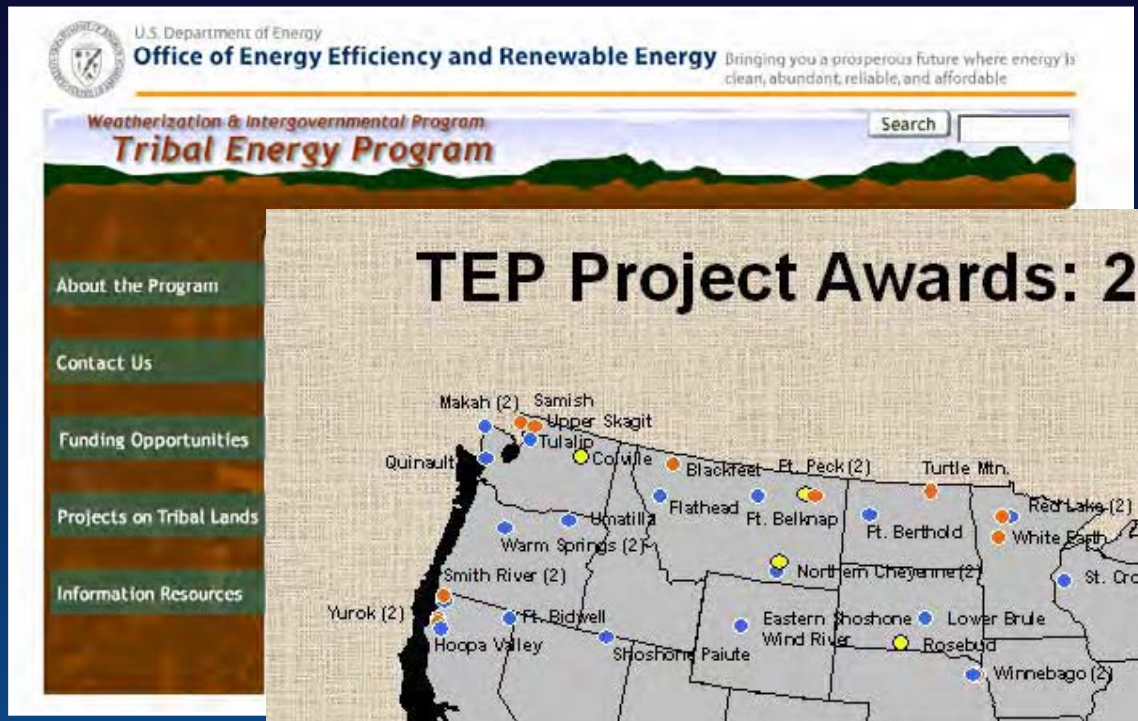
NAEMI Renewable Energy Analysis & Economics Training Workshop

Roger Taylor
TEP Manager
National Renewable Energy Laboratory

Introduction

Major DOE National Laboratories



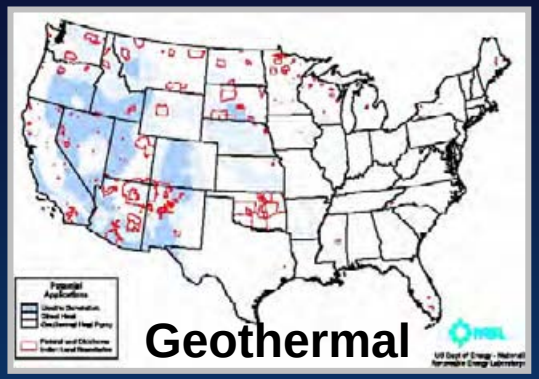
TEP Project Awards: 2000 - 2006

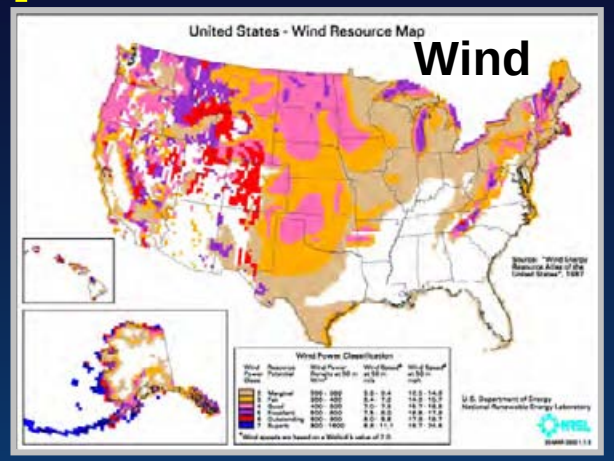
First Steps - 25
Feasibility - 45
Development - 6
Total Projects - 76

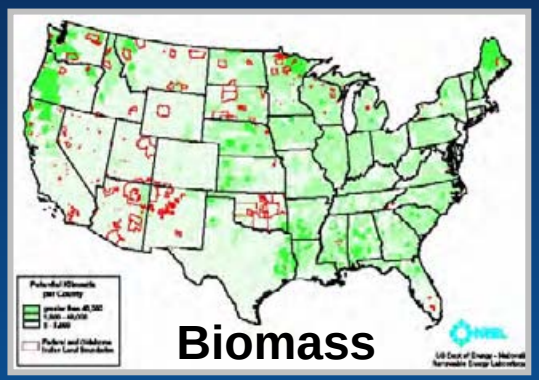
Makah (2)
Samish
Upper Skagit
Tulalip
Quinault
Colville
Blackfeet
Ft. Peck (2)
Turtle Mtn.
Aroostook
Penobscot
Flathead
Ft. Belknap
Ft. Berthold
Red Lake (2)
White Earth
Umatilla
Warm Springs (2)
Sault Ste. Marie
Little Traverse
Grand Traverse
Northern Cheyenne (2)
St. Croix
Smith River (2)
Yurok (2)
Ft. Bidwell
Hoopa Valley
Eastern Shoshone
Wind River
Lower Brule
Rosebud
Seneca
Shoshone Paiute
Winnebago (2)
Hualapai
Navajo
Jicarilla Apache
Kaw
Ft. Mojave
Ramona
Hopi (2)
Taos
Morongo
Agua Caliente
Jemez
Pueblo Laguna
Pawnee
Cherokee
Mesa Grande
Cahuazon
Yavapai
Citizen Potawatomi (2)
Viejas
White Mtn.
Ft. Sill Apache
Manzanita
Ak-Chin
Augustine/Cahuila
MI Choctaw
Venetie
YKHC
Kenaitze
Bristol Bay
Sealaska
Pribilof Islands
Port Graham

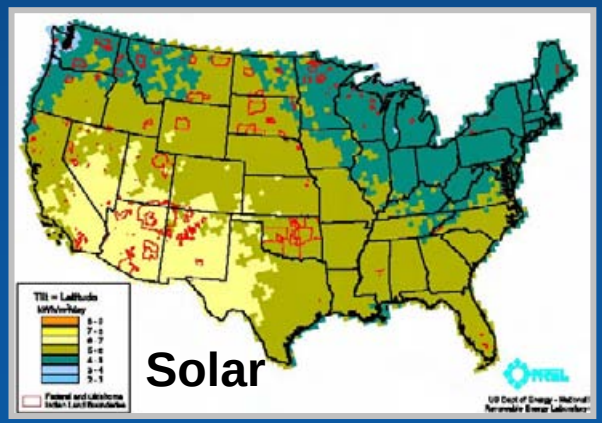
www.eere.energy.gov/tribalenergy

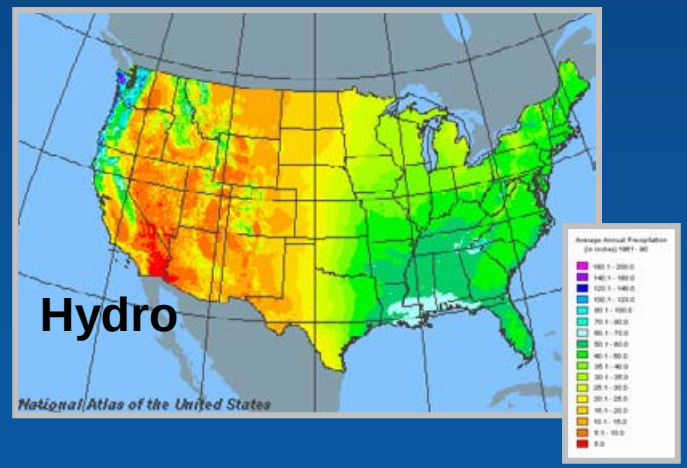
Renewable Resource Options











What is Resource Assessment?

Understanding the **spatial** and **temporal** variations of renewable energy resources:

- » Solar Radiation
- » Wind Power
- » Bioenergy
- » Geothermal
- » Hydrological

For supporting:

- Production of electricity, heat, fuels and other products generally derived from non-renewable sources
- Energy efficiency opportunities (e.g., buildings, transportation, etc.)

Resource Assessment

Resource *DATA* ⇒ Technology *INFORMATION*

Maps

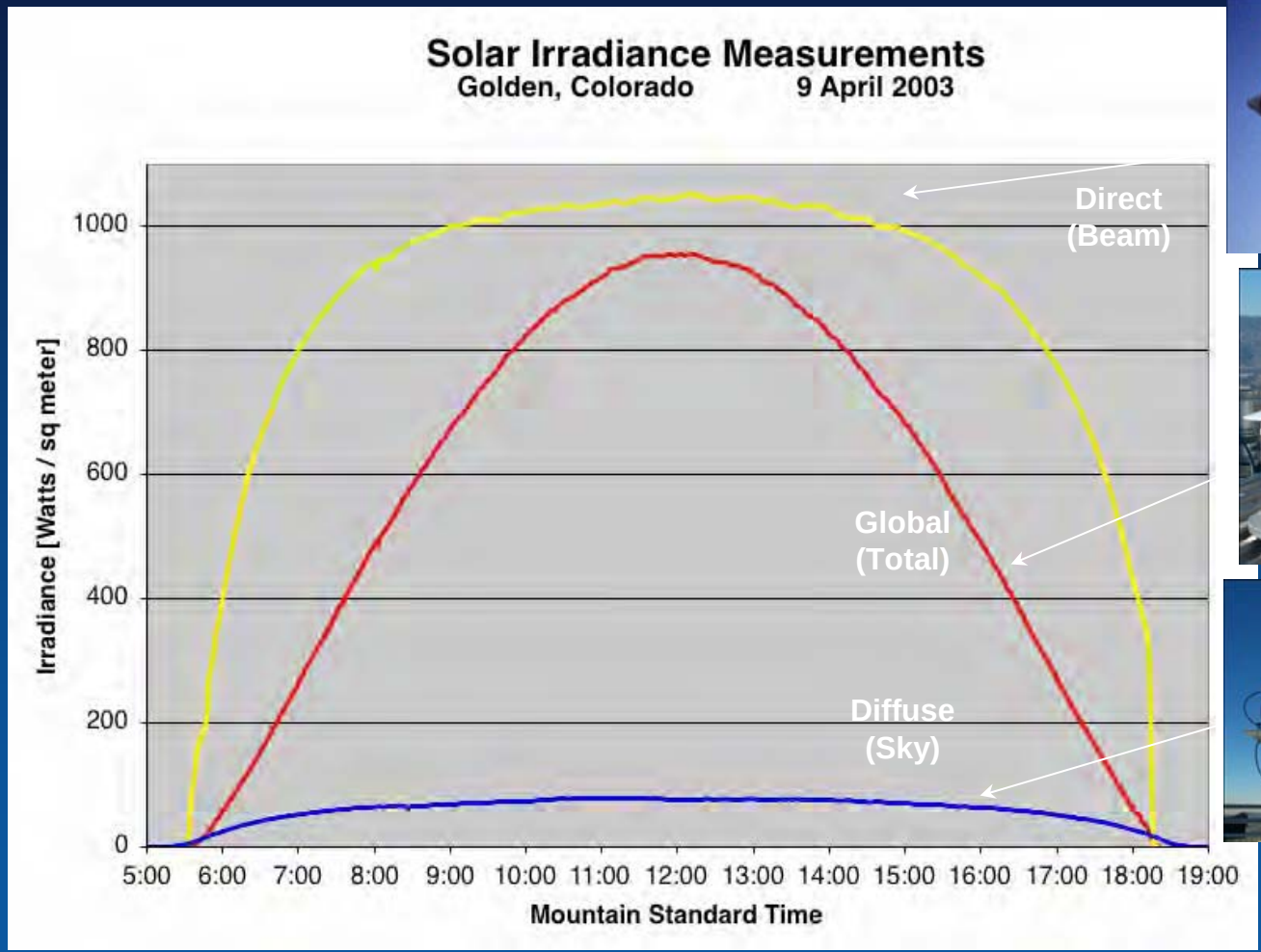
Databases

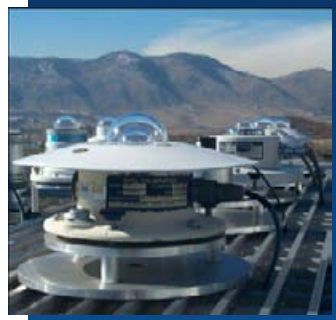
Models

Climate Summaries

Real-Time Data

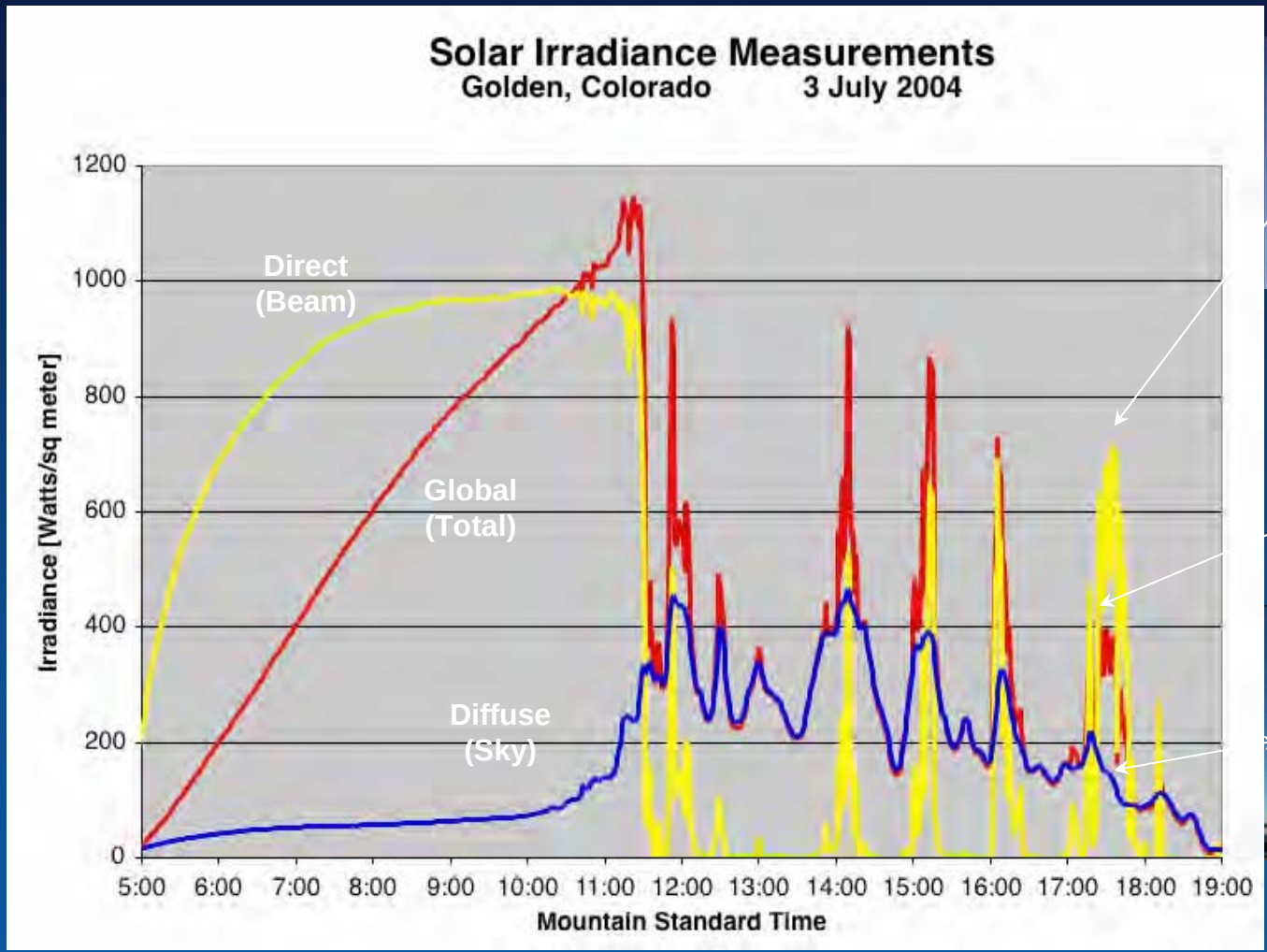
Clear Sky





http://www.nrel.gov/srrl

Partly Cloudy Sky



http://www.nrel.gov/srrl

Fixed Tilt and Tracking

Fixed Tilt Facing Equator tilt=latitude

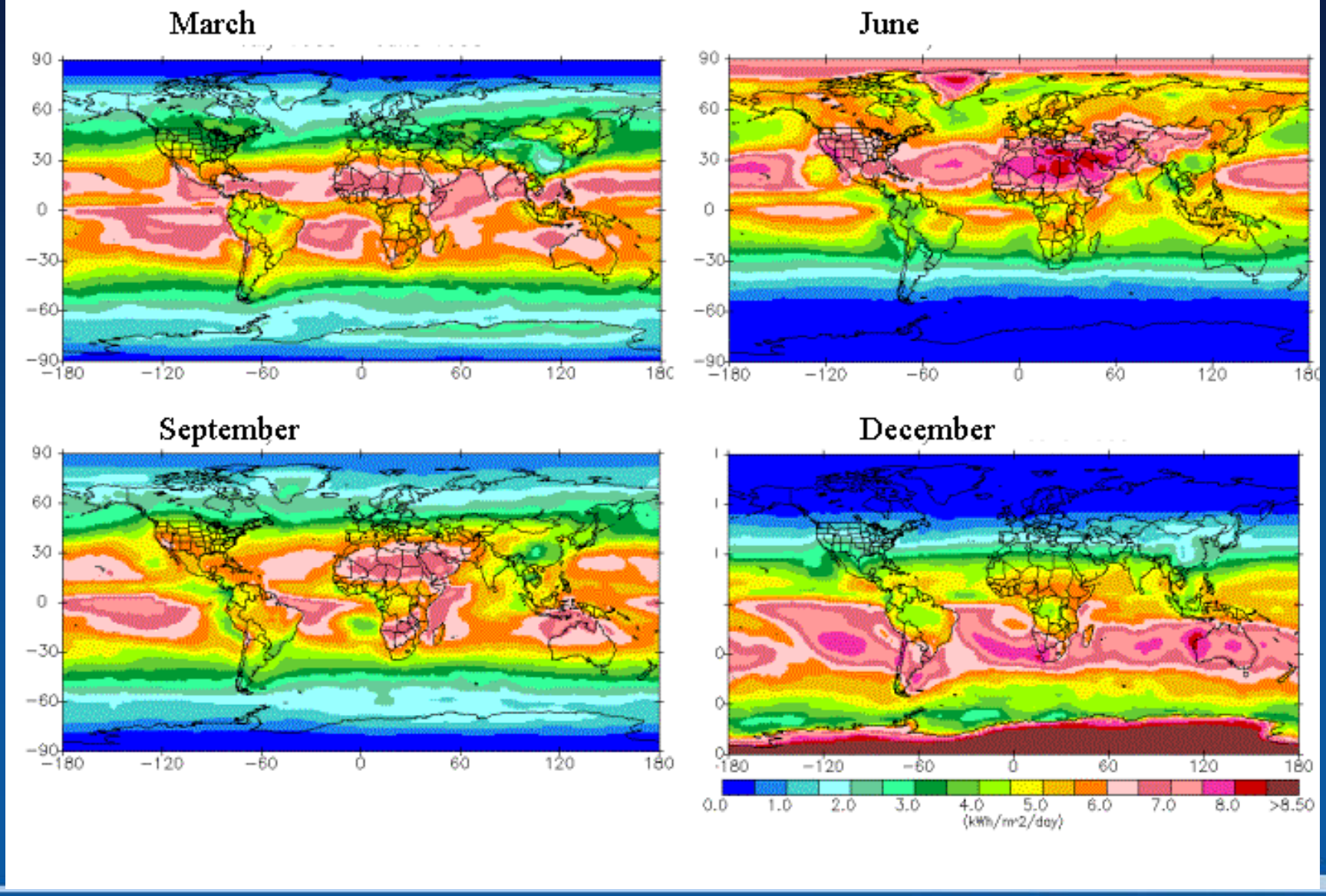
tilt<latitude for summer gain

tilt>latitude for winter gain

One Axis Tracking around axis tilted or flat

Two Axis Tracking both azimuth and altitude of sun around two axes

Daily Average Solar Resource



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Solar Thermal Water & Air

PV

Solar Options

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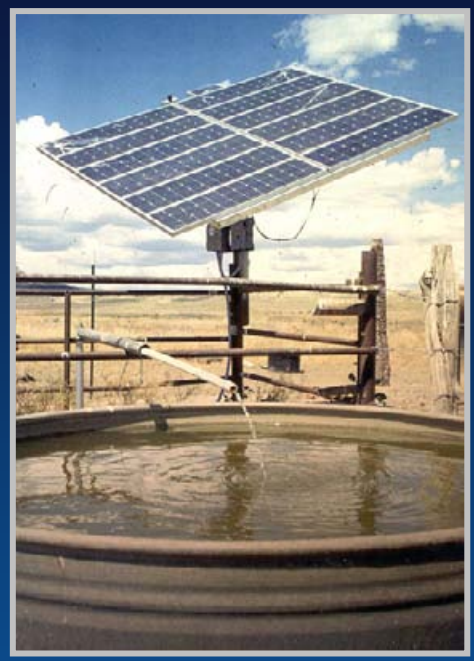
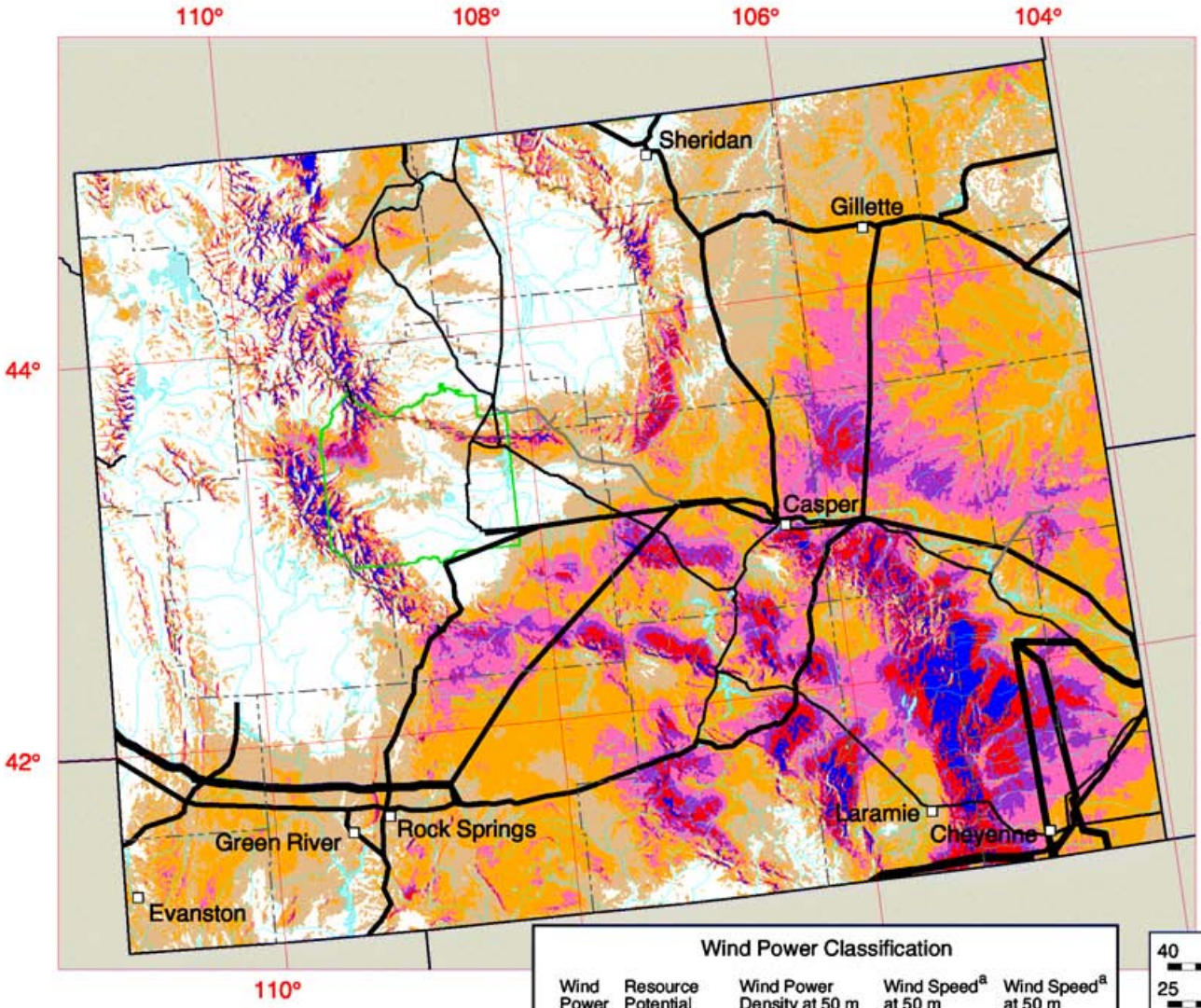
PV





Wyoming

Wind Power Resource Estimates

Wind River Indian Reservation

Transmission Line*
Voltage (kV)
69
115
230
345
* Source: POWERmap,©2002 Platts, A Division of the McGraw-Hill Companies

Wind Power Classification

Wind Power Class	Resource Potential	Wind Power Density at 50 m W/m^2	Wind Speed[a] at 50 m m/s	Wind Speed[a] at 50 m mph
2	Marginal	200 - 300	5.6 - 6.4	12.5 - 14.3
3	Fair	300 - 400	6.4 - 7.0	14.3 - 15.7
4	Good	400 - 500	7.0 - 7.5	15.7 - 16.8
5	Excellent	500 - 600	7.5 - 8.0	16.8 - 17.9
6	Outstanding	600 - 800	8.0 - 8.8	17.9 - 19.7
7	Superb	> 800	> 8.8	> 19.7

[a]Wind speeds are based on a Weibull k value of 2.0

40 0 40 80 120 160 Kilometers
25 0 25 50 75 100 Miles

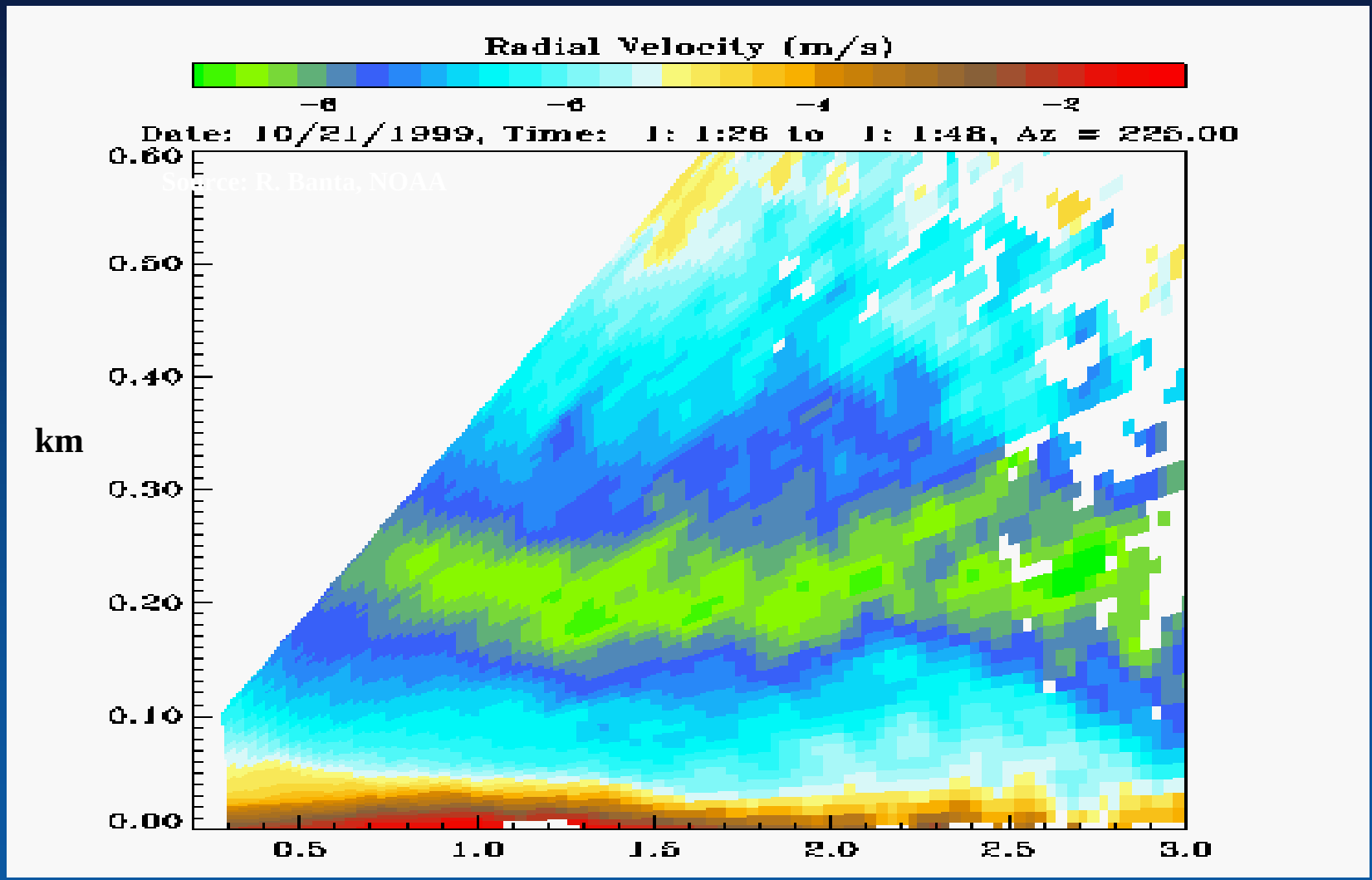
The wind power resource data for this map was produced by TrueWind Solutions using the Mesomap system and historical weather data. It has been validated with available surface data by the National Renewable Energy Laboratory and wind energy meteorological consultants.

U.S. Department of Energy
National Renewable Energy Laboratory

NREL

06-JUN-2002 2.1.2

Technology Challenges: Nocturnal Jet



Wind Turbine Sizes and Applications

Small (≤10 kW)

- Homes
- Farms
- Remote Applications (e.g. water pumping, telecom sites, icemaking)

Kotzebue

Intermediate (10-250 kW)

- Village Power
- Hybrid Systems
- Distributed Power

Large (250 kW – 2+ MW)

- Central Station Wind Farms
- Distributed Power

St. Paul

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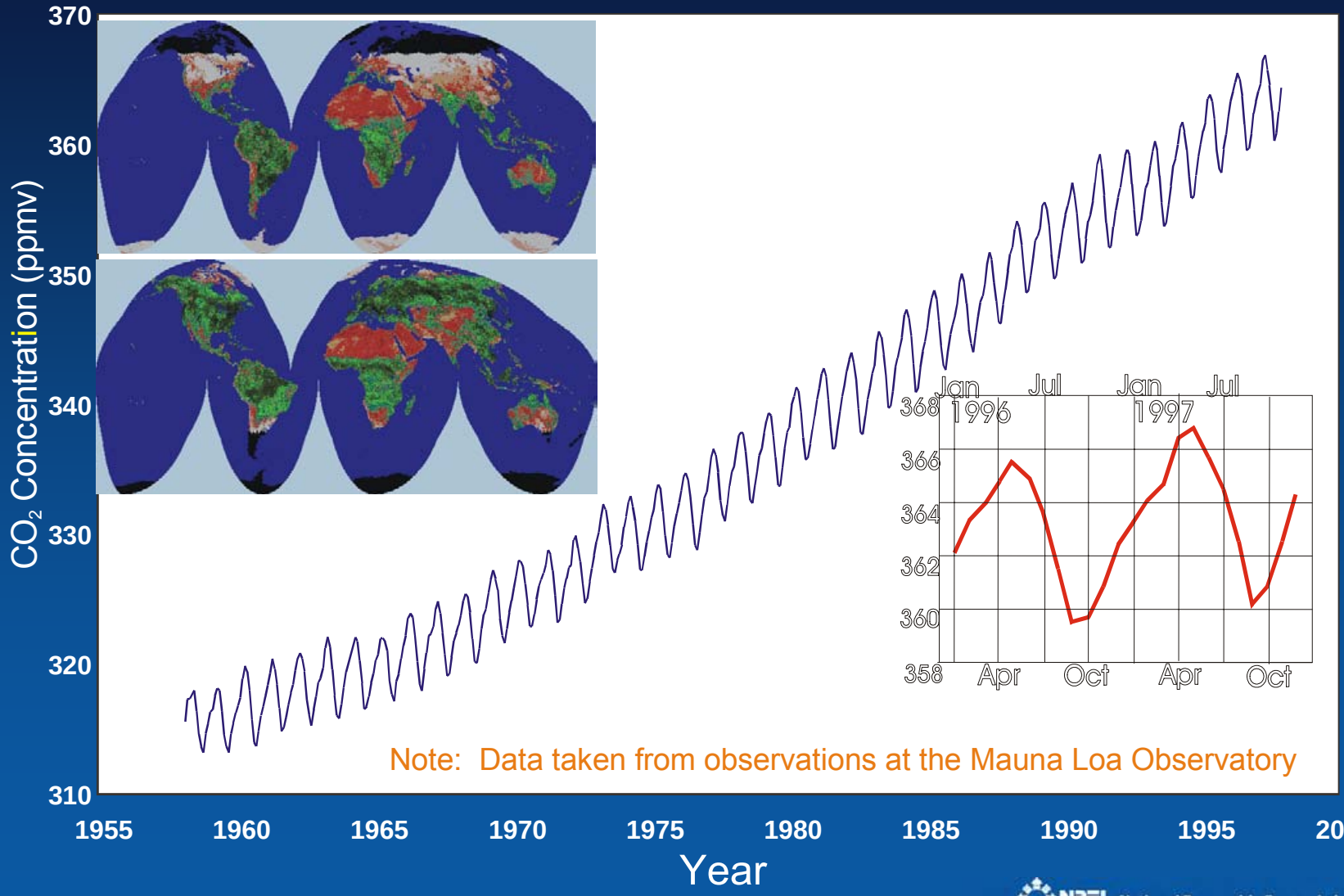
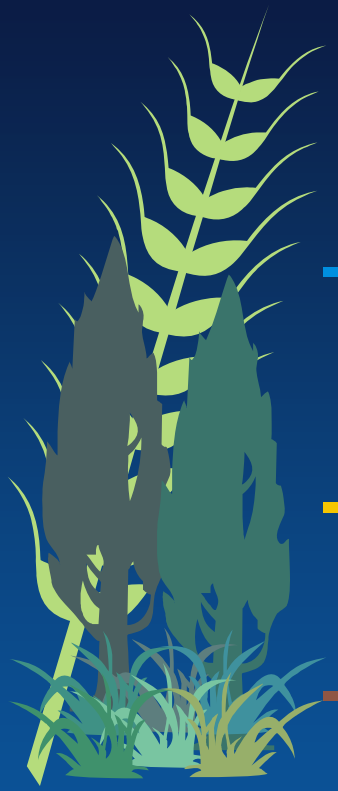
NREL National Renewable Energy Laboratory

Carbon Dioxide - The Biosphere and the Earth's Atmosphere



Biomass & Bioenergy Flows



Biomass

Fiber

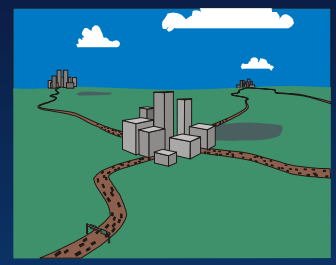
pulp
paper
lumber
plywood
cotton

Materials

Process Residues
black liquor
sawdust
bark

Crops, Animals

Food



Consumers

MSW clean fraction
yard trimmings
constr. & demolition wood
non-recyclable organics

Process Residues
dung
bagasse

stalks & straws
harvest residues
forest slash
forest harvest for energy plantations

Bioenergy

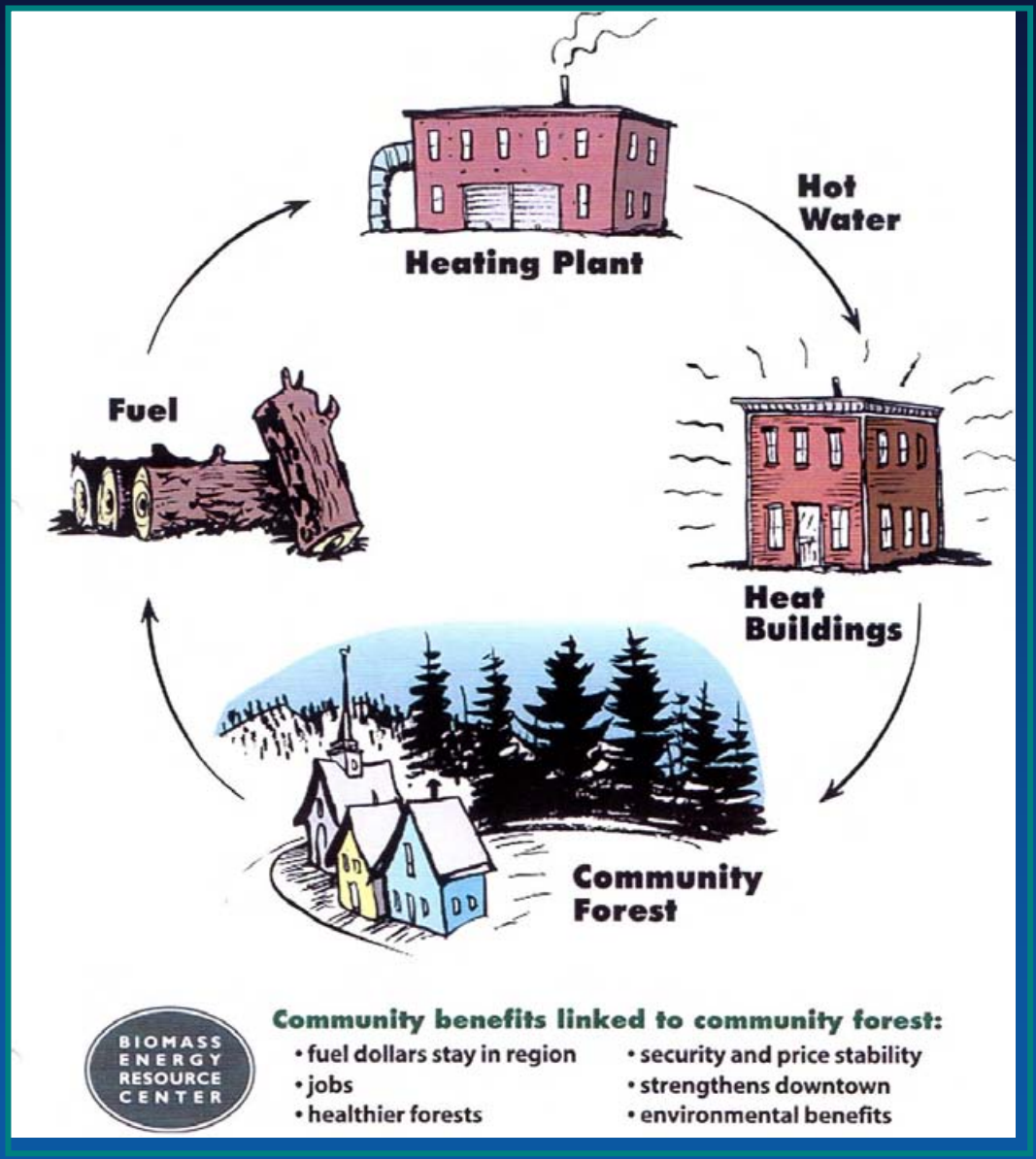
Energy Services

heat
CHP
electricity

charcoal
biogas
ethanol

Biofuels

Benefits of Using Forest Biomass



- Sustainable renewable fuel source
- Local and regional economic development
- Positive action on climate change
- Low cost fuel
- Restoring forest health

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Biomass Heating
Combined Heat & Power

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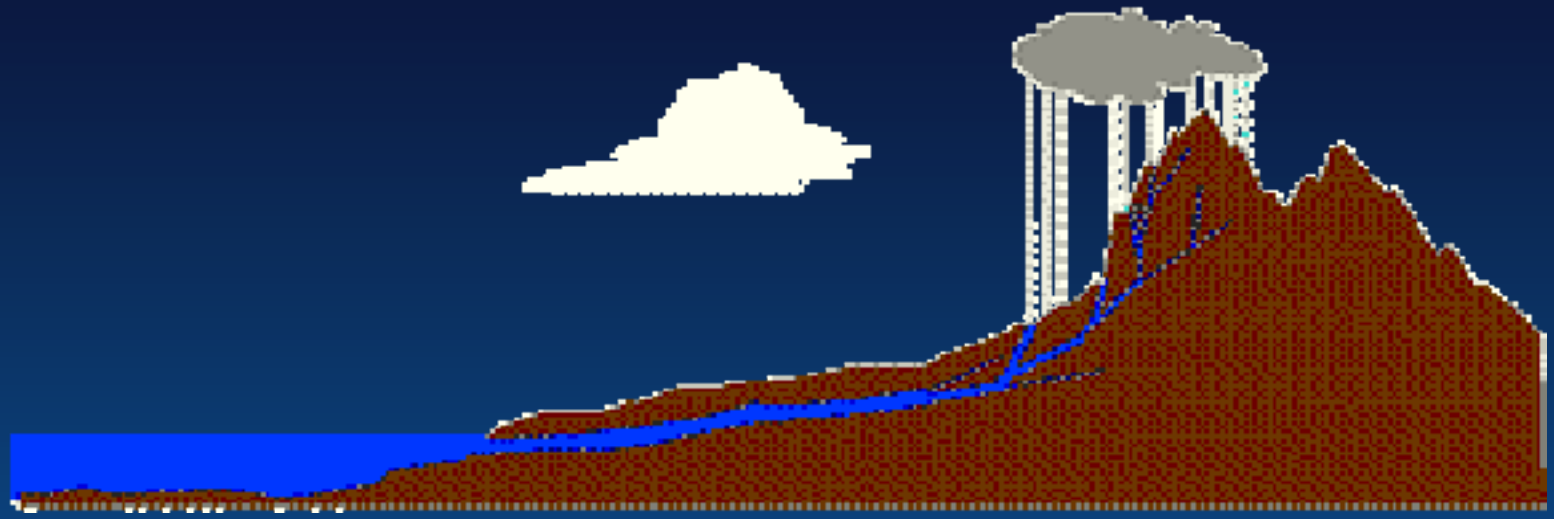
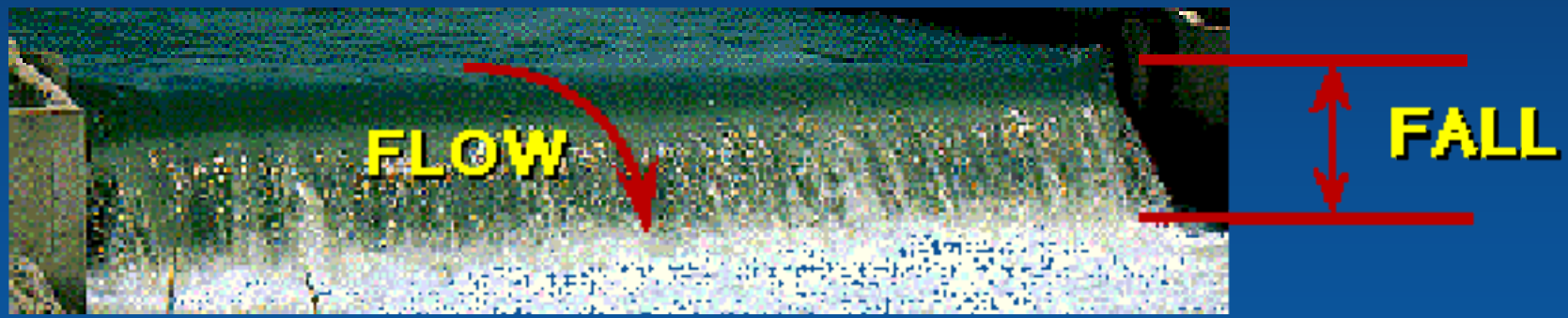
Biogas Engine
Microturbine
Fuel Cell

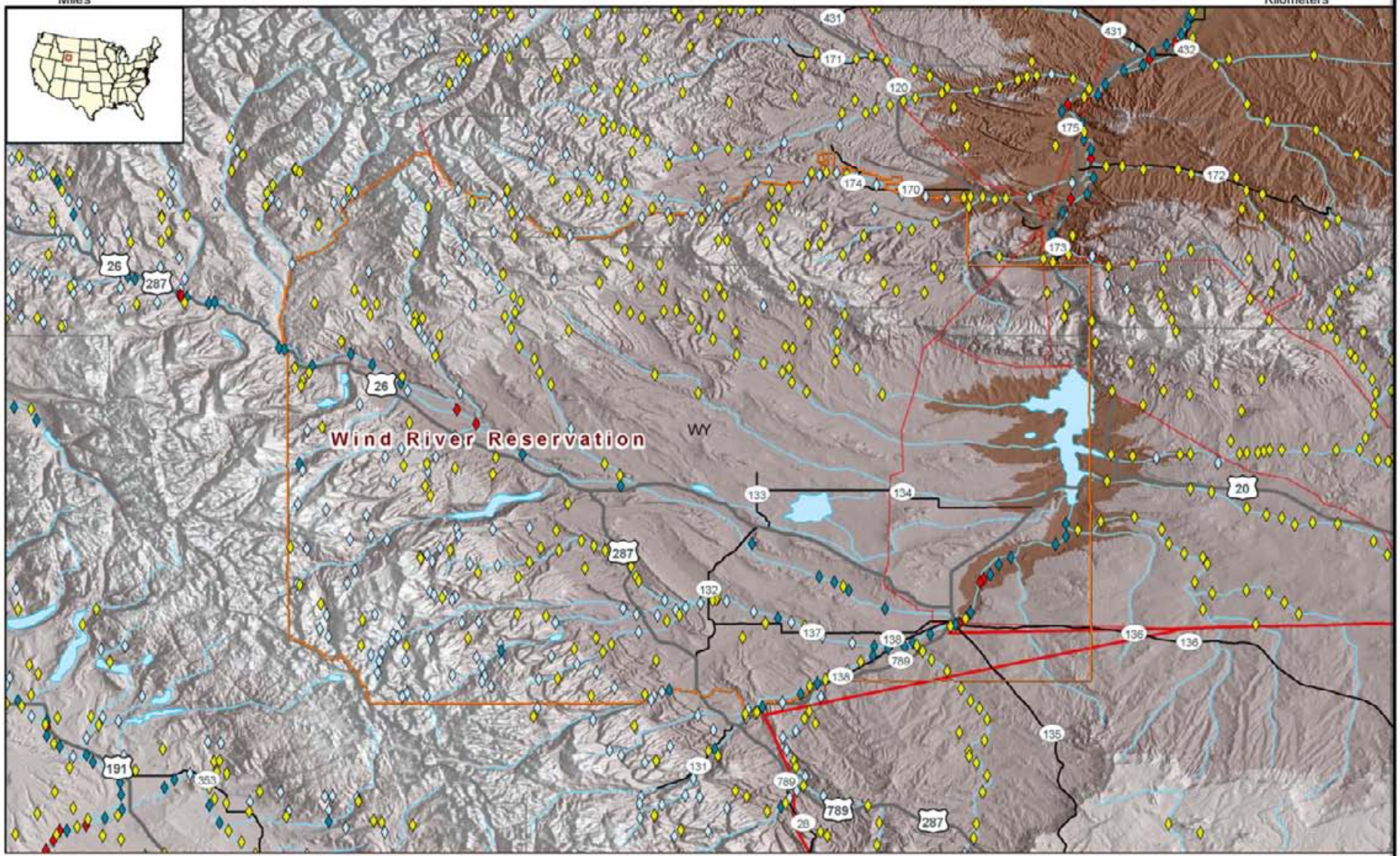
Hydro Power Resource Assessment





Power (kW) = 10 x flow (m^3/s) x fall (m) x η

Wind River Reservation - Wyoming



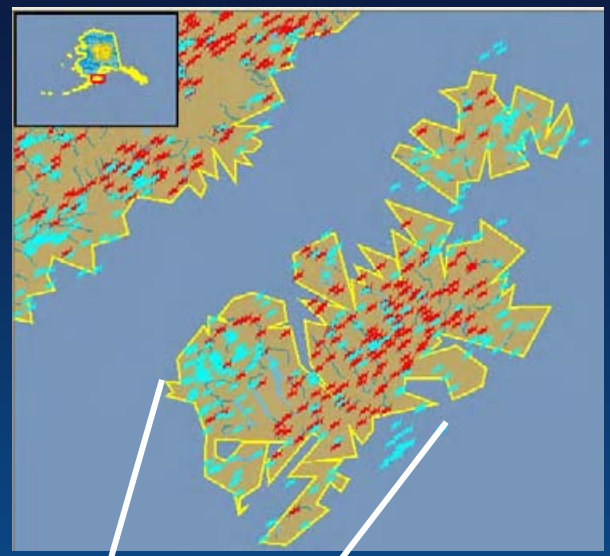
Note: This computer-generated map shows potential small hydroelectric plant sites. The low power sites (< 1 MW) shown are color coded by the class of technology that might be installed. Power potential is based on mean annual flow rate over a 30 year period and varies from year to year. Flow rate and therefore potential power are also likely to exhibit seasonal variations. A lower limit of 10kW has been used to remove microhydro sites suspected of having very short flow durations. Actual on-site measurements and evaluations must be undertaken during the feasibility assessment of any proposed project. Sites are not shown in protected and biologically sensitive areas.

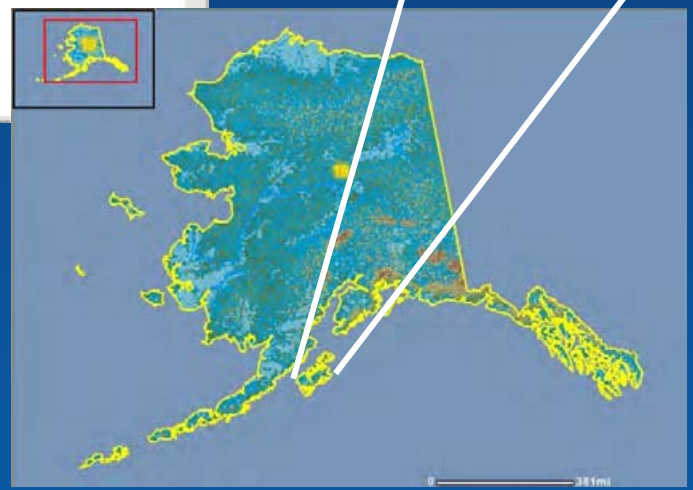
The hydro data was produced by the Idaho National Laboratory for the DOE Wind and Hydropower Technologies Program

NREL

July 5, 2005

Small Hydro Power Options





http://hydropower.inl.gov/prospector/

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Small Hydro

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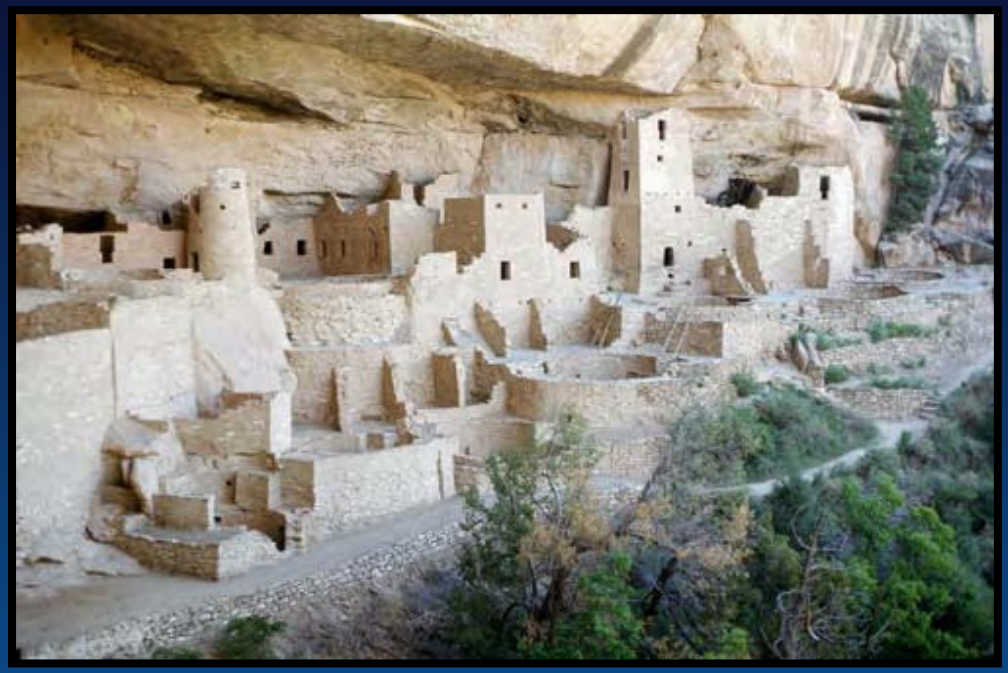
Run of River Hydro

Building Design



"Whole Buildings" Strategy:

Existing R&D programs, building technologies, and components tied together by Systems Integration and Computerized Design Tools.

Passive Solar Strategies

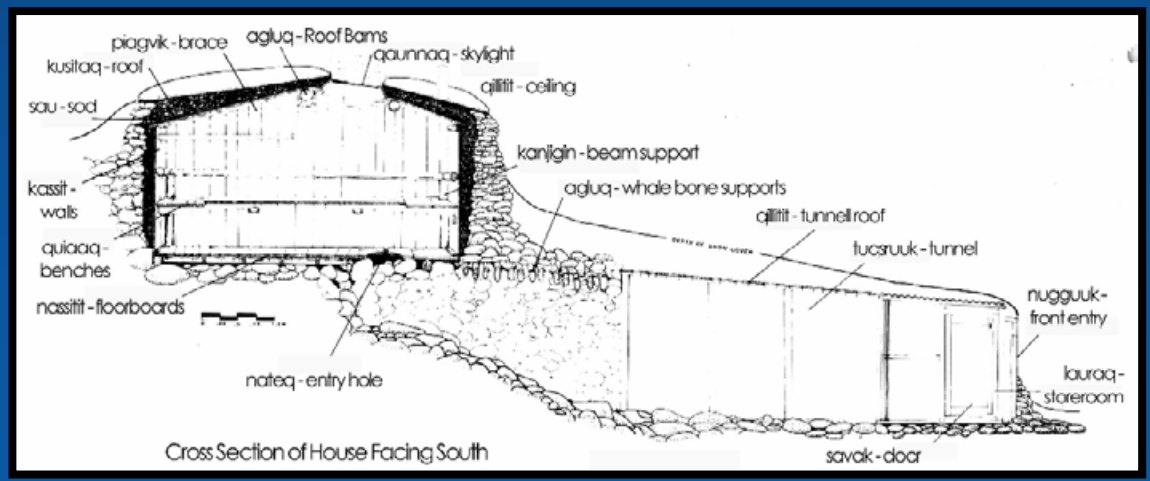
Siting and orientation, glazing size and location, and shading strategies contribute to a passive solar, or "climate-responsive," building.

Advanced Technologies

Energy-saving appliances, advanced energy controls and thermostats, efficient heating and cooling systems, photovoltaics, and solar water heating systems.

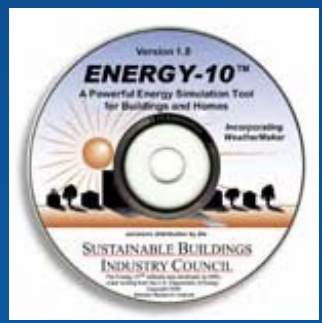
Energy-Efficient Materials

Superior building materials, including high-efficiency windows, insulation, brick, concrete masonry, and interior finish products.



Energy Efficiency 1ST Then Renewables

- Every $ spent on efficiency saves at least as much as $2 spent on renewables
- Climate sensitive design (passive solar)
- Long axis of building faces south, south glass with overhangs, 7 – 12% glass area of building floor area
- Limit east, west and north glass



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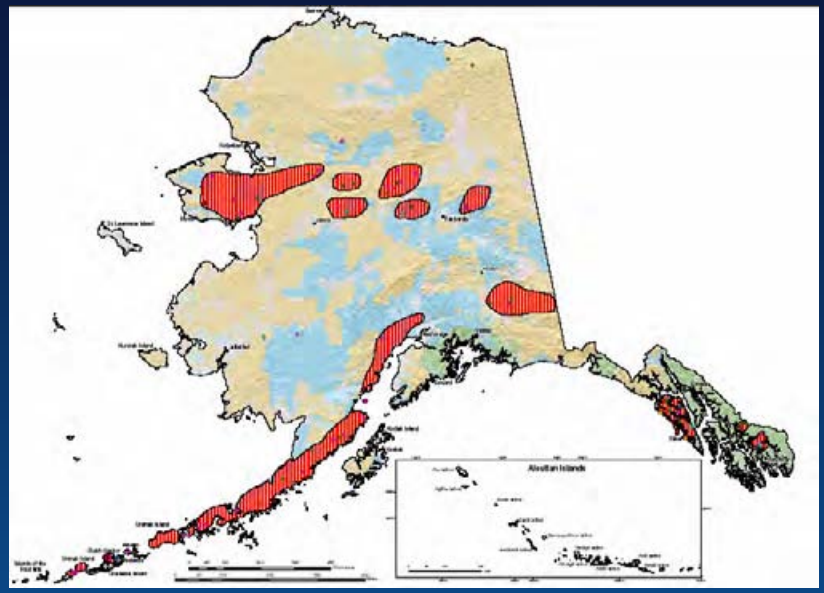
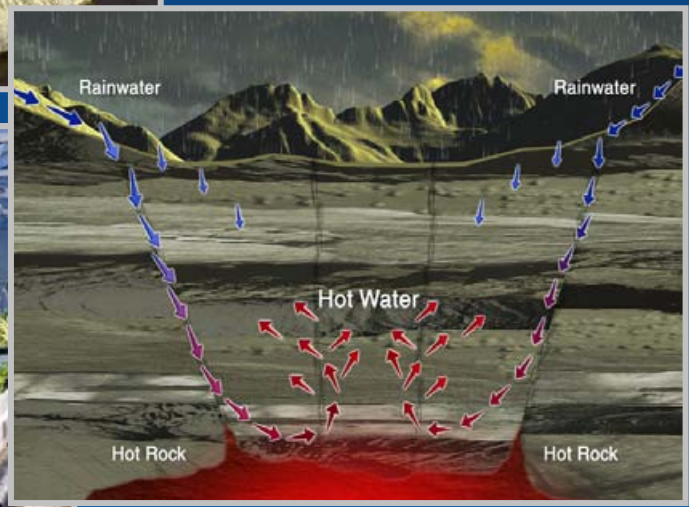
Passive

Geothermal Options



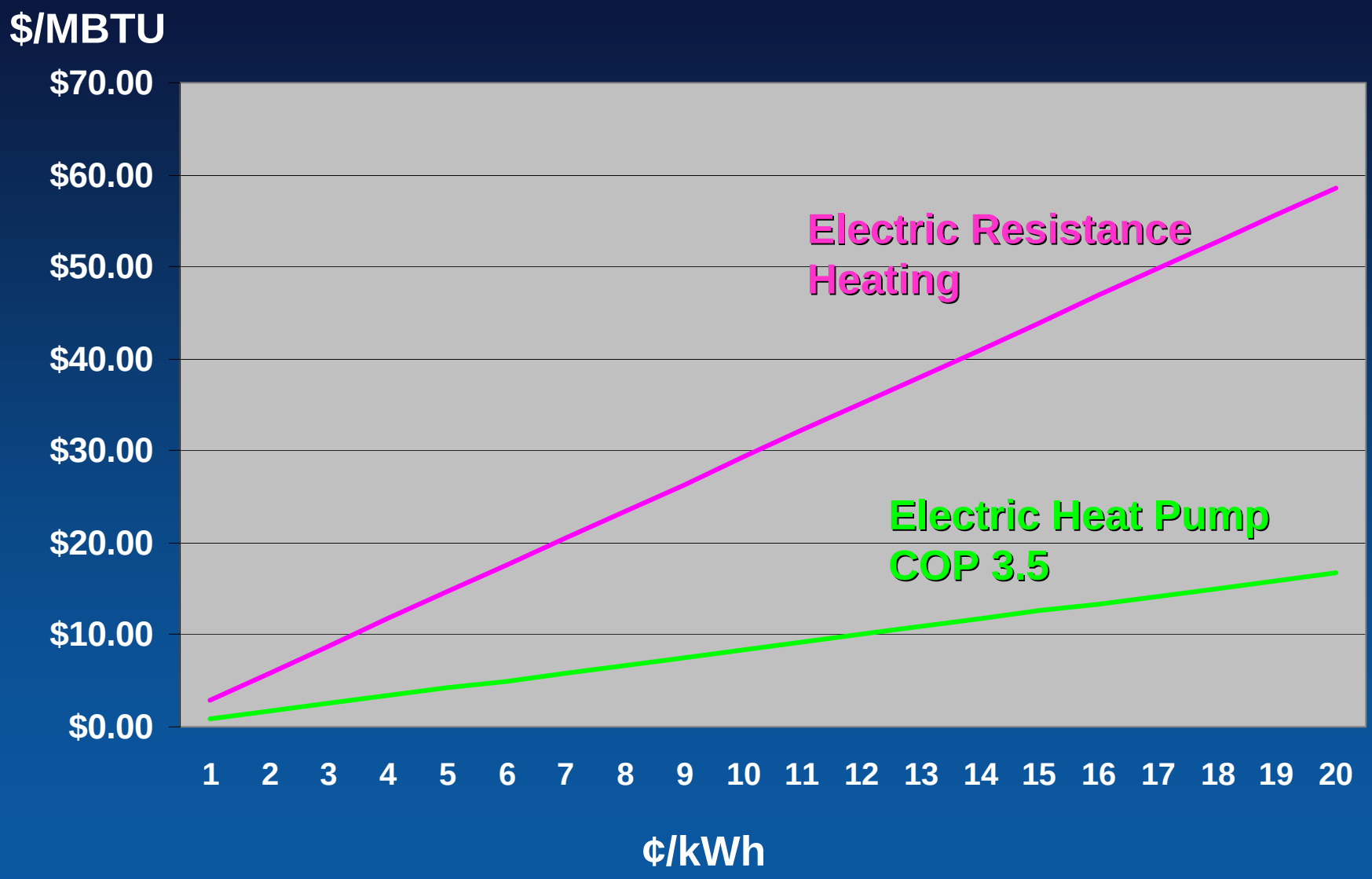


Geothermal Heat Pump Characteristics
"Using Mother Nature Effectively"

- Highly energy efficient
- High level of comfort
- Typically ~70% renewable energy
- Suitable for residential, commercial or industrial
- Typically 15-25 year life
- Environmentally beneficial with no combustion
- Higher first costs, but lower life cycle costs
- Multiple ways to install, with suitability for almost all geographic locations
- Proven technology

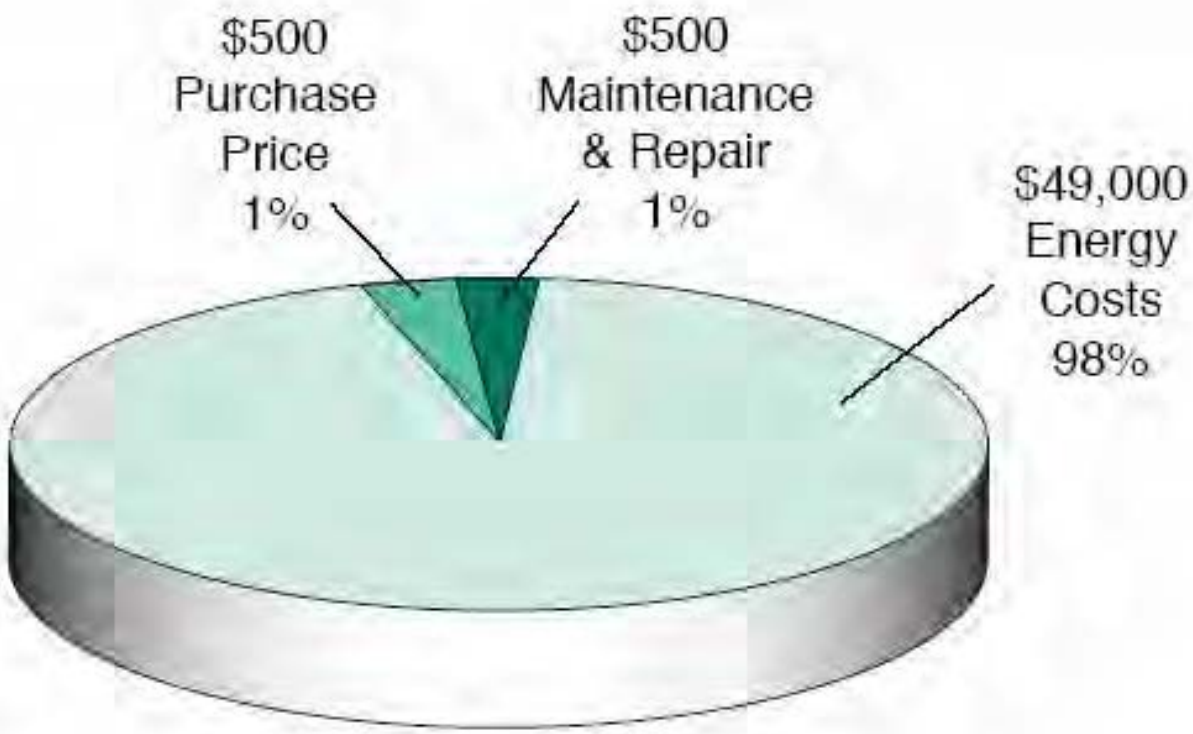
RETScreen®
Ground-Source Heat Pumps

Electric Heating



Importance of Life-Cycle Costing

Example A: Purchase price and the 20-year operating cost of a 10 hp electric motor



http://www.efficiencymaine.com/business/pdfs/Life-Cycle-Costing-SAW.pdf

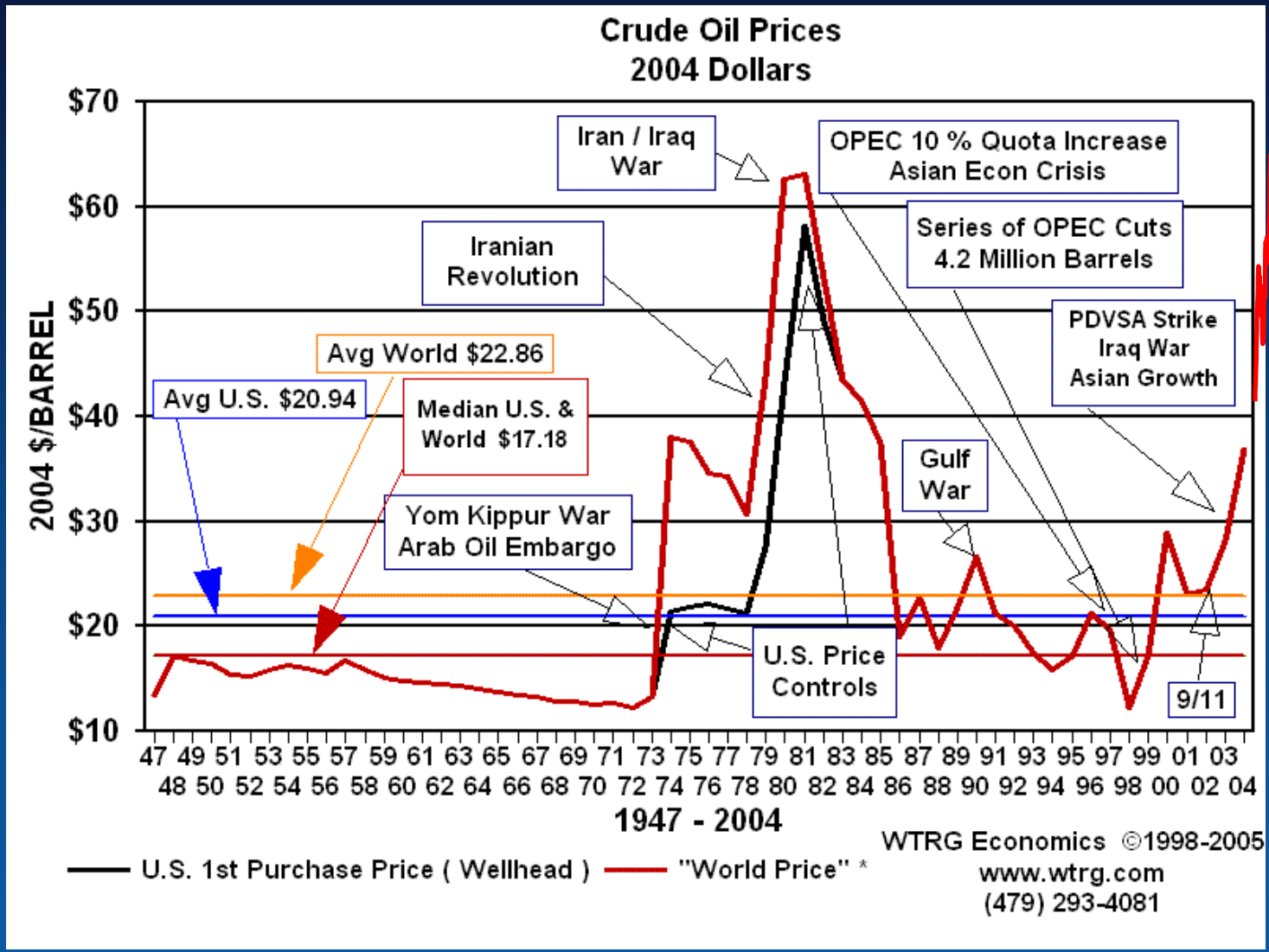
Example B: Light bulbs – Incentive for Existing Schools and Small Businesses

	Incandescent	Compact Fluorescent
Bulb Wattage	60	15
Light output	800 lumens	900 lumens
Purchase price	$0.65	$7.00
Incentive		$2.00
Bulb life (hours)	750	10,000
Bulb life (years)	0.6	7.8
Annual usage	77 kWh	19 kWh
Annual cost	$11.55	$2.85
Present value energy cost	$74.59	$15.37
Present value bulb cost	$7.15	$5.00
Life Cycle Cost	$81.74	$20.37

Assumptions: Bulbs used 3.5 hours/day; electricity price $.15/kWh; discount rate 2.5%

http://www.efficiencymaine.com/business/pdfs/Life-Cycle-Costing-SAW.pdf

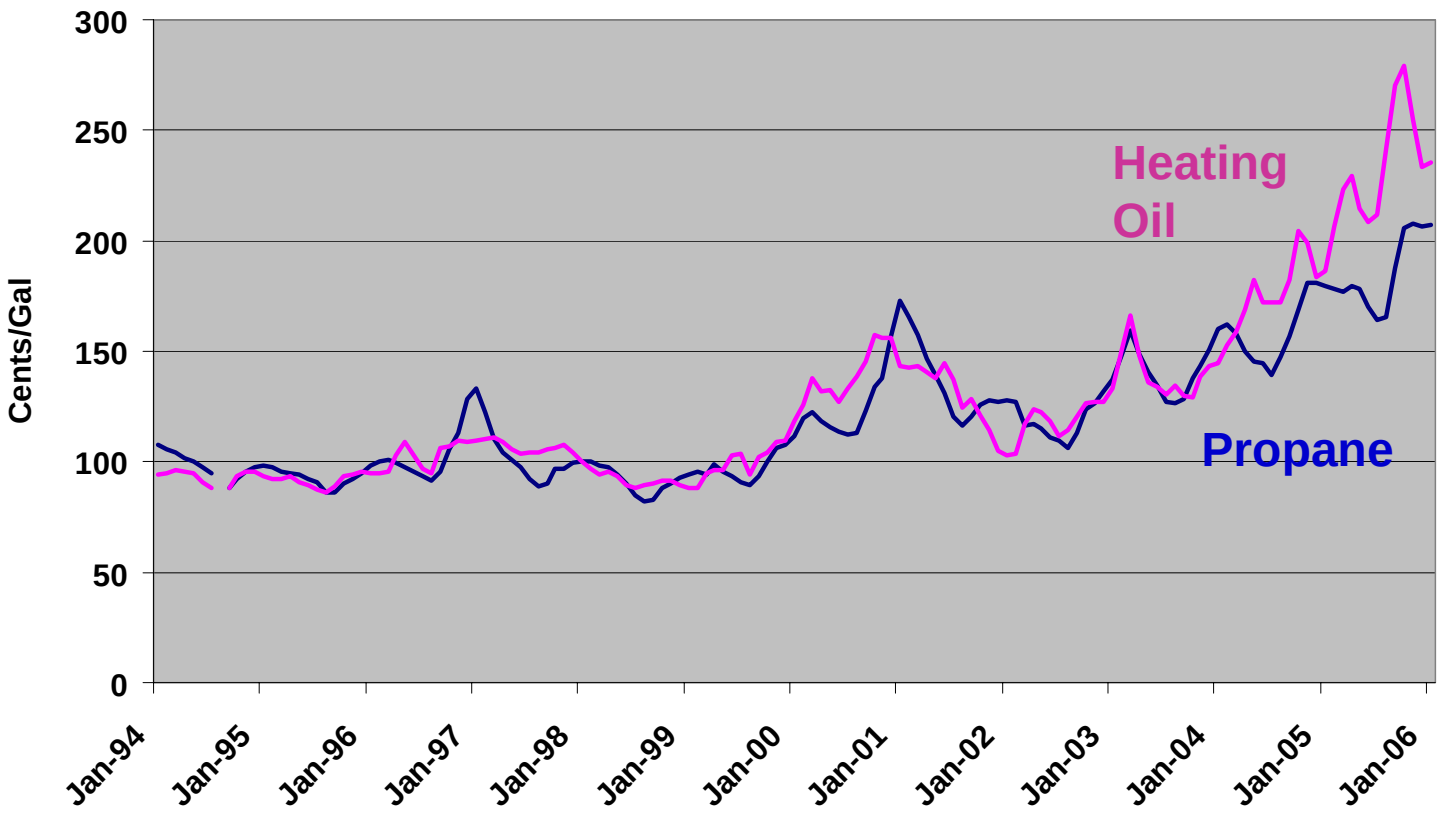
Oil – A Changing Global Landscape



~$77.30/bbl

($1.84/gal)

Propane and Heating Oil Cost



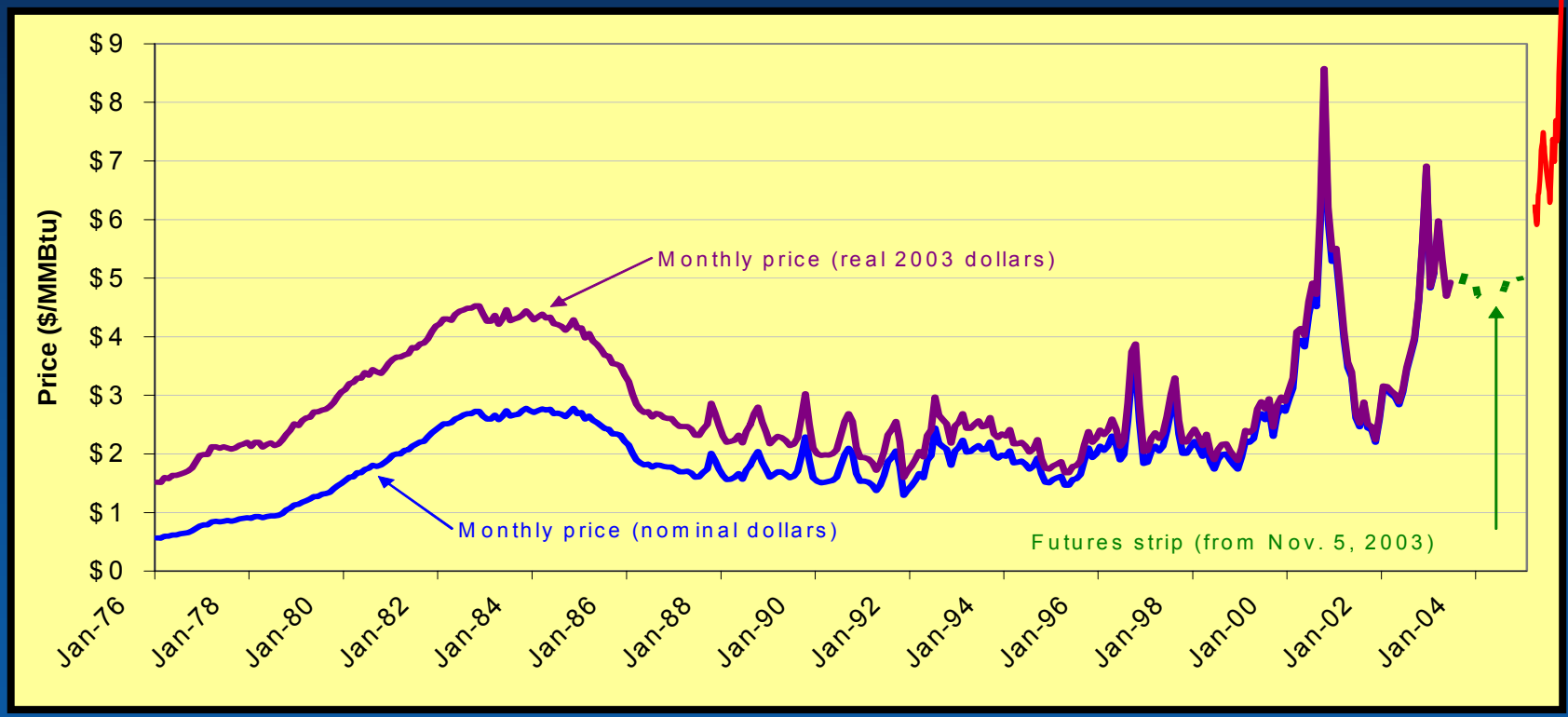
Cost of Delivered Heat

~$20/MBTU

~$28/MBTU

Source: DOE-EIA

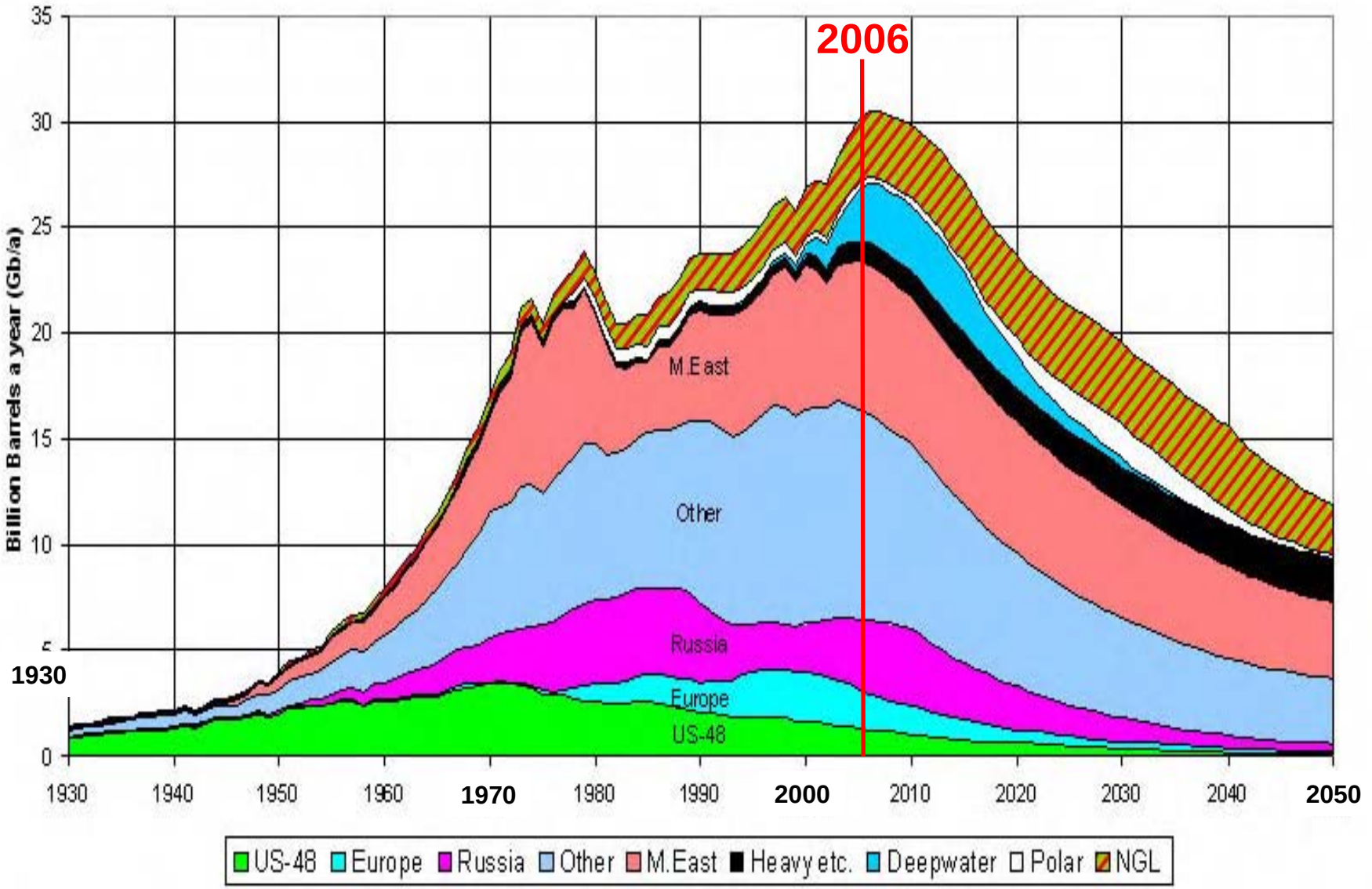
After a decade of low prices, natural gas prices are now more volatile at a higher level.



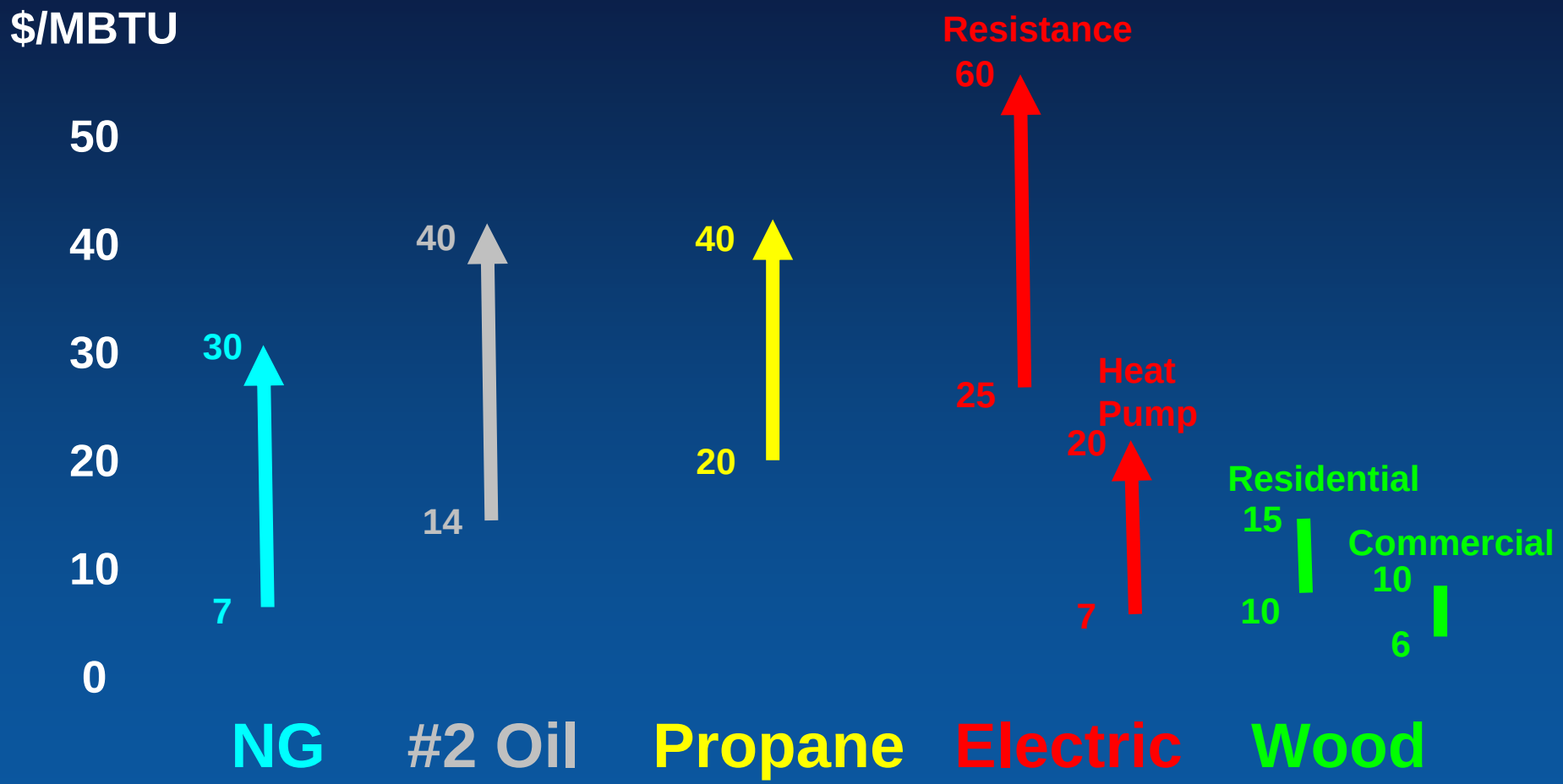
~$15 MMBTU Henry Hub

~$6.35 MMBTU

The Age of Oil



Heating Option Price Comparison



NAEMI RE Analysis & Economics Workshop

Tuesday	**RETScreen**
Wednesday	**HOMER**
Thursday	**Energy 10**

RETScreen Family of Tools

		Software & Data	User Manual	Engineering Textbook
Software & Data	**Version 4**	Coming soon	Coming soon	13.0 MB
Software & Data	**Version 3**			
Introduction	Version 3.0	---	---	3.0 MB
Wind Energy	Version 3.2	1.0 MB	1.0 MB	1.0 MB
Small Hydro	Version 3.2	2.0 MB	1.0 MB	2.0 MB
Photovoltaics	Version 3.2	2.0 MB	1.0 MB	1.0 MB
Combined Heat & Power	Version 3.6	8.0 MB	4.0 MB	Coming soon
Biomass Heating	Version 3.1	2.0 MB	1.0 MB	1.0 MB
Solar Air Heating	Version 3.1	1.0 MB	1.0 MB	1.0 MB
Solar Water Heating	Version 3.1	2.0 MB	1.0 MB	2.0 MB
Passive Solar Heating	Version 3.1	2.0 MB	1.0 MB	1.0 MB
Ground-Source Heat Pumps	Version 3.1	2.0 MB	1.0 MB	2.0 MB
Refrigeration	Version --	Coming soon	Coming soon	---

http://www.retscreen.net/

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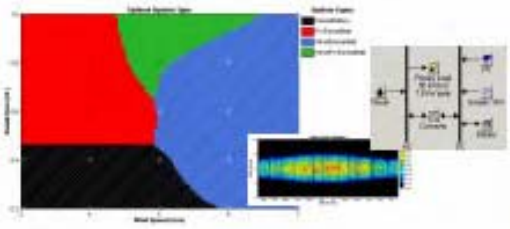

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Getting Started Guide (PDF File, 720 kB)
Brochure (English) (PDF File, 964 kB)
Brochure (Spanish) (PDF File, 1.3 MB)

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Security & Privacy

HOMER is a computer model that simplifies the task of evaluating design options for both off-grid and grid-connected power systems for remote, stand-alone, and distributed generation (DG) applications. HOMER's optimization and sensitivity analysis algorithms allow you to evaluate the economic and technical feasibility of a large number of technology options and to account for variation in technology costs and energy resource availability. HOMER models both conventional and renewable energy technologies:

Power sources:
- solar photovoltaic (PV)
- wind turbine
- run-of-river hydro power
- generator: diesel, gasoline, biogas, alternative and custom fuels, cofired
- electric utility grid
- microturbine
- fuel cell

Storage:
- battery bank
- hydrogen

Loads:
- daily profiles with seasonal variation
- deferrable (water pumping, refrigeration)
- thermal (space heating, crop drying)
- efficiency measures

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NREL sponsored the first HOMER User Group Webcast on May 16, 2006 at 0230 GMT (10:30 PM EDT May 15). Click here to download the presentations and supporting material.

ENERGY-10™:
A Powerful Energy Simulation Tool for Buildings and Homes

Version 1.8

ENERGY-10™ software is a powerful design tool that analyzes—and illustrates—the energy and cost savings that can be achieved through more than a dozen sustainable design strategies. Hourly energy simulations help you quantify, assess, and clearly depict the benefits of daylighting, passive solar heating, natural ventilation, well-insulated envelopes, better windows, lighting systems, mechanical equipment, and more. **Version 1.8** offers many new features: a **Photovoltaic** module that provides the ability to model and simulate the performance of a PV system; a **Solar Domestic Hot Water** module provides a new solar domestic/service hot water modeling capability; and a new library ("ASHRAELIB") defining constructions (wall, roof, window, etc.) as spelled out in ASHRAE 90.1-2004. The CD-Rom includes *ENERGY-10™* Version 1.8 software, *Mastering ENERGY-10™* User Manual (PDF) and Version 1.8 Installation Manual (PDF). Read full review

http://www.sbicouncil.org/store/e10.php