2013 Indiana Renewable Resources Study

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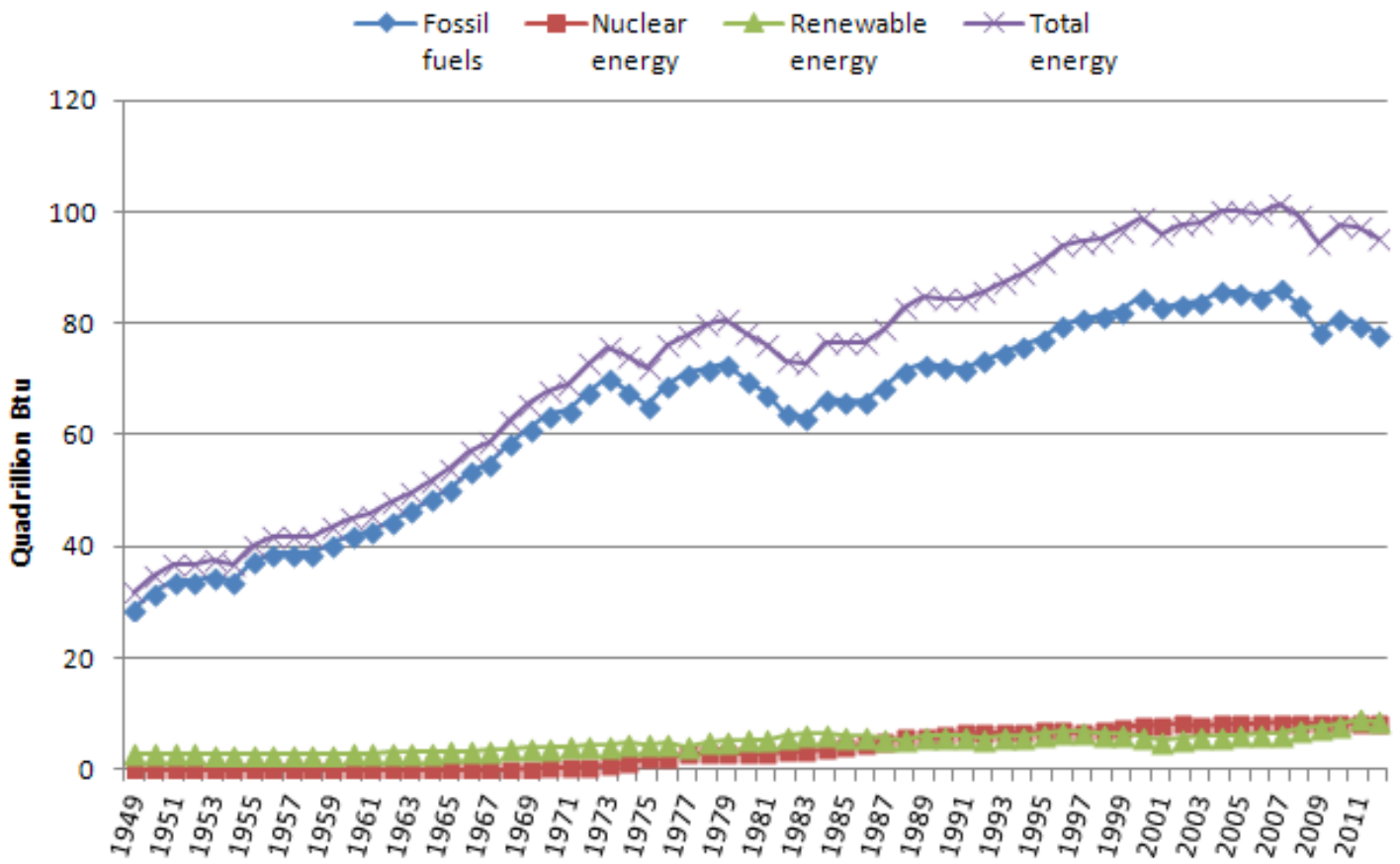
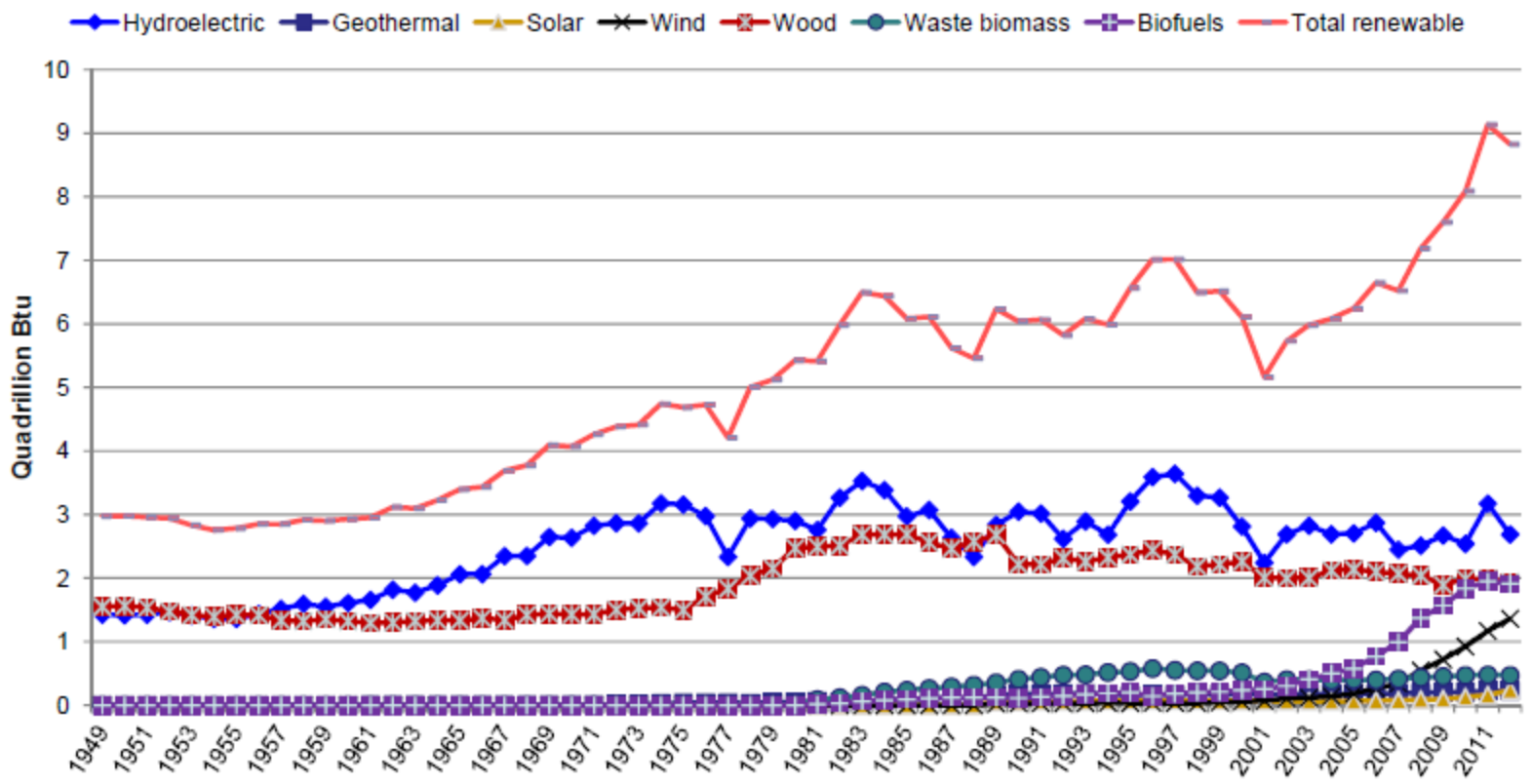
Contents

U.S. Total Energy Consumption



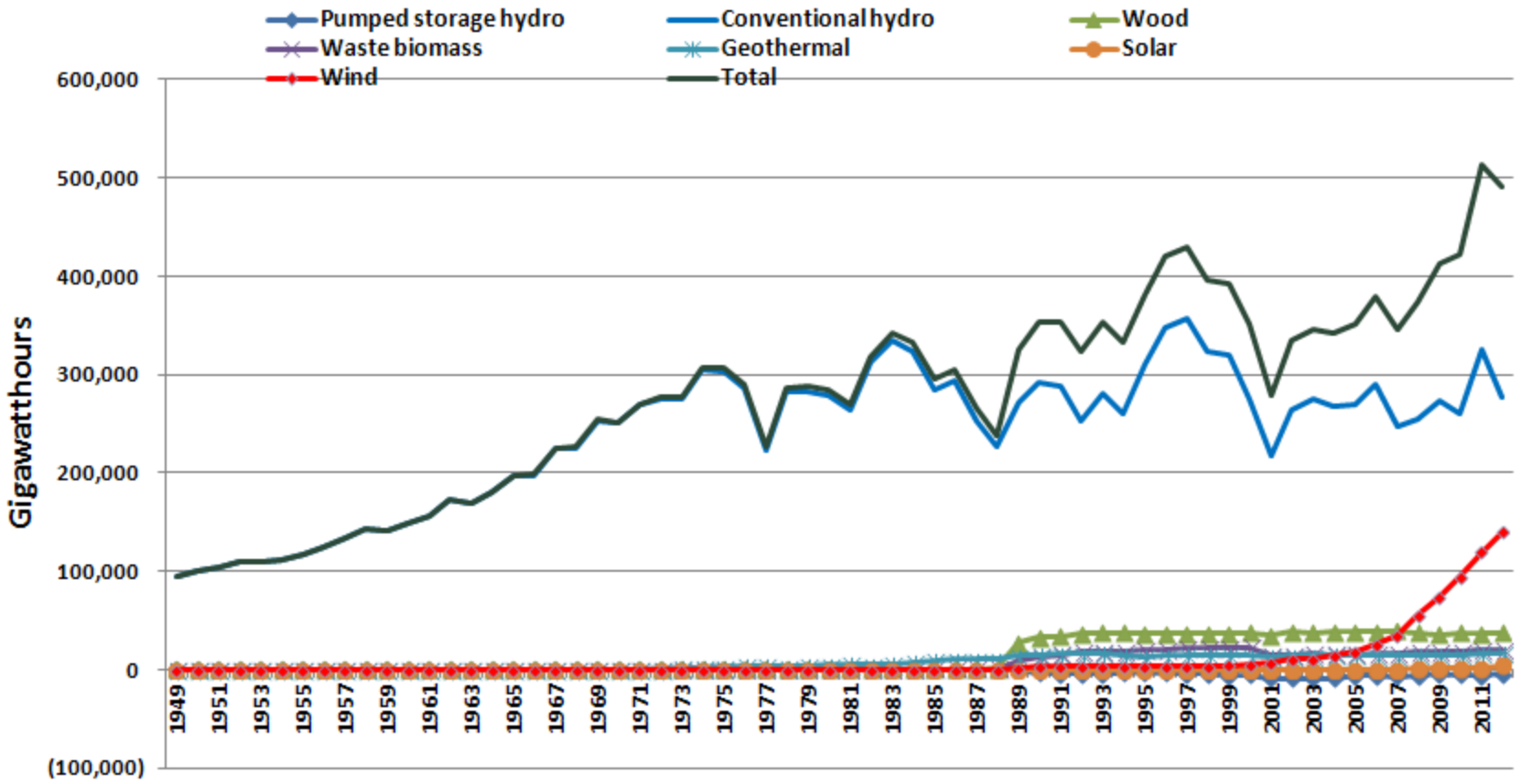
Data source: EIA

Renewables in U.S. Total Energy Consumption



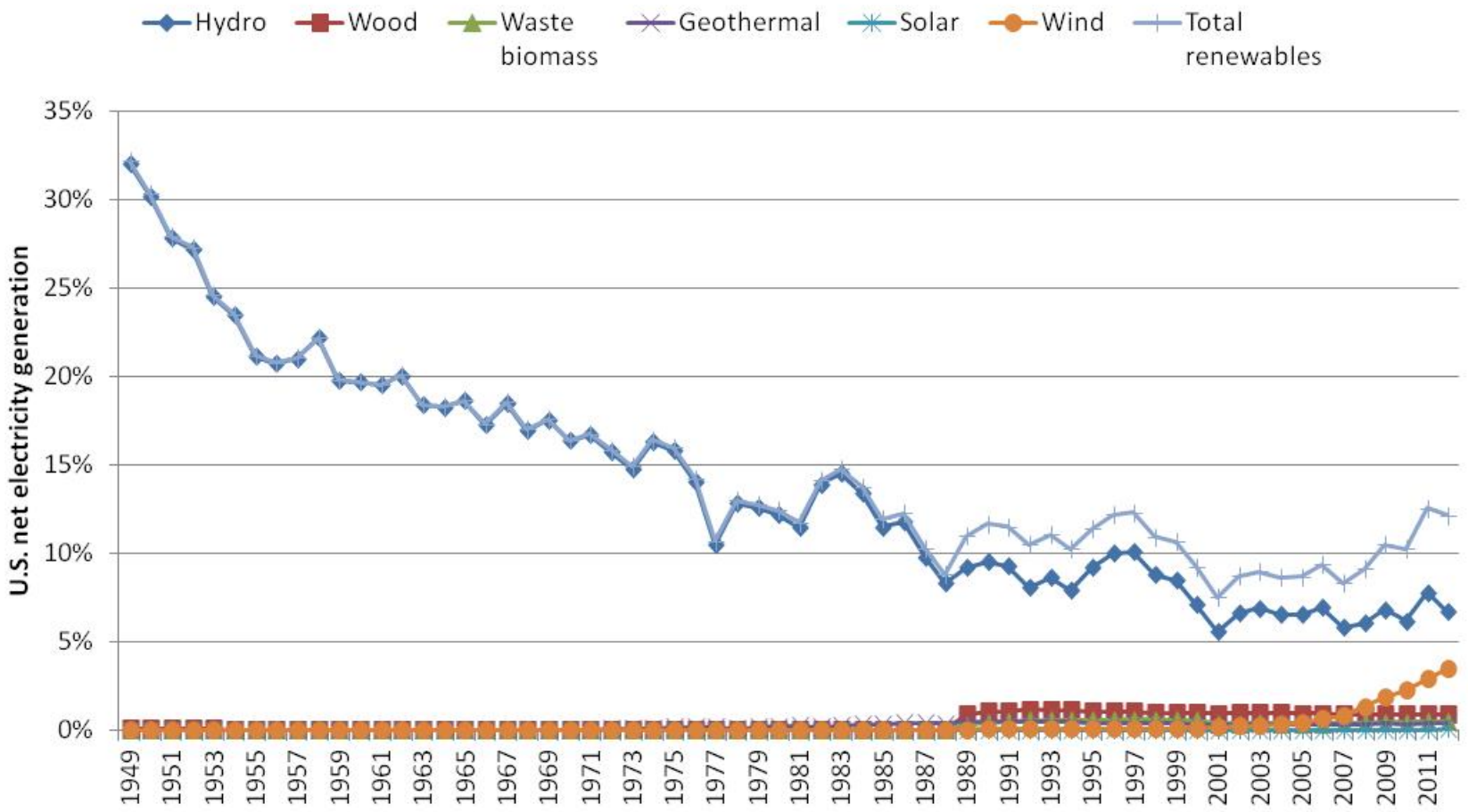
Data source: EIA

Renewables in U.S. electricity



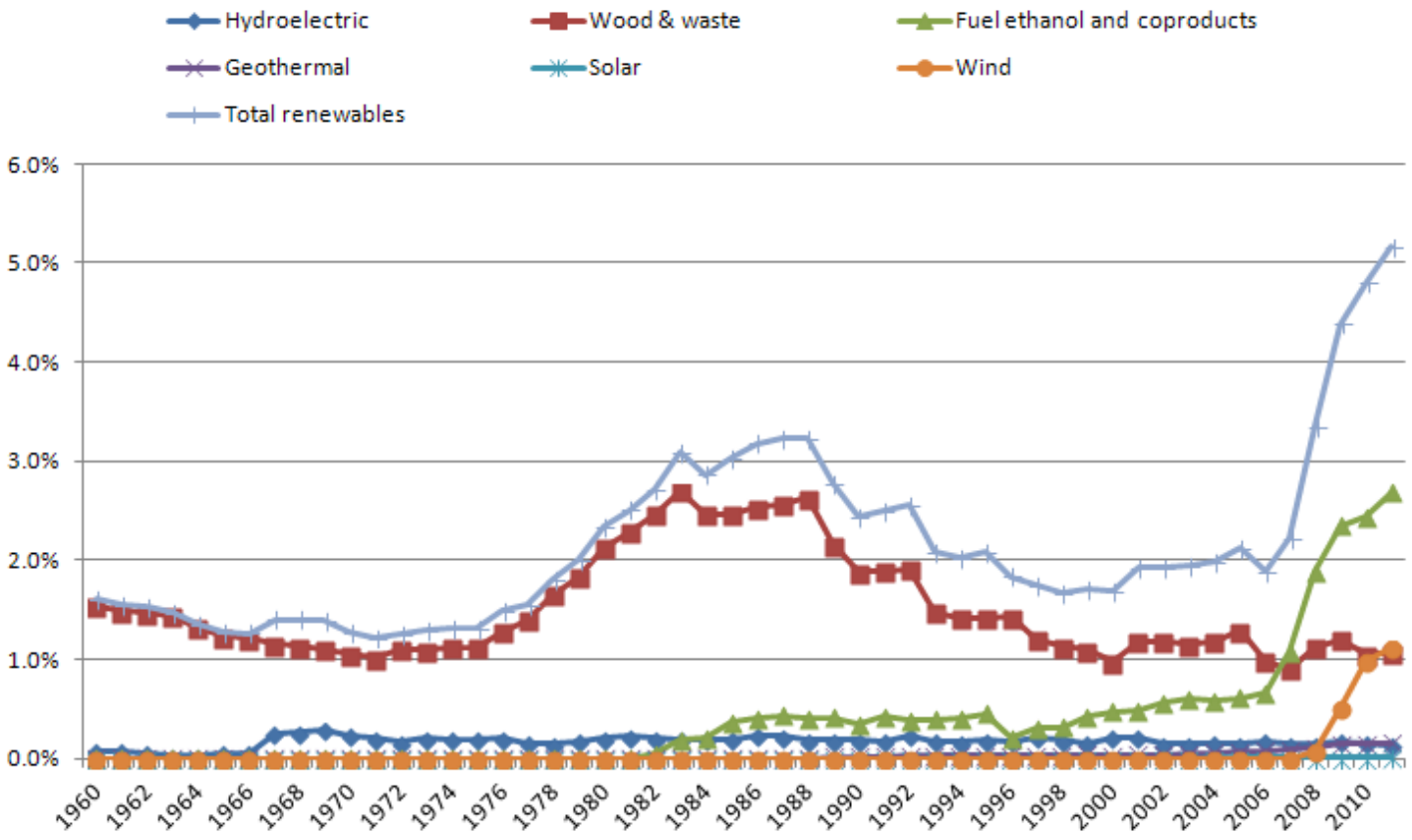
Data source: EIA

Renewables Share of U.S. electricity generation



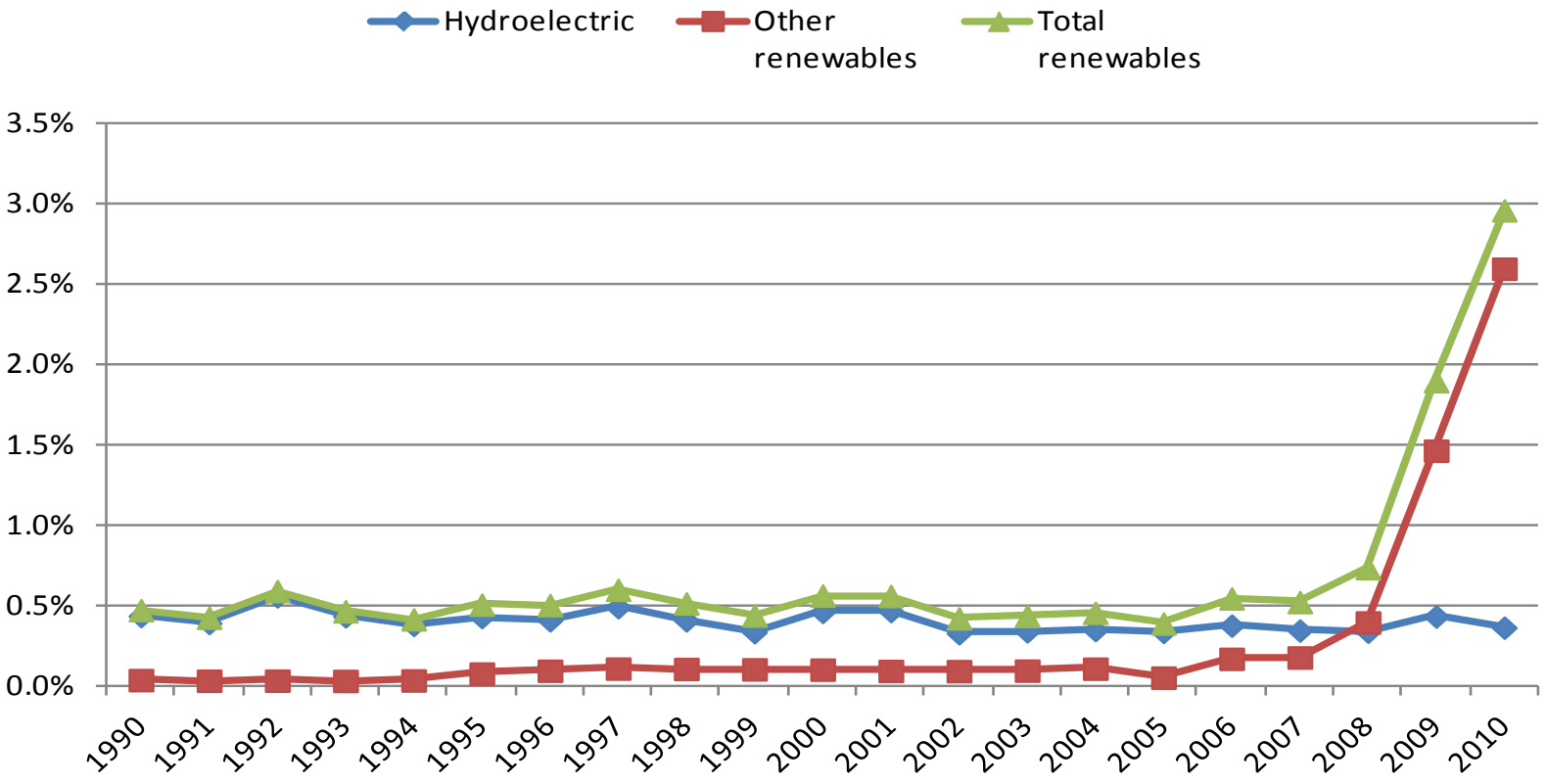
Data source: EIA

Renewables Share of Indiana Total Energy Consumption



Data source: EIA

Renewables Share of Indiana Electricity Generation

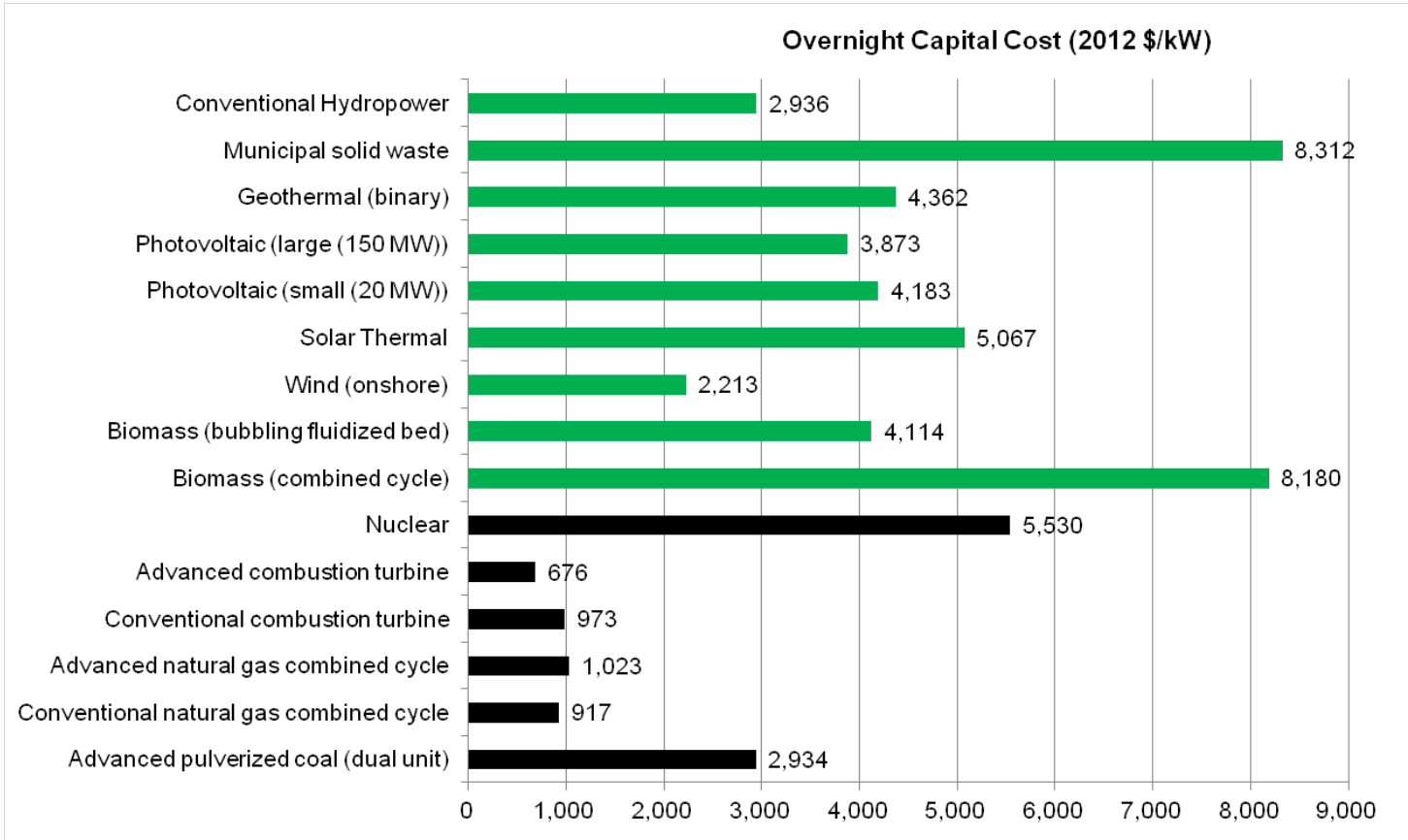


Data source: EIA

Barriers to Renewables

- Major barrier is cost
  - Most renewable technologies have high capital costs
  - According to EIA Indiana's average electric rate in 2011 was 8.01 cents/kWh vs. the national average of 9.90 cents/kWh
- Limited availability for some resources
  - Solar/photovoltaics, hydropower
- Intermittency for some resources
  - Solar/photovoltaics, wind

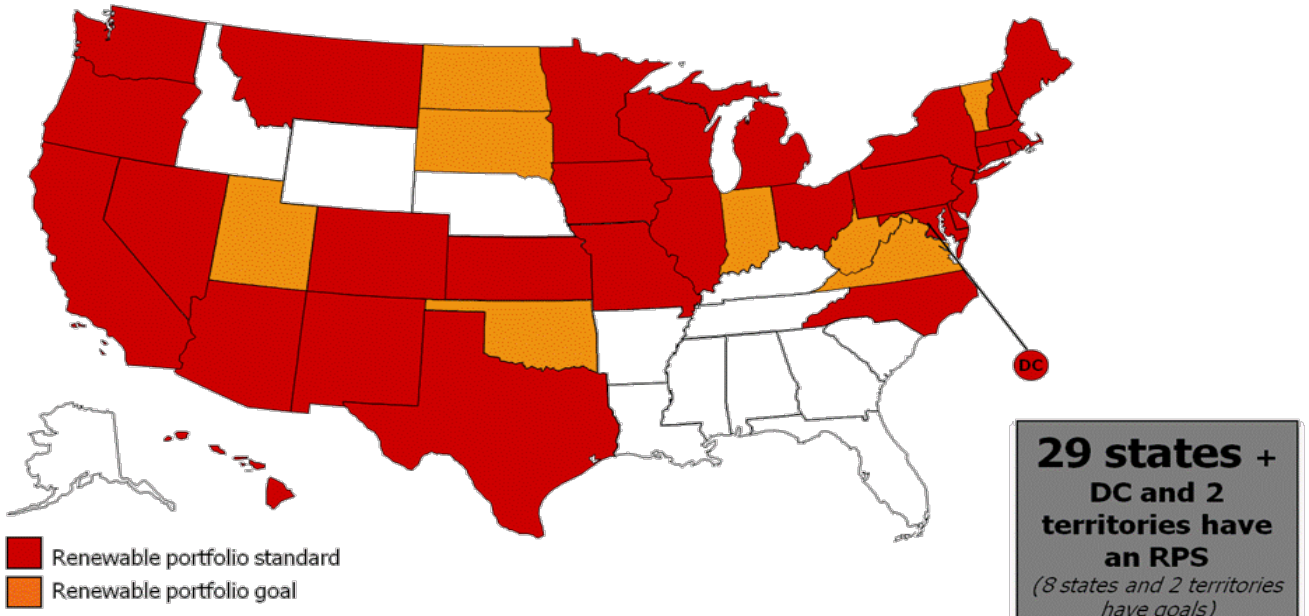
Capital Costs for Various Generation Sources



Data source: EIA

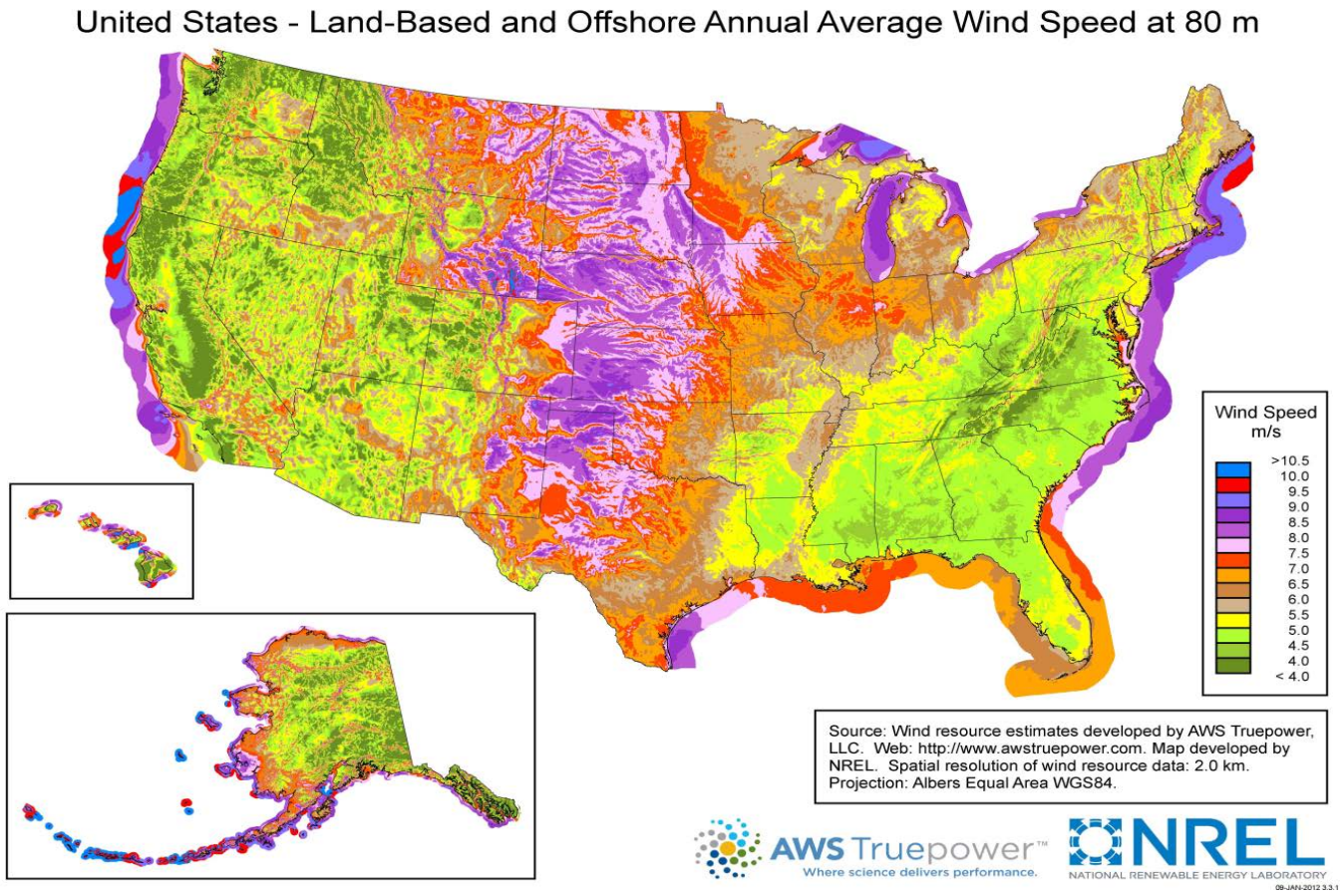
Drivers

- Federal PTC (2.3 ¢/kWh),
- State renewable portfolio standards
- Utility feed-in-tariffs

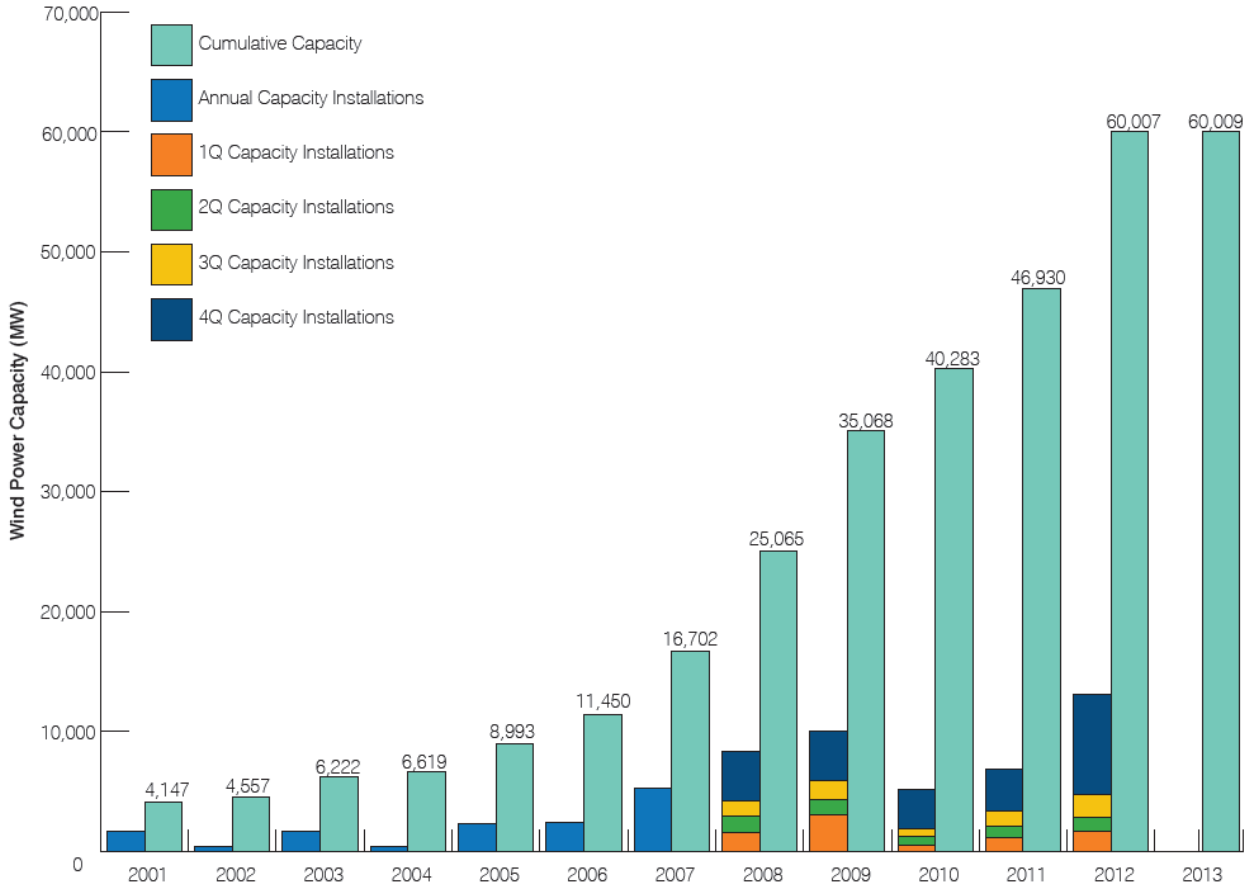


Source: DSIRE

U.S. Wind

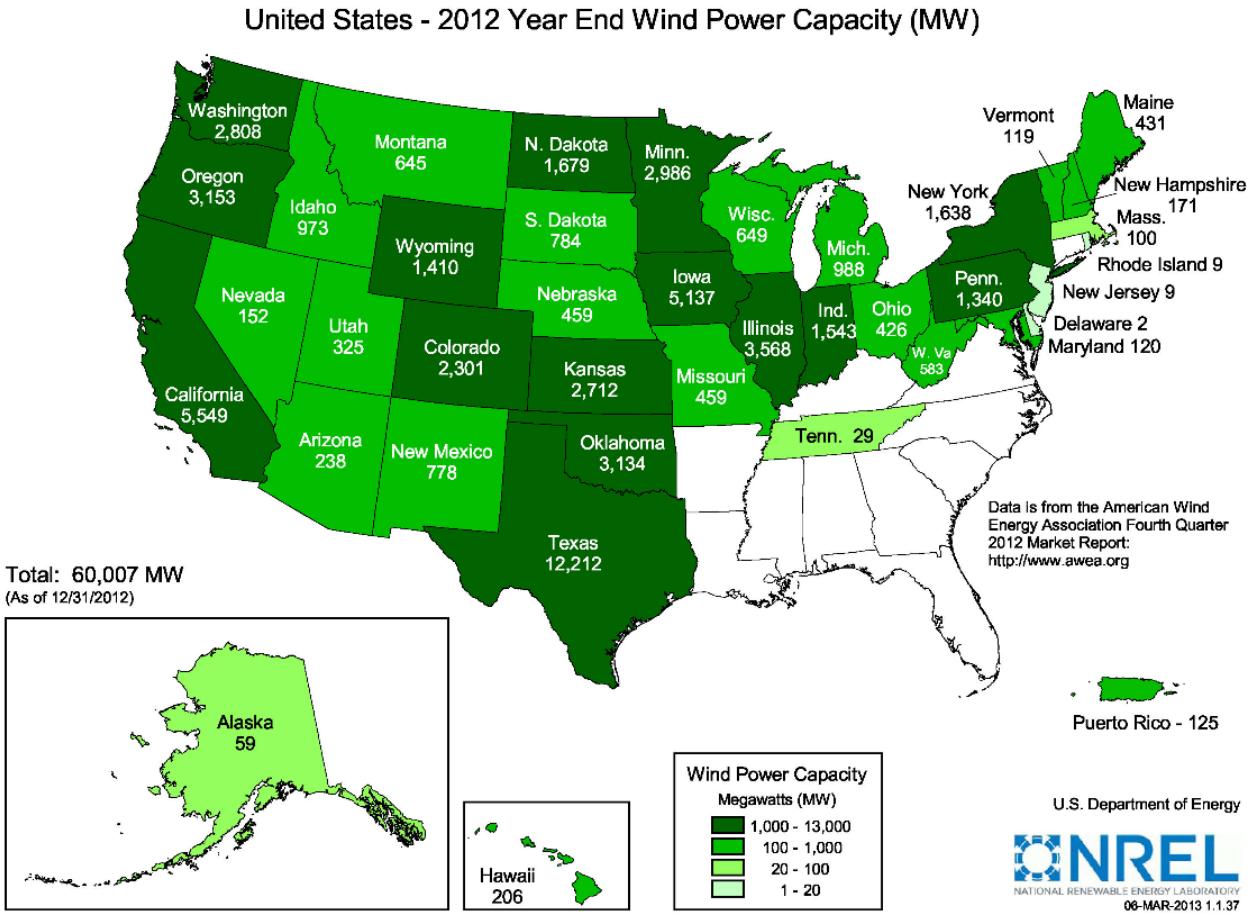

United States - Land-Based and Offshore Annual Average Wind Speed at 80 m
Wind Speed m/s
>10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
< 4.0
Source: Wind resource estimates developed by AWS Truepower, LLC. Web: http://www.awstruepower.com. Map developed by NREL. Spatial resolution of wind resource data: 2.0 km. Projection: Albers Equal Area WGS84.
AWS Truepower™
Where science delivers performance.
NREL
NATIONAL RENEWABLE ENERGY LABORATORY
09-JAN-2012 3.3.1

U.S. Wind

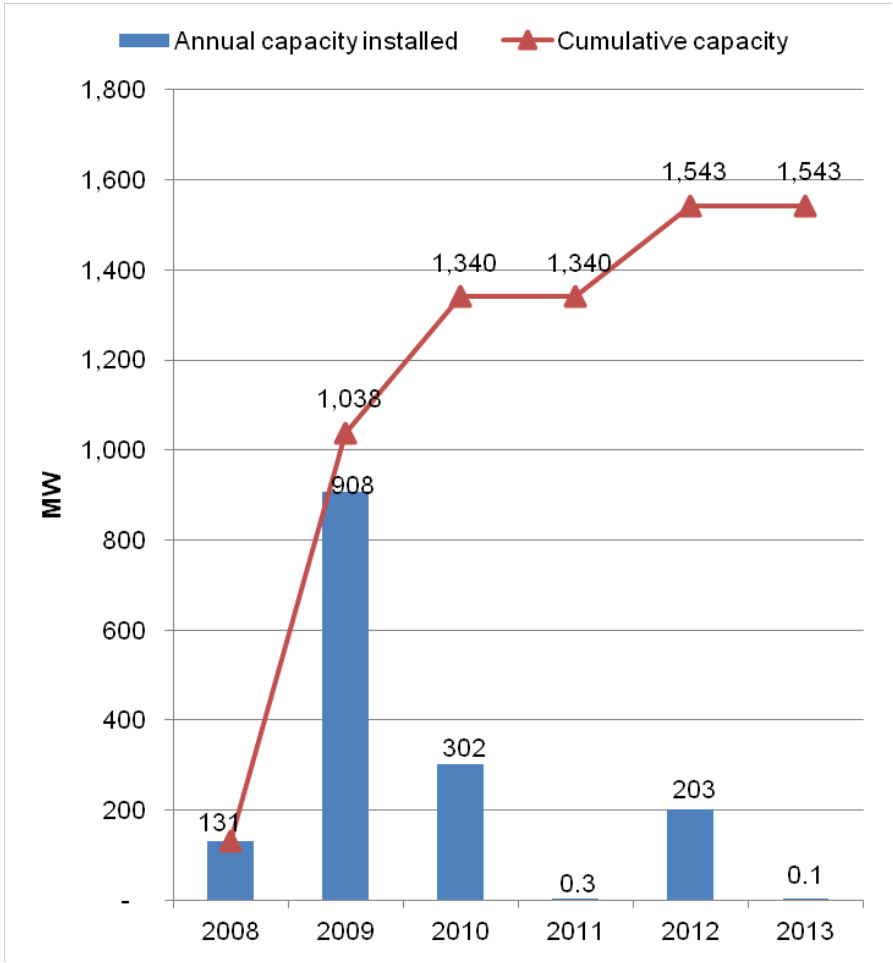


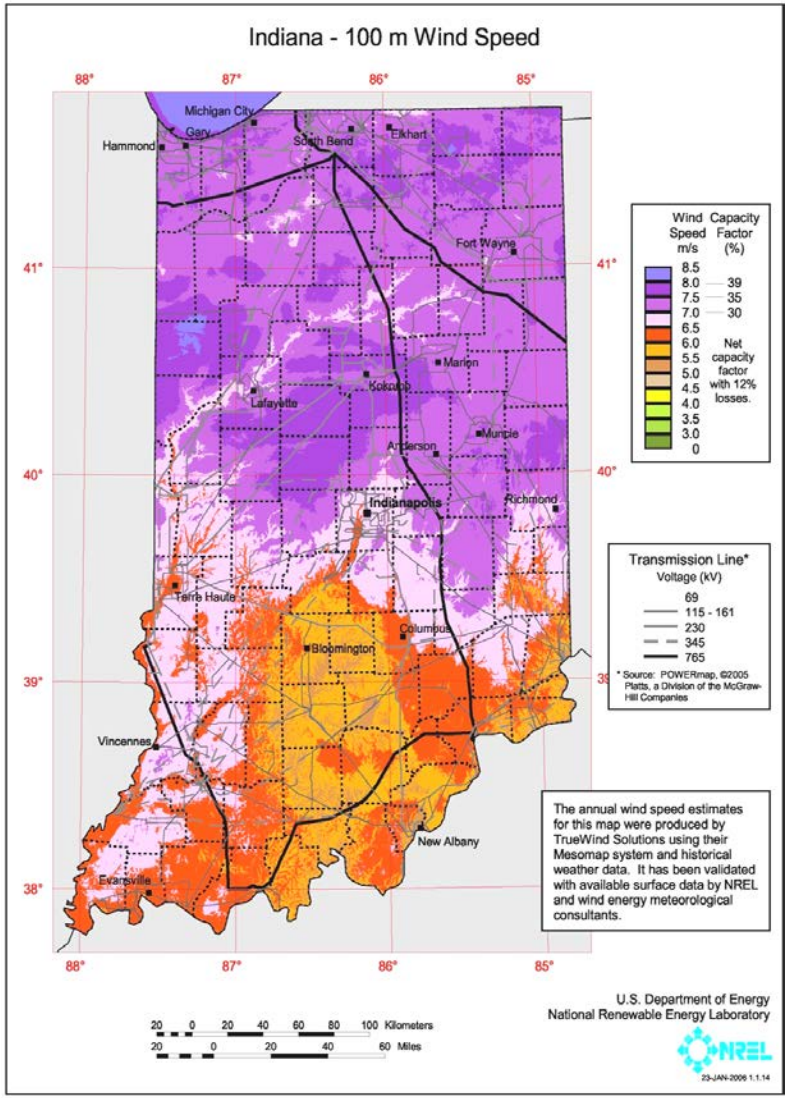
Source: AWEA

Wind Capacity Dec. 2012



Indiana Wind

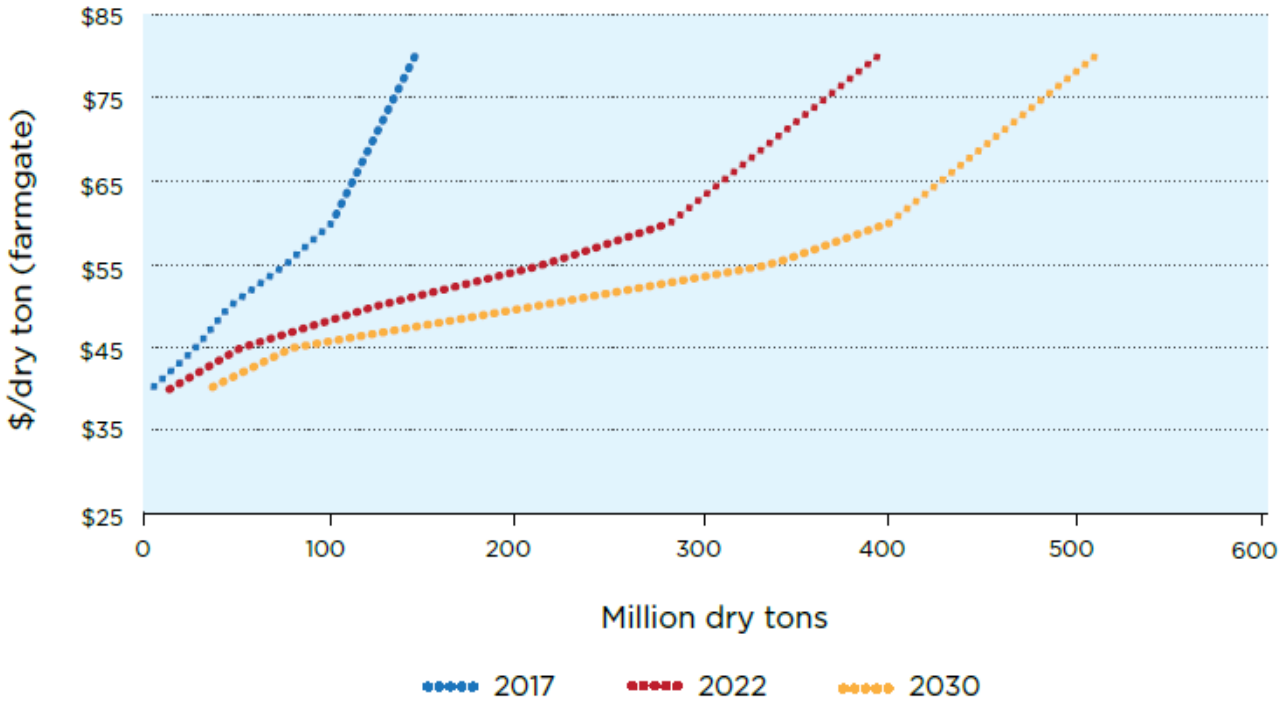




Energy Crops

- Crops
  - Fast growing hardwood trees (poplars, willows, eucalyptus, …….)
  - Grasses (switchgrass, miscanthus, …..)
- Barriers to be overcome
  - Other high-value uses for the land
  - Price of competing fossil fuels
  - Harvesting and transportation costs

Energy Crops Supply Curves



Source: DOE-Billion-ton study

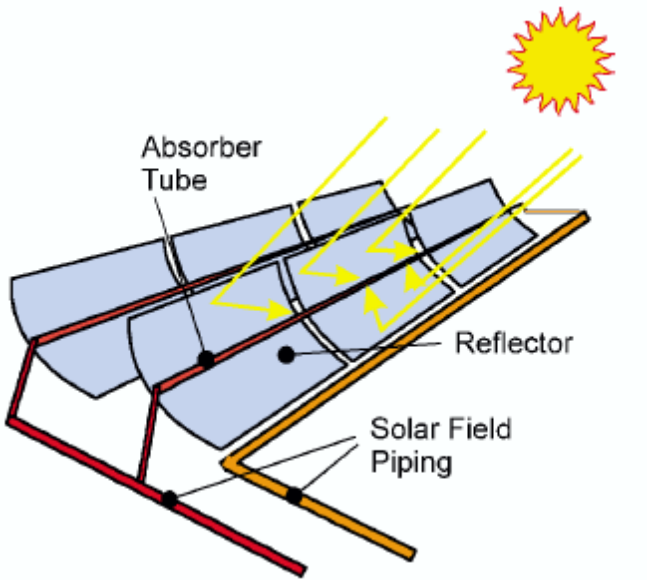
Organic Waste Biomass

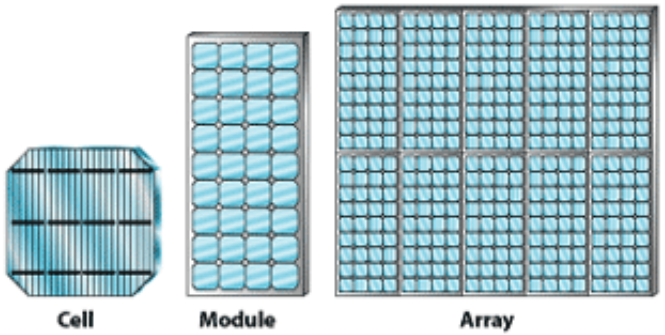
- Today
  - Wood and wood waste
  - Landfill gas
  - Municipal solid waste
  - Animal waste biogas
  - Wastewater treatment
- Tomorrow
  - Agricultural crop residues

Organic Waste Biomass

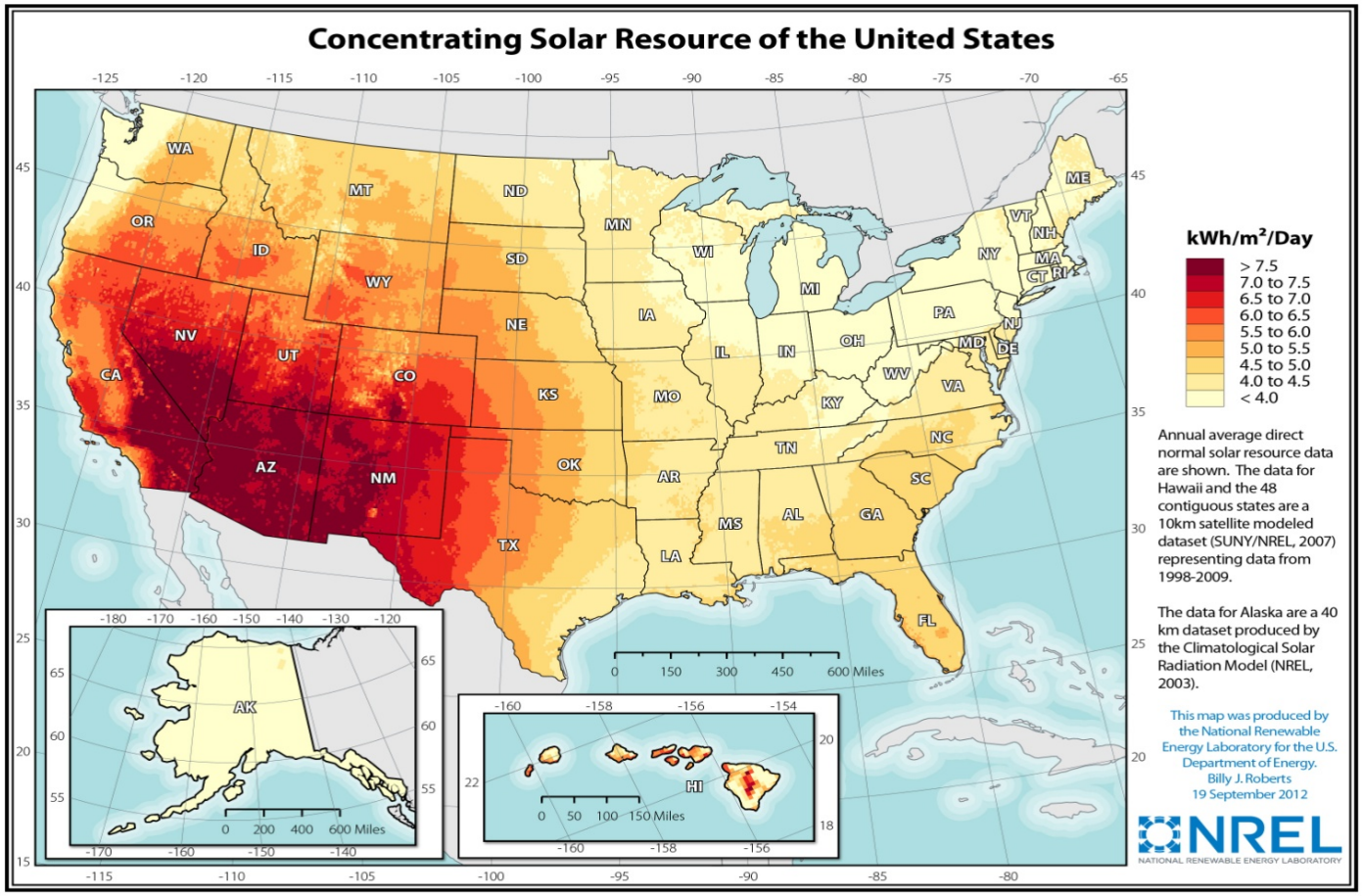
- U.S.
  - 27% renewable energy 2012 (hydro-30%)
  - 7% net renewable electricity 2012 (hydro-56%, wind-22%)
- Indiana
  - 21% renewable energy 2011(biofuels-52%, wind-22%)
  - 4% net renewable electricity 2010 (wind-92%, hydro-4%)

Solar Thermal / Solar PV

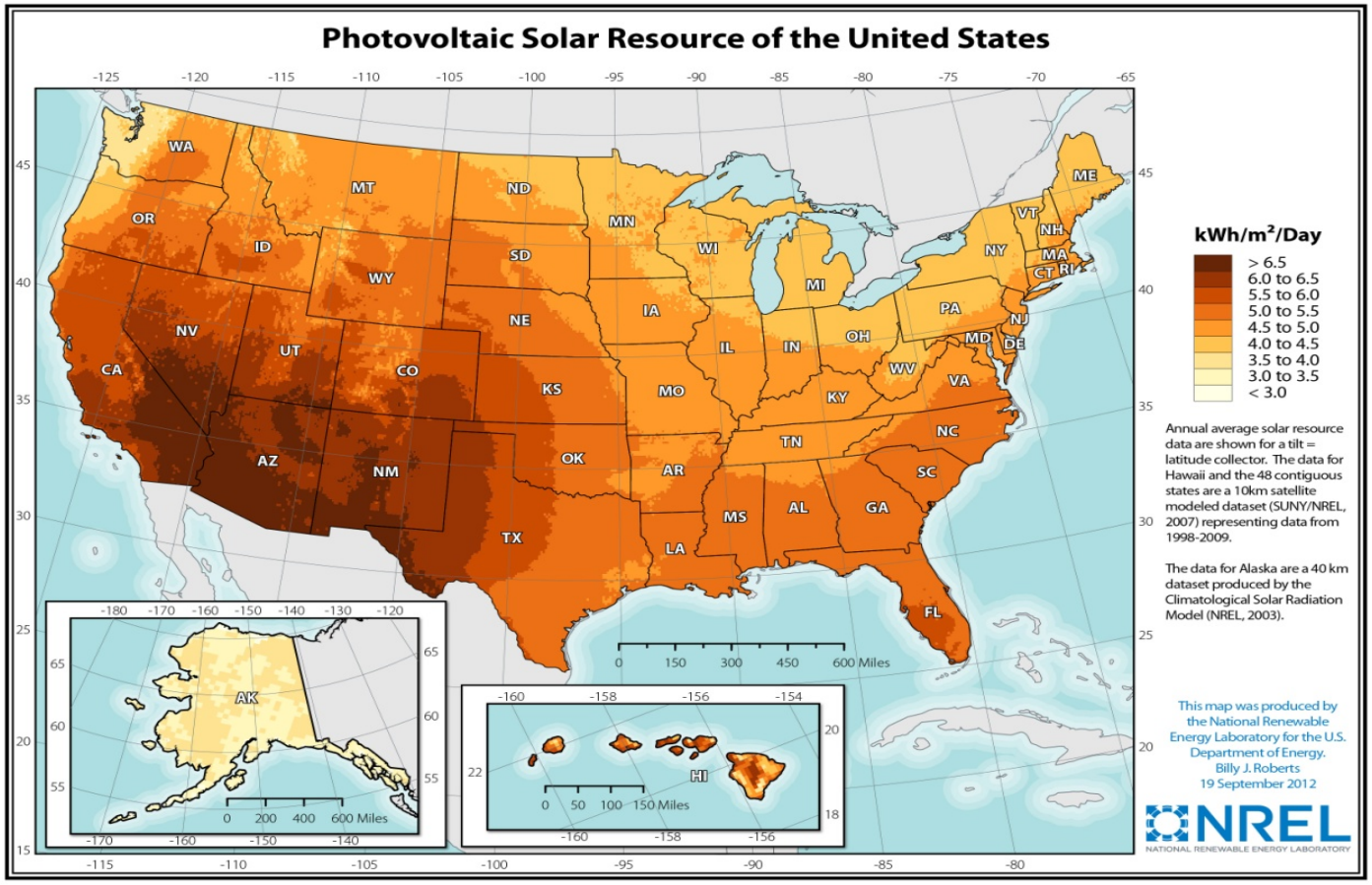




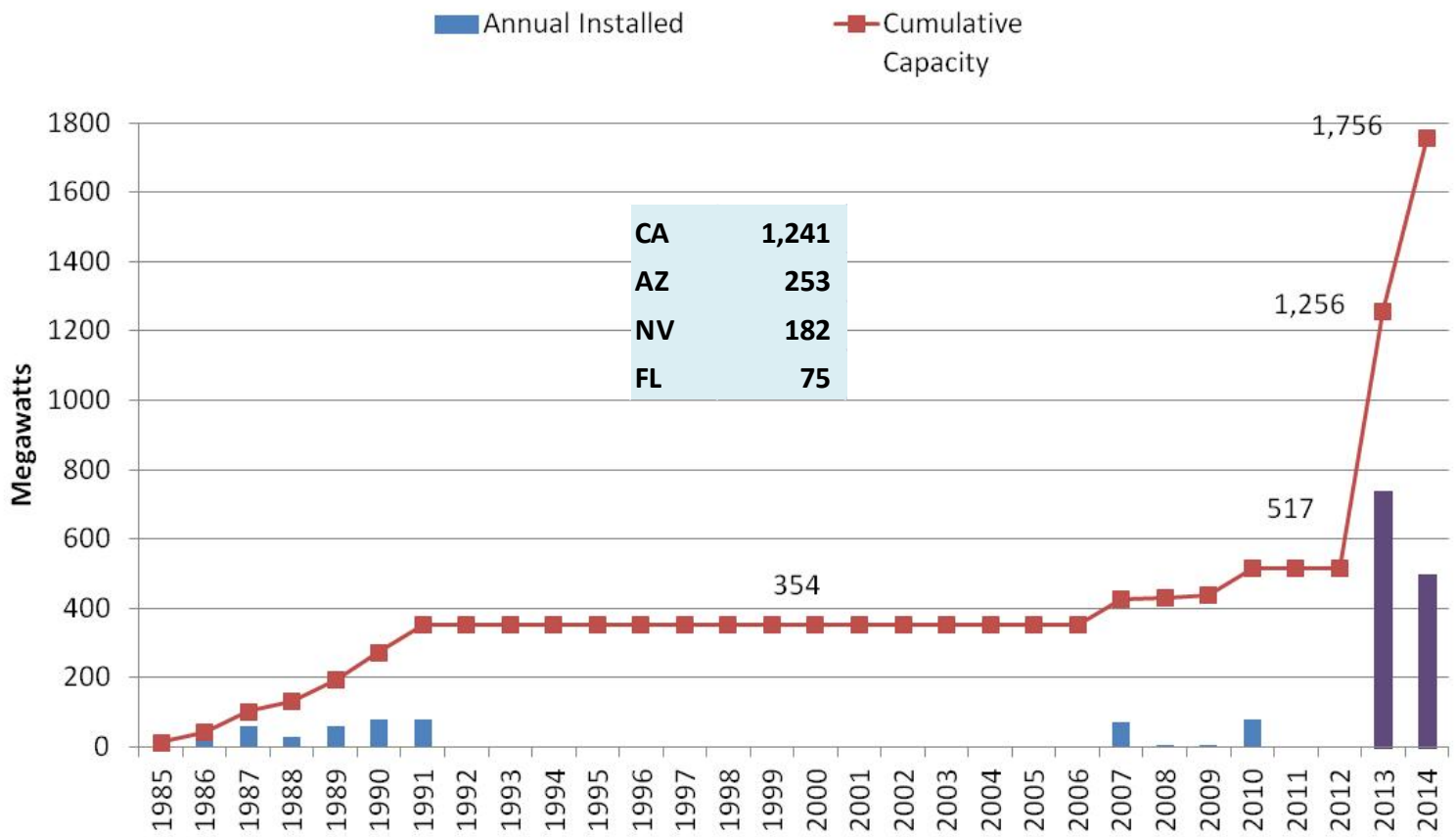
Solar Thermal



Solar Photovoltaic



U.S. Solar Thermal Capacity



Data source: NREL

U.S. Solar Thermal Installations

Project Name	Developer/ Owner	State	Capacity (MW)	Online Date
Solar Energy Generating System (I-IX)	Luz/Nextra	CA	**354**	1985 -1991
Saguaro Solar Power Plant	Solargenix	AZ	1	2006
Nevada Solar One	Acciona	NV	**72**	2007
Kimberlina	Ausra	CA	5	2008
Sierra SunTower	eSolar	CA	5	2009
Holaniku at Keyhole Point	Sopogy	HI	2	2009
Maricopa Solar Power Plant	Tessera Solar	AZ	1.5	2010
Colorado Integrated Solar Project	Abengoa/Xcel	CO	2	2010
Martin Next Generation Solar Center	Florida Power & Light	FL	**75**	2010

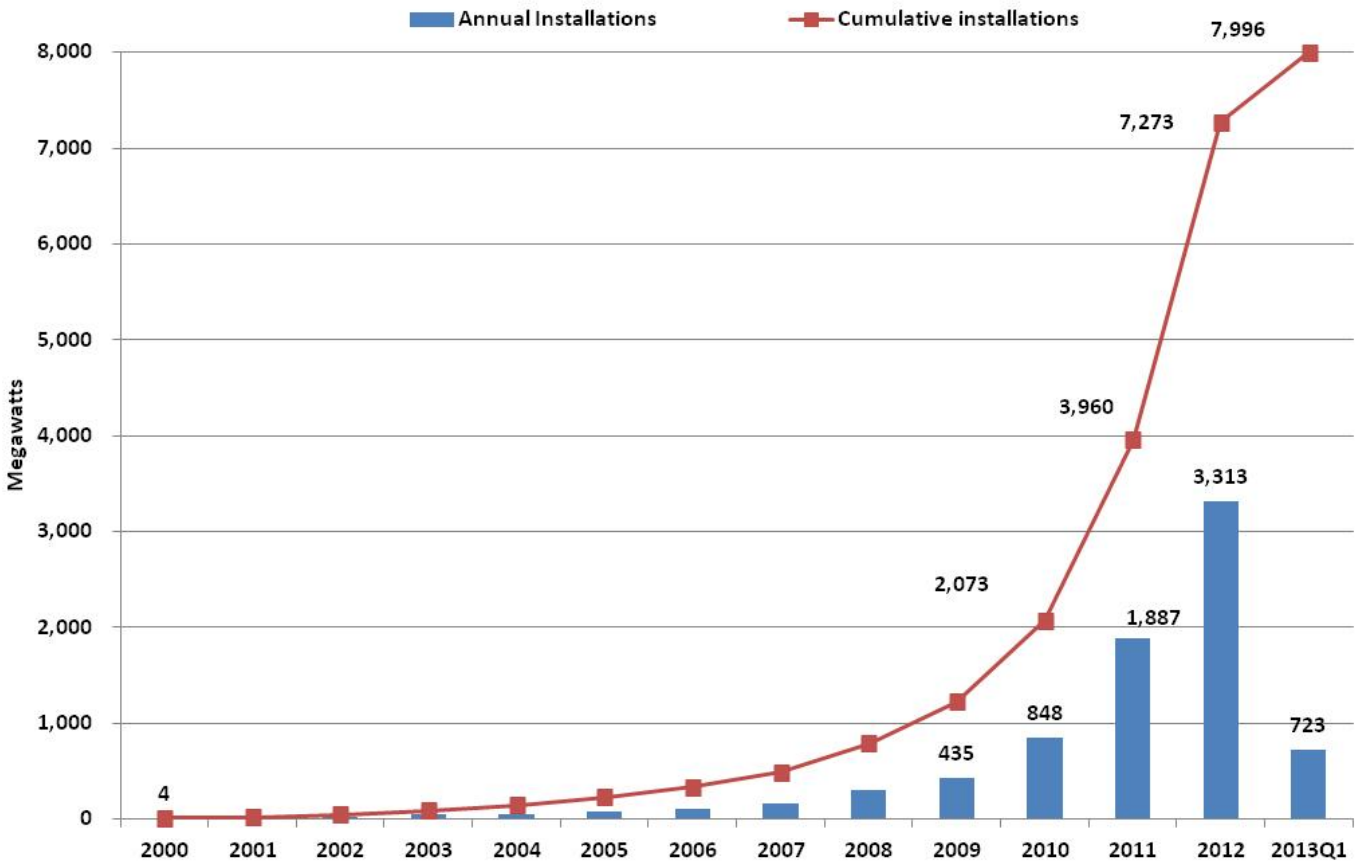
Data source: NREL

U.S. Solar Thermal Under Construction

Project Name	State	Capacity (MW)	Technology	Expected Online Year
Tooele Army Depot	UT	1.5	Dish/Engine	2013
Ivanpah Solar Electric Generating System	CA	377	Power tower	2013
Crescent Dunes Solar Energy Project	NV	110	Power tower	2013
Solana Generating Station	AZ	250	Parabolic Trough	2013
Genesis Solar Energy Project	CA	250	Parabolic Trough	2014
Mojave Solar Project	CA	250	Parabolic Trough	2014

Data source: NREL

U.S. Photovoltaic Capacity



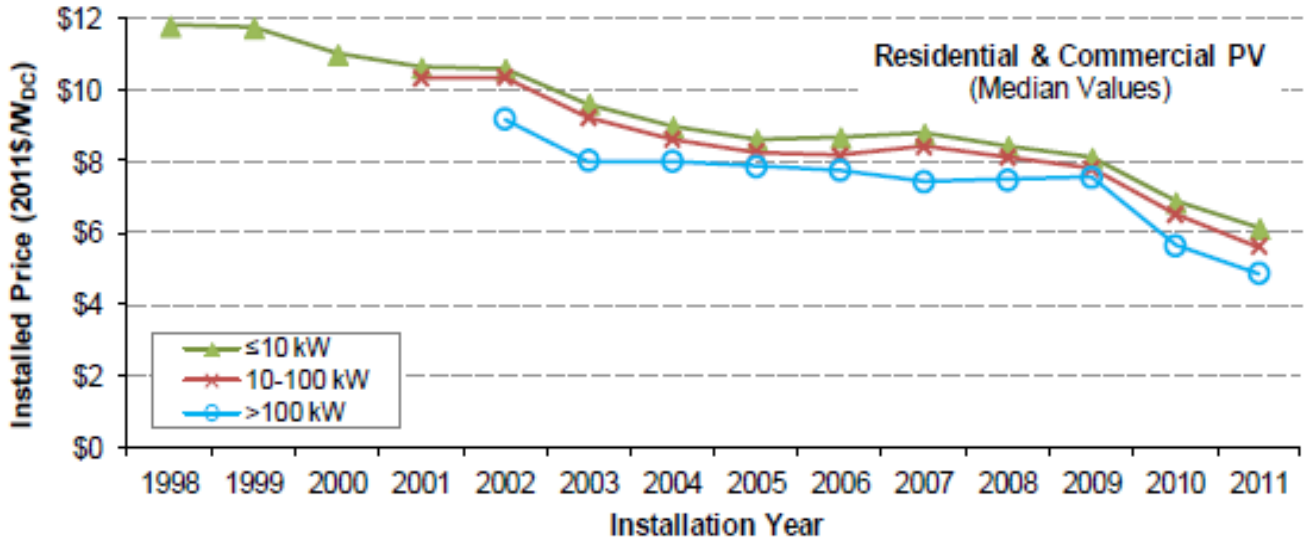
Data source: Solar Energy Industries Association

Large PV Installations

Project Name	Developer	Capacity (MW)	State	Online Date
California Valley Solar Ranch	SunPower	130	CA	2012
Agua Caliente	First Solar	100	AZ	2012
Copper Mountain 2	First Solar	92	NV	2012
Agua Caliente	First Solar	70	AZ	2012
AV Solar Ranch One	First Solar	115	CA	2013
Alpine Solar Project	First Solar	66	CA	2013
Mesquite Solar	Sempra Generation	66	AZ	2013
Catalina Solar Project	EDF Renewables	60	CA	2013

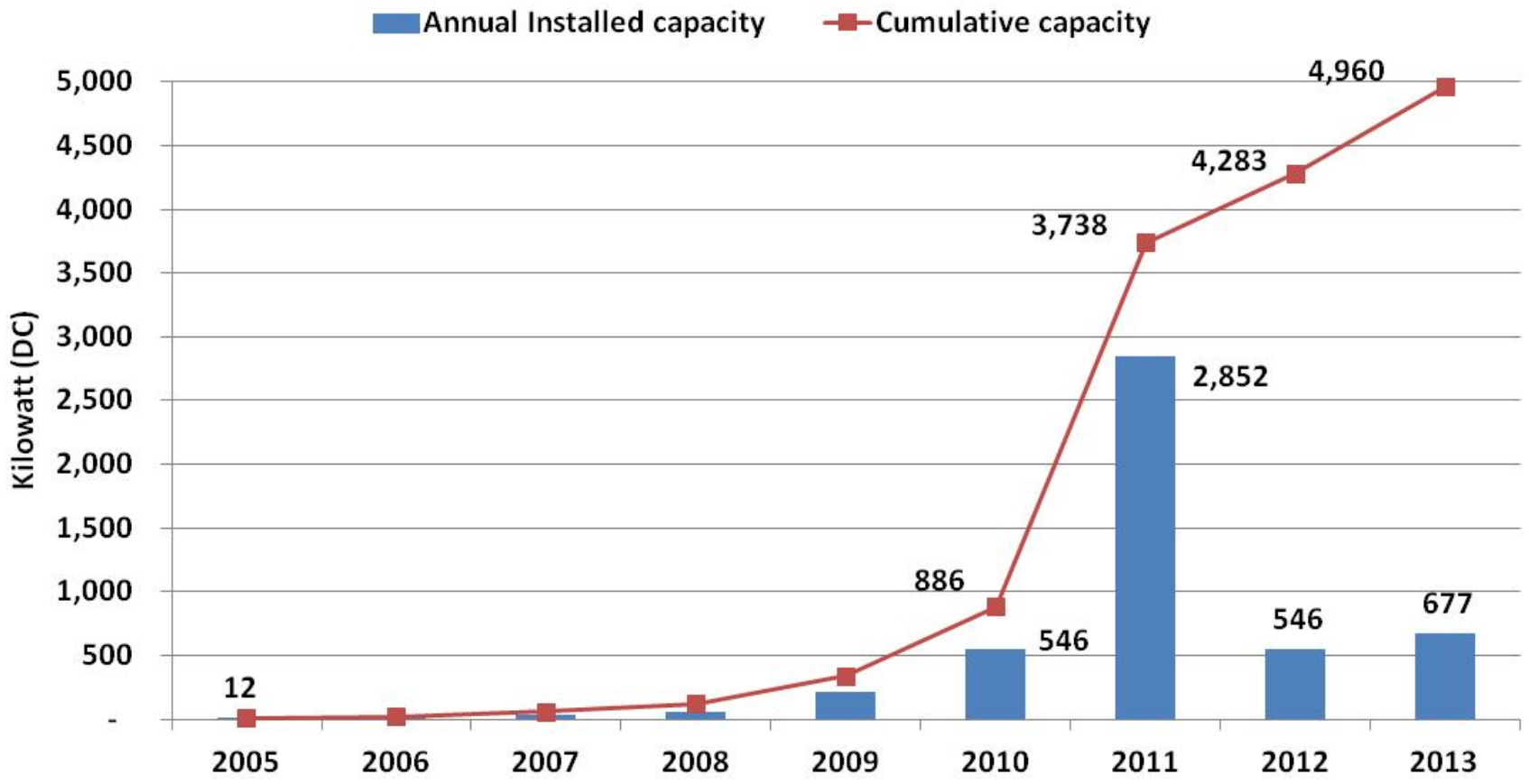
Data source: Solar Energy Industries Association

PV Cost Trends (Residential & Commercial)



Source: Lawrence Berkeley National Laboratory

Indiana PV Capacity

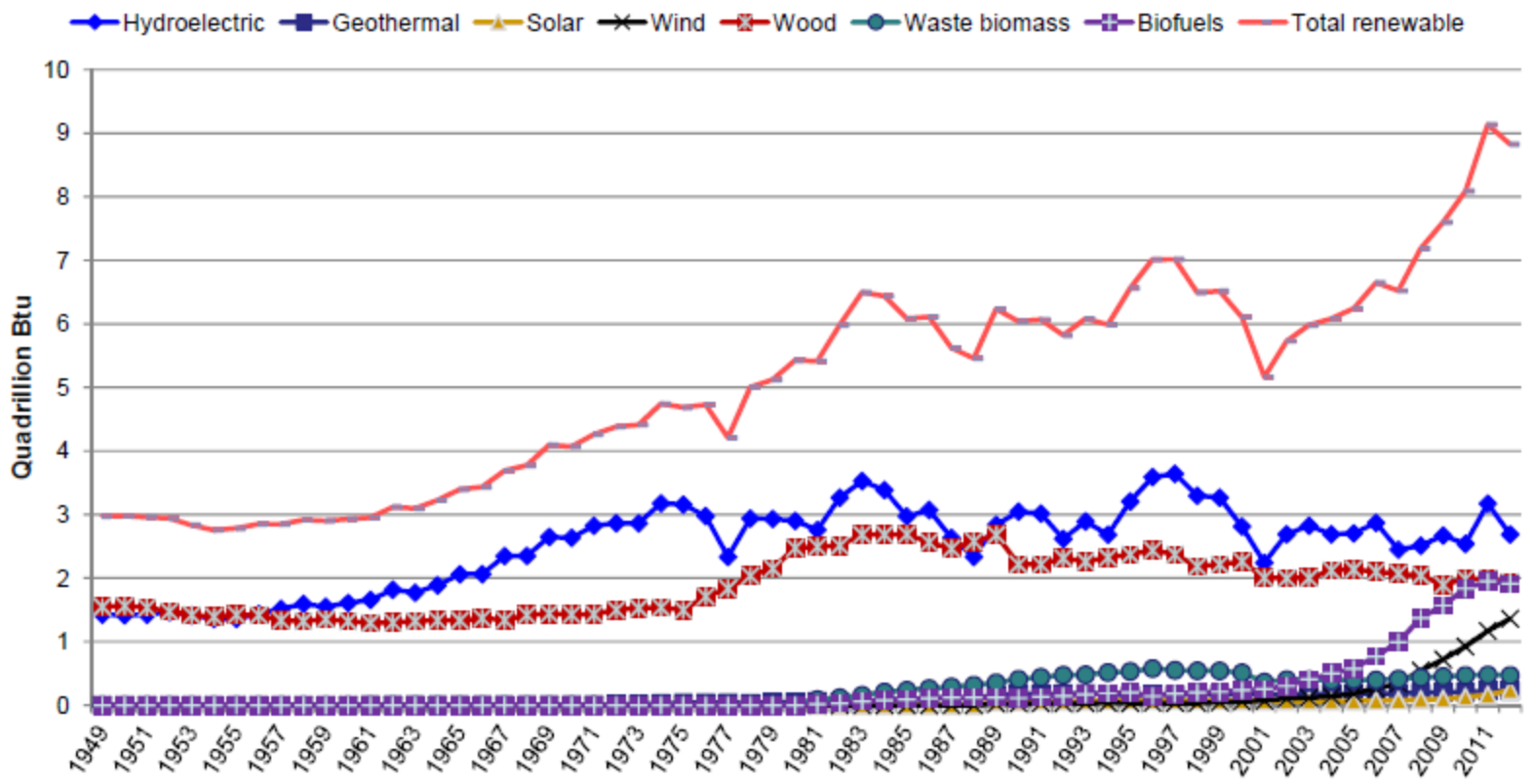


Data source: NREL

Indiana PV Drivers

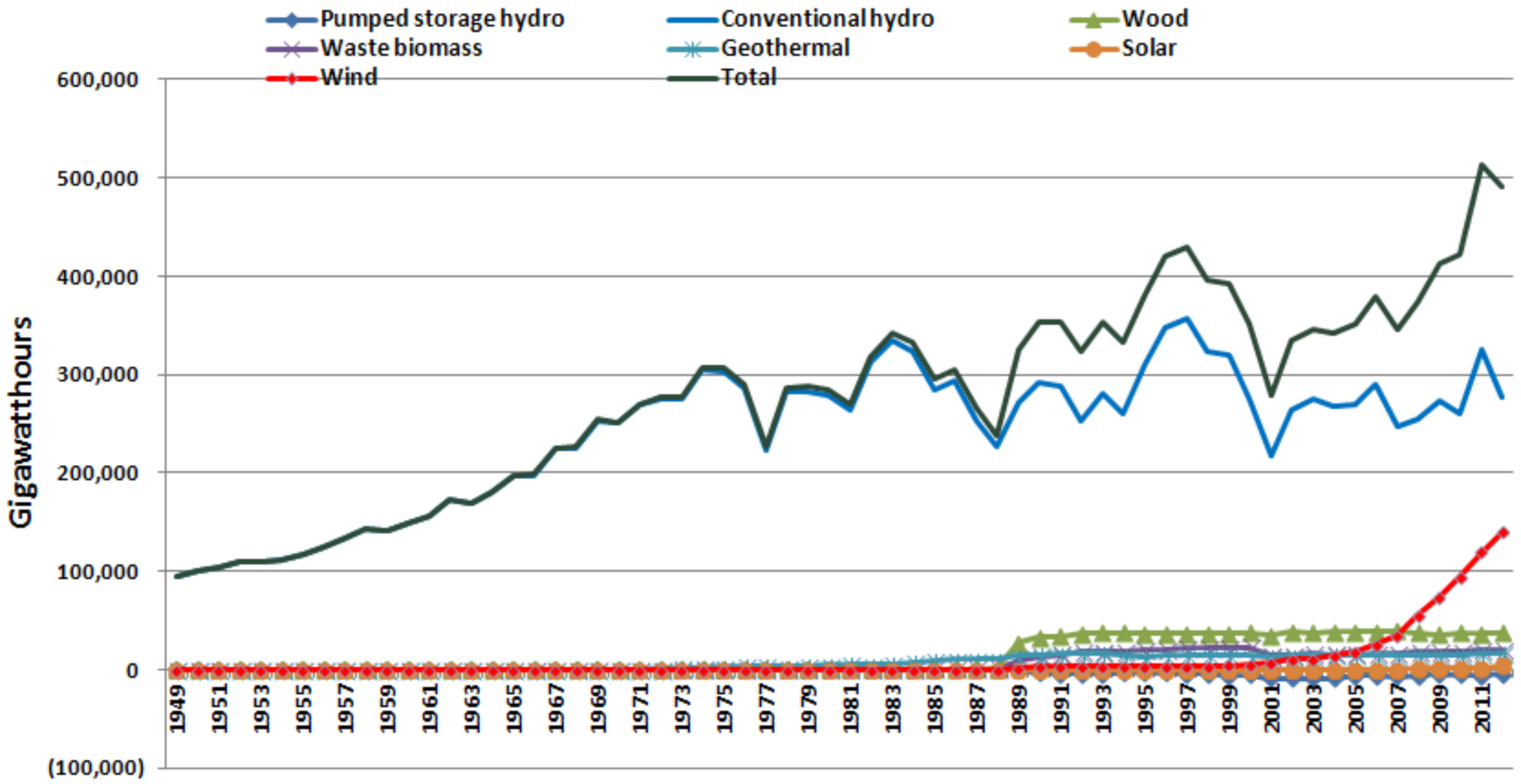
- IPL feed-in tariff (expired)
  100 MW committed
  - $0.24/kWh (20kW - 100 kW)
  - $0.20/kWh (>100kW -10MW
- NIPSCO tariff (fully subscribed)
  12.3 MW committed
  - $0.30/kWh (<= 10kW)
  - 0.26/kWh (10kW – 2 MW)

Hydro in U.S. Total Energy Consumption



Data source: EIA

Hydro in U.S. electricity generation



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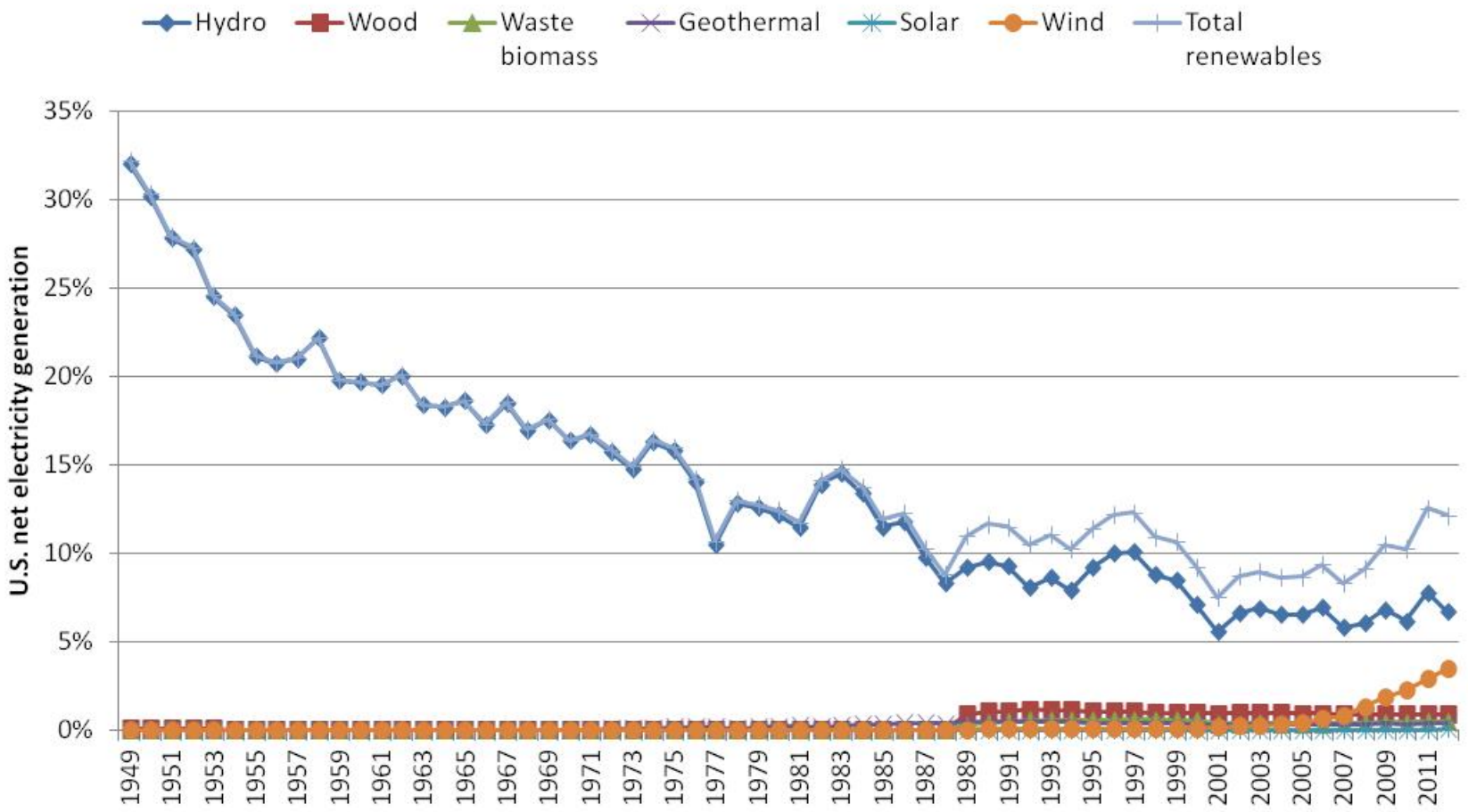
Hydro Share of U.S. electricity generation

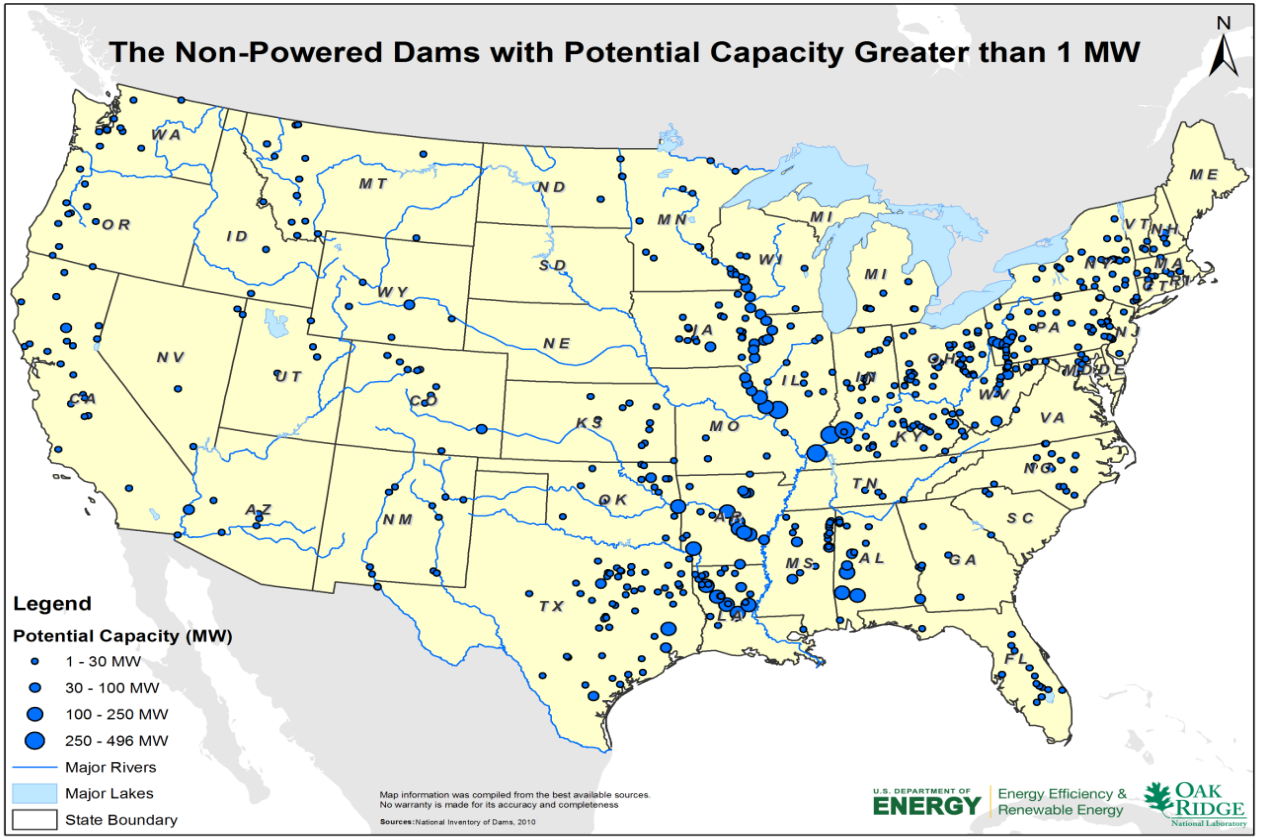


Data source: EIA

Hydro Expansion Potential in Existing Non-Powered Dams

12,000 MW U.S.

454 MW Indiana



Indiana Hydro

- Indiana has 73 MW of hydroelectric generating capacity.
  - mostly run-of-the-river (no dam)
  - 2nd largest source of renewable electricity
- American Municipal Power is constructing an 84 MW facility at the Cannelton Locks on the Ohio River
  - expected to be operational in 2014

Further Information

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