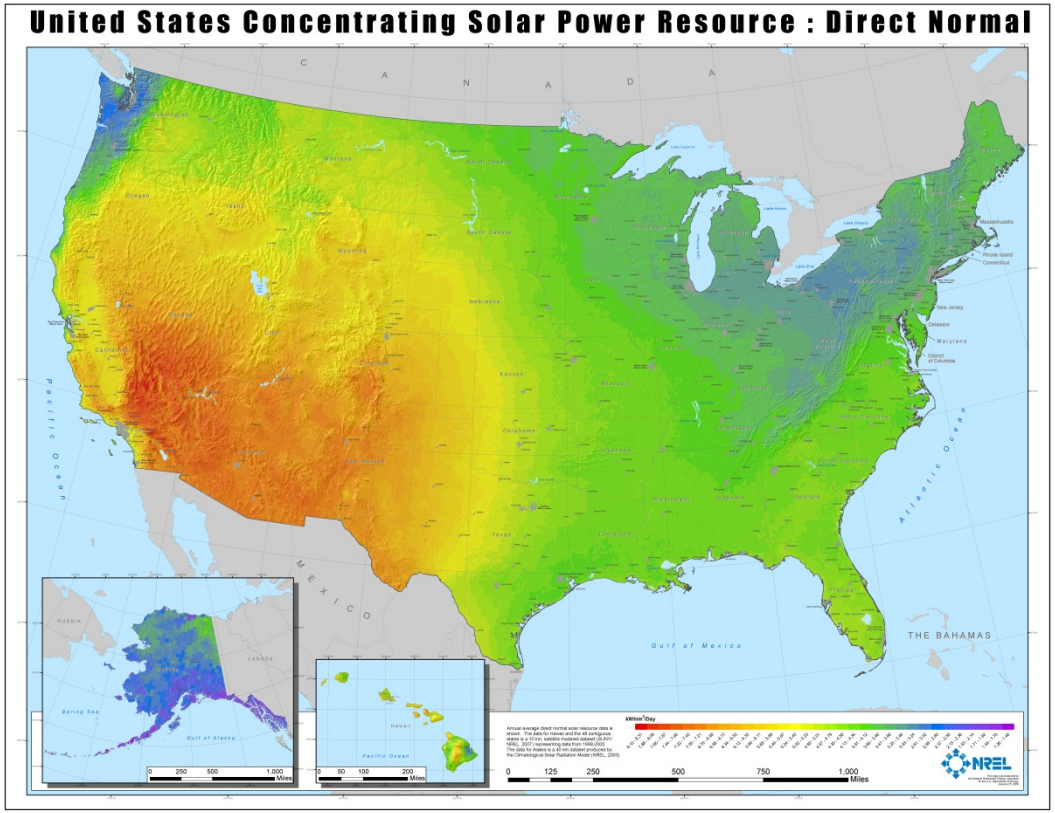


Heated water going to the Back-Up.

Incoming cold water

Credit: http://homepower.com/basics/hotwater/

Solar Thermal – Sunny Wyo



Solar Thermal – Where it works best

- Excellent solar resource in Wyoming
- Best applied where heating costs are the highest
  - Propane
  - Electric
- Can be retrofitted, but new certainly should be considered in all new construction

Solar hot water is generally more practical than solar heat!

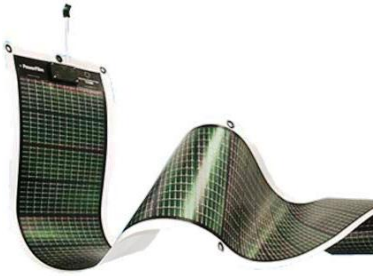
Solar Thermal – Not your father's solar panel…

Solar Electric – How

PV materials absorb the sun's light energy

Solar electric – Types

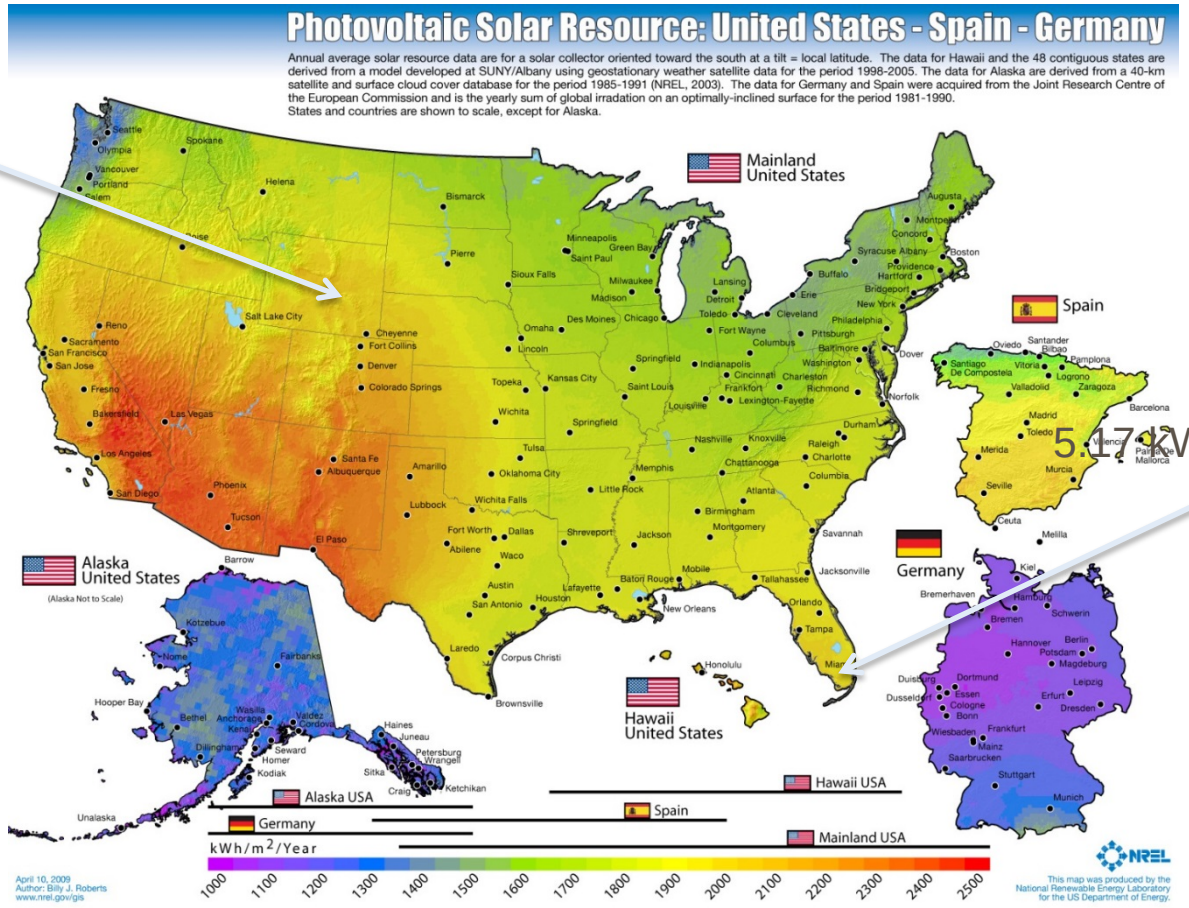
Crystalline Silicon



Thin-Film

Solar – WHYoming

5.35 kWh/ m2/day



5.17 kWh/m2/day

Context

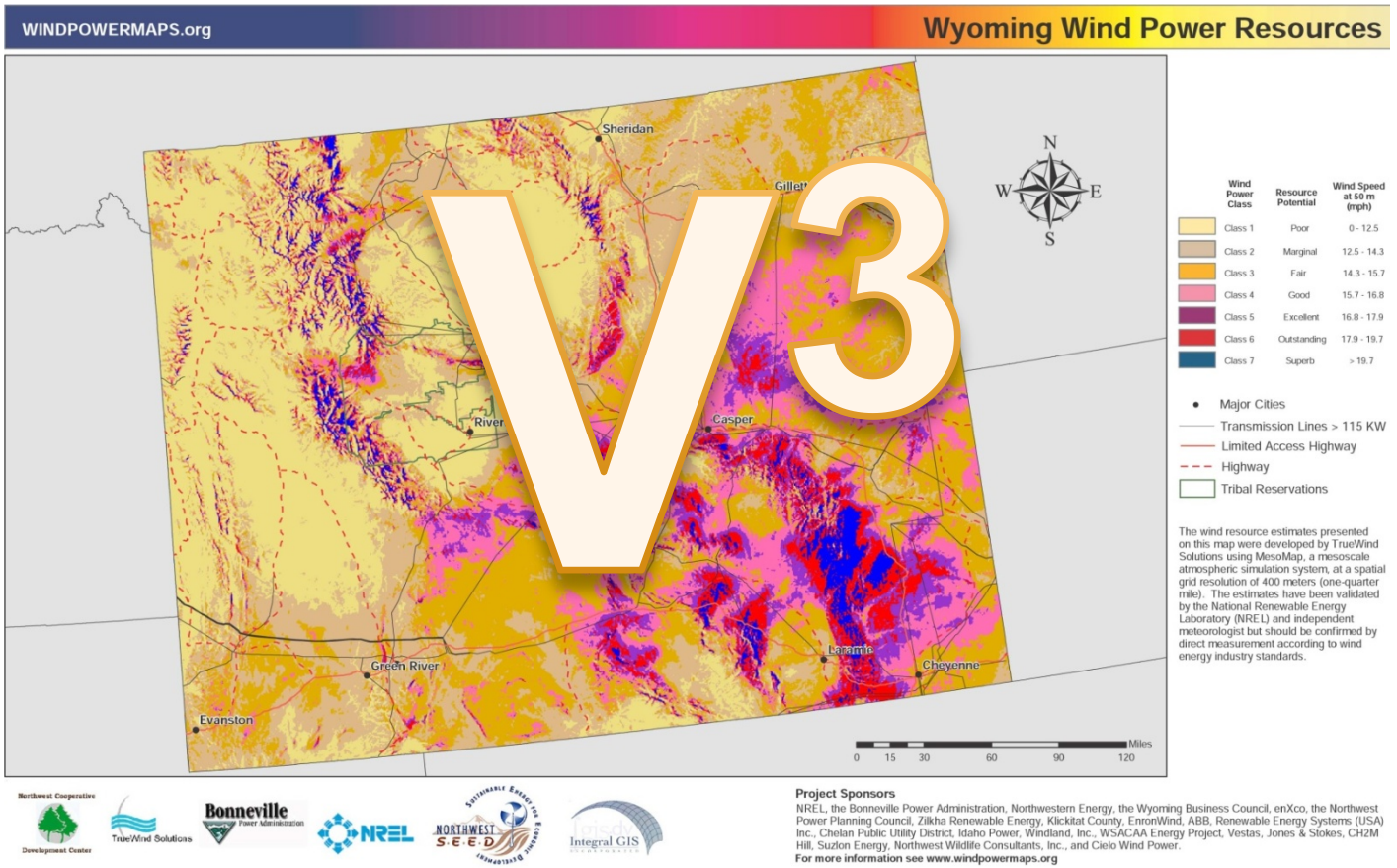
Solar – Why isn't it everywhere?

Cost!

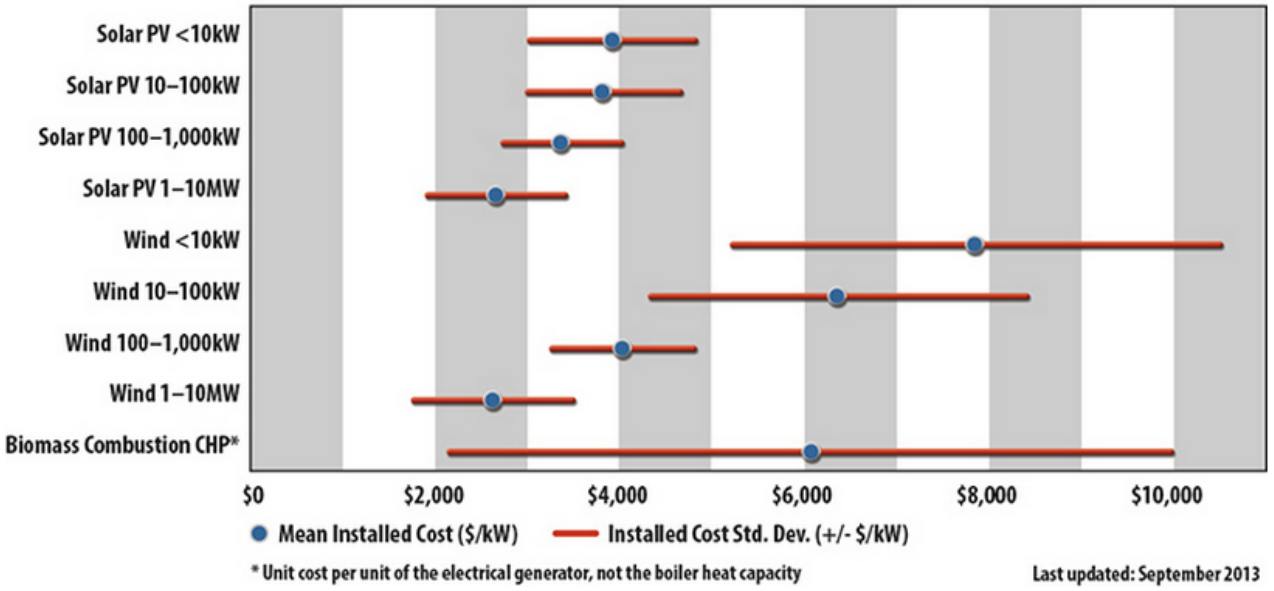
Produce electricity at 12-16¢/kWh!

US Department of energy has goal of $1/watt

Small wind


WINDPOWERMAPS.org
Wyoming Wind Power Resources
V3
Sheridan
Gillette
Casper
River
Green River
Evanston
Laramie
Cheyenne
N
W
E
S
Wind Power Class
Resource Potential
Wind Speed at 50 m (mph)
Class 1 Poor 0 - 12.5
Class 2 Marginal 12.5 - 14.3
Class 3 Fair 14.3 - 15.7
Class 4 Good 15.7 - 16.8
Class 5 Excellent 16.8 - 17.9
Class 6 Outstanding 17.9 - 19.7
Class 7 Superb > 19.7
Major Cities
Transmission Lines > 115 KW
Limited Access Highway
Highway
Tribal Reservations
The wind resource estimates presented on this map were developed by TrueWind Solutions using MesoMap, a mesoscale atmospheric simulation system, at a spatial grid resolution of 400 meters (one-quarter mile). The estimates have been validated by the National Renewable Energy Laboratory (NREL) and independent meteorologist but should be confirmed by direct measurement according to wind energy industry standards.
Miles
0 15 30 60 90 120
Northwest Cooperative Development Center
TrueWind Solutions
Bonneville Power Administration
NREL
Northwest SEED
Integral GIS
Project Sponsors
NREL, the Bonneville Power Administration, Northwestern Energy, the Wyoming Business Council, enXco, the Northwest Power Planning Council, Zilkha Renewable Energy, Klickitat County, EnronWind, ABB, Renewable Energy Systems (USA) Inc., Chelan Public Utility District, Idaho Power, Windland, Inc., WSACAA Energy Project, Vestas, Jones & Stokes, CH2M Hill, Suzlon Energy, Northwest Wildlife Consultants, Inc., and Cielo Wind Power.
For more information see www.windpowermaps.org

What about costs…



* Unit cost per unit of the electrical generator, not the boiler heat capacity

Last updated: September 2013

Costs for Thermal Technologies

Technology Type	Mean Installed Cost	Installed Cost Std. Dev. (+/-)
Solar Water Heat, flat plate and evacuated tube ($/ft^2)	$141	$82
Solar Water Heat, plastic collector ($/ft^2)	$59	$15
Solar Vent Preheat ($/ft^2)	$31	$15
Biomass Wood Heat ($/kW)	$600	$361
Ground Source Heat Pump ($/ton)	$7,518	$4,164

Source: NREL

Incentives – Maximize your economic return

- Utility incentives
  - Numerous and varied
    - Efficiency and ground source heat pumps
- State incentives
  - Limited
- Federal incentives
  - Robust and plentiful (until 2016)

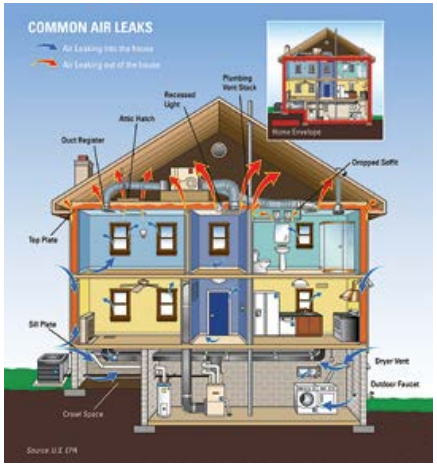
Can be used with most types of renewables!

Incentives – State

- Policies
  - Net metering
  - Interconnection standards
- Small Business Energy Audit Program
  - Wyoming Business Council, State Energy Office

Incentives – Federal

- Residential Tax Benefits
  - 30% tax credit on solar (thermal & PV), wind, & geothermal heat pumps (no limit)



Incentives - Federal

- Commercial
  - Tax credits
    - 30% for wind and solar
    - 10% for geothermal
    - Production tax credits for larger systems
  - Modified Accelerated Cost Recovery System (MACRS)
    - Rapid depreciation
  - USDA Rural Development REAP grants and loans
    - 25% grants for RE and EE
  - USDA NRCS EQIP
    - Up to 50% cost share (variable)

Incentives Matter

- Solar electric on commercial ranch building – Rock Springs
  - 6 kW
  - $3.80/watt
  - $0.0935/kWh (no demand charges)
  - Use Business Investment Tax Credit (30%), USDA RD REAP (25%), and MACRS (NPV ~11%)
- Net Present Value (25-year) = +$10,609 (-$4,439)
- Internal Rate of Return = 12% (1.2%)
- Annual cost savings = $1,003

Source: RETScreen

Tools and resources – All in one place

http://renewables.uwyo.edu

Contact Information

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