Renewable Resources

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Presented to:
Purdue Women's Club

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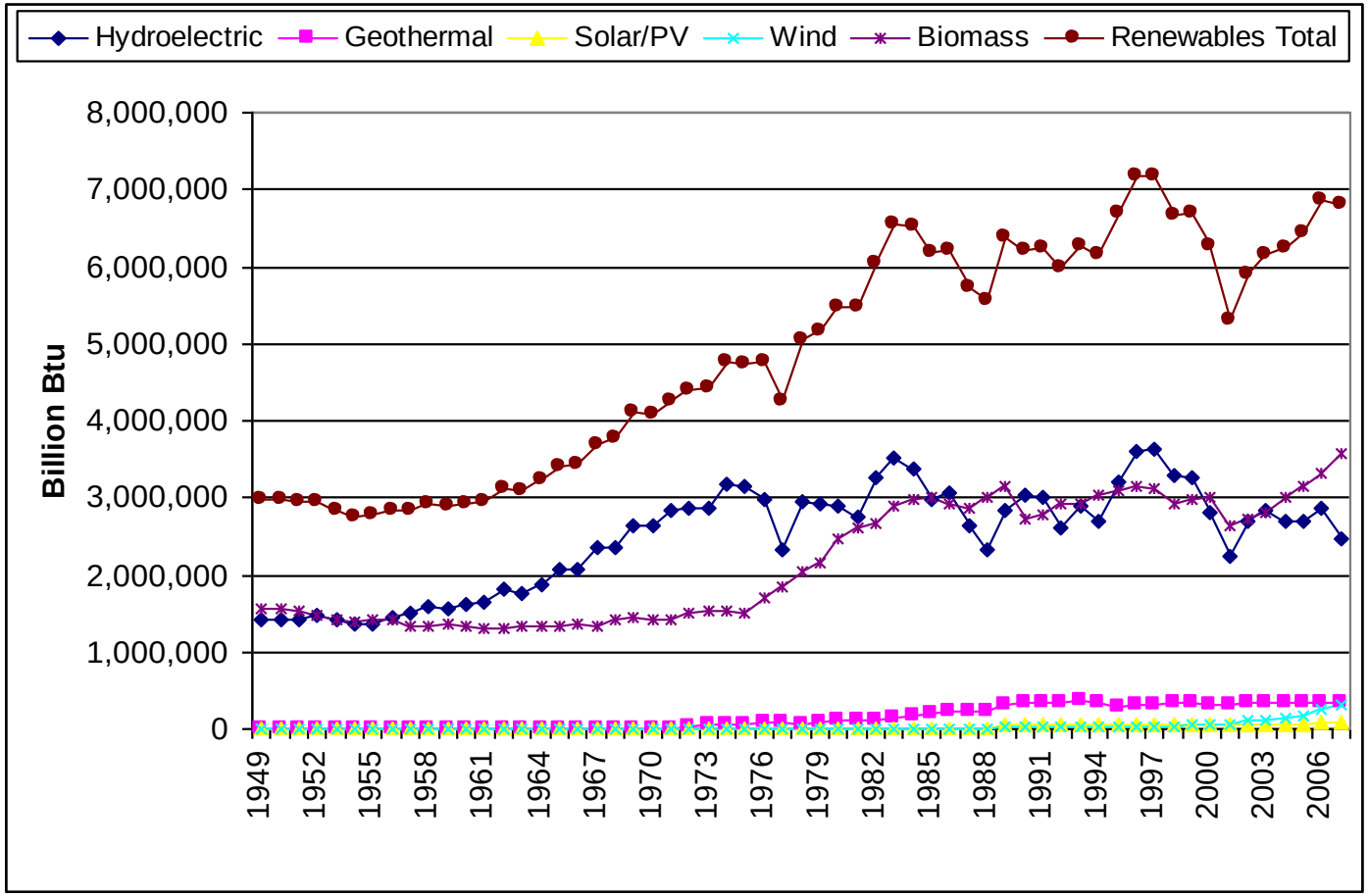
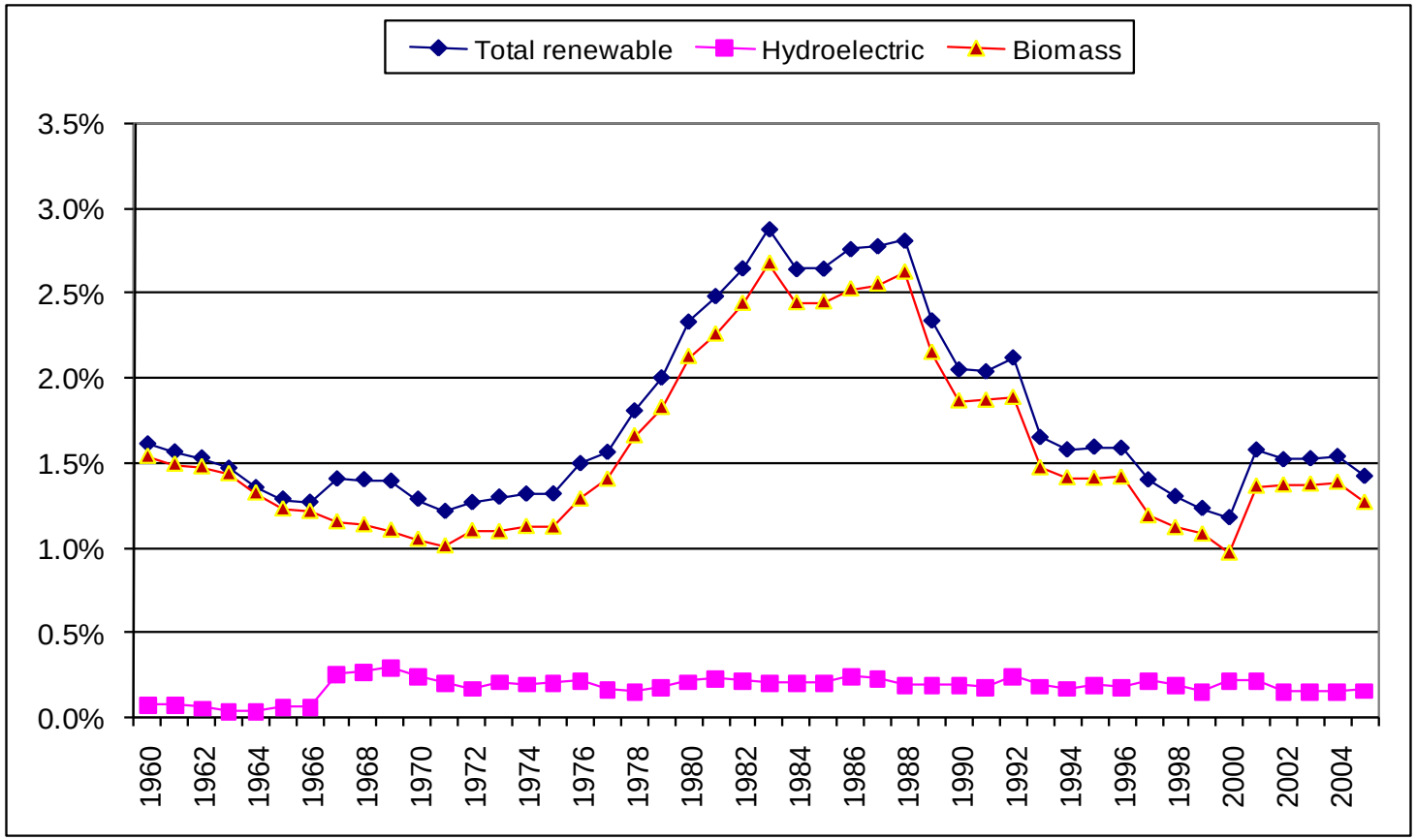
Historical Renewable Energy in the U.S.



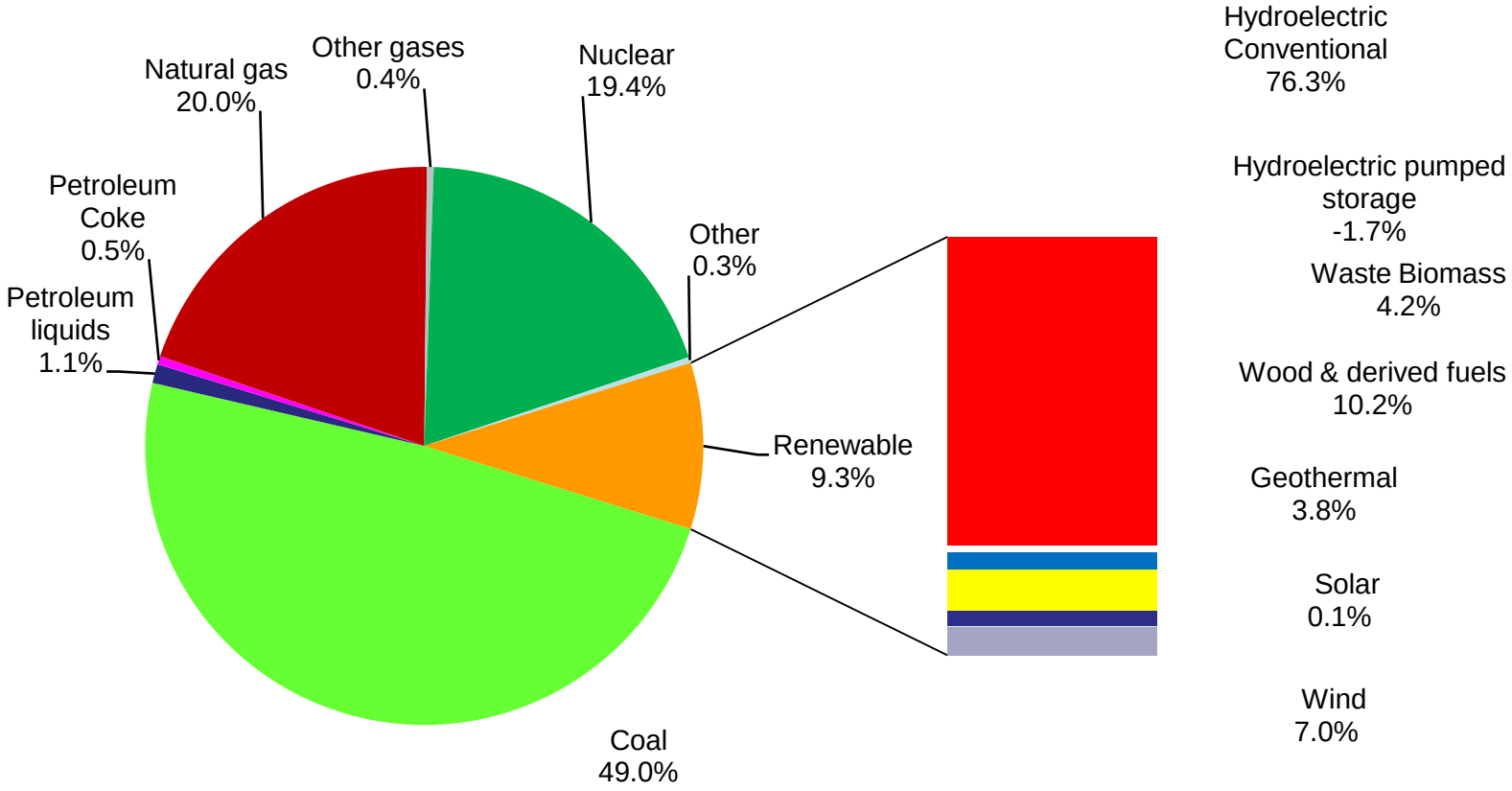
Data source: EIA

Renewables Share of Indiana Total Energy Consumption



Source: EIA

2006 U.S. Electricity Generation by Energy Source



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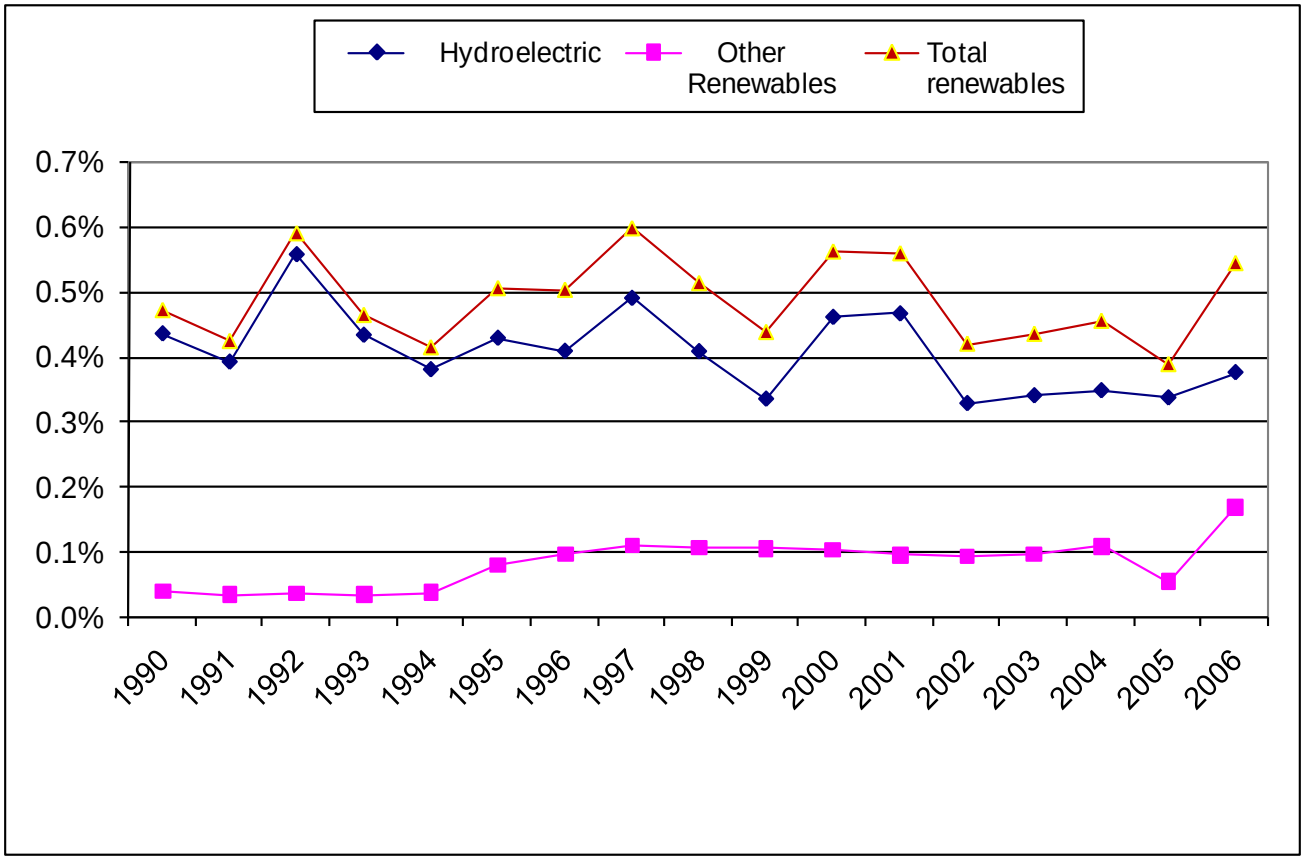
Renewables Share of Indiana Total Electricity Generation



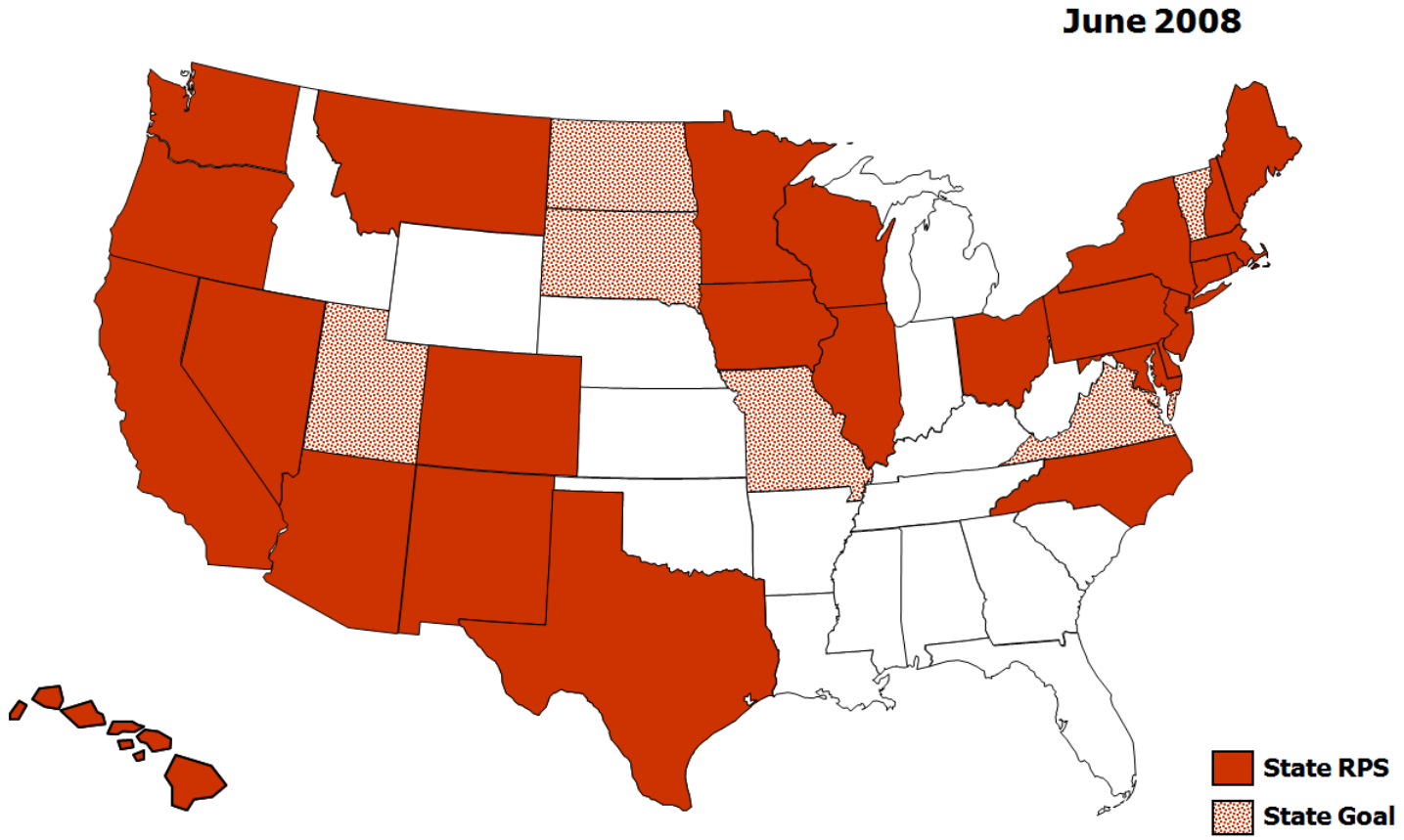
Barriers to Renewables

- Major barrier is cost
  - most renewable technologies have high capital costs
  - Indiana had the 10th lowest electricity rates in the country in 2004, (6.46 cents/kWh vs. national average 8.90 cents/kWh)
- Limited resources are also a problem for some technologies
  - solar/photovoltaics, hydropower, wind
- Intermittency

Incentives for Renewables

- Federal
  - tax credits and exemptions (production tax credit)
  - grant programs
- State
  - net metering rule
  - grant programs
  - tax credits
  - emissions credits
  - renewable portfolio standards
- Utilities
  - green pricing programs

Renewable Portfolio Standards

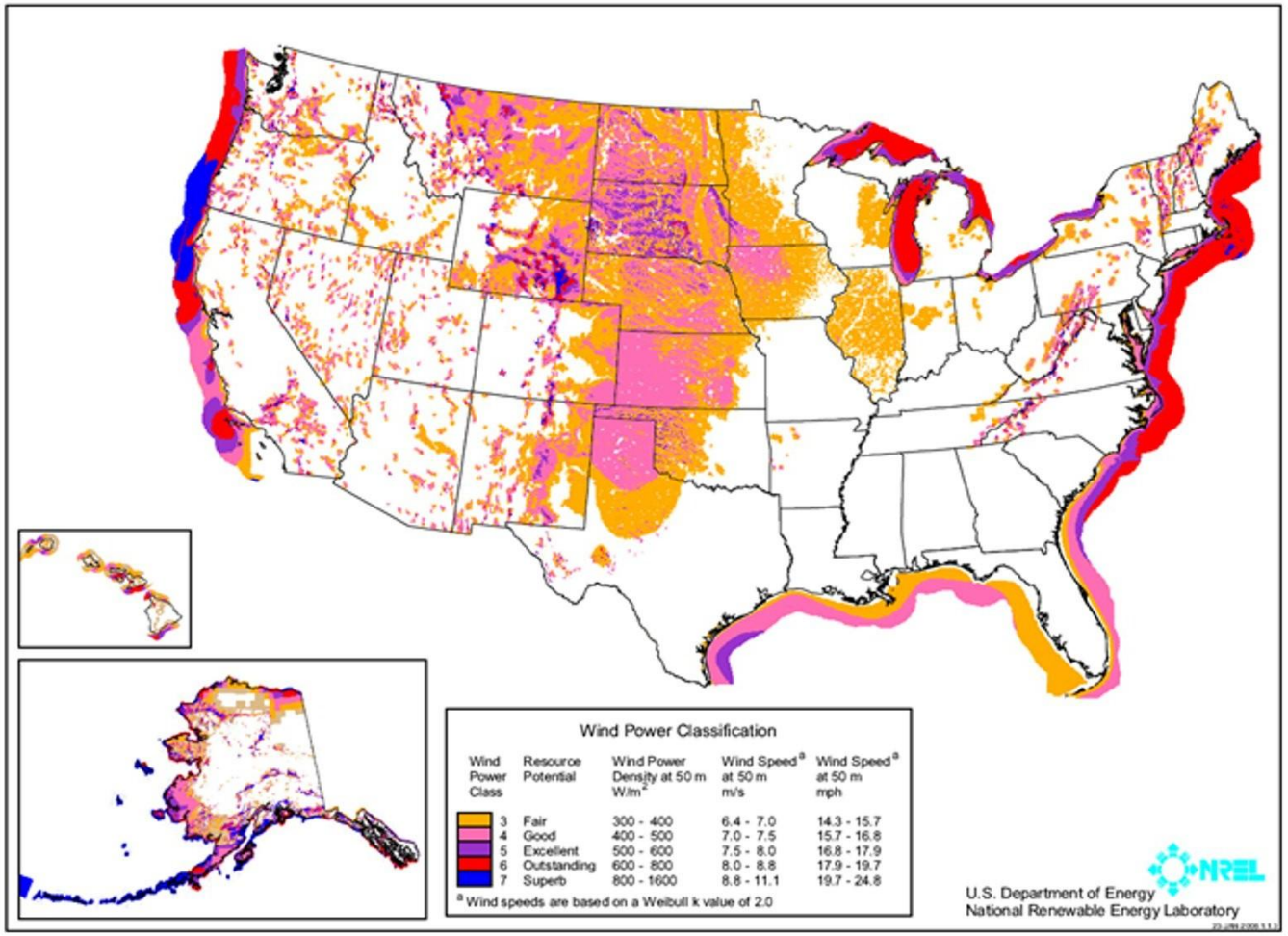


Source: DSIRE

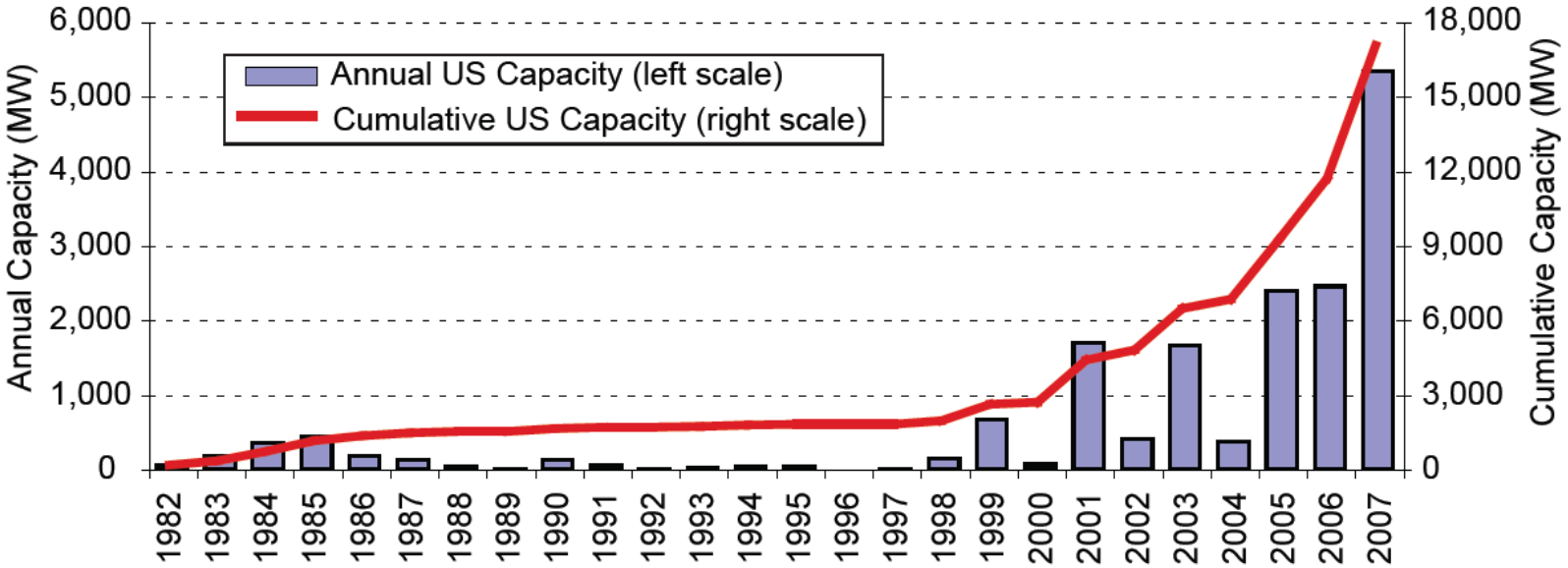
Wind

- Advantages
  - inexhaustible
  - free fuel
  - clean
  - modular
  - scalable
  - high system reliability
  - uses no water
- Disadvantages
  - intermittent
  - usually located far from load centers
  - bird mortality
  - radar interference
  - somewhat geographically limited

Wind Resources

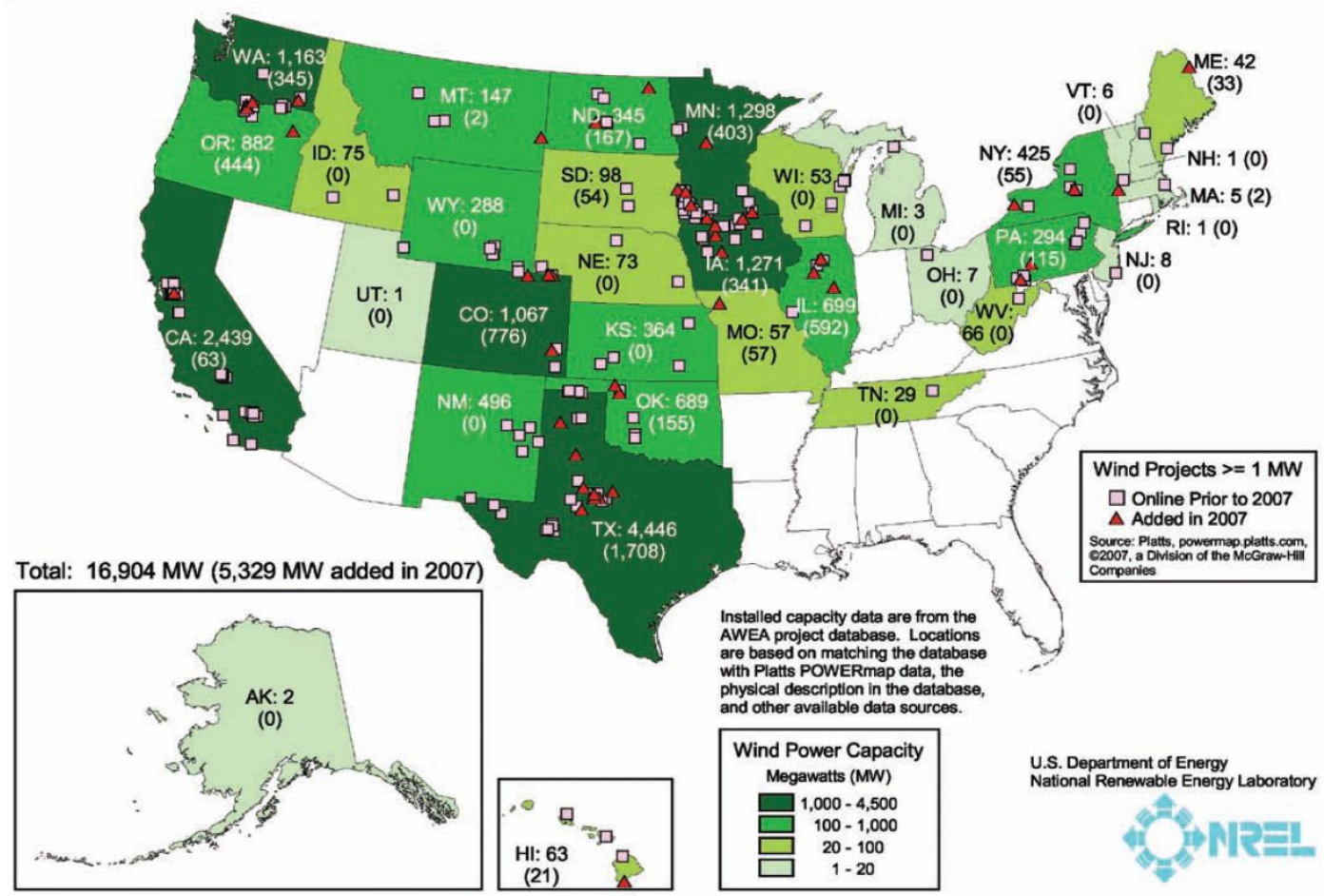


Growth in U.S. Wind Power

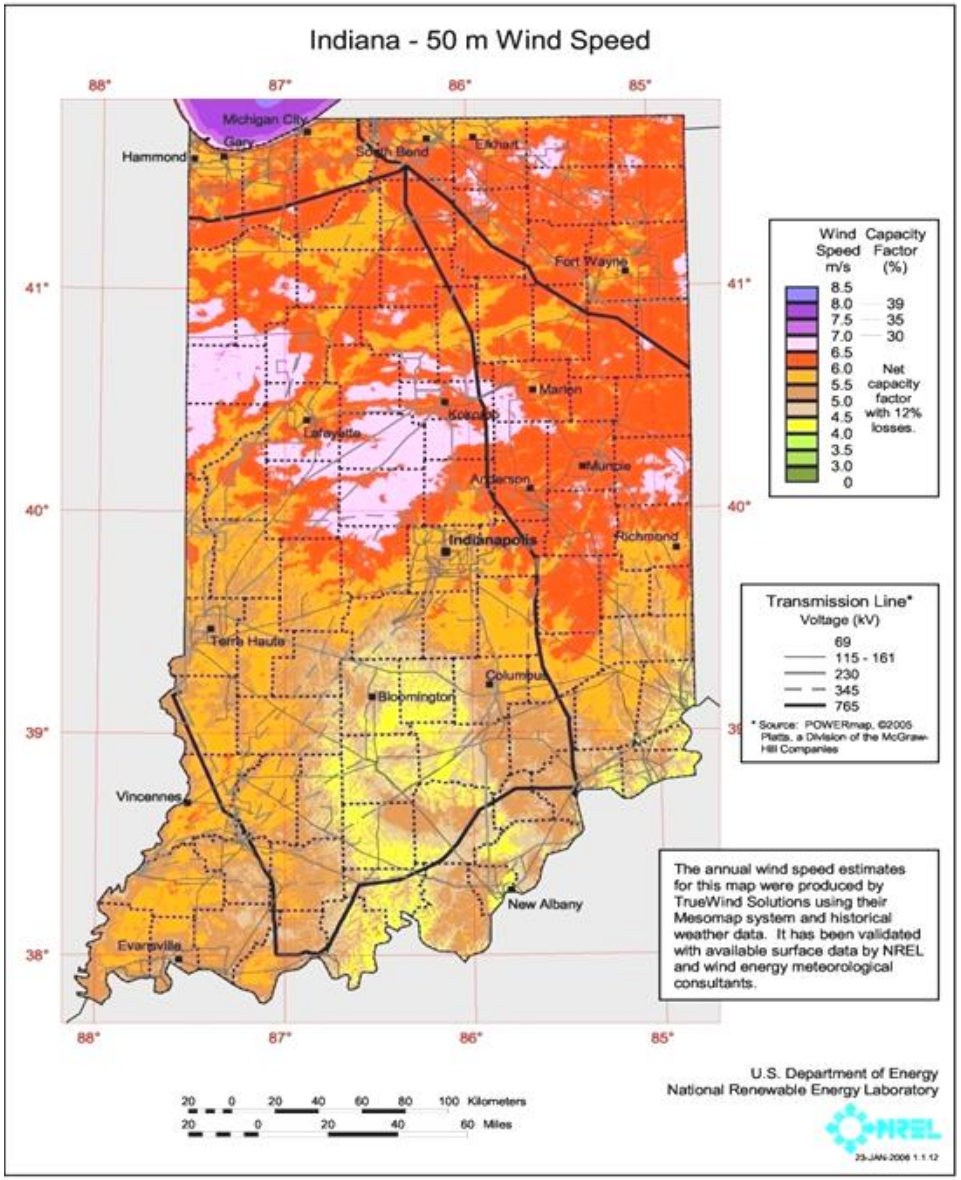


Source: AWEA.

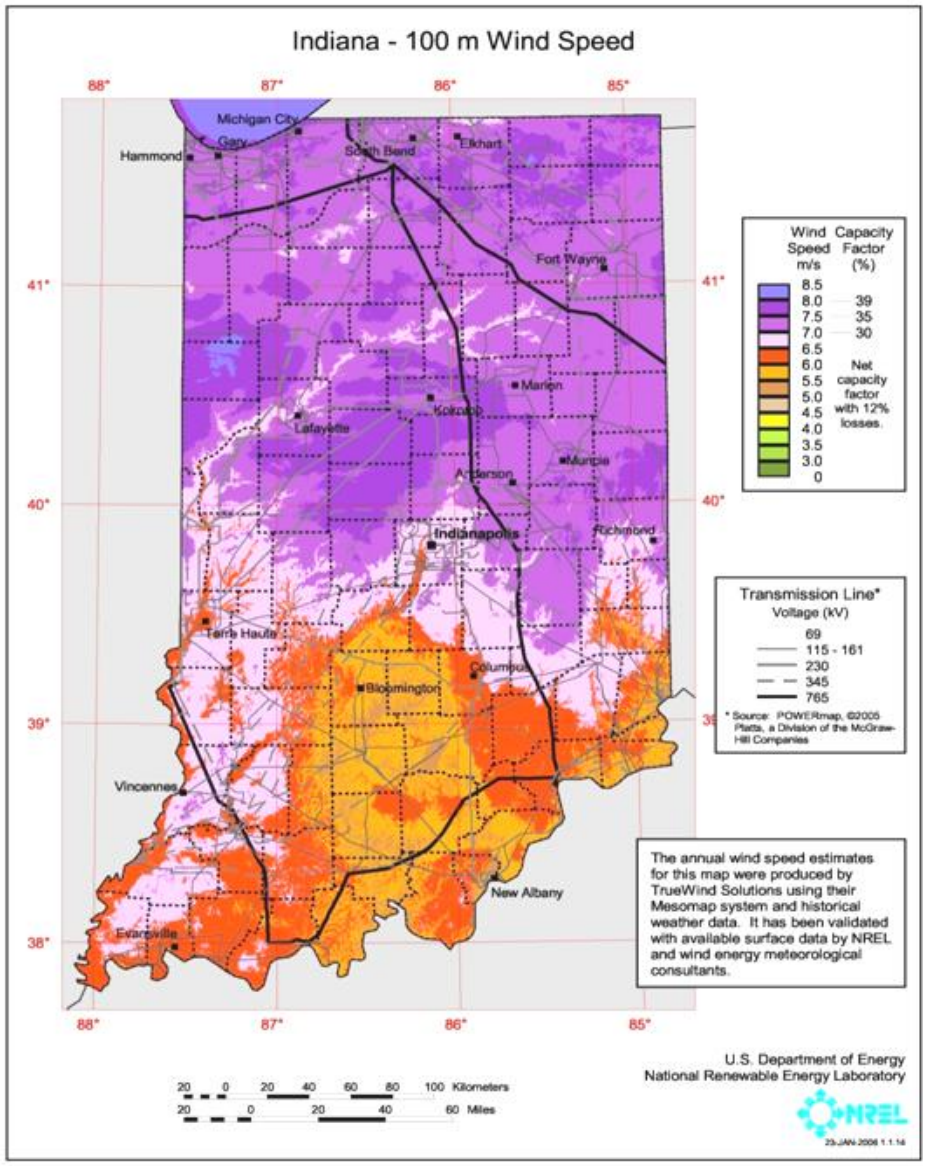
Wind Power Capacity



Wind Speed at 50 Meters



Wind Speed at 100 Meters



Indiana Wind Developments

Project Name	Counties	Developer	Rated Capacity (MW)	Construction Schedule	Status
Benton County Wind Farm	Benton	Orion Energy	130	Completed Spring 2008	Completed
Fowler Ridge Phase 1	Benton	BP Alternative Energy & Dominion	400	To be completed by end of 2008	Under construction
Hoosier Wind Project	Benton	enXco	102	2009	Approved
Fowler Ridge Phase 2	Benton	BP Alternative Energy & Dominion	350	Begin early 2009	Approved
Tri-County Wind Energy Center	Tippecanoe, Montgomery, Fountain	Invenergy	300-500	Begin 2010	Proposed
Meadow Lake Wind Farm	Benton, White	Horizon Energy	600-1000	Begin 2010	Proposed
	Randolph	Horizon Energy	100-200		Proposed
	Howard	Horizon Energy	200		Proposed

Indiana Utility Wind PPAs

Utility	Project	State	MW	Status
Duke Energy	Benton County Wind Farm	IN	100	Operational
SIGECO	Benton County Wind Farm	IN	30	Operational
WVPA	AgriWind	IL	8	Operational
Indiana Michigan	Fowler Ridge	IN	100	Approved
NIPSCO	Buffalo Ridge	SD	50	Approved
NIPSCO	Barton Windpower	IA	50	Approved
IPALCO	Hoosier Wind	IN	102	Approved

Energy Crops

- Sources
  - fast growing hardwood trees
    - hybrid poplar
    - willow
  - grasses
    - switchgrass
    - Miscanthus
  - food crop byproducts
    - corn stover
- Barriers
  - other high-value uses for the land
  - harvesting and transportation costs
  - price of competing fossil fuels

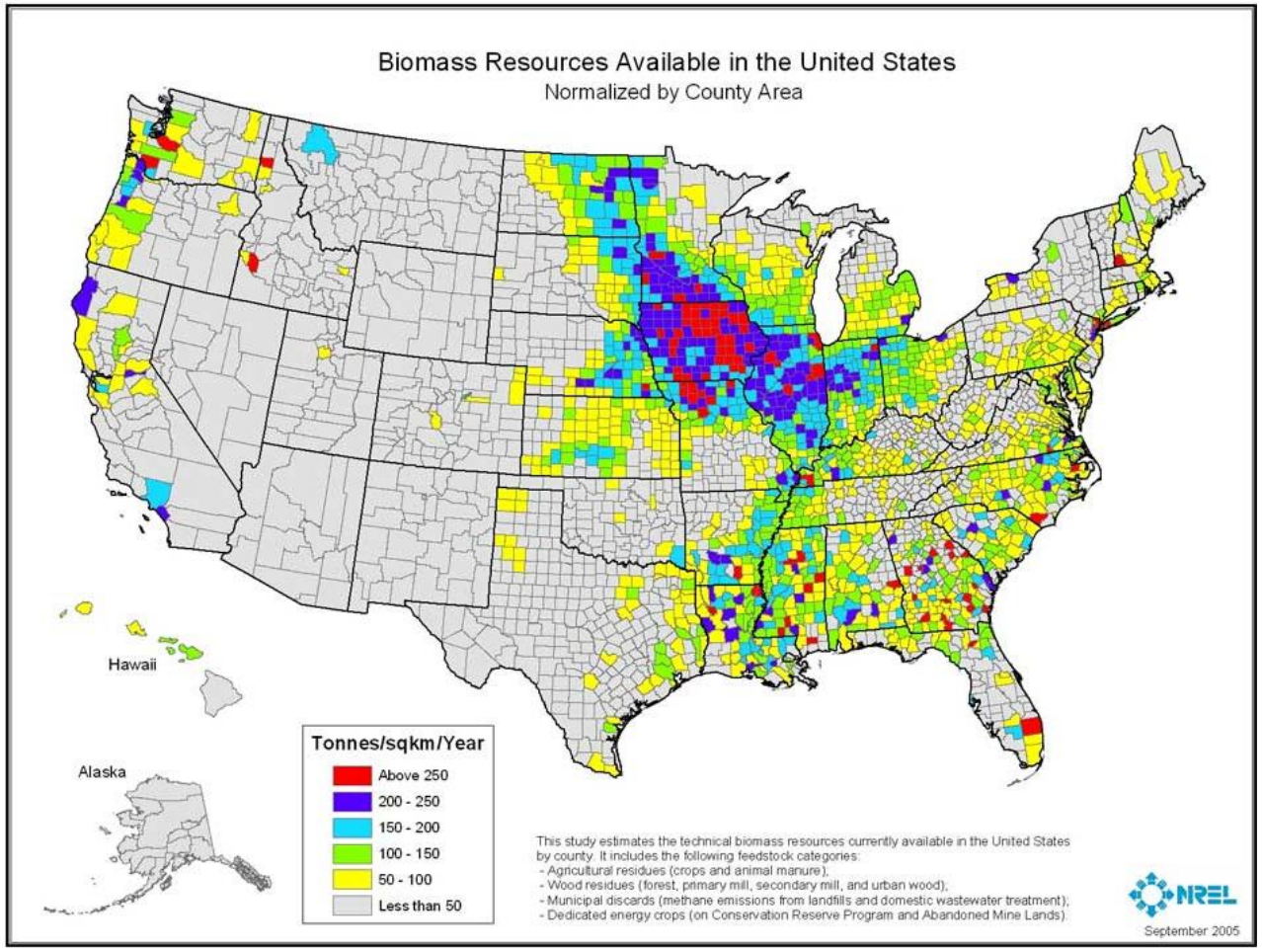
Energy Crops

- Transportation fuels
  - ethanol
  - soy diesel
- Other possibilities
  - fast growing hardwood trees (hybrid poplar/willow)
  - grasses (switchgrass)
- Barriers to be overcome
  - other high-value uses for the land
  - harvesting and transportation costs
  - price of competing fossil fuels

Organic Waste Biomass

- This resource is the single largest source of renewable energy in Indiana
  - primarily due to the use of wood waste
- In 2007, it was the second largest source of renewable electricity generation in the state
  - landfill gas
  - municipal solid waste
  - animal waste biogas
  - wastewater treatment

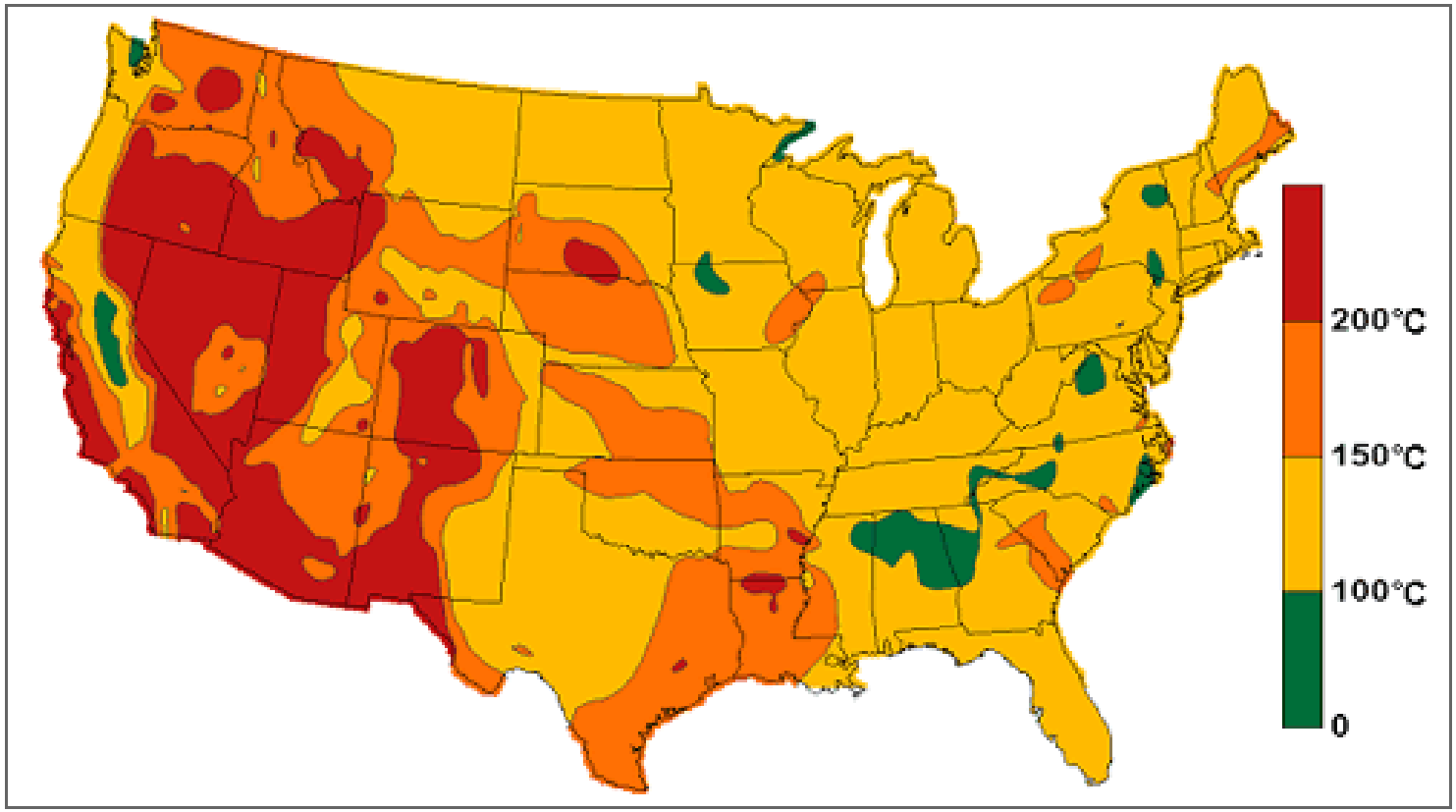
Biomass Resources



Geothermal

- Advantages
  - clean
  - free fuel
  - high availability (95 percent)
  - nearly inexhaustible
- Disadvantages
  - geographically limited
  - usually located far from load centers

Geothermal Resources

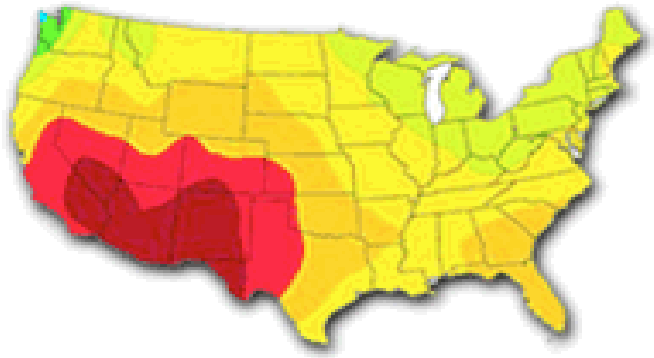


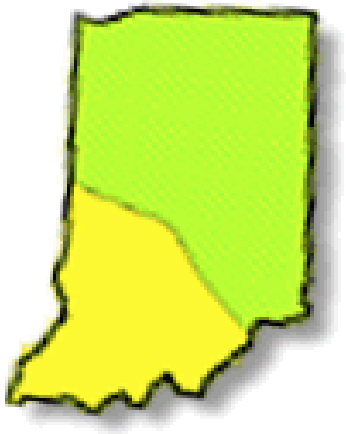
Source: EERE

Solar

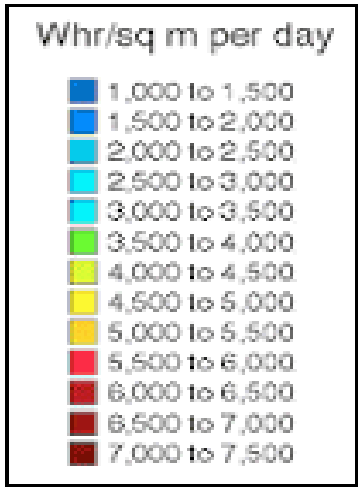
- Advantages
  - inexhaustible
  - free fuel
  - clean
  - modular
  - scalable
  - high system reliability
  - uses no water
- Disadvantages
  - intermittent
  - high capital cost
  - geographically limited

Flat Panel Solar Resources

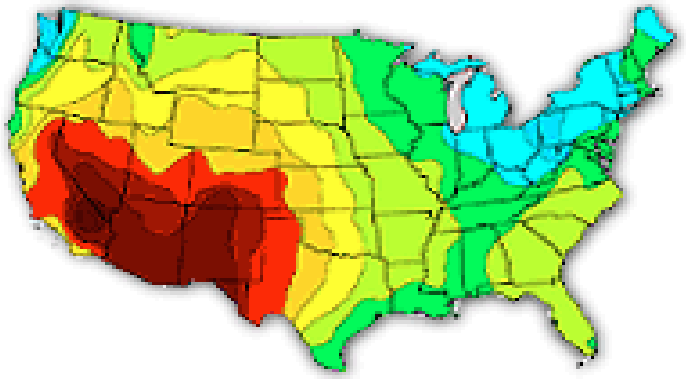


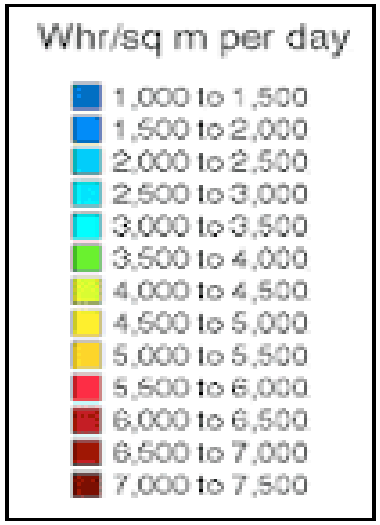


Solar resource for a flat-plate collector



Concentrating Solar Resources





Solar resource for a concentrating collector

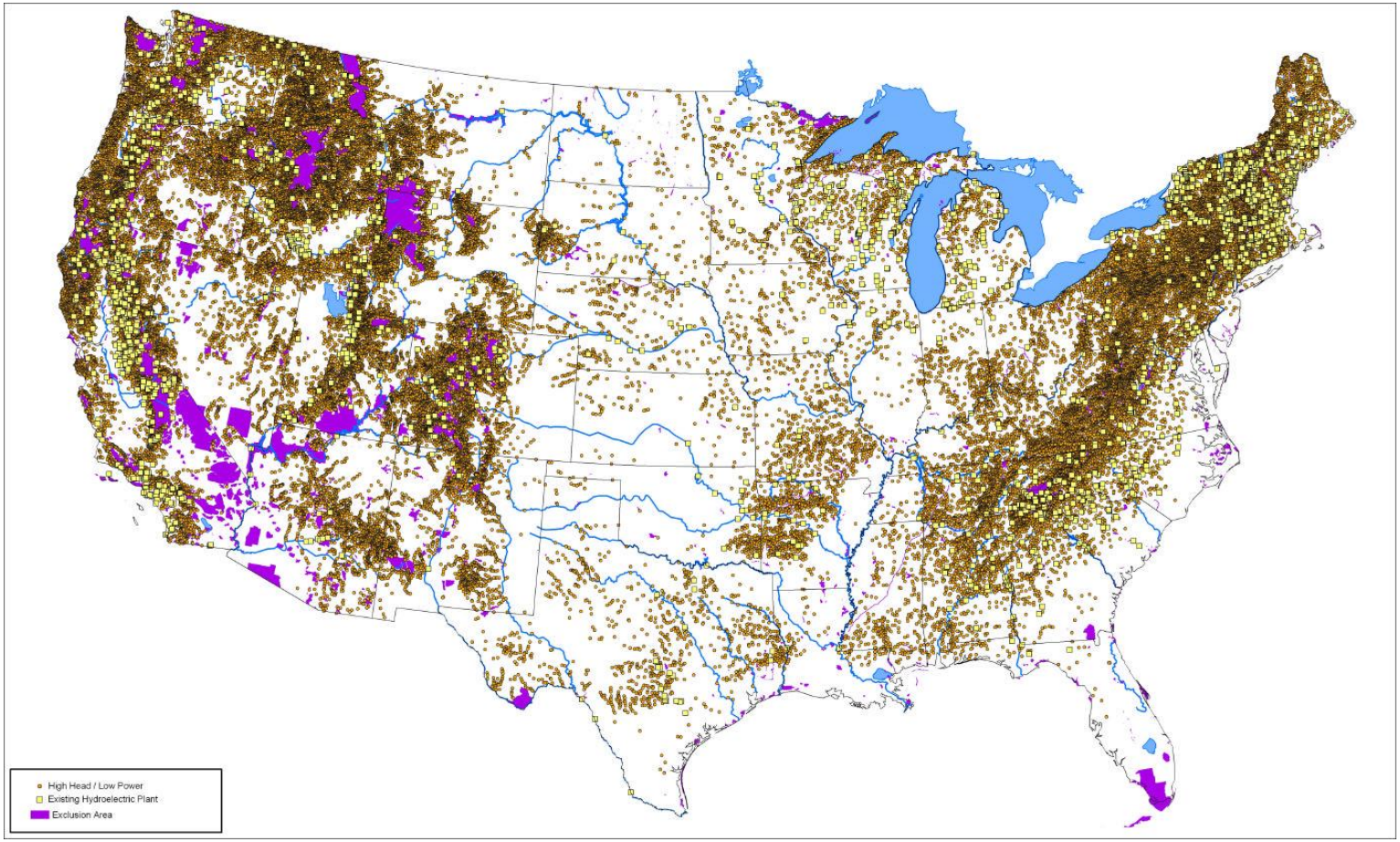
Hydroelectricity

- Advantages
  - inexhaustible
  - free fuel
  - clean
  - operational flexibility
- Disadvantages
  - geographically limited
  - impact on aquatic life
  - changes in water quantity/quality downstream

Hydroelectric Power

- Indiana has about 60 MW of hydroelectric generating capacity.
  - mostly run-of-the-river (no dam)
  - largest source of renewable electricity
- The U.S. Department of Energy has identified another 66 MW of potential hydropower at existing dams
  - Only about 42 MW was considered viable (spread out over 27 sites)

Hydroelectric Resources



Source: EERE

Further Information

- State Utility Forecasting Group
  - http://www.purdue.edu/dp/energy/SUFG/