

# 2010 Renewable Energy Data Book



## Acknowledgments

This report was produced by Rachel Gelman, edited by Scott Gossett, and designed by Stacy Buchanan of the National Renewable Energy Laboratory (NREL). We greatly appreciate the input of Carla Frisch, Hoyt Battey, and Patrick Gilman of the U.S. Department of Energy, as well as Lynn Billman, David Kline, and Robin Newmark of NREL.

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## Key Findings

- Although renewable energy (excluding hydropower) is a relatively small portion of total energy supply both globally and in the United States, the installed **global renewable energy capacity has more than quadrupled between 2000 and 2010**.
- Including hydropower, **renewable energy represents nearly 12% of total installed capacity and more than 10% of total generation in the United States in 2010**. Installed renewable energy capacity (including hydropower) is more than 137 gigawatts (GW). Not including hydropower, 2010 renewable electricity installed capacity has reached about 59 GW in the United States.
- In 2010 in the United States, wind and solar photovoltaics (PV) were two of the fastest growing generation technologies. **In 2010, cumulative wind capacity increased by 15% and cumulative solar PV capacity grew 71% from the previous year**.

## Key Findings, *continued*

- Worldwide, wind energy is one of the fastest growing renewable energy technologies— **between 2000 and 2010, wind energy generation worldwide increased by a factor of 11.** The United States experienced even more dramatic growth, as installed wind energy capacity increased by a factor of nearly 16 between 2000 and 2010.
- In the United States, renewable energy has been capturing a growing percentage of new capacity additions during the past few years. **In 2010, renewable energy accounted for more than 25% of all new electrical capacity installations in the United States**—a large change from 2004 when all renewable energy captured only 2% of new capacity additions.
- Since 2006, the United States has been the world's leading ethanol producer. **Between 2000 and 2010, production of corn ethanol increased by a factor of 8.** Use of ethanol in the United States has also grown substantially, and it accounts for 9.4% of all gasoline and gasoline blends consumed, up from 1% in 2000.

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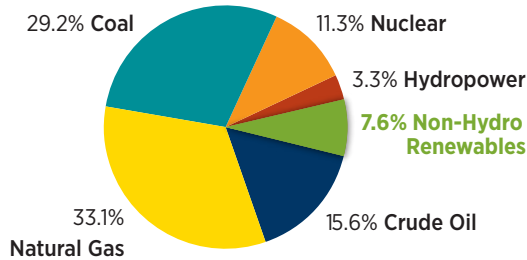
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## I. U.S. Energy Background Information

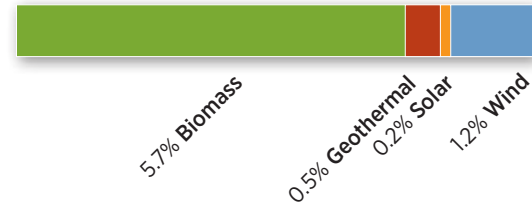


# U.S. Energy Production and Consumption (2010)

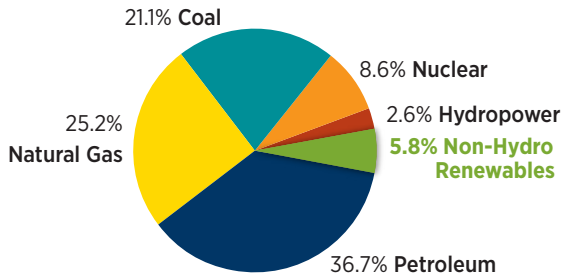
## U.S. Energy Production (2010): 74.9 Quadrillion Btu



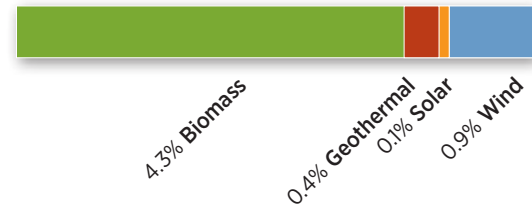
## U.S. Non-Hydro Renewable Energy Production: 5.2 Quadrillion Btu



## U.S. Energy Consumption (2010): 98.0 Quadrillion Btu



## U.S. Non-Hydro Renewable Energy Consumption: 5.7 Quadrillion Btu



Source: EIA; full references are provided starting on p. 123.

Note: Because hydropower is considered a conventional source of energy, it is accounted for separate from other new renewable sources of energy. Energy consumption is higher than energy production due to oil imports.

# U.S. Energy Production by Energy Source (%) 2000–2010

	Coal	Natural Gas*	Crude Oil	Nuclear	Hydropower	Non-Hydro Renewables	Total Production (Quadrillion Btu)
2000	31.8%	31.2%	17.3%	11.0%	3.9%	4.8%	71.5
2001	32.8%	31.6%	17.1%	11.2%	3.1%	4.3%	71.9
2002	32.0%	31.0%	17.1%	11.5%	3.8%	4.5%	70.9
2003	31.5%	31.3%	17.1%	11.3%	4.0%	4.7%	70.2
2004	32.5%	30.6%	16.4%	11.7%	3.8%	5.0%	70.4
2005	33.3%	30.0%	15.8%	11.7%	3.9%	5.3%	69.6
2006	33.5%	30.1%	15.2%	11.6%	4.0%	5.5%	71.0
2007	32.8%	31.0%	15.0%	11.8%	3.4%	5.9%	71.6
2008	32.5%	31.5%	14.3%	11.5%	3.4%	6.6%	73.3
2009	29.7%	32.5%	15.6%	11.5%	3.7%	7.0%	72.8
2010	29.2%	33.1%	15.6%	11.3%	3.3%	7.6%	74.9

Source: EIA

\* Includes natural gas plant liquids.

Note: Annual totals may not equal 100% due to rounding.

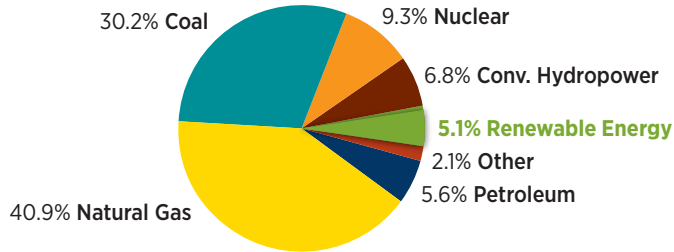


# U.S. Energy Consumption by Energy Source (%) 2000–2010

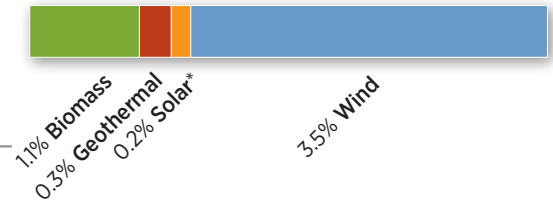
	Coal	Natural Gas	Petroleum	Nuclear	Hydropower	Non-Hydro Renewables	Total Consumption (Quadrillion Btu)
2000	22.8%	24.1%	38.7%	7.9%	2.8%	3.5%	98.9
2001	22.8%	23.7%	39.7%	8.3%	2.3%	3.2%	96.3
2002	22.4%	24.1%	39.1%	8.3%	2.7%	3.3%	97.8
2003	22.8%	23.3%	39.6%	8.1%	2.9%	3.4%	98.1
2004	22.4%	22.9%	40.2%	8.2%	2.7%	3.6%	100.2
2005	22.7%	22.5%	40.2%	8.1%	2.7%	3.7%	100.4
2006	22.5%	22.3%	40.1%	8.2%	2.9%	4.0%	99.7
2007	22.4%	23.3%	39.2%	8.3%	2.4%	4.2%	101.5
2008	22.5%	24.0%	37.5%	8.5%	2.5%	4.9%	99.4
2009	20.8%	24.7%	37.4%	8.8%	2.8%	5.4%	94.6
2010	21.1%	25.2%	36.7%	8.6%	2.6%	5.8%	98.0

# U.S. Nameplate Capacity and Generation (2010)

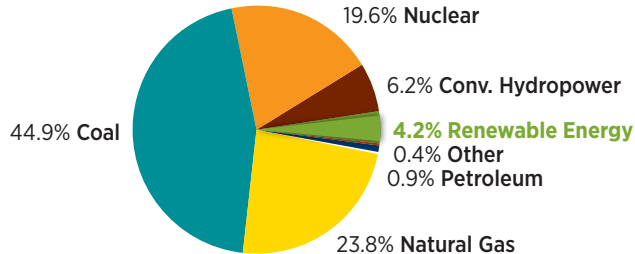
## U.S. Electric Nameplate Capacity (2010): 1,148 GW



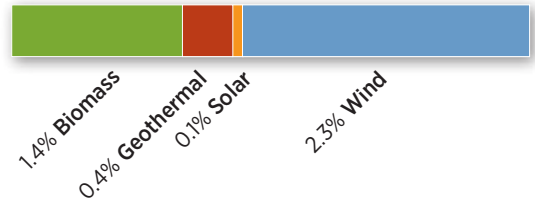
## U.S. Renewable Capacity: 59 GW



## U.S. Electric Net Generation (2010): 4,123 billion kWh



## U.S. Renewable Generation: 171 billion kWh



Sources: EIA, AWEA, GEA, LBNL, SEIA/GTM, Larry Sherwood/IREC

Other includes: pumped storage, batteries, chemicals, hydrogen, pitch, purchased steam, sulfur, tire-derived fuels, and miscellaneous technologies.

\* On-grid capacity only.

# U.S. Electric-Generating Capacity by Source (%) 2000–2010

	Coal	Petroleum	Natural Gas	Other Gases	Nuclear	Hydro	Renewables	Hydro Pumped Storage	Other	Total Capacity (GW)
2000	38.8%	7.9%	28.0%	0.3%	12.1%	8.9%	1.9%	2.2%	0.1%	867
2001	36.9%	8.0%	30.9%	0.2%	11.5%	8.4%	2.0%	2.1%	0.1%	914
2002	34.5%	6.8%	35.9%	0.2%	10.7%	7.9%	1.9%	2.0%	0.1%	980
2003	32.5%	6.5%	39.1%	0.2%	10.2%	7.5%	2.0%	1.9%	0.1%	1,032
2004	31.9%	6.2%	40.3%	0.2%	10.1%	7.3%	2.0%	1.9%	0.1%	1,050
2005	31.5%	6.1%	40.9%	0.2%	9.9%	7.2%	2.2%	1.8%	0.1%	1,068
2006	31.2%	6.0%	41.2%	0.2%	9.8%	7.2%	2.5%	1.8%	0.1%	1,076
2007	30.9%	5.7%	41.3%	0.2%	9.7%	7.1%	3.0%	1.9%	0.1%	1,088
2008	30.5%	5.6%	41.4%	0.2%	9.6%	7.0%	3.8%	1.8%	0.1%	1,104
2009	30.2%	5.6%	40.9%	0.2%	9.5%	6.9%	4.7%	1.8%	0.1%	1,123
2010	30.2%	5.6%	40.9%	0.2%	9.3%	6.8%	5.1%	1.8%	0.1%	1,148

# U.S. Electricity Generation by Source (%) 2000–2010

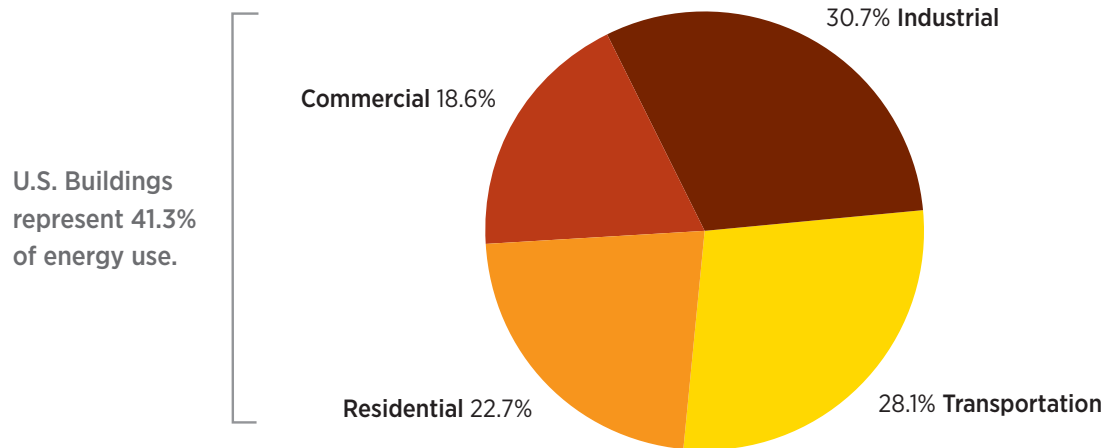
	Coal	Petroleum Liquids	Petroleum Coke	Natural Gas	Other Gases	Nuclear	Hydro	Renewables	Hydro Pumped Storage	Other	Total Generation (million kWh)
2000	51.7%	2.7%	0.2%	15.8%	0.4%	19.8%	7.2%	2.1%	-0.1%	0.1%	3,802,416
2001	50.9%	3.1%	0.3%	17.1%	0.2%	20.6%	5.8%	1.9%	-0.2%	0.3%	3,736,922
2002	50.1%	2.0%	0.4%	17.9%	0.3%	20.2%	6.9%	2.1%	-0.2%	0.4%	3,858,755
2003	50.8%	2.6%	0.4%	16.7%	0.4%	19.7%	7.1%	2.1%	-0.2%	0.4%	3,883,580
2004	49.8%	2.5%	0.5%	17.9%	0.4%	19.9%	6.8%	2.1%	-0.2%	0.4%	3,970,535
2005	49.6%	2.5%	0.6%	18.8%	0.3%	19.3%	6.7%	2.2%	-0.2%	0.3%	4,055,900
2006	49.0%	1.1%	0.5%	20.1%	0.3%	19.4%	7.1%	2.4%	-0.2%	0.3%	4,065,404
2007	48.5%	1.2%	0.4%	21.6%	0.3%	19.4%	6.0%	2.6%	-0.2%	0.3%	4,157,852
2008	48.2%	0.8%	0.3%	21.4%	0.3%	19.6%	6.2%	3.1%	-0.2%	0.3%	4,120,731
2009	44.4%	0.7%	0.3%	23.3%	0.3%	20.2%	6.9%	3.7%	-0.1%	0.3%	3,952,271
2010	44.9%	0.6%	0.3%	23.8%	0.3%	19.6%	6.2%	4.2%	-0.1%	0.3%	4,123,235

Sources: EIA, AWEA, GEA, LBNL, SEIA/GTM, Larry Sherwood/IREC

Note: Electricity generation from hydro pumped storage is negative because more electricity is consumed than generated by these plants.

# U.S. Energy Consumption by Sector (2010)

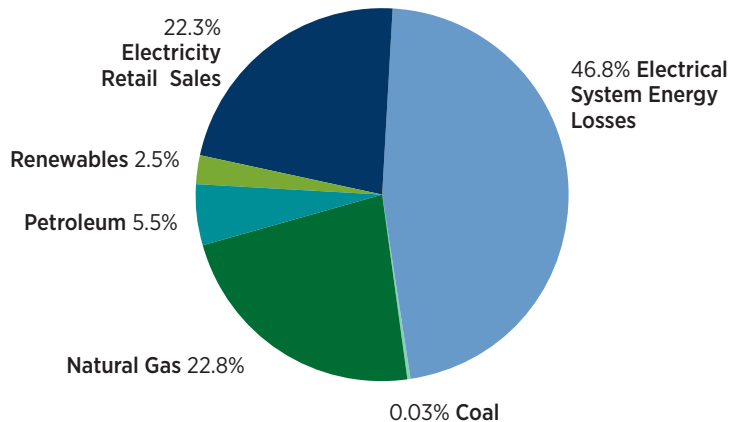
U.S. Energy Consumption in 2010 was 98,010 Trillion BTUs



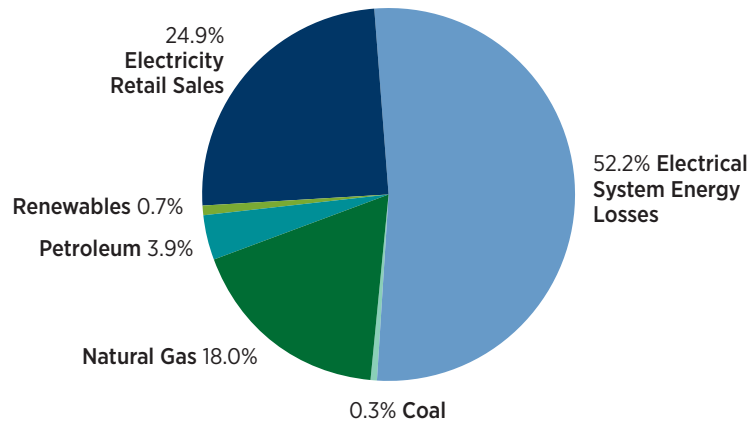
# U.S. Energy Consumption – Residential and Commercial (2010)

I

**Residential Energy Consumption**  
(22,201 Trillion Btu) – 2010



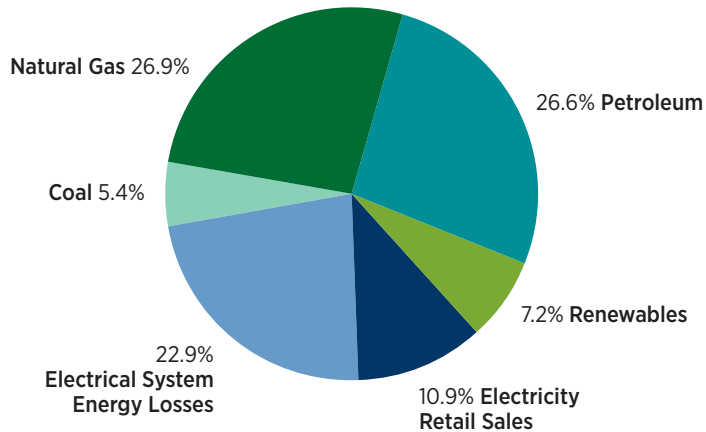
**Commercial Energy Consumption**  
(18,241 Trillion Btu) – 2010



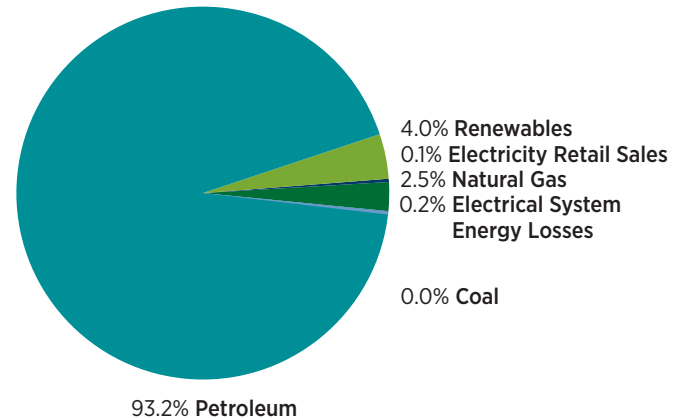
# U.S. Energy Consumption – Industrial and Transportation (2010)



**Industrial Energy Consumption**  
(30,096 Trillion Btu) – 2010



**Transportation Energy Consumption**  
(27,507 Trillion Btu) – 2010



## II. Renewable Electricity in the U.S.





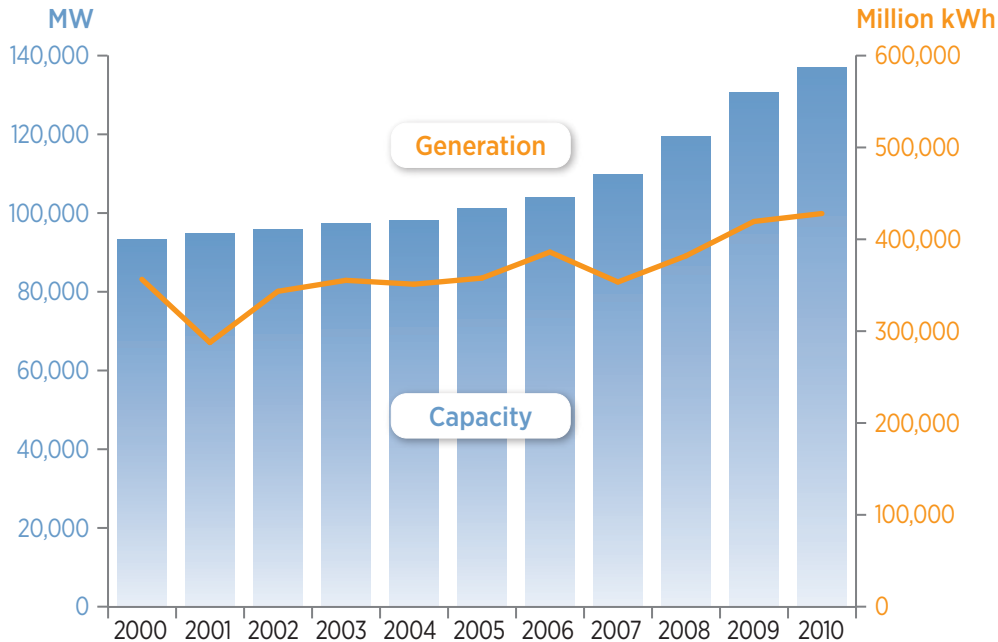
# Renewable Electricity in the U.S.: Summary

- Since 2000, renewable electricity installations in the United States (excluding hydropower) have more than tripled, and in 2010 represent **59 GW of installed U.S. capacity**.
- Renewable electricity (excluding hydropower) has grown at a compounded annual average of nearly **14% per year from 2000–2010**.
- Although it is a growing part of U.S. energy supply, renewable electricity (excluding hydropower) in 2010 still represents a small percentage of overall installed electricity capacity (5.1%) and generation (4.2%) in the United States.
- Wind, CSP and solar PV are the fastest growing renewable energy sectors. **In 2010 in the U.S., wind capacity installations increased by nearly 15%, solar PV grew over 71% and CSP grew by 18% from the previous year.**



- In 2010, **biomass** produced about **33% of total renewable electricity generation** (excluding hydropower), **wind produced 55%**, **solar** (PV and CSP) **produced 3%** and **geothermal produced 9% in the U.S.**
- **Wind energy** accounted for about **81% of annual installed U.S. renewable electricity capacity** in 2010 (excluding hydropower).
- Electricity generation from biomass, geothermal, and hydropower have remained relatively stable since 2000.

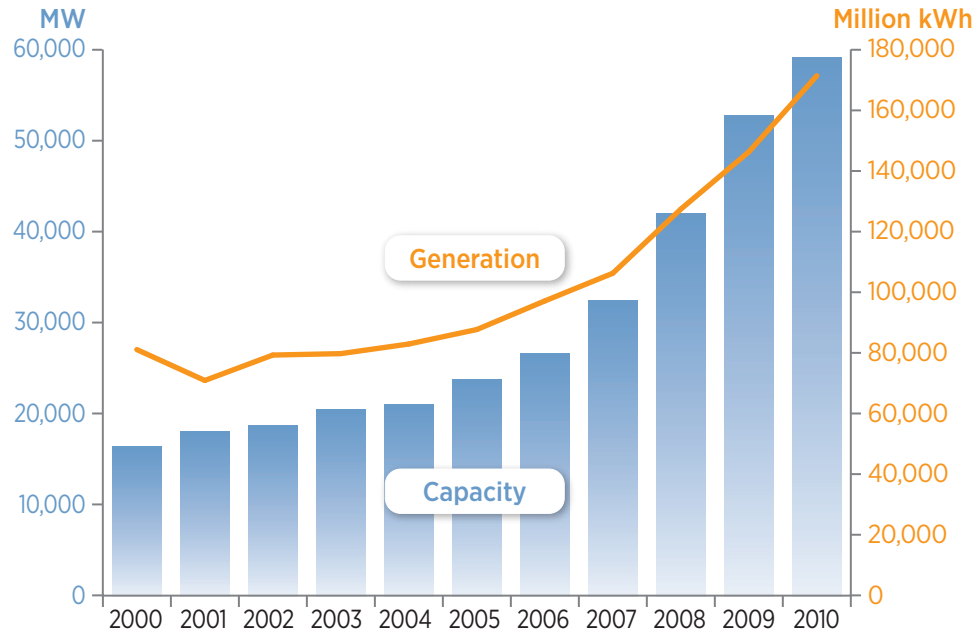
# Capacity and Generation: All Renewables (including hydropower)



	Total Nameplate Capacity (MW)	Total Generation (Million kWh)
2000	93,370	356,789
2001	94,943	288,009
2002	95,804	343,740
2003	97,478	355,689
2004	98,195	351,465
2005	101,113	358,129
2006	104,072	386,474
2007	109,845	353,854
2008	119,640	382,276
2009	130,678	419,765
2010	137,013	428,402

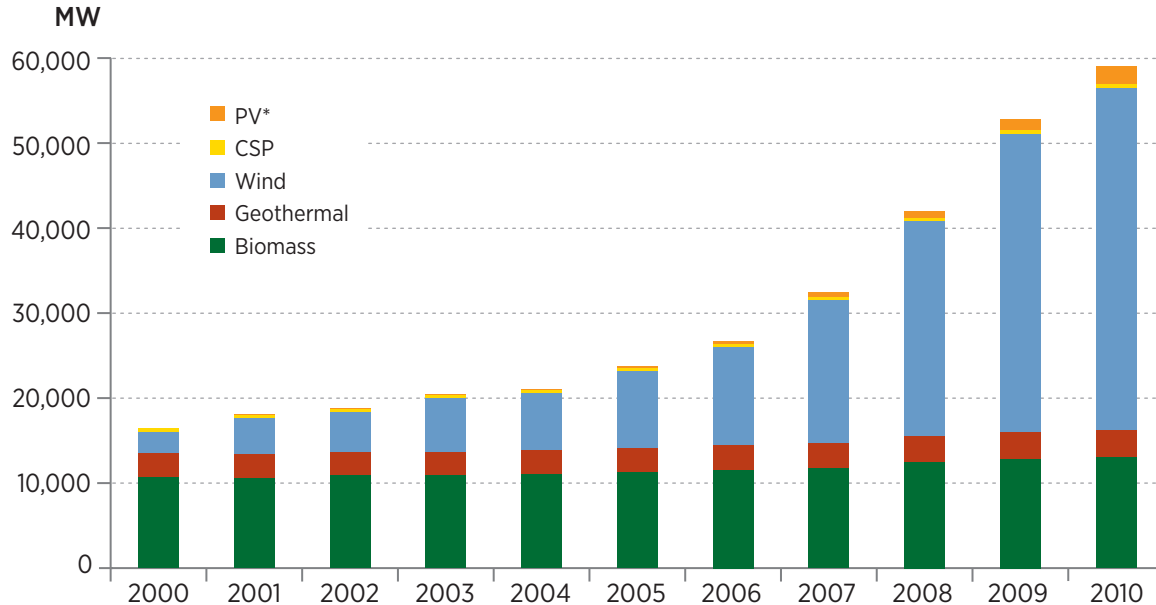
# Capacity and Generation: Renewables (excluding hydropower)

II



	Total Nameplate Capacity (MW)	Total Generation (Million kWh)
2000	16,424	81,216
2001	18,032	71,048
2002	18,757	79,411
2003	20,458	79,880
2004	21,065	83,048
2005	23,759	87,808
2006	26,653	97,228
2007	32,413	106,344
2008	42,000	127,445
2009	52,768	146,310
2010	59,082	171,350

# Renewable Electricity Generating Capacity by Source (excluding hydropower)



Sources: EIA, AWEA, GEA, LBNL, SEIA/GTM, Larry Sherwood/IREC

\* Includes on-grid capacity only.

# Renewable Electricity Nameplate Capacity Added (MW) and Percent Annual Change from Previous Year

II

	Solar PV	CSP	Wind	Geothermal	Biomass	Total Capacity Added (w/o Hydropower)	% Annual Change in Growth from Previous Year
2000	18	0	66	59	(323)	(180)	-128%
2001	11	0	1,697	0	(100)	1,608	+994%
2002	23	0	411	0	291	725	-55%
2003	45	0	1,667	0	(11)	1,701	+135%
2004	58	0	372	0	177	607	-64%
2005	79	0	2,396	30	189	2,694	+344%
2006	105	1	2,454	3	331	2,894	+7%
2007	169	64	5,237	106	185	5,760	+99%
2008	311	(0)	8,425	104	747	9,586	+66%
2009	438	11	9,922	46	351	10,768	+12%
2010	896	78	5,113	15	218	6,319	-41%



# Renewable Electricity Nameplate Capacity (MW) and Percent Cumulative Increase from Previous Year

	Hydro	Solar PV*	CSP	Wind	Geothermal	Biomass	Total (without Hydropower)	Total U.S.
2000	76,946 0%	85 26.9%	354 0%	2,578 2.6%	2,798 2.2%	10,676 2.6%	16,424 -1.1%	93,370 -0.3%
2001	76,911 0%	112 31.7%	354 0%	4,275 65.8%	2,798 0%	10,576 0.9%	18,032 9.8%	94,943 1.7%
2002	77,047 0.2%	156 39.2%	354 0%	4,686 9.6%	2,798 0%	10,867 2.8%	18,757 4.0%	95,804 0.9%
2003	77,020 0%	226 44.8%	354 0%	6,353 35.6%	2,798 0%	10,856 0.1%	20,458 9.1%	97,478 1.7%
2004	77,130 0.1%	312 38%	354 0%	6,725 5.9%	2,798 0%	11,033 1.6%	21,065 3.0%	98,195 0.7%
2005	77,354 0.3%	424 35.8%	354 0%	9,121 35.6%	2,828 1.1%	11,222 1.7%	23,759 12.8%	101,113 3.0%
2006	77,419 0.1%	566 33.4%	355 0.3%	11,575 26.9%	2,831 0.1%	11,553 2.9%	26,653 12.2%	104,072 2.9%
2007	77,432 0%	771 36.2%	419 18%	16,812 45.2%	2,937 3.7%	11,738 1.6%	32,413 21.6%	109,845 5.5%
2008	77,640 0.3%	1,106 43.5%	419 0%	25,237 50.1%	3,040 3.5%	12,485 6.4%	42,000 29.6%	119,640 8.9%
2009	77,910 0.3%	1,677 51.6%	431 2.9%	35,159 39.3%	3,087 1.5%	12,727 1.9%	52,768 25.6%	130,678 9.2%
2010	77,931 0%	2,153 71.3%	507 18.0%	40,267 14.5%	3,102 0.5%	13,053 1.7%	59,082 12.0%	137,013 4.8%



Sources: EIA, AWEA, GEA, LBNL, SEIA/GTM, Larry Sherwood/IREC

\* Includes on- and off-grid capacity.



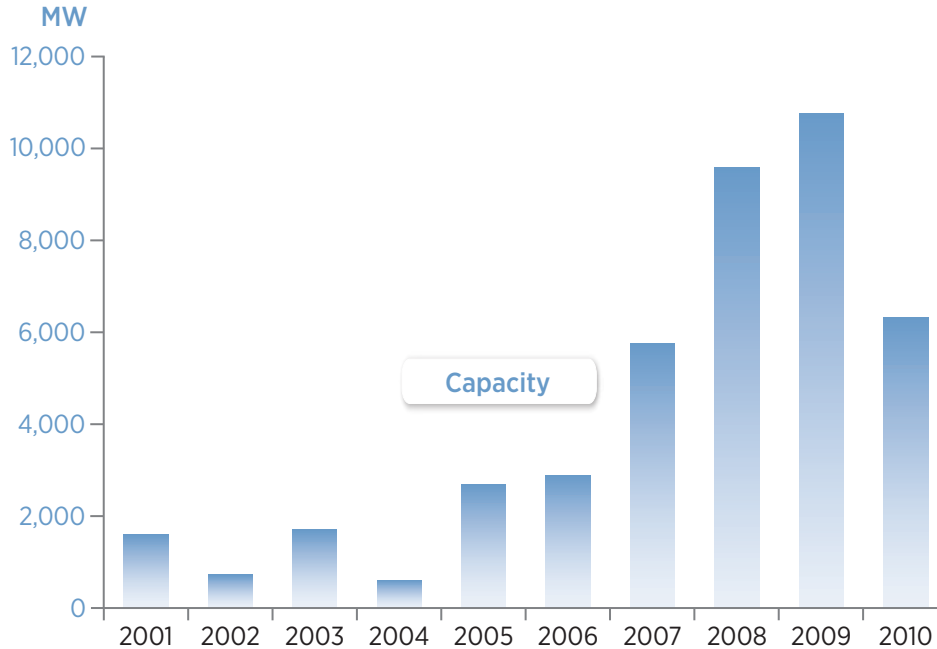
# Renewable Electricity Nameplate Capacity as a Percent of Total Electricity Generating Capacity

II

	Hydro	Solar PV	CSP	Wind	Geothermal	Biomass	Renewables w/o Hydro	All Renewables
2000	8.9%	0.0%	0.0%	0.3%	0.3%	1.2%	1.9%	10.8%
2001	8.4%	0.0%	0.0%	0.5%	0.3%	1.2%	2.0%	10.4%
2002	7.9%	0.0%	0.0%	0.5%	0.3%	1.1%	1.9%	9.8%
2003	7.5%	0.0%	0.0%	0.6%	0.3%	1.1%	2.0%	9.4%
2004	7.3%	0.0%	0.0%	0.6%	0.3%	1.1%	2.0%	9.4%
2005	7.2%	0.0%	0.0%	0.9%	0.3%	1.1%	2.2%	9.5%
2006	7.2%	0.1%	0.0%	1.1%	0.3%	1.1%	2.5%	9.7%
2007	7.1%	0.1%	0.0%	1.5%	0.3%	1.1%	3.0%	10.1%
2008	7.0%	0.1%	0.0%	2.3%	0.3%	1.1%	3.8%	10.8%
2009	6.9%	0.1%	0.0%	3.1%	0.3%	1.1%	4.7%	11.6%
2010	6.8%	0.2%	0.0%	3.5%	0.3%	1.1%	5.1%	11.9%



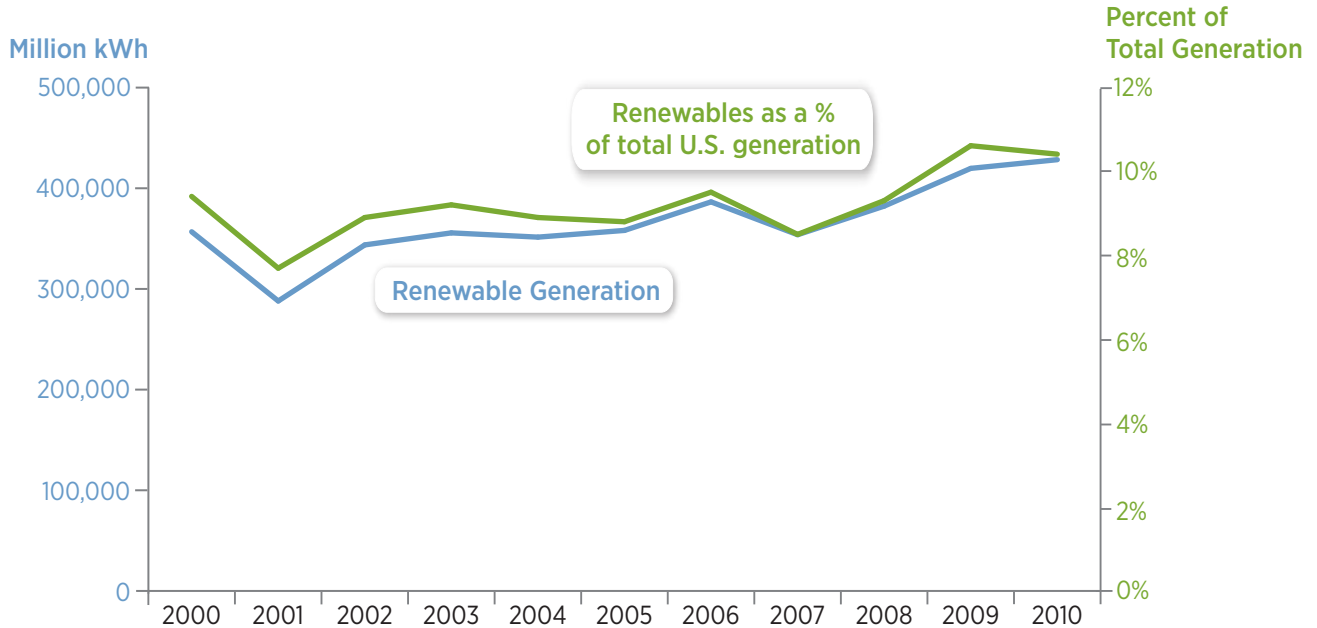
# Annual Installed Renewable Electric Capacity Growth (excluding hydropower)



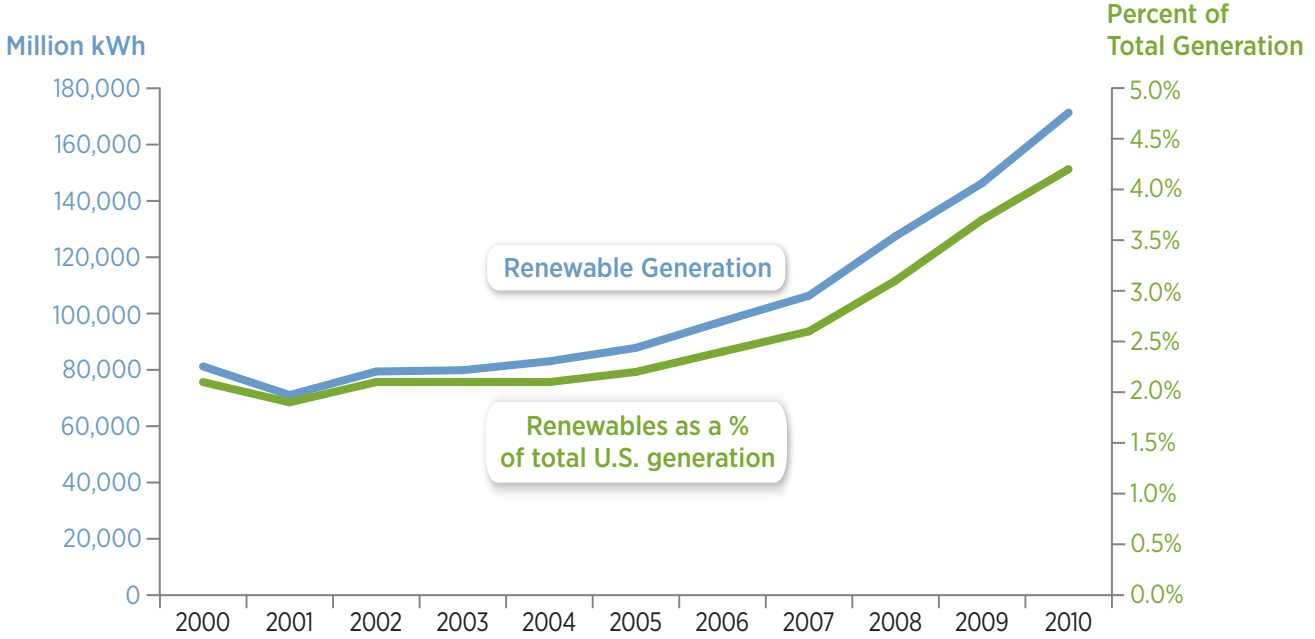
	Compounded Annual Growth Rate (CAGR) (2000-2010)
Wind	31.6%
Solar PV	61.3%
CSP	3.7%
Biomass	2.0%
Geothermal	1.0%
Renewables (excl. Hydro)	13.7%

# U.S. Renewable Electricity Generation (including hydropower)

II

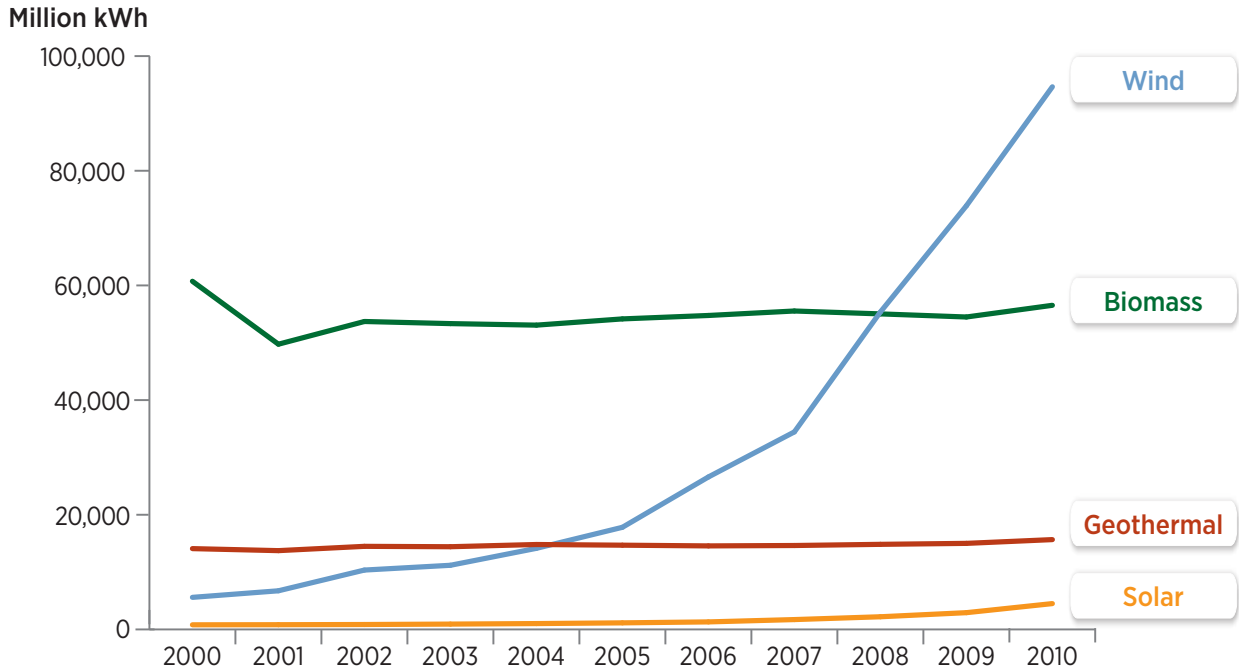


# U.S. Renewable Electricity Generation (excluding hydropower)



Sources: EIA, AWEA, GEA, LBNL, SEIA/GTM, Larry Sherwood/IREC  
 Note: The generation decrease from 2000 to 2001, in part, reflects an EIA classification change. Beginning with 2001 data, non-biogenic municipal solid waste (MSW) and tire-derived fuels were reclassified as non-renewable energy sources (previously considered waste biopower).

# U.S. Renewable Generation by Technology (excluding hydropower)



# Renewable Electricity as a Percent of Total Generation

	Hydro	Solar	Biomass	Wind	Geothermal	Renewables w/o Hydro	All Renewables
2000	7.2%	0.0%	1.6%	0.1%	0.4%	2.1%	9.4%
2001	5.8%	0.0%	1.3%	0.2%	0.4%	1.9%	7.7%
2002	6.9%	0.0%	1.4%	0.3%	0.4%	2.1%	8.9%
2003	7.1%	0.0%	1.4%	0.3%	0.4%	2.1%	9.2%
2004	6.8%	0.0%	1.3%	0.4%	0.4%	2.1%	8.9%
2005	6.7%	0.0%	1.3%	0.4%	0.4%	2.2%	8.8%
2006	7.1%	0.0%	1.3%	0.7%	0.4%	2.4%	9.5%
2007	6.0%	0.1%	1.3%	0.8%	0.4%	2.6%	8.5%
2008	6.2%	0.1%	1.3%	1.3%	0.4%	3.1%	9.3%
2009	6.9%	0.1%	1.4%	1.9%	0.4%	3.6%	10.6%
2010	6.2%	0.1%	1.4%	2.3%	0.4%	4.2%	10.4%



# Renewable Electricity Generation (Million kWh) and Percent Cumulative Increase from Previous Year

II

	Hydropower	Solar	Wind	Geothermal	Biomass	All Renewables	Renewables without Hydropower
2000	275,573 -13.8%	804 8.3%	5,593 24.6%	14,093 -5.0%	60,726 1.9%	356,789 -10.6%	81,216 2.0%
2001	216,961 -21.3%	822 2.2%	6,737 20.5%	13,741 -2.5%	49,748 -18.1%	288,009 -19.3%	71,048 -12.5%
2002	264,329 21.8%	857 4.3%	10,354 53.7%	14,491 5.5%	53,709 8.0%	343,740 19.4%	79,411 11.7%
2003	275,806 4.3%	929 8.4%	11,187 8.0%	14,424 -0.5%	53,340 -0.7%	355,686 3.5%	79,880 0.6%
2004	268,417 -2.7%	1,020 9.8%	14,144 26.4%	14,811 2.7%	53,073 -0.5%	351,465 -1.2%	83,048 4.0%
2005	270,321 0.7%	1,145 12.2%	17,811 25.9%	14,692 -0.8%	54,160 2.0%	358,129 1.9%	87,808 5.7%
2006	289,246 7.0%	1,312 14.6%	26,589 49.3%	14,568 -0.8%	54,759 1.1%	386,474 7.9%	97,228 10.7%
2007	247,510 -14.4%	1,718 31.0%	34,450 29.6%	14,637 0.5%	55,539 1.4%	353,854 -8.4%	106,344 9.4%
2008	254,831 3.0%	2,208 28.5%	55,363 60.7%	14,840 1.4%	55,034 -0.9%	382,276 8.0%	127,445 19.8%
2009	273,455 7.3%	2,922 32.4%	73,886 33.5%	15,009 1.1%	54,493 -1.0%	419,765 9.8%	146,310 14.8%
2010	257,052 -6.0%	4,505 54.2%	94,647 28.1%	15,666 4.4%	56,532 3.7%	428,402 2.1%	171,350 17.1%

- annual decrease | annual increase +

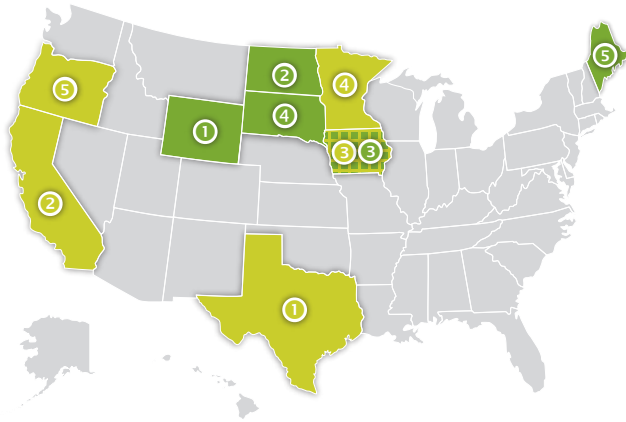
# State Renewable Energy Information: Summary

- In 2010, **Texas had the most installed renewable electric capacity (excluding hydropower)** of any U.S. state.
- **Washington is the leader** in installed renewable energy capacity when including hydropower.
- In 2008, **Texas became the national leader** in wind power development, and in 2010 has over 10 GW of wind capacity installed.
- A combination of **state incentives and renewable portfolio standards** for renewable energy and renewable resource development has driven renewable growth in some states.



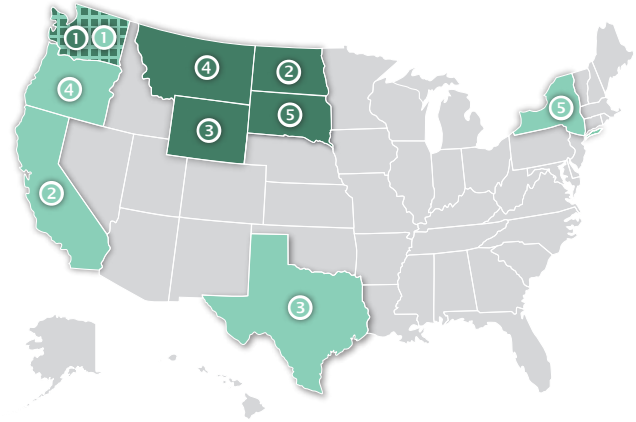
# Top States for Renewable Electricity Installed Nameplate Capacity (2010)

II



Total Renewables (excluding hydropower)
1 Texas
2 California
3 Iowa
4 Minnesota
5 Oregon

Per Capita Renewables (excluding hydropower)
1 Wyoming
2 North Dakota
3 Iowa
4 South Dakota
5 Maine

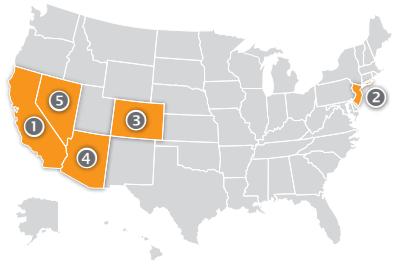


Total Renewables (including hydropower)
1 Washington
2 California
3 Texas
4 Oregon
5 New York

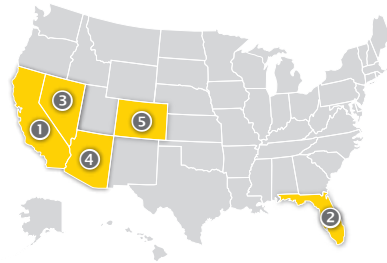
Per Capita Renewables (including hydropower)
1 Washington
2 North Dakota
3 Wyoming
4 Montana
5 South Dakota



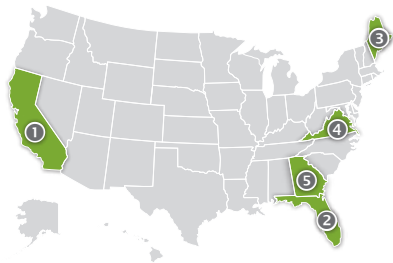
# Top States for Renewable Electricity Installed Nameplate Capacity (2010)



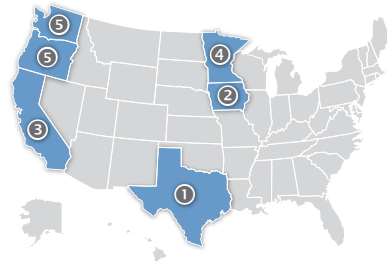
Solar PV	
1	California
2	New Jersey
3	Colorado
4	Arizona
5	Nevada



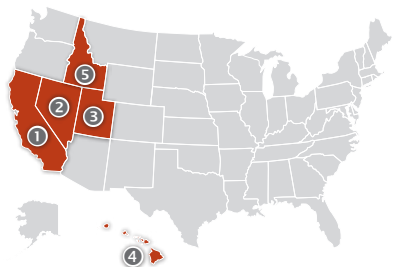
CSP	
1	California
2	Florida
3	Nevada
4	Arizona
5	Colorado



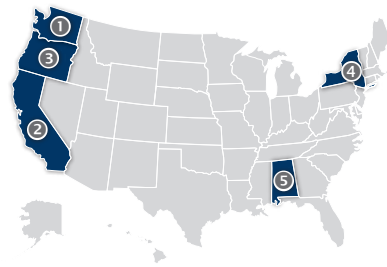
Biomass	
1	California
2	Florida
3	Maine
4	Virginia
5	Georgia



Wind	
1	Texas
2	Iowa
3	California
4	Minnesota
5	Oregon/ Washington



Geothermal	
1	California
2	Nevada
3	Utah
4	Hawaii
5	Idaho



Hydropower	
1	Washington
2	California
3	Oregon
4	New York
5	Alabama



# Renewables 2010 Installed Nameplate Capacity (MW)

## NORTHEAST

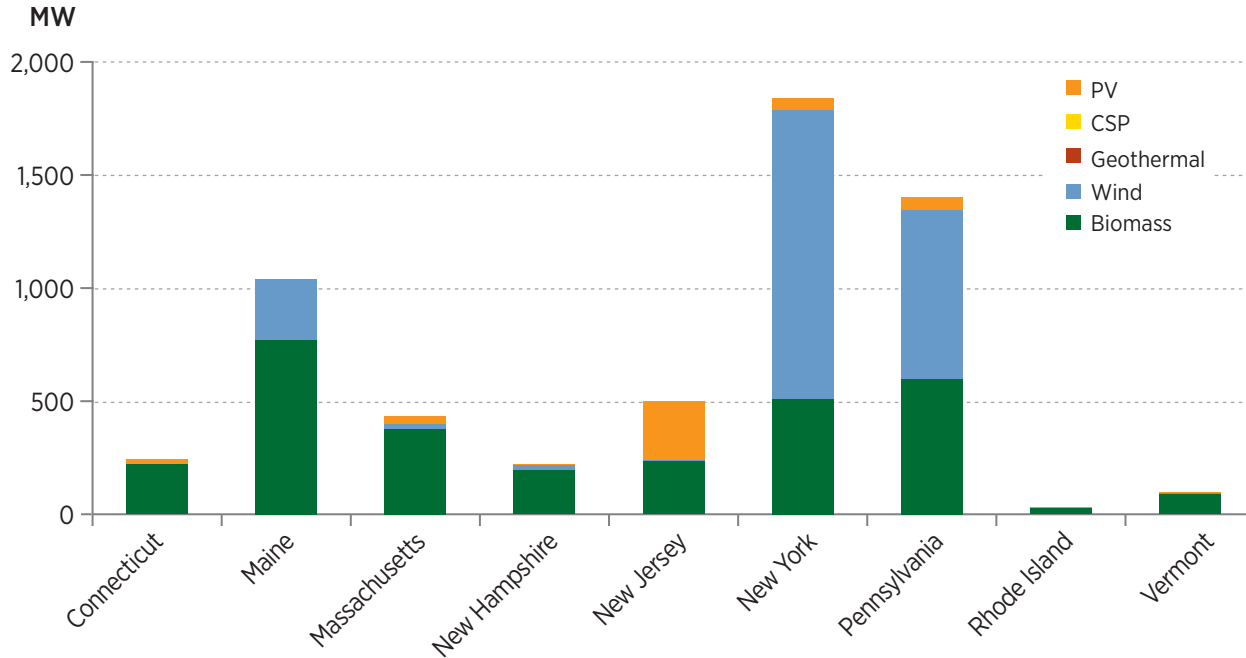
II

	Wind	PV*	CSP	Geothermal	Biomass	Hydropower	Total Renewables (incl. hydro)	Per capita RE (excl. hydro) watts/person
New York	1,274	55.5	0	0	510	4,657	6,496	335
Pennsylvania	748	54.8	0	0	597	778	2,178	171
Maine	266	0.5	0	0	771	725	1,762	1,327
Massachusetts	18	38.2	0	0	377	271	705	108
New Hampshire	25	2.0	0	0	194	445	667	507
Vermont	6	2.9	0	0	88	315	412	658
Connecticut	0	24.6	0	0	221	119	364	102
New Jersey	8	259.9	0	0	233	13	514	58
Rhode Island	2	0.6	0	0	26	3	31	30

Sources: EIA, LBNL, GEA, SEIA/GTM, Larry Sherwood/IREC, U.S. Census

\* Does not include off-grid installations

# Renewables 2010 Installed Nameplate Capacity (excluding hydropower) NORTHEAST



# Renewables 2010 Installed Nameplate Capacity (MW)

## MIDWEST

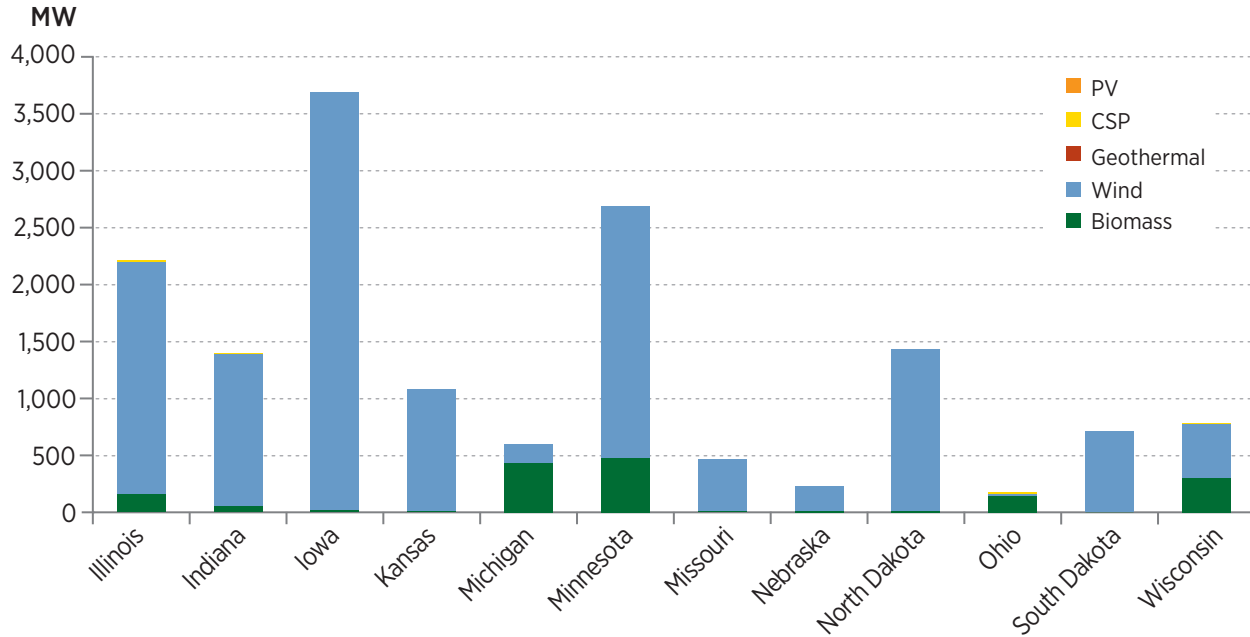
II

	Wind	PV*	CSP	Geothermal	Biomass	Hydropower	Total Renewables (incl. hydro)	Per capita RE (excl. hydro) watts/person
South Dakota	709	0.0	0	0	0	1,598	2,307	871
Minnesota	2,205	3.6	0	0	478	204	2,891	506
Iowa	3,675	0.1	0	0	15	131	3,821	1,211
Wisconsin	469	8.7	0	0	304	518	1,299	137
North Dakota	1,424	0.0	0	0	10	614	2,048	2,132
Michigan	164	2.6	0	0	432	377	976	61
Missouri	457	0.7	0	0	8	499	965	78
Nebraska	213	0.2	0	0	11	332	556	123
Kansas	1,074	0.0	0	0	6	3	1,082	378
Illinois	2,045	15.5	0	0	157	40	2,257	173
Ohio	10	20.7	0	0	146	128	305	15
Indiana	1,339	0.5	0	0	52	92	1,484	215

Sources: EIA, LBNL, GEA, SEIA/GTM, Larry Sherwood/IREC, U.S. Census

\* Does not include off-grid installations

# Renewables 2010 Installed Nameplate Capacity (excluding hydropower) MIDWEST



# Renewables 2010 Installed Nameplate Capacity (MW)

## SOUTH

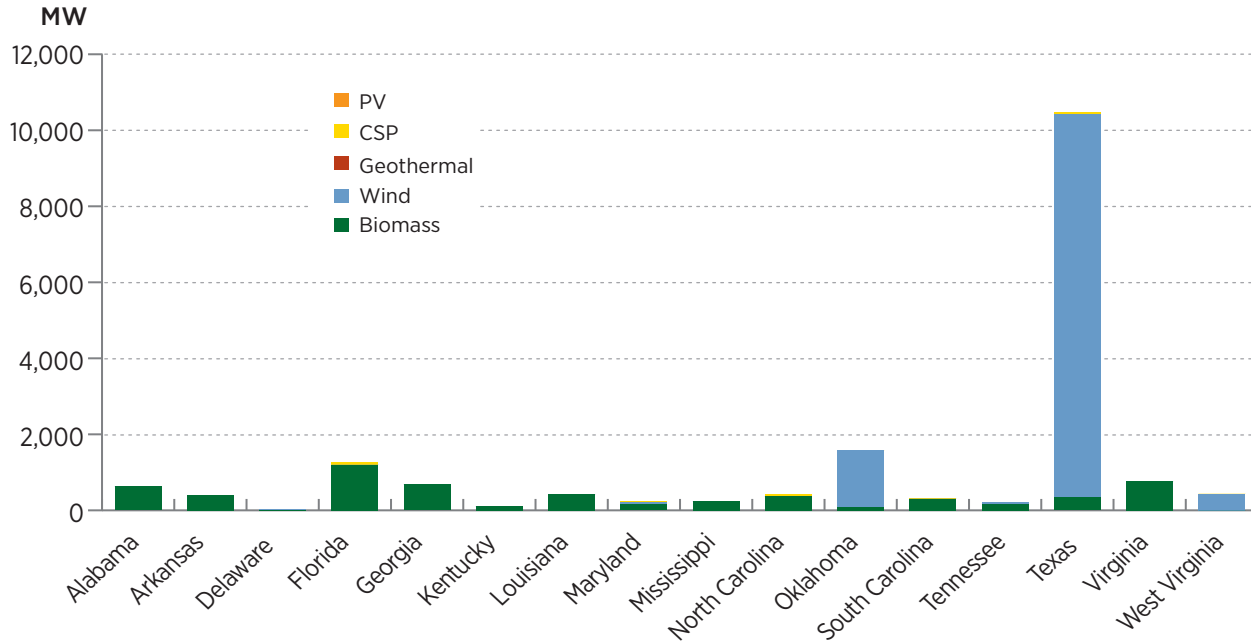
II

	Wind	PV*	CSP	Geothermal	Biomass	Hydropower	Total Renewables (incl. hydro)	Per capita RE (excl. hydro) watts/person
Alabama	0	0.4	0	0	627	3,280	3,902	131
Texas	10,089	34.5	0	0	342	697	11,162	416
Tennessee	29	4.7	0	0	175	2,479	2,688	33
Georgia	0	1.8	0	0	684	1,932	2,617	71
North Carolina	0	40.0	0	0	373	1,848	2,261	43
Arkansas	0	1.0	0	0	399	1,321	1,721	137
South Carolina	0	0.2	0	0	300	1,363	1,663	65
Virginia	0	2.8	0	0	770	744	1,516	97
Oklahoma	1,482	0.0	0	0	85	792	2,358	418
Florida	0	73.5	75	0	1,197	56	1,401	72
Kentucky	0	0.2	0	0	110	804	914	25
Maryland	70	10.9	0	0	157	527	765	41
Louisiana	0	0.3	0	0	426	192	618	94
Mississippi	0	0.3	0	0	238	0	238	80
West Virginia	431	0.0	0	0	0	325	756	233
Delaware	2	5.6	0	0	8	0	16	17

Sources: EIA, LBNL, GEA, SEIA/GTM, Larry Sherwood/IREC, U.S. Census

\* Does not include off-grid installations

# Renewables 2010 Installed Nameplate Capacity (excluding hydropower) SOUTH



# Renewables 2010 Installed Nameplate Capacity (MW)

## WEST

II

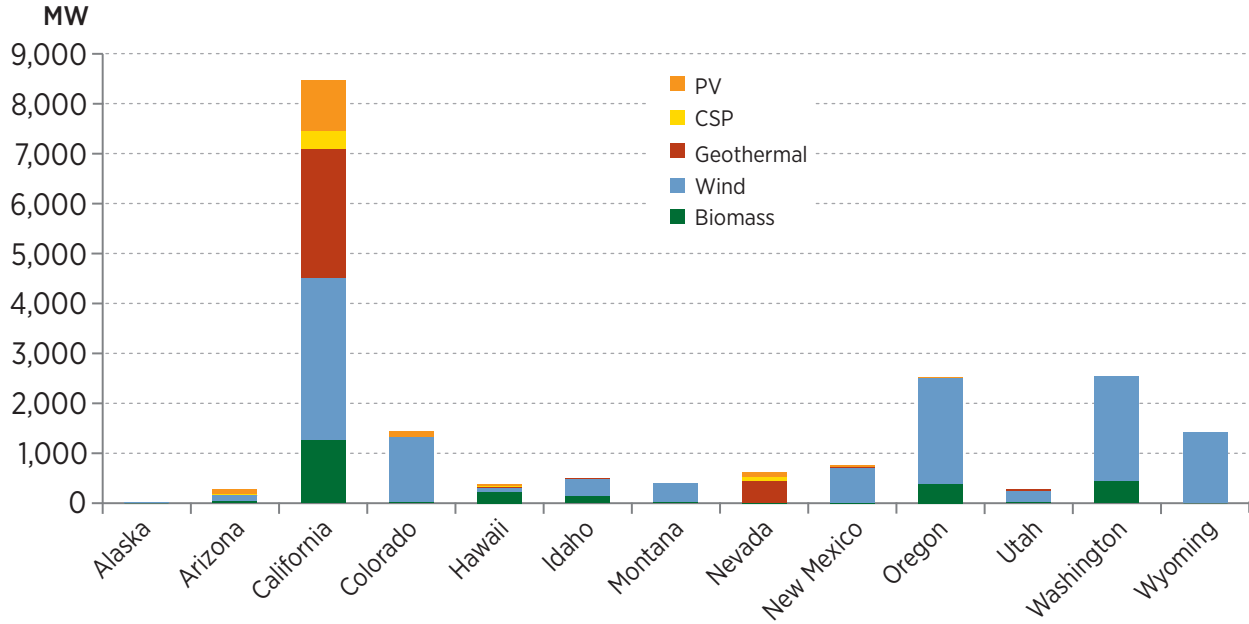
	Wind	PV*	CSP	Geothermal	Biomass	Hydropower	Total Renewables (incl. hydro)	Per capita RE (excl. hydro) watts/person
Washington	2,104	8.0	0	0	437	20,815	<b>23,364</b>	<b>379</b>
California	3,253	1,021.7	364	2,565.5	1,258	10,049	<b>18,510</b>	<b>227</b>
Oregon	2,104	23.9	0	0.3	384	8,240	<b>10,752</b>	<b>656</b>
Arizona	128	109.8	3	0.0	35	2,718	<b>2,994</b>	<b>43</b>
Idaho	353	0.4	0	15.8	133	2,531	<b>3,032</b>	<b>320</b>
Montana	386	0.7	0	0.0	17	2,570	<b>2,974</b>	<b>408</b>
Nevada	0	104.7	64	441.8	3	1,052	<b>1,666</b>	<b>227</b>
Colorado	1,299	121.1	1	0.0	18	650	<b>2,089</b>	<b>286</b>
New Mexico	700	43.3	0	0.2	7	79	<b>829</b>	<b>364</b>
Wyoming	1,412	0.2	0	0.3	0	301	<b>1,713</b>	<b>2,506</b>
Alaska	9	0.0	0	0.7	0	419	<b>429</b>	<b>14</b>
Utah	223	2.1	0	42.0	10	263	<b>539</b>	<b>100</b>
Hawaii	63	44.7	1	35.0	227	25	<b>395</b>	<b>272</b>

Sources: EIA, LBNL, GEA, SEIA/GTM, Larry Sherwood/IREC, U.S. Census

\* Does not include off-grid installations



# Renewables 2010 Installed Nameplate Capacity (excluding hydropower) WEST



### III. Global Renewable Energy Development

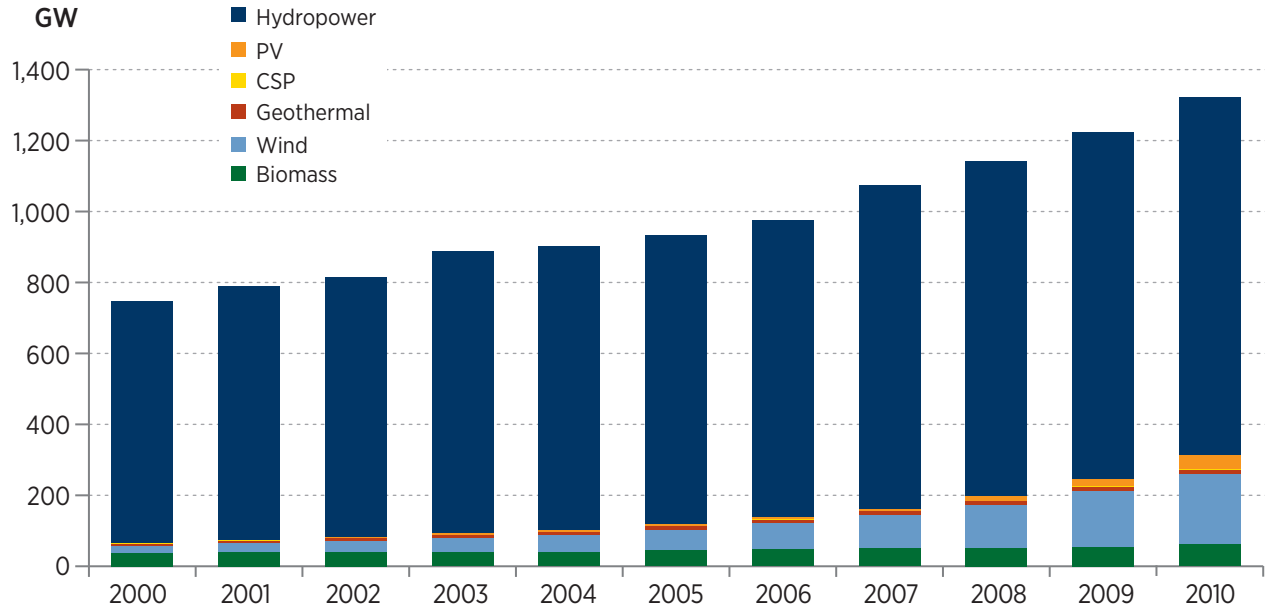


# Global Renewable Energy Development: Summary

- Global renewable electricity installations (excluding hydropower) have **more than quadrupled** from 2000–2010.
- Including hydropower, renewable energy accounts for **21%** of all global electricity generation; without hydropower, renewable energy accounts for **3.8%** of global generation.
- Wind and solar energy are the fastest growing renewable energy technologies worldwide. Wind grew by a factor of 11 and solar PV generation **grew by a factor of more than 28** between 2000 and 2010.
- In 2010, Germany led the world in cumulative solar PV installed capacity. The United States leads the world in geothermal and biomass installed capacity. China leads in wind, and Spain leads in CSP.

# Renewable Electricity Capacity Worldwide (including hydropower)

III



# Renewable Electricity Generating Capacity Worldwide (excluding hydropower)



\*Grid-tied capacity.

Sources: REN21, GWEC, GEA, EIA, SEIA/GTM

# World Renewable Cumulative Electricity Capacity Percent Increase from the Previous Year

III

	Hydro	Solar PV	CSP	Wind	Geothermal	Biomass	Renewables without Hydro	All Renewables
2000	0%	22%	0%	31%	0%	6%	11%	1%
2001	5%	29%	0%	33%	0%	8%	15%	6%
2002	2%	33%	0%	29%	2%	0%	11%	3%
2003	9%	25%	0%	29%	9%	-3%	11%	9%
2004	1%	33%	0%	20%	0%	0%	10%	1%
2005	2%	38%	0%	23%	4%	13%	18%	4%
2006	2%	32%	0%	25%	3%	7%	17%	4%
2007	9%	5%	5%	27%	0%	6%	17%	10%
2008	4%	71%	14%	29%	4%	4%	22%	6%
2009	4%	62%	22%	31%	7%	4%	25%	7%
2010	3%	90%	83%	25%	3%	15%	27%	8%



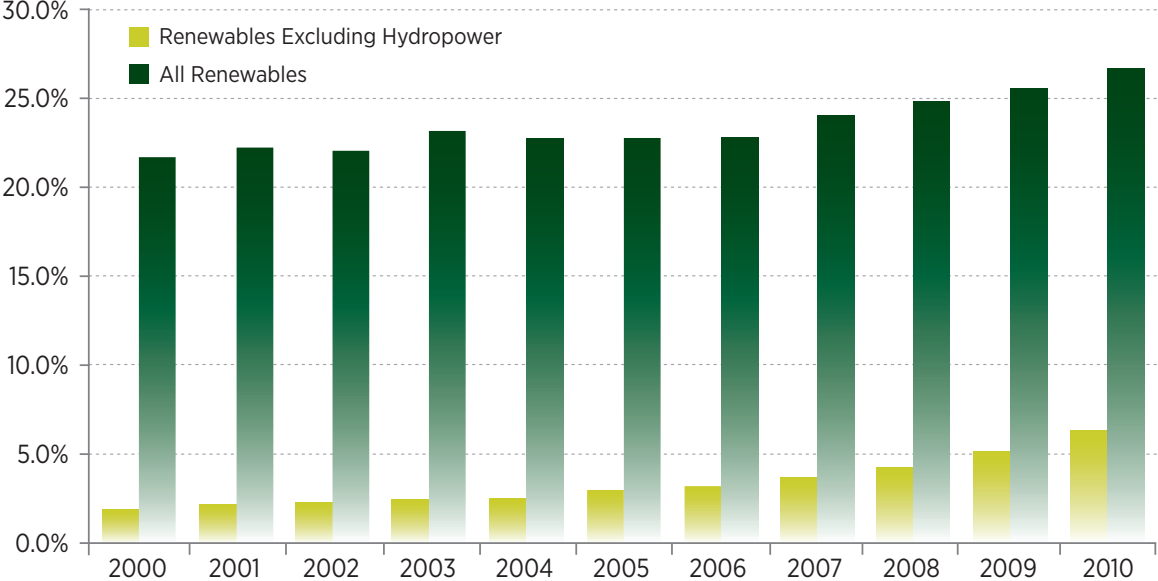
# Renewables as a Percent of Total Installed Nameplate Capacity Worldwide

	Hydro	Solar PV	CSP	Wind	Geothermal	Biomass	All Renewables	Renewables without Hydropower	Renewable Capacity without Hydropower (GW)
2000	19.8%	0.0%	0.0%	0.5%	0.2%	1.1%	21.6%	1.9%	65
2001	20.1%	0.1%	0.0%	0.7%	0.2%	1.1%	22.2%	2.1%	74
2002	19.8%	0.1%	0.0%	0.8%	0.2%	1.1%	22.0%	2.2%	82
2003	20.8%	0.1%	0.0%	1.0%	0.2%	1.0%	23.1%	2.4%	91
2004	20.2%	0.1%	0.0%	1.2%	0.2%	1.0%	22.7%	2.5%	100
2005	19.8%	0.1%	0.0%	1.4%	0.2%	1.1%	22.7%	2.9%	118
2006	19.5%	0.2%	0.0%	1.7%	0.2%	1.1%	22.7%	3.2%	138
2007	20.4%	0.2%	0.0%	2.1%	0.2%	1.1%	24.0%	3.6%	162
2008	20.4%	0.3%	0.0%	2.6%	0.2%	1.1%	24.7%	4.2%	197
2009	20.4%	0.4%	0.0%	3.3%	0.2%	1.1%	25.5%	5.1%	245
2010	20.3%	0.8%	0.0%	4.0%	0.2%	1.2%	26.6%	6.3%	312

III

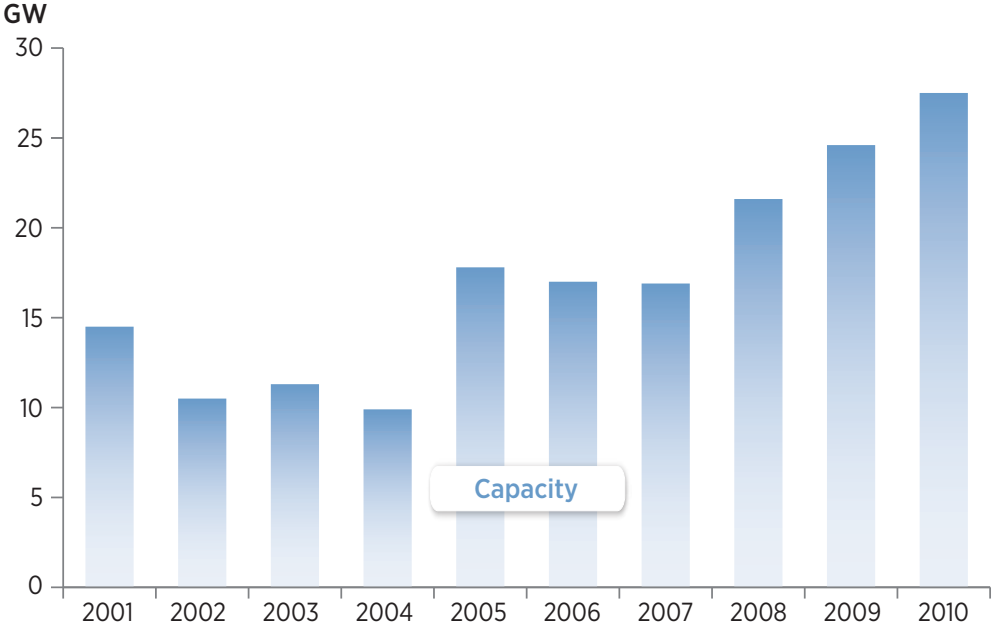
# Renewables Share of Total Electricity Capacity Worldwide

III





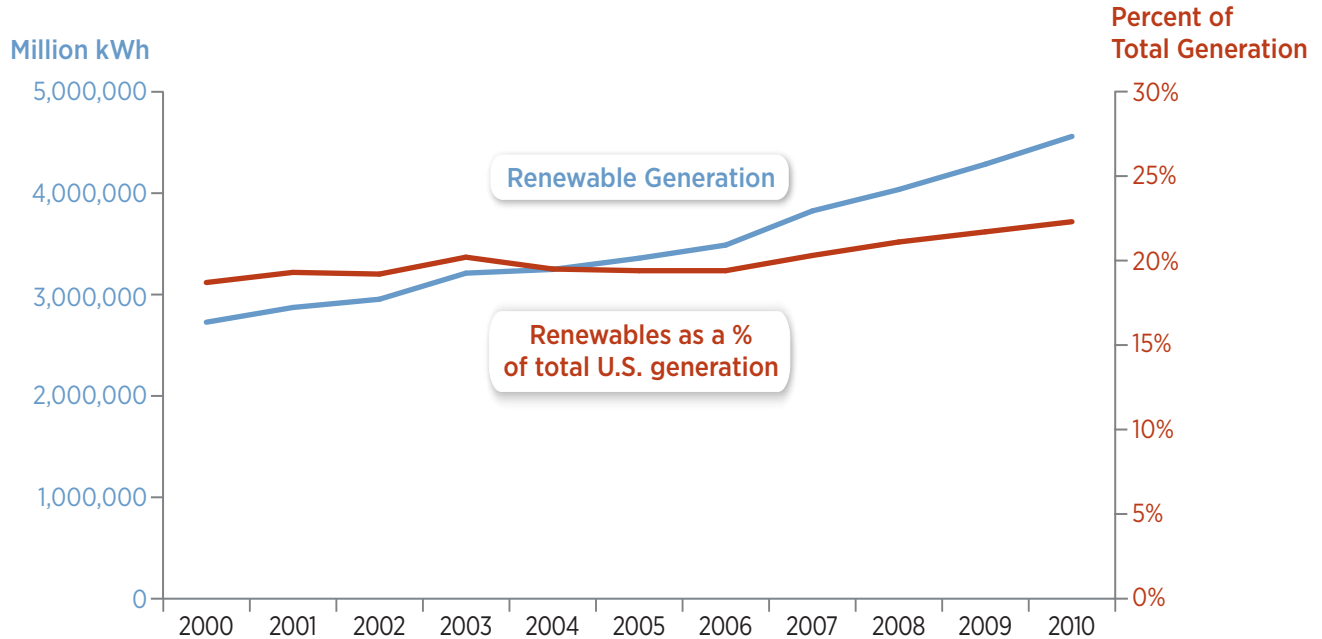
# Annual Installed Renewable Electricity Growth Worldwide (excluding hydropower)



	Compounded Annual Growth Rate (CAGR) (2000–2010)
Wind	27.1%
Solar PV	39.8%
CSP	10.3%
Geothermal	3.2%
Biomass	5.3%
Renewables (excl. Hydro)	17.0%

# Worldwide Renewable Electricity Generation (including hydropower)

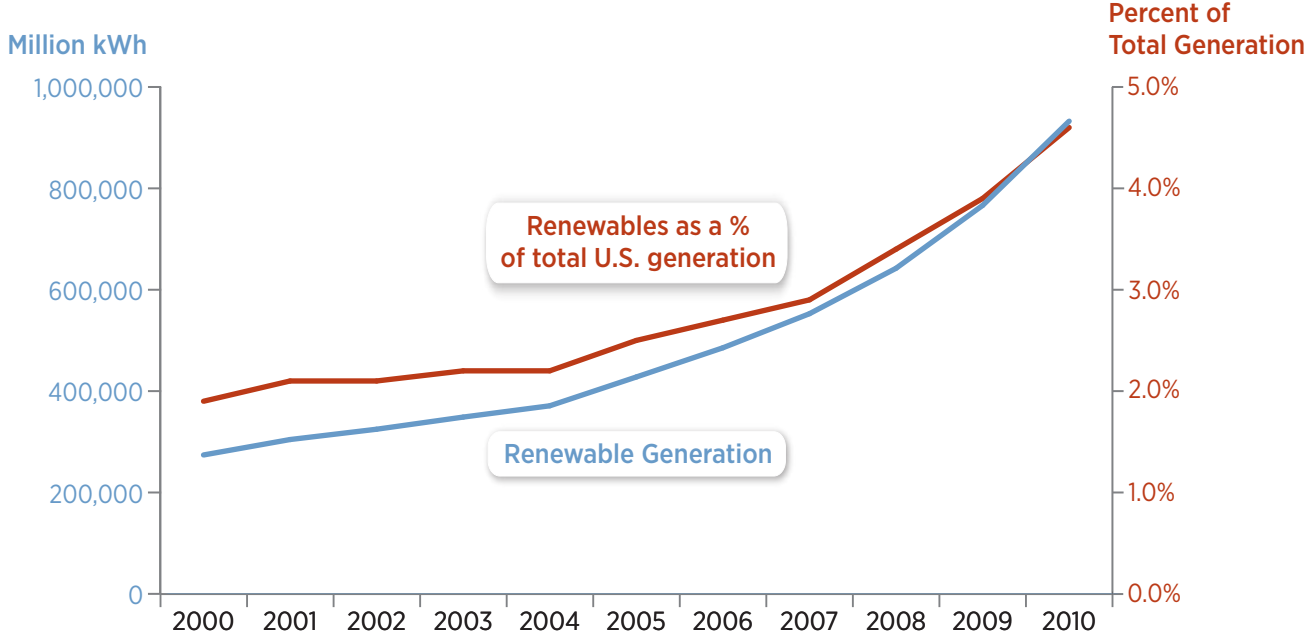
III



Generation derived using capacity factors of 14% for PV, 30% for wind, 70% for geothermal, 54% for biomass, 25% for CSP, and 41% for hydro.

Sources: REN21, GWEC, GEA, EIA, SEIA/GTM

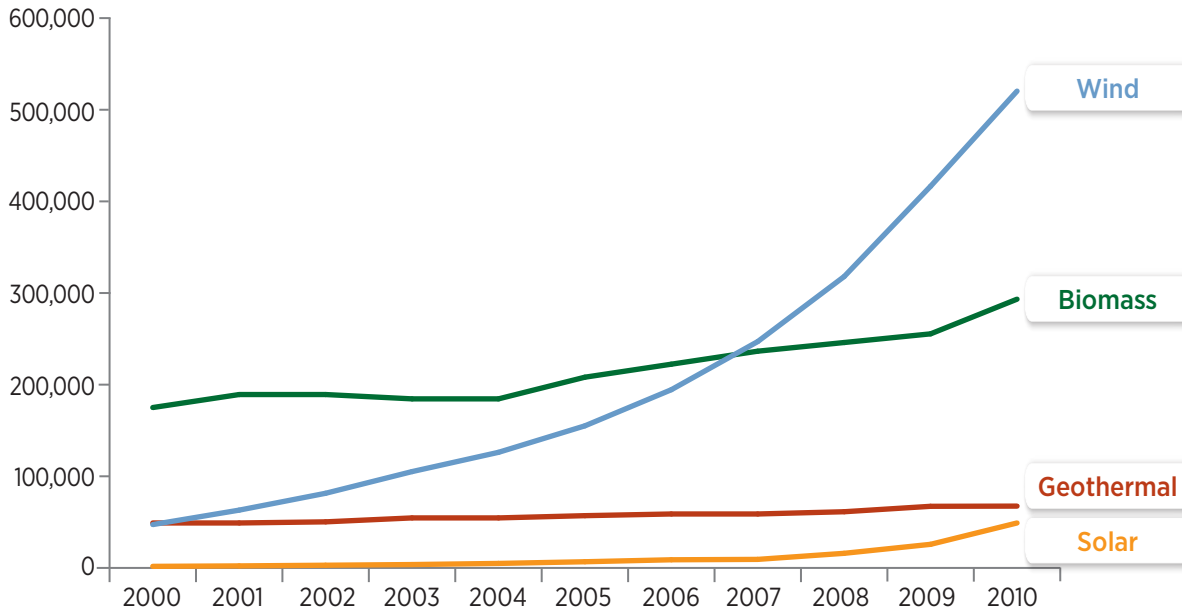
# Renewable Electricity Generation Worldwide (excluding hydropower)



Generation derived using capacity factors of 14% for PV, 30% of wind, 70% for geothermal, 54% for biomass, 25% for CSP, and 41% for hydro.  
 Sources: REN21, GWEC, GEA, EIA, SEIA/GTM

# Renewable Electricity Generation Worldwide by Technology (2000–2010)

Million kWh



Generation derived using capacity factors of 14% for PV, 30% of wind, 70% for geothermal, 54% for biomass, 25% for CSP, and 41% for hydro.

Sources: REN21, GWEC, GEA, EIA, SEIA/GTM

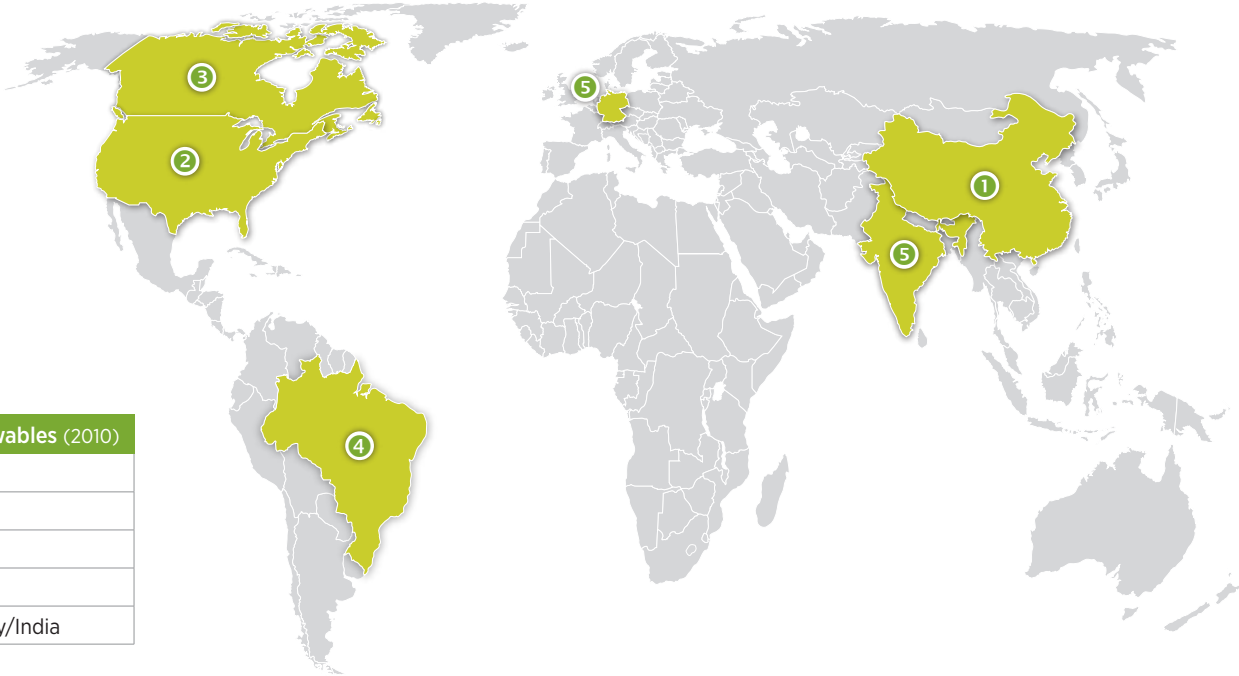
# Worldwide Renewable Electricity Generation as a Percent of Total Generation

	Hydro	Solar PV	Biomass	Wind	Geothermal	All Renewables	Renewables without Hydropower	Renewable Generation without Hydropower (million kWh)
2000	16.8%	0.0%	1.2%	0.3%	0.3%	18.7%	1.9%	274,019
2001	17.3%	0.0%	1.3%	0.4%	0.3%	19.3%	2.1%	304,469
2002	17.1%	0.0%	1.2%	0.5%	0.3%	19.2%	2.1%	324,827
2003	18.0%	0.0%	1.2%	0.7%	0.3%	20.2%	2.2%	348,777
2004	17.3%	0.0%	1.1%	0.8%	0.3%	19.5%	2.2%	371,028
2005	16.9%	0.0%	1.2%	0.9%	0.3%	19.4%	2.5%	427,880
2006	16.7%	0.1%	1.2%	1.1%	0.3%	19.4%	2.7%	485,477
2007	17.4%	0.1%	1.3%	1.3%	0.3%	20.3%	2.9%	552,703
2008	17.8%	0.1%	1.3%	1.7%	0.3%	21.1%	3.4%	642,327
2009	17.8%	0.1%	1.3%	2.1%	0.3%	21.7%	3.9%	766,333
2010	17.7%	0.3%	1.4%	2.5%	0.3%	22.3%	4.6%	932,590

III

# Top Countries with Installed Renewable Electricity

III

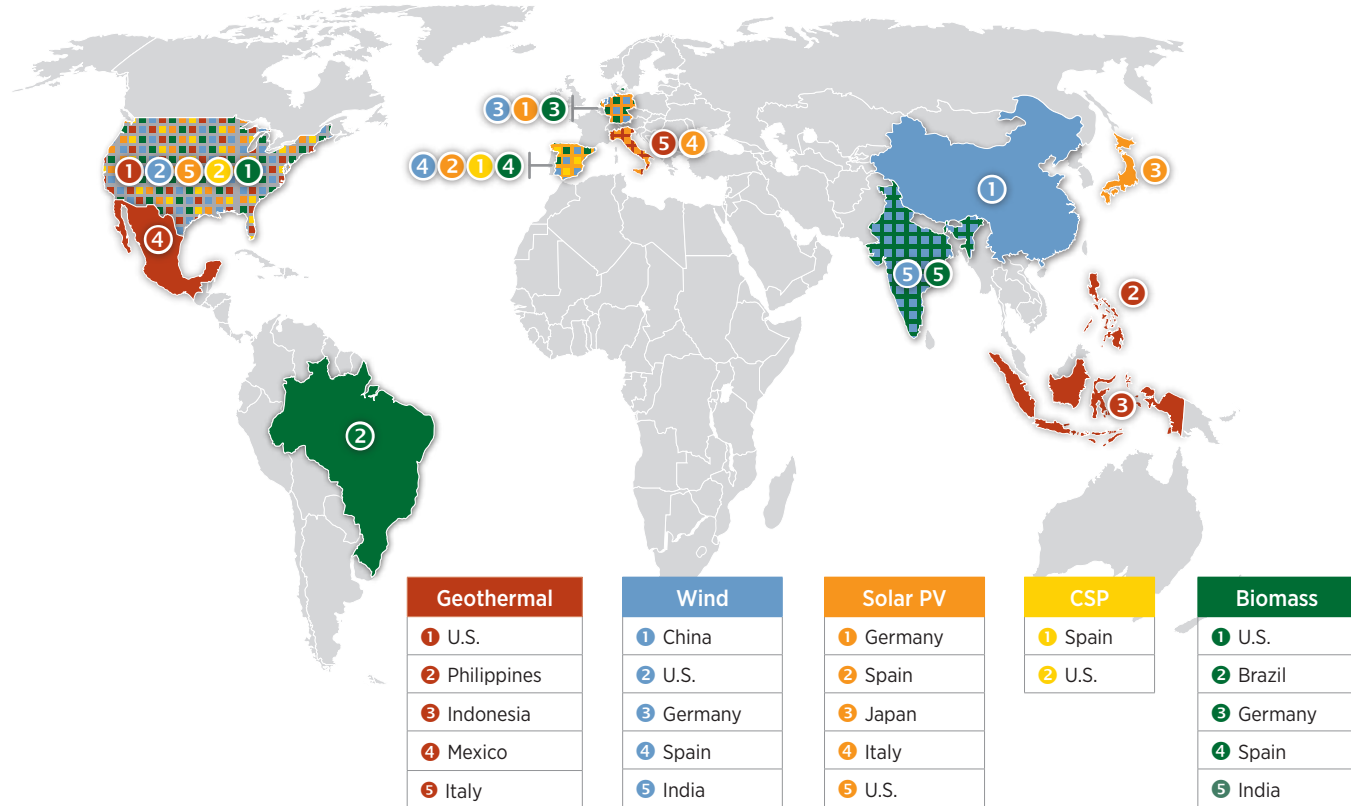


Total Renewables (2010)	
1	China*
2	U.S.
3	Canada
4	Brazil
5	Germany/India

Sources: REN21, GWEC, SEIA/GTM

\* Majority of China's renewable energy is from small hydropower.

# Top Countries with Installed Renewable Electricity by Technology (2010)



## IV. Wind



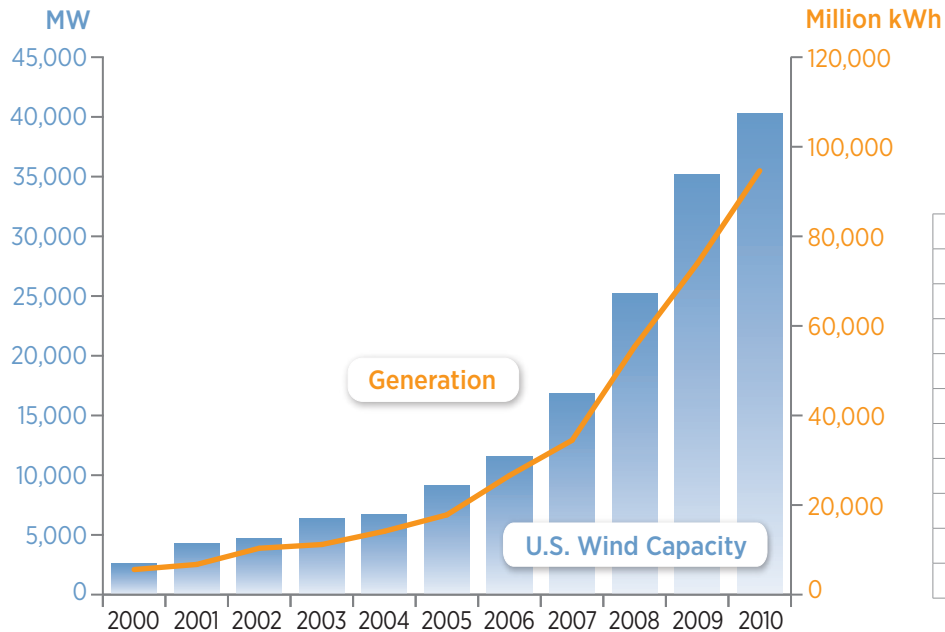


# Wind: Summary

- In the United States, installed wind energy capacity **increased almost 16 fold between 2000 and 2010**.
- In the United States, wind experienced strong growth in 2010 and **over 5 GW of new capacity was added**. Texas led the United States in wind installations in 2010, installing 680 MW of wind capacity.
- In 2010, **China surpassed the United States** as the world leader in cumulative installed wind capacity, with more than 42 GW installed.

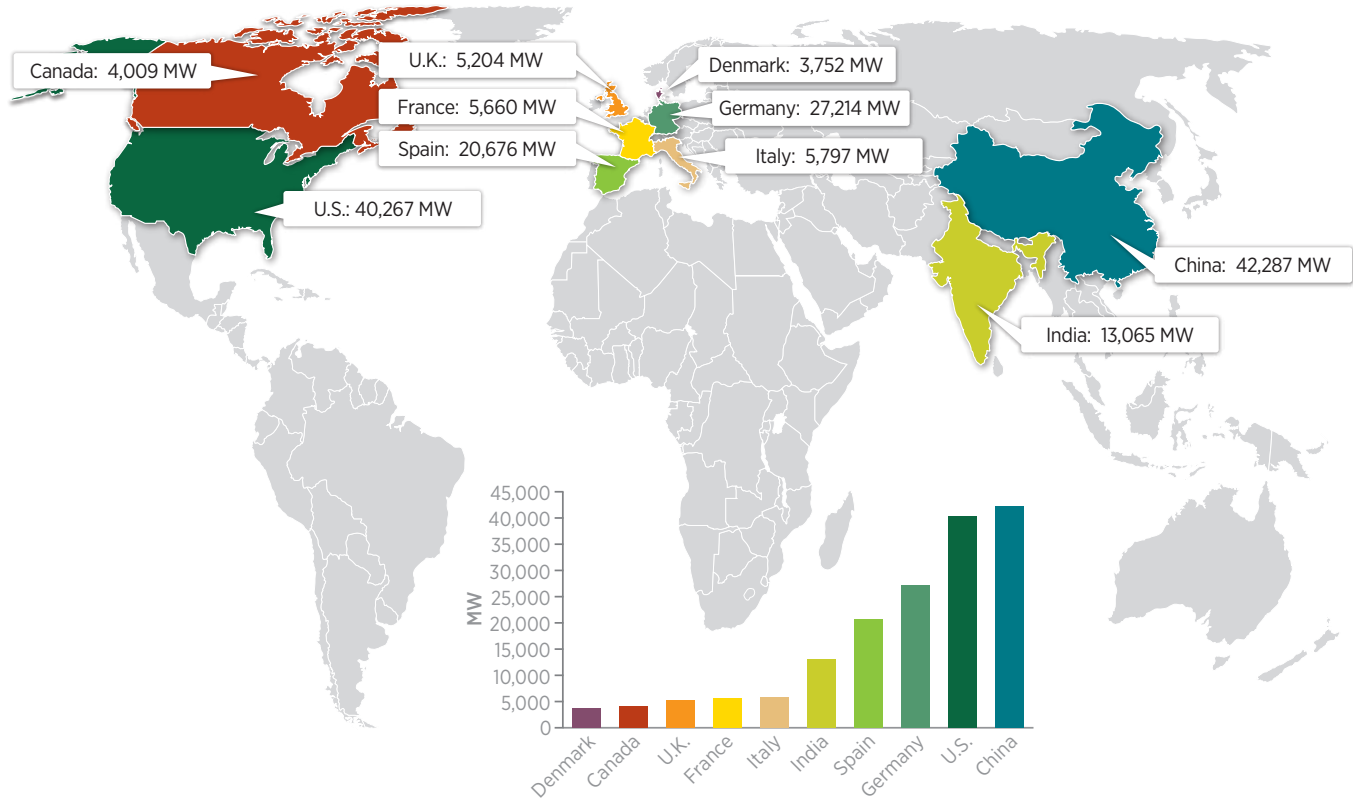
# U.S. Total Installed Wind Energy Nameplate Capacity and Generation

IV



	U.S. Wind Energy Generation (Million kWh)	U.S. Wind Energy Capacity and Percent Increase from Previous Year	
		Total (MW)	% Increase
2000	5,593	2,578	2.6%
2001	6,737	4,275	65.8%
2002	10,354	4,686	9.6%
2003	11,187	6,353	35.6%
2004	14,144	6,725	5.9%
2005	17,811	9,121	35.6%
2006	26,589	11,575	26.9%
2007	34,450	16,812	45.2%
2008	55,363	25,237	50.1%
2009	73,886	35,159	39.3%
2010	94,647	40,267	14.5%

# Wind Energy Capacity (2010) – Select Countries

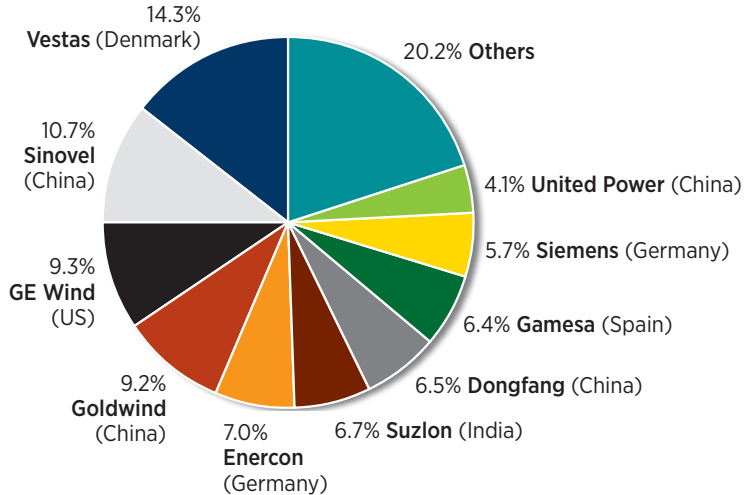


# Turbine Manufacturing

IV

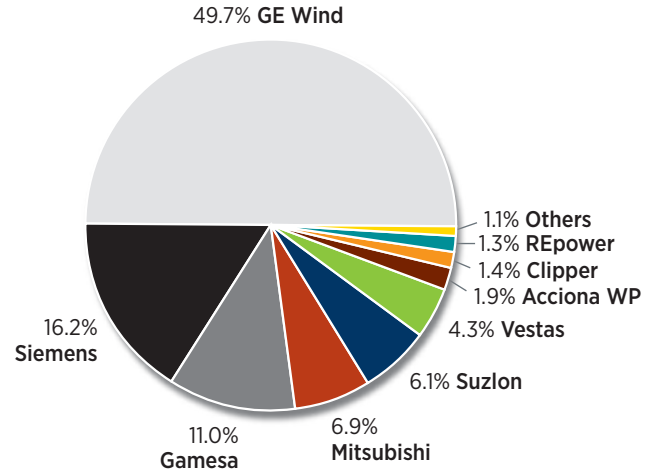
## Global Wind Turbine Market Share 2010

Total Turbine Installations: 30 GW

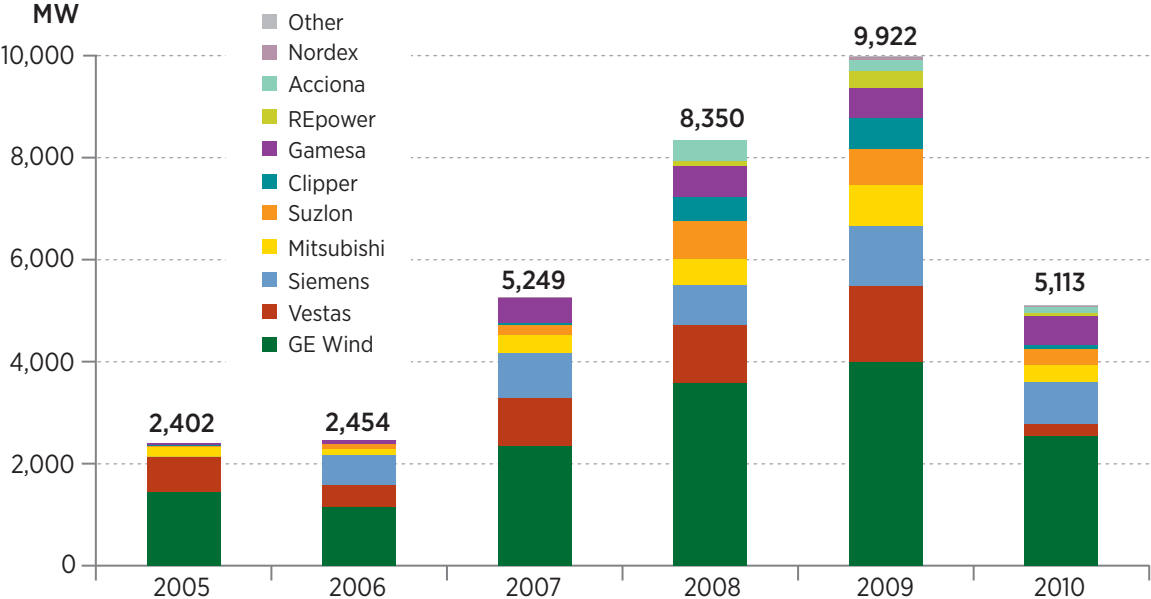


## U.S. Wind Turbine Market Share 2010

Total Turbine Installations: 5,113 MW



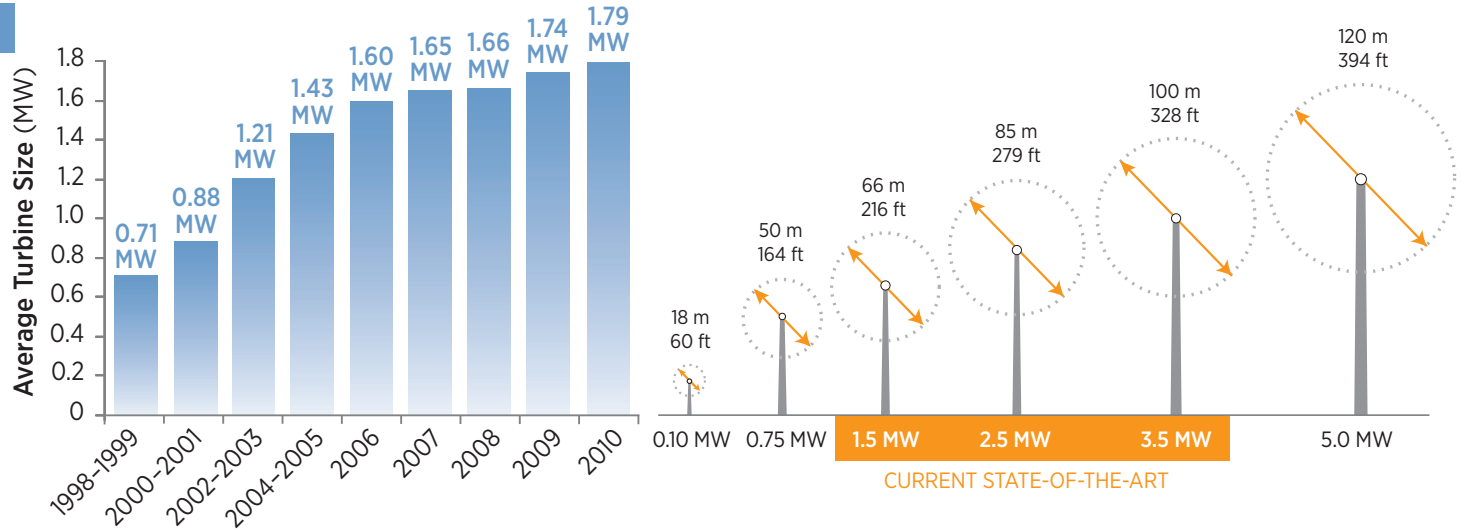
# Annual U.S. Wind Turbine Installations, by Manufacturer (MW)



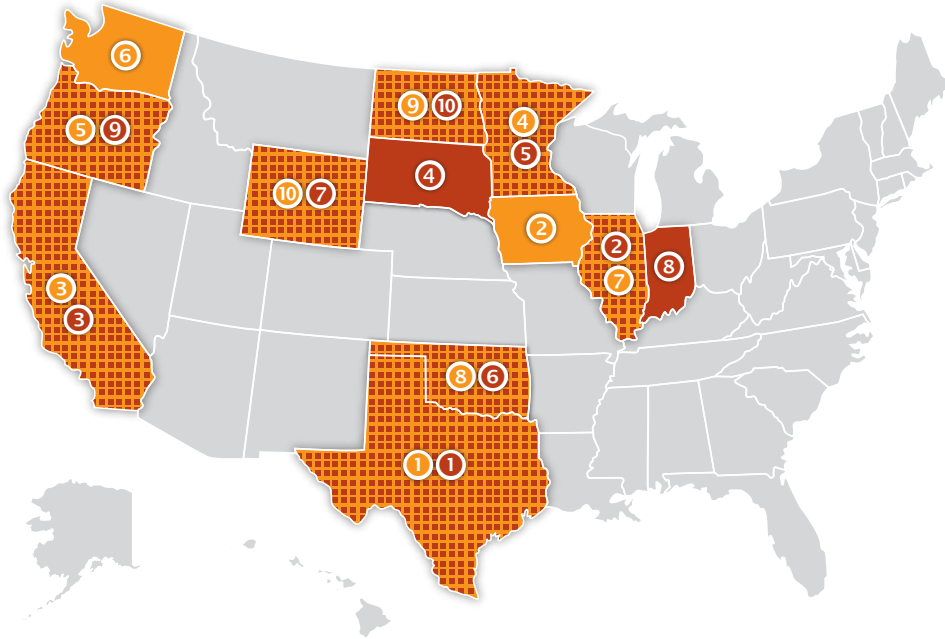
IV

# Average Installed Turbine Size

IV



# States Leading Wind Power Development

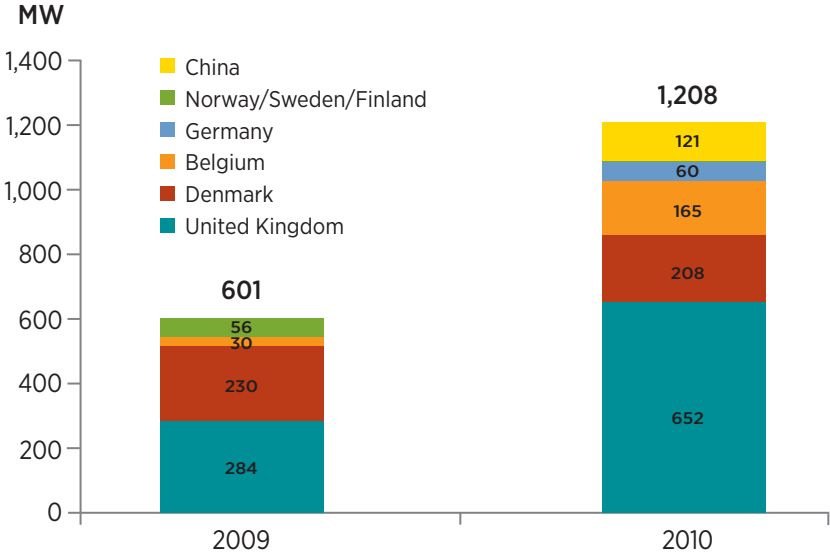


Cumulative Capacity (2010, MW)	
1 Texas .....	10,089
2 Iowa .....	3,675
3 California .....	3,253
4 Minnesota .....	2,205
5 Oregon .....	2,104
6 Washington .....	2,104
7 Illinois .....	2,045
8 Oklahoma .....	1,482
9 North Dakota .....	1,424
10 Wyoming .....	1,412

Annual Capacity (2010, MW)	
1 Texas .....	680
2 Illinois .....	498
3 California .....	455
4 South Dakota .....	396
5 Minnesota .....	396
6 Oklahoma .....	352
7 Wyoming .....	311
8 Indiana .....	303
9 Oregon .....	283
10 North Dakota .....	221

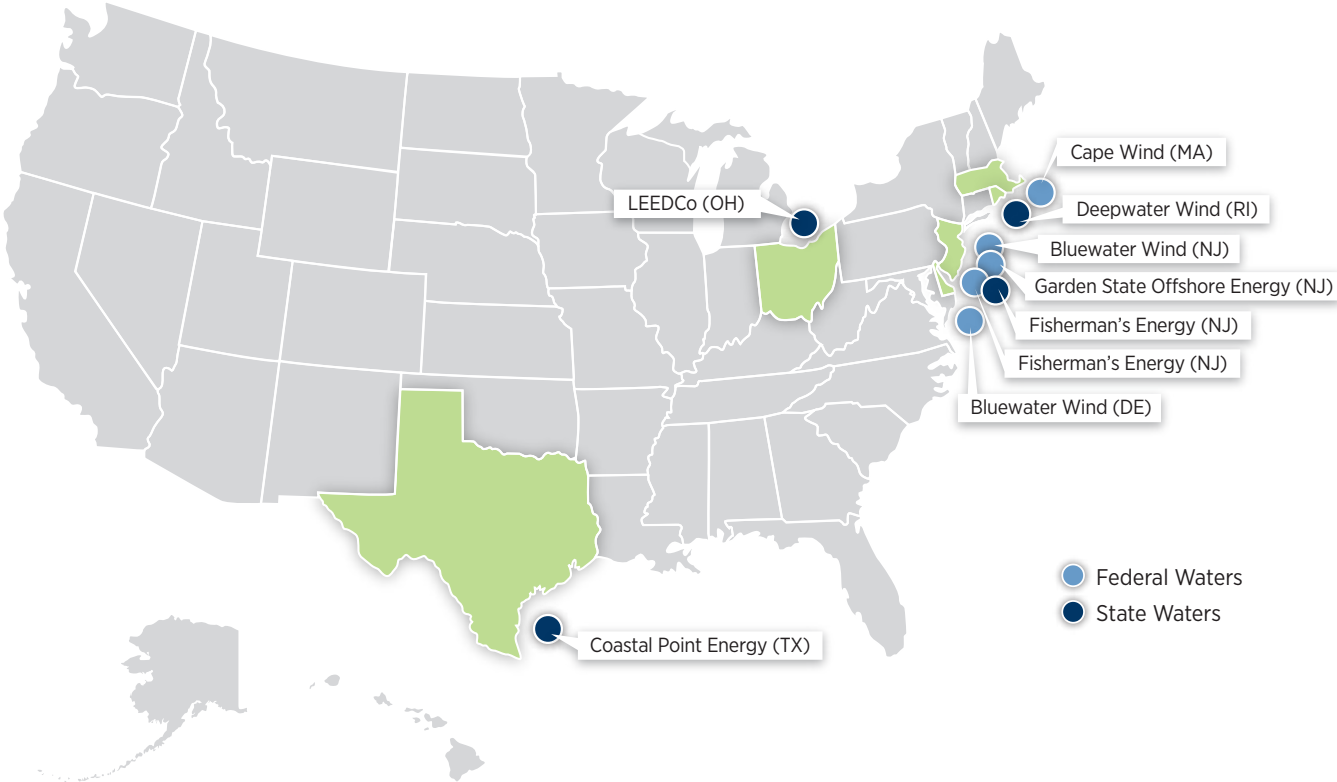
# Annual Installed Offshore Wind Capacity By Country (MW)

IV





# U.S. Offshore Wind Energy Proposed Projects





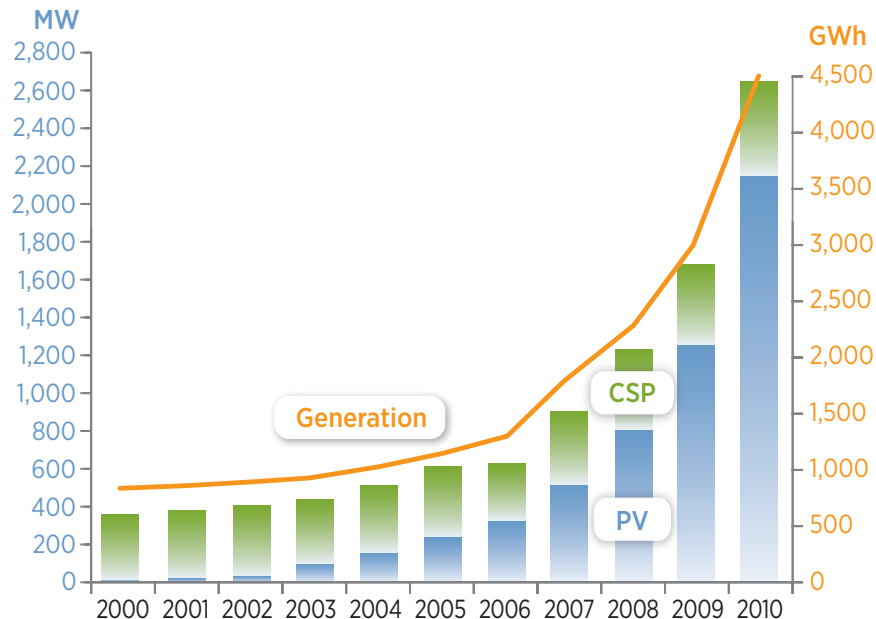
V. Solar

# Solar: Summary

- Solar energy electricity generation has **grown by a factor of over 5 between 2000 and 2010**, but still represents a very small part of overall U.S. electricity generation.
- Countries with aggressive solar policies—such as Germany, Spain, and Japan—lead the world in solar photovoltaic (PV) deployment. Similarly, **U.S. states with aggressive solar incentives lead the United States in both cumulative and annual installations in 2010** (California, New Jersey, Colorado, Arizona, and Nevada).
- U.S. manufacturers currently have a small share of the world PV market. **China and Taiwan are the market leaders with nearly 60% of the global PV cell production** combined.
- A number of concentrating solar power (CSP) plants came online in 2010, including 77.5 MW in the United States and 150 MW in Spain.

# U.S. Total Installed Solar Energy Nameplate Capacity and Generation

V



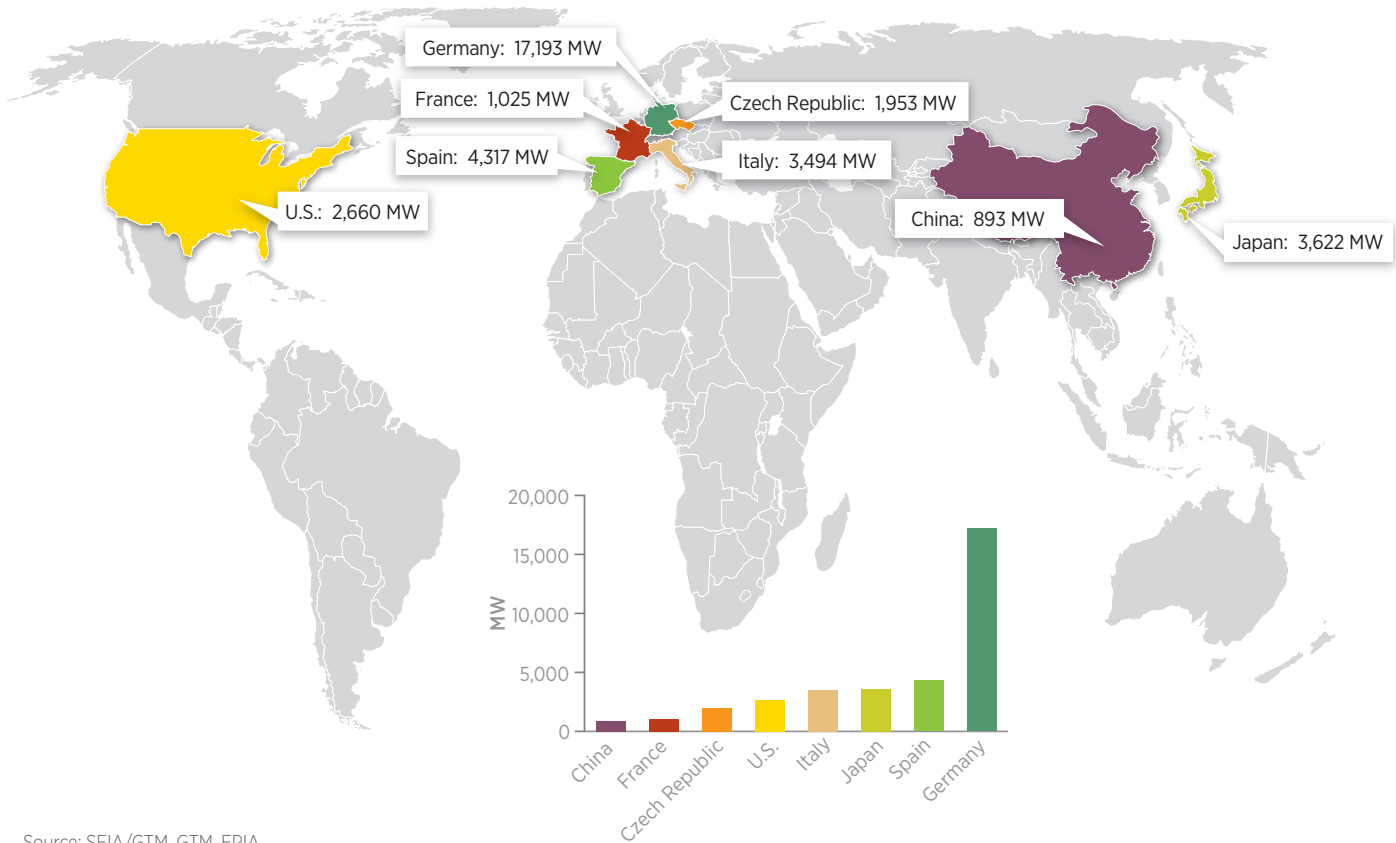
	U.S. Solar Energy Generation (Million kWh)	U.S. Solar Energy Capacity (MW) and % Increase from Previous Year			
		PV*	CSP	Total	Increase
2000	804	18	354	372	4.3%
2001	822	29	354	383	3.0%
2002	857	52	354	406	5.9%
2003	929	97	354	451	11.2%
2004	1,020	155	354	509	12.8%
2005	1,145	234	354	588	15.5%
2006	1,312	339	355	694	18.0%
2007	1,718	508	419	927	33.5%
2008	2,208	819	419	1,237	33.5%
2009	2,922	1,257	430	1,686	36.3%
2010	4,505	2,153	507	2,660	57.7%

Sources: SEIA/GTM, Larry Sherwood/IREC

Note: Generation numbers calculated from installed capacity using a 18% capacity factor for PV and 25% capacity factor for CSP.

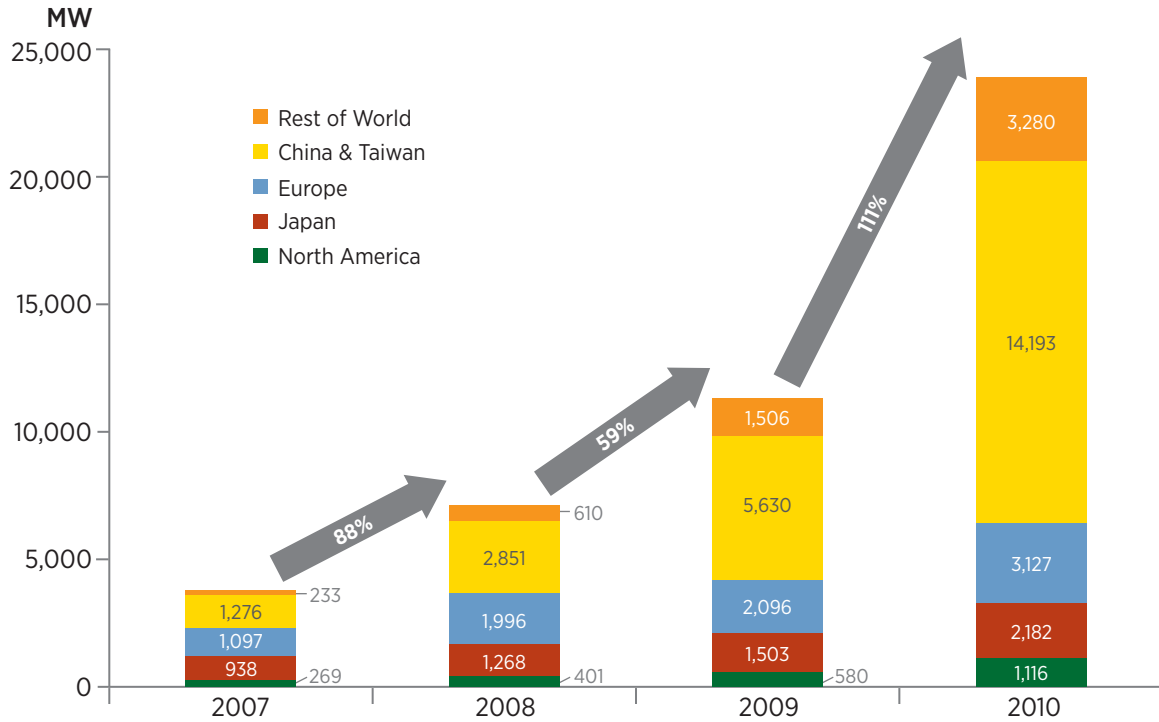
\* Includes on- and off-grid capacity.

# Solar Energy Installed Capacity (2010) – Select Countries



Source: SEIA/GTM, GTM, EPIA  
\* Includes PV and CSP

# Solar Manufacturing by Country

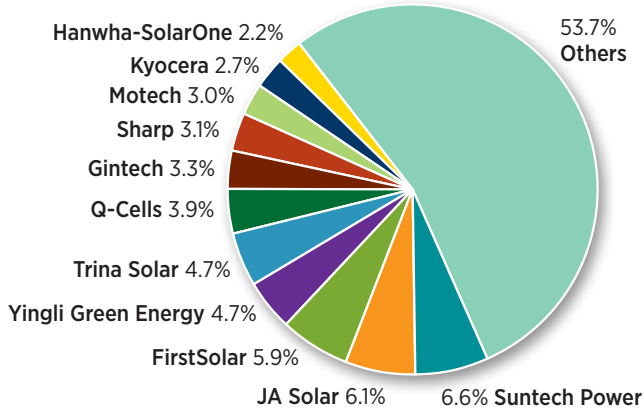


V

# Photovoltaic Manufacturing

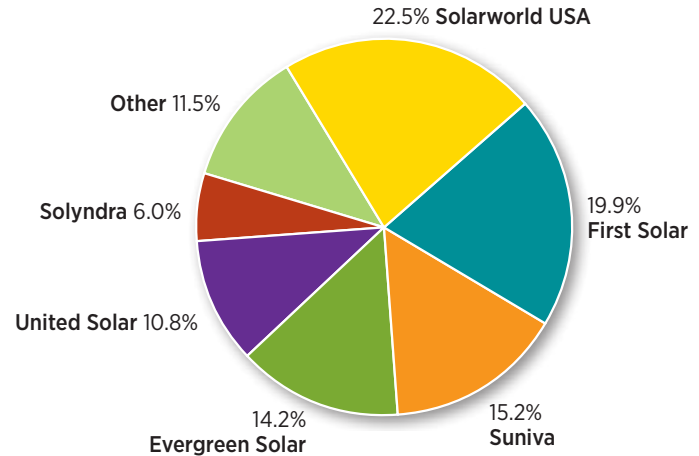
## Global Solar Cell Production 2010:

23,899 MW



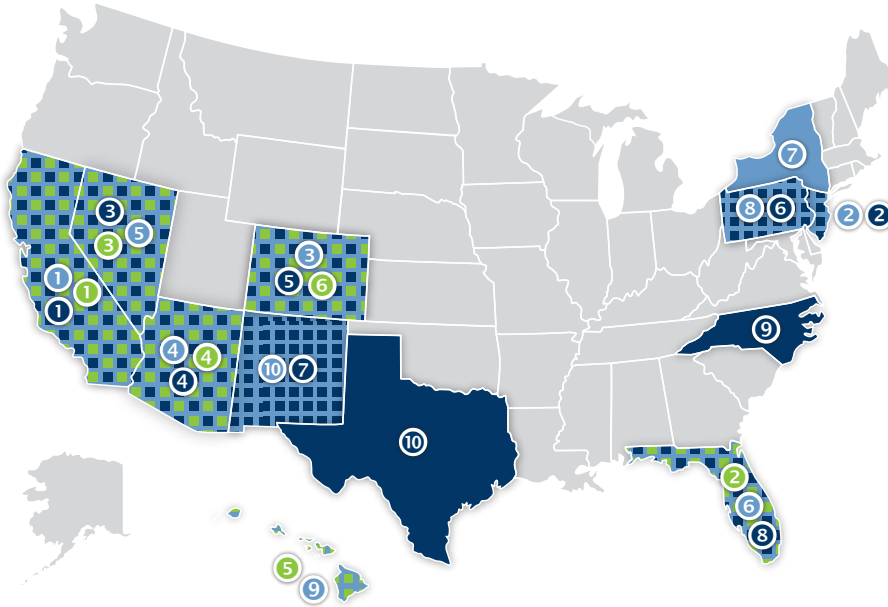
## North America Cell Production 2010:

1,116 MW



# States Leading Solar Energy Development (2010)

V



PV Cumulative Capacity (2010, MW)	
1 California .....	1,021.7
2 New Jersey .....	259.9
3 Colorado .....	121.1
4 Arizona .....	109.8
5 Nevada .....	104.7
6 Florida .....	73.5
7 New York .....	55.5
8 Pennsylvania .....	54.8
9 Hawaii .....	44.7
10 New Mexico .....	43.3

PV Annual Capacity Additions (2010, MW)	
1 California .....	252.0
2 New Jersey .....	132.4
3 Nevada .....	68.3
4 Arizona .....	63.6
5 Colorado .....	62.0
6 Pennsylvania .....	46.5
7 New Mexico .....	40.9
8 Florida .....	34.8
9 North Carolina .....	28.7
10 Texas .....	25.9

CSP Cumulative Capacity (2010, MW)	
1 California .....	364
2 Florida .....	75
3 Nevada .....	64
4 Arizona .....	2
5 Hawaii .....	1
6 Colorado .....	1

Sources: SEIA/GTM, Larry Sherwood/IREC  
 Note: Grid-tied capacity only.





## VI. Geothermal

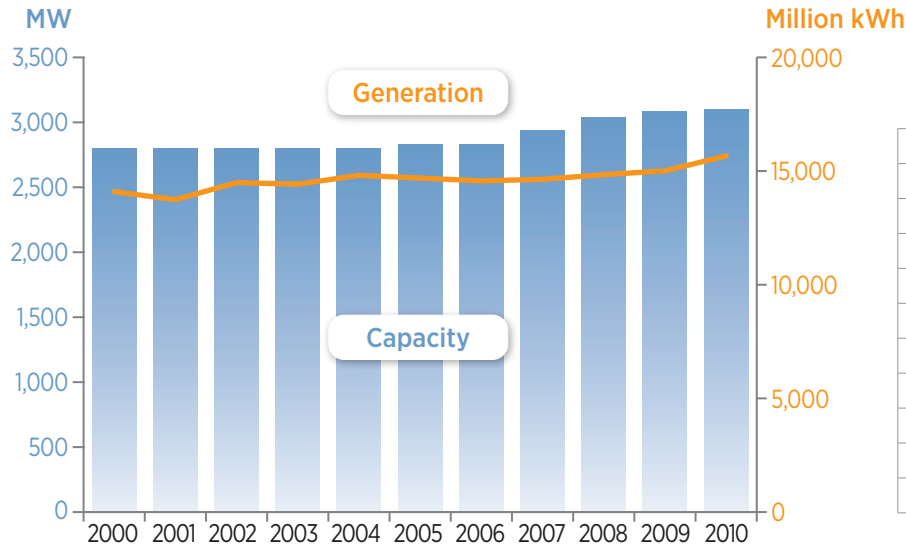


# Geothermal: Summary

- U.S. geothermal energy generation has remained relatively stable from 2000 to 2010, with the **past 10 years experiencing an average of 1.0% growth.**
- **The United States leads the world in installed geothermal electricity capacity and generation**, with most of that power installed in California.
- As a base-load source of energy, geothermal is distinct from other renewables such as wind and solar, because **it can provide consistent electricity.**

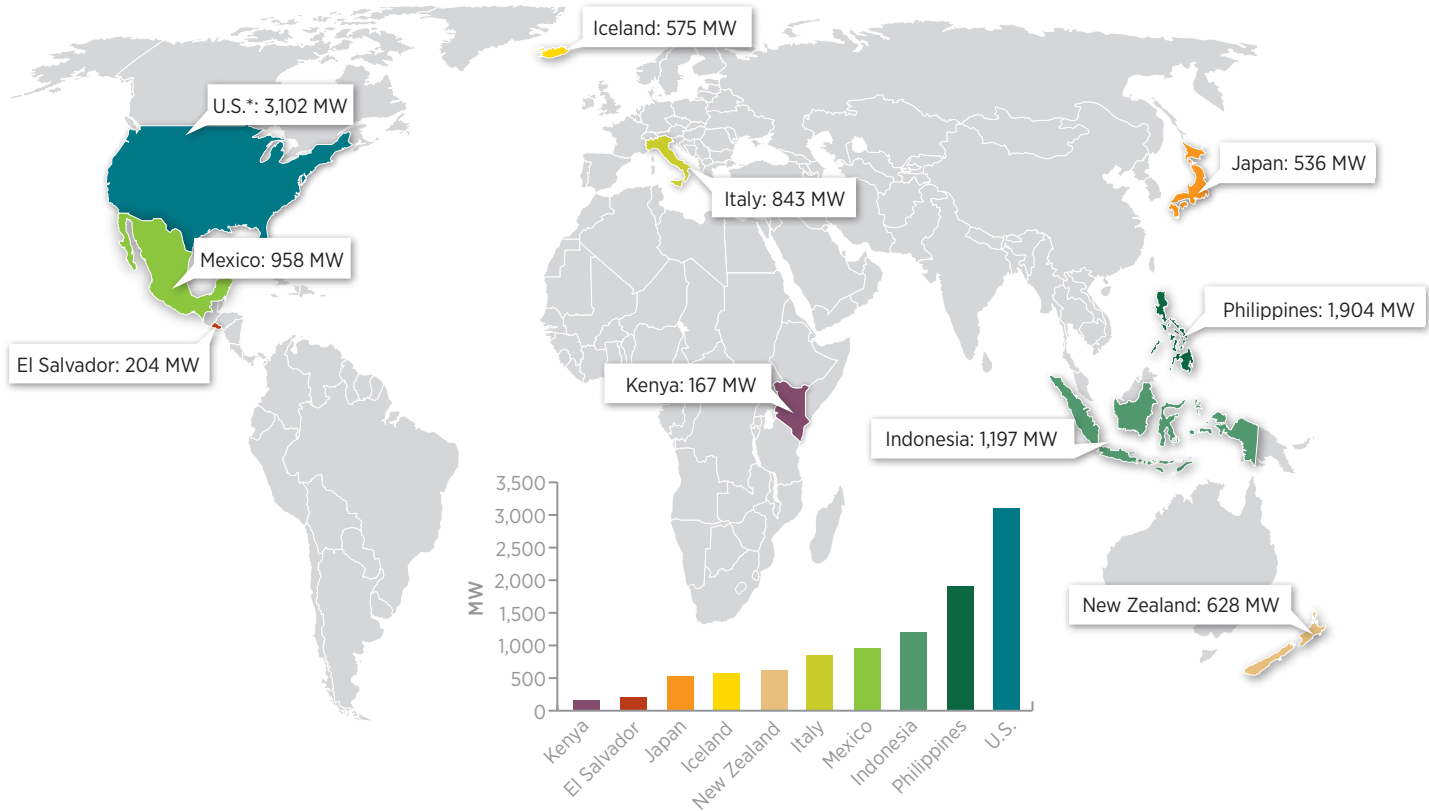
# U.S. Geothermal Electricity Nameplate Capacity and Generation

VI



	U.S. Geothermal Electricity Generation (Million kWh)	U.S. Geothermal Electricity Capacity and % Increase from Previous Year	
		Total (MW)	% Increase
2000	14,093	2,798	2.2%
2001	13,741	2,798	0.0%
2002	14,491	2,798	0.0%
2003	14,424	2,798	0.0%
2004	14,811	2,798	0.0%
2005	14,692	2,828	1.1%
2006	14,568	2,831	0.1%
2007	14,637	2,937	3.7%
2008	14,840	3,040	3.5%
2009	15,009	3,087	1.5%
2010	15,666	3,102	0.5%

# Global Geothermal Electricity Capacity (2009) – Select Countries



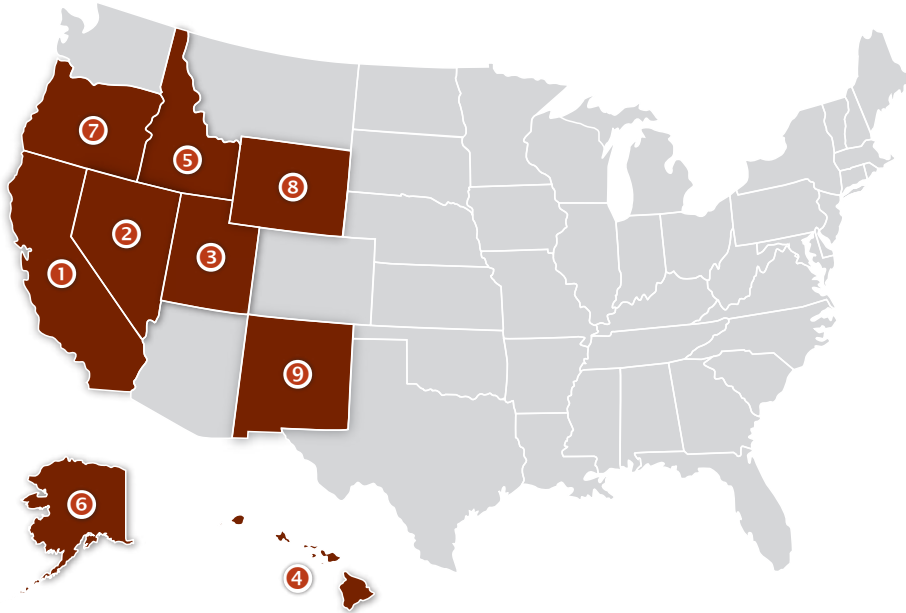
VI

Source: GEA

\*Note: U.S. is updated for 2010

# State Geothermal Energy Development (2010)

VI



Total Installed Capacity (2010, MW)	
1 California .....	2,565.5
2 Nevada .....	441.8
3 Utah .....	42.0
4 Hawaii .....	35.0
5 Idaho .....	15.8
6 Alaska .....	0.7
7 Oregon .....	0.3
8 Wyoming .....	0.3
9 New Mexico .....	0.2





VII. Biopower



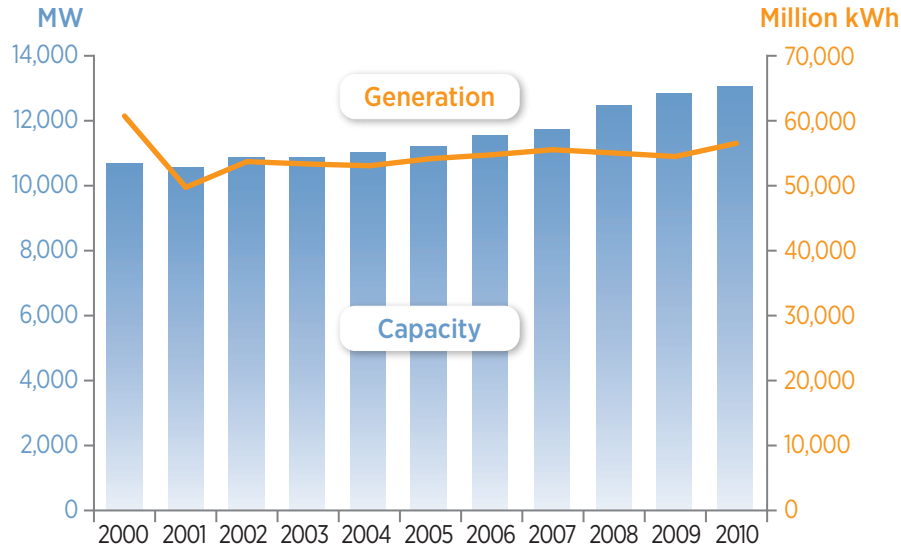
# Biopower: Summary

- Biopower generation has remained steady during the past seven years, and currently accounts for **33% of all renewable energy generated in the United States** (excluding hydropower).
- Biomass electricity primarily comes from wood and agricultural residues that are burned as a fuel for cogeneration in the industrial sector (such as in the pulp and paper industry).
- U.S. installed biopower capacity has grown recently, with a **Compound Annual Growth Rate (CAGR) of 3.1% from 2006–2010**.

VII

# U.S. Biopower Nameplate Capacity and Generation

VII

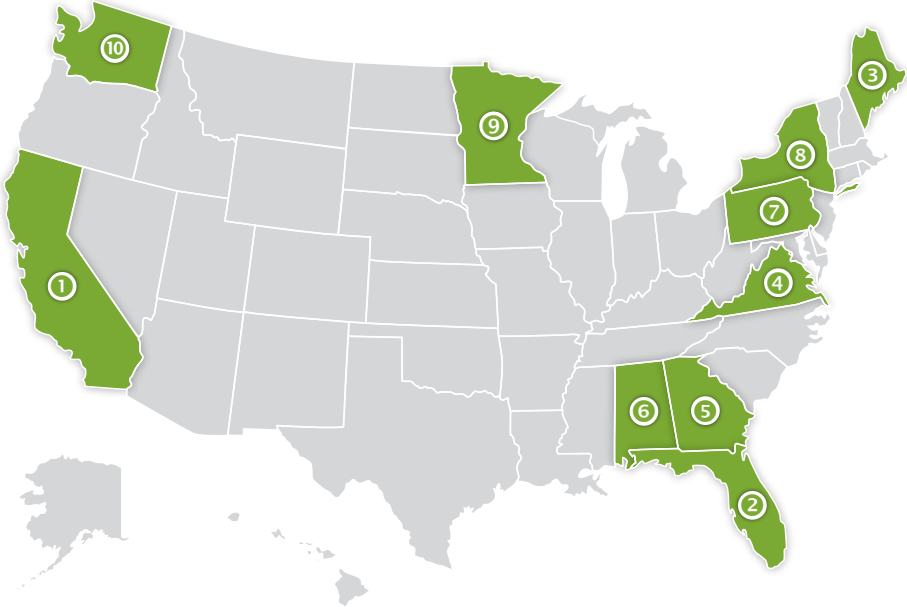


	U.S. Biopower Generation (Million kWh)	U.S. Biopower Capacity and % Increase from Previous Year	
		Total (MW)	% Change
2000	60,726	10,676	- 2.9%
2001	49,748	10,576	- 0.9%
2002	53,709	10,867	2.8%
2003	53,340	10,856	- 0.1%
2004	53,073	11,033	1.6%
2005	54,160	11,222	1.7%
2006	54,759	11,553	2.9%
2007	55,539	11,738	1.6%
2008	55,034	12,485	6.4%
2009	54,493	12,836	2.8%
2010	56,532	13,053	1.7%

Source: EIA

Note: The generation decrease between 2000 to 2001 reflects an EIA classification change. Beginning with 2001 data, non-biogenic municipal solid waste and tire-derived fuels were reclassified as non-renewable energy sources (previously considered waste biopower).

# States Leading Biopower Energy Development (2010)

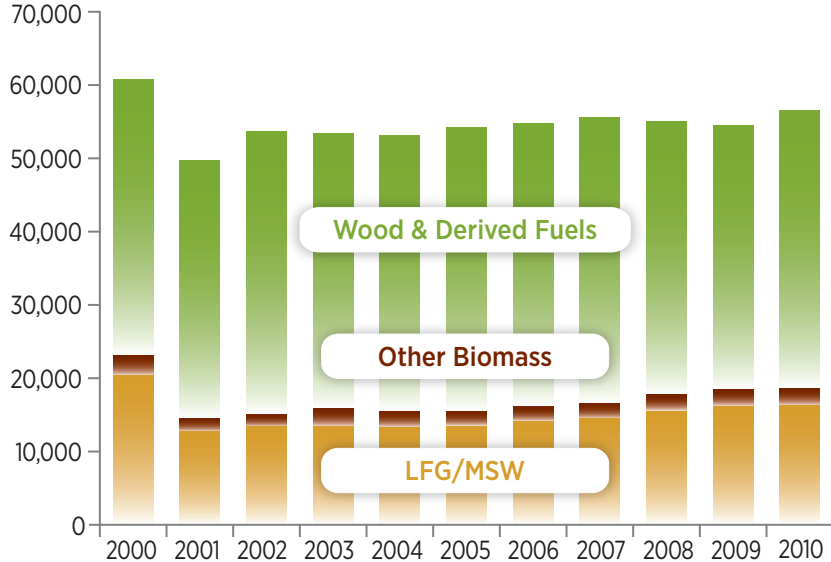


Total Installed Capacity (2010, MW)	
1 California .....	1,258
2 Florida .....	1,197
3 Maine .....	771
4 Virginia .....	770
5 Georgia .....	684
6 Alabama .....	627
7 Pennsylvania .....	597
8 New York .....	510
9 Minnesota .....	478
10 Washington .....	437

VII

# U.S. Biopower Generation Sources (2000–2010)

Million kWh



	LFG/MSW	Other Biomass	Wood and Derived Fuel	TOTAL
2000	20,305	2,826	37,595	60,726
2001	12,714	1,834	35,200	49,748
2002	13,398	1,646	38,665	53,709
2003	13,383	2,428	37,529	53,340
2004	13,281	2,216	37,576	53,073
2005	13,470	2,009	38,681	54,160
2006	14,106	2,004	38,649	54,759
2007	14,462	2,063	39,014	55,539
2008	15,520	2,214	37,300	55,034
2009	16,140	2,303	36,050	54,493
2010	16,240	2,317	37,975	56,532

Source: EIA

Note: LFG stands for Landfill Gas and MSW stands for Municipal Solid Waste

Note: The generation decrease between 2000 to 2001 reflects an EIA classification change. Beginning with 2001 data, non-biogenic municipal solid waste and tire-derived fuels were reclassified as non-renewable energy sources (previously considered waste biopower).



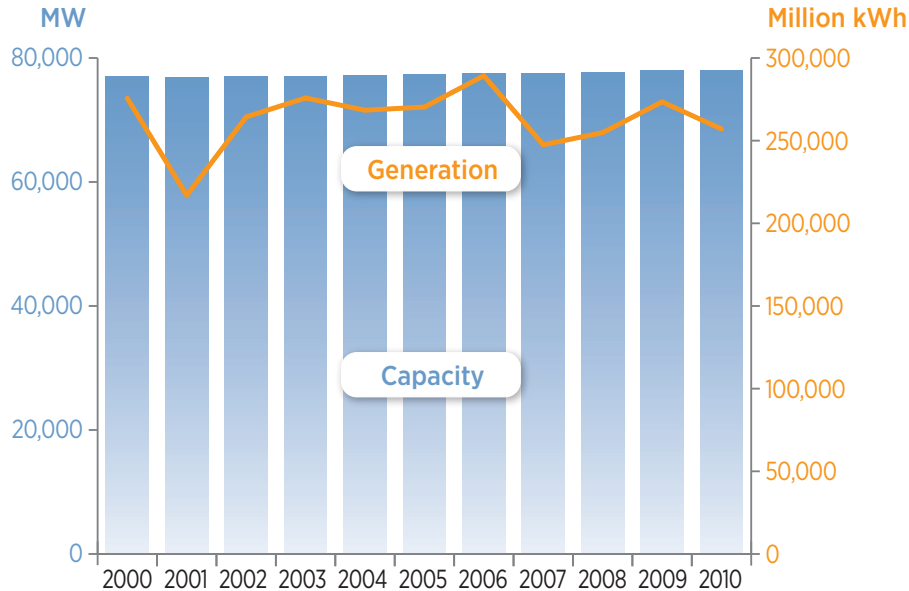
## VIII. Hydropower



# Hydropower: Summary

- Hydropower **capacity has remained constant between 2000–2010**, with generation fluctuation depending on water supply.
- Hydropower remains the largest source of renewable energy generation, and an important component of the energy mix; primarily large-scale hydropower **accounts for 6.2% of U.S. electricity generation.**

# U.S. Hydropower\* Nameplate Capacity and Generation



	U.S. Hydropower Generation (Million kWh)	U.S. Hydropower Capacity and % Increase from Previous Year	
		Total (MW)	% Increase
2000	275,573	76,946	0.0%
2001	216,961	76,911	0.0%
2002	264,329	77,047	0.2%
2003	275,806	77,020	0.0%
2004	268,417	77,130	0.1%
2005	270,321	77,354	0.3%
2006	289,246	77,419	0.1%
2007	247,510	77,432	0.0%
2008	254,831	77,640	0.3%
2009	273,455	77,910	0.3%
2010	257,052	77,931	0.0%

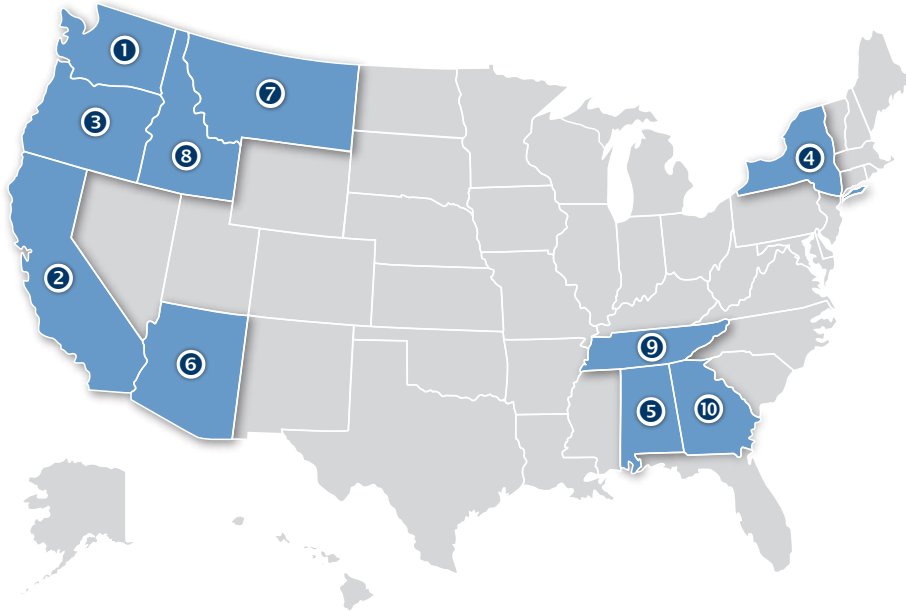
VIII

Source: EIA

\*Note: Excludes pumped storage.



# States Leading Hydropower Generation (2010)



Capacity (2010, MW)	
1 Washington .....	20,815
2 California .....	10,049
3 Oregon .....	8,240
4 New York .....	4,657
5 Alabama .....	3,280
6 Arizona .....	2,718
7 Montana .....	2,570
8 Idaho .....	2,531
9 Tennessee .....	2,479
10 Georgia .....	1,932

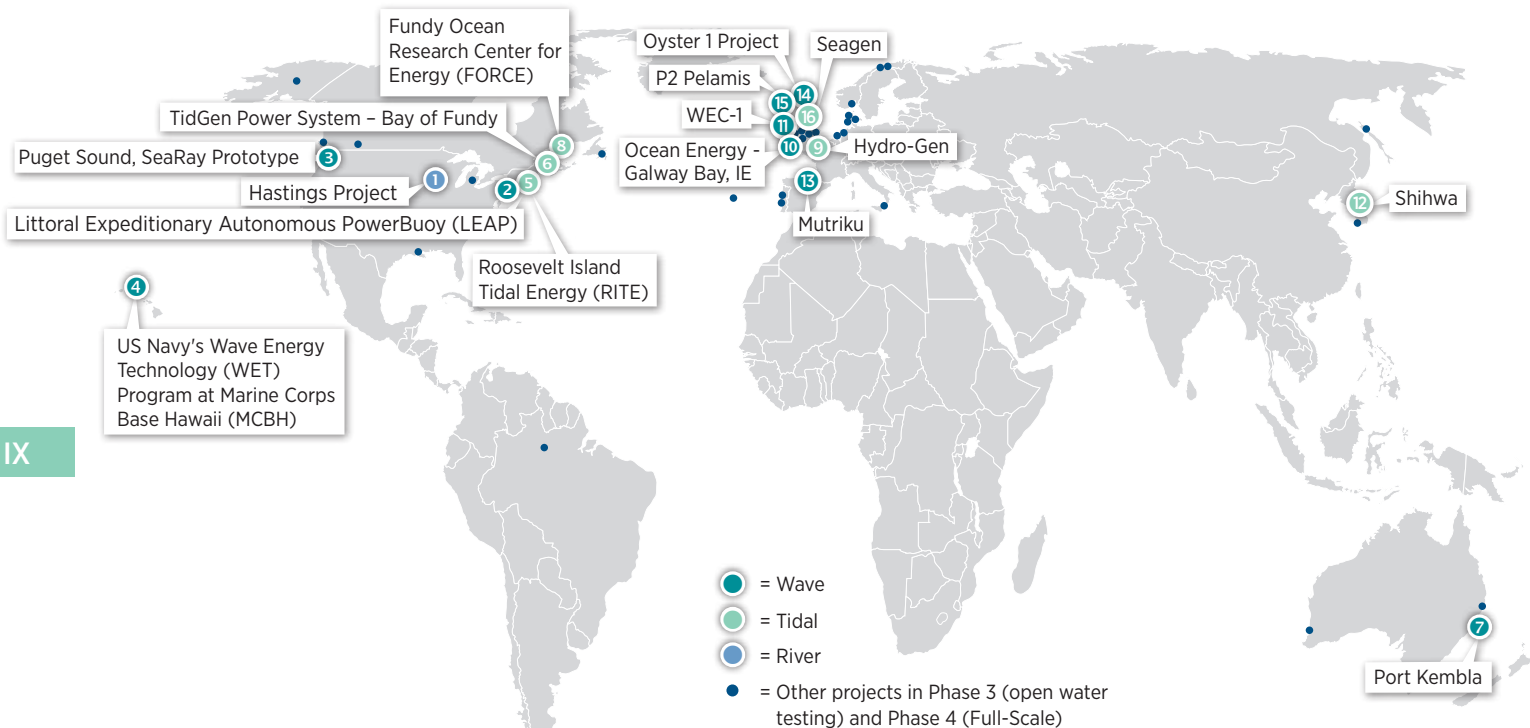


## IX. Advanced Water Power

# Advanced Water Power: Summary

- U.S. interest in advanced water power—such as **tidal, river and ocean current**, and **ocean wave** energy—is just beginning to grow, with many prototype projects in testing stages and permits being filed at the Federal Energy Regulatory Commission (FERC).
- No wave or tidal plants came online in 2010, although the U.S. currently has 68 projects that have received Preliminary Permits from FERC (as of September 2011) to commence site evaluations prior to applying for a department license.
- More information may be found at the FERC website at: <http://www.ferc.gov/industries/hydropower/gen-info/licensing/hydrokinetics.asp>

# Worldwide Advanced Water Power: Sample of Commercial and Pilot Plants



Note: Information pertaining to additional projects can be found on the EERE's Marine and Hydrokinetic Technology Database, accessible online at: <http://www1.eere.energy.gov/windandhydro/hydrokinetic/default.aspx>

Sources: FERC, EERE

# Worldwide Advanced Water Power: Sample of Commercial and Pilot Plants

PROJECT NAME	Type	Country	Location	Size (MW)	Installed
1 Hastings Project	River	United States	Mississippi River, Hastings, MN	0.07	2009
2 Littoral Expeditionary Autonomous PowerBuoy (LEAP)	Wave	United States	New Jersey	0.04	2011
3 Puget Sound, SeaRay Prototype	Wave	United States	Puget Sound, WA	0.08	2011
4 US Navy's Wave Energy Technology (WET) Program at Marine Corps Base Hawaii (MCBH)	Wave	United States	1 mile off Kaneohe Bay, Oahu, HI	0.1	2004
5 Roosevelt Island Tidal Energy (RITE)	Tidal	United States	New York City, NY	0.175	2002
6 TidGen Power System - Bay of Fundy	Tidal	United States	Maine (Bay of Fundy)	0.01	2010
7 Port Kembla	Wave	Australia	New South Wales, Port Kembla	0.45	2005
8 Fundy Ocean Research Center for Energy (FORCE)	Tidal	Canada	Bay of Fundy, Nova Scotia	1	2009
9 Hydro-Gen	Tidal	France	Brouennou	1	2011
10 Ocean Energy - Galway Bay, IE	Wave	Ireland	Galway Bay	0.015	2006
11 WEC-1	Wave	Ireland	Galway Bay (near Belmullet)	0.25	2006
12 Shihwa	Tidal	South Korea	40km south-west of Seoul	254	2011
13 Mutriku	Wave	Spain	Near Bilbao	0.3	2011
14 Oyster 1 Project	Wave	United Kingdom	Scotland Stromness, Orkney	0.315	2008
15 P2 Pelamis	Wave	United Kingdom	Scotland Stromness, Orkney	0.75	2011
16 Seagen Strangford	Tidal	United Kingdom	Northern Ireland Strangford Narrows	1.2	2003

Note: Information pertaining to additional projects can be found on the EERE's Marine and Hydrokinetic Technology Database, accessible online at: <http://www1.eere.energy.gov/windandhydro/hydrokinetic/default.aspx>

Sources: FERC, EERE

X. Hydrogen



# Hydrogen: Summary

- At the end of 2010, there were approximately **58 hydrogen fueling stations** in the United States.
- An estimated 156 fuel cell vehicles are available in the United States to date.
- There are over 1,000 stationary fuel cell installations worldwide, 22 of which are greater than 1 MW in capacity.

X

# Hydrogen – Transportation

## Hydrogen Production

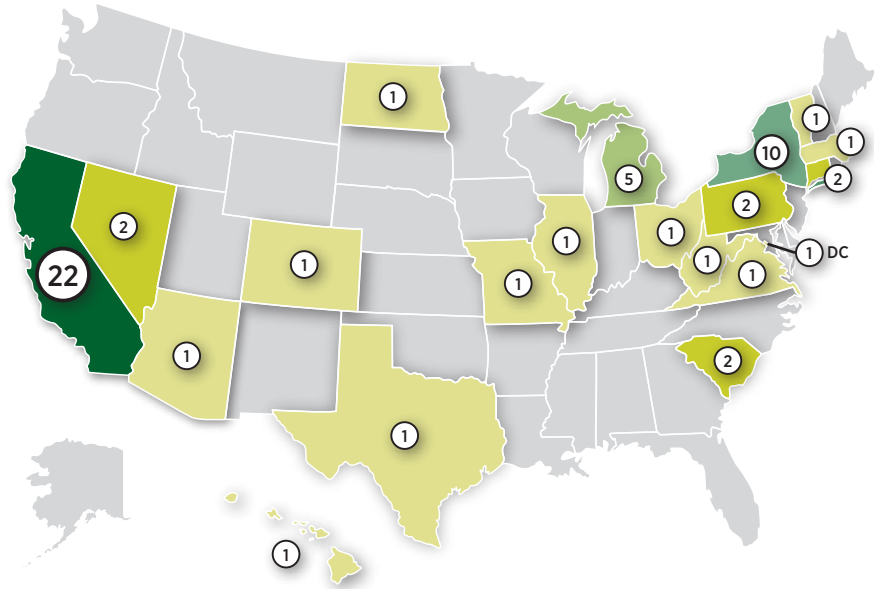
**50 million tons** of hydrogen are produced each year worldwide; **9 million tons** are consumed in the United States.

Approximately **60%** is used for making ammonia for fertilizer; **23%** is used to make gasoline cleaner by removing sulfur; **9%** is used to make methanol; and the remainder is for chemical processing, metal production, electronics, and for space exploration.

X

## Number of Operational U.S. Hydrogen Fueling Stations

(December 2010 – Total of 58)

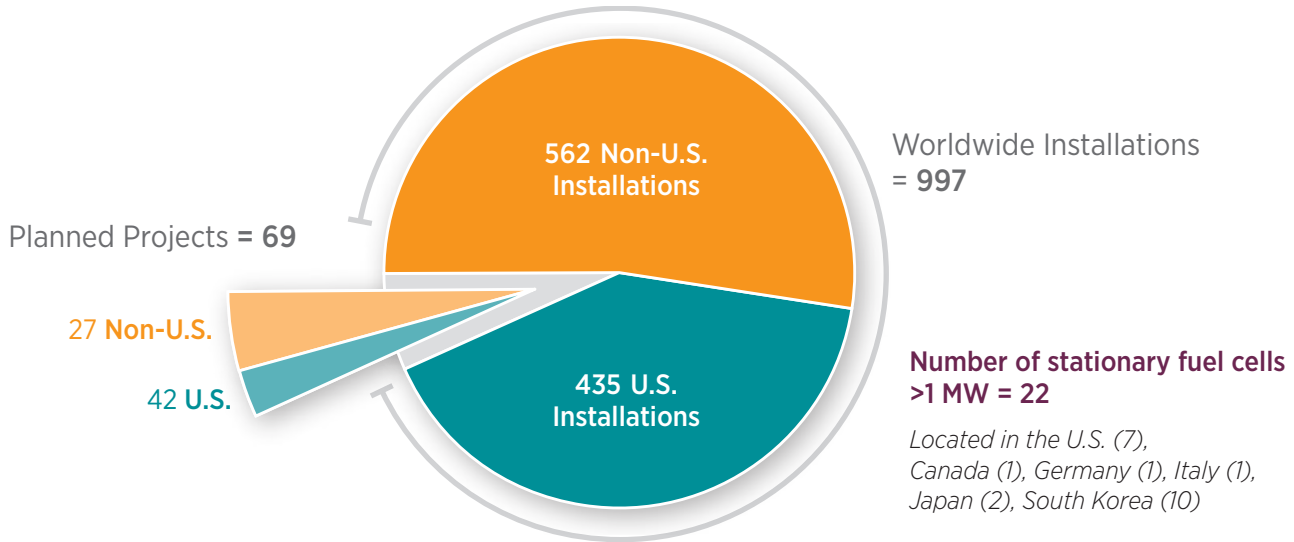


Number of recorded fuel cell vehicles in the United States = 156



# Hydrogen – Electricity

## Stationary Fuel Cell Installations (2010)





## XI. Renewable Fuels

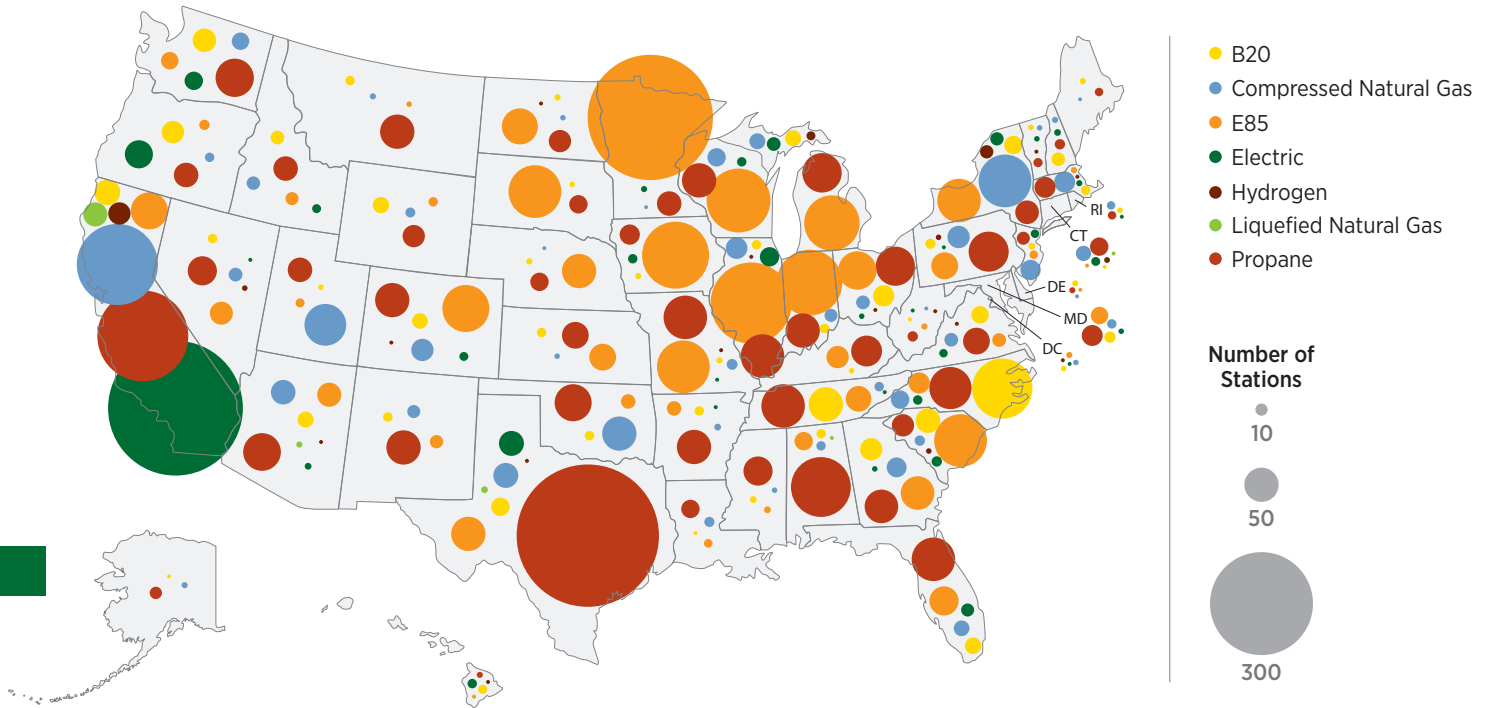
# Renewable Fuels – Ethanol: Summary

- Corn ethanol production continues to expand rapidly in the United States. **Between 2000 and 2010, production increased nearly 8 times.**
- Ethanol production **grew nearly 19% in 2010** to reach **13,000 million gallons** per year.
- Ethanol has steadily increased its percentage of the overall gasoline pool, and was **9.4%** in 2010.
- In 2010, the United States\* produced 56.5% of the world's ethanol, followed by Brazil at 30.1%, the European Union at 5.1%, China at 2.4%, and Canada at 1.5%.

\* Most U.S. ethanol is currently produced from corn (in contrast to Brazil's ethanol coming from sugar cane); but efforts are underway by the U.S. Department of Energy and others to commercialize cellulosic ethanol, which is produced from non-food crops.

Note: Ethanol is blended with gasoline and generally comprises up to 10% of the fuel with gasoline as the other 90% (E10). Additionally, flex-fuel vehicles use a blend of 85% ethanol and 15% gasoline (E85).

# Alternative Fueling Stations by State

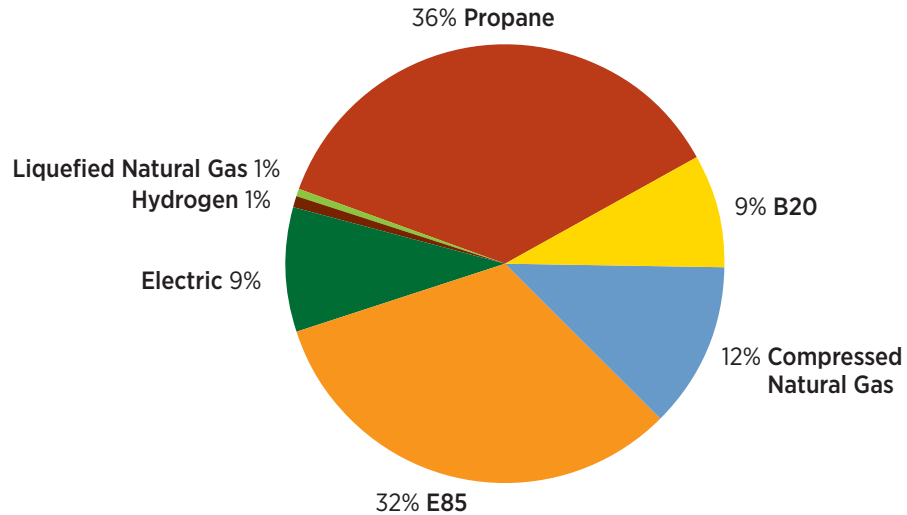


XI

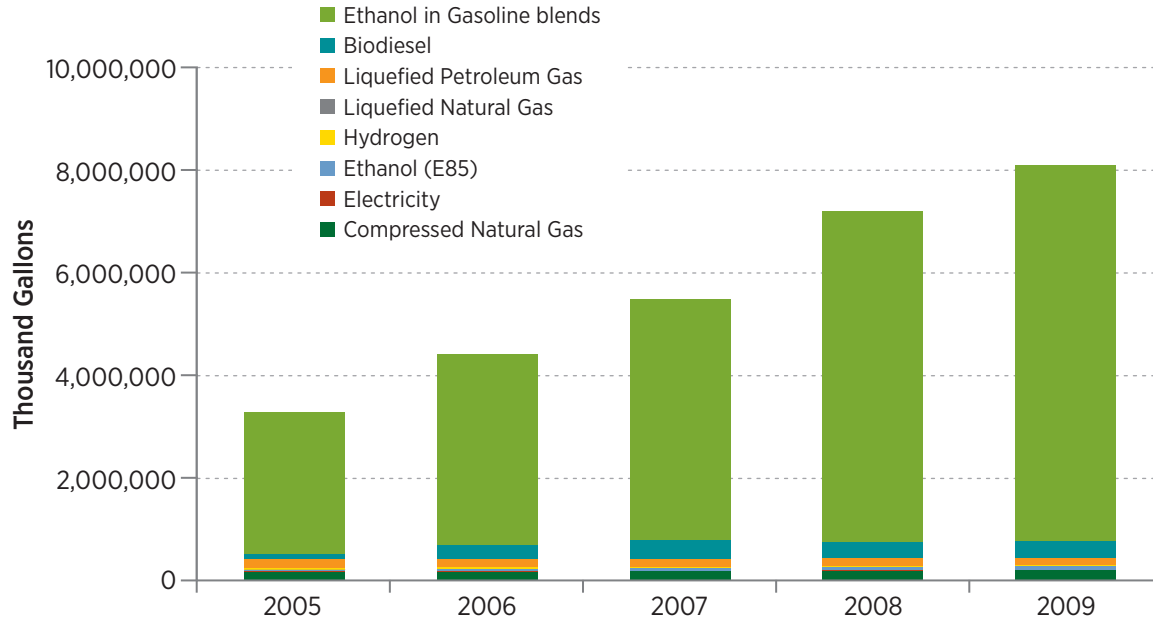
Note: Data as of 12/31/2010  
Sources: EERE, EIA

# Alternative Fueling Stations

7,149 alternative fueling stations in the U.S.



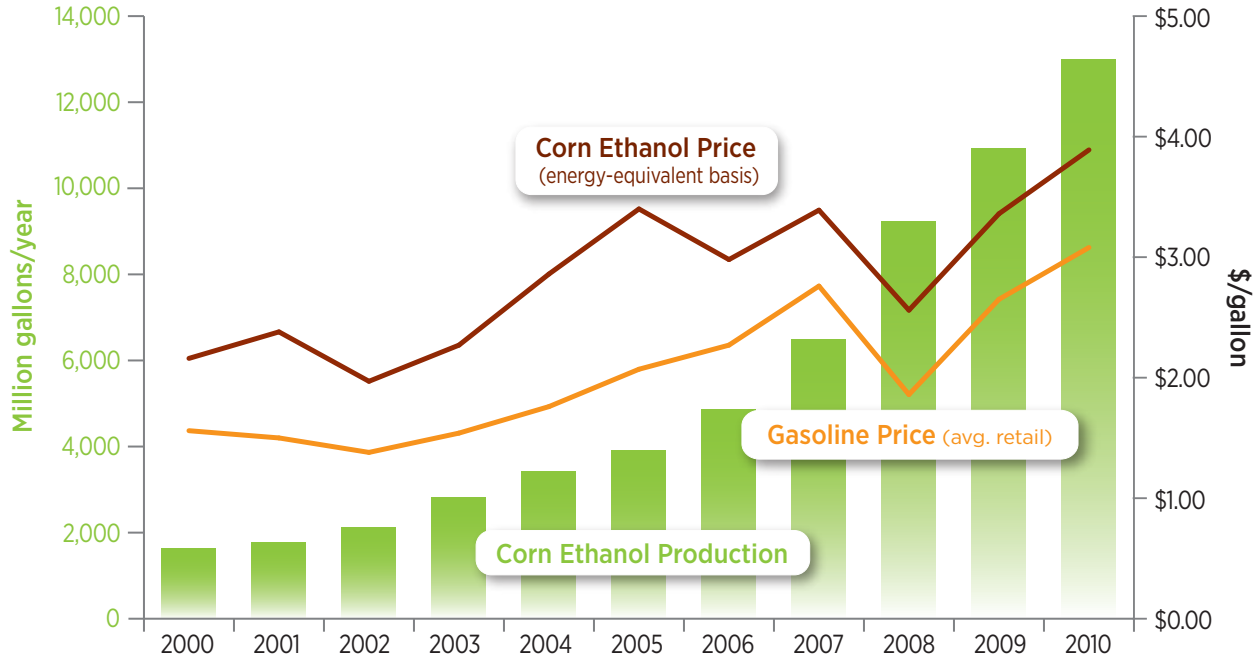
# Consumption of Alternative Fuel in the U.S. (2005-2009)



XI

# U.S. Corn Ethanol Production and Price Trends

In 2010, there were **1,424,878 ethanol (E85) fueled vehicles** on the road in the U.S.



XI

# U.S. Ethanol Production and Growth in Gasoline Pool by Volume

	Gasoline Pool (Million gallons/yr)	Ethanol Production (Million gallons/yr)	Annual Growth (%)	Percent of Gasoline Pool
2000	128,662	1,630	11.0%	1.3%
2001	129,312	1,770	8.6%	1.4%
2002	132,782	2,130	20.3%	1.6%
2003	134,089	2,810	31.9%	2.1%
2004	137,022	3,410	21.4%	2.5%
2005	136,949	3,905	14.5%	2.9%
2006	138,378	4,855	24.3%	3.5%
2007	142,287	6,485	33.6%	4.6%
2008	137,797	9,235	42.4%	6.7%
2009	137,736	10,935	18.4%	7.9%
2010	138,456	13,000	18.9%	9.4%

## U.S. Ethanol Distribution and Utilization

**2,318 E85 stations** (December 2010)

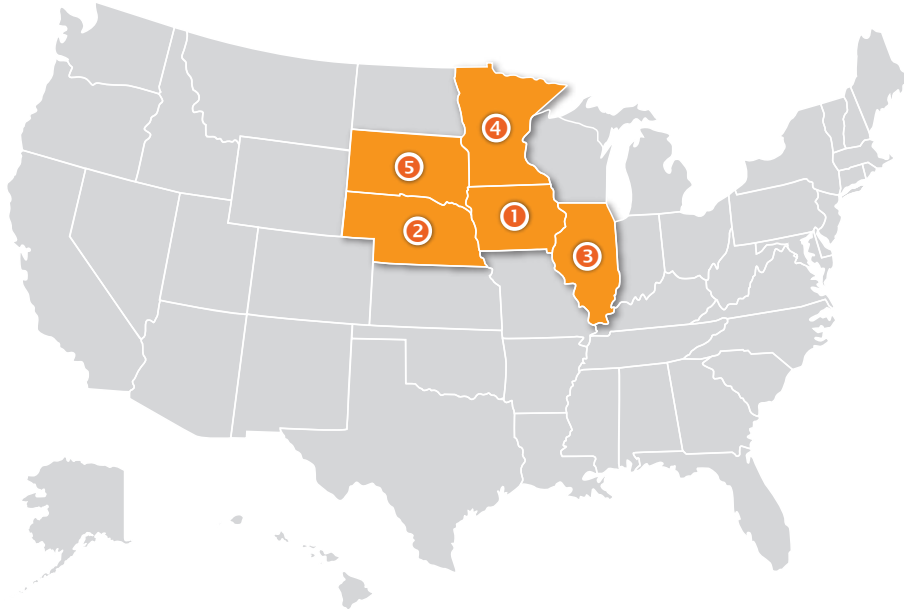
E85 average retail price (January 2011):  
**\$3.89/gallon** (gasoline gallon equivalent  
basis), gasoline price: \$3.08/gallon

**Approximately 8 million flex-fuel  
vehicles (FFV)** are on the road

XI



# U.S. Ethanol Production Capacity



Top Five States for U.S. Ethanol (operating) Production Capacity in 2010 (millions of gallons)	
1 Iowa.....	3,595
2 Nebraska.....	1,839
3 Illinois.....	1,480
4 Minnesota.....	1,119
5 South Dakota.....	1,016

Note: No sugarcane ethanol is currently produced in the United States.  
Source: RFA

# U.S. Ethanol Production Capacity

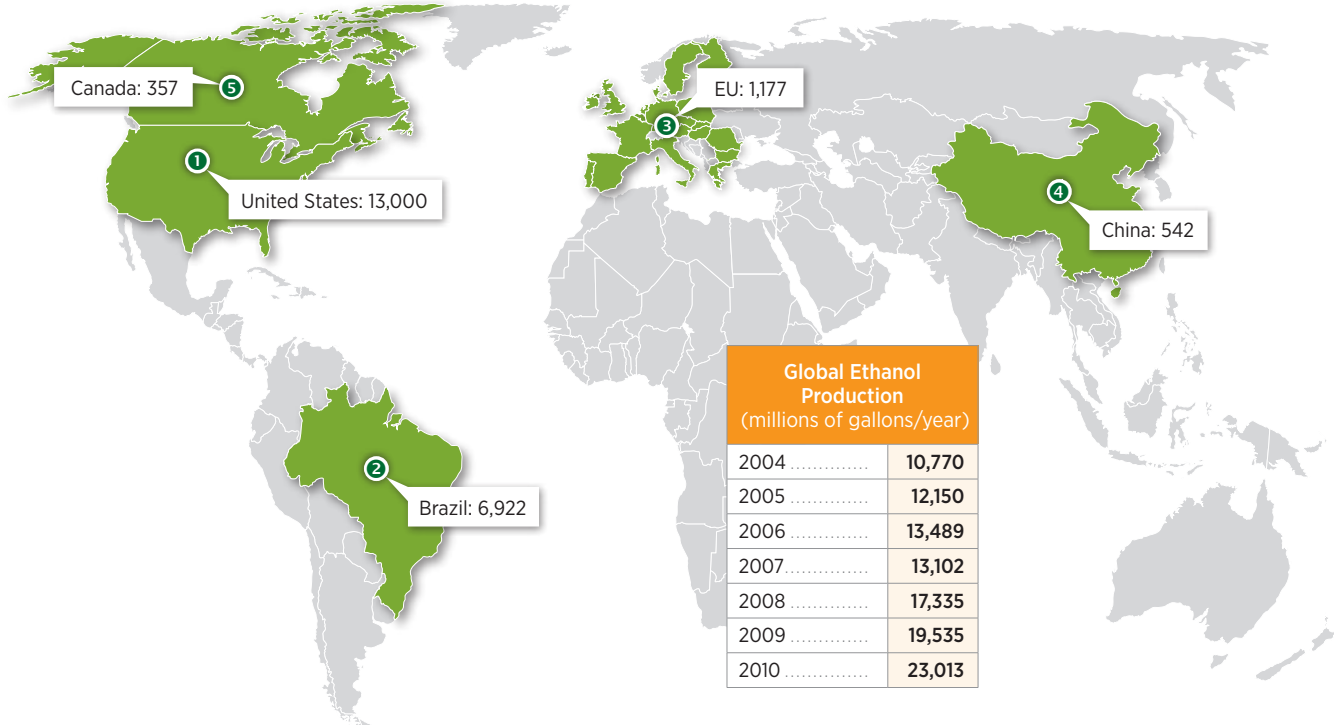
## Total U.S. Ethanol Operating Production Capacity (2010):

13,507.9 million gallons/year (mmgy)

Top Five Ethanol Companies —Production Capacity 2010 (millions of gallons/year)	
1 Archer Daniels Midland Co. ....	1,750
2 Poet Biorefining .....	1,537
3 Valero Renewable Fuels .....	1,130
4 Green Plains Renewable Energy.....	657
5 Flint Hills Resources .....	420

# Global Ethanol Production

## Top Five Countries (2010) Ethanol Production (millions of gallons/year)

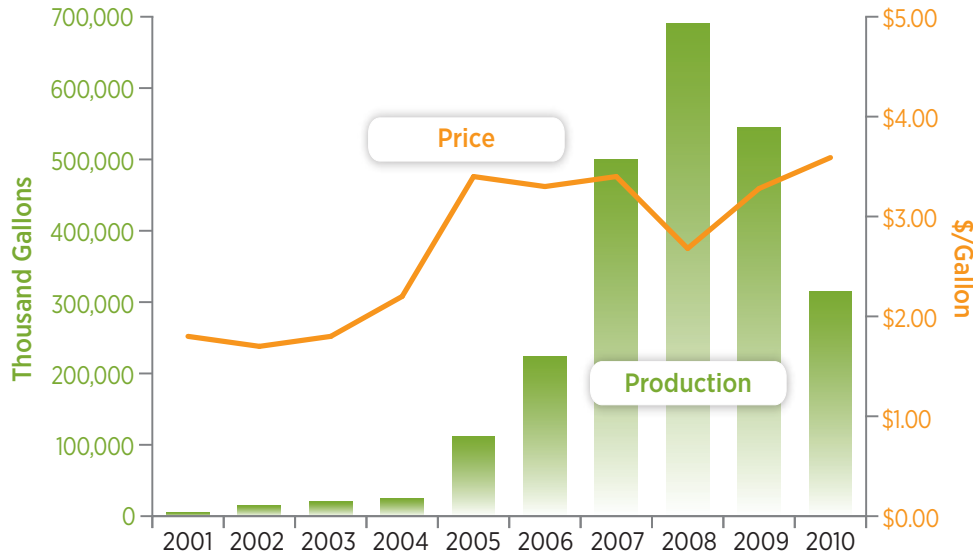


Global Ethanol Production (millions of gallons/year)	
2004 .....	10,770
2005 .....	12,150
2006 .....	13,489
2007 .....	13,102
2008 .....	17,335
2009 .....	19,535
2010 .....	23,013

# Renewable Fuels – Biodiesel: Summary

- Biodiesel has expanded from a relatively small production base in 2000, to a total U.S. production of **315 million gallons** in 2010. However, biodiesel is still a small percentage of the alternative fuel pool in the U.S., as over 40 times more ethanol was produced in 2010.
- Biodiesel production in the U.S. in 2010 is **63 times** what it was in 2001.
- Germany leads the world in biodiesel production, followed by Brazil, Argentina and France.
- Biodiesel production globally grew more than 14% in 2010.

# U.S. Biodiesel Demand and Price (2000–2010)



	Annual Growth	Total Production (thousand gallons)
2000	300%	2,000
2001	150%	5,000
2002	200%	15,000
2003	33%	20,000
2004	25%	25,000
2005	348%	112,000
2006	100%	224,000
2007	123%	500,000
2008	38%	691,000
2009	(21%)	545,000
2010	(42%)	315,000

XI

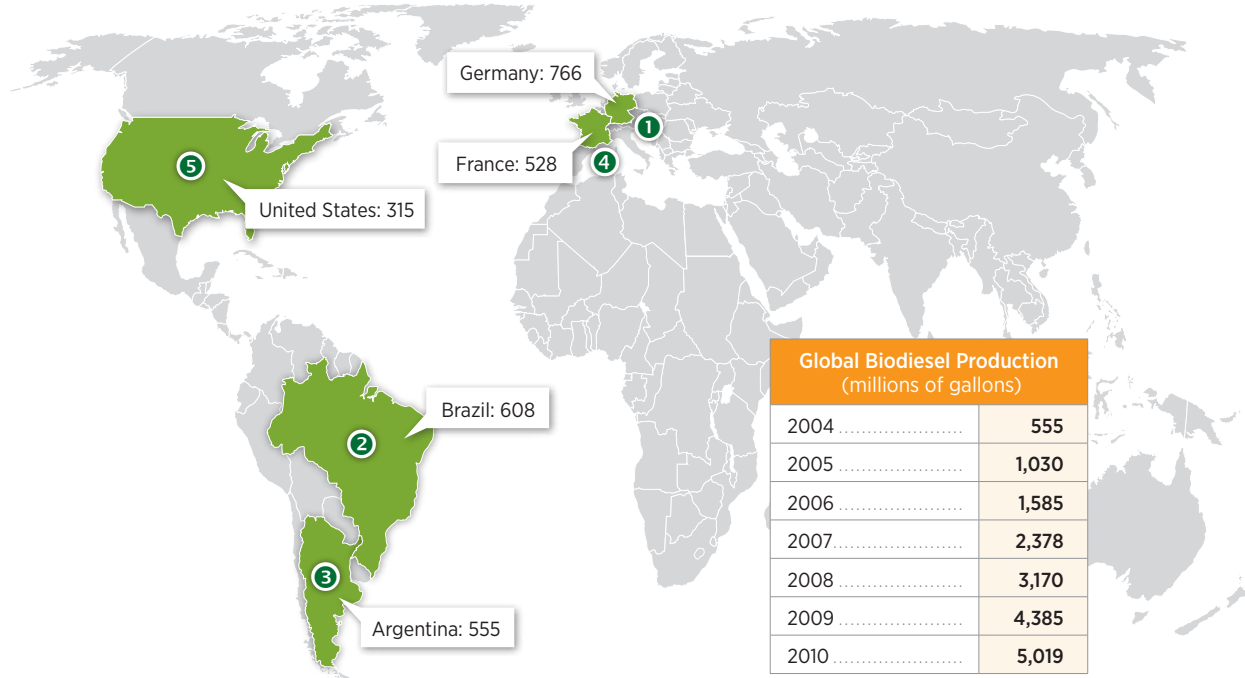
# U.S. Biodiesel Production Capacity

**Total U.S. Biodiesel Production Capacity (2010):** 2,504.0 million gallons/year (mmgy)

Top Five Biodiesel Companies — Production Capacity 2010 (millions of gallons/year)	
1 Renewable Energy Group, Inc.....	182
2 Renewable Biofuels, Inc.....	180
3 Imperium Renewables, Inc.....	100
4 Green Earth Fuels, LLC.....	90
5 Archer Daniels Midland Company.....	85

# Global Biodiesel Production

## Top Five Countries (2010) Biodiesel Production (millions of gallons)





**XII. Clean Energy Investments**

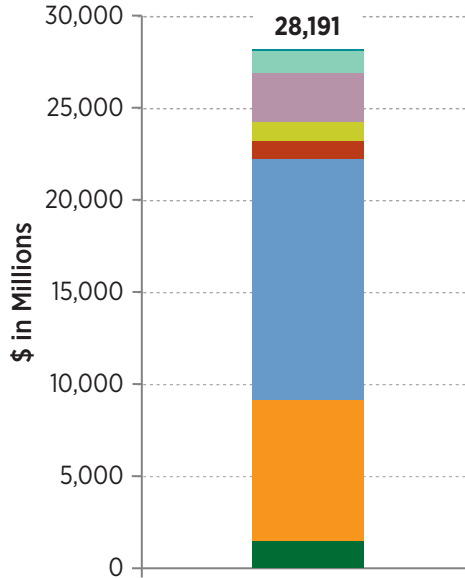


# Clean Energy Investments: Summary

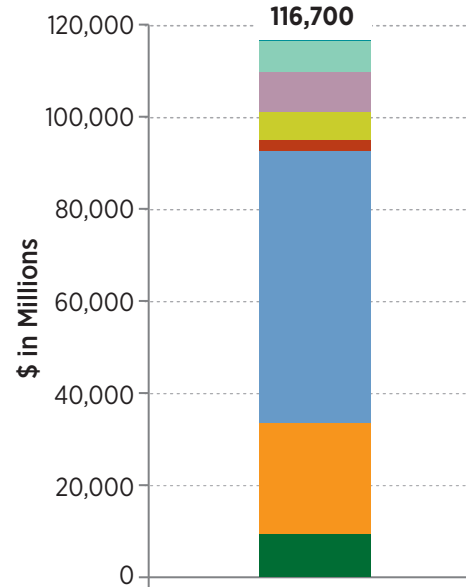
- U.S. investment in renewable energy has grown dramatically in the past decade, and in **2010 annual investment reached more than \$28 billion.**
- U.S. investment in wind energy projects **grew from \$303 million in 2001 to more than \$13 billion in 2010.**
- In 2010, U.S. venture capital and private equity investment in renewable energy technology companies was **\$2.7 billion—up from \$261 million in 2001.**
- U.S. venture capital and private equity investment in solar technology companies has **increased from \$40 million in 2001 to more than \$1.7 billion in 2010.**

# U.S. and Global Total Investment in Renewable Energy, 2010 (\$ millions)

## U.S. Total Investment



## Global Total Investment

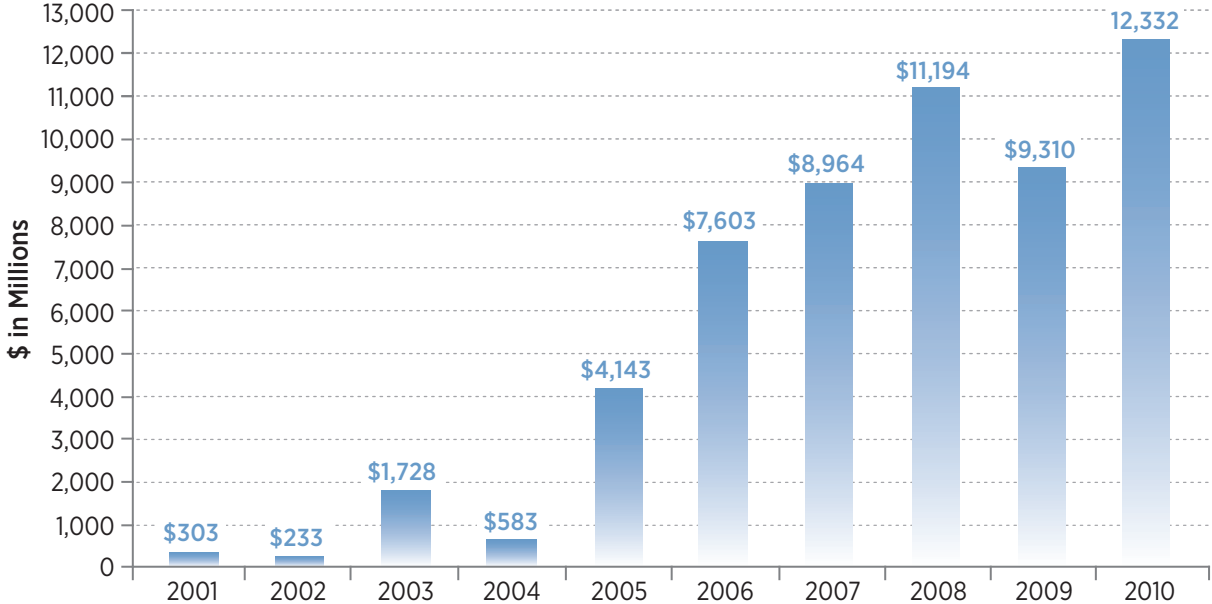


- Power Storage
- Efficiency
- Marine
- Fuel Cells
- Biopower
- Geothermal
- Wind
- Solar
- Biofuels

XII

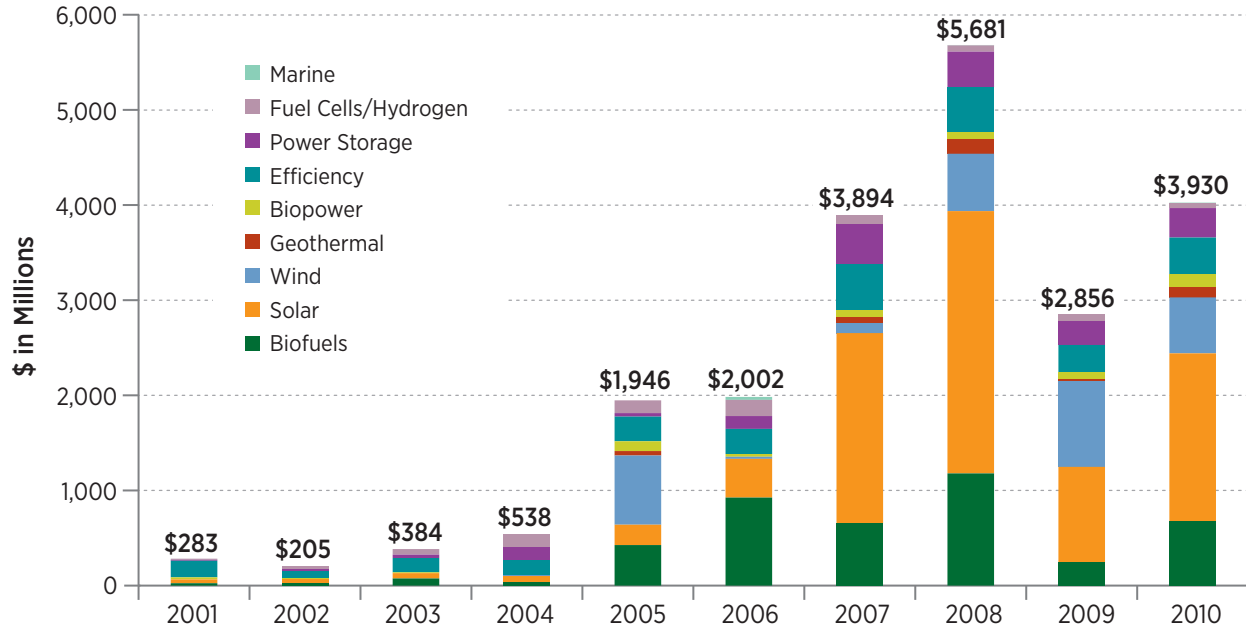
Source: Bloomberg New Energy Finance  
Completed and disclosed deals only. Does not adjust for undisclosed transactions.  
Includes VC/PE, public market activity, and asset financing.

# U.S. Wind Energy Project Asset Financing Transactions (\$ millions), 2001-2010



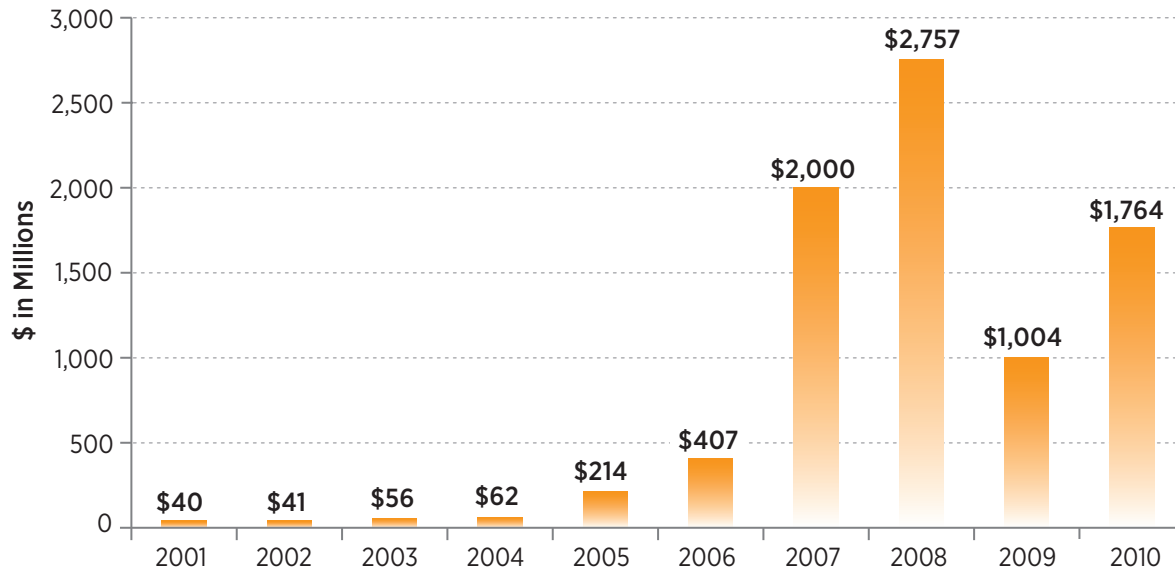
Figures represent disclosed deals derived from Bloomberg New Energy Finance's Desktop database.

# U.S. Venture Capital and Private Equity Investment (\$ millions) in Renewable Energy Technology Companies, 2001–2010

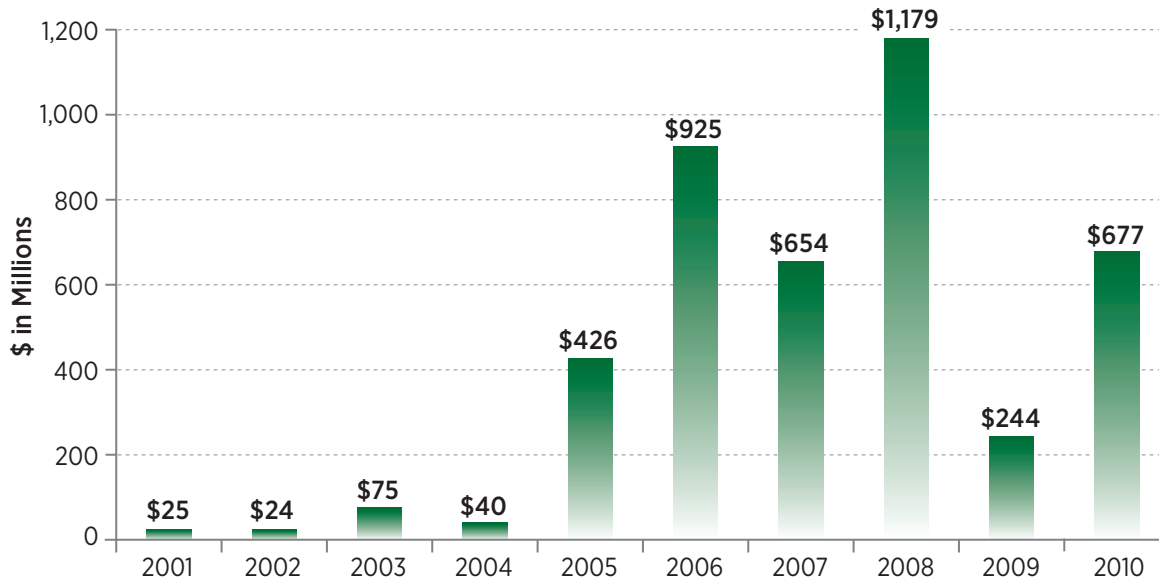


XII

# U.S. Venture Capital and Private Equity Investment (\$ millions) in Solar Energy Technology Companies, 2001–2010



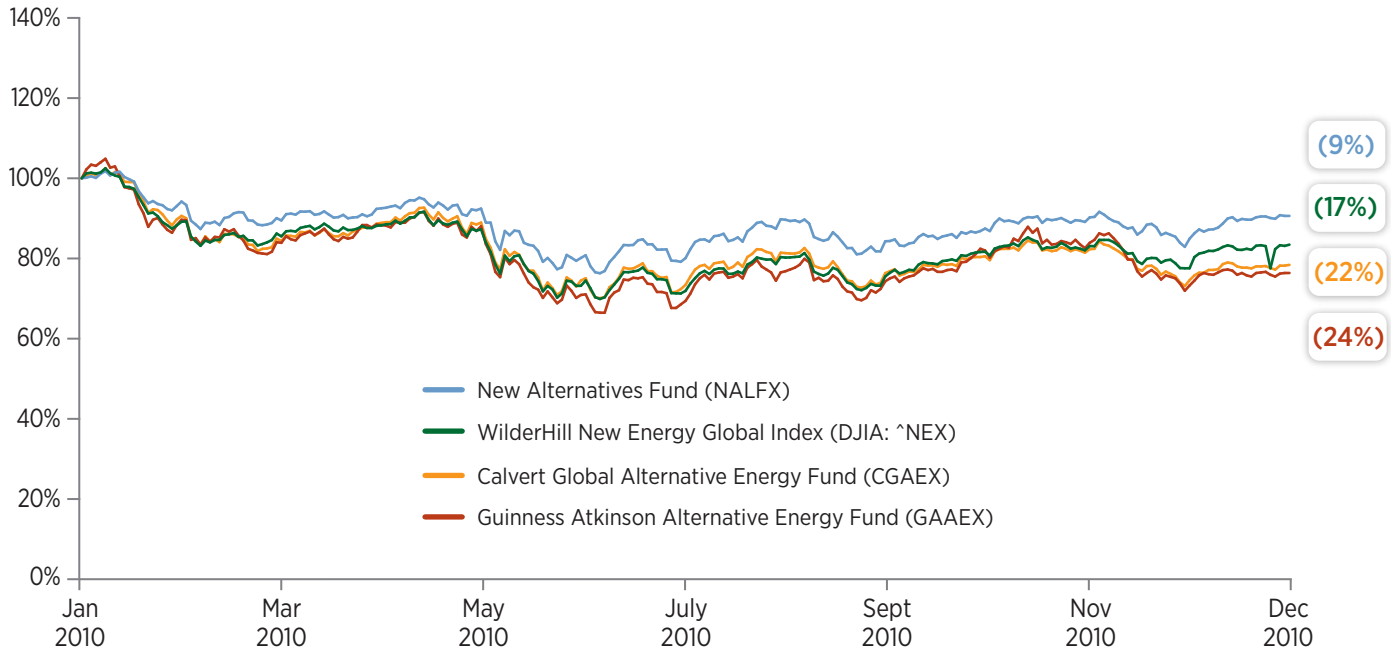
# U.S. Venture Capital and Private Equity Investment (\$ millions) in Biofuels Technology Companies, 2001-2010



XII

Figures represent disclosed deals derived from  
Bloomberg New Energy Finance's Desktop database.

# Public Renewable Energy Index Performance, 2010 (Indexed to 100)







# Glossary

## B2O

A fuel containing a mixture of 20 percent biodiesel and 80 percent petrodiesel.

## Base-load capacity

The generating equipment normally operated to serve loads on an around-the-clock basis.

## Biodiesel

Any liquid biofuel suitable as a diesel fuel substitute or diesel fuel additive or extender. Biodiesel fuels are typically made from oils such as soybeans, rapeseed, or sunflowers; or from animal tallow. Biodiesel can also be made from hydrocarbons derived from agricultural products such as rice hulls.

## Biofuels

Liquid fuels and blending components produced from biomass (plant) feedstocks, used primarily for transportation.

## Biomass

Organic non-fossil material of biological origin constituting a renewable energy source.

## British Thermal Unit (Btu)

The quantity of heat required to increase the temperature of 1 pound of liquid water by 1 degree Fahrenheit at the temperature at which water has its greatest density (approximately 39 degrees Fahrenheit).

## Capacity Factor

The ratio of the electrical energy produced by a generating unit for the period of time considered to the electrical energy that could have been produced at continuous full power operation during the same period.

## Compound Annual Growth Rate

The year-over-year growth rate applied during a multiple-year period. The formula for calculating CAGR is  $(\text{Current Value} / \text{Base Value})^{(1/\# \text{ of years})} - 1$ .

## Concentrating Solar Power (CSP)

A solar energy conversion system characterized by the optical concentration of solar rays through an arrangement of mirrors to heat working fluid to a high temperature. Concentrating solar power (but not solar thermal power) may also refer to a system that focuses solar rays on a photovoltaic cell to increase conversion efficiency.

## Cost

The amount paid to produce a good or service. Cost represents the sum of the value of the inputs in production

## Direct Use

Use of electricity that (1) is self-generated, (2) is produced by either the same entity that consumes the power or an affiliate, and (3) is used in direct support of a service or industrial process located within the same facility or group of facilities that house the generating equipment. Direct use is exclusive of station use.

## E85

A fuel containing a mixture of 85 percent ethanol and 15 percent gasoline.

## Ethanol

A clear, colorless, flammable oxygenated hydrocarbon. Ethanol is typically produced chemically from ethylene, or biologically from fermentation of various sugars from carbohydrates found in agricultural crops and cellulosic residues from crops or wood. It is used in the United States as a gasoline octane enhancer and oxygenate (blended up to 10 percent concentration). Ethanol can also be used in high concentrations (E85) in vehicles designed for its use.

## Federal Energy Regulatory Commission (FERC)

The federal agency with jurisdiction over interstate electricity sales, wholesale electric rates, hydroelectric licensing, natural gas pricing, oil pipeline rates, and gas pipeline certification. FERC is an independent regulatory agency within the Department of Energy (DOE) and is the successor to the Federal Power Commission.

## Flexible-Fuel Vehicles

Vehicles that can operate on (1) alternative fuels (such as E85); (2) 100 percent petroleum-based fuels; (3) any mixture of an alternative fuel (or fuels) and a petroleum-based fuel. Flexible-fuel vehicles have a single fuel system to handle alternative and petroleum-based fuels.

## Fuel Cell

A device capable of generating an electrical current by converting the chemical energy of a fuel (e.g., hydrogen) directly into electrical energy. Fuel cells differ from conventional electrical cells in that the active materials such as fuel and oxygen are not contained within the cell but are supplied from outside. It does not contain an intermediate heat cycle, as do most other electrical generation techniques.

## Gasoline Pool

All gasoline produced by volume, including any additions such as ethanol or methyl tertiary-butyl ether (MTBE).

## Generation

The total amount of electric energy produced by generating units and measured at the generating terminal in kilowatt-hours (kWh) or megawatt-hours (MWh).

## Geothermal Energy

The heat that is extracted from hot water or steam that is mined from geothermal reservoirs in the earth's crust. Water or steam can be used as a working fluid for geothermal heat pumps, water heating, or electricity generation, and then is injected back into the earth.

## Geothermal Heat Pump

A heat pump in which the refrigerant exchanges heat (in a heat exchanger) with a fluid circulating through an earth connection medium (ground or ground water). The fluid is contained in a variety of loop (pipe) configurations depending on the temperature of the ground and the ground area available. Loops may be installed horizontally or vertically in the ground or submersed in a body of water.

# Glossary

## Gigawatt (GW)

One billion watts or one thousand megawatts.

## Gigawatt-hour (GWh)

One billion watt-hours.

## Incremental Capacity

Capacity added on an annual basis.

## Insolation

The amount of radiation from the sun received at the surface of the Earth in a particular geographic location or region.

## Kilowatt (kW)

One thousand watts.

## Kilowatt-hour (kWh)

A measure of electricity defined as a unit of work or energy, measured as 1 kilowatt (1,000 watts) of power expended for 1 hour. One kWh is equivalent to 3,412 Btu.

## Landfill Gas

Gas that is generated by decomposition of organic material at landfill disposal sites. The average composition of landfill gas is approximately 50% methane and 50% carbon dioxide and water vapor by volume. The methane in landfill gas may be vented, flared, or combusted to generate electricity or useful thermal energy on-site, or injected into a pipeline for combustion off-site.

## Levelized Cost

The present value of the total cost of building and operating a generating plant over its economic life, converted to equal annual payments. Costs are levelized in real dollars (i.e., adjusted to remove the impact of inflation).

## Megawatt (MW)

One million watts of electricity.

## Megawatt-hour (MWh)

One thousand kilowatt-hours or 1 million watt-hours.

## Municipal Solid Waste (MSW)

Residential solid waste and some nonhazardous commercial, institutional, and industrial wastes.

## Nameplate Capacity

The maximum rated output of a generator under specific conditions designated by the manufacturer. Nameplate capacity is usually indicated in units of kilovolt-amperes (kVA) and in kilowatts (kW) on a nameplate physically attached to the generator.

## Ocean Energy

Energy conversion technologies that harness the energy in tides, waves, and thermal gradients in the oceans.

# Glossary

## Photovoltaic (PV) Cell

An electronic device consisting of layers of semiconductor materials fabricated to form a junction (adjacent layers of materials with different electronic characteristics) and electrical contacts and being capable of converting incident light directly into electricity (direct current).

## Price

The amount paid to acquire a good or service.

## Pumped-Storage Hydroelectric Plant

A plant that usually generates electric energy during peak load periods by using water previously pumped into an elevated storage reservoir during off-peak periods when excess generating capacity is available to do so. When additional generating capacity is needed, the water can be released from the reservoir through a conduit to turbine generators located in a power plant at a lower level.

## Renewable Energy Resources

Energy resources that are naturally replenishing but flow-limited. They are virtually inexhaustible in duration but limited in the amount of energy that is available per unit of time. Renewable energy resources include: biomass, hydro, geothermal, solar, wind, ocean thermal, wave action, and tidal action.

## Solar Thermal Collector

A device designed to receive solar radiation and convert it to thermal energy. Normally, a solar thermal collector includes a frame, glazing, and an absorber, together with appropriate insulation. The heat collected by the solar collector may be used immediately or stored for later use. Solar collectors are used for space heating; domestic hot water heating; and heating swimming pools, hot tubs, or spas.

## Thermoelectric Power Plant

A term used to identify a type of electric generating station, capacity, capability, or output in which the source of energy for the prime mover is heat.

## Wind Energy

Kinetic energy present in wind motion that can be converted to mechanical energy for driving pumps, mills, and electric power generators.

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DOE/GO-102011-3310  
October 2011

Prepared by the National Renewable Energy Laboratory (NREL)  
NREL is a national laboratory of the U.S. Department of Energy  
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