

2008 Renewable Energy Data Book



Acknowledgments

This report was produced by Rachel Gelman and Steve Hockett, edited by Michelle Kubik, and designed by Stacy Buchanan of the National Renewable Energy Laboratory (NREL). We greatly appreciate the input and reviews received from Jacques Beaudry-Losique, Sunita Satyapal, and Jesse Johnson of the U.S. Department of Energy; and Robert Remick, Fort Felker, Doug Arent, Nate Blair, and Selya Price of NREL.

Photo on front page courtesy of NASA

© 2009 U.S. Department of Energy

Key Findings

- Although renewable energy (excluding hydropower) is a relatively small portion of total energy supply both globally and in the United States, **renewable energy installations in both the world and in the United States have nearly tripled between 2000 and 2008.**
- Including hydropower, **renewable energy represents nearly 11% of total installed capacity and more than 9% of total generation in the United States in 2008.**
Installed renewable energy capacity (including hydropower) is 119 gigawatts (GW).
Not including hydropower, 2008 renewable electricity installed capacity has reached about 42 GW in the United States.
- In the United States, growth in sectors such as wind and solar photovoltaics (PV) signify an ongoing shift in the composition of our electricity supply. **In 2008, cumulative wind capacity increased by 51% and cumulative solar PV capacity grew 44% from the previous year.**

Key Findings, *continued*

- Worldwide, wind energy is the fastest growing renewable energy technology—**between 2000 and 2008, wind energy generation worldwide increased by a factor of almost 7**. The United States experienced even more dramatic growth, as installed wind energy capacity increased almost 10 times between 2000 and 2008.
- In the United States, renewable energy has been capturing a growing percent of new capacity additions during the past few years. **In 2008, renewable energy accounted for more than 43% of all new grid-connected electrical capacity installations in the United States**—a large contrast 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 2008, production of corn ethanol increased more than 5 times, and biodiesel production increased 350 times**. Use of ethanol in the United States has also grown substantially, and it currently accounts for 6.5% of the total U.S. gasoline pool, up from 1% in 2000.

Table of Contents

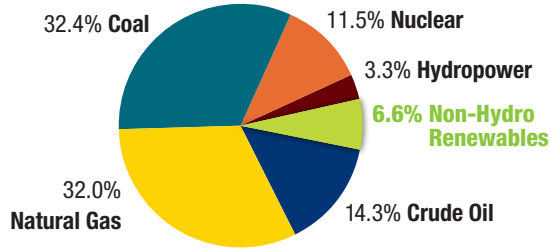
U.S. Energy Background Information	I
Renewable Electricity in the U.S.	II
Global Renewable Energy Development	III
Wind	IV
Solar	V
Geothermal	VI
Biopower	VII
Hydropower	VIII
Advanced Water Power	IX
Hydrogen	X
Renewable Fuels	XI
Clean Energy Investments	XII
Glossary	XIII
References	XIV

I. U.S. Energy Background Information

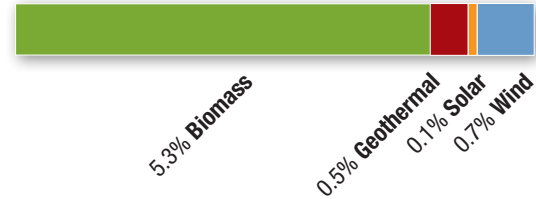


U.S. Energy Production and Consumption (2008)

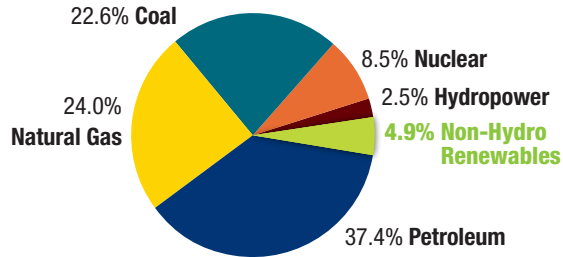
U.S. Energy Production (2008): 73.7 Quadrillion Btu



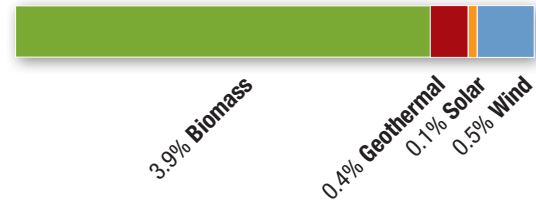
U.S. Non-Hydro Renewable Energy Production: 4.9 Quadrillion Btu



U.S. Energy Consumption (2008): 99.3 Quadrillion Btu



U.S. Non-Hydro Renewable Energy Consumption: 4.8 Quadrillion Btu



Source: EIA; full references are provided starting on p. 122.

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 (%) 2000–2008

	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	31.4%	31.4%	17.1%	11.3%	4.0%	4.7%	70.3
2004	32.5%	30.6%	16.3%	11.7%	3.8%	5.1%	70.4
2005	33.3%	30.1%	15.7%	11.7%	3.9%	5.3%	69.6
2006	33.5%	30.1%	15.3%	11.6%	4.1%	5.5%	71.0
2007	32.7%	31.0%	15.1%	11.7%	3.4%	6.0%	71.7
2008	32.4%	32.0%	14.3%	11.5%	3.3%	6.6%	73.7

Source: EIA

* Includes natural gas plant liquids.

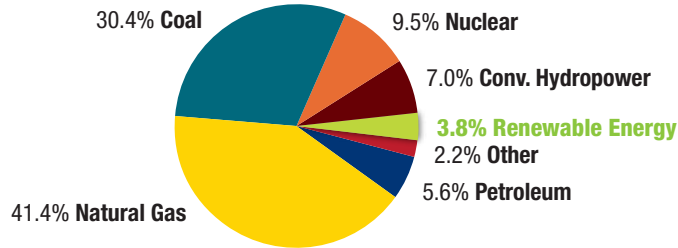
Note: Annual totals may not equal 100% due to rounding.

U.S. Energy Consumption by Energy Source (%) 2000–2008

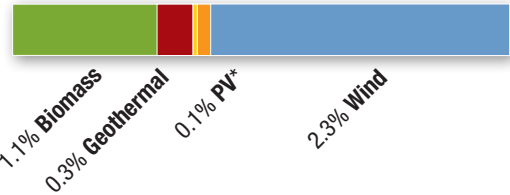
	Coal	Natural Gas	Petroleum	Nuclear	Hydropower	Non-Hydro Renewables	Total Consumption (Quadrillion Btu)
2000	22.8%	24.1%	38.7%	7.9%	2.8%	3.5%	99.0
2001	22.8%	23.6%	39.6%	8.3%	2.3%	3.2%	96.3
2002	22.4%	24.1%	39.1%	8.3%	2.7%	3.3%	97.9
2003	22.7%	23.3%	39.5%	8.1%	2.9%	3.4%	98.2
2004	22.4%	22.9%	40.2%	8.2%	2.7%	3.6%	100.4
2005	22.6%	22.7%	40.1%	8.1%	2.7%	3.7%	100.5
2006	22.5%	22.5%	39.8%	8.2%	2.9%	4.1%	99.9
2007	22.4%	23.3%	39.2%	8.3%	2.4%	4.2%	101.6
2008	22.6%	24.0%	37.4%	8.5%	2.5%	4.9%	99.3

U.S. Nameplate Capacity and Generation

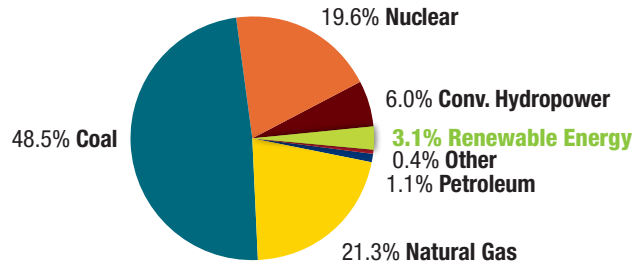
U.S. Electric Nameplate Capacity (2008): 1,109 GW



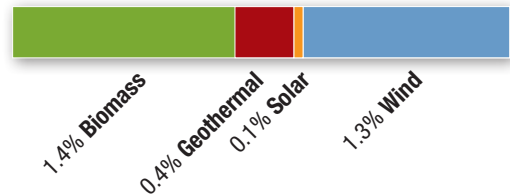
U.S. Renewable Capacity: 42 GW



U.S. Electric Net Generation (2008): 4,112 billion kWh



U.S. Renewable Generation: 125 billion kWh



Source: EIA

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

* Includes on- and off-grid capacity.

U.S. Electric-Generating Capacity by Source (%) 2000–2008

	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	36.8%	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%	40.2%	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	30.4%	5.6%	41.4%	0.2%	9.5%	7.0%	3.8%	-1.8%	0.1%	1,109

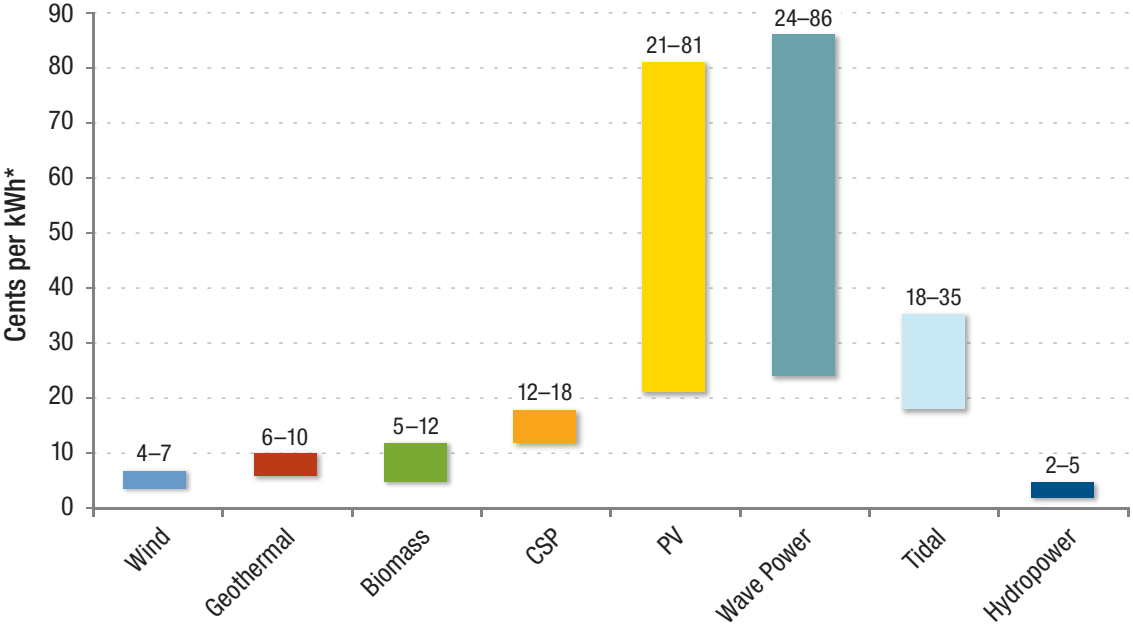
U.S. Electricity Generation by Source (%) 2000–2008

	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%	3,802,521
2001	50.9%	3.1%	0.3%	17.1%	0.2%	20.6%	5.8%	1.9%	-0.2%	0.3%	3,737,052
2002	50.1%	2.0%	0.4%	17.9%	0.3%	20.2%	6.8%	2.1%	-0.2%	0.4%	3,858,919
2003	50.8%	2.6%	0.4%	16.7%	0.4%	19.7%	7.1%	2.1%	-0.2%	0.4%	3,883,783
2004	49.8%	2.5%	0.5%	17.9%	0.4%	19.9%	6.8%	2.1%	-0.2%	0.4%	3,970,782
2005	49.6%	2.5%	0.6%	18.8%	0.3%	19.3%	6.7%	2.2%	-0.2%	0.3%	4,056,199
2006	49.0%	1.1%	0.5%	20.1%	0.3%	19.4%	7.1%	2.4%	-0.2%	0.3%	4,065,762
2007	48.5%	1.2%	0.4%	21.6%	0.3%	19.4%	6.0%	2.6%	-0.2%	0.3%	4,158,267
2008	48.5%	0.8%	0.3%	21.3%	0.3%	19.6%	6.0%	3.1%	-0.2%	0.3%	4,112,078

Source: EIA

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

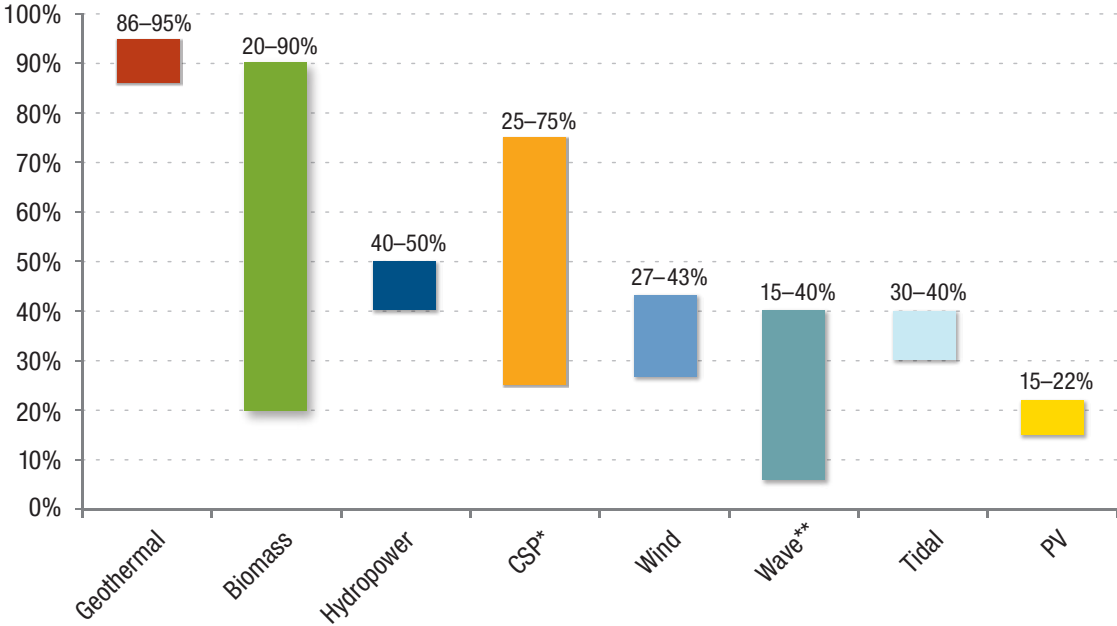
Price Range of Renewable Electricity by Technology (2008)



* Average cost will vary according to financing used and the quality of the renewable energy resource available.

Sources: Idaho National Laboratory, Carbon Trust, Simmons Energy Monthly, U.S. DOE-EERE, IEA, Solarbuzz LLC, REN21, LBNL

Capacity Factor for Renewable Resources (2008)



* Concentrating solar power (CSP) reaches the upper part of this range when systems incorporate thermal storage.

** This range is derived from experimental wave installations

Sources: EERE, GEA, NREL, Idaho National Laboratory, EPRI, Ocean Power Delivery LTD, Simmons Energy Monthly, Solarbuzz, LBNL

II. Renewable Electricity in the U.S.



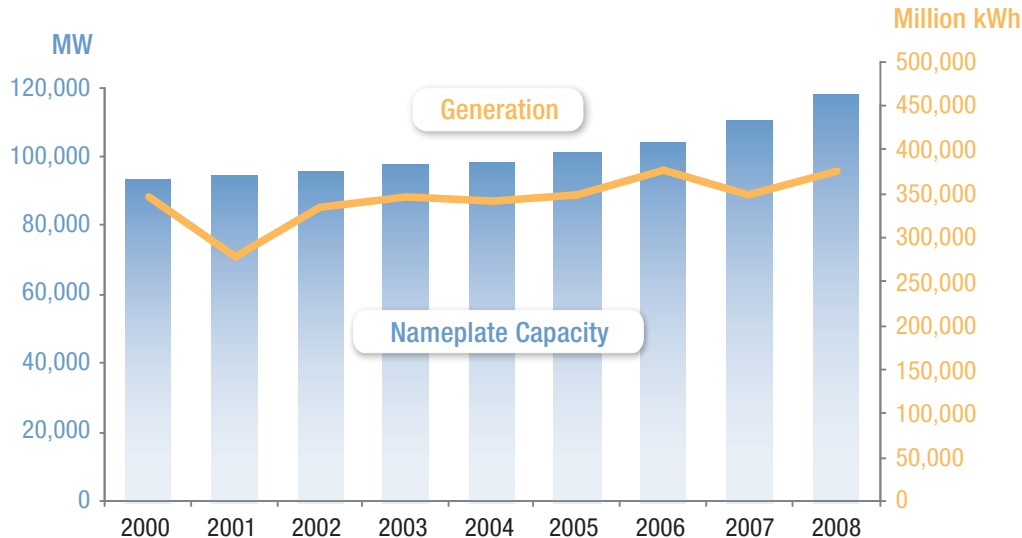
Renewable Electricity in the U.S.: Summary

- Since 2000, renewable electricity installations in the United States (excluding hydropower) have nearly tripled, and in 2008 represent **42 GW of installed capacity**.
- Renewable electricity (excluding hydropower) has grown at a compounded annual average of **12% per year from 2000–2008**.
- Although it is a growing part of U.S. energy supply, renewable electricity (excluding hydropower) in 2008 still represents a small percentage of overall installed electricity capacity (3.8%) and generation (3.1%) in the United States.
- Wind and solar PV are the fastest growing renewable energy sectors. **In 2008, wind capacity installations increased by 51% and solar PV grew 44% from the previous year.**



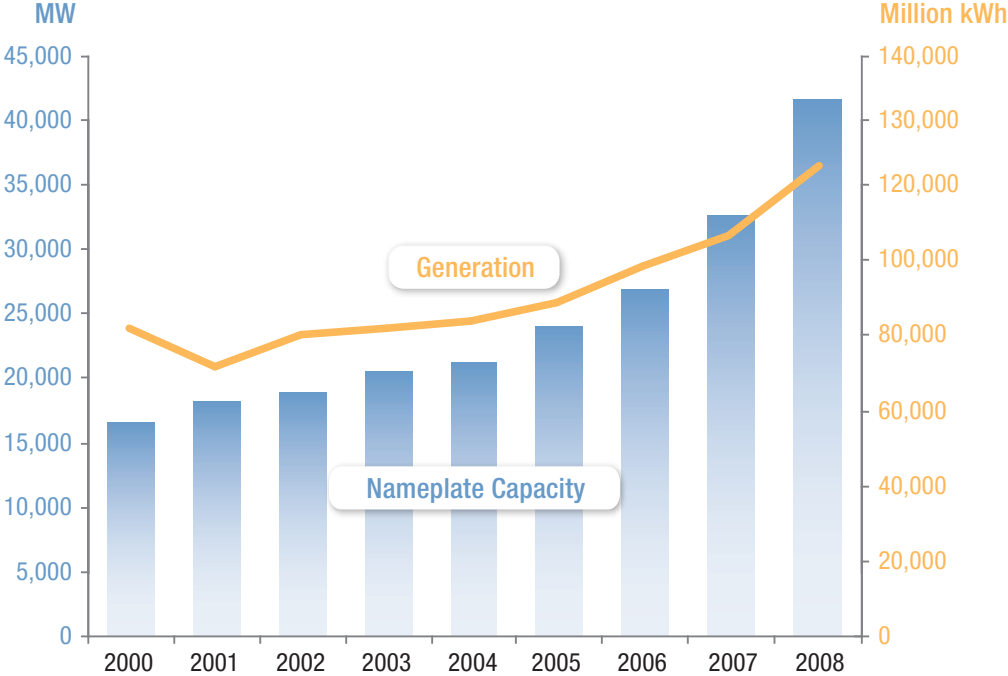
- In 2008, **biomass** produced about **45% of total renewable electricity generation** (excluding hydropower).
- **Wind energy** accounted for about **93% of total installed renewable electricity capacity** in 2008 (excluding hydropower).
- Electricity generation from biomass, geothermal, and hydropower have remained relatively stable since 2000.

Capacity and Generation: All Renewables (*including hydropower*)



	Total Nameplate Capacity (MW)	Total Generation (Million kWh)
2000	93,437	356,894
2001	95,026	288,139
2002	95,908	343,904
2003	97,607	355,889
2004	98,352	351,712
2005	101,303	358,428
2006	104,299	386,832
2007	110,121	354,269
2008	119,327	373,507

Capacity and Generation: Renewables (excluding hydropower)

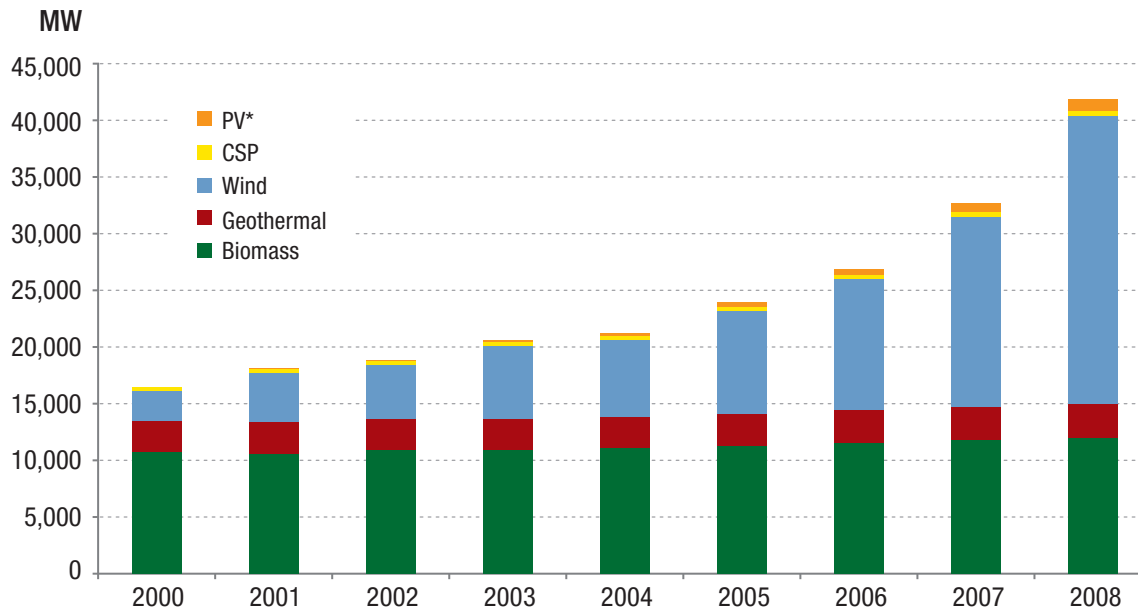


	Total Nameplate Capacity (MW)	Total Generation (Million kWh)
2000	16,491	81,321
2001	18,115	71,178
2002	18,861	79,575
2003	20,587	80,083
2004	21,222	83,295
2005	23,949	88,107
2006	26,880	97,586
2007	32,689	106,759
2008	41,877	125,422



Sources: EIA, AWEA, IEA PVPS, Navigant, GEA, Larry Sherwood/IREC, Greentech Media

Renewable Electricity Generating Capacity by Source (excluding hydropower)



Sources: EIA, AWEA, IEA PVPS, Navigant, GE, Larry Sherwood/IREC, Greentech Media

* Includes on- and off-grid capacity.

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

	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	27	0	1,697	0	(100)	1,624	+ 1,002%
2002	44	0	411	0	291	746	- 54%
2003	70	0	1,667	0	(11)	1,726	+ 131%
2004	86	0	372	0	177	635	- 63%
2005	112	0	2,396	30	189	2,727	+ 329%
2006	142	1	2,454	3	331	2,931	+ 7%
2007	205	64	5,249	106	185	5,809	+ 98%
2008	335	0	8,545	104	205	9,189	+ 58%



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%	16,491 -1.1%	93,437 -0.3%
2001	76,911 0%	112 31.7%	354 0%	4,275 65.8%	2,798 0%	10,576 0.9%	18,115 9.8%	95,026 1.7%
2002	77,047 0.2%	156 39.2%	354 0%	4,686 9.6%	2,798 0%	10,867 2.8%	18,861 4.1%	95,908 0.9%
2003	77,020 0%	226 44.8%	354 0%	6,353 35.6%	2,798 0%	10,856 0.1%	20,587 9.1%	97,607 1.8%
2004	77,130 0.1%	312 38%	354 0%	6,725 5.9%	2,798 0%	11,033 1.6%	21,222 3.1%	98,352 0.8%
2005	77,354 0.3%	424 35.8%	354 0%	9,121 35.6%	2,828 1.1%	11,222 1.7%	23,949 12.8%	101,303 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%	26,880 12.2%	104,299 3.0%
2007	77,432 0%	771 36.2%	419 18%	16,824 45.3%	2,937 3.7%	11,738 1.6%	32,689 21.6%	110,121 5.6%
2008	77,450 0%	1,106 43.5%	419 0%	25,369 50.8%	3,040 3.5%	11,943 1.7%	41,877 28.1%	119,327 8.4%



Sources: EIA, AWEA, IEA PVPS, Navigant, GEA, Larry Sherwood/IREC, Greentech Media

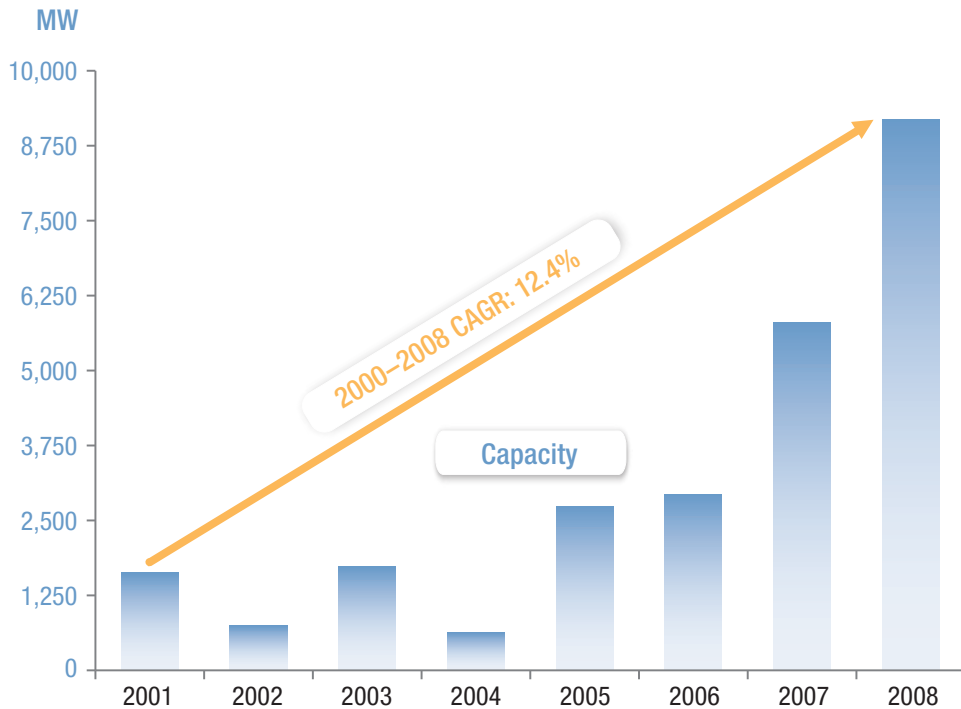
* Includes on- and off-grid capacity.

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



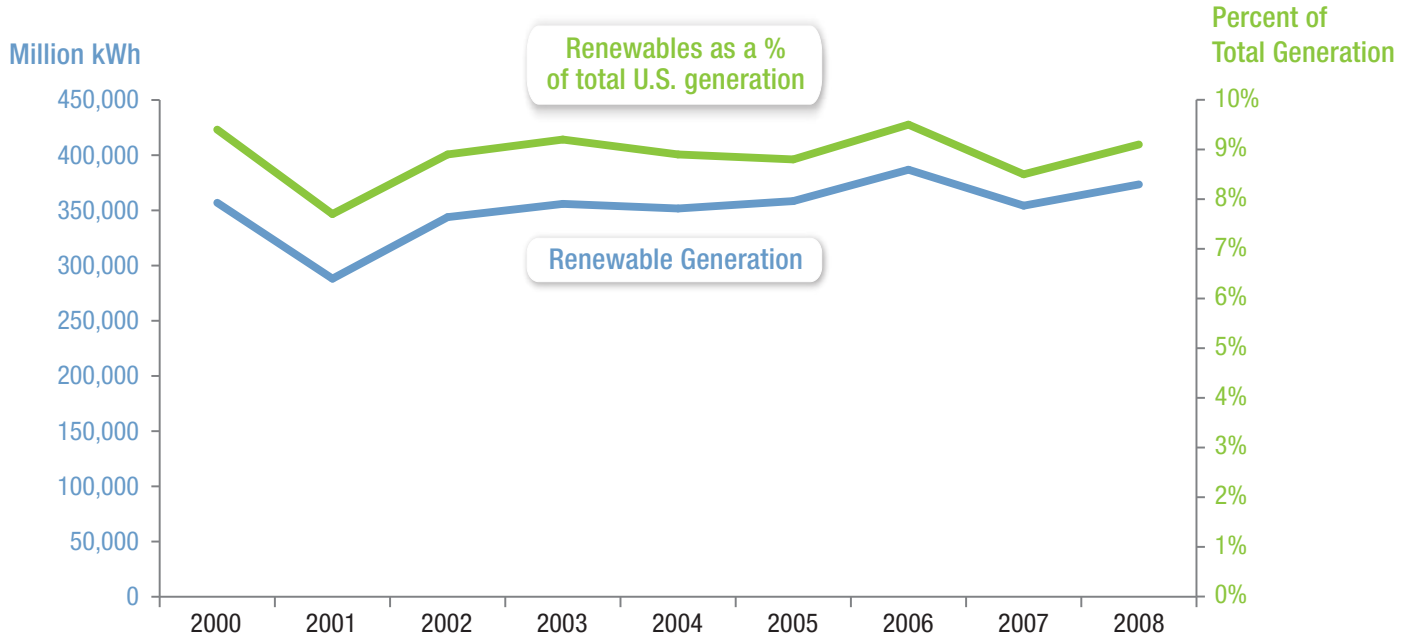
	Hydro	Solar PV	CSP	Wind	Geothermal	Biomass	Renewables w/o Hydro	All Renewables
2000	8.9%	0.0%	0.0%	0.3%	0.3%	1.2%	1.9%	10.8%
2001	8.4%	0.0%	0.0%	0.5%	0.3%	1.2%	2.0%	10.4%
2002	7.9%	0.0%	0.0%	0.5%	0.3%	1.1%	1.9%	9.8%
2003	7.5%	0.0%	0.0%	0.6%	0.3%	1.1%	2.0%	9.5%
2004	7.3%	0.0%	0.0%	0.6%	0.3%	1.1%	2.0%	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%

Annual Renewable Electric Capacity Growth (*excluding hydropower*)

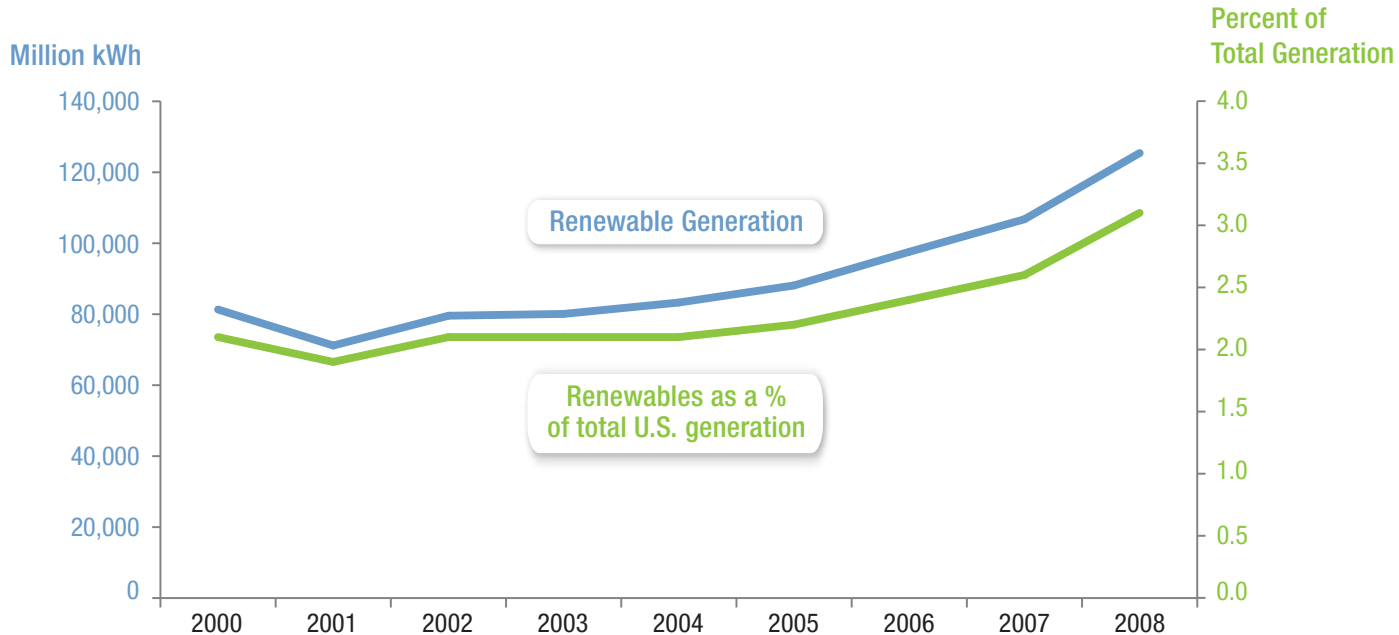


	Compounded Annual Growth Rate (CAGR) (2000–2008)
Wind	33.1%
Solar PV	37.8%
CSP	2.1%
Biomass	1.4%
Geothermal	1.0%

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



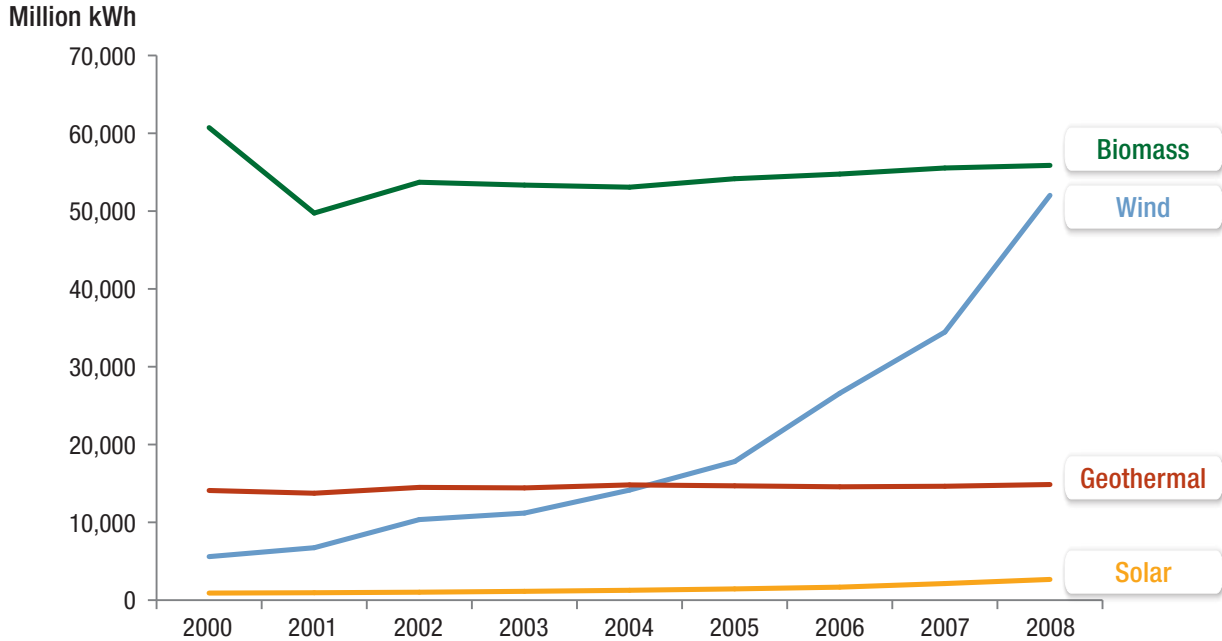
U.S. Renewable Electricity Generation (*excluding hydropower*)



Source: EIA

Note: The generation decrease between 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%	1.4%	0.7%	0.4%	2.4%	9.5%
2007	6.0%	0.1%	1.3%	0.8%	0.4%	2.6%	8.5%
2008	6.0%	0.1%	1.4%	1.3%	0.4%	3.1%	9.1%

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



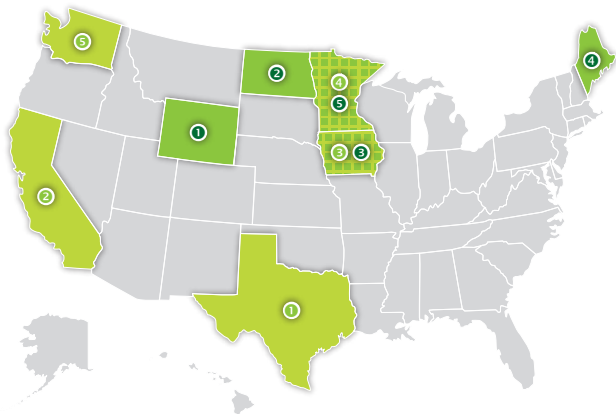
	Hydropower	Solar	Wind	Geothermal	Biomass	All Renewables	Renewables without Hydropower
2000	275,573 -13.8%	909 8.3%	5,593 24.6%	14,093 -5.0%	60,726 1.9%	356,894 -10.6%	81,321 2.0%
2001	216,961 -21.3%	952 4.7%	6,737 20.5%	13,741 -2.5%	49,748 -18.1%	288,139 19.3%	71,178 -12.5%
2002	264,329 21.8%	1,021 7.3%	10,354 53.7%	14,491 5.5%	53,709 8.0%	343,904 19.3%	79,575 11.8%
2003	275,806 4.3%	1,132 10.8%	11,187 8.0%	14,424 -0.5%	53,340 -0.7%	355,889 3.5%	80,083 0.6%
2004	268,417 -2.7%	1,267 12%	14,144 26.4%	14,811 2.7%	53,073 -0.5%	351,712 -1.2%	83,295 4.0%
2005	270,321 0.7%	1,444 13.9%	17,811 25.9%	14,692 -0.8%	54,160 2.0%	358,428 1.9%	88,107 5.8%
2006	289,246 7.0%	1,670 15.7%	26,589 49.3%	14,568 -0.8%	54,759 1.1%	386,832 7.9%	97,586 10.8%
2007	247,510 -14.4%	2,133 27.8%	34,450 29.6%	14,637 0.5%	55,539 1.4%	354,269 -8.4%	106,759 9.4%
2008	248,085 0.2%	2,662 24.8%	52,026 51%	14,859 1.5%	55,875 0.6%	373,507 5.4%	125,422 17.5%



State Renewable Energy Information: Summary

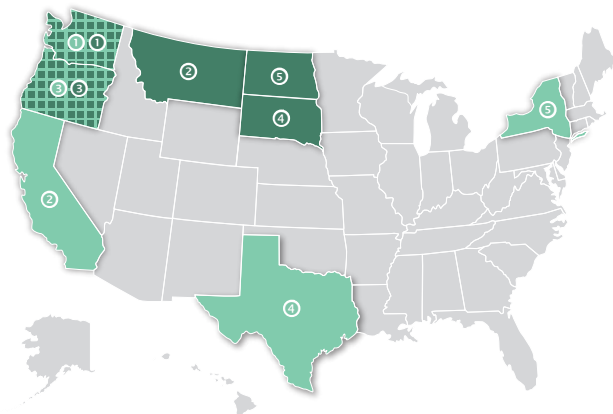
- In 2008, **Texas advanced over California** as having the most renewable electricity (excluding hydropower) of any U.S. state.
- **Washington is the leader** in installed renewable energy capacity when including hydropower.
- In 2008, **Texas became the national leader** in wind power development.
- 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 (2008)



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

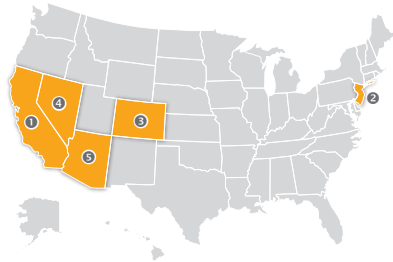
Per Capita Renewables (excluding hydropower)
1 Wyoming
2 North Dakota
3 Iowa
4 Maine
5 Minnesota



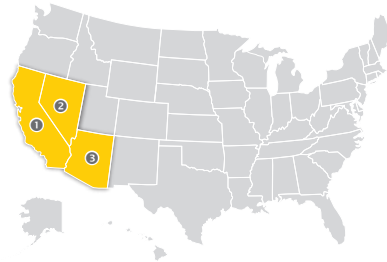
Total Renewables (including hydropower)
1 Washington
2 California
3 Oregon
4 Texas
5 New York

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

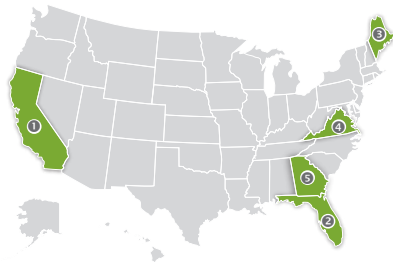
Top States for Renewable Electricity Installed Nameplate Capacity (2008)



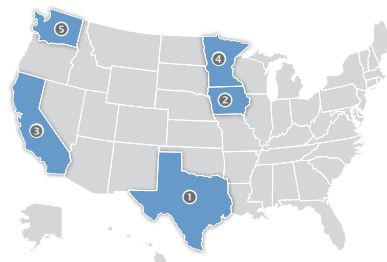
Solar PV	
1	California
2	New Jersey
3	Colorado
4	Nevada
5	Arizona



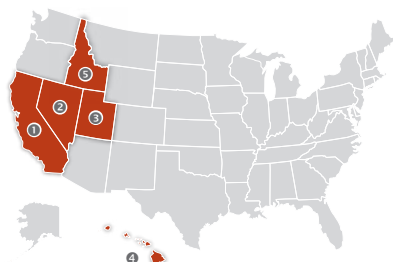
CSP	
1	California
2	Nevada
3	Arizona



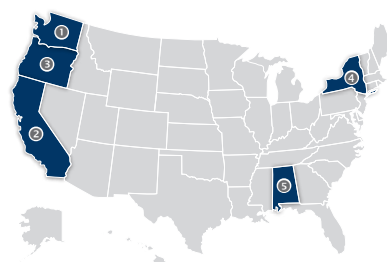
Biomass	
1	California
2	Florida
3	Maine
4	Virginia
5	Georgia



Wind	
1	Texas
2	Iowa
3	California
4	Minnesota
5	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 2008 Installed Nameplate Capacity (MW)

NORTHEAST

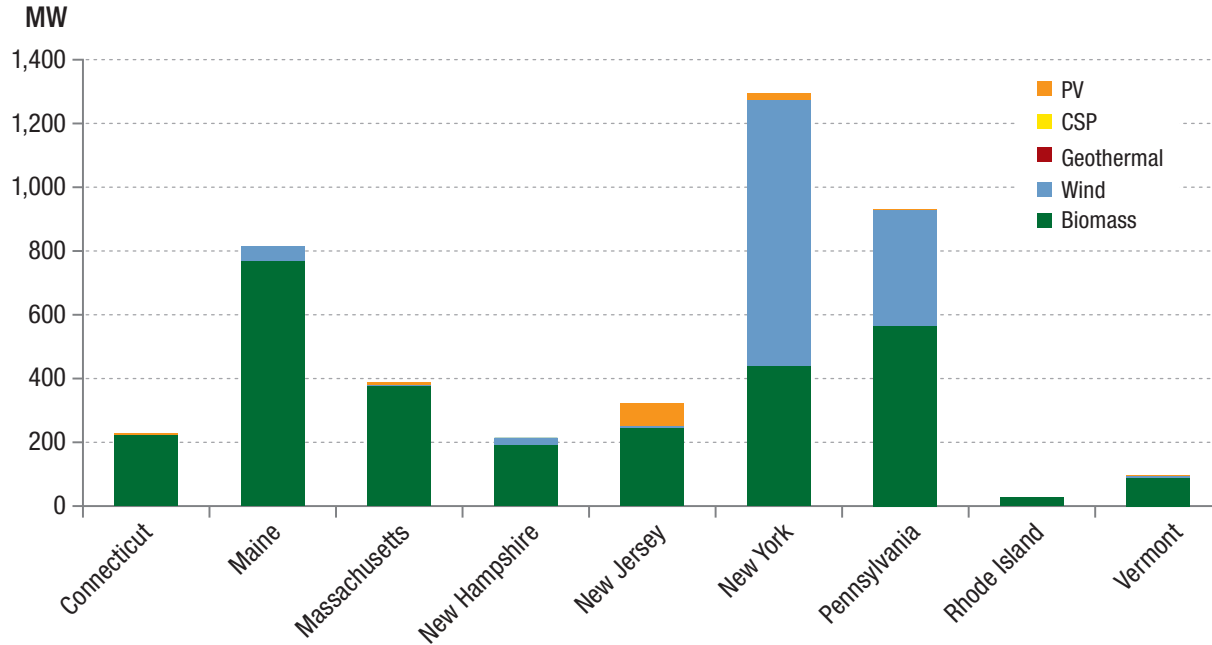
	Wind	PV*	CSP	Geothermal	Biomass	Hydropower	Total Renewables (incl. hydro)	Per capita RE (excl. hydro) watts/person
New York	832	22	0	0	439	4,654	5,947	66
Pennsylvania	361	4	0	0	565	775	1,705	75
Maine	47	0	0	0	768	722	1,537	619
Massachusetts	5	8	0	0	375	272	660	60
New Hampshire	25	0	0	0	190	445	661	164
Vermont	6	1	0	0	88	309	404	153
Connecticut	0	9	0	0	221	119	349	66
New Jersey	8	70	0	0	243	13	334	37
Rhode Island	1	1	0	0	26	4	32	26

Sources: EIA, Navigant, AWEA, GEA, NREL, EERE, Larry Sherwood/IREC

* Does not include off-grid

Renewables 2008 Installed Nameplate Capacity (excluding hydropower)

NORTHEAST



Renewables 2008 Installed Nameplate Capacity (MW)

MIDWEST

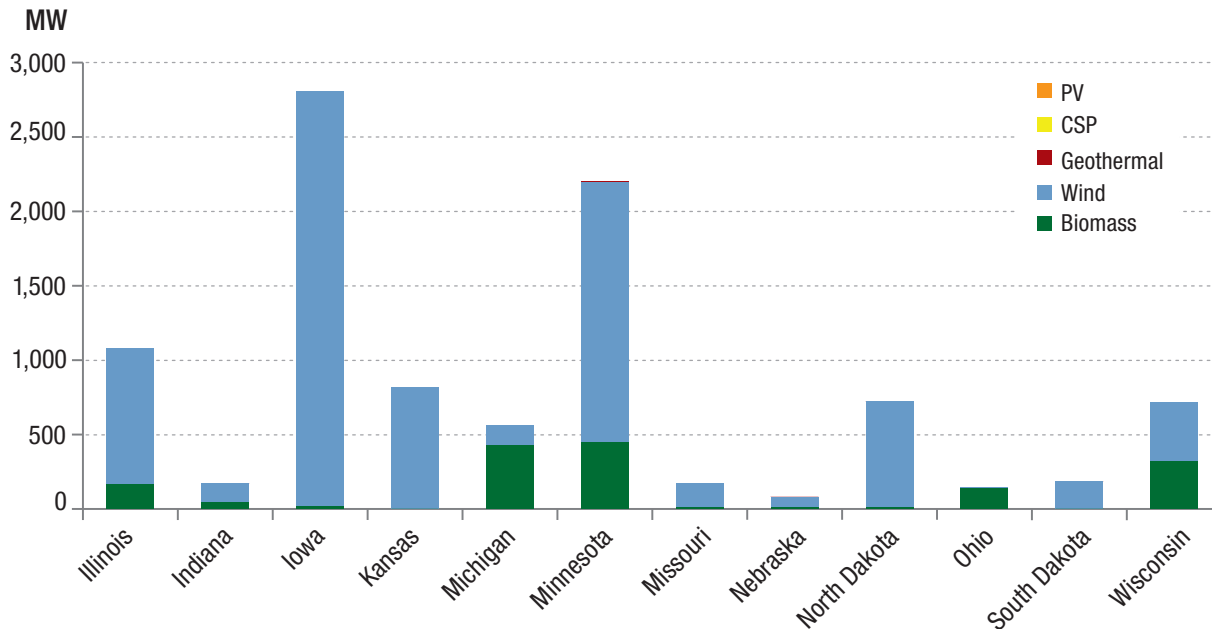
	Wind	PV*	CSP	Geothermal	Biomass	Hydropower	Total Renewables (incl. hydro)	Per capita RE (excl. hydro) watts/person
South Dakota	187	0	0	0	0	1,598	1,785	232
Minnesota	1,754	1	0	0	445	186	2,385	421
Iowa	2,791	0	0	0	15	131	2,937	935
Wisconsin	395	3	0	0	321	505	1,224	128
North Dakota	714	0	0	0	10	614	1,338	1,129
Michigan	129	0	0	0	430	374	934	56
Missouri	163	0	0	0	8	499	670	29
Nebraska	72	0	0	0	10	327	409	46
Kansas	815	0	0	0	0	3	817	291
Illinois	915	3	0	0	164	38	1,120	84
Ohio	7	1	0	0	140	128	277	13
Indiana	131	0	0	0	42	92	265	27

Sources: EIA, Navigant, AWEA, GEA, NREL, EERE, Larry Sherwood/IREC

* Does not include off-grid

Renewables 2008 Installed Nameplate Capacity (excluding hydropower)

MIDWEST



Renewables 2008 Installed Nameplate Capacity (MW)

SOUTH

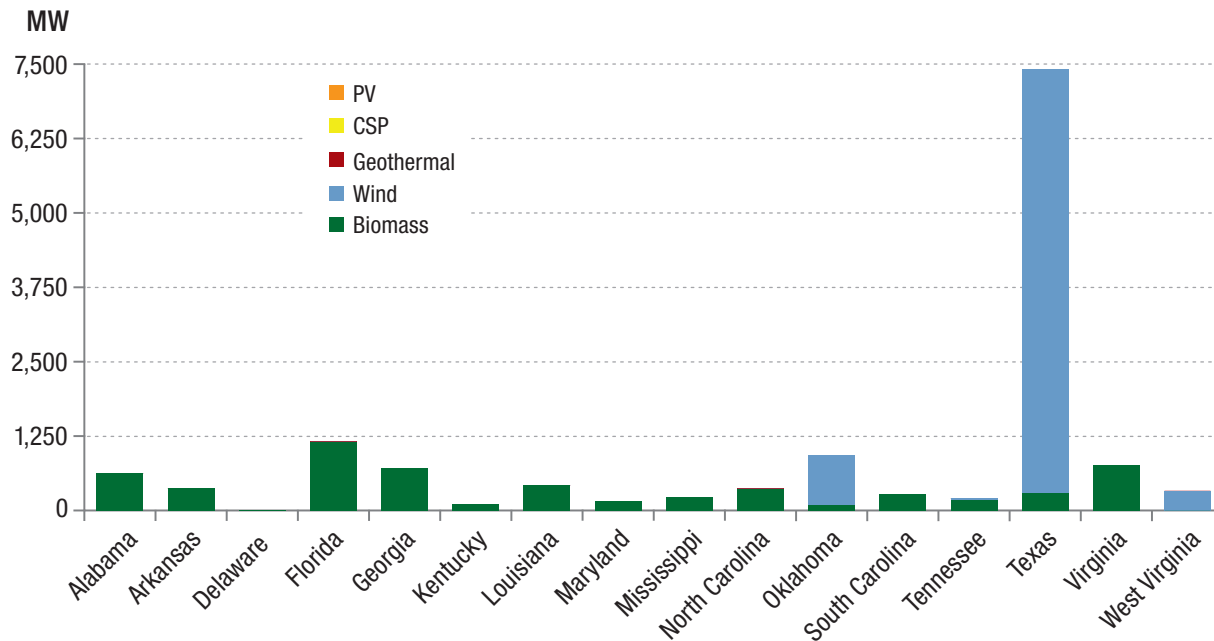
	Wind	PV*	CSP	Geothermal	Biomass	Hydropower	Total Renewables (incl. hydro)	Per capita RE (excl. hydro) watts/person
Alabama	0	0	0	0	622	3,280	3,902	133
Texas	7,118	4	0	0	295	672	8,089	305
Tennessee	29	0	0	0	176	2,418	2,623	33
Georgia	0	0	0	0	712	1,932	2,644	74
North Carolina	0	5	0	0	367	1,828	2,199	40
Arkansas	1	0	0	0	375	1,309	1,685	132
South Carolina	0	0	0	0	270	1,363	1,633	60
Virginia	0	0	0	0	760	743	1,503	98
Oklahoma	831	0	0	0	90	790	1,711	253
Florida	0	3	0	0	1,158	56	1,217	63
Kentucky	0	0	0	0	108	777	885	25
Maryland	0	3	0	0	155	527	685	28
Louisiana	0	0	0	0	426	192	618	97
Mississippi	0	0	0	0	223	0	223	76
West Virginia	330	0	0	0	0	325	655	182
Delaware	0	2	0	0	7	0	9	10

Sources: EIA, Navigant, AWEA, GEA, NREL, EERE, Larry Sherwood/IREC

* Does not include off-grid

Renewables 2008 Installed Nameplate Capacity (excluding hydropower)

SOUTH



Renewables 2008 Installed Nameplate Capacity (MW)

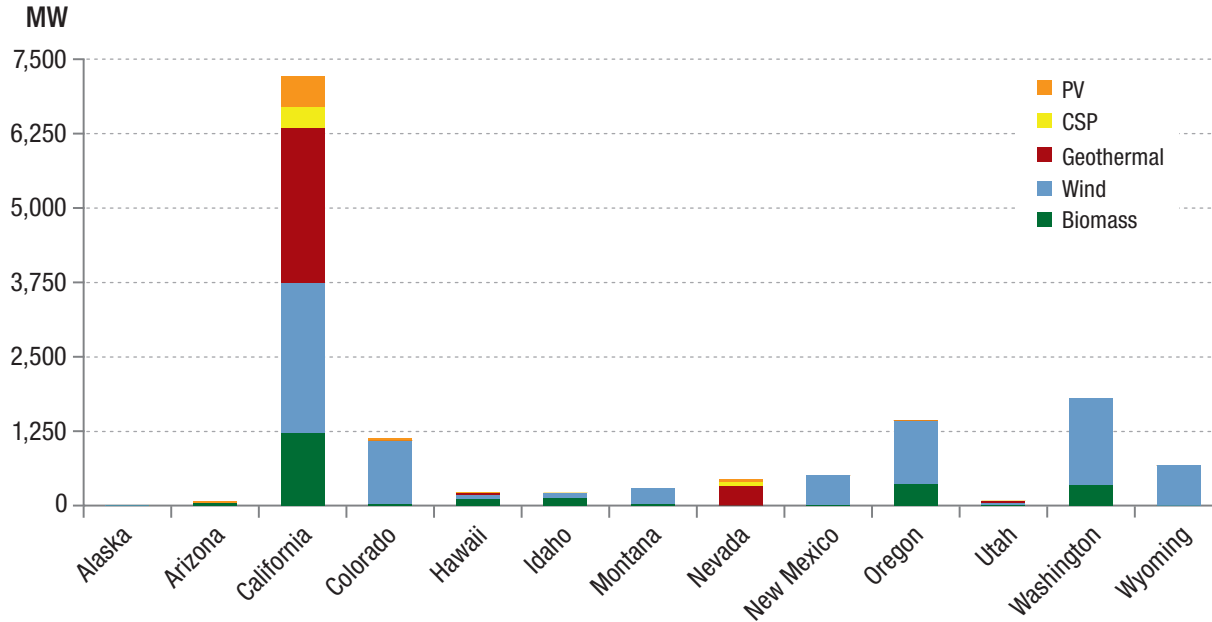
WEST

	Wind	PV*	CSP	Geothermal	Biomass	Hydropower	Total Renewables (incl. hydro)	Per capita RE (excl. hydro) watts/person
Washington	1,447	4	0	0	350	20,807	22,607	275
California	2,517	528	354	2,605	1,217	10,032	17,254	196
Oregon	1,067	8	0	0	356	8,261	9,692	378
Arizona	0	25	1	0	40	2,718	2,784	10
Idaho	75	0	0	16	126	2,516	2,733	143
Montana	272	1	0	0	17	2,548	2,837	299
Nevada	0	34	64	333	0	1,047	1,478	166
Colorado	1,068	36	0	0	18	649	1,770	227
New Mexico	497	1	0	0	7	79	584	255
Wyoming	676	0	0	0	0	300	976	1,270
Alaska	3	0	0	1	0	401	405	6
Utah	20	0	0	50	10	262	341	29
Hawaii	63	14	0	35	114	25	250	175

Sources: EIA, Navigant, AWEA, GEA, NREL, EERE, Larry Sherwood/IREC

* Does not include off-grid

Renewables 2008 Installed Nameplate Capacity (excluding hydropower) WEST



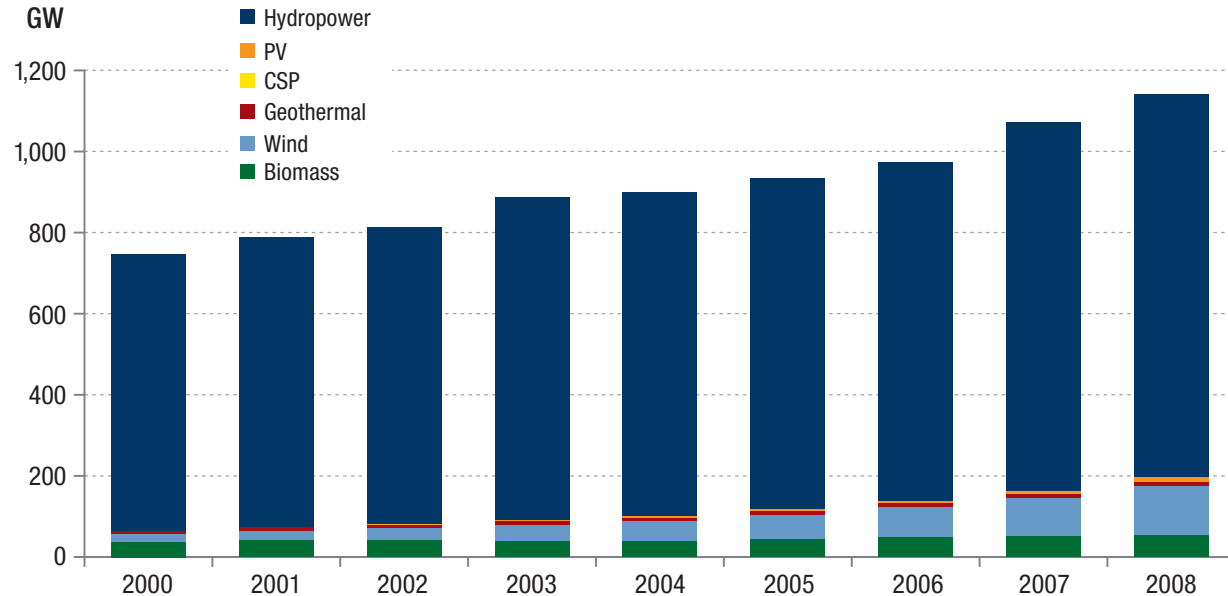
III. Global Renewable Energy Development



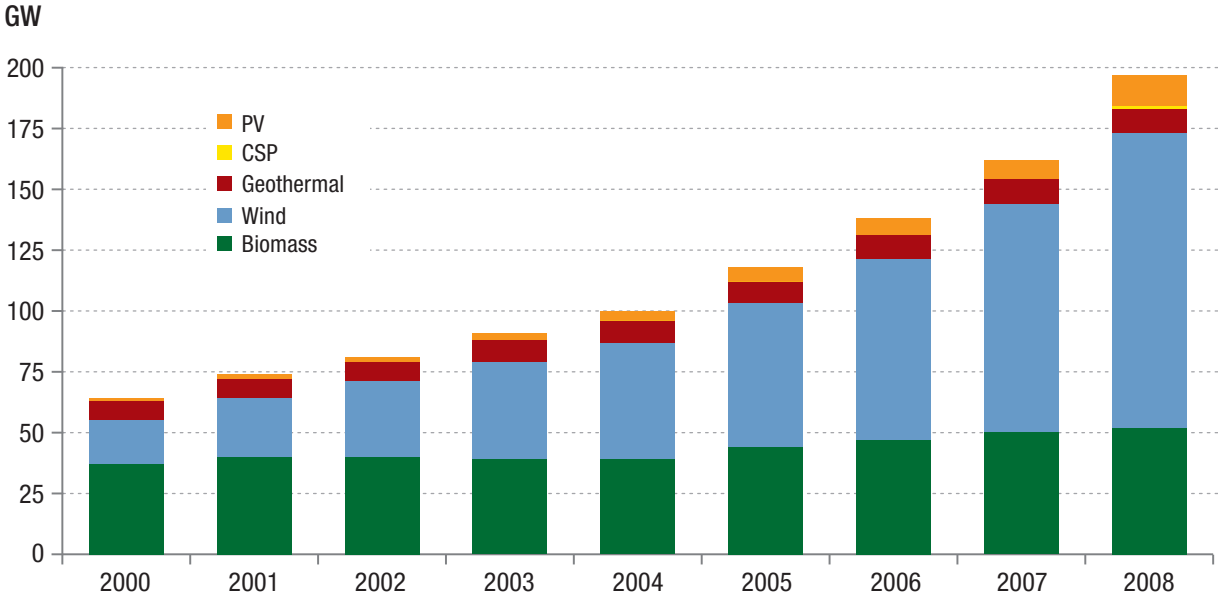
Global Renewable Energy Development: Summary

- Global renewable electricity installations (excluding hydropower) have **more than tripled** from 2000–2008.
- Including hydropower, renewable energy accounts for **18%** of all global electricity generation; without hydropower, renewable energy accounts for **2.5%** of global generation.
- Wind energy is the fastest growing renewable energy technology worldwide, and its generation **grew by a factor of almost 7** between 2000 and 2008.
- In 2008, Germany led the world in cumulative solar PV installed capacity. The United States leads the world in wind, geothermal, biomass, and CSP installed capacity.

Renewable Electricity Capacity Worldwide (including hydropower)



Renewable Electricity Generating Capacity Worldwide (excluding hydropower)



III

World Renewable Cumulative Electricity Capacity Percent Increase from the Previous Year

	Hydro	Solar PV	GSP	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%

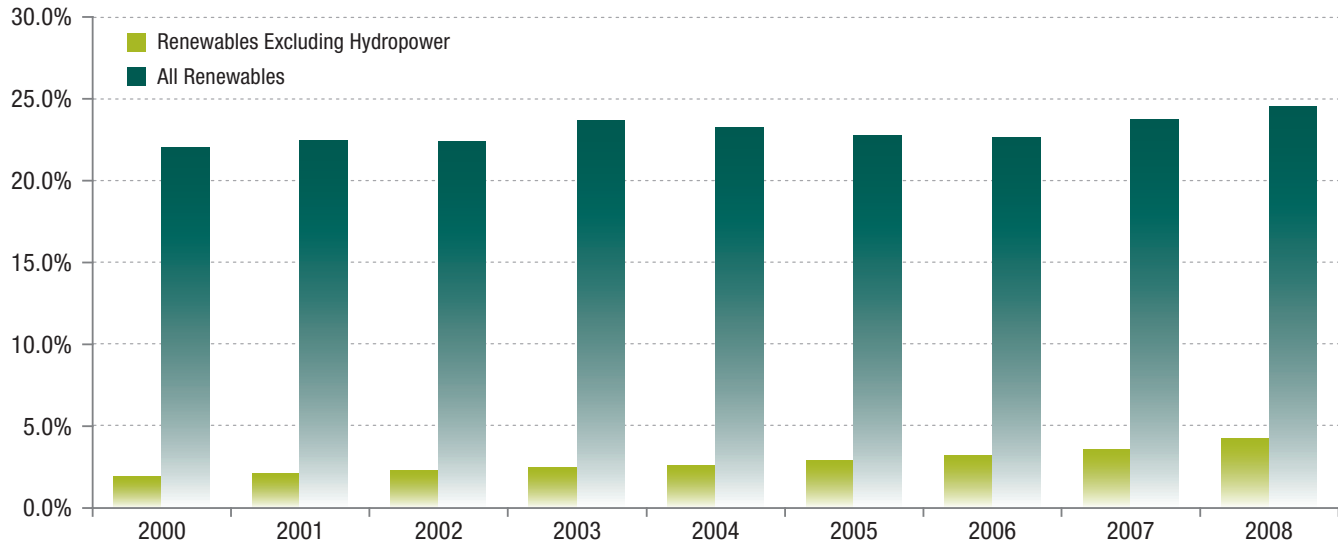


Renewables as a Percent of Total Installed Nameplate Capacity Worldwide

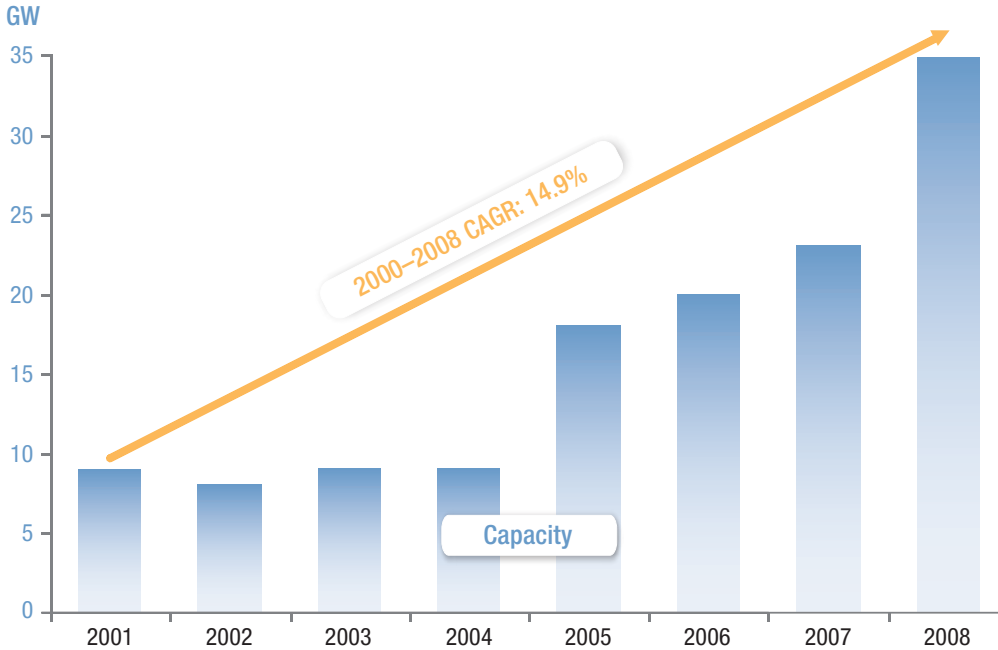
III

	Hydro	Solar PV	CSP	Wind	Geothermal	Biomass	All Renewables	Renewables without Hydropower	Renewable Capacity without Hydropower (GW)
2000	20.1%	0.0%	0.0%	0.5%	0.2%	1.1%	22.0%	1.9%	65
2001	20.4%	0.1%	0.0%	0.7%	0.2%	1.1%	22.5%	2.1%	74
2002	20.1%	0.1%	0.0%	0.9%	0.2%	1.1%	22.4%	2.3%	82
2003	21.3%	0.1%	0.0%	1.1%	0.2%	1.0%	23.7%	2.4%	91
2004	20.7%	0.1%	0.0%	1.2%	0.2%	1.0%	23.3%	2.6%	100
2005	19.9%	0.1%	0.0%	1.4%	0.2%	1.1%	22.8%	2.9%	118
2006	19.4%	0.2%	0.0%	1.7%	0.2%	1.1%	22.7%	3.2%	138
2007	20.2%	0.2%	0.0%	2.1%	0.2%	1.1%	23.8%	3.6%	162
2008	20.1%	0.3%	0.0%	2.6%	0.2%	1.1%	24.3%	4.2%	197

Renewables Share of Total Electricity Capacity Worldwide

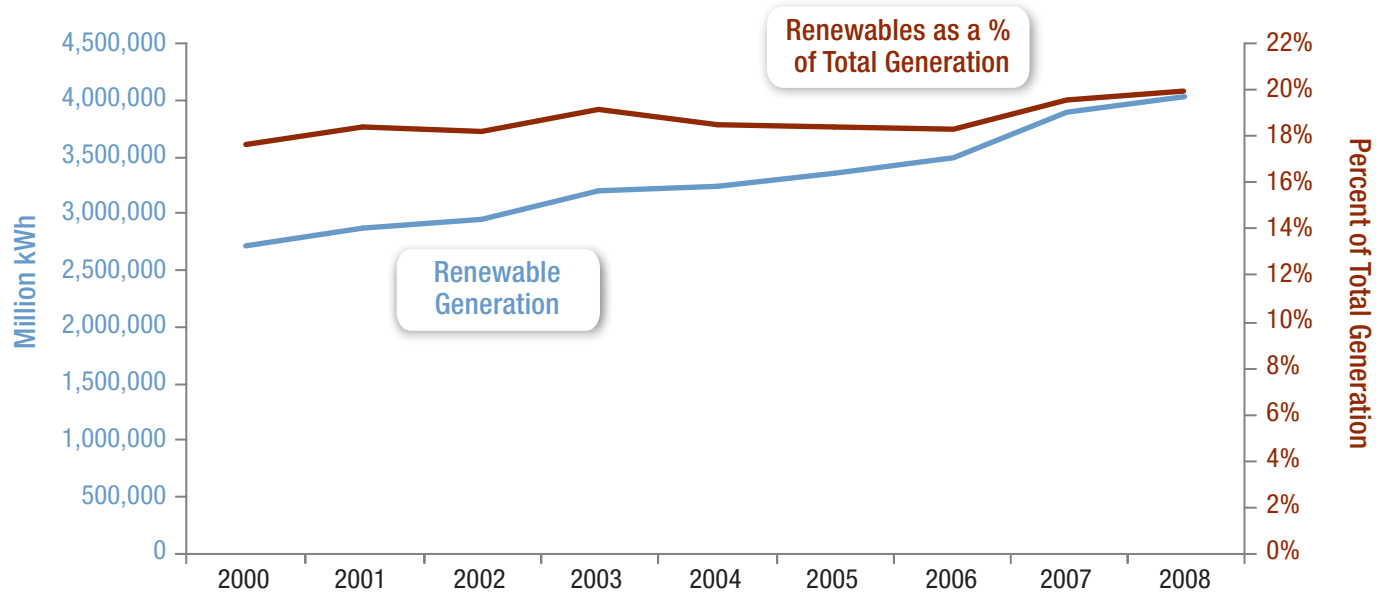


Annual Renewable Electricity Growth Worldwide *(excluding hydropower)*

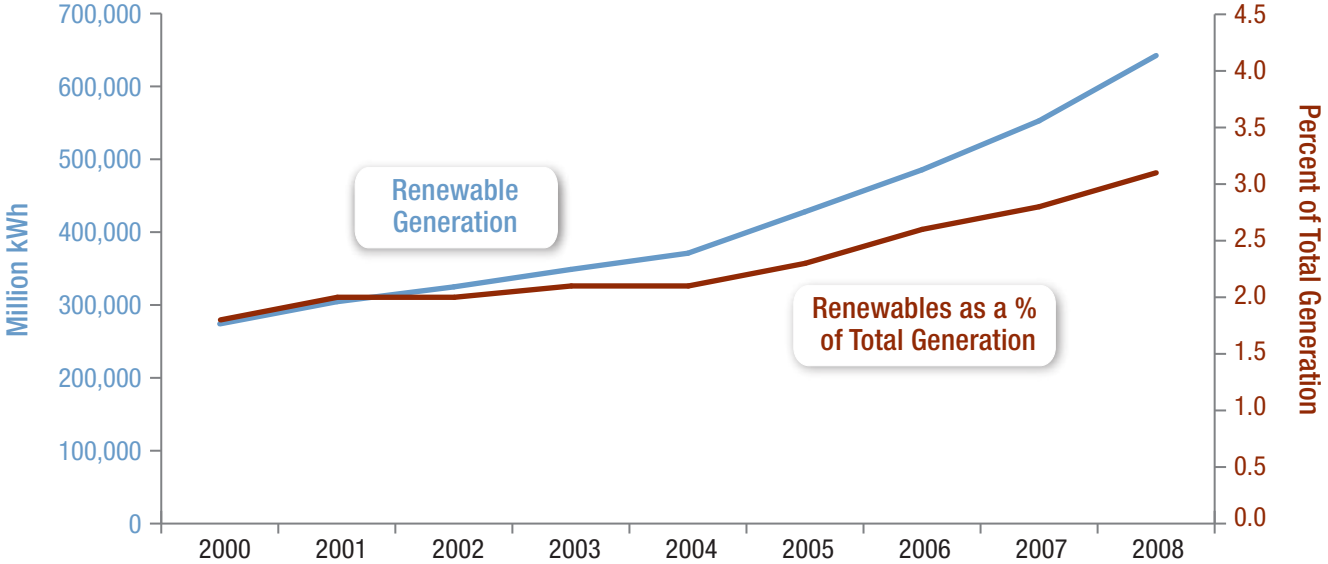


	Compounded Annual Growth Rate (CAGR) (2000-2008)
Wind	26.9%
Solar PV	32.1%
CSP	2.2%
Geothermal	2.8%
Biomass	4.3%

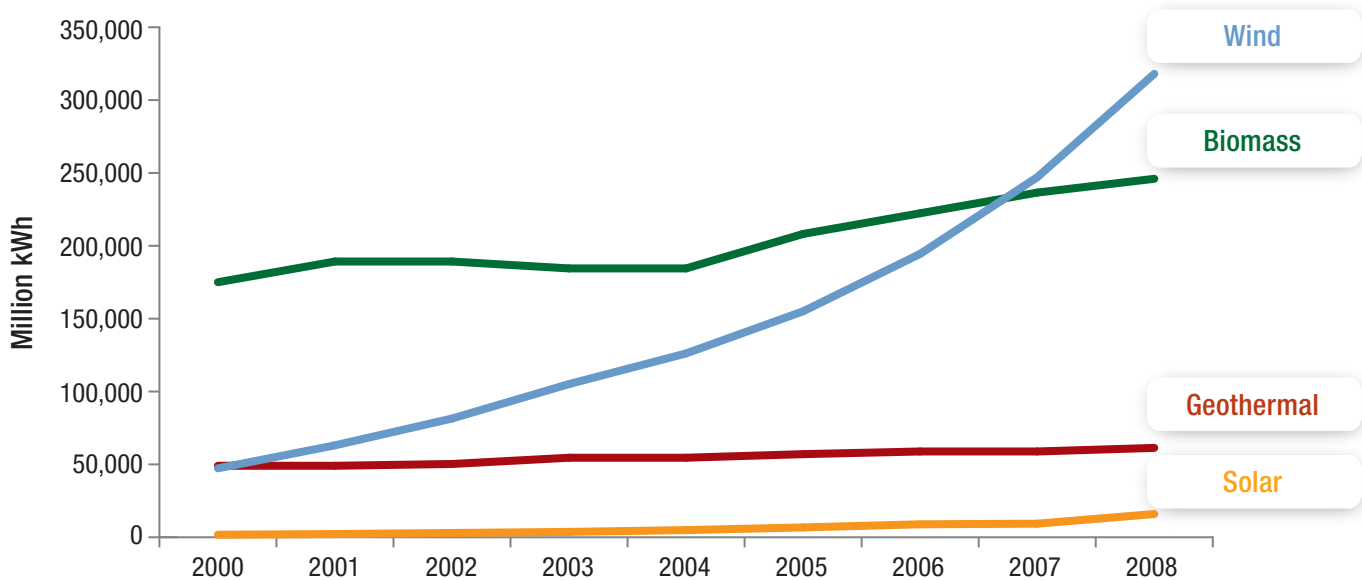
Worldwide Renewable Electricity Generation *(including hydropower)*



Renewable Electricity Generation Worldwide (excluding hydropower)



Renewable Electricity Generation Worldwide by Technology (2000–2008)



Sources: IEA, REN21, NREL, UNDP, Martinot, WWEA, BP

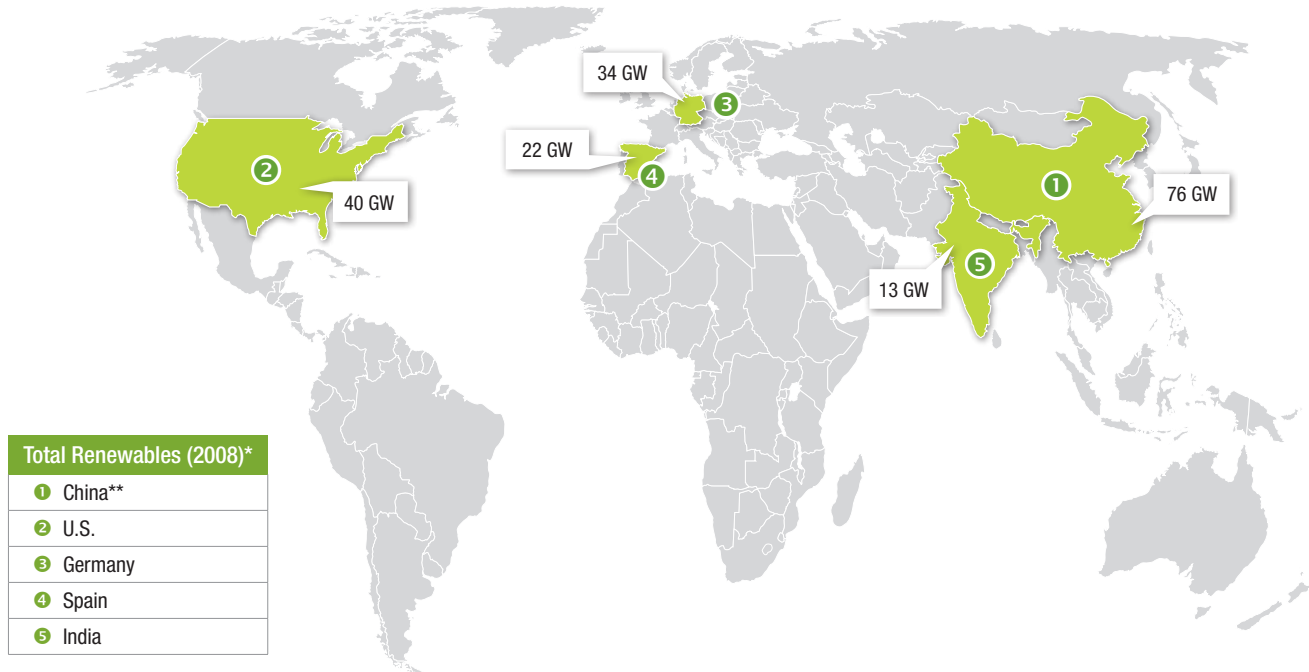
Note: World capacity data used, with generation derived using capacity factors of 14% for solar power, 30% for wind, 70% for geothermal, 54% for biomass.

Worldwide Renewable Electricity Generation as a Percent of Total Generation

III

	Hydro	Solar PV	Biomass	Wind	Geothermal	All Renewables	Renewables without Hydropower	Renewable Generation without Hydropower (million kWh)
2000	15.9%	0.0%	1.1%	0.3%	0.3%	17.7%	1.8%	274,063
2001	16.5%	0.0%	1.2%	0.4%	0.3%	18.4%	2.0%	304,513
2002	16.2%	0.0%	1.2%	0.5%	0.3%	18.3%	2.0%	324,871
2003	17.1%	0.0%	1.1%	0.6%	0.3%	19.1%	2.1%	348,821
2004	16.4%	0.0%	1.1%	0.7%	0.3%	18.5%	2.1%	371,072
2005	16.0%	0.0%	1.1%	0.8%	0.3%	18.4%	2.3%	427,924
2006	15.8%	0.1%	1.2%	1.0%	0.3%	18.3%	2.6%	485,521
2007	16.6%	0.1%	1.2%	1.3%	0.3%	19.4%	2.8%	552,750
2008	16.6%	0.1%	1.2%	1.6%	0.3%	19.8%	3.1%	642,380

Top Countries with Installed Renewable Electricity

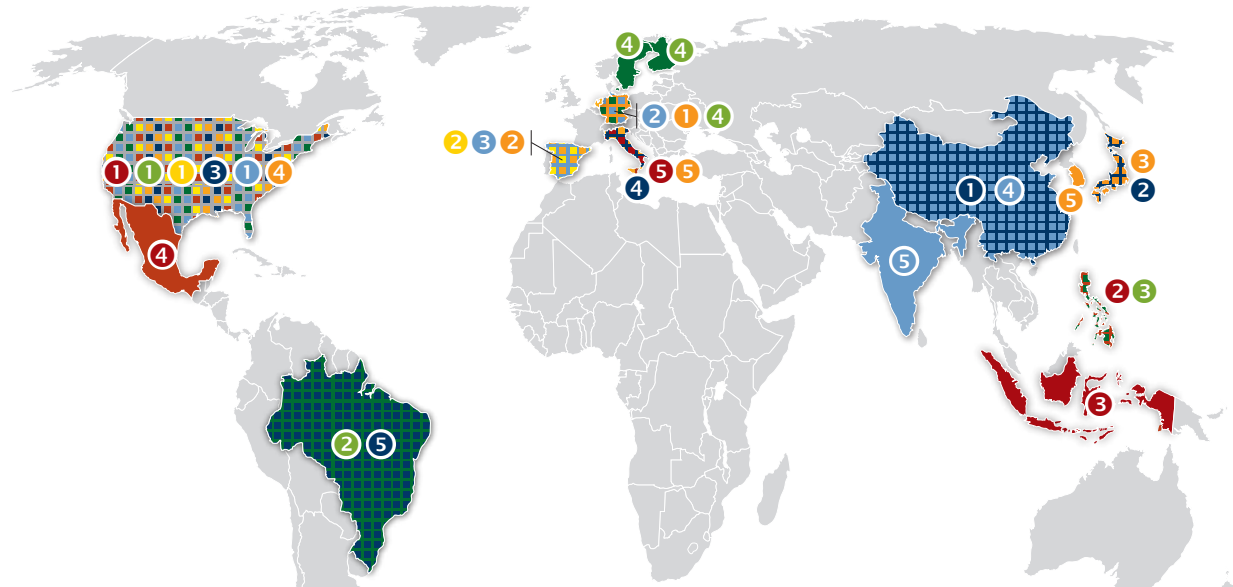


Source: REN21, IGA, EIA

* Including small hydro, geothermal, solar, wind, and biomass.
Does not include large hydropower capacity.

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

Top Countries with Installed Renewable Electricity by Technology (2008)



III

Small Hydropower	
1	China
2	Japan
3	U.S.
4	Italy
5	Brazil

Geothermal	
1	U.S.
2	Philippines
3	Indonesia
4	Mexico
5	Italy

Wind	
1	U.S.
2	Germany
3	Spain
4	China
5	India

Solar PV	
1	Germany
2	Spain
3	Japan
4	U.S.
5	South Korea

CSP	
1	U.S.
2	Spain

Biomass	
1	U.S.
2	Brazil
3	Philippines
4	Germany / Sweden / Finland

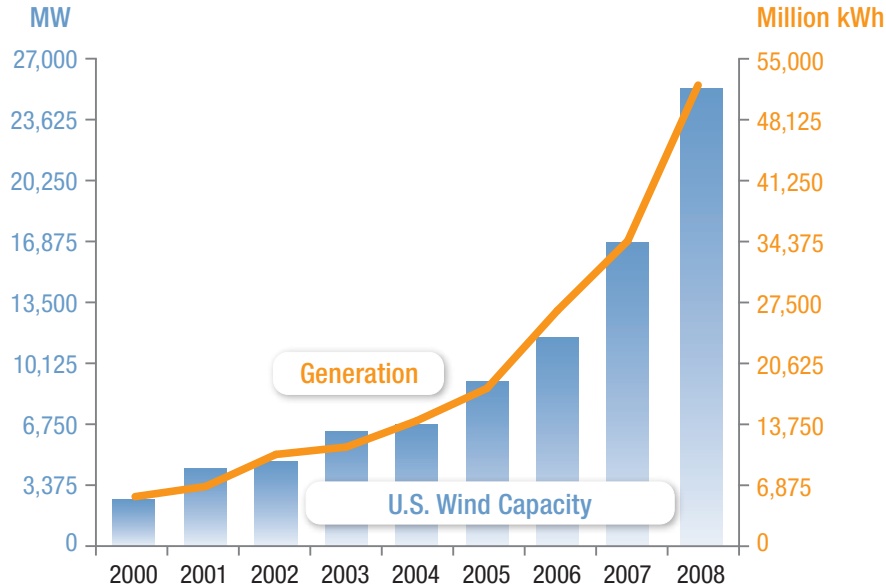
IV. Wind



Wind: Summary

- In the United States, wind energy installed capacity **increased almost 10 times between 2000 and 2008**, and it is the fastest growing renewable electricity technology.
- In the United States, wind experienced record growth in 2008 and **more wind capacity was installed in 2008 than in 2006 and 2007 combined**. Texas led the United States in wind installations in 2008, installing more than 2,671 MW of wind capacity.
- The average price of wind power, including the production tax credit, was about **4 cents per kilowatt hour in 2008**—a price that competes with fossil fuel-generated electricity.
- In 2008, the United States surpassed Germany as the world leader in installed wind capacity.
- Indiana and Michigan both made significant investments in wind energy. Each added about 130 MW in 2008 to a base of fewer than 5 MW.

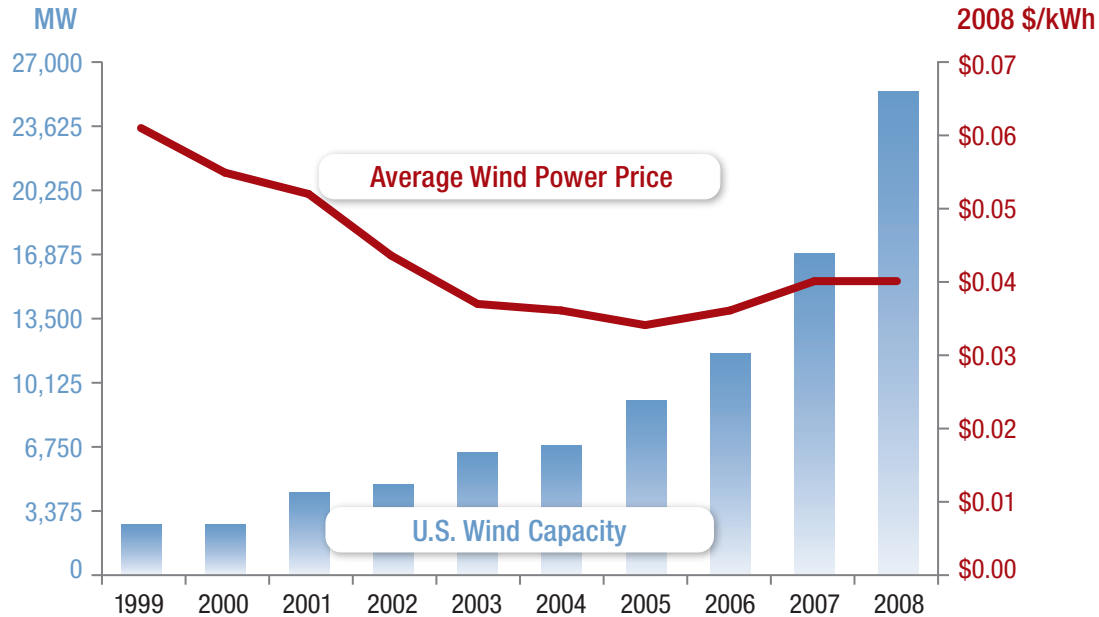
U.S. Total Installed Wind Energy Nameplate Capacity and Generation



	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	16,824	45.3%
2008	52,026	25,369	50.8%

IV

U.S. Wind Power Sales Price



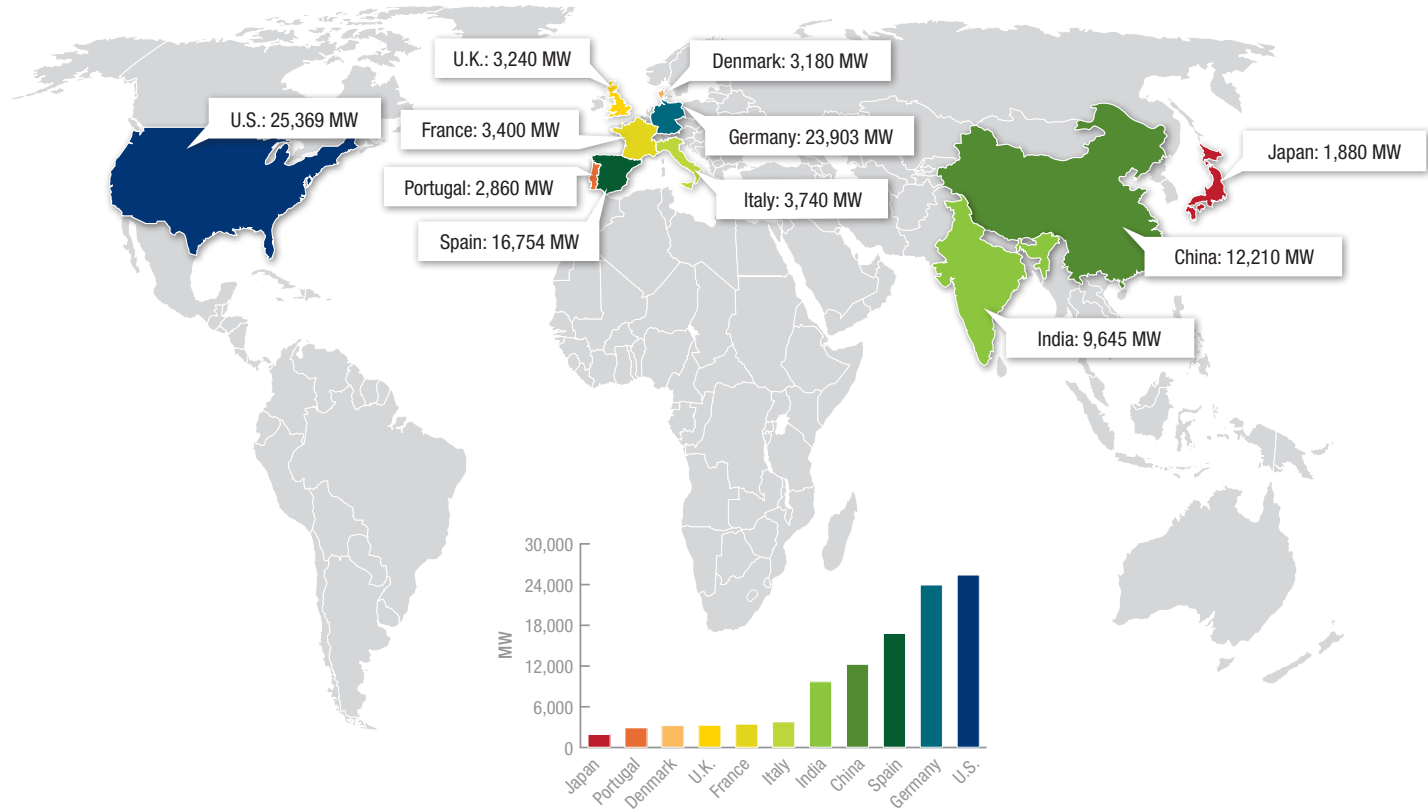
IV

Sources: EERE, LBNL

Note: Prices reflect cumulative capacity-weighted average wind power prices and include state and federal incentives in the price.

The recent increase in wind power price is due to increased demand for turbines coupled with global increases in prices for steel, cement, copper, and other commodity materials.

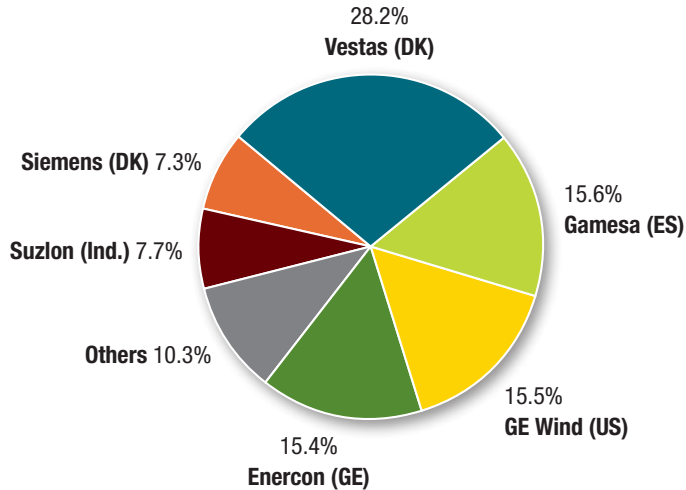
Wind Energy Capacity (2008) – Select Countries



Turbine Manufacturing

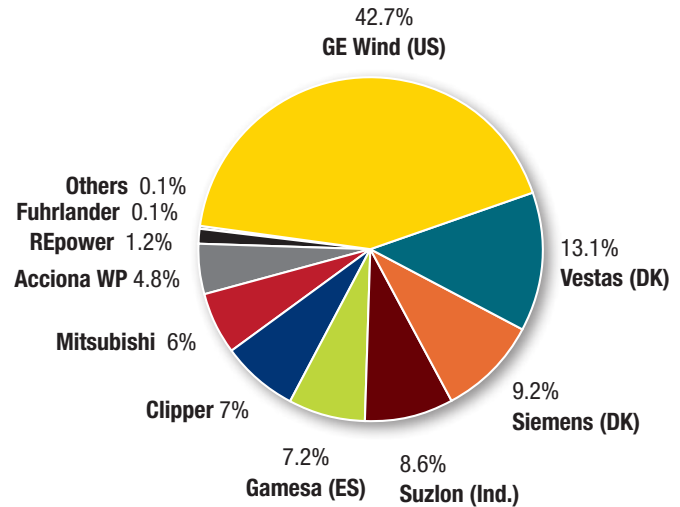
Global Wind Turbine Market Share 2006

Total Turbine Installations: 15,016 MW

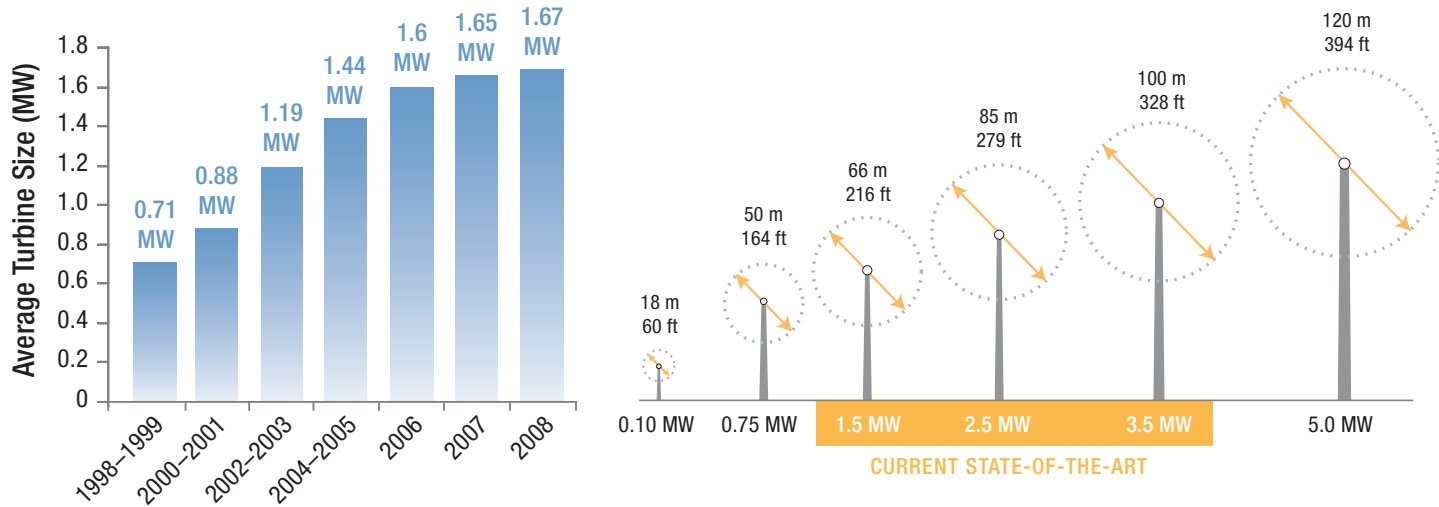


U.S. Wind Turbine Market Share 2008

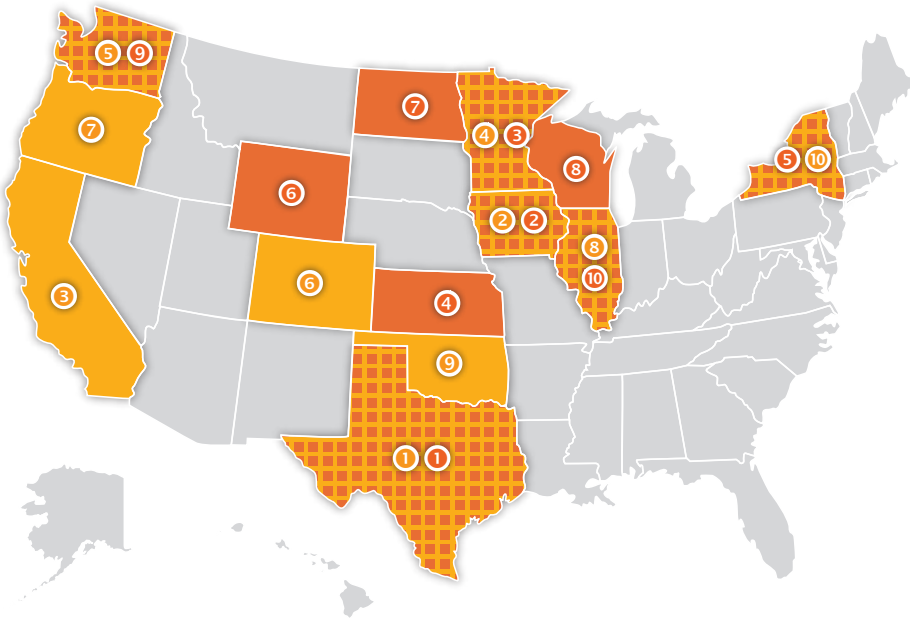
Total Turbine Installations: 8,558 MW



Average Installed Turbine Size



States Leading Wind Power Development



Cumulative Capacity (2008, MW)

1 Texas	7,118
2 Iowa	2,791
3 California	2,517
4 Minnesota	1,754
5 Washington	1,447
6 Colorado	1,068
7 Oregon	1,067
8 Illinois	915
9 New York	832
10 Oklahoma	831

Annual Capacity (2008, MW)

1 Texas	2,671
2 Iowa	1,600
3 Minnesota	456
4 Kansas	450
5 New York	407
6 Wyoming	388
7 North Dakota	370
8 Wisconsin	342
9 Washington	284
10 Illinois	216

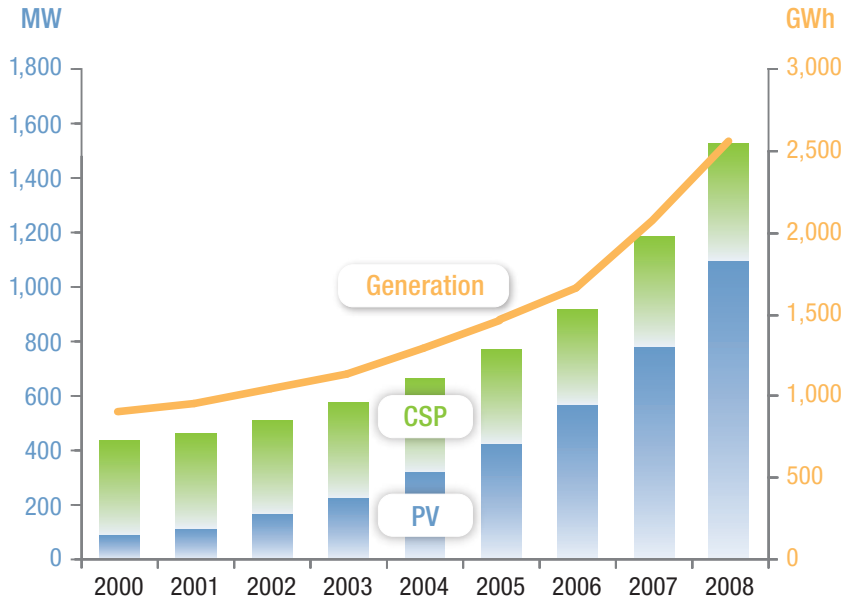


V. Solar

Solar: Summary

- Solar energy electricity generation has **more than tripled between 2000 and 2008**, 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 installations** (California, New Jersey, Nevada, and Colorado).
- U.S. manufacturers currently have a **small share of the world PV market**. Q-cells (based in Germany) is currently the market leader with 8.2% of the global PV market.
- Although no concentrating solar power (CSP) plants came online in 2008, there are **currently about 80 MW of CSP** under construction or with financing secured.

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



	U.S. Solar Energy Generation (Million kWh)	U.S. Solar Energy Capacity (MW) and % Increase from Previous Year			
		PV*	CSP	Total	Increase
2000	909	85	354	439	4.3%
2001	952	112	354	466	6.2%
2002	1,021	156	354	510	9.4%
2003	1,132	226	354	580	13.7%
2004	1,267	312	354	666	14.8%
2005	1,444	424	354	778	16.8%
2006	1,670	566	355	921	18.4%
2007	2,133	771	419	1,190	29.2%
2008	2,662	1,106	419	1,525	28.2%

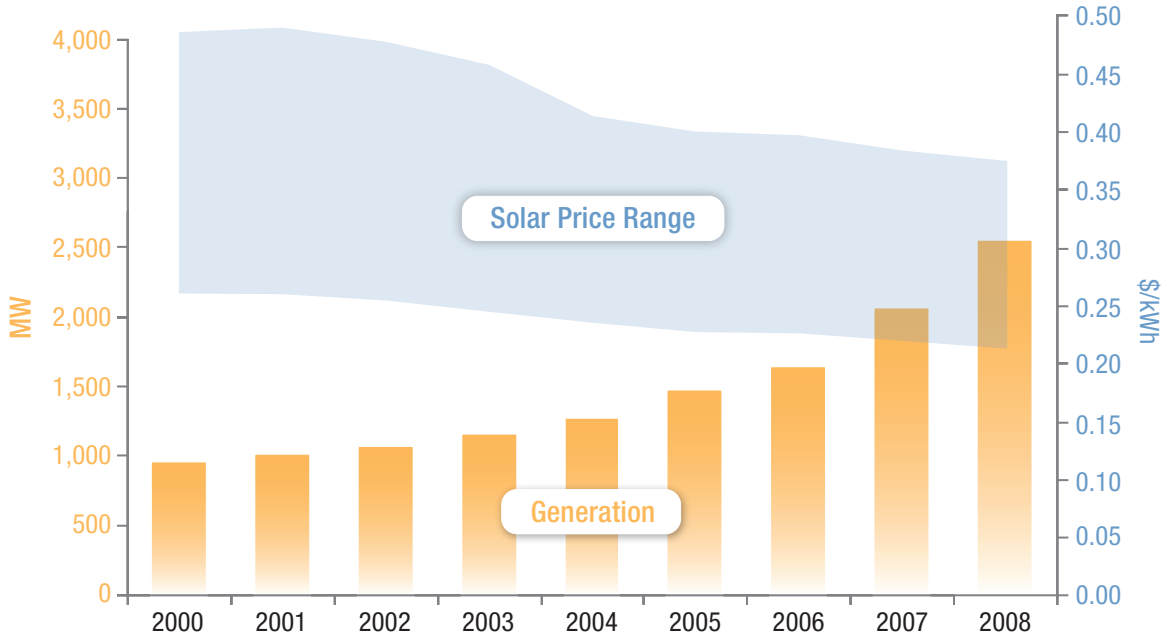


Sources: Larry Sherwood/IREC, Greentech Media

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.

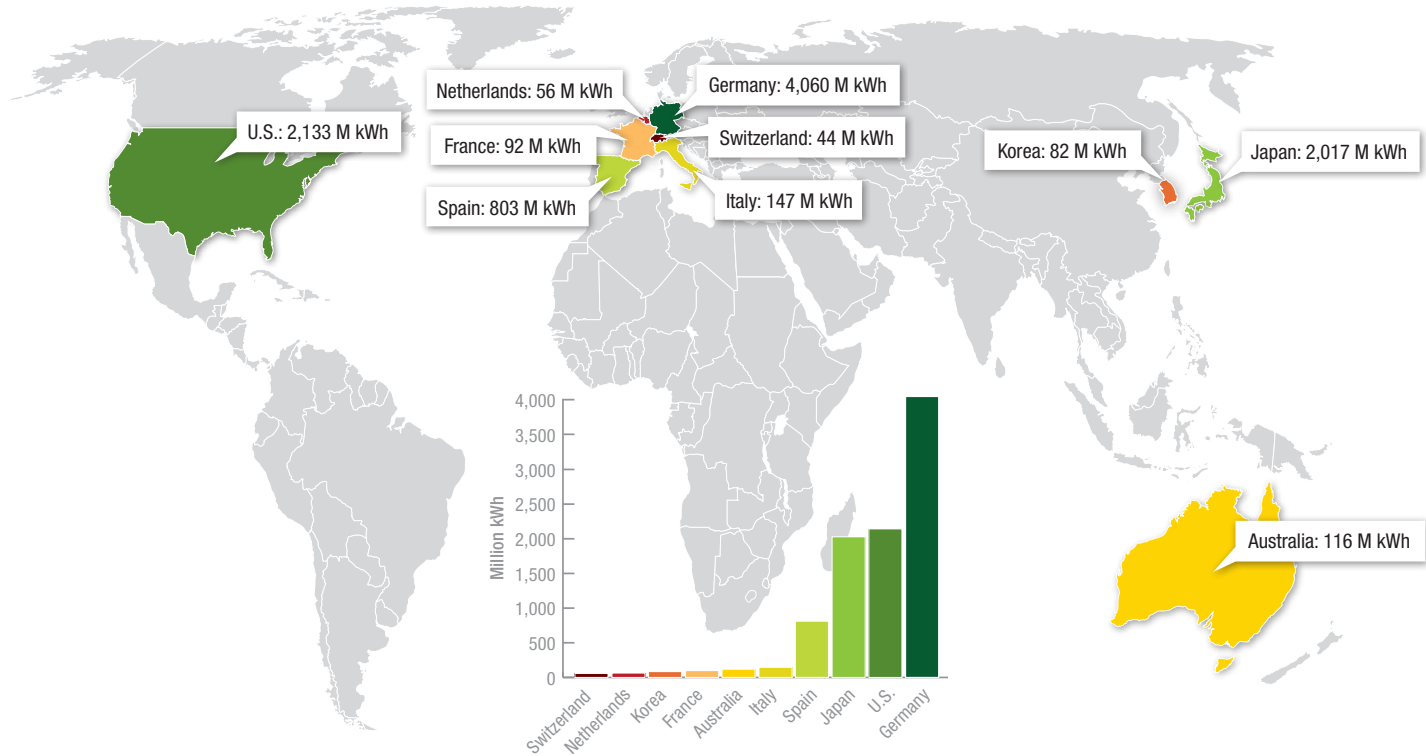
U.S. PV Power Sales Price



V

Source: Solarbuzz LLC, BLS
Note: Data from Solarbuzz is corrected for inflation.

Solar Energy Generation (2007) – Select Countries

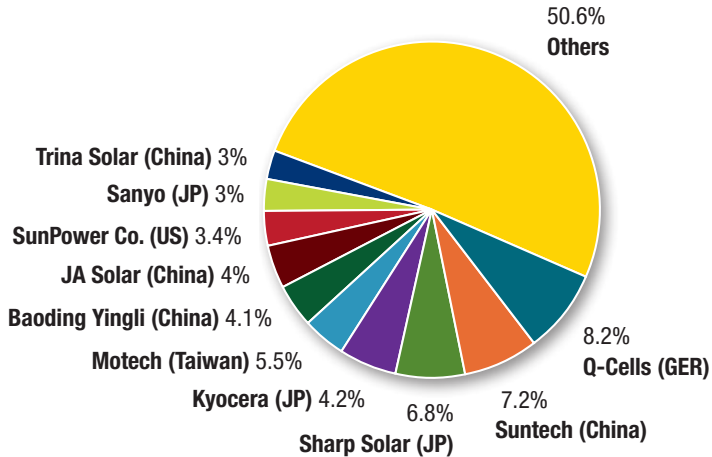


Source: IEA PVPS; La Generacion del Sol

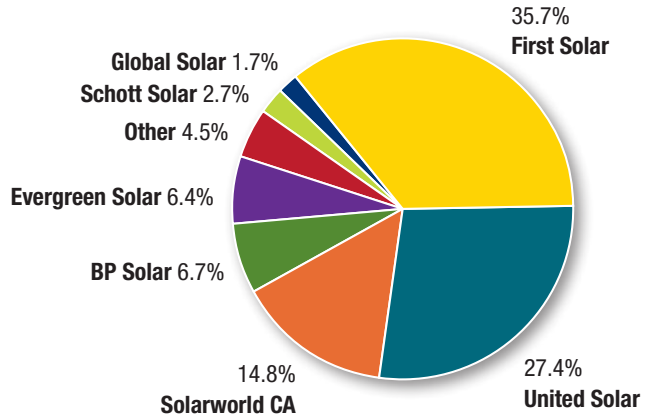
Note: Numbers calculated using capacity factors of 18% for PV in U.S., Australia, and Mexico; 14% for PV in Spain, Italy, France, and Switzerland; 12% for PV in Germany, Japan, Korea, and the Netherlands; and 25% for CSP (in U.S. and Spain only)

Photovoltaic Manufacturing

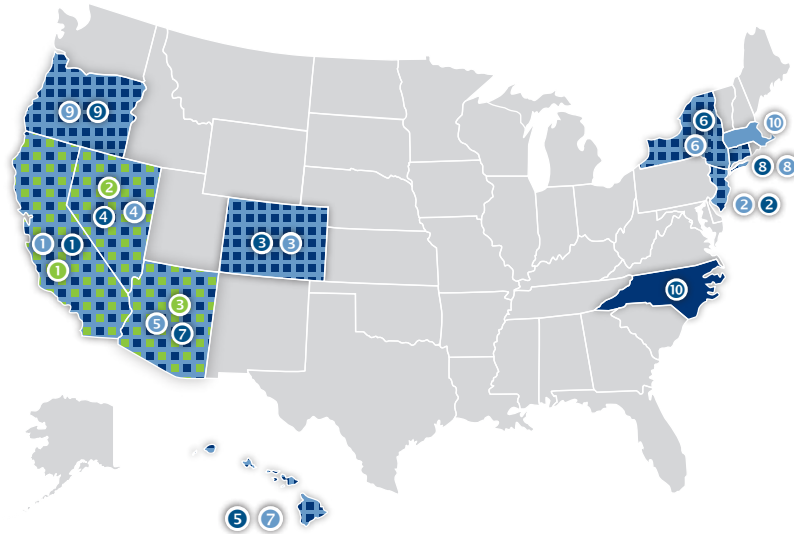
Global Solar PV Production 2008:
6,941 MW nameplate capacity



U.S. Cell Production 2008:
412.1 MW nameplate capacity



States Leading Solar Energy Development



PV Cumulative Capacity (2008, MW)	
1 California	528.3
2 New Jersey	70.2
3 Colorado	35.7
4 Nevada	34.2
5 Arizona	25.3
6 New York	21.9
7 Hawaii	13.5
8 Connecticut	8.8
9 Oregon	7.7
10 Massachusetts	7.5

PV Annual Capacity Additions (2008, MW)	
1 California	178.7
2 New Jersey	22.5
3 Colorado	21.7
4 Nevada	14.9
5 Hawaii	8.6
6 New York	7.0
7 Arizona	6.4
8 Connecticut	5.3
9 Oregon	4.8
10 North Carolina	4.0

CSP Cumulative Capacity (2008, MW)	
1 California	354
2 Nevada	64
3 Arizona	1

Source: Larry Sherwood/IREC

Note: All installments equal 1% or less of electricity generation in states.



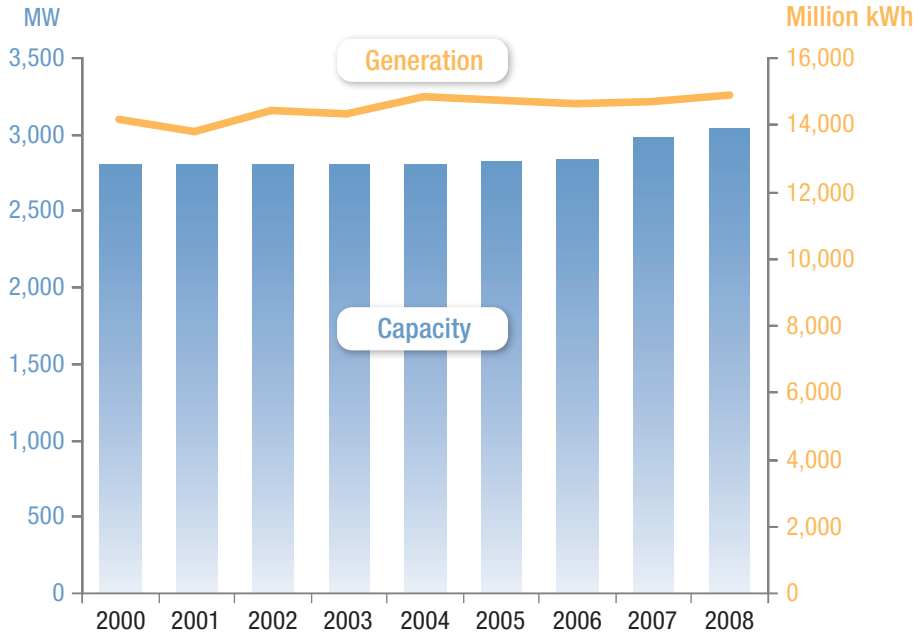
VI. Geothermal



Geothermal: Summary

- U.S. geothermal energy generation has remained relatively stable from 2000 to 2008, with the **past two years experiencing more than 3% growth.**
- Geothermal energy generates power for **between 6 and 10 cents / kilowatt-hour.**
- **The United States leads the world in terms of 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 electricity 24 hours a day, 365 days a year.**

U.S. Geothermal Electricity Nameplate Capacity and Generation



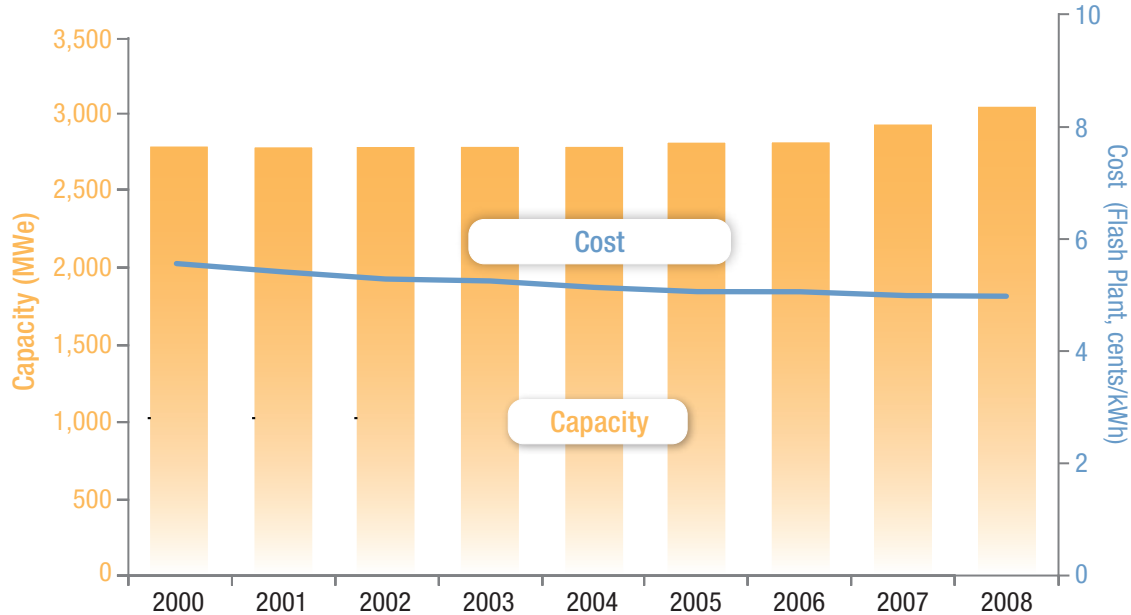
	U.S. Geothermal Electricity Generation (Million kWh)	U.S. Geothermal Electricity Capacity and % Increase from Previous Year	
		Total (MW)	% Increase
2000	14,093	2,798	2.2%
2001	13,741	2,798	0%
2002	14,491	2,798	0%
2003	14,424	2,798	0%
2004	14,811	2,798	0%
2005	14,692	2,828	1.1%
2006	14,568	2,831	0.1%
2007	14,637	2,937	3.7%
2008	14,859	3,040	3.5%

VI

Source: GEA, EIA

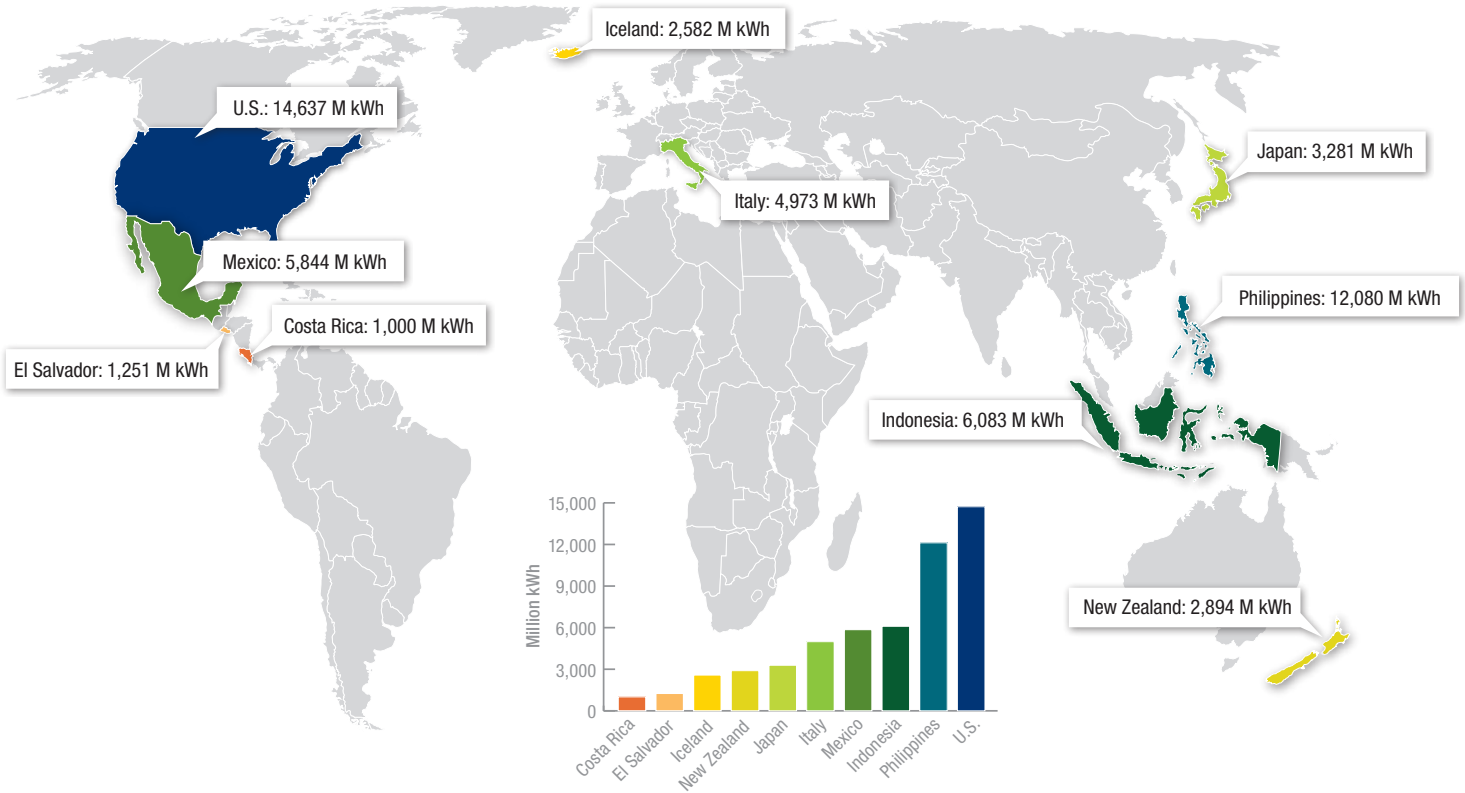
Note: Total U.S. generation from direct use of geothermal energy in 2005 was 8,700 Million kWh.

U.S. Geothermal Capacity and Cost Trends



VI

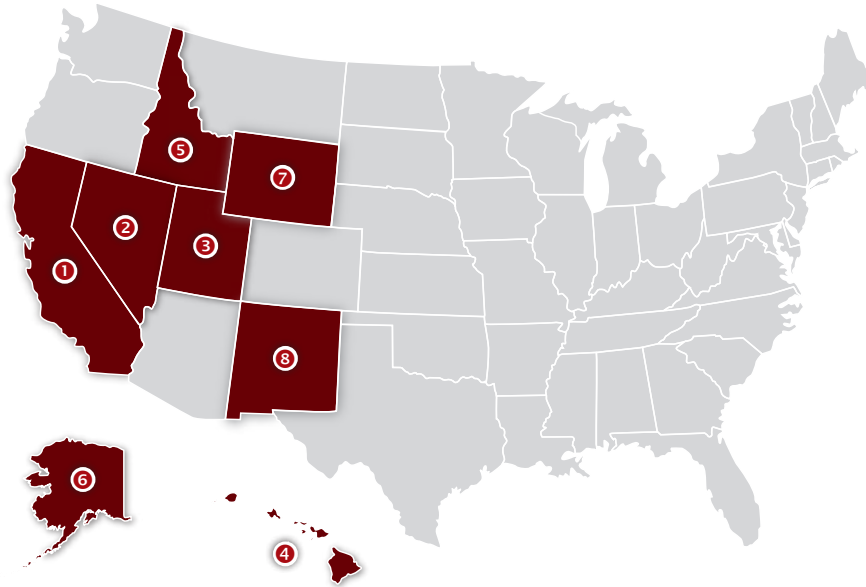
Global Geothermal Electricity Generation (2007) – Select Countries



VI

Source: Bertani, U.S. data from GEA

State Geothermal Energy Development (2008)



Total Installed Capacity (2008, MW)	
1 California	2,605.3
2 Nevada	333.0
3 Utah	50.0
4 Hawaii	35.0
5 Idaho	15.8
6 Alaska	0.7
7 Wyoming	0.3
8 New Mexico ...	0.2

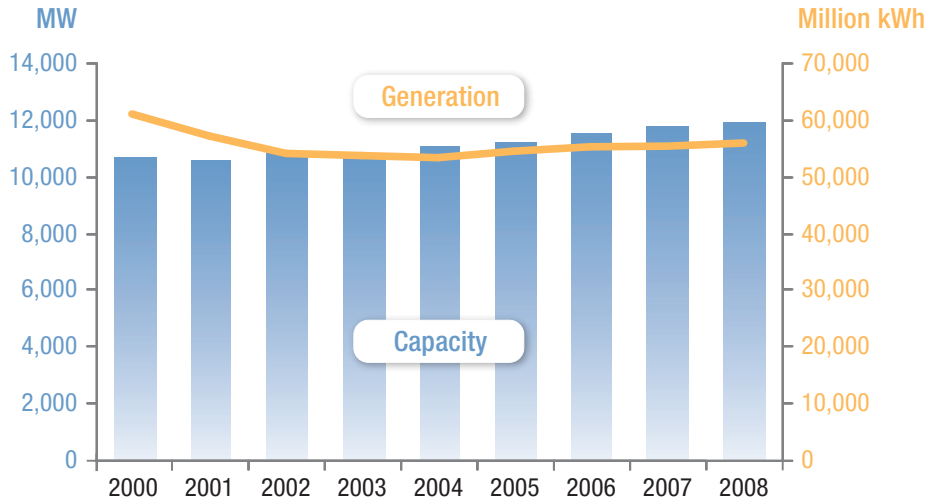


VII. Biopower

Biopower: Summary

- Biopower generation has remained steady during the past seven years, and currently accounts for **45% 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. Biopower Nameplate Capacity and Generation



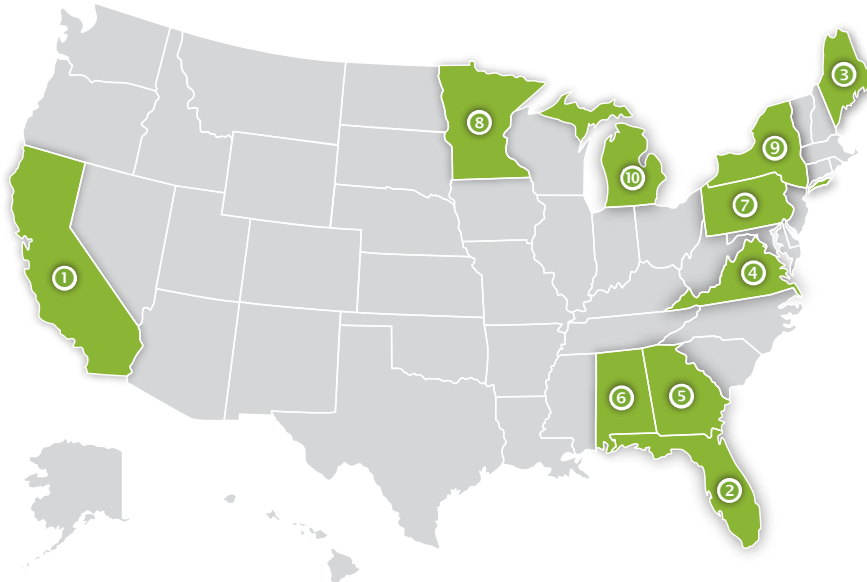
	U.S. Biopower Generation (Million kWh)	U.S. Biopower Capacity and % Increase from Previous Year	
		Total (MW)	% Change
2000	60,726	10,676	- 2.9%
2001	49,748	10,576	- 0.9%
2002	53,709	10,867	2.8%
2003	53,340	10,856	- 0.1%
2004	53,073	11,033	1.6%
2005	54,160	11,222	1.7%
2006	54,759	11,553	2.9%
2007	55,539	11,738	1.6%
2008	55,875	11,943	1.7%

VII

Source: EIA

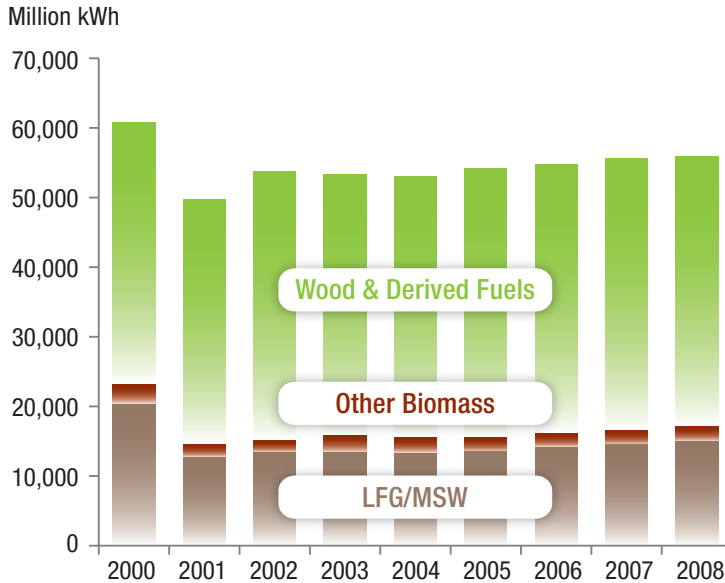
Note: The generation decrease between 2000 to 2001 reflects an EIA classification change. Beginning with 2001 data, non-biogenic municipal solid waste and tire-derived fuels were reclassified as non-renewable energy sources (previously considered waste biopower).

States Leading Biopower Energy Development (2008)



Total Installed Capacity (2008, MW)	
1 California	1,217
2 Florida	1,158
3 Maine	768
4 Virginia	760
5 Georgia	712
6 Alabama	622
7 Pennsylvania	565
8 Minnesota	445
9 New York	439
10 Michigan	430

U.S. Biopower Generation Sources (2000–2008)



	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	14,953	2,133	38,789	55,875

VII

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).

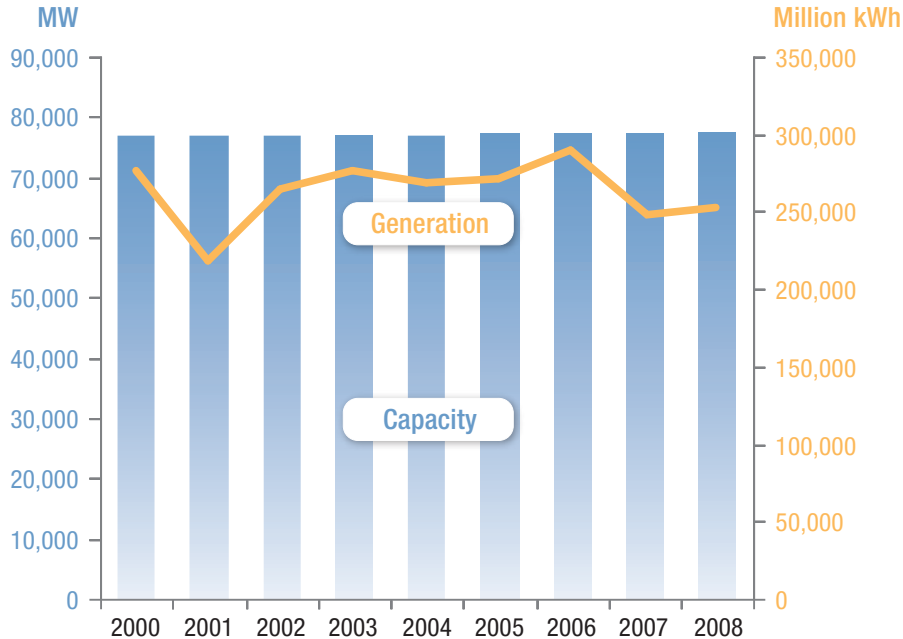


VIII. Hydropower

Hydropower: Summary

- Hydropower **capacity has remained constant between 2000–2008**, 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% of U.S. electricity generation.**

U.S. Hydropower* Nameplate Capacity and Generation

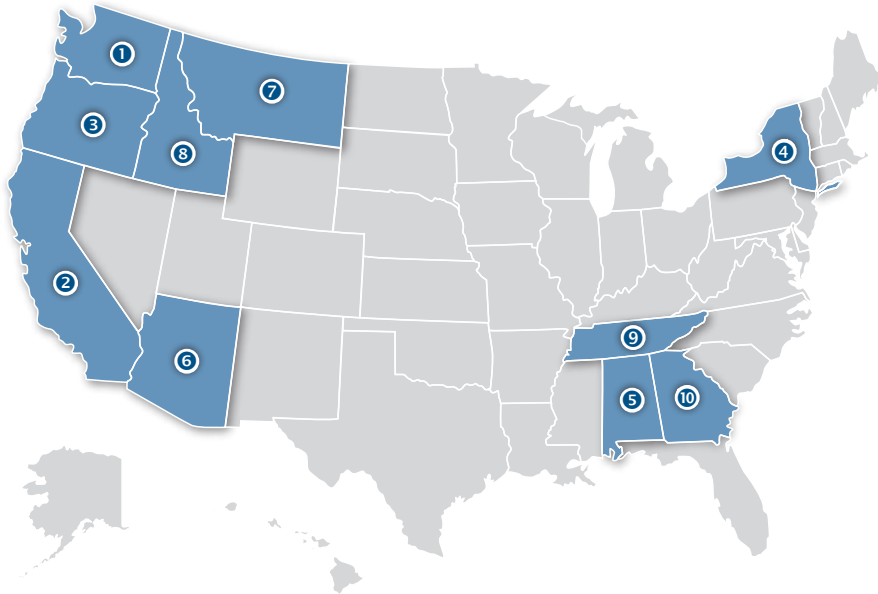


	U.S. Hydropower Generation (Million kWh)	U.S. Hydropower Capacity and % Increase from Previous Year	
		Total (MW)	% Increase
2000	275,573	76,946	0.0%
2001	216,961	76,911	0.0%
2002	264,329	77,047	0.2%
2003	275,806	77,020	0.0%
2004	268,417	77,130	0.1%
2005	270,321	77,354	0.3%
2006	289,246	77,419	0.1%
2007	247,510	77,432	0.0%
2008	248,085	77,450	0.0%

Source: EIA

*Note: Excludes pumped storage.

States Leading Hydropower Generation (2008)



Generation (2008, Million kWh)	
1 Washington	20,807
2 California	10,032
3 Oregon	8,261
4 New York	4,654
5 Alabama	3,280
6 Arizona	2,718
7 Montana	2,548
8 Idaho	2,516
9 Tennessee	2,418
10 Georgia	1,932

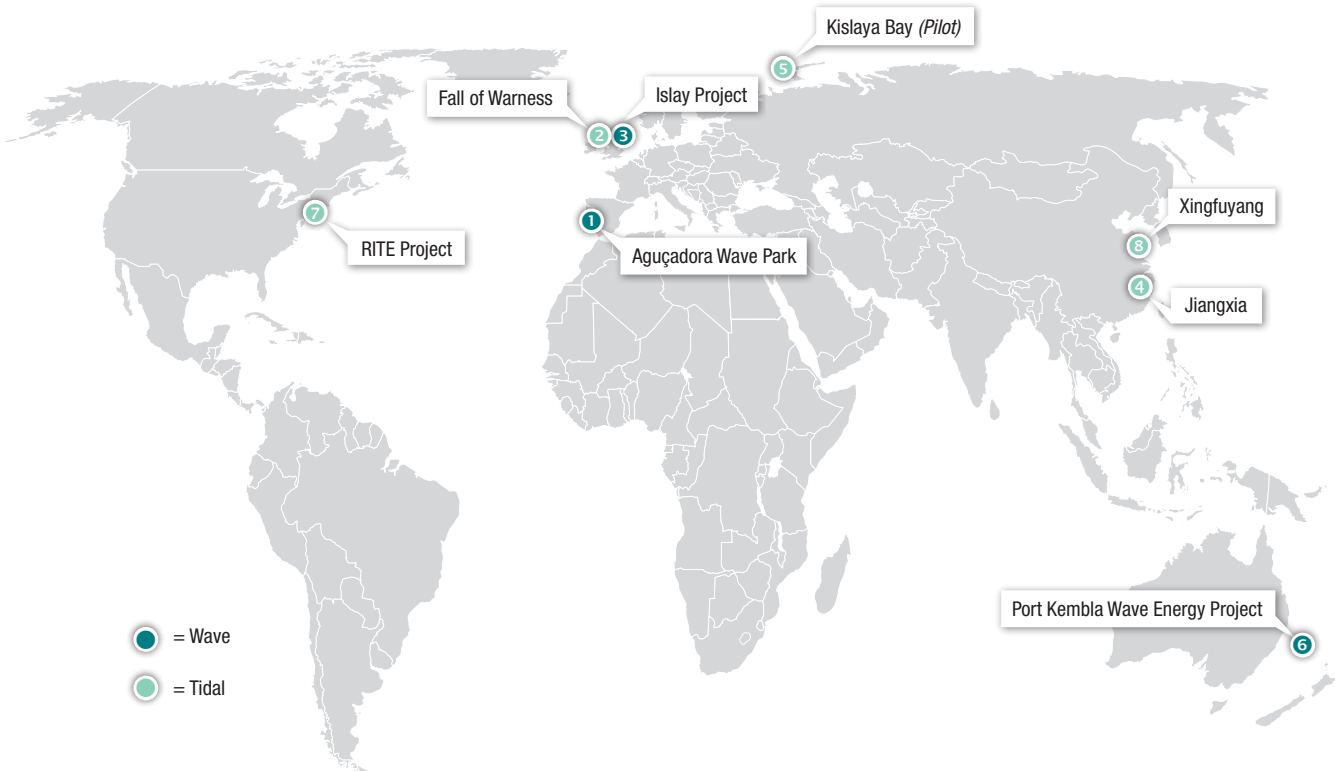


IX. Advanced Water Power

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).
- In fiscal year 2008, the Congress appropriated **\$10 million to DOE for water power research and development.**

Worldwide Advanced Water Power Commercial and Pilot Plants in Operation



Worldwide Advanced Water Power Commercial and Pilot Plants in Operation

PROJECT NAME	Type	Location	Technology	Size	Year of Oper.
① Aguçadora Wave Park	WAVE	Póvoa de Varzim, Portugal	Pelamis Wave Energy Converter	2.25 MW	2007
② Fall of Warness	TIDAL	United Kingdom	Open Hydro Open Centre Turbine	250 kW	2008
③ Islay Project	WAVE	United Kingdom	Wavegen Limpet Device	500 kW	2000
④ Jiangxia	TIDAL	China	n/a	3.2 MW	~1980
⑤ Kislaya Bay	TIDAL	Barents Sea, Russia	Orthogonal rotor	200 kW	1968 <small>(updated in 2005)</small>
⑥ Port Kembla Wave Energy Project	WAVE	Australia	Oceanlinx Wave Energy System	500 kW	2006
⑦ RITE Project	TIDAL	East River, New York	Verdant Free Flow Turbines	120 kW	2007
⑧ Xingfuyang	TIDAL	China	n/a	1.3 MW	~1980

 = Commercial Plants

FERC Permitted and Licensed Projects in the U.S. (2008)	Permitted	Pending Permit	Licensed	Pending licenses
	120	14	1	0

X. Hydrogen



Hydrogen: Summary

- As of May 2009, there are approximately **60 hydrogen fueling stations** in the United States.
- Approximately **34,000 fuel cell units have been delivered globally**; more than 8,500 units were shipped in 2007 for stationary, portable, and transport applications.
- More than 200 vehicles have been demonstrated in the United States to date, with major automakers starting to lease vehicles.
- Global public R&D investment for hydrogen is **~\$1 billion/year worldwide**, with more than \$400 million in the United States.

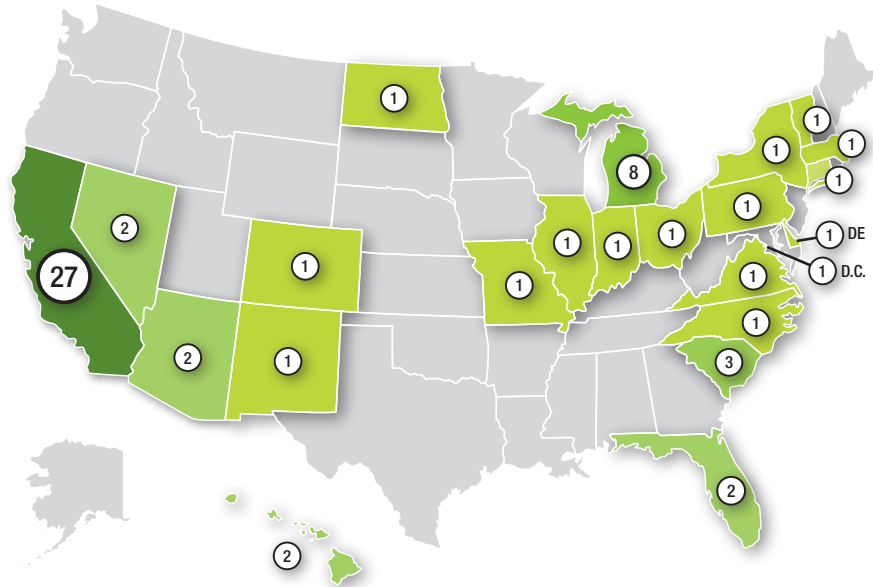
Hydrogen – Transportation

Hydrogen Production

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

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

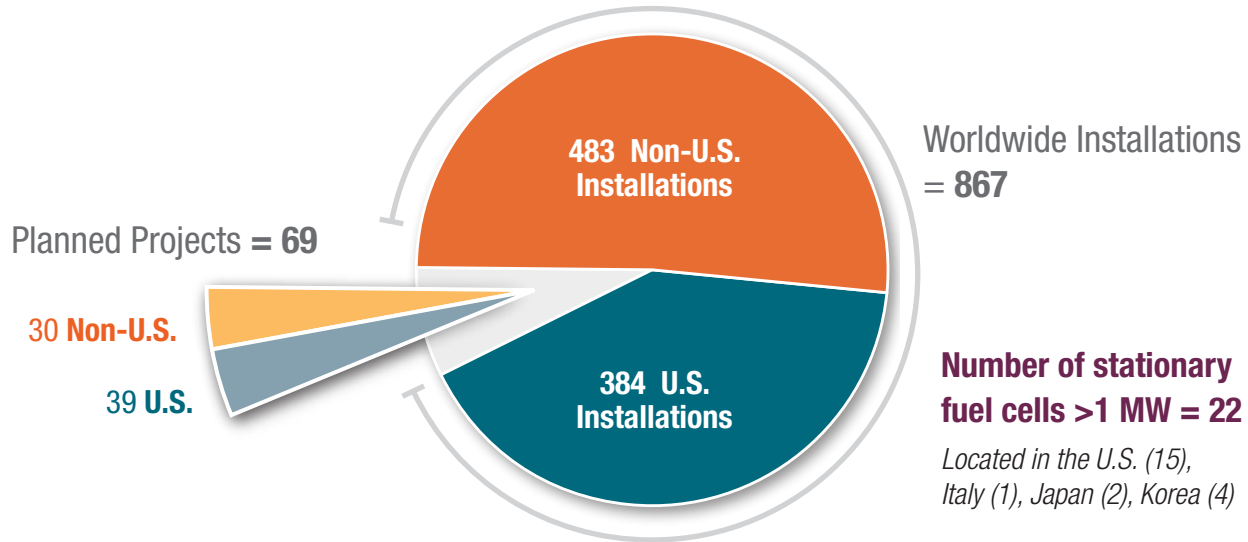
Number of Operational U.S. Hydrogen Fueling Stations (May 2009 – Total of 62)



Number of recorded fuel cell vehicles in the United States = 223

Hydrogen – Electricity

Stationary Fuel Cell Installations (2008)



X



XI. Renewable Fuels

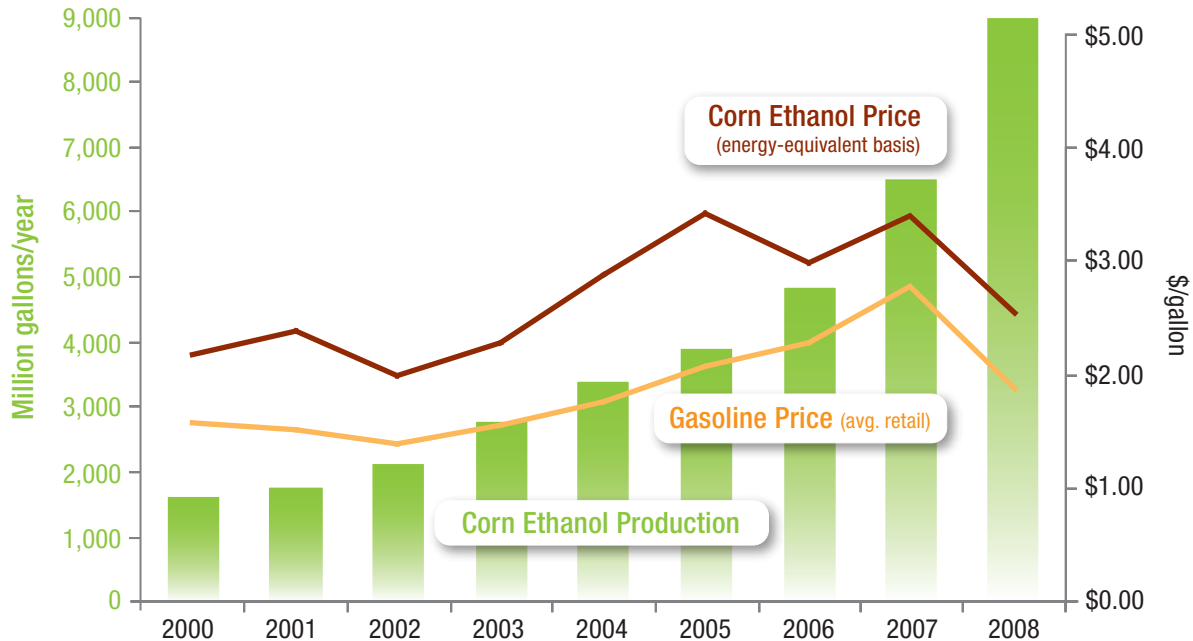
Renewable Fuels – Ethanol: Summary

- Corn ethanol production continues to expand rapidly in the United States. **Between 2000 and 2008, production increased 5.5 times.**
- Ethanol production **grew more than 38% in 2008** to reach **9,000 million gallons** per year.
- Ethanol has steadily increased its percentage of the overall gasoline pool, and in 2008 was estimated to be **6.5%**.
- In 2008, the United States* produced 51.9% of the world's ethanol, followed by Brazil at 37.3%, the European Union at 4.2%, China at 2.9%, and Canada at 1.4%.

* All 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).

U.S. Corn Ethanol Production and Price Trends



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%	1.3%
2001	129,312	1,770	9%	1.4%
2002	132,782	2,130	20%	1.6%
2003	134,089	2,800	31%	2.1%
2004	137,022	3,400	21%	2.5%
2005	136,949	3,904	15%	2.9%
2006	138,378	4,855	24%	3.5%
2007	142,287	6,500	34%	4.6%
2008	137,414	9,000	39%	6.5%

U.S. Ethanol Distribution and Utilization

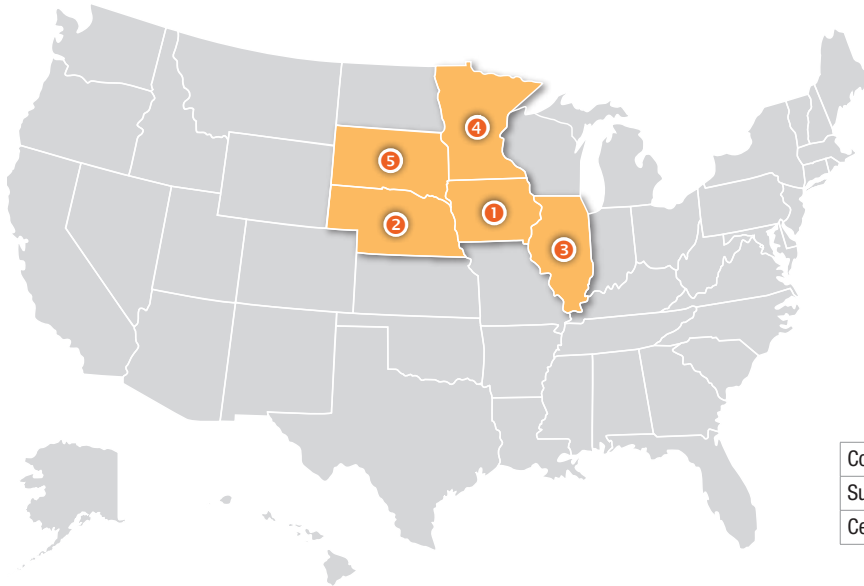
1,877 E85 stations (May 2009)

E85 average retail price (Oct. 2008):
\$3.99/gallon (energy-equivalent basis),
gasoline price: \$3.04/gallon

**Approximately 7.5 million flex-fuel
vehicles (FFV)** are on the road, with
790,000 of those built in 2007

* Includes ethanol

U.S. Ethanol Production Capacity and Ethanol Yields and Emissions



Top Five States 2008 for U.S. Ethanol (operating) Production Capacity (millions of gallons)	
1 Iowa	2,856
2 Nebraska	1,164
3 Illinois	1,190
4 Minnesota	838
5 South Dakota	799

	Yields (gallons/acre)	GHG Emissions* (% less than gasoline)
Corn	330	22%
Sugarcane	600-800	56%
Cellulosic	>1,000	91%

* In terms of lbs/gallon produced for production and use of fuel
 Note: No sugarcane ethanol is currently produced in the United States.
 Sources: RFA, EIA, National Geographic, Cornell University

U.S. Ethanol Production Capacity

Total U.S. Ethanol Operating Production Capacity (2008): 10,569.4 million gallons/year (mmgy)

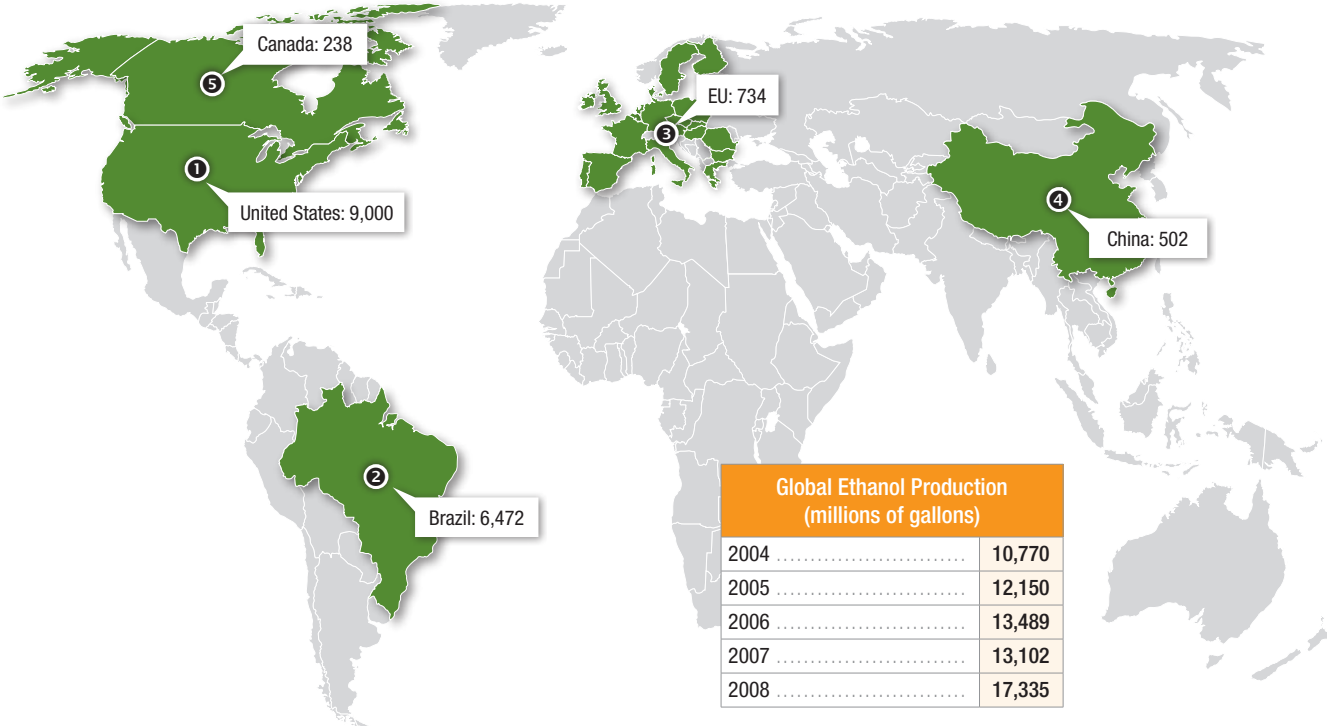
Top Five Ethanol Companies — Production Capacity 2008 (millions of gallons/year)	
1 Poet	1,419
2 Archer Daniels Midland Co.	1,070
3 VeraSun Energy	450
4 US BioEnergy Corp.	445
5 BioFuel Energy	230

Source: RFA

Note: On March 31, 2008, VeraSun Energy merged with US BioEnergy Corporation.

Global Ethanol Production

Top Five Countries (2008) Ethanol Production (millions of gallons)

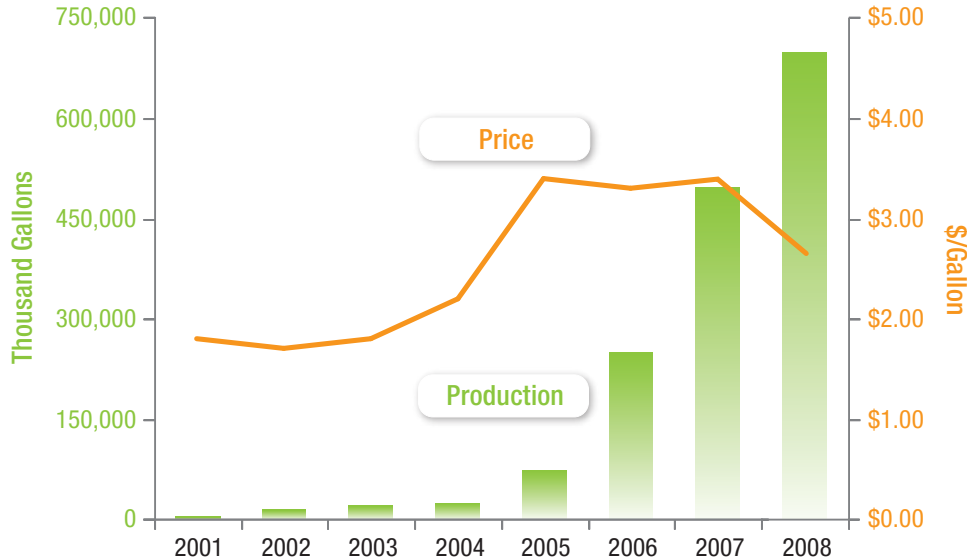


Global Ethanol Production (millions of gallons)	
2004	10,770
2005	12,150
2006	13,489
2007	13,102
2008	17,335

Renewable Fuels – Biodiesel: Summary

- Biodiesel has expanded from a relatively small production base in 2000, to a total U.S. production of **700 million gallons** in 2008.
- Biodiesel production in 2008 is **350 times** what it was in 2000.
- Europe leads the world in biodiesel production, with most production and consumption in Germany.

U.S. Biodiesel Demand and Price (2000–2008)



	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	200%	75,000
2006	233%	250,000
2007	100%	500,000
2008	40%	700,000

XI

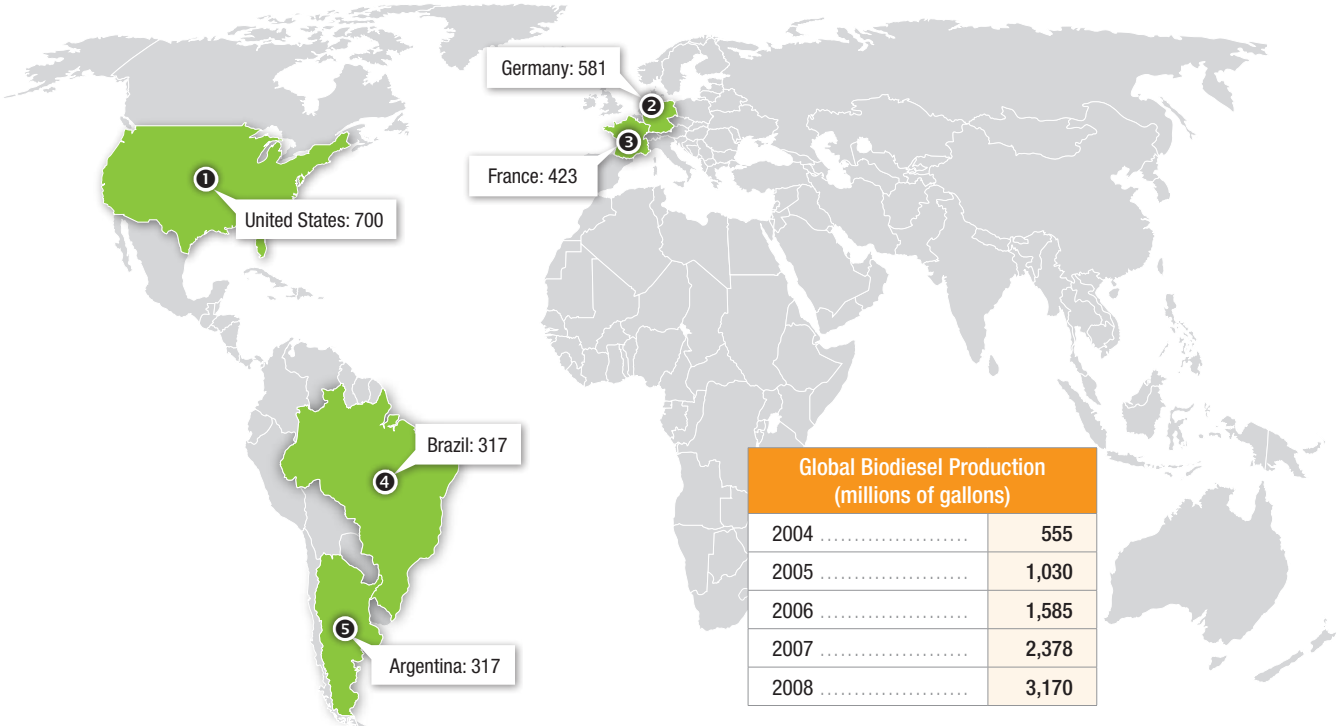
U.S. Biodiesel Production Capacity

Total U.S. Biodiesel Production Capacity (2008): 2,610 million gallons/year (mmgy)

Top Six Biodiesel Companies — Production Capacity 2008 (millions of gallons/year)	
1 Green Hunter Biofuels	105
2 Imperium Grays Harbor	100
3 Green Earth Fuels of Houston	90
4 ADM	85
5 Delta Biofuels	80
6 Louis Dreyfus Agricultural Industries	80

Global Biodiesel Production

Top Five Countries (2008) Biodiesel Production (millions of gallons)



Global Biodiesel Production (millions of gallons)	
2004	555
2005	1,030
2006	1,585
2007	2,378
2008	3,170



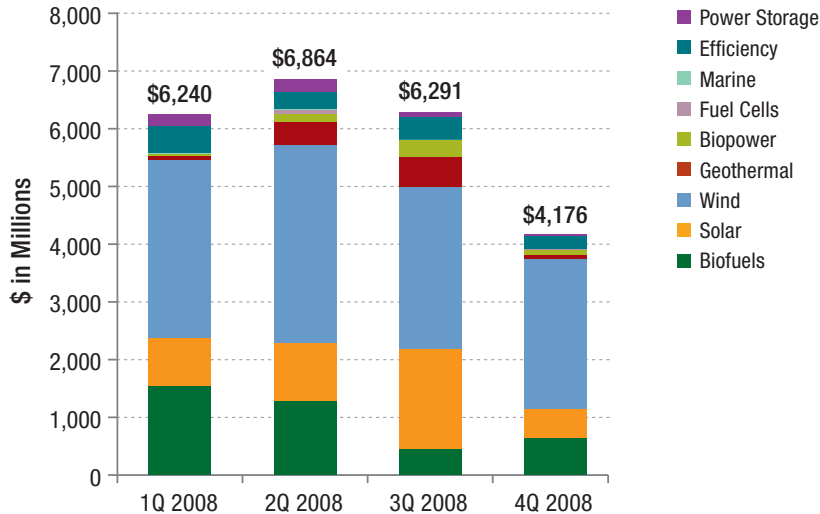
XII. Clean Energy Investments

Clean Energy Investments: Summary

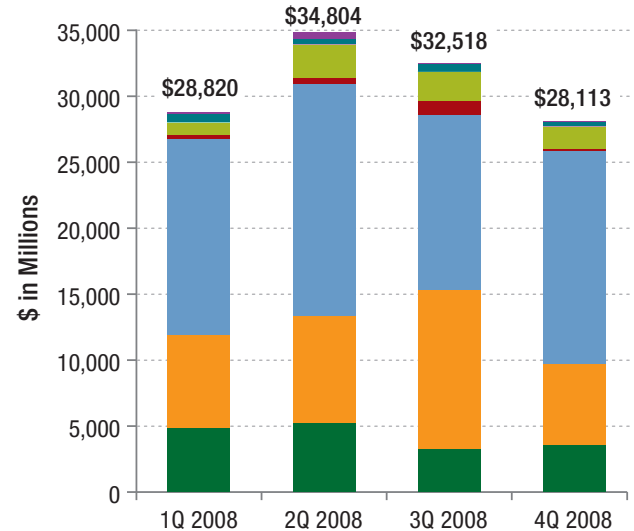
- U.S. investment in renewable energy projects has grown dramatically in the past decade, and in 2008 investment reached more than **\$23 billion**. In the last quarter of 2008, U.S. investment declined by more than 30% compared to the previous quarter, reflecting the overall economic decline.
- U.S. investment in wind energy projects grew from \$250 million in 2001 to **almost \$12 billion in 2008**.
- In 2008, U.S. venture capital and private equity investment in renewable energy technology companies was **\$3.9 billion**—up from \$30 million in 2001.
- U.S. venture capital and private equity investment in solar technology companies has increased from \$5 million in 2001 to more than **\$2 billion** in 2008.

U.S. and Global Total Investment in Renewable Energy, 2008 (\$ millions)

U.S. Total Investment



Global Total Investment

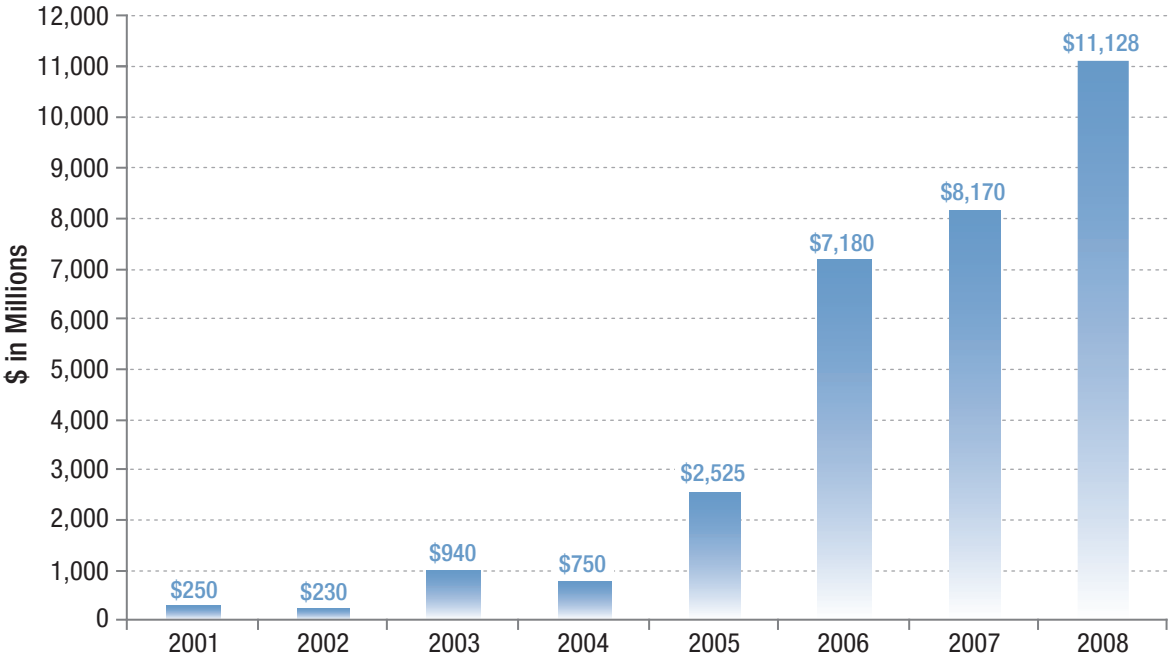


Source: New Energy Finance

Completed and disclosed deals only.

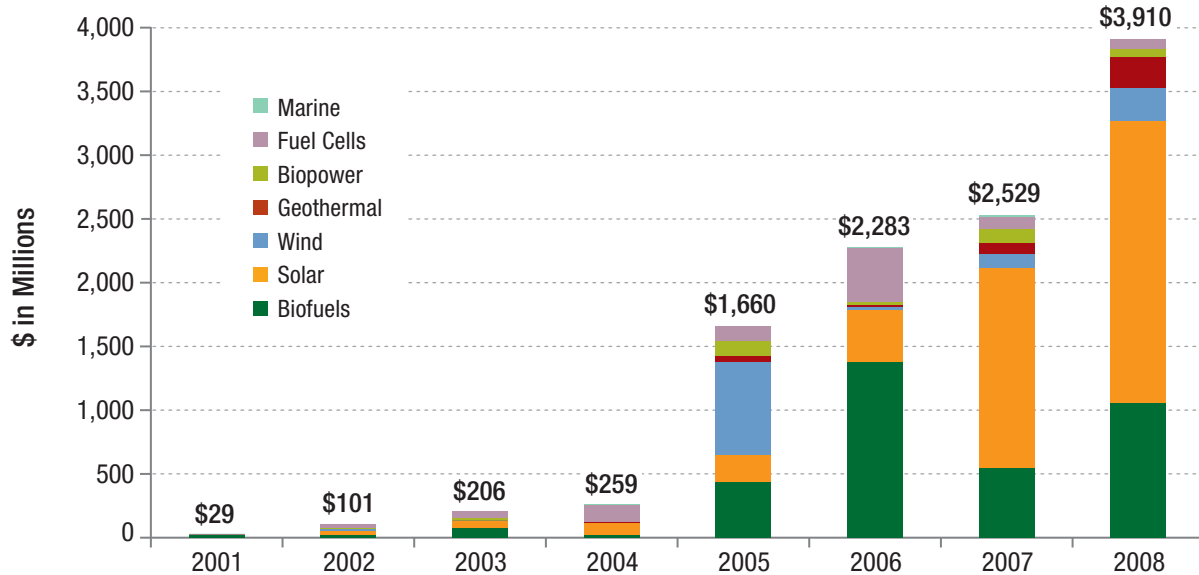
Includes VC/PE, public market activity, asset financing, and acquisition transactions.

U.S. Wind Energy Project Asset Financing Transactions (\$ millions), 2001–2008

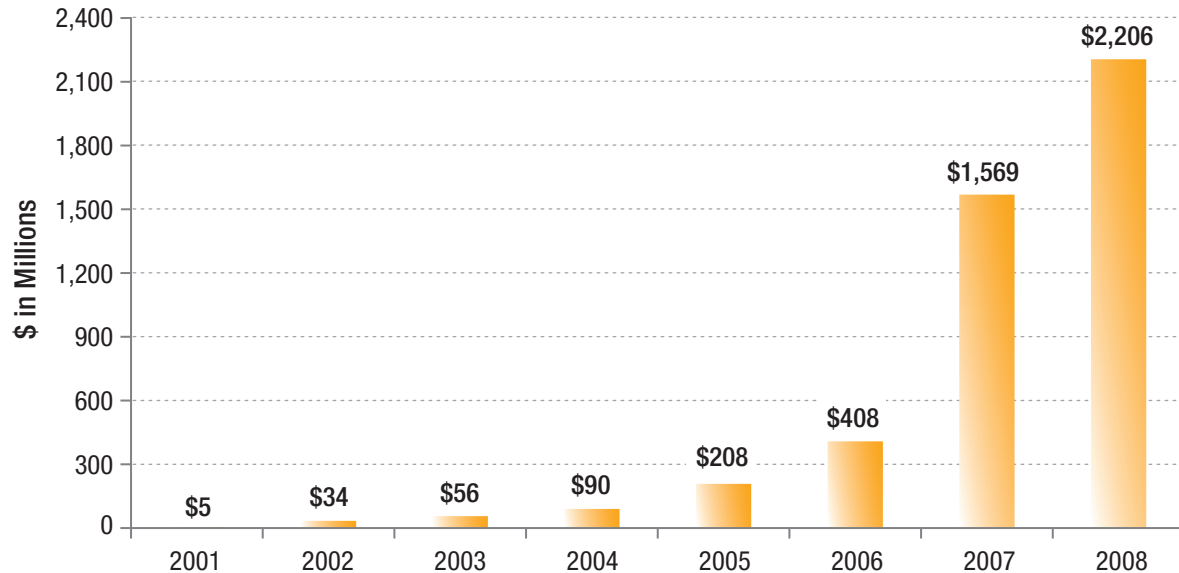


Figures represent Disclosed Deals derived from New Energy Finance's Desktop database.

U.S. Venture Capital and Private Equity Investment (\$ millions) in Renewable Energy Technology Companies, 2001–2008

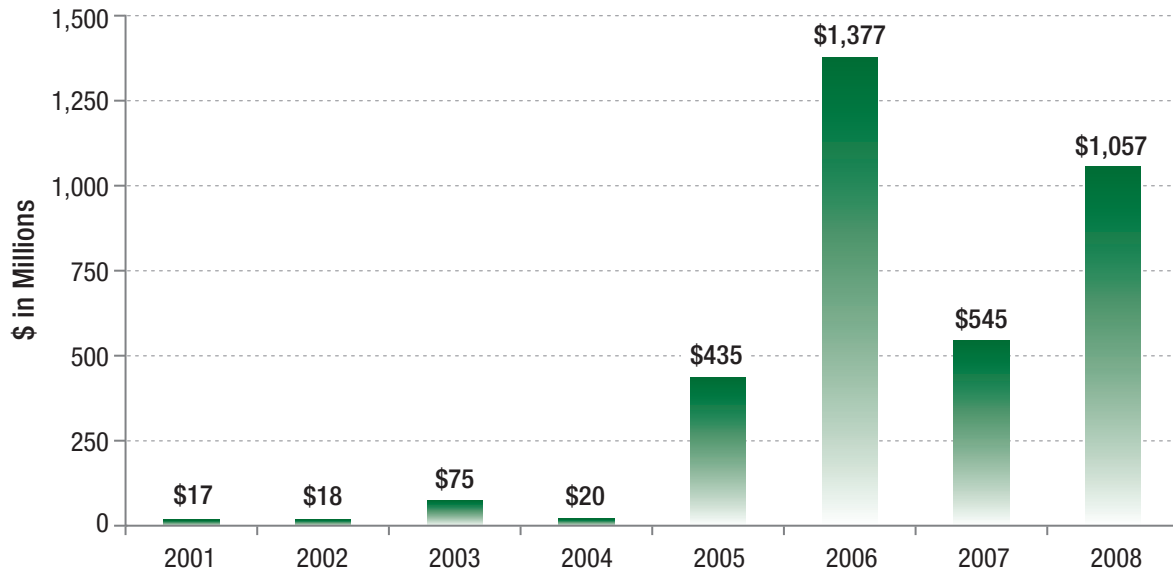


U.S. Venture Capital and Private Equity Investment (\$ millions) in Solar Energy Technology Companies, 2001–2008

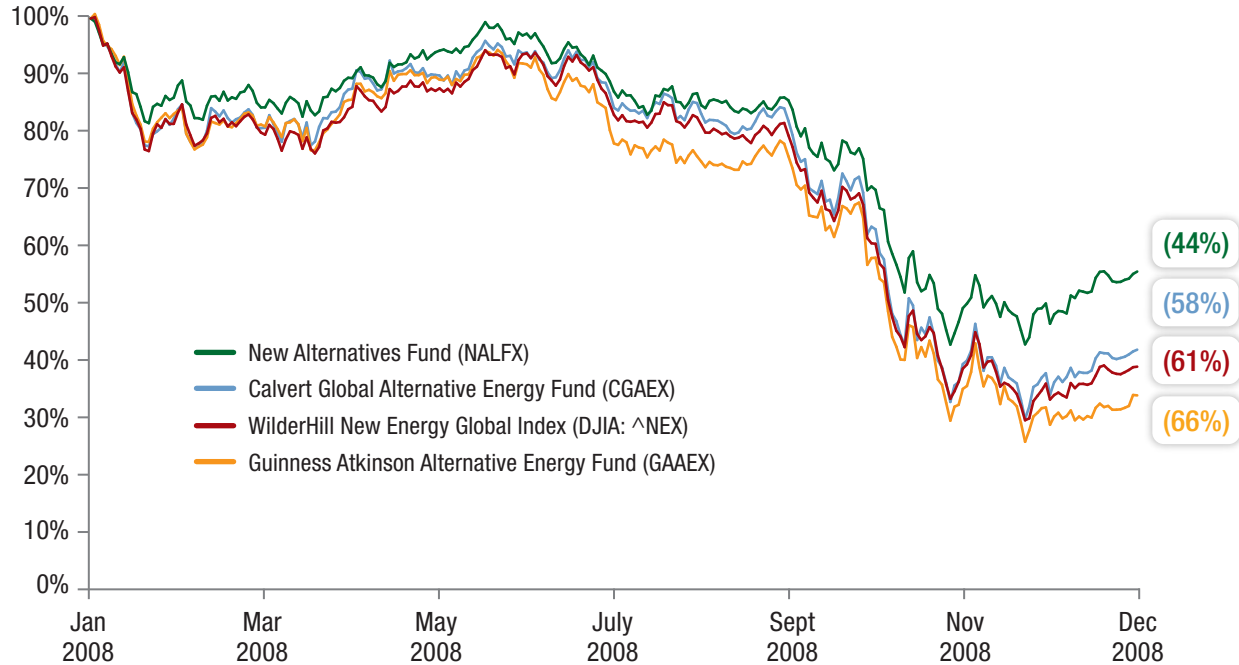


Figures represent Disclosed Deals derived from New Energy Finance's Desktop database.

U.S. Venture Capital and Private Equity Investment (\$ millions) in Biofuels Technology Companies, 2001–2008



Public Renewable Energy Index Performance, 2008 (Indexed to 100)





Glossary

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.

Glossary

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 reinjected 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.

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).

Glossary

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.

References

U.S. Energy Production and Consumption — Pages 7–9

- Energy Information Administration (EIA) – Annual Energy Review
Production: EIA – Monthly Energy Review, April 2009, http://www.eia.doe.gov/emeu/aer/pdf/pages/sec1_7.pdf
Consumption: EIA – Monthly Energy Review, April 2009, http://www.eia.doe.gov/emeu/aer/pdf/pages/sec1_9.pdf

U.S. Nameplate and Generation Pie Charts — Pages 10–12

- EIA – Electric Power Monthly, May 2009, <http://tonto.eia.doe.gov/ftproot/electricity/epm/02260905.pdf>
- EIA – Electric Power Annual, 2007, http://www.eia.doe.gov/cneaf/electricity/epa/epa_sum.html
- EIA – State Historical Tables for 2006, http://www.eia.doe.gov/cneaf/electricity/epa/existing_capacity_state.xls
- American Wind Energy Association (AWEA) – AWEA Wind Power Projects Database, <http://www.awea.org/Projects/growth.xls>
- International Energy Association (IEA) Photovoltaic Power Systems Programme – National Status Report 2006
- Geothermal Energy Association (GEA), Geothermal Developing Projects Update – November 2006, <http://www.geo-energy.org/publications/reports/November%202006%20Geothermal%20Power%20Production%20and%20Development%20Survey.pdf>
- EIA – Electric Power Monthly, Chapter 1, Net Generation by Energy Source: Total – All Sectors, http://www.eia.doe.gov/cneaf/electricity/epm/epmxf1_1.xls
- EIA – Electric Power Monthly, Chapter 1, Net Generation, Other Renewables: Total – All Sectors, http://www.eia.doe.gov/cneaf/electricity/epm/epmxf1_1_a.xls
- Larry Sherwood/Interstate Renewable Energy Council (IREC)

Price of Technology — Page 13

- Idaho National Laboratory, http://hydropower.inel.gov/hydrofacts/plant_costs.shtml
- Carbon Trust, Future Marine Energy, 2006, <http://www.carbontrust.co.uk/Publicsites/cScape.CT.PublicationsOrdering/PublicationAudit.aspx?id=CTC601>
- IEA, Biomass for Power Generation and CHP, <http://www.iea.org/Textbase/techno/essentials3.pdf>

References

- Ryan Wiser at Lawrence Berkeley National Laboratory (LBNL)
- REN21 – Renewable Global Status Report 2007, http://www.ren21.net/pdf/RE2007_Global_Status_Report.pdf
- Simmons Energy Monthly: Alternative Energy Review, May 2007
- Solarbuzz, <http://www.solarbuzz.com/SolarIndices.htm>, <http://www.solarbuzz.com/solarprices.htm>
- EERE – “Geothermal Tomorrow 2008,” http://www1.eere.energy.gov/geothermal/pdfs/geothermal_tomorrow_2008.pdf, p.21

Capacity Factor — Page 14

- GEA Update on U.S. Geothermal Power Production and Development, May 2007, <http://www.geo-energy.org/publications/reports/May2007GEAUpdateonUSGeothermalPowerProductionandDevelopment.pdf>
- NREL Power Technologies Energy Data Book, http://www.nrel.gov/analysis/power_databook/docs/pdf/db_chapter02_bio.pdf
- Simmons Energy Monthly: Alternative Energy Review, May 2007
- Solarbuzz, <http://www.solarbuzz.com/SolarIndices.htm>, <http://www.solarbuzz.com/solarprices.htm>
- Idaho National Laboratory, http://hydropower.inel.gov/hydrofacts/plant_costs.shtml
- Electric Power Research Institute (EPRI), http://www.aas.org/spp/cstc/docs/07_06_1ERPI_report.pdf
- Ocean Power Delivery LTD, http://hydropower.inel.gov/hydrokinetic_wave/pdfs/day1/09_heavesurge_wave_devices.pdf
- NREL and Kearney and Associates, http://www.ases.org/climatechange/toc/04_csp.pdf
- Selya Price (NREL) and Ryan Wiser (LBNL)
- Annual Report on U.S. Wind Power Installation, Cost, and Performance Trends: 2007, <http://www1.eere.energy.gov/windandhydro/pdfs/43025.pdf>

References

Capacity and Generation — Pages 19–25

- EIA – State Historical Tables for 2006,
http://www.eia.doe.gov/cneaf/electricity/epa/existing_capacity_state.xls
<http://www.eia.doe.gov/cneaf/electricity/page/capacity/capacity.html>
2007 Hydro capacity: added 13 MW based on planned capacity additions in 2007, http://www.eia.doe.gov/cneaf/electricity/epa/planned_capacity_state.xls
2007 Biomass capacity: added 184 MW based on new and planned capacity additions in 2007, <http://www.eia.doe.gov/cneaf/electricity/epm/epmfiles3.xls>
- AWEA – AWEA Wind Power Projects Database, <http://www.awea.org/Projects/growth.xls>
- IEA – Photovoltaic Power Systems Programme, National Status Report 2006
- Larry Sherwood/IREC
- Greentech Media and Prometheus Institute, “Concentrating Solar Power 2008 Industry Report”
- Navigant Consulting, Table 8–12, State by State Results for the Base Case, with SAI System Pricing
- GEA, <http://www.geo-energy.org/information/plants.asp>
2006 Geothermal Developing Projects Update, November 2006,
<http://www.geo-energy.org/publications/reports/November%202006%20Geothermal%20Power%20Production%20and%20Development%20Survey.pdf>
GEA Update on U.S. Geothermal Power Production and Development, May 2007,
<http://www.geo-energy.org/publications/reports/May2007GEAUpdateonUSGeothermalPowerProductionandDevelopment.pdf>
- AWEA – 2009 Annual Wind Industry Report, <http://www.awea.org/publications/reports/AWEA-Annual-Wind-Report-2009.pdf> (pp. 21–23)
- GEA U.S. Geothermal Production and Development Update, March 2009,
http://www.geo-energy.org/publications/reports/Industry_Update_March_Final.pdf (pp. 21–23)
- EIA – Electric Power Annual, http://www.eia.doe.gov/cneaf/electricity/epa/epa_sum.html (pp. 21–24)
- EIA – Electric Power Monthly, January 2009, http://www.eia.doe.gov/cneaf/electricity/epm/epm_sum.html#one (pp. 19, 20)

References

Generation — Pages 26–30

- EIA – Electric Power Monthly, Chapter 1, Net Generation, Other Renewables: Total – All Sectors, http://www.eia.doe.gov/cneaf/electricity/epm/epmxf1file1_1_a.xls
- Solar – Numbers calculated using capacity factors of 18% for PV and 25% for CSP based on installed capacity
- EIA – Electric Power Monthly, January 2009, http://www.eia.doe.gov/cneaf/electricity/epm/epm_sum.html#one (pp. 26, 27, 28, 30)

State Numbers by Technology — Pages 32–41

- EIA – State Historical Tables for 2006, http://www.eia.doe.gov/cneaf/electricity/epa/existing_capacity_state.xls
- AWEA – AWEA Wind Power Projects Database, <http://www.awea.org/Projects/growth.xls>
- Navigant Consulting, Table 8–12, State by State Results for the Base Case, with SAI System Pricing
- GEA – U.S. Geothermal Power Production and Development Update, May 2007, <http://www.geo-energy.org/publications/reports/May2007GEAUpdateonUSGeothermalPowerProductionandDevelopment.pdf>
- NREL, http://www.nrel.gov/analysis/repis/online_reports.asp
- U.S. DOE Solar Program News, Largest Solar Thermal Plant in 16 Years Now Online, http://www1.eere.energy.gov/solar/news_detail.html?news_id=11030
- Navigant Consulting, Table 8–12, State by State Results for the Base Case, with SAI System Pricing
- GEA – U.S. Geothermal Power Production and Development Update, March 2009, http://www.geo-energy.org/publications/reports/Industry_Update_March_Final.pdf
- Solar Energy Industry Association (SEIA) – U.S. Solar Industry Year in Review 2008, http://www.seia.org/galleries/pdf/2008_Year_in_Review-small.pdf
- Larry Sherwood/IREC
- AWEA, <http://www.awea.org/projects>
- EIA State Historical Tables for 2007, Proposed Additions by State, http://www.eia.doe.gov/cneaf/electricity/epa/planned_capacity_state.xls
- EIA State Historical Tables for 2007, Existing Capacity by State, http://www.eia.doe.gov/cneaf/electricity/epa/existing_capacity_state.xls
- USDA Economic Research Service, State Fact Sheets, <http://www.ers.usda.gov/StateFacts/>

References

World Renewable Energy — Pages 43–51

- REN21 – Renewables 2005 Global Status Report, Table N3. Renewable Energy Capacities and Installations, 2004, http://www.ren21.net/pdf/RE2005_Notes_References.pdf
- REN21 – Renewables 2006 Global Status Report, Table 1. Renewable Energy Added and Existing Capacities, 2005, http://www.ren21.net/pdf/RE_GSR_2006_Update.pdf
- REN21 – Renewables Global Status Report 2007, Selected Indicators, http://www.ren21.net/pdf/REN21_GSR2007_Prepub_web.pdf
- REN21 – Renewables 2007, Global Status Report, http://www.ren21.net/pdf/RE2007_Global_Status_Report.pdf
- United Nations Development Programme, World Energy Assessment, Table 7. Status of Renewable Energy Technologies, End 2001, <http://www.energyandenvironment.undp.org/undp/indexAction.cfm?module=Library&action=GetFile&DocumentAttachmentID=1010>
- IEA, Renewables for Power Generation, http://www.iea.org/textbase/nppdf/free/2000/renewpower_2003.pdf
- NREL, Power Technologies Energy Data Book, http://www.nrel.gov/analysis/power_databook/docs/pdf/db_chapter02_bio.pdf
- World Wind Energy Association (WWEA), News Release, January 29, 2007, http://www.wwindea.org/home/images/stories/pdfs/pr_statistics2006_290107.pdf
- Eric Martinot, Renewable Energy Information on Markets, Policy, Investment, and Future Pathways
- Solar Photovoltaic Capacity World Total, 1990–2003 (MW), <http://www.martinot.info/Figure2.pdf>
- BP Statistical Review of World Energy 2007, <http://www.bp.com/productlanding.do?categoryId=6848&contentId=7033471>
- REN21 – Renewables Global Status Report 2009 Update, <http://www.ren21.net/globalstatusreport/g2009.asp>

World Electricity Generation — Pages 52–53

- World capacity data used, with generation derived through using capacity factors of 14% for solar power, 30% for wind, 70% for geothermal, 54% for biomass.

References

Top Countries — Pages 54–55

- REN21 – Renewables 2006 Global Status Report, Table 1. Renewable Energy Added and Existing Capacities, 2005, http://www.ren21.net/pdf/RE_GSR_2006_Update.pdf
- International Geothermal Association (IGA), <http://iga.igg.cnr.it/geoworld/geoworld.php?sub=elgen>
- EIA – Electric Power Monthly, January 2009, http://www.eia.doe.gov/cneaf/electricity/epm/epm_sum.html#one

U.S. Total Installed Wind Energy Capacity and Generation — Page 58

- Capacity Numbers (2000–2006): AWEA, <http://www.awea.org/Projects/growth.xls>
- Capacity Number 2007: AWEA, 2007 Market Report, http://www.awea.org/projects/pdf/Market_Report_Jan08.pdf
- Generation Numbers: EIA, 2007, Electric Power Monthly, http://www.eia.doe.gov/cneaf/electricity/epm/table1_1_a.html
- For 2000 and 2001 numbers, <http://tonto.eia.doe.gov/ftproot/renewables/060302.pdf>
- 2002–2007 Ryan Wiser (LBNL) Wind Data Book
- AWEA – 2009 Annual Wind Industry Report, 2008, <http://www.awea.org/publications/reports/AWEA-Annual-Wind-Report-2009.pdf>
- Generation Data: EIA – Electric Power Monthly, May 2009 – Table 1.1.A, http://www.eia.doe.gov/cneaf/electricity/epm/epm_sum.html#one

U.S. Wind Power Sales Price — Page 59

- EERE, 2007, Annual Report on U.S. Wind Power, Installation, Cost and Performance Trends 2006, <http://www1.eere.energy.gov/windandhydro/pdfs/41435.pdf>
- Mark Bolinger (LBNL) – “The capacity-weighted average wind power price in the year 2008 from a cumulative sample of 147 wind projects totaling 10,033 MW and built in the years 1998–2008 is \$40.3/MWh.”

References

Wind Energy Generation Select Countries — Page 60

- Global Wind Energy Council, Global Wind 2006 Report, http://www.gwec.net/fileadmin/documents/Publications/gwec-2006_final_01.pdf
Note: these installed capacity numbers were converted to reflect GWh generation, using a 30% capacity factor
- Estimated Global Wind Energy Generation U.S.: EIA, Electric Power Monthly, 2007, http://www.eia.doe.gov/cneaf/electricity/epm/table1_1_a.html
- Electric Power Monthly, May 2009, http://www.eia.doe.gov/cneaf/electricity/epm/table1_1_a.html
- 2008 Data: AWEA 2009 Annual Wind Industry Report, <http://www.awea.org/publications/reports/AWEA-Annual-Wind-Report-2009.pdf>
- 2008 Data: REN 21 Global Status Report 2009 Update, http://www.ren21.net/pdf/RE_GSR_2009_update.pdf
- Japan Data: Global Wind Energy Council, <http://www.gwec.net/index.php?id=123>

Manufacturing – Global and Domestic — Page 61

- AWEA – 2007 Market Report, http://www.awea.org/projects/pdf/Market_Report_Jan08.pdf
- 2007 Data: Annual Report on U.S. Wind Power Installation, Cost, and Performance Trends: 2007, <http://www1.eere.energy.gov/windandhydro/pdfs/43025.pdf>
- AWEA – 2009 Annual Wind Industry Report, <http://www.awea.org/publications/reports/AWEA-Annual-Wind-Report-2009.pdf>

Turbine Size — Page 62

- EERE, 2007, Annual Report on U.S. Wind Power, Installation, Cost and Performance Trends 2006, <http://www1.eere.energy.gov/windandhydro/pdfs/41435.pdf>
- Figure is from Sandia National Laboratory
- 2006 Data: Annual Report on U.S. Wind Power Installation, Cost, and Performance Trends: 2007, <http://www1.eere.energy.gov/windandhydro/pdfs/43025.pdf>
- 2007 and 2008 Data: AWEA's 2009 Annual Wind Industry Report, <http://www.awea.org/publications/reports/AWEA-Annual-Wind-Report-2009.pdf>

References

Top States for Wind Energy Development — Page 63

- AWEA –2007 Market Report, http://www.awea.org/projects/pdf/Market_Report_Jan08.pdf
- AWEA – 2009 Annual Wind Industry Report, <http://www.awea.org/publications/reports/AWEA-Annual-Wind-Report-2009.pdf>

U.S. Total Installed Solar Energy Capacity and Generation — Page 66

- Larry Sherwood/IREC
- Greentech Media and Prometheus Institute, “Concentrating Solar Power 2008 Industry Report”

PV Power Sales Price — Page 67

- Solarbuzz LLC, Solar Energy Industry Electricity Prices, <http://www.solarbuzz.com/SolarPrices.htm>
- Bureau of Labor Statistics, BLS Statistics on Inflation and Prices, <http://www.bls.gov/bls/inflation.htm>
- Source: Nominal data from Solarbuzz, <http://www.solarbuzz.com/SolarPrices.htm>

Solar Energy Generation, Select Countries — Page 68

- U.S., Netherlands, Mexico, Korea, Italy, France, Australia: A PVPS, 2007, Trends in PV Applications, p. 4, http://www.iea-pvps.org/products/download/rep1_16.pdf
- Germany: IEA PVPS. A National Survey Report of PV Power Applications in Germany 2006, p. 6, <http://www.iea-pvps.org/countries/germany/06deunsr.pdf>
- Japan: IEA PVPS. A National Survey Report of PV Power Applications in Japan 2006, p.11, Table 1, <http://www.iea-pvps.org/countries/japan/06jpnnrs.pdf>
- Spain: La Generacion del Sol, 2007, <http://www.lageneraciondelsol.com/secciones/lomasinformativo/noticias/noticia.asp?noticia=208>
- Numbers calculated using capacity factors of 16% for PV in US, Australia, and Mexico; 14% for PV in Spain, France, and Italy; and 12% for PV in Germany, Korea, the Netherlands, and Japan; and 25% for CSP (Spain and U.S.)
- IEA PVPS, <http://www.iea-pvps.org/>
- La Generacion del Sol, <http://www.lageneraciondelsol.com/>

References

PV Manufacturing — Page 69

- PV News, April 2009

Top States: Solar Energy Development PV and CSP — Page 70

- CSP: Calculated by taking the base installed capacity that's been there for 15+ years and adding on two new additions in past two years (Nevada Solar One 64 MW project, and 1 MW Arizona Public Service project).
- 2008 State Data: Larry Sherwood/IREC

Geothermal Capacity and Generation — Page 74

- GEA – Update on U.S. Geothermal Power Production and Development, May 2007, <http://www.geo-energy.org/publications/reports/May2007GEAUpdateonUSGeothermalPowerProductionandDevelopment.pdf>
- 2006 Geothermal Developing Projects Update, November 2006, <http://www.geo-energy.org/publications/reports/November%202006%20Geothermal%20Power%20Production%20and%20Development%20Survey.pdf>
- GEA – Power Plant Database, 2000–2005, <http://www.geo-energy.org/information/plants.asp>
- Geothermal Generation: EIA, Electric Power Monthly, 2007, http://www.eia.doe.gov/cneaf/electricity/epm/table1_1_a.html
- GEA – US Geothermal Production and Development Update, March 2009, http://www.geo-energy.org/publications/reports/Industry_Update_March_Final.pdf
- EIA – Electric Power Monthly, May 2009, http://www.eia.doe.gov/cneaf/electricity/epm/epm_sum.html#one

References

U.S. Geothermal Power Sales Price — Page 75

- EERE Geothermal Technologies Program
- GEA – US Geothermal Production and Development Update, March 2009, http://www.geo-energy.org/publications/reports/Industry_Update_March_Final.pdf
- GEA, <http://www.geo-energy.org>

Geothermal Electricity Generation, Select Countries — Page 76

- Global data: Bertani, <http://geoheat.oit.edu/bulletin/bull28-3/art3.pdf>
- Geothermal generation was calculated using a 70% capacity factor.

State Geothermal Generation — Page 77

- GEA, Update on U.S. Geothermal Power Production and Development, May 2007, <http://www.geo-energy.org/publications/reports/May2007GEAUpdateonUSGeothermalPowerProductionandDevelopment.pdf>
- EIA – Electric Power Monthly, May 2009, http://www.eia.doe.gov/cneaf/electricity/epm/epm_sum.html#one

References

Biopower Capacity and Generation — Pages 80–81

- EIA, Electricity Generating Capacity, <http://www.eia.doe.gov/cneaf/electricity/page/capacity/capacity.html>
- Generation: EIA – Electric Power Annual, http://www.eia.doe.gov/cneaf/electricity/epm/table1_1_a.html
- EIA – Electric Power Monthly, May 2009, http://www.eia.doe.gov/cneaf/electricity/epa/epa_sum.html
- EIA – State Historical Tables for 2007, Proposed Capacity Additions by State, http://www.eia.doe.gov/cneaf/electricity/epa/planned_capacity_state.xls
- EIA – State Historical Tables for 2007, Existing Capacity by State, 2007, http://www.eia.doe.gov/cneaf/electricity/epa/existing_capacity_state.xls

Biopower Generation by Source — Page 82

- EIA, various publications of Electricity Net Generation from Renewable Energy by Energy Use Sector and Energy Source. See:
http://www.eia.doe.gov/cneaf/solar.renewables/page/prelim_trends/table6.xls
http://www.eia.doe.gov/cneaf/solar.renewables/page/prelim_trends/table3.xls
http://www.eia.doe.gov/cneaf/solar.renewables/page/rea_data/table11.xls
<http://tonto.eia.doe.gov/ftproot/renewables/060304.pdf>
- Calculated by distributing evenly based on 2007 figures

References

Hydropower Capacity and Generation — Page 86

- EIA, Net Generation by Energy Source, http://www.eia.doe.gov/cneaf/electricity/epm/table1_1.html
- Capacity, http://www.eia.doe.gov/cneaf/electricity/epa/existing_capacity_state.xls
2007 added <http://www.eia.doe.gov/cneaf/electricity/epa/epat2p4.html>
- EIA – Electric Power Monthly, January 2009, http://www.eia.doe.gov/cneaf/electricity/epm/epm_sum.html#one
- EIA – Renewable Energy Trends in Consumption and Electricity, 2005, <http://www.eia.doe.gov/cneaf/solar.renewables/page/trends/table11.pdf>
- EIA – State Historical Tables for 2007, Proposed Capacity Additions by State, http://www.eia.doe.gov/cneaf/electricity/epa/planned_capacity_state.xls

State Rankings — Page 87

- EIA, 2007, Table 1.13.B. Net Generation from Hydroelectric (Conventional) Power by State by Sector, Year-to-Date through August 2007 and 2006, <http://www.eia.doe.gov/cneaf/solar.renewables/page/hydroelec/hydroelec.html>
- EIA – State Historical Tables for 2007, Proposed Capacity Additions by State, http://www.eia.doe.gov/cneaf/electricity/epa/planned_capacity_state.xls
- EIA – State Historical Tables for 2007, Existing Capacity by State, 2007, http://www.eia.doe.gov/cneaf/electricity/epa/existing_capacity_state.xls

Other Water Power: Wave and Tidal — Pages 90–91

- FERC, <http://www.ferc.gov/industries/hydropower/indus-act/hydrokinetics.asp>
- Wave Power – Pelamis Wave Power, <http://www.pelamiswave.com/content.php?id=149>
- Tidal Power – Verdant Power, MIT Technology Review, EDF, <http://verdantpower.com/what-initiative>
<http://www.technologyreview.com/Energy/18567/>
<http://www.edf.fr/html/en/decouvertes/voyage/usine/retour-usine.html>
- Permits – FERC, <http://www.ferc.gov/industries/hydropower/indus-act/hydrokinetics/permits.asp>
<http://www.ferc.gov/industries/hydropower/indus-act/hydrokinetics/licences.asp>

References

Hydrogen: Summary — Page 93

- DOE Hydrogen Program Hydrogen Analysis Resource Center, <http://hydrogen.pnl.gov/cocoon/morf/hydrogen/article/707>
- Fuel Cell Today Industry Review 2008
- DOE Hydrogen Program Hydrogen Analysis Resource Center, <http://hydrogen.pnl.gov/cocoon/morf/hydrogen/article/709>
- Fuel Cell Today Industry Review 2008

Hydrogen Transportation — Page 94

- National Hydrogen Association (NHA) Key Facts, <http://www.hydrogenassociation.org/pdf/keyHydrogenMessages.pdf>
- Fueling Stations from Learning Demo Presentation at EVS23 and updates, http://www.nrel.gov/hydrogen/proj_learning_demo.html
<http://www.nrel.gov/hydrogen/pdfs/42264.pdf>
- Hydrogen Consumption, <http://www.fossil.energy.gov/programs/fuels/hydrogen/currenttechnology.html>
- Number of hydrogen cars, <http://www.GaleGroup.com>
- DOE Hydrogen Program Hydrogen Analysis Resource Center, <http://hydrogen.pnl.gov/cocoon/morf/hydrogen/article/707>
- NHA, <http://www.hydrogenassociation.org/general/fuelingSearch.asp#null>

Hydrogen electricity — Page 95

- Stationary fuel cells, <http://www.fuelcells.org/db/>
- FuelCells.org, <http://www.fuelcells.org/db/index.php>

References

Biomass Production and Price — Page 98

- EIA, Refiner Gasoline Prices by Grade and Sales Type, http://tonto.eia.doe.gov/dnav/pet/pet_pri_refmg_dcu_nus_a.htm
- Renewable Fuels Association (RFA), Historic U.S. Fuel Ethanol Production, <http://www.ethanolrfa.org/industry/statistics/#A>
- U.S. DOE EERE – Alternative Fuel Price Report, http://www.eere.energy.gov/afdc/price_report.html
- National Biodiesel Board, <http://www.biodiesel.org/>
- U.S. DOE EERE – Alternative Fuel Price Report, January 2009, http://www.afdc.energy.gov/afdc/pdfs/afpr_jan_09.pdf

U.S. Ethanol in Gasoline Pool — Page 99

- RFA, Historic U.S. Fuel Ethanol Production, <http://www.ethanolrfa.org/industry/statistics/#A>
- RFA – Changing the Climate: Ethanol Industry Outlook 2008, http://www.ethanolrfa.org/objects/pdf/outlook/RFA_Outlook_2008.pdf
- U.S. DOE EERE – Alternative Fuel Price Report, http://www.eere.energy.gov/afdc/price_report.html
- EERE, “Light Duty FFVs in Use,” Alternative Fuels and Advanced Vehicles Data Center, http://www.eere.energy.gov/afdc/data/docs/ffvs_in_use.xls
- EIA – Retail Motor Gasoline and On-Highway Diesel Fuel Prices, <http://www.eia.doe.gov/emeu/aer/bxt/ptb0524.html>
 - 2007 projection: personal correspondence
 - Biofuels in the U.S. Transportation Sector, Table 11, <http://www.eia.doe.gov/oiaf/analysispaper/pdf/tbl11.pdf>
- RFA – 2009 Outlook, http://www.ethanolrfa.org/objects/pdf/outlook/RFA_Outlook_2009.pdf
- U.S. DOE EERE, http://www.afdc.energy.gov/afdc/fuels/stations_counts.html
- EIA Basic Petroleum Statistics, <http://www.eia.doe.gov/basics/quickoil.html>

References

Production Growth, Yields, and Emissions — Page 100

- RFA, Historic U.S. Fuel Ethanol Production, <http://www.ethanolrfa.org/industry/statistics/#A>; Annual Industry Outlook, http://www.ethanolrfa.org/objects/pdf/outlook/RFA_Outlook_2007.pdf
- RFA – Changing the Climate: Ethanol Industry Outlook 2008, http://www.ethanolrfa.org/objects/pdf/outlook/RFA_Outlook_2008.pdf
- EIA, personal correspondence
- National Geographic, Biofuels Compared, October 2007, <http://ngm.nationalgeographic.com/ngm/2007-10/biofuels/biofuels-interactive.html>
- Cornell University, <http://www.news.cornell.edu/releases/Aug01/corn-basedethanol.hrs.html>
- RFA 2009 Outlook, http://www.ethanolrfa.org/objects/pdf/outlook/RFA_Outlook_2009.pdf

Top U.S. Ethanol Companies — Page 101

- RFA – Changing the Climate: Ethanol Industry Outlook 2008, http://www.ethanolrfa.org/objects/pdf/outlook/RFA_Outlook_2008.pdf
- RFA 2009 Outlook, http://www.ethanolrfa.org/objects/pdf/outlook/RFA_Outlook_2009.pdf

Global Ethanol Production — Page 102

- RFA, Ethanol Industry Statistics, <http://www.ethanolrfa.org/industry/statistics/#E>
- RFA – Changing the Climate: Ethanol Industry Outlook 2008, http://www.ethanolrfa.org/objects/pdf/outlook/RFA_Outlook_2008.pdf
- RFA 2009 Outlook, http://www.ethanolrfa.org/objects/pdf/outlook/RFA_Outlook_2009.pdf
- RFA, Historic U.S. Fuel Ethanol Production, <http://www.ethanolrfa.org/industry/statistics/#A>

References

Biodiesel Production and Price — Page 104

- U.S. DOE EERE – Alternative Fuel Price Report, http://www.eere.energy.gov/afdc/price_report.html
- National Geographic, Biofuels Compared, October 2007, <http://ngm.nationalgeographic.com/ngm/2007-10/biofuels/biofuels-interactive.html>
- National Biodiesel Board, <http://www.biodiesel.org/>
http://www.biodiesel.org/pdf_files/fuelfactsheets/Production_Graph_Slide.pdf
- National Biodiesel Board, <http://www.biodiesel.org/resources/faqs/>
- U.S. DOE EERE – Alternative Fuel Price Report, January 2009, http://www.afdc.energy.gov/afdc/pdfs/afpr_jan_09.pdf

Top U.S. Biodiesel Companies — Page 105

- National Biodiesel Board – Commercial Biodiesel Production Plants, Sept 7, 2007, http://www.biodiesel.org/buyingbiodiesel/producers_marketers/ProducersMap-Existing.pdf
- National Biodiesel Board, http://www.biodiesel.org/buyingbiodiesel/producers_marketers/Producers%20Map-Existing.pdf
- National Biodiesel Board, http://www.biodiesel.org/pdf_files/fuelfactsheets/Production%20Capacity_91708.pdf

Top Biodiesel Countries — Page 106

- National Biodiesel Board, http://www.biodiesel.org/pdf_files/fuelfactsheets/Production_Graph_Slide.pdf
- REN 21 – Global Renewables Status Report, 2009 Update, http://www.ren21.net/pdf/RE_GSR_2009_update.pdf

U.S. Investments in Clean Energy — Page 110–114

- New Energy Finance, <http://www.newenergyfinance.com>

U.S. Investments in Clean Energy — Page 145

- Public data

U.S. DEPARTMENT OF
ENERGY

Energy Efficiency &
Renewable Energy

Prepared by the National Renewable Energy Laboratory (NREL)
NREL is a national laboratory of the U.S. Department of Energy
Office of Energy Efficiency and Renewable Energy
Operated by the Alliance for Sustainable Energy, LLC

DOE/GO-102009-2827
July 2009

For more information contact:
EERE Information Center
1-877-EERE-INF (1-877-337-3463)
www.eere.energy.gov/informationcenter

Printed with a renewable-source ink on paper containing at
least 50% wastepaper, including 10% post consumer waste.