Assessing Your Renewable Energy Resources

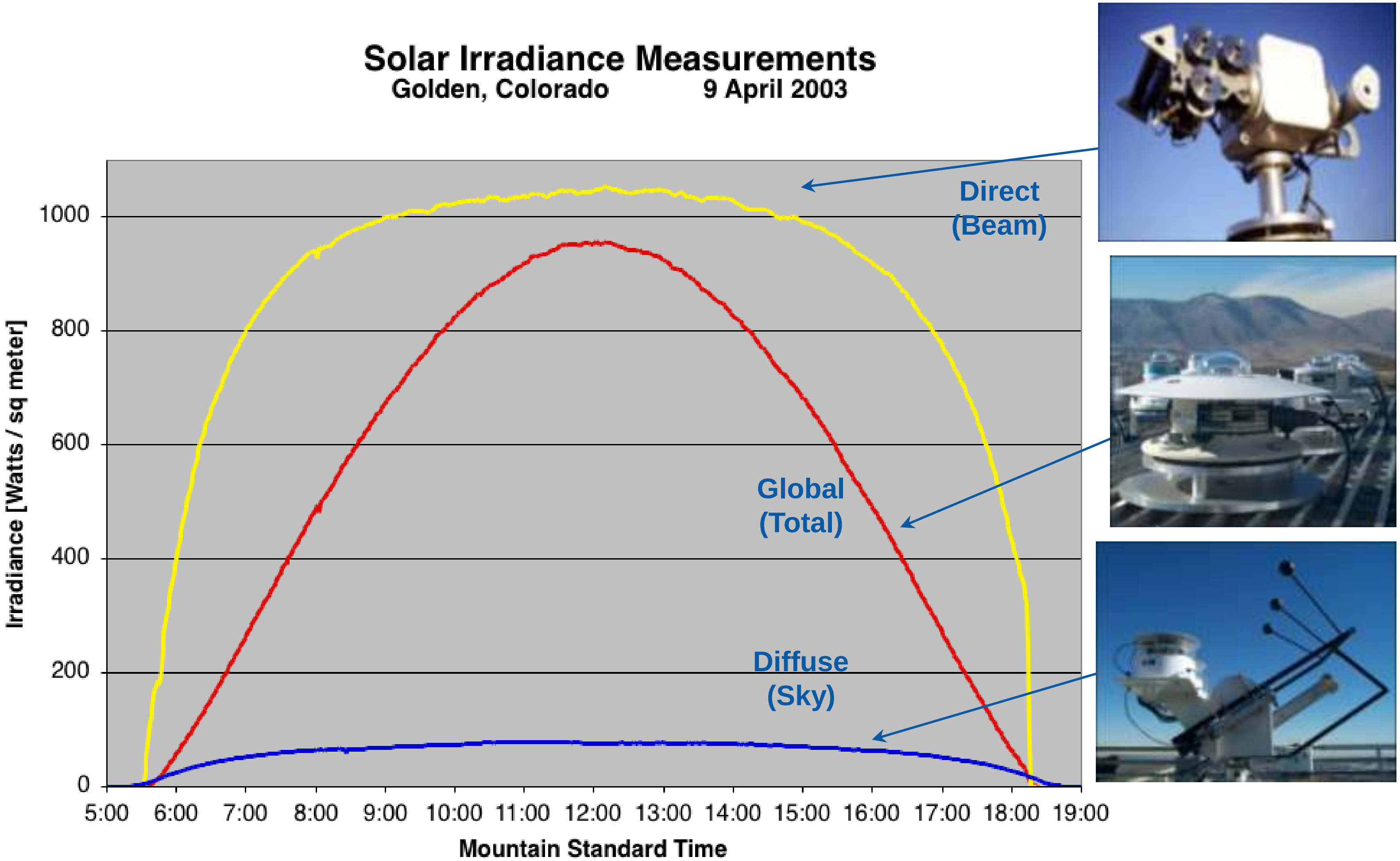
Roger Taylor

Principal Project Manager

Tribal Energy Program

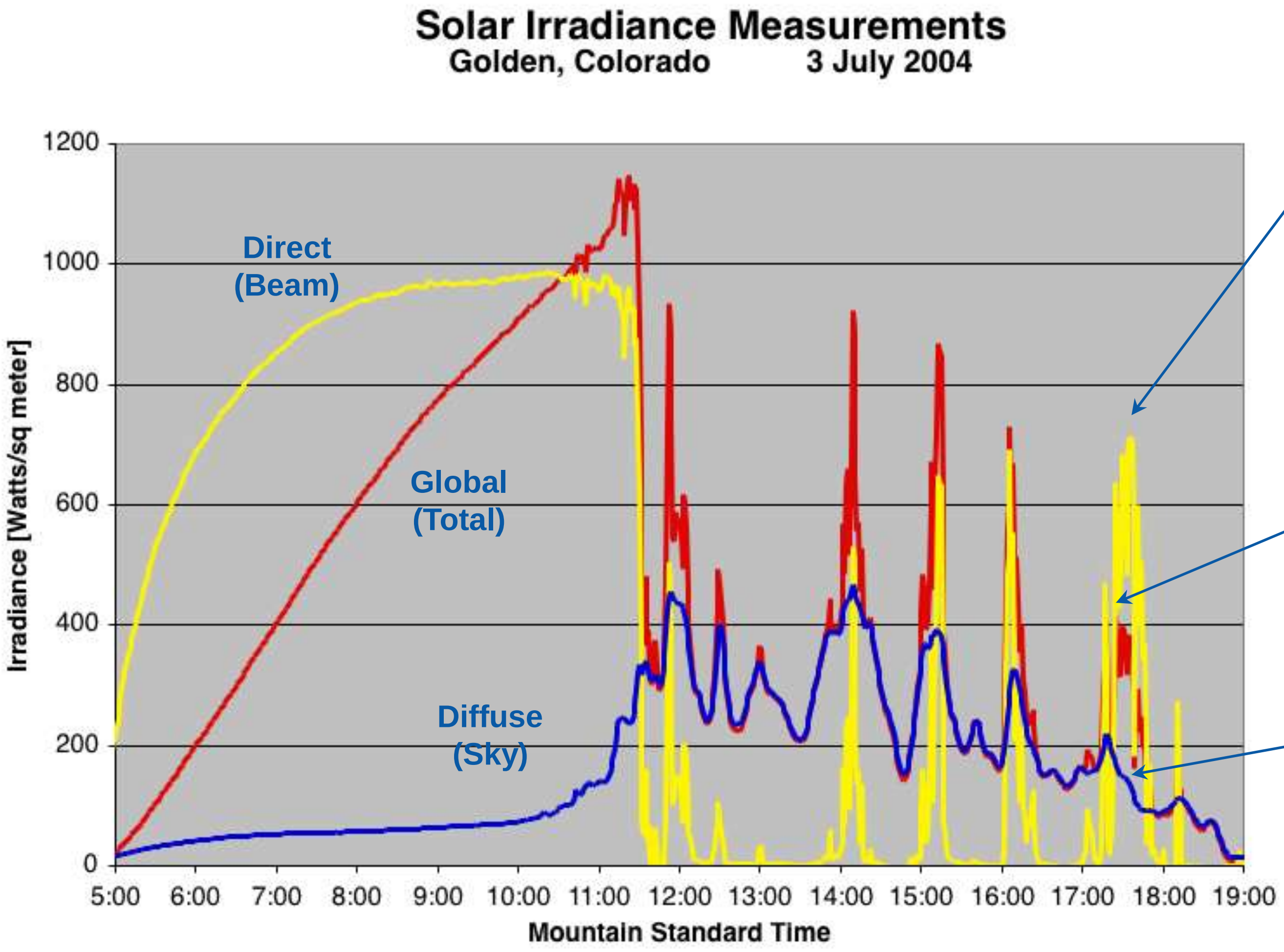
10/27/2010

Clear Sky

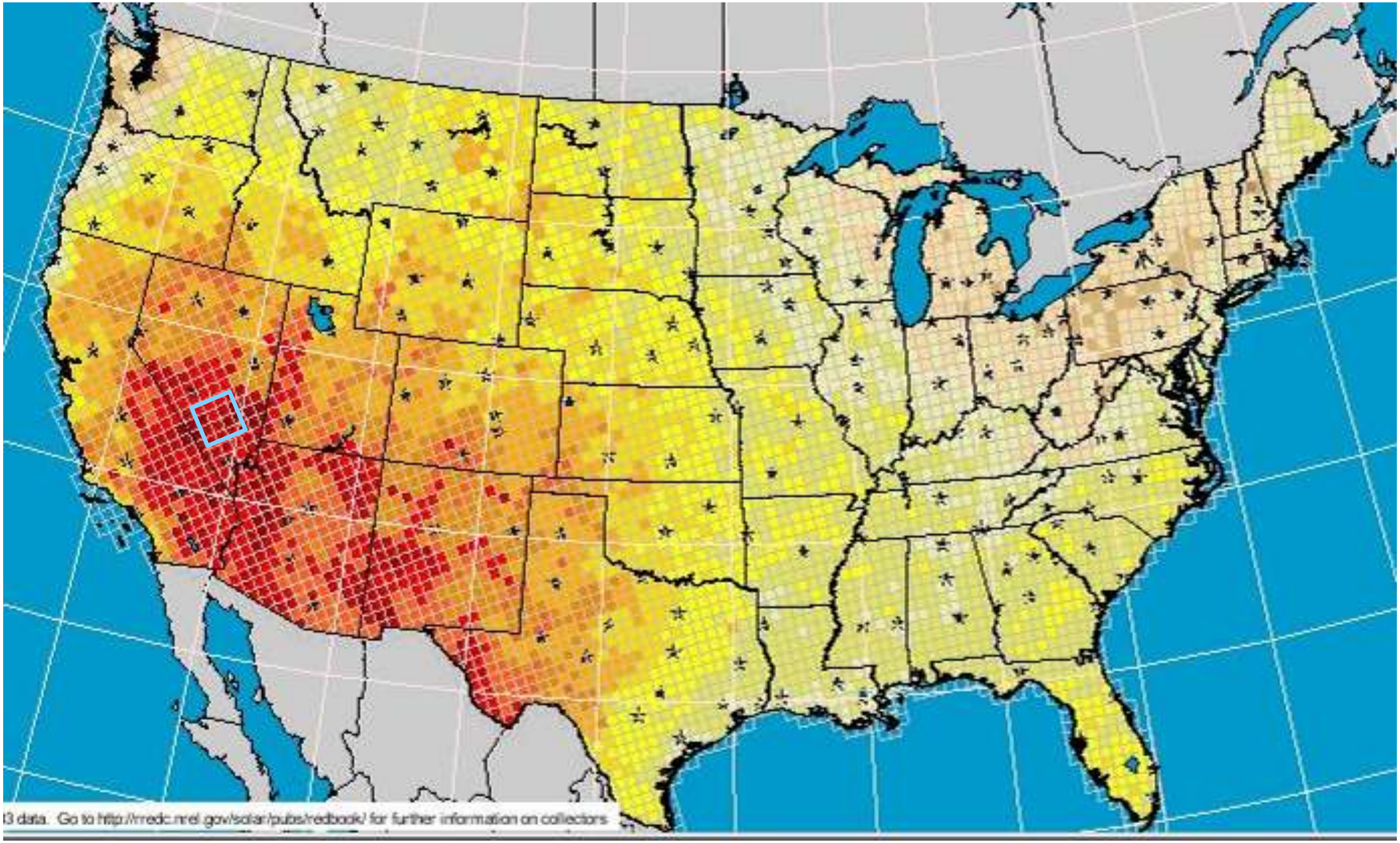


Solar Irradiance Measurements
Golden, Colorado
9 April 2003
Irradiance [Watts / sq meter]
1000
800
600
400
200
0
5:00 6:00 7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00
Mountain Standard Time
Direct (Beam)
Global (Total)
Diffuse (Sky)

Partly Cloudy Sky



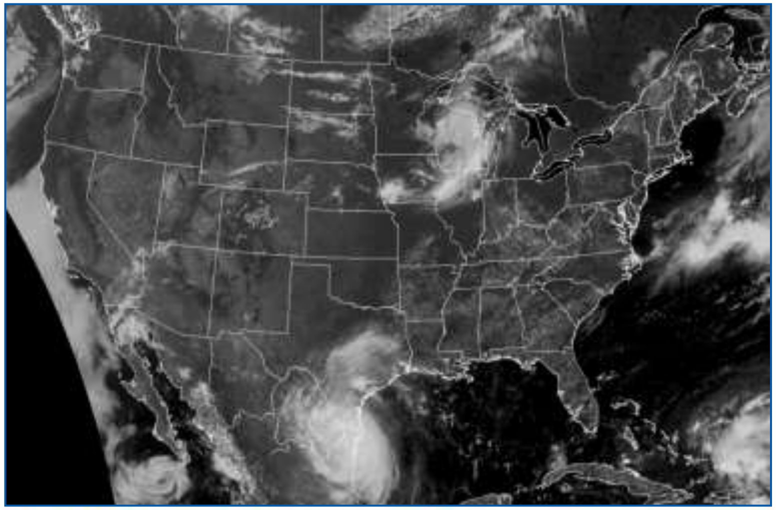
A Plot of Land, 100 Miles on a side, in Nevada could provide all the kWh consumed by the U.S.

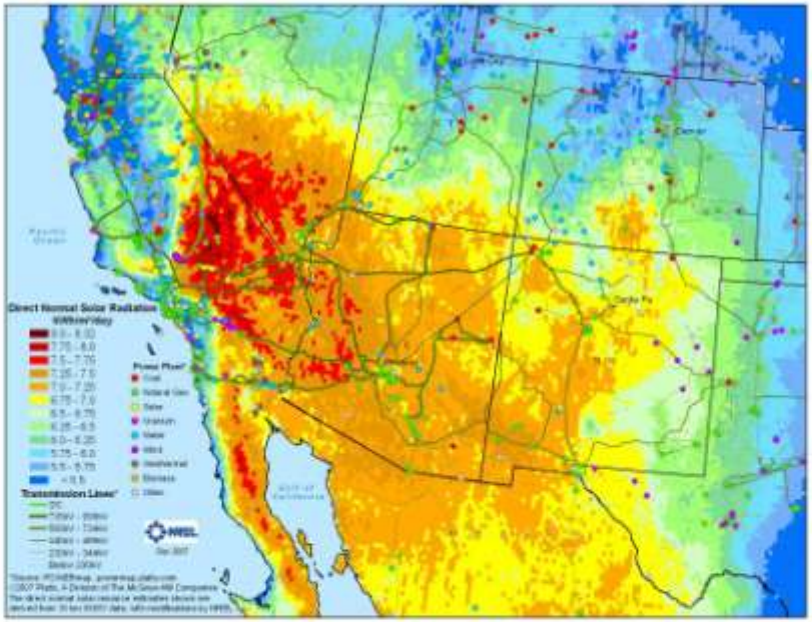


U.S. Southwest GIS Screening Analysis for CSP Generation

Screening Approach

•Initial solar resource and GIS screening analysis used to identify regions most economically favorable to construction of large-scale CSP systems





•GIS analysis used in conjunction with transmission and market analysis to identify favorable regions in the southwest

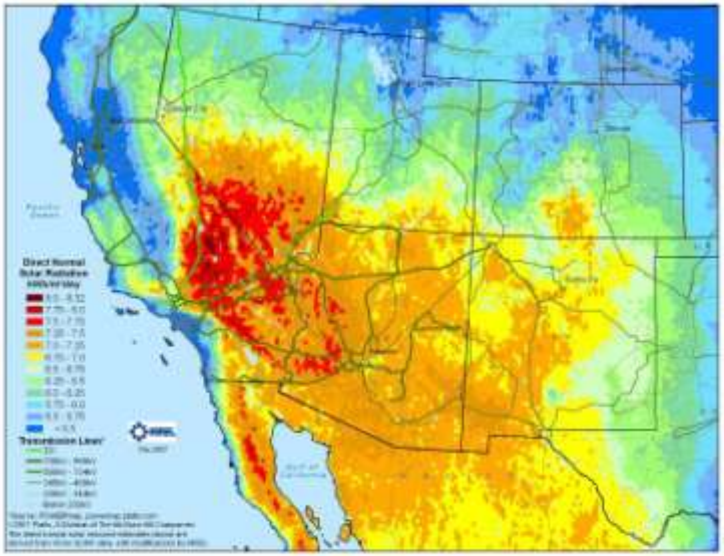
Solar Resource Screening Analysis

All Solar Resources

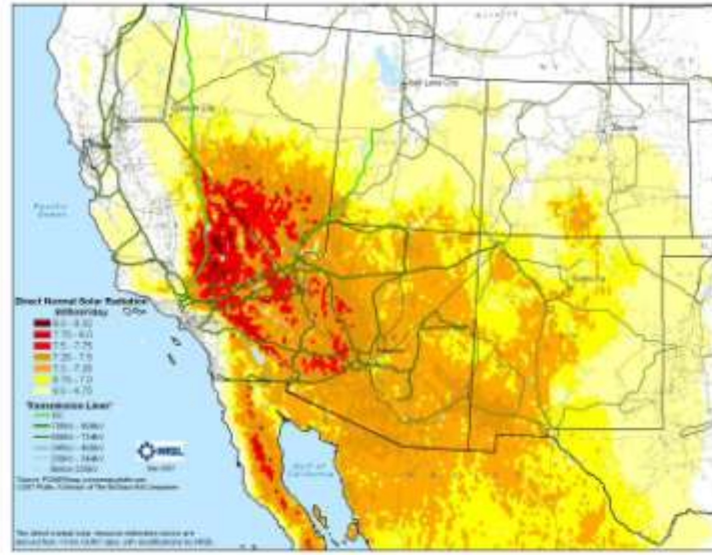
Locations Suitable for Development

1. Start with direct normal solar resource estimates derived from 10 km satellite data.
2. Eliminate locations with less than 6.0 kWh/m^2/day.
3. Exclude environmentally sensitive lands, major urban areas, and water features.
4. Remove land areas with greater than 1% (and 3%) average land slope.
5. Eliminate areas with a minimum contiguous area of less than 1 square kilometers.

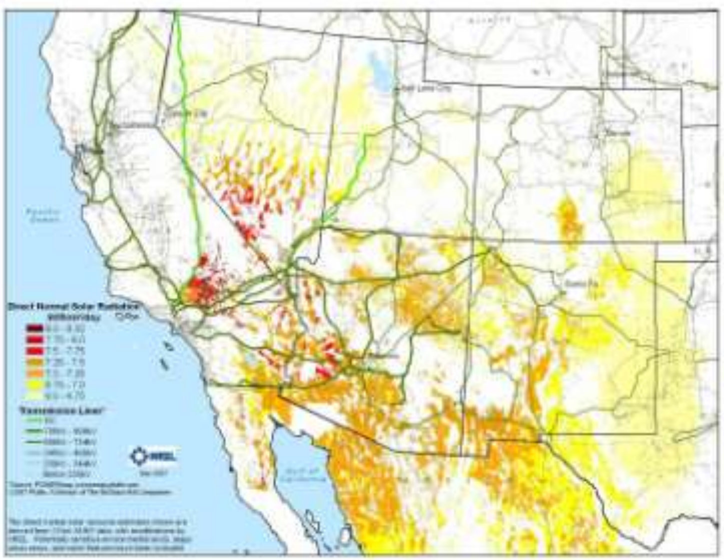
GIS Solar Resource Screening Analysis



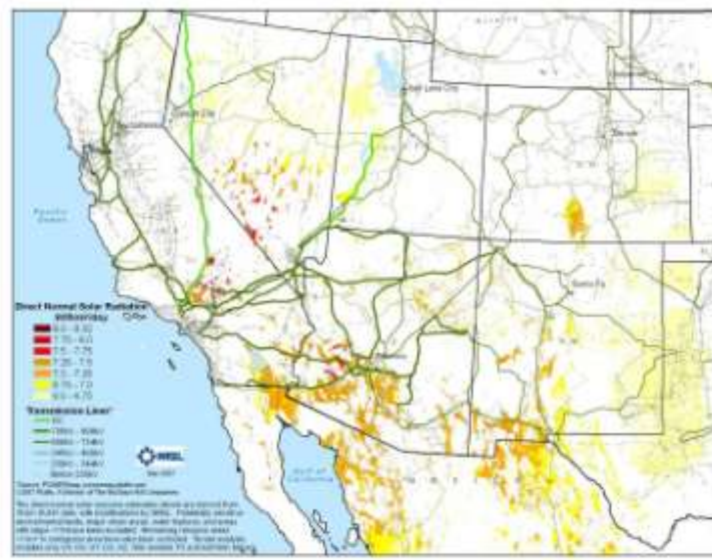
Unfiltered Resource



Solar > 6.0 kwh/m^2-day



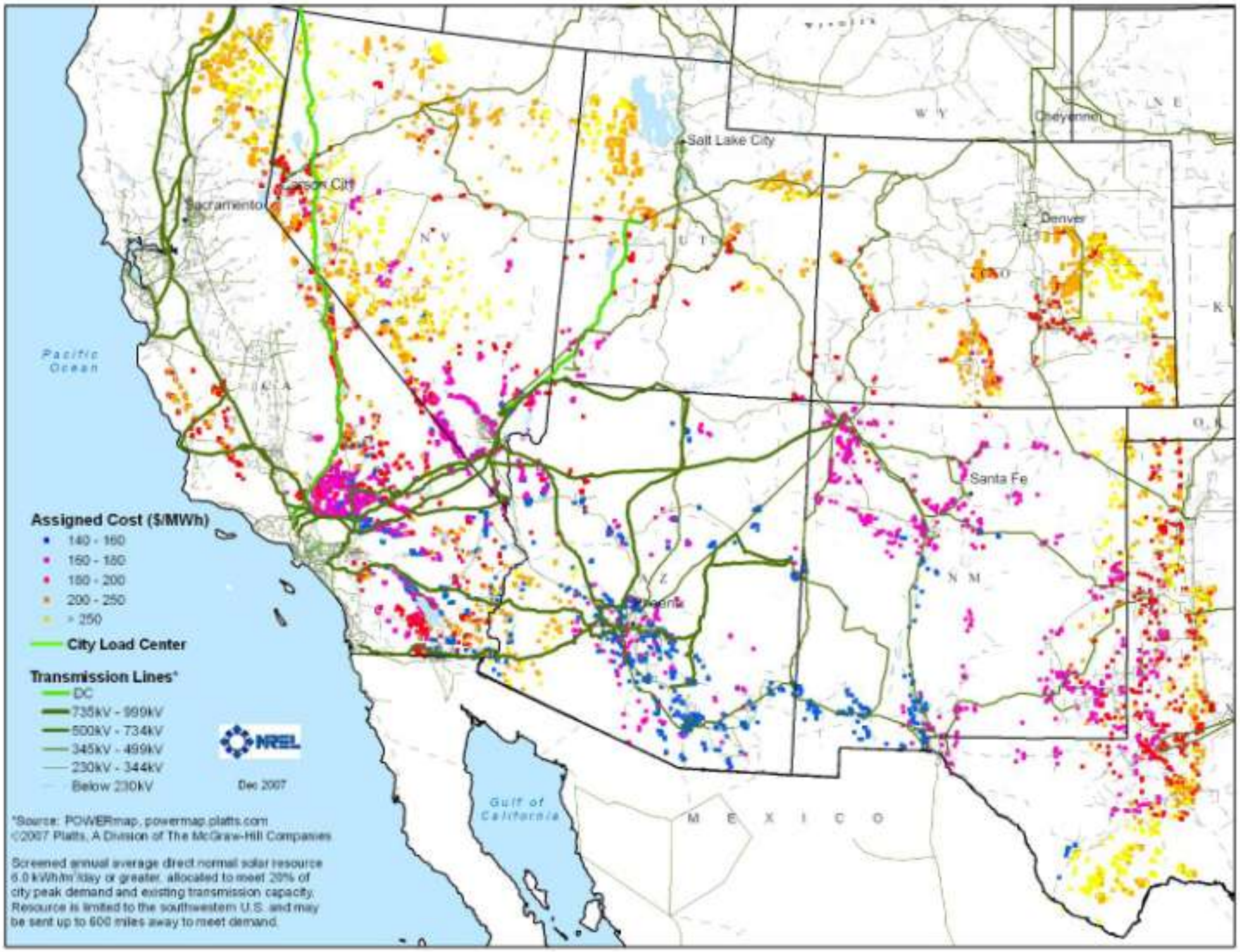
Land Exclusions



Slope Exclusions

National Renewable

Optimal CSP Sites
from CSP Capacity Supply Curves

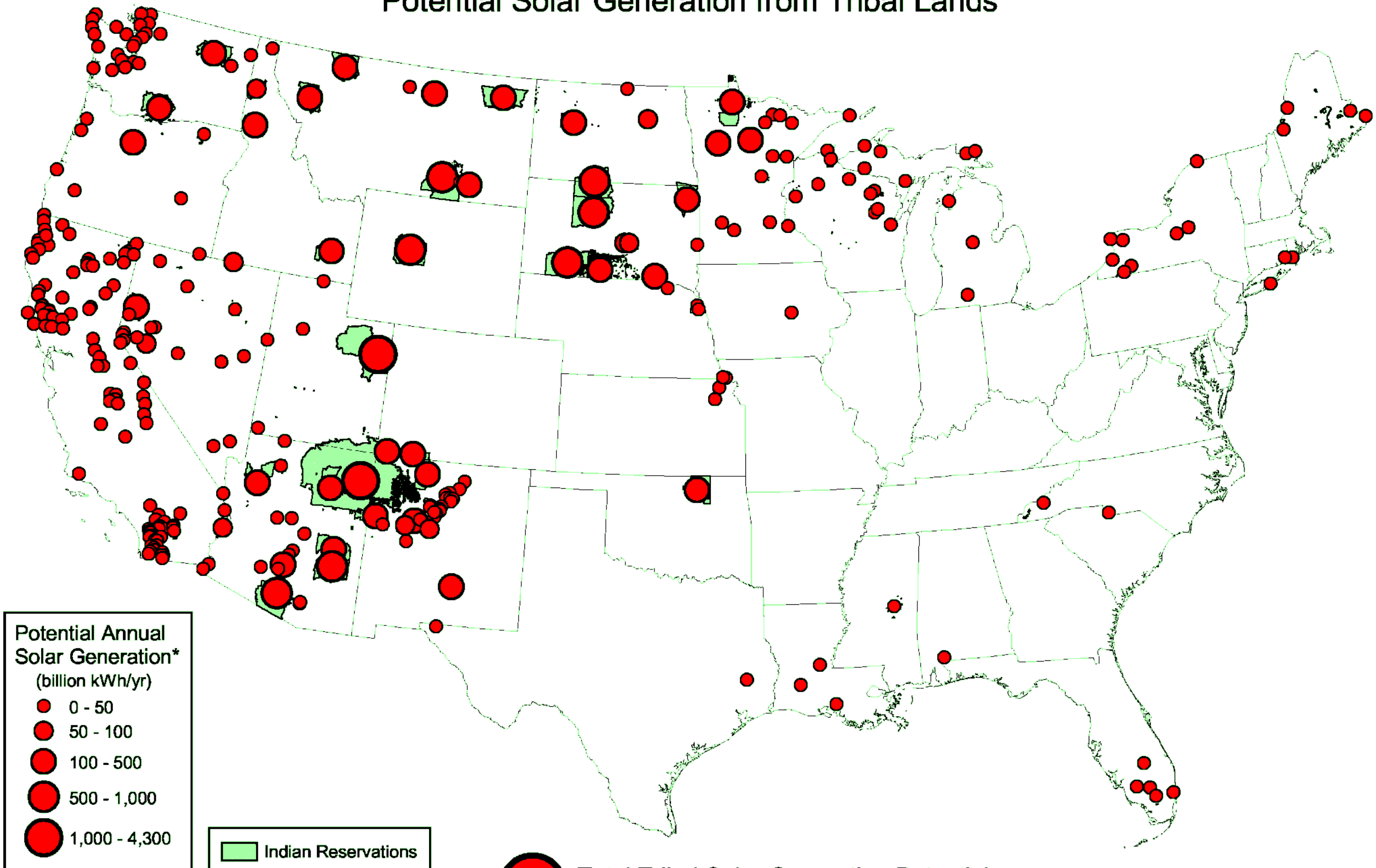


354 MW Luz Solar Electric Generating Systems (SEGS)
Nine Plants built 1984 - 1991

64 MWe Acciona Nevada Solar One
Solar Parabolic Trough Plant

SunEdison 8MW, San Louis Valley, CO

Potential Solar Generation from Tribal Lands



Total Tribal Solar Generation Potential: 17,606 Billion kWh/yr

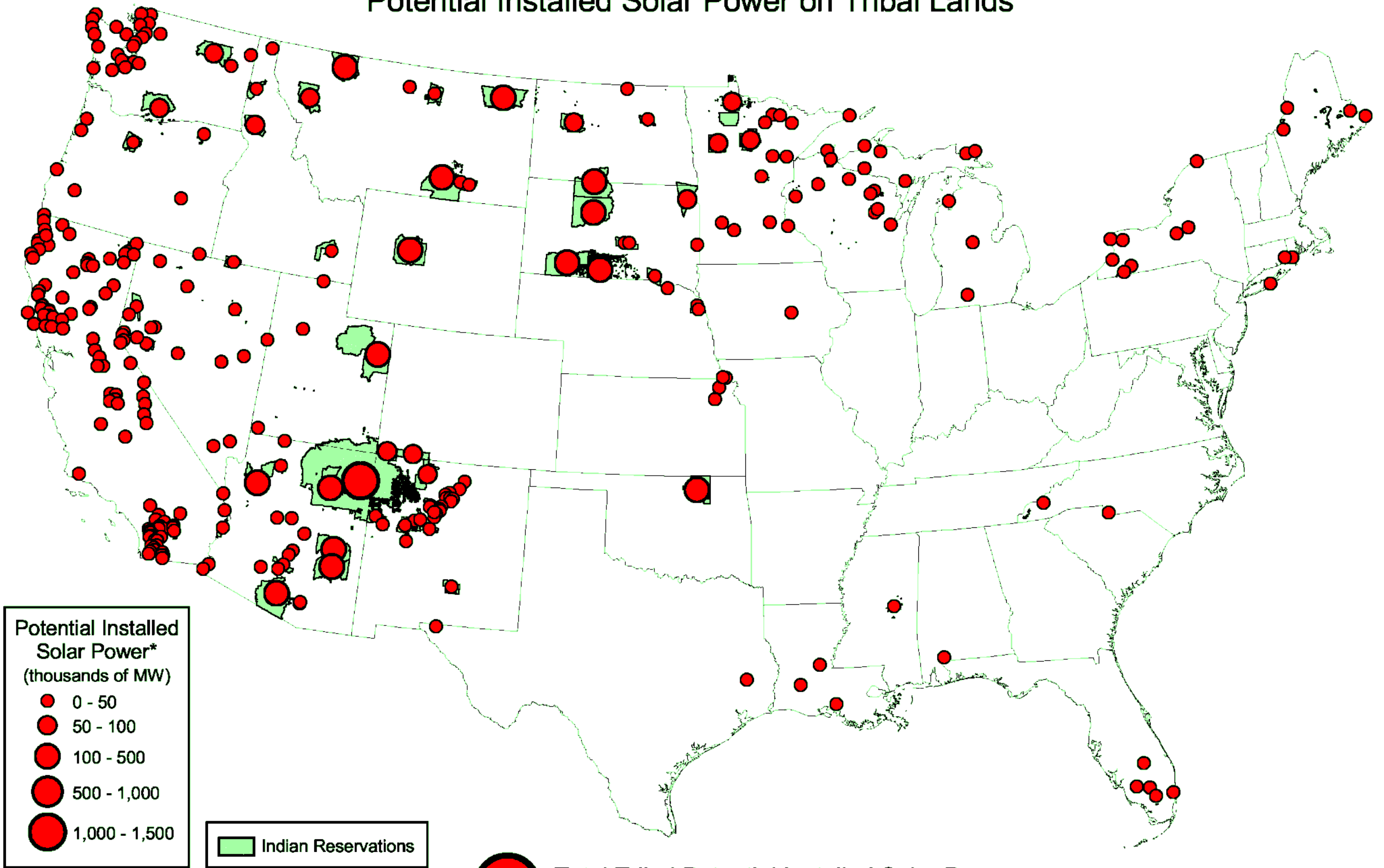
U.S. Total Electric Generation (2004 Est.): 3,853 Billion kWh/yr (EIA)

* Generation estimated using annual average solar resource from a tilt = latitude collector. The formula is:
Resource (kWh/m²/day) * 365 * Area (m²) * 0.03,
where 0.03 represents solar panels covering 30% of the total reservation area with a panel efficiency of 10%.

U.S. Department of Energy
National Renewable Energy Laboratory

DHJul3004solgen

Potential Installed Solar Power on Tribal Lands



* Installed power is estimated using annual average solar resource from a tilt = latitude collector. The formula is:
Resource (kWh/m²/day) * 365 * 8760 * Area (m²) * 0.01,
where 0.01 represents solar panels covering 30% of the total reservation area, producing energy 33% of the time and with a panel efficiency of 10%.

Total Tribal Potential Installed Solar Power:
6,029,320 MW

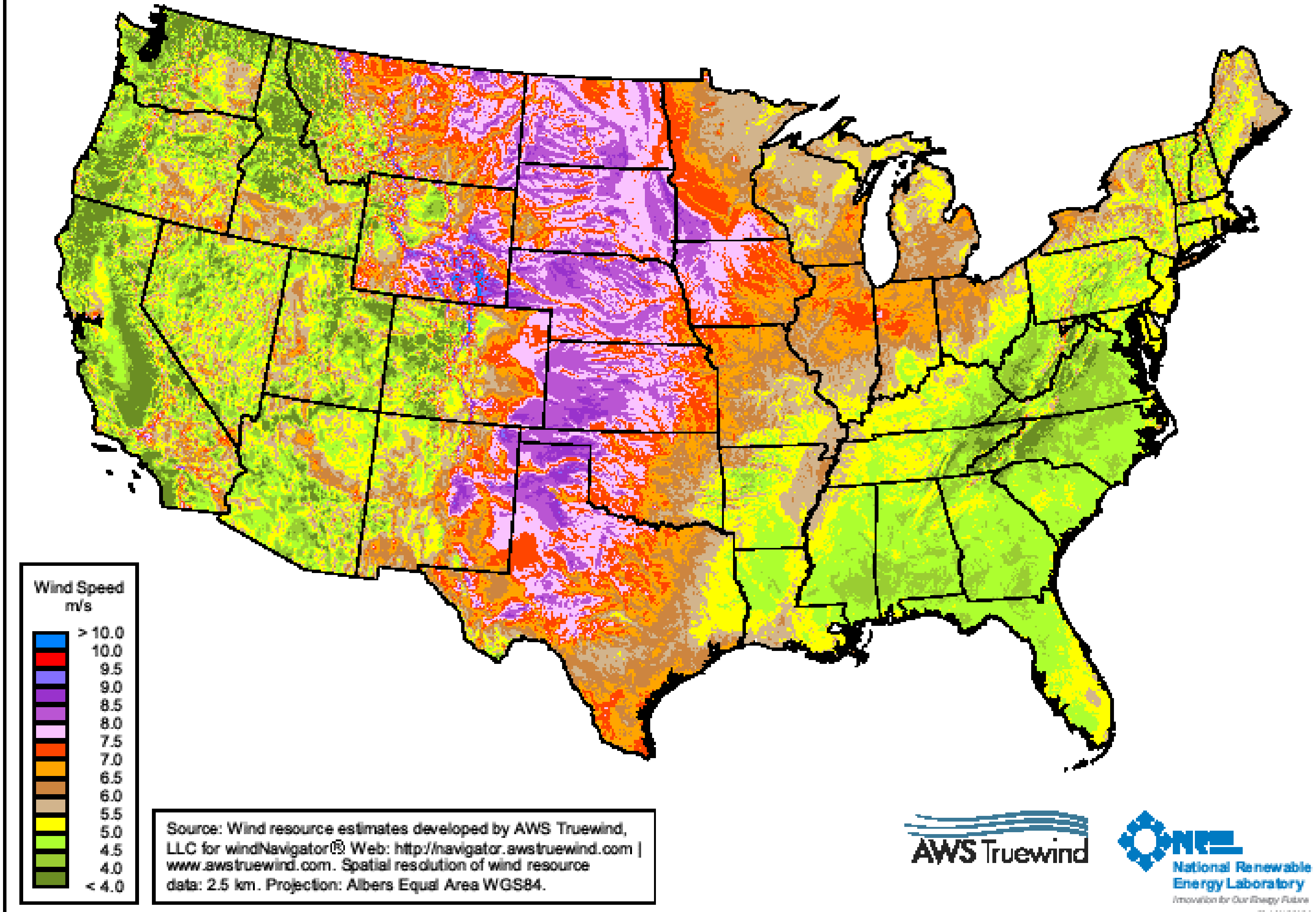
U.S. Total Installed Electric Power (2004 Est.):
944,000 MW (EIA)

U.S. Department of Energy
National Renewable Energy Laboratory

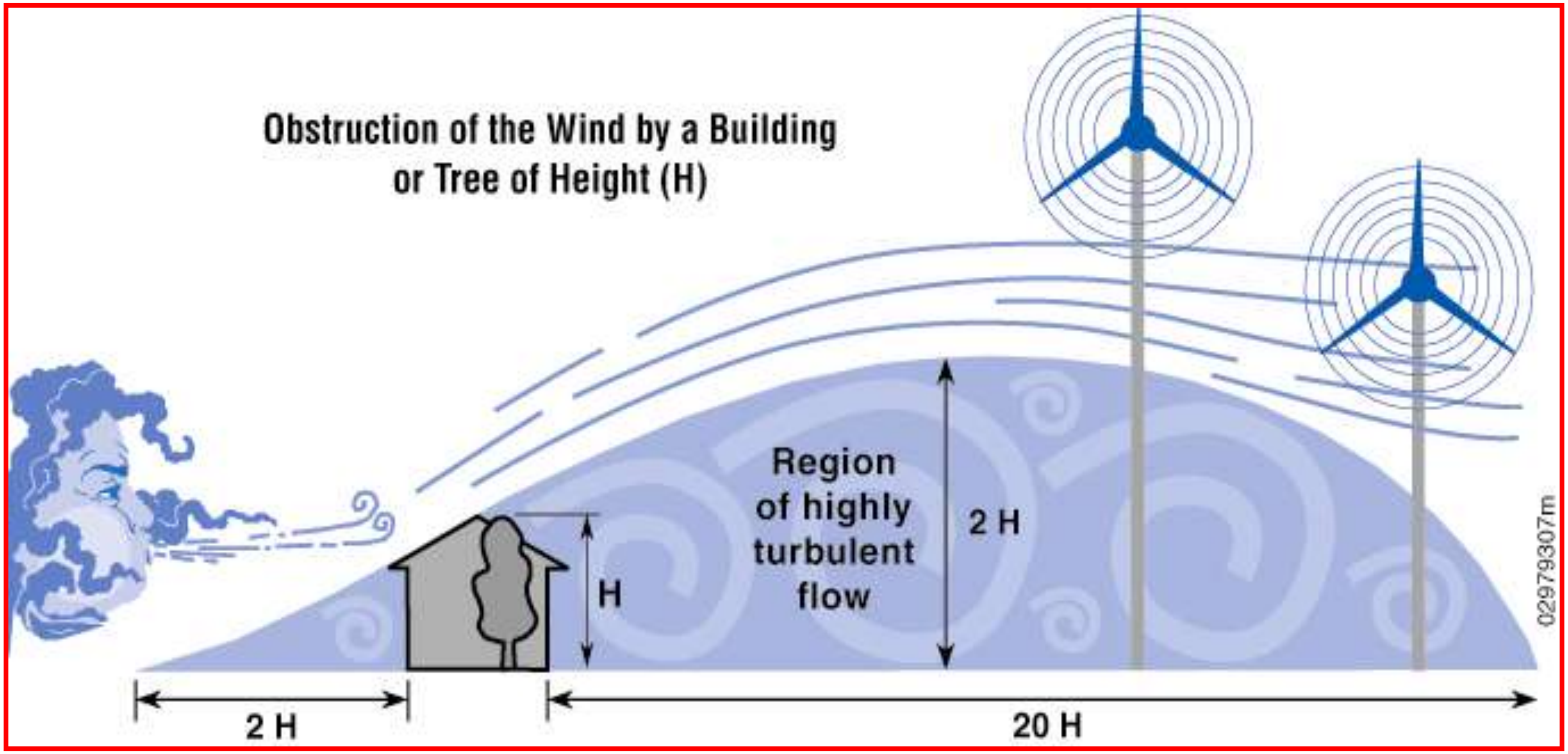
NREL

DHJul3004solpow

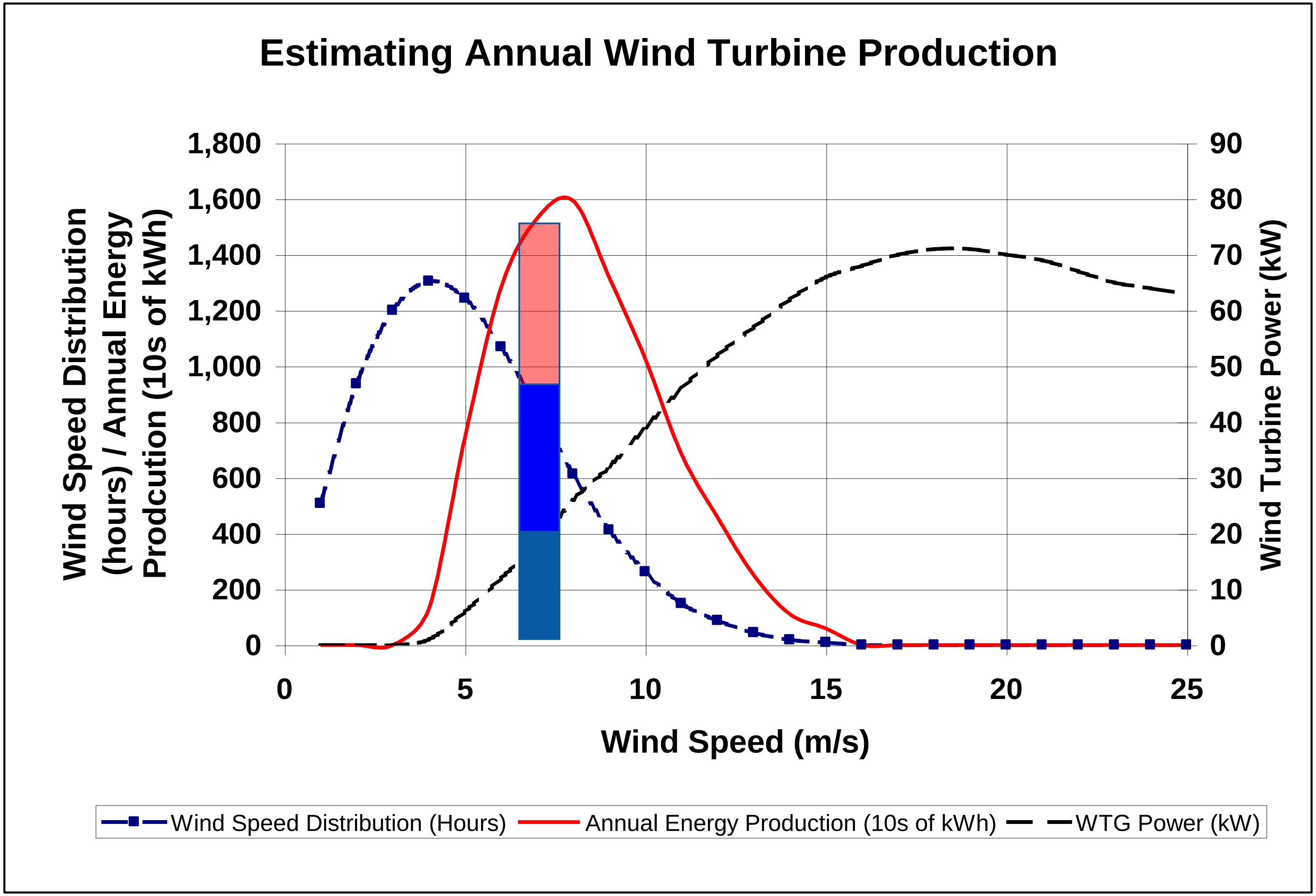
United States - Annual Average Wind Speed at 80 m



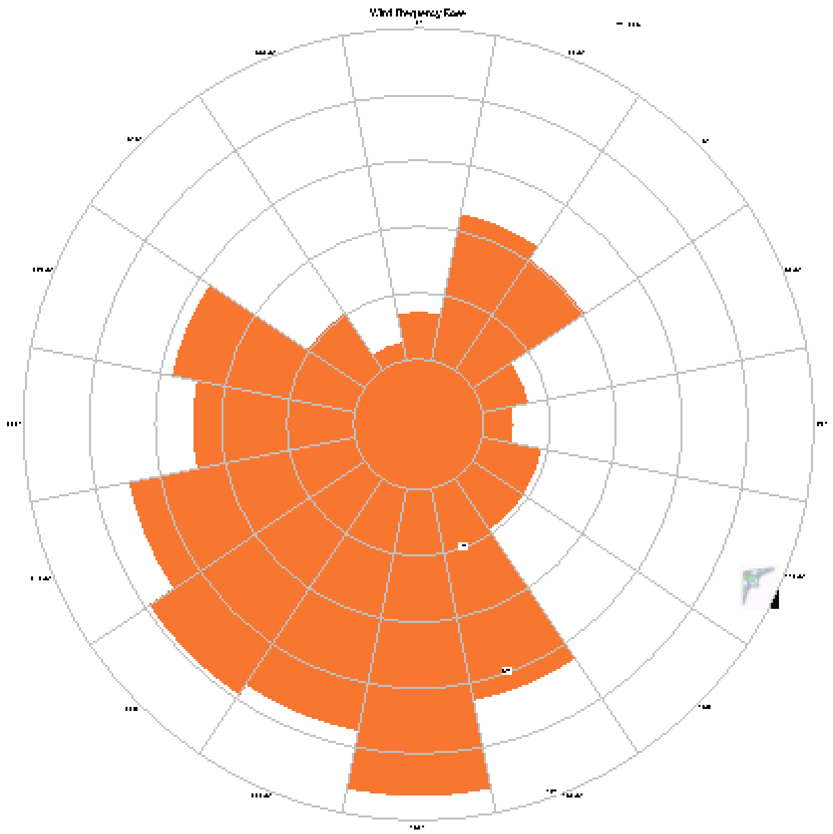
Importance of "Micro-Siting"



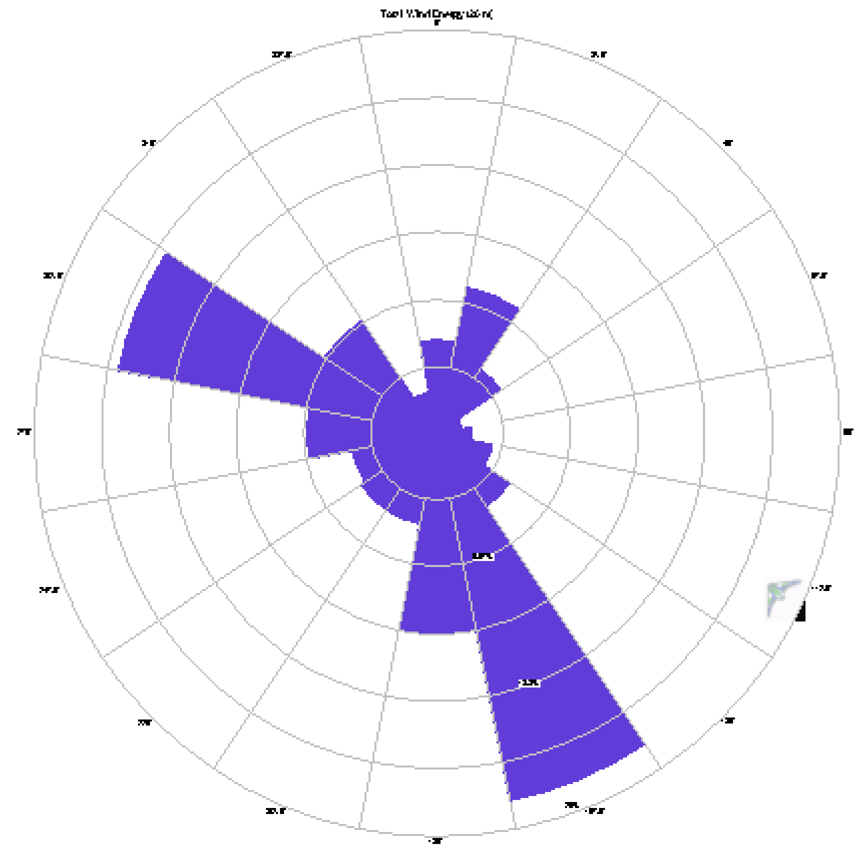
Calculating Turbine Output



WIND ROSE

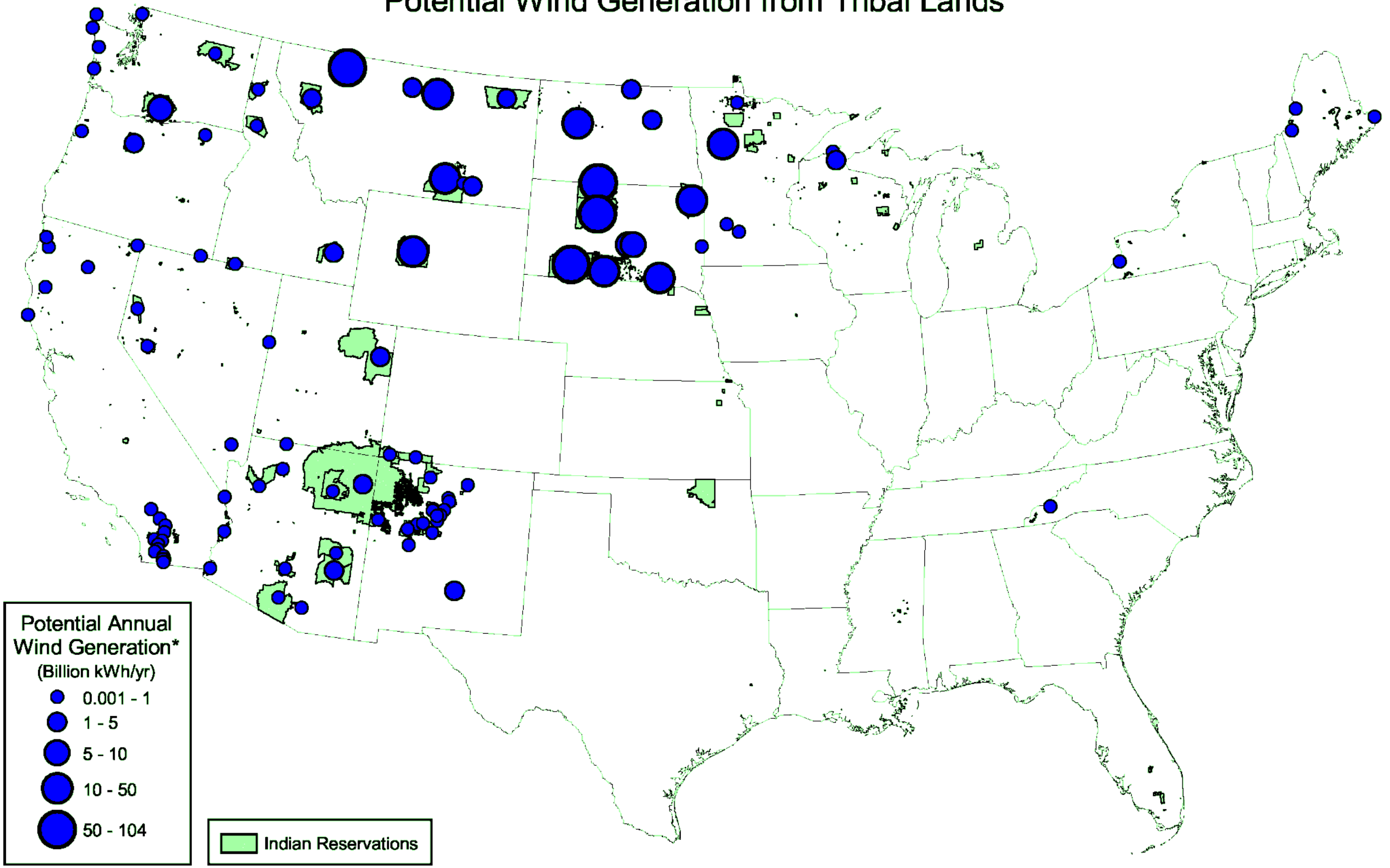


Wind Rose



Energy Rose

Potential Wind Generation from Tribal Lands



* Generation estimated for areas of class >= 4 annual average wind resource, assuming 5 MW/km^2 of installed capacity, and capacity factors ranging from 25.1% (class 4) to 41.4% (class 7).

Aggregate technical estimate of 209 GW does not account for sacred sites, transmission access, water bodies, or other factors that will significantly impact development potential.

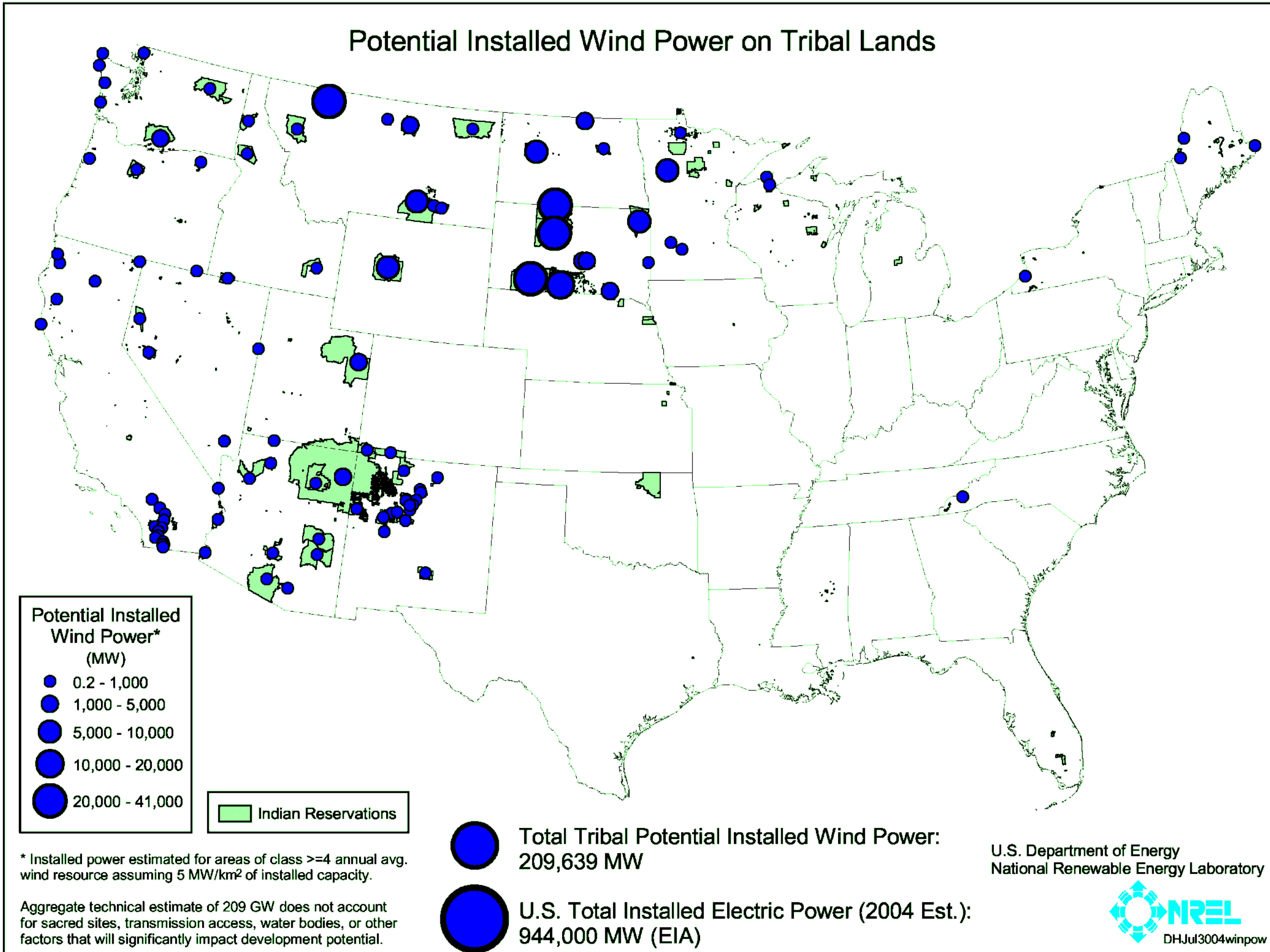
Total Tribal Wind Generation Potential: 535 Billion kWh/yr

U.S. Total Electric Generation (2004 Est.): 3,853 Billion kWh/yr (EIA)

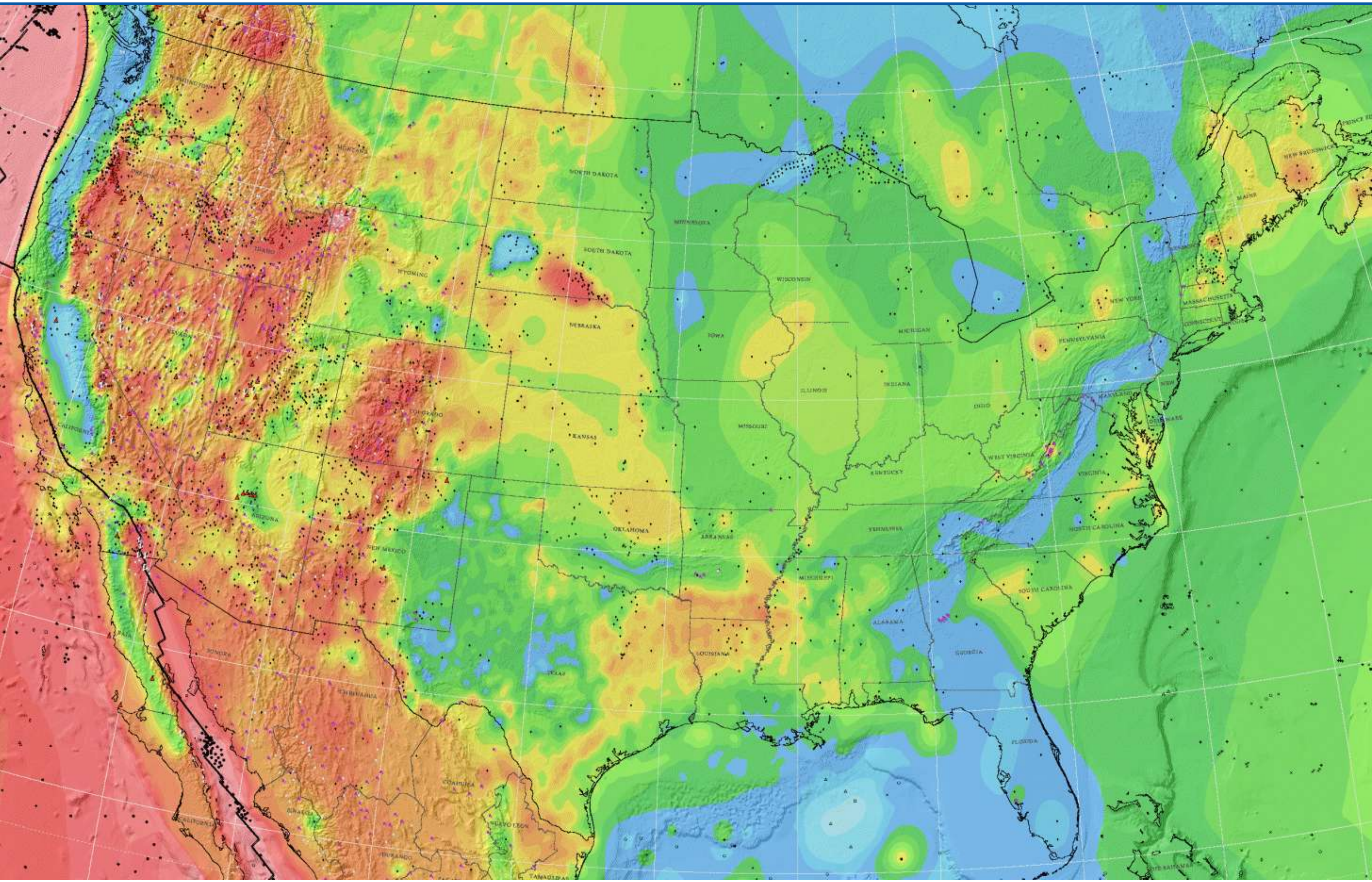
U.S. Department of Energy
National Renewable Energy Laboratory

NREL

DHJul3004wingen


Potential Installed Wind Power on Tribal Lands
Potential Installed Wind Power* (MW)
0.2 - 1,000
1,000 - 5,000
5,000 - 10,000
10,000 - 20,000
20,000 - 41,000
Indian Reservations
* Installed power estimated for areas of class >=4 annual avg. wind resource assuming 5 MW/km2 of installed capacity.
Aggregate technical estimate of 209 GW does not account for sacred sites, transmission access, water bodies, or other factors that will significantly impact development potential.
Total Tribal Potential Installed Wind Power: 209,639 MW
U.S. Total Installed Electric Power (2004 Est.): 944,000 MW (EIA)
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
DHJul3004winpow

Geothermal Resource Potential



Geothermal Manifestations

Geysir, Iceland

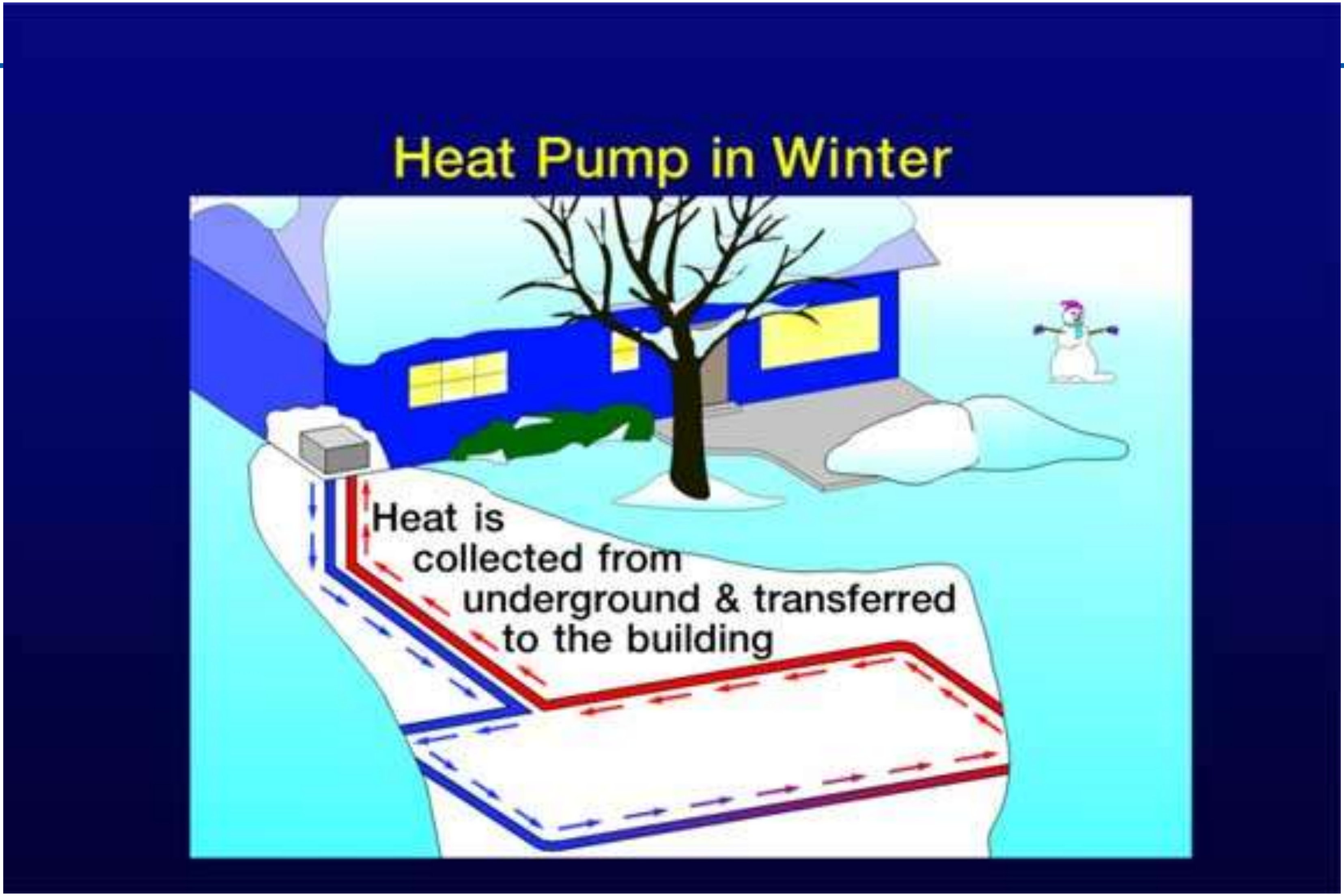


Diagram courtesy of the the Geothermal Education Office

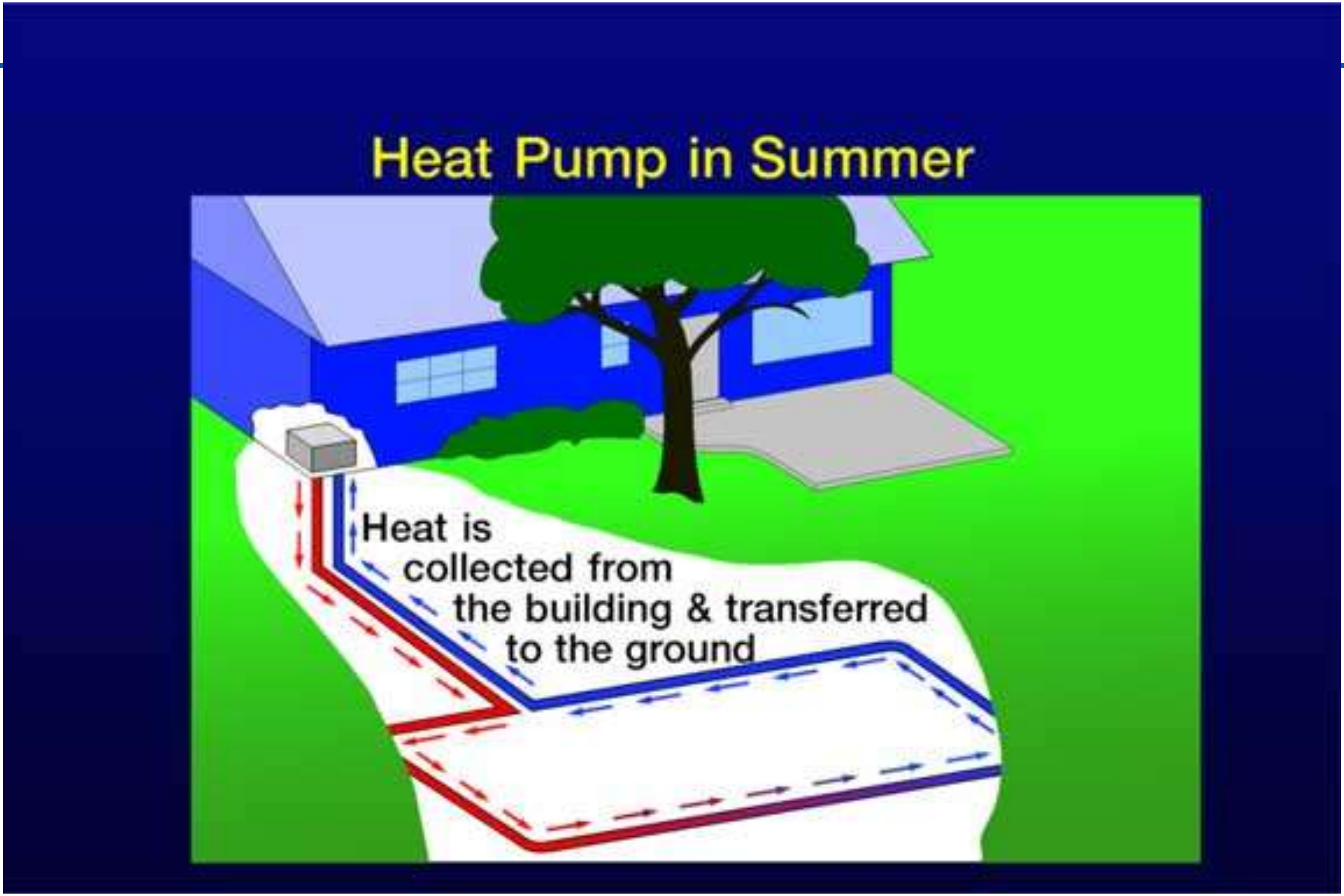


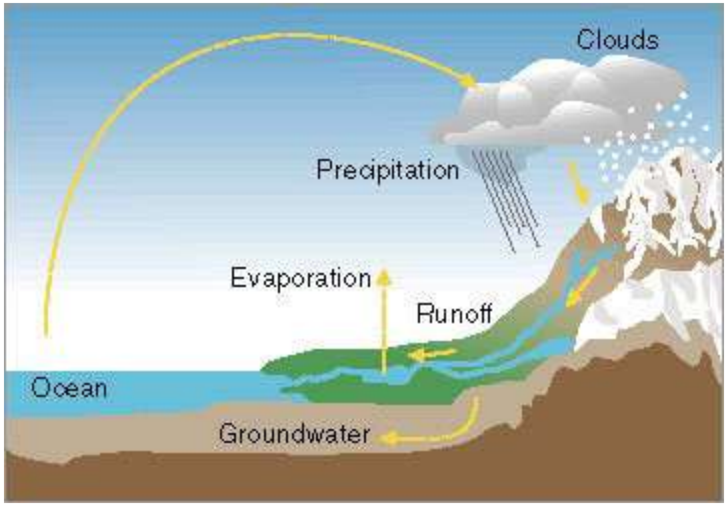
Diagram courtesy of the the Geothermal Education Office


6 2:35PM


EXIT
ONLY
DIES

Hydroelectric Power: Where It Comes From

- Flowing water has energy that can be captured for some useful purpose
- When this energy is captured and used to generate electricity, it is called hydroelectric power or hydropower
- Hydropower plants use the energy of flowing water to turn a turbine that rotates a generator to produce electricity
- Hydrologic cycle: sun causes evaporation from lakes and oceans, forms clouds, falls as rain or snow, then flows back down to the ocean, and the cycle repeats
- Hydropower is renewable because the water cycle is an endless, constantly recharging system
- Hydropower uses a fuel (water) that is not consumed in the process of generating electricity



The water (hydrologic) cycle

Hydroelectricity Physics

Power (kW) = 10 x Flow (m^3/s) x Head (m) x η

Power (kW) = Head (ft) x Flow (cfs) x η /11.8

η= turbine-generator efficiency ~80%

Potential Resources

Virtual Hydropower Prospector
Region Selector
http://hydropower.id.doe.gov/prospector/r_selector.shtml

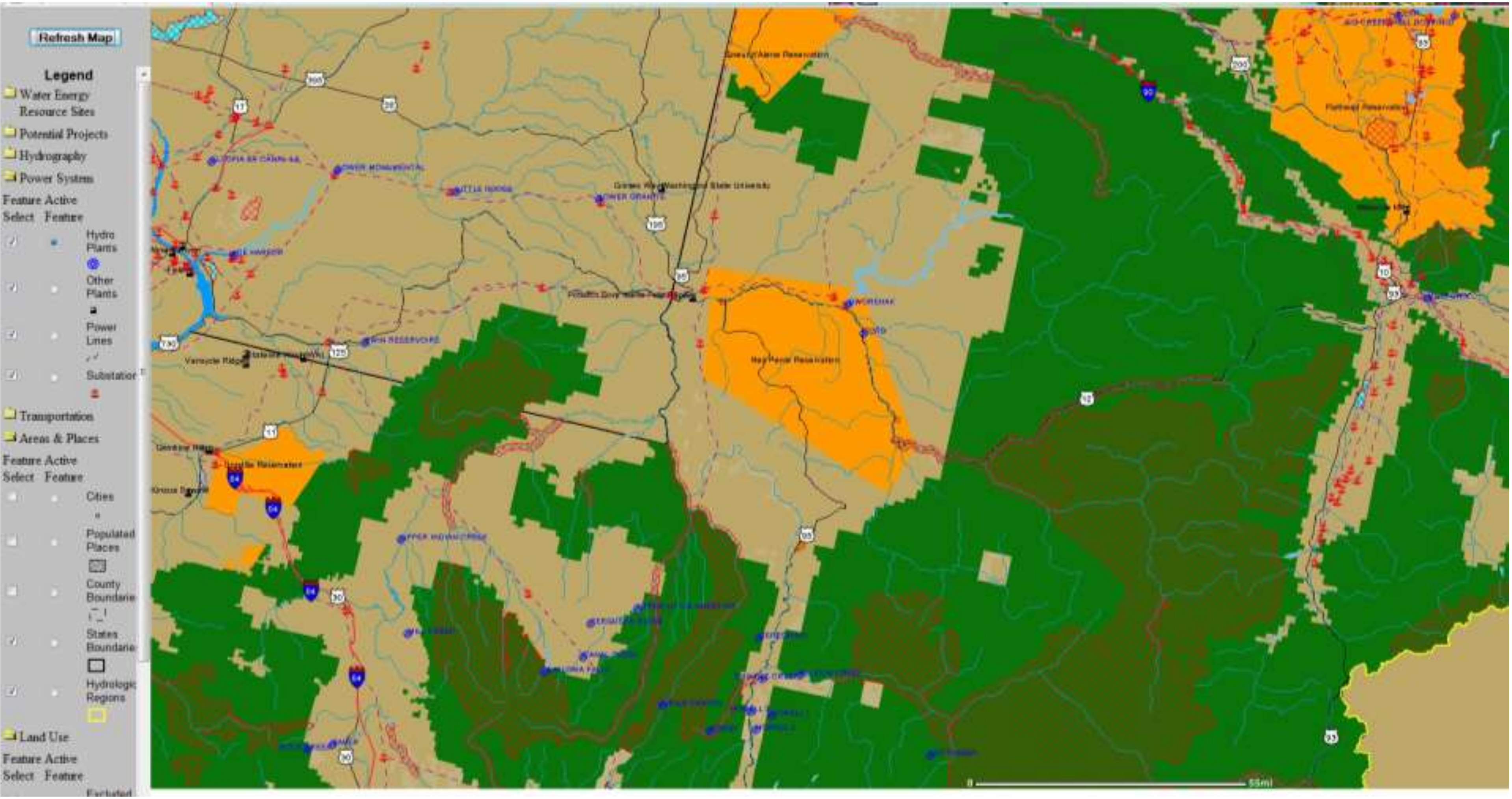
New Conventional Hydro (low power to large hydro) = 62,300 MW

Hydrokinetic = 12,800 MW (tidal only assessed for 5 states, ocean current not assessed)

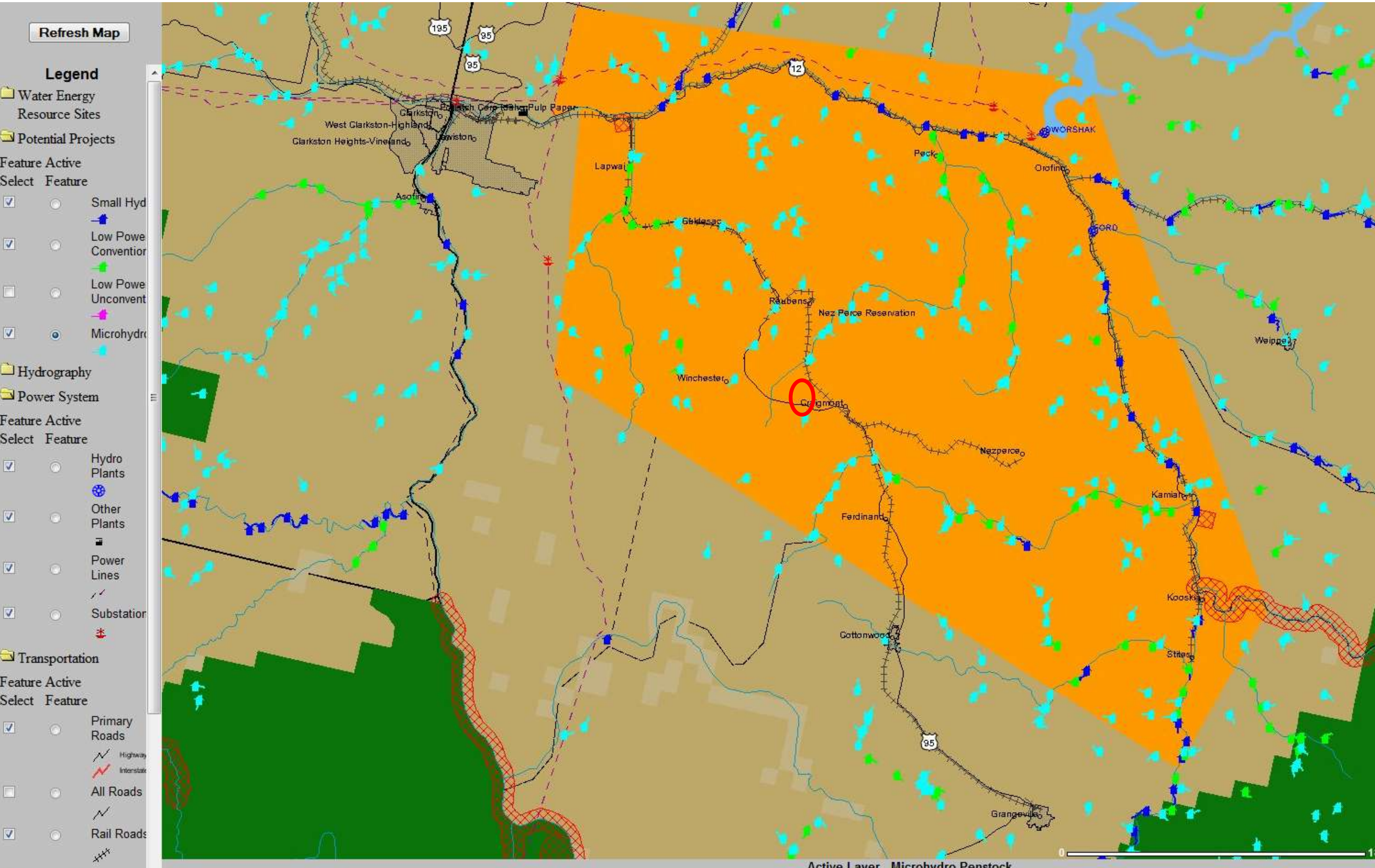
Wave Energy = 10,000 to 20,000 MW

TOTAL = 85-95 GW

Existing Hydro, Transmission, Land Ownership



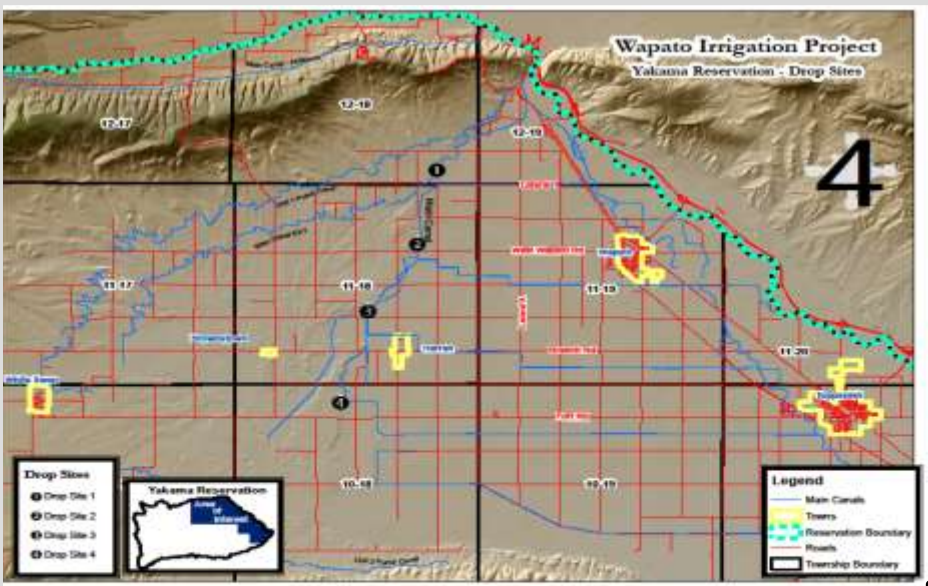
Micro-Hydro Penstock



Active Layer - Microhydro Penstock

Rec	Power (mW)	Power Class	Prime Candidate	State	County
1	0.061	Microhydro	Y	Idaho	Idaho

Yakama Wapato Irrigation Project



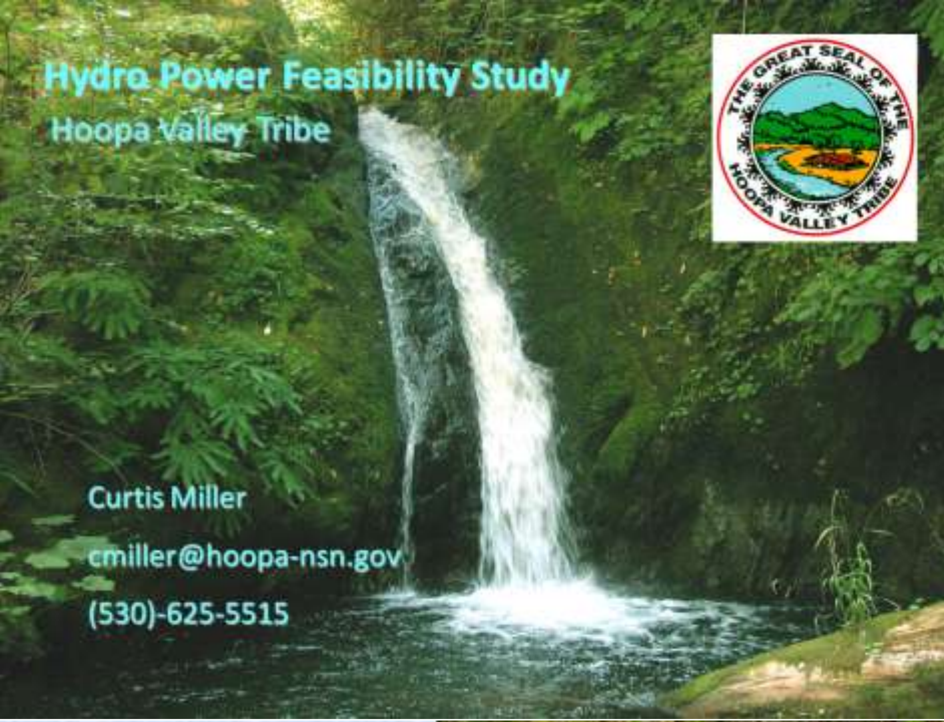
Hydro Power Feasibility Study

Hoopa Valley Tribe

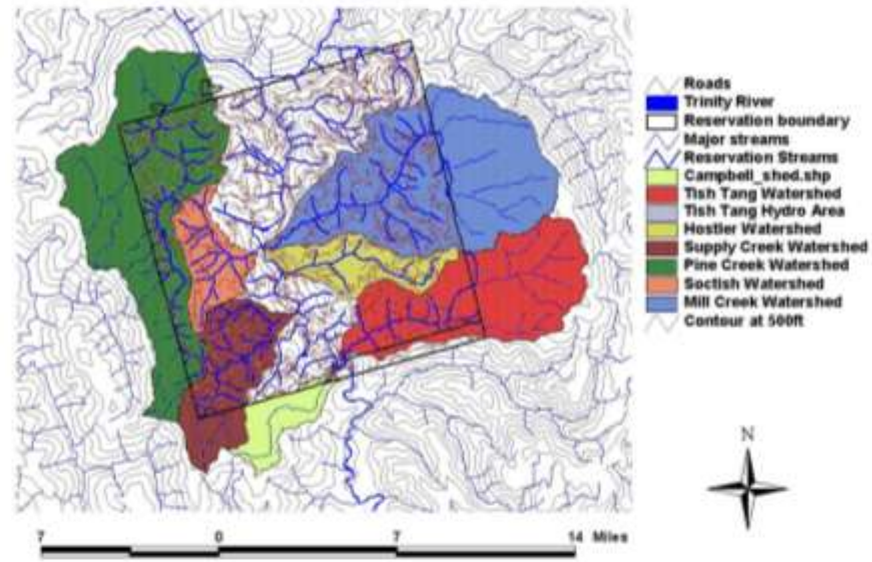
Curtis Miller

cmiller@hoopa-nsn.gov

(530)-625-5515



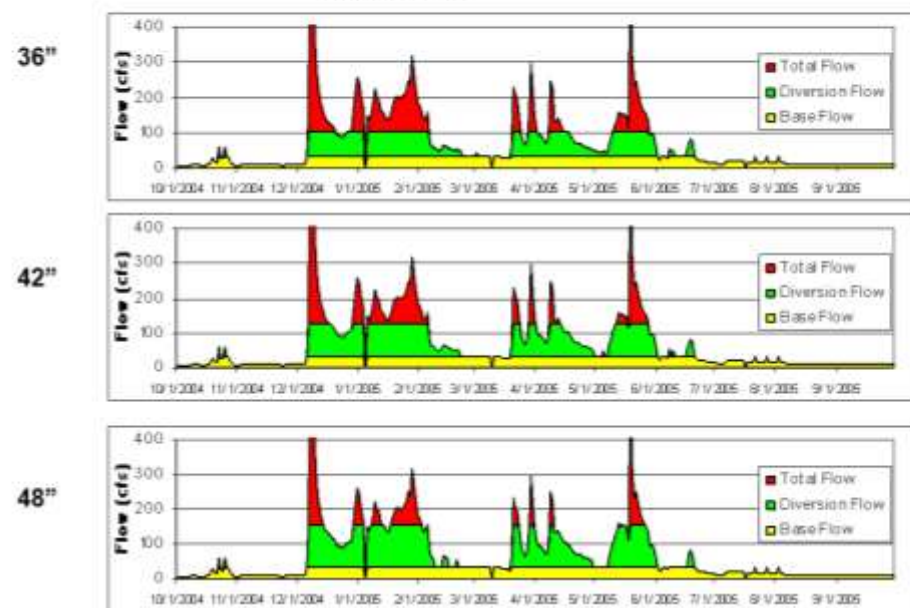
Hoopa Valley Hydrosheds



Hostler Creek

- Gross head, 39 feet
- Length of pipe, 375 feet
- Design flow, 10 cfs
- Flow duration 217 days
- Recommended pipe diameter, 16"
- Calculated net head, 35 feet
- Expected power, 19KW
- Revenue ~$6,000 annually

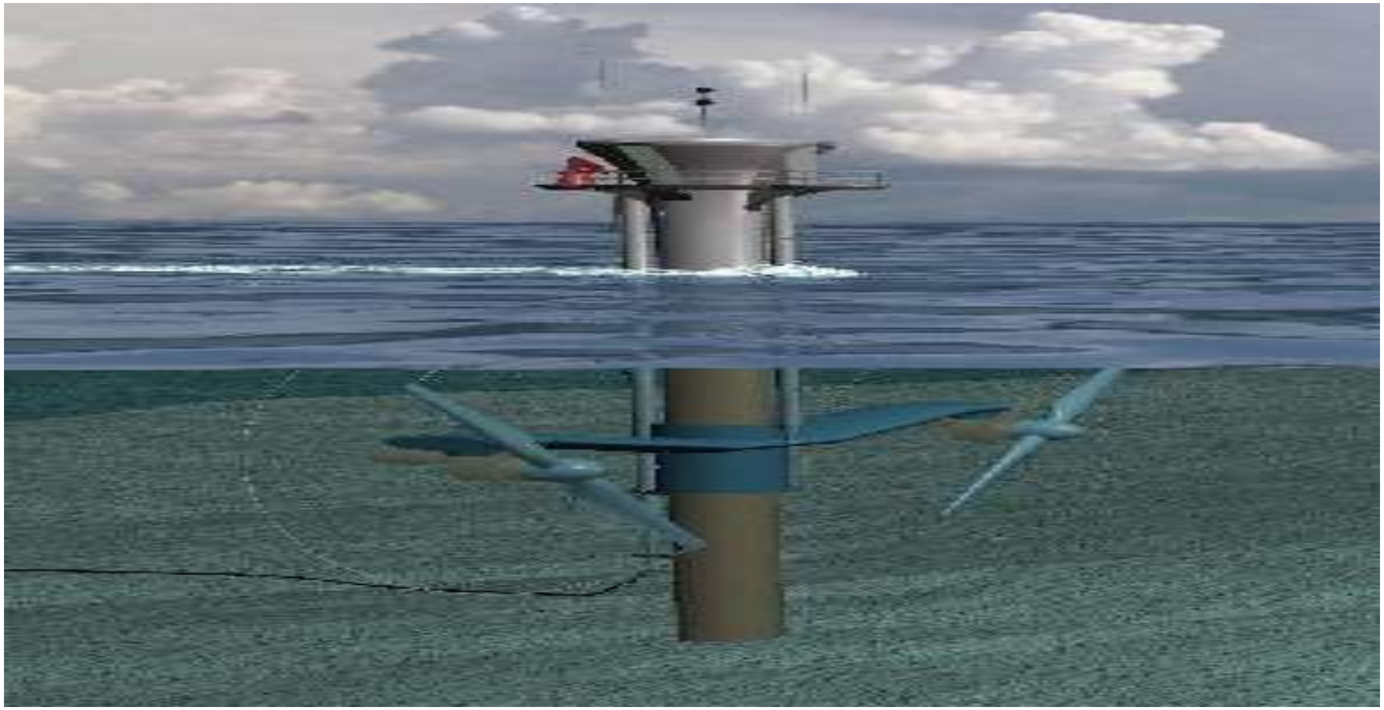
Supply Creek



Definitions

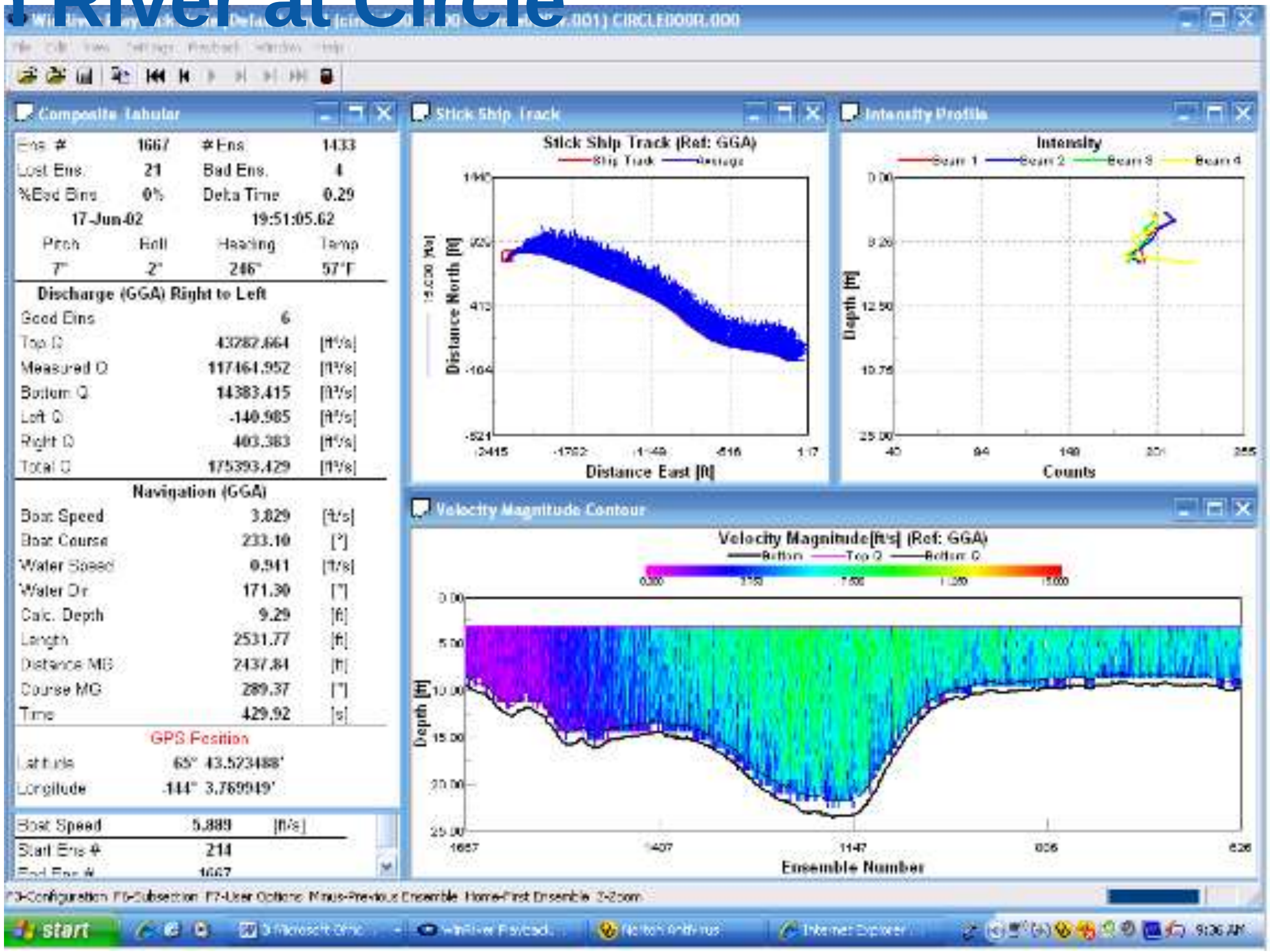
Hydrokinetic: “Moving Water” (no dams!)

- Currents: Ocean & River
- Waves



Resource Assessment

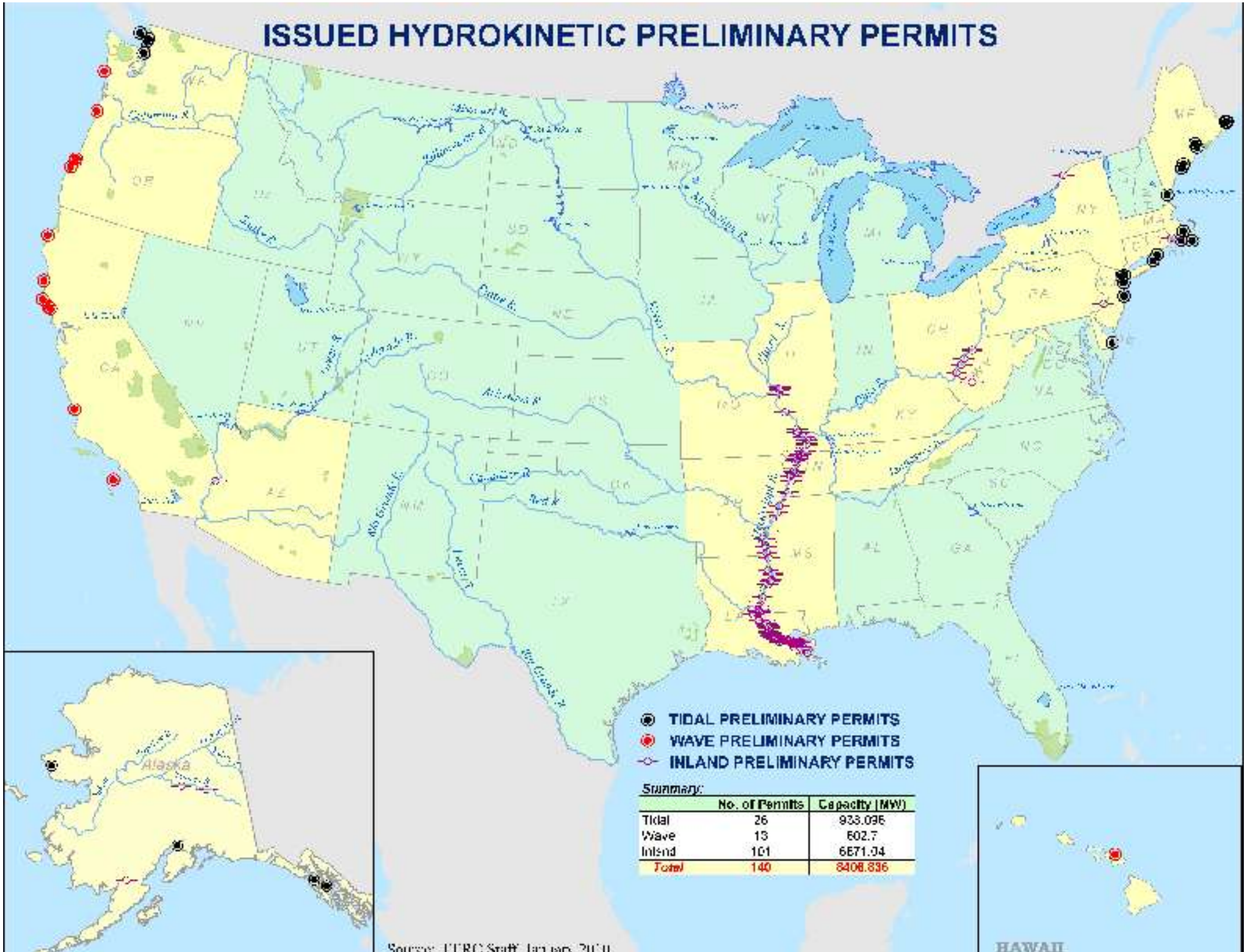
Water Speed Profile of Yukon River at Circle



Hydro Green Energy delivered the first of two hydrokinetic turbines to Hastings, Minnesota, in early December. The barge-mounted power plant will be parked in the output of Mississippi Lock and Dam No. 2, which is visible in the background. (12/15/08)

http://www.eere.energy.gov/news/images/08_12_17_hydrokinetic_turbine.jpg

Challenges/Considerations

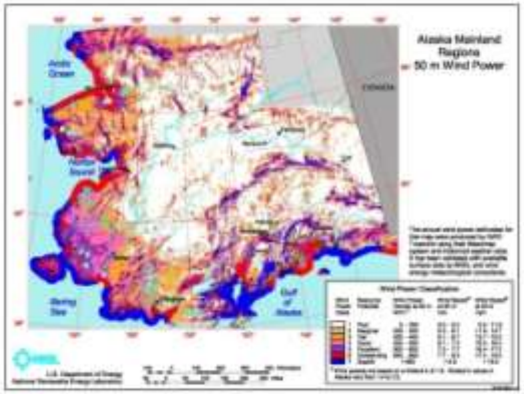


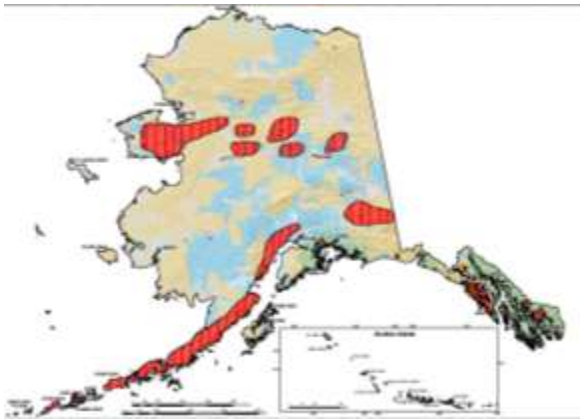
From: http://www.ferc.gov/industries/hydropower/indus-act/hydrokinetics/issued-hydrokinetic-permits-map.pdf

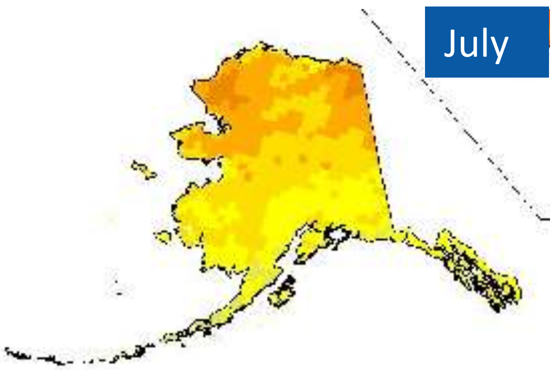
Potential in Alaska

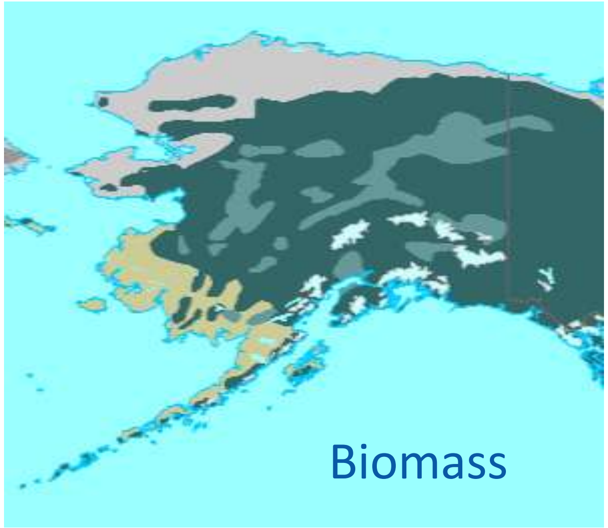
Indigenous renewable energy resources are key to human survival and future village economies in Alaska

Diesel-based villages are likely, not sustainable

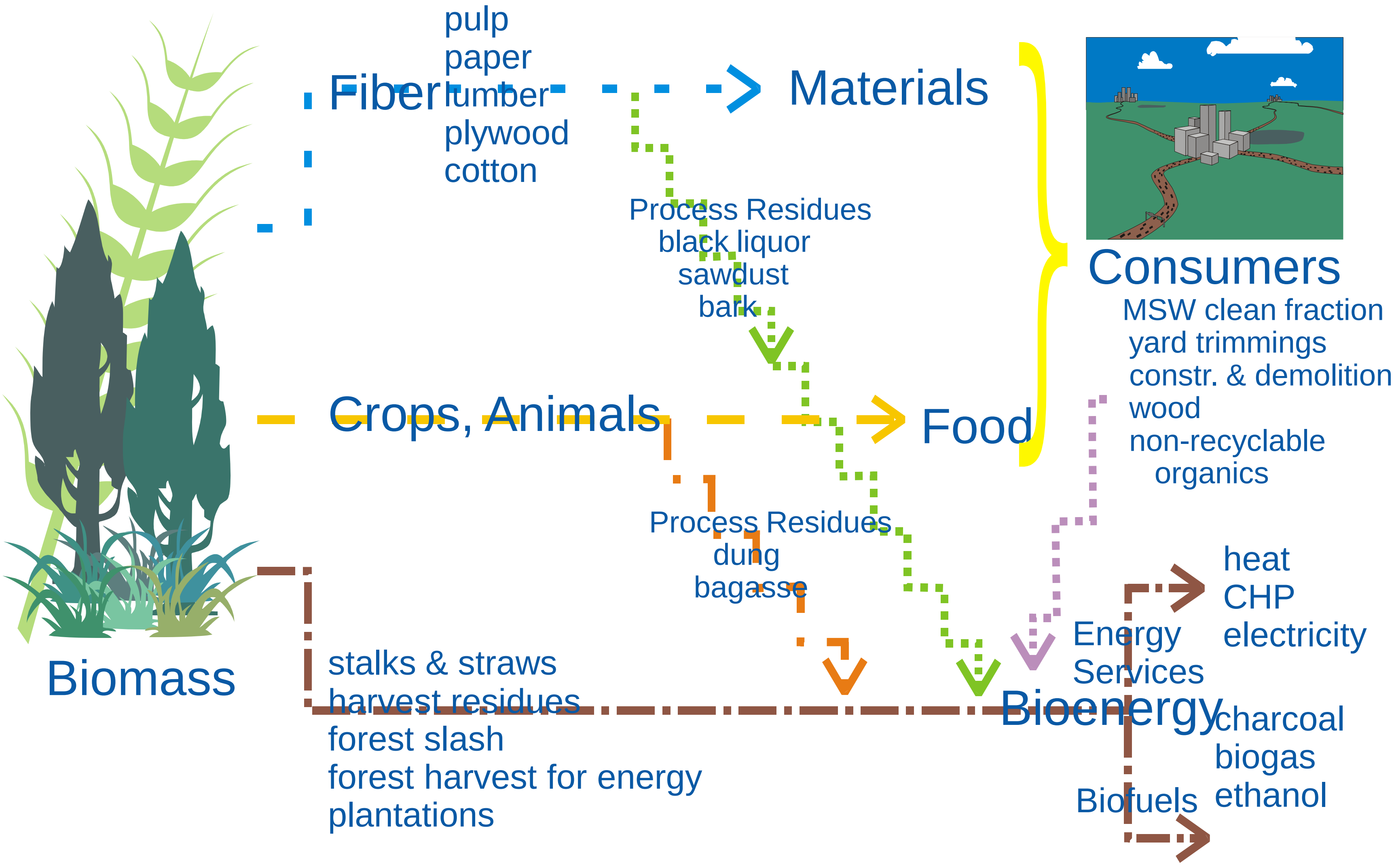


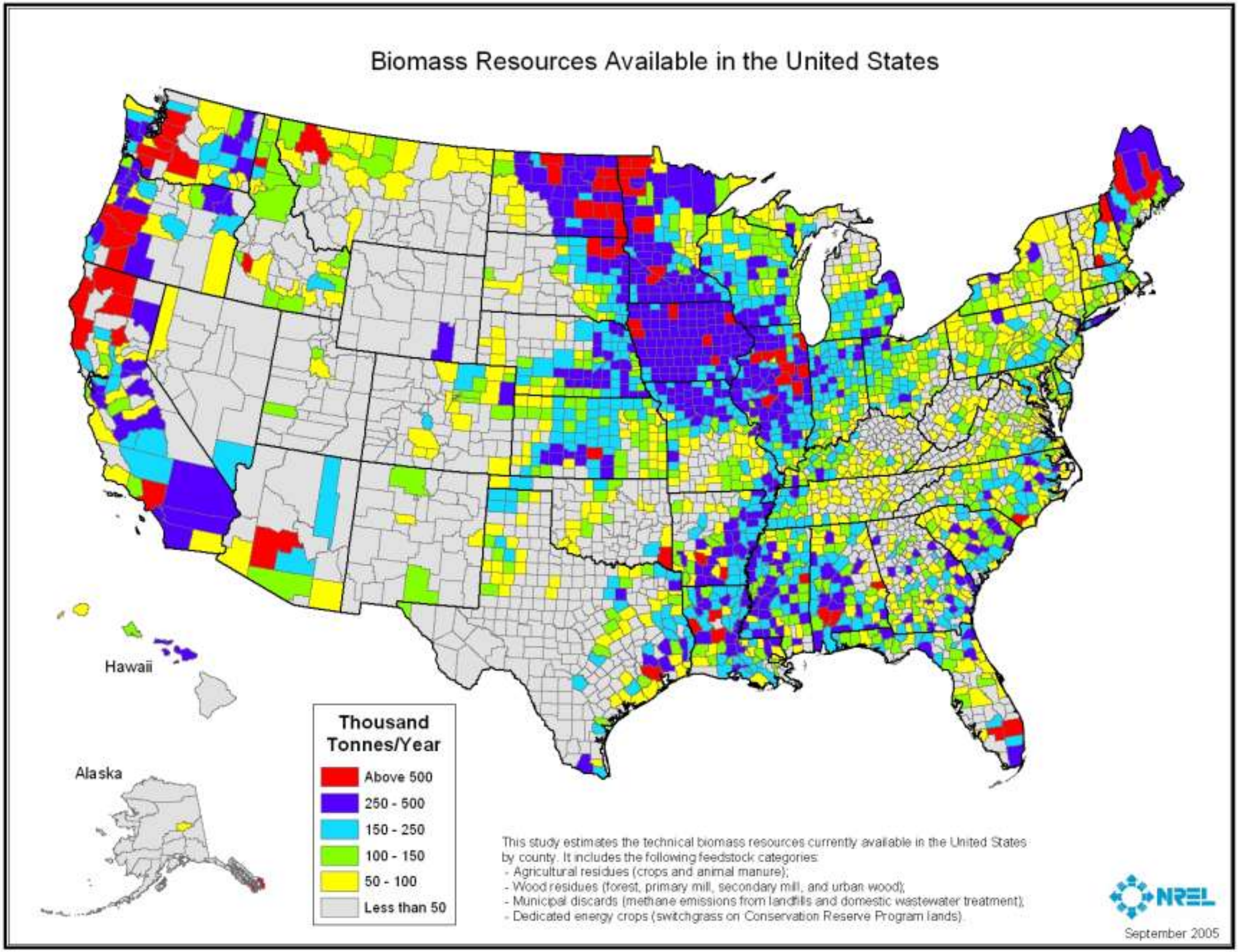




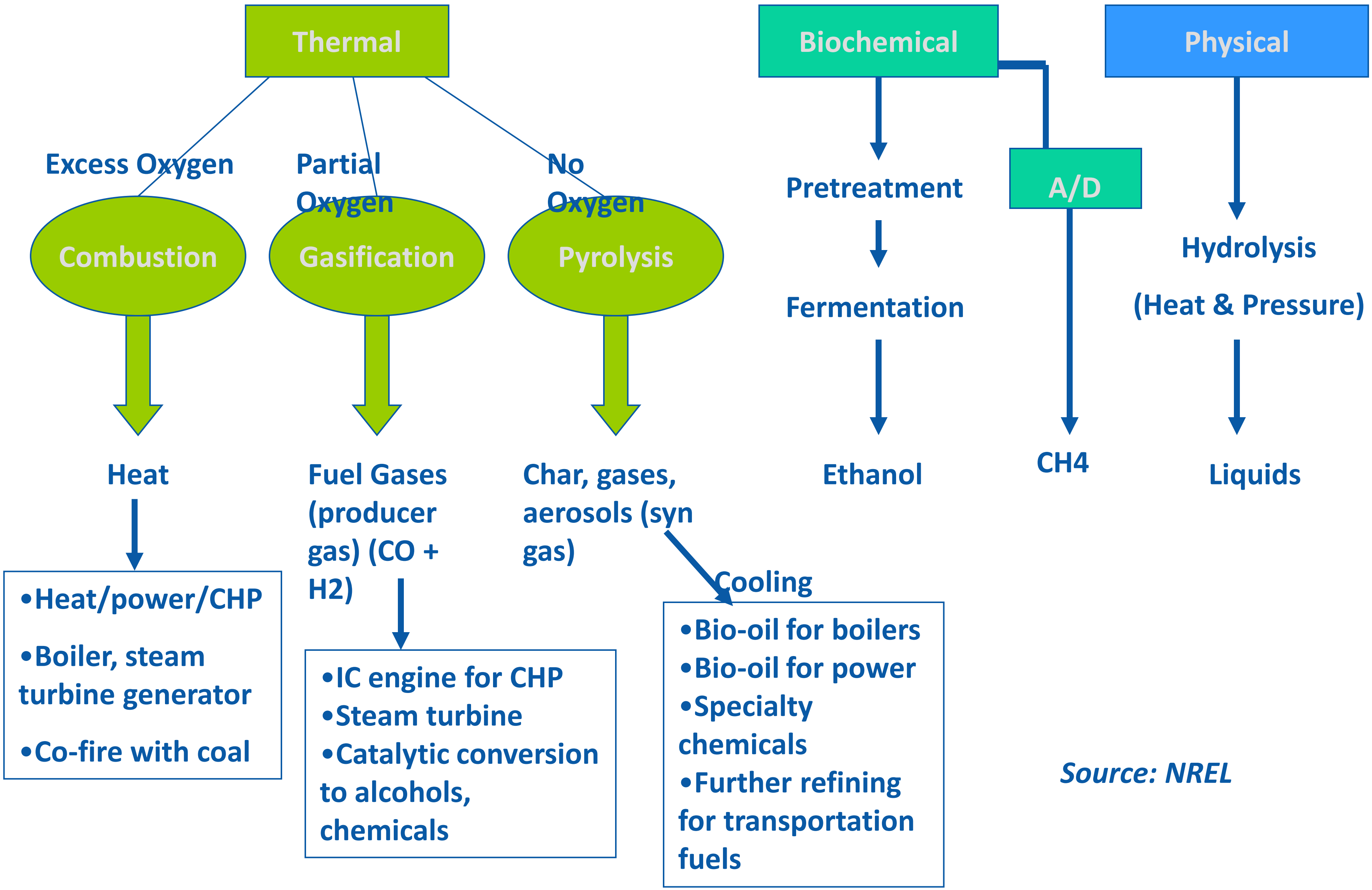


Biomass & Bioenergy Flows




Biomass Resources Available in the United States
Hawaii
Alaska
Thousand Tonnes/Year
Above 500
250 - 500
150 - 250
100 - 150
50 - 100
Less than 50
This study estimates the technical biomass resources currently available in the United States by county. It includes the following feedstock categories:
- Agricultural residues (crops and animal manure);
- Wood residues (forest, primary mill, secondary mill, and urban wood);
- Municipal discards (methane emissions from landfills and domestic wastewater treatment);
- Dedicated energy crops (switchgrass on Conservation Reserve Program lands).
NREL
September 2005

Biomass Energy Pathways



Source: NREL

Wood stove heating

Seasoned firewood (20% moisture) @ $300/cord (~$150/ton)

~20 MBTU/cord → high efficiency wood stove @ 77% efficiency

~ $20/MBTU delivered to home
~$2.50/gal heating oil

Commercial-Scale Wood Heating

Green wood chips (50% moisture) @ $50/ton
~8.6 MBTU/ton in a
high efficiency wood boiler @ 85% efficiency

~ $7.00/MBTU delivered to building

Range of Biorefinery Concepts

- Trees
- Grasses
- Agricultural Crops
- Residues
- Animal Wastes
- Municipal Solid Waste
- Algae
- Food Oils

- Enzymatic Fermentation
- Gas/liquid Fermentation
- Acid Hydrolysis/ Fermentation
- Gasification
- Combustion
- Co-firing
- Trans-esterification

Products

Fuels
- Ethanol
- Biodiesel
- “Green” Gasoline & Diesel

Power
- Electricity
- Heat

Chemicals
- Plastics
- Solvents
- Chemical Intermediates
- Phenolics
- Adhesives
- Furfural
- Fatty Acids
- Acetic Acid
- Carbon Black
- Paints
- Dyes, Pigments, and Ink
- Detergents
- Etc.

Food and Feed

U.S. Biomass Resource Potentials

Corn (largest volume grain and source of EtOH in U.S.)

- Potential to displace 10-20% of our gasoline

Soybeans, fats & greases (largest sources of biodiesel)

- Potential to displace 5-10% of our diesel

Food Supplies

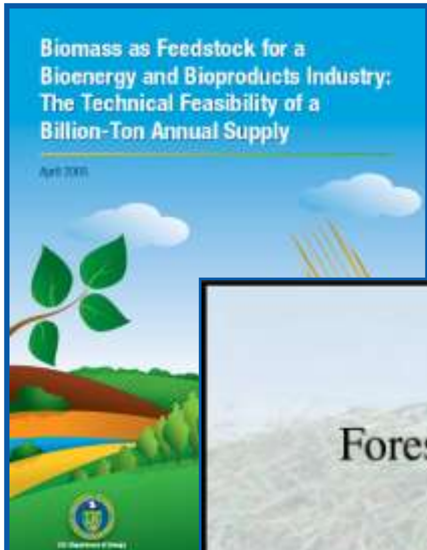
Over 1 billion tons/year of lignocellulosic biomass (trees, grasses, etc.) could be available in the U.S.

- Potential to displace 50-70% of our gasoline

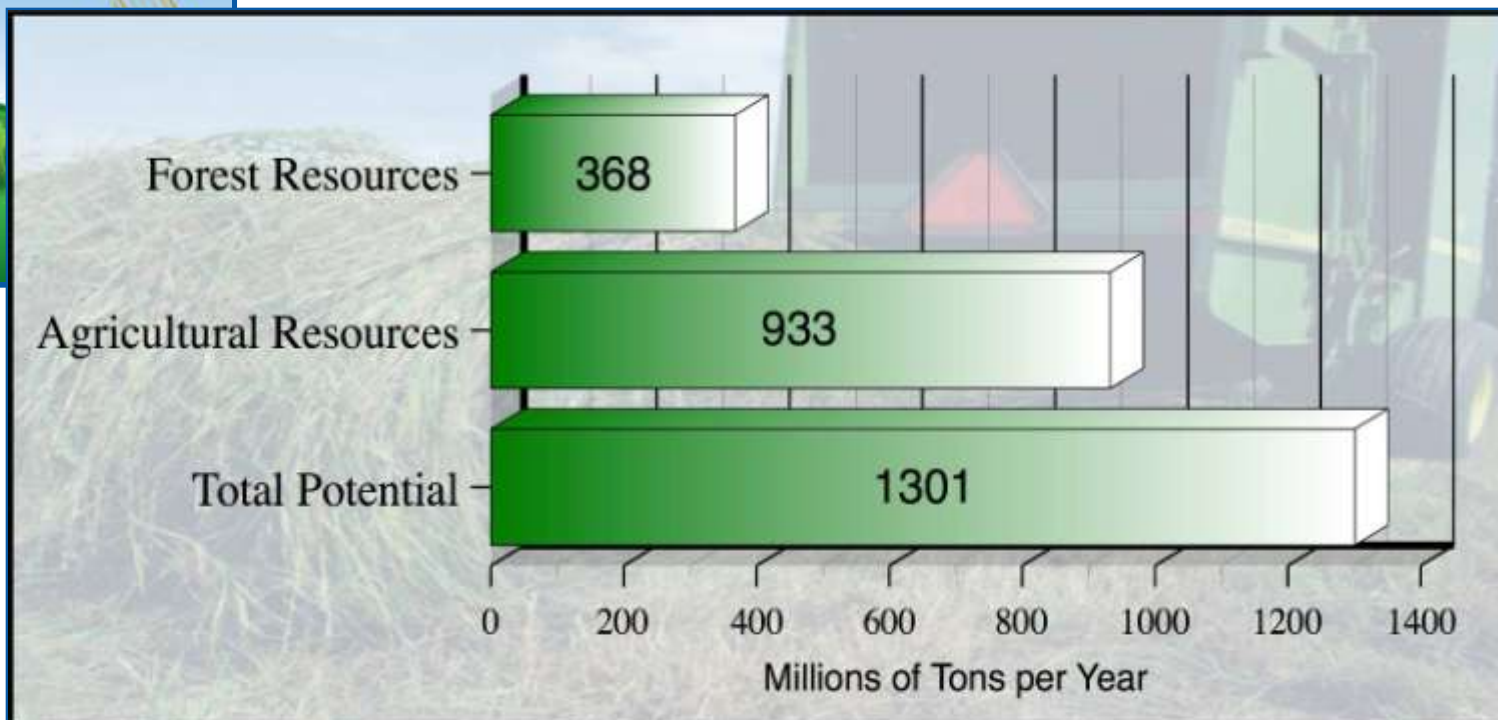
Not a Food Supply

Short-term: improve cost and efficiency of corn ethanol & biodiesel
Mid to Long-term: focus on lignocellulose (trees, grasses, & residues)

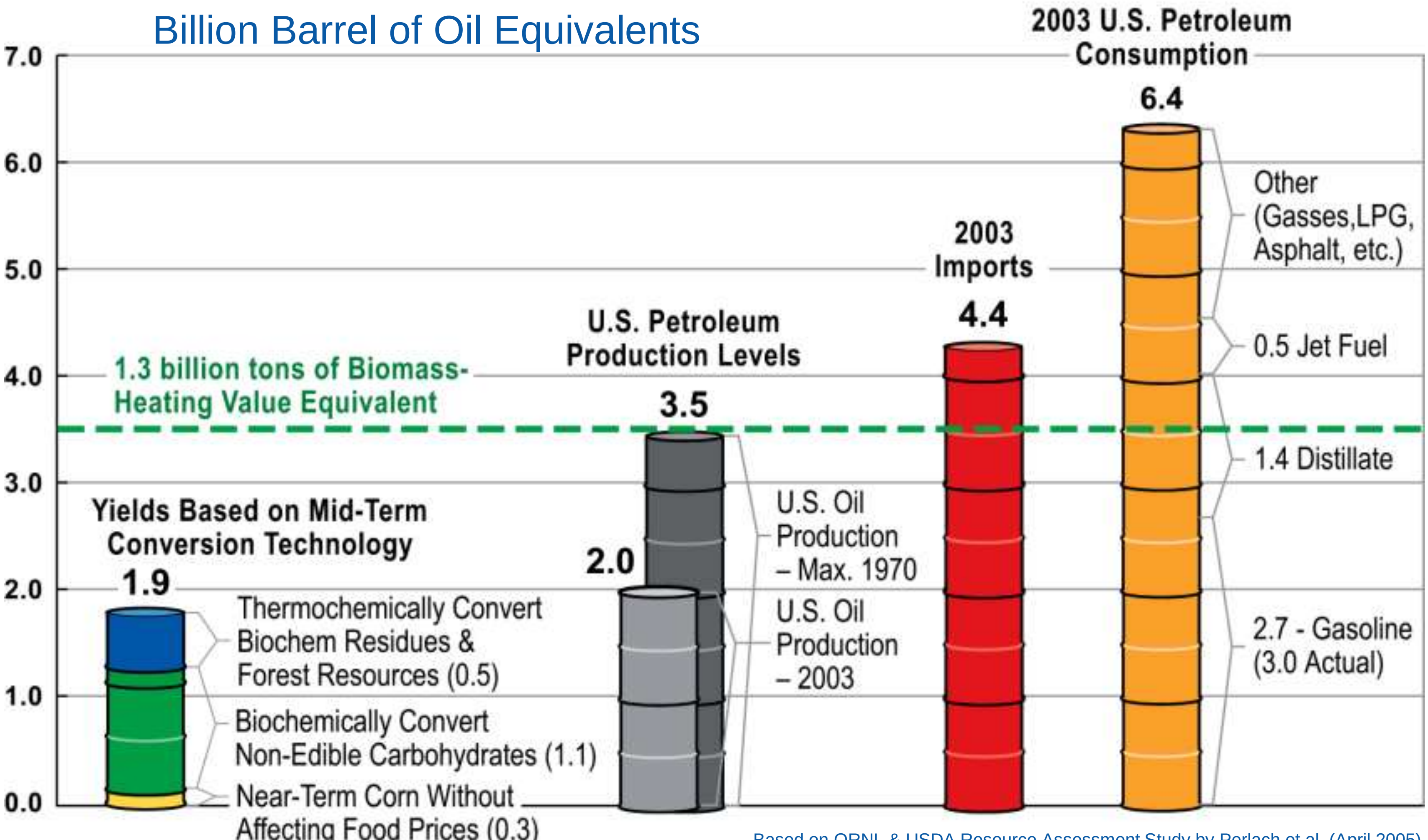
U.S. Biomass Resource Assessment



- Updated resource assessment - April 2005
- Jointly developed by U.S. DOE and USDA
- Referred to as the "Billion Ton Study"

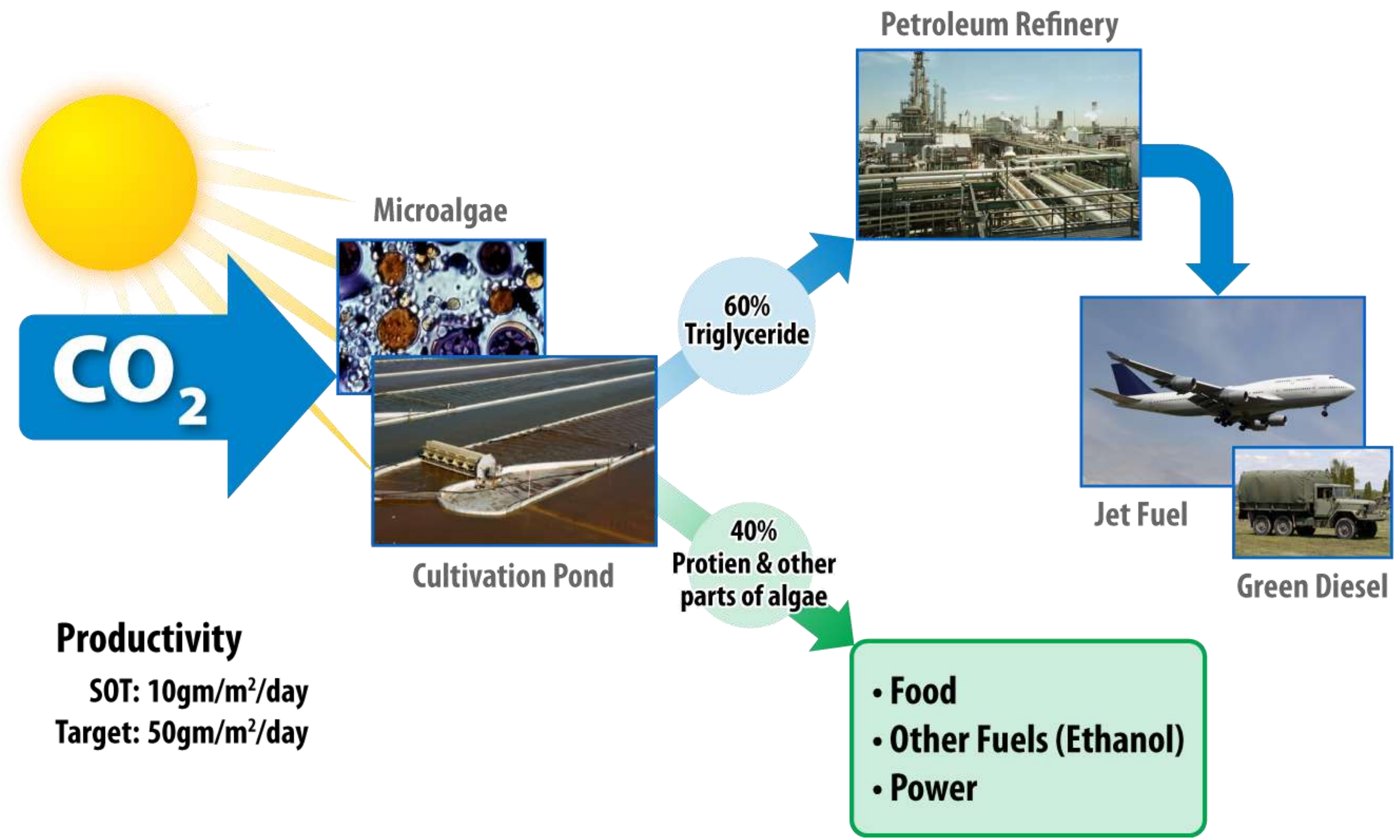


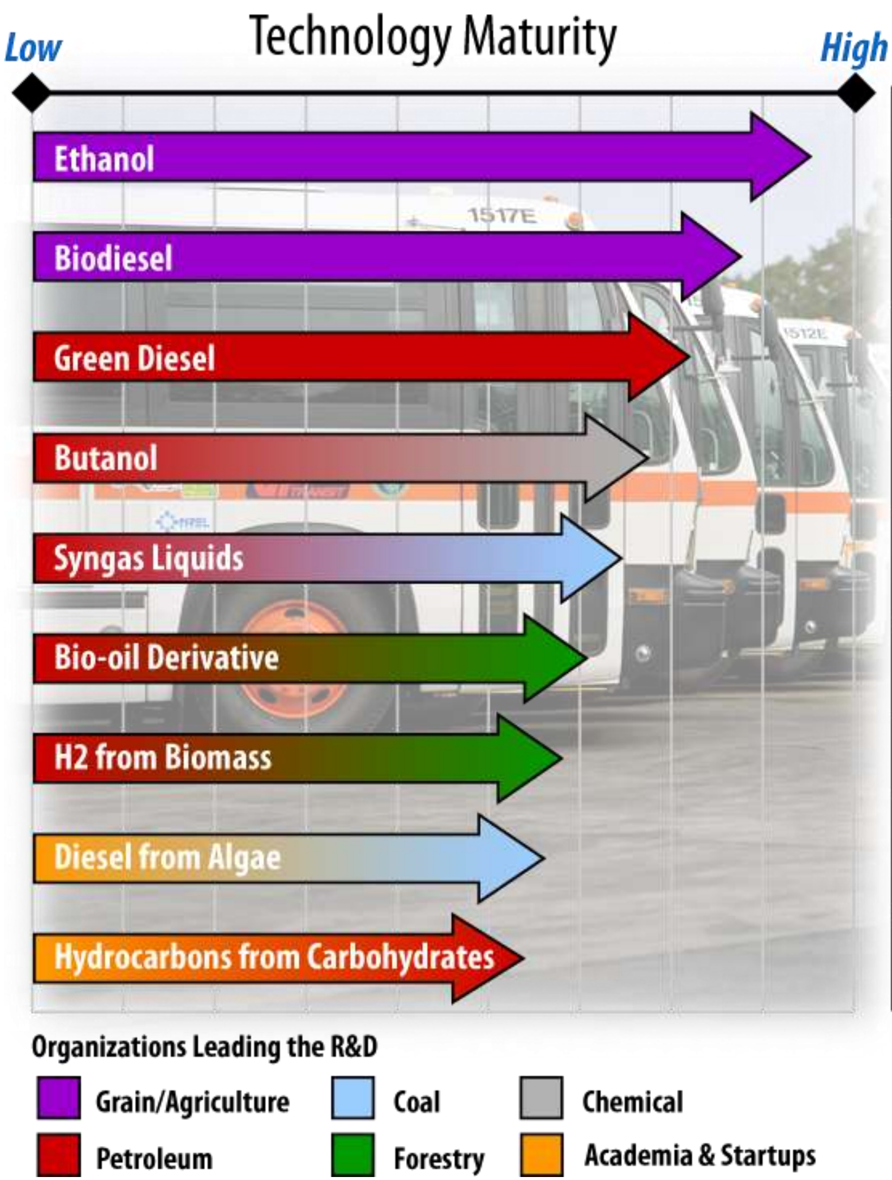
The 1.3 Billion Ton Biomass Scenario



Based on ORNL & USDA Resource Assessment Study by Perlach et.al. (April 2005)
http://www.eere.energy.gov/biomass/pdfs/final_billionton_vision_report2.pdf

Jet Fuel From Algae

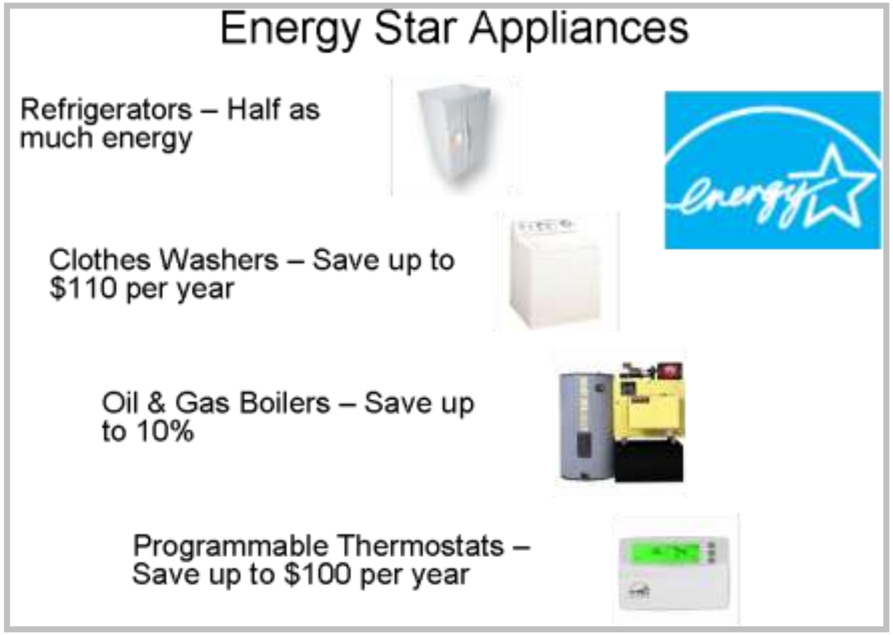




Key Drivers	Value Added
New market for grain and agriculture products. Large supply of lignocellulose.	High octane gasoline blend stock from carbohydrates.
New market for excess oils, fats, and greases.	Petroleum compatible and biodegradable.
Lower cost and higher product quality than FAME.	Utilize existing assets. High quality jet fuel or diesel.
New market for grain and agriculture products. Large supply of lignocellulose.	Better gasoline blending properties than ethanol.
Integration of biomass with Coal, Coke, Shale, or Heavy Oils.	High quality jet fuel or diesel. Reduced criteria for sequestration, and economy of scale (in combination with fossil).
Technical fit with woody biomass and liquid bio-crude.	Potential to integrate into existing large scale refinery and pipeline infrastructure.
Potential transportation fuel from any fuel/power source.	Ideal feed for fuel cells, and lowest tail pipe emissions.
Lg. source of biomass on non-arable land, and capture of CO^2.	High quality jet fuel or diesel yield per acre, with both off-shore and on-shore potential.
Better compatibility with petroleum products.	Potential for higher reaction rates than fermentation, and potential as H2 carrier.

Renewable Fuels & Low GHG Emissions

Energy Efficiency



Building Design