U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

AUGUST 2010

2009 Renewable Energy Data Book

Acknowledgments

This report was produced by Rachel Gelman, edited by Michelle Kubik, and designed by Stacy Buchanan of the National Renewable Energy Laboratory (NREL). We greatly appreciate the input of Mike Cliggett and Carla Frisch of the U.S. Department of Energy; as well as Lynn Billman, Helena Chum, Dale Gardner, Maureen Hand, Roland Hulstrom, and Jordan Macknick of NREL.

Front page background photo: Courtesy of NASA
Front page inset photos (left to right): One through six, and eight – iStock; seven – PIX 17854
Pages 2, 6, 42, 56, 66, 74, 80, 86, 90, 98, 110, 118: iStock
Page 16: PIX 14369
Page 94: PIX 17854

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 **renewable energy capacity in both the world and in the United States has more than tripled between 2000 and 2009.**

- Including hydropower, **renewable energy represents nearly 12% of total installed capacity and more than 10% of total generation in the United States in 2009.** Installed renewable energy capacity (including hydropower) is more than 130 gigawatts (GW). Not including hydropower, 2009 renewable electricity installed capacity has reached about 53 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 the nation's electricity supply. **In 2009, cumulative wind capacity increased by 39% and cumulative solar PV capacity grew nearly 52% from the previous year.**

- Worldwide, wind energy is the fastest growing renewable energy technology—**between 2000 and 2009, wind energy generation worldwide increased by a factor of almost 9.** The United States experienced even more dramatic growth, as installed wind energy capacity increased by a factor of 14 between 2000 and 2009.

- In the United States, renewable energy has been capturing a growing percent of new capacity additions during the past few years. **In 2009, renewable energy accounted for more than 55% of all new electrical capacity installations in the United States**—a large contrast from 2004 when all renewable energy captured only 2% of new capacity additions.

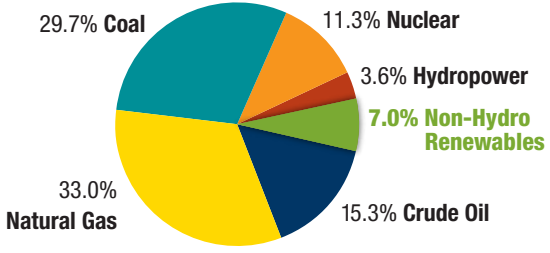
- Since 2006, the United States has been the world's leading ethanol producer. **Between 2000 and 2009, production of corn ethanol increased by a factor of 6, and biodiesel production increased by a factor of more than 100**. Use of ethanol in the United States has also grown substantially, and it accounts for 7.8% of the total U.S. gasoline pool, up from 1% in 2000.

Table of Contents

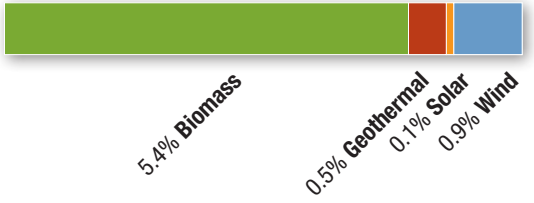
I. U.S. Energy Background Information

U.S. Energy Production and Consumption (2009)

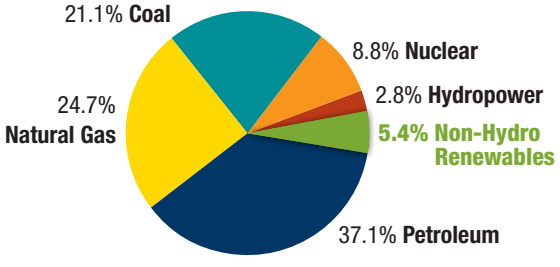
U.S. Energy Production (2009): 73.5 Quadrillion Btu



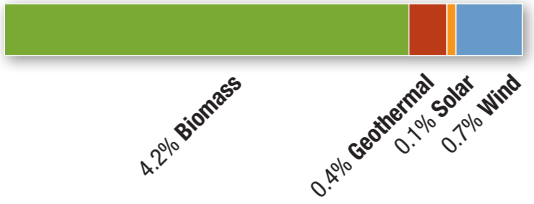
U.S. Non-Hydro Renewable Energy Production: 5.2 Quadrillion Btu



U.S. Energy Consumption (2009): 94.9 Quadrillion Btu



U.S. Non-Hydro Renewable Energy Consumption: 5.1 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 (%) 2000–2009

	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%	30.0%	15.7%	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%	6.1%	71.7
2008	32.5%	31.7%	14.3%	11.5%	3.4%	6.7%	73.5
2009	29.7%	33.0%	15.3%	11.3%	3.6%	7.0%	73.4

Source: EIA

* Includes natural gas plant liquids.

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

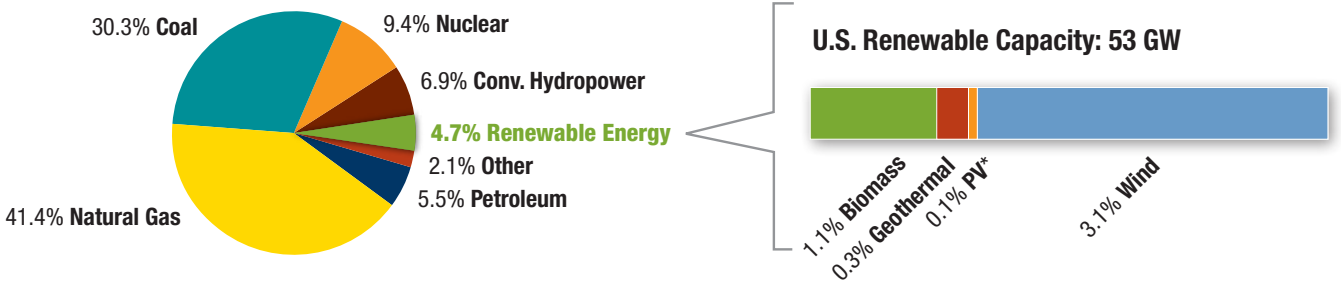
U.S. Energy Consumption by Energy Source (%) 2000–2009

	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%	39.7%	8.3%	2.3%	3.2%	96.3
2002	22.4%	24.1%	39.1%	8.3%	2.7%	3.3%	97.8
2003	22.7%	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%	100.2
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%	4.3%	101.6
2008	22.5%	23.9%	37.5%	8.5%	2.5%	4.9%	99.5
2009	21.1%	24.7%	37.1%	8.8%	2.8%	5.4%	94.9

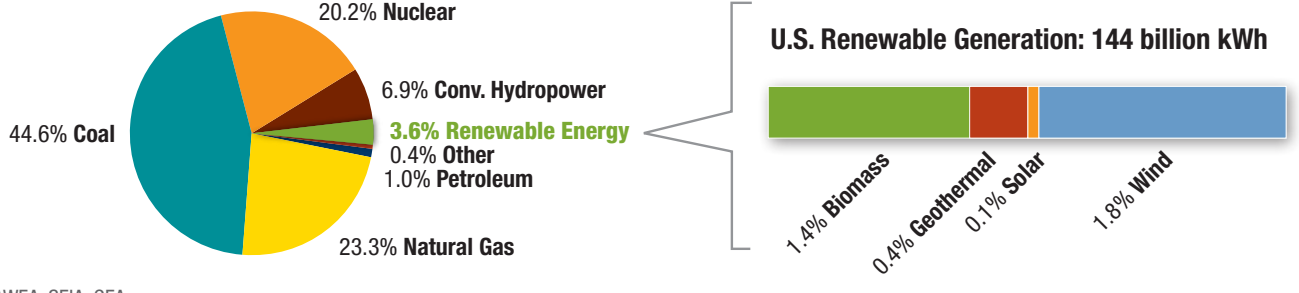
Source: EIA, AWEA, SEIA, GEA

U.S. Nameplate Capacity and Generation (2009)

U.S. Electric Nameplate Capacity (2009): 1,121 GW



U.S. Electric Net Generation (2009): 3,954 billion kWh



Source: EIA, AWEA, SEIA, GEA

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 (%) 2000–2009

	Coal	Petroleum	Natural Gas	Other Gases	Nuclear	Hydro	Renew-ables	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	30.5%	5.6%	41.4%	0.2%	9.6%	7.0%	3.8%	1.8%	0.1%	1,102
2009	30.3%	5.5%	41.4%	0.2%	9.4%	6.9%	4.7%	1.8%	0.1%	1,121

Sources: EIA, AWEA, SEIA, GEA

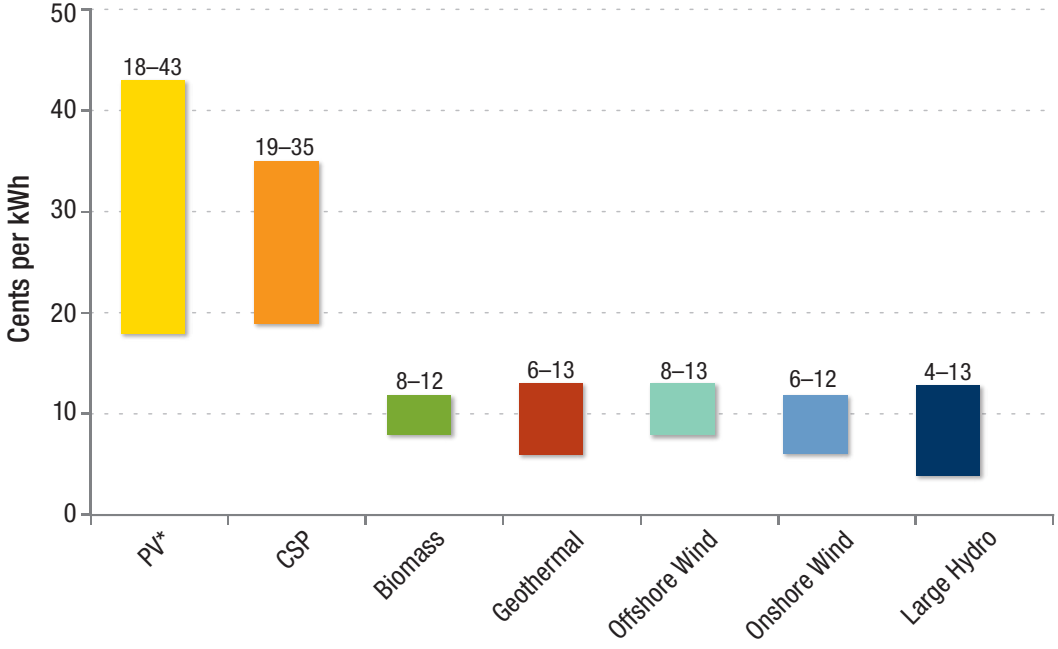
U.S. Electricity Generation by Source (%) 2000–2009

	Coal	Petroleum Liquids	Petroleum Coke	Natural Gas	Other Gases	Nuclear	Hydro	Renew-ables	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	48.2%	0.8%	0.3%	21.4%	0.3%	19.6%	6.2%	3.1%	-0.2%	0.3%	4,121,184
2009	44.6%	0.7%	0.3%	23.3%	0.3%	20.2%	6.9%	3.6%	-0.1%	0.3%	3,953,898

Source: EIA

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

Levelized Cost of Energy of Renewable Electricity by Technology (2009)



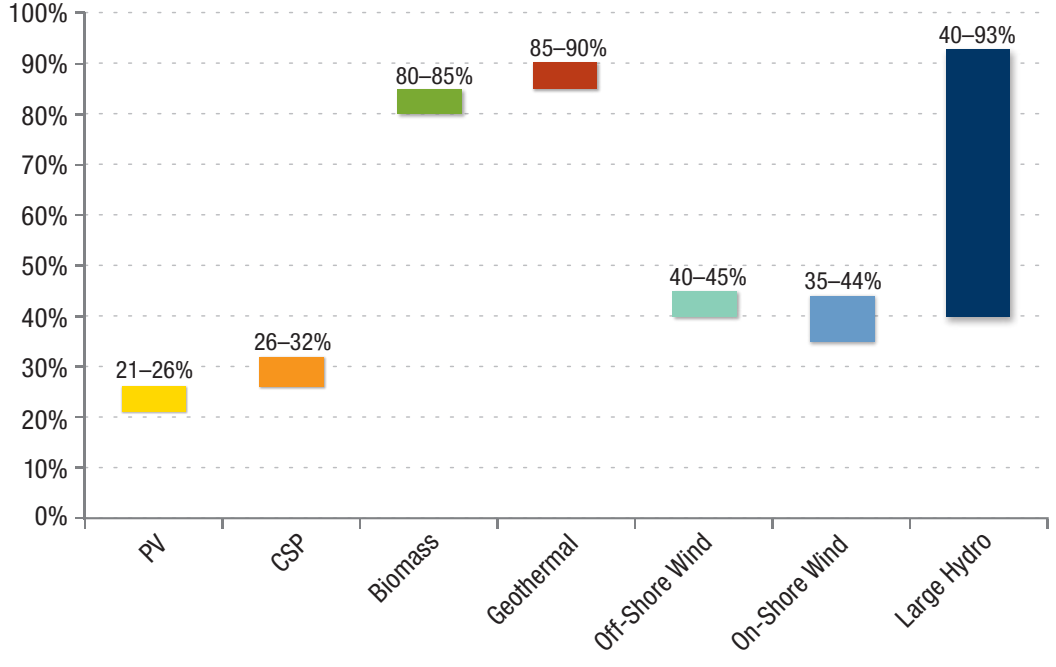
Assumptions

- Currency: 2009 US $ (real)
- Real Discount Rate: 10.5%
- Inflation Rate: 3%
- Economic Lifetime: 30 years
- Taxes: none
- Tax credits: none
- Debt/Equity Financing: none
- Biomass Fuel Costs: AEO 2009
- PV Degradation: none
- CSP Technology: no storage
- Geothermal Technology: hydrothermal

* Current range of utility scale (greater than 5MW) PV in the U.S.

Sources: AEO, EPA, EPRI, NREL, McGowin, DeMeo et al.

Capacity Factor for Renewable Resources (2009)



Sources: AEO, EPA, EPRI, NREL, McGowin, DeMeo et al.

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 2009 represent **53 GW of installed capacity**.

- Renewable electricity (excluding hydropower) has grown at a compounded annual average of **14% per year from 2000–2009.**

- Although it is a growing part of U.S. energy supply, renewable electricity (excluding hydropower) in 2009 still represents a small percentage of overall installed electricity capacity (4.7%) and generation (3.6%) in the United States.

- Wind and solar PV are the fastest growing renewable energy sectors. **In 2009, wind capacity installations increased by 39% and solar PV grew nearly 52% from the previous year.**

II

- In 2009, **biomass** produced about **38% of total renewable electricity generation** (excluding hydropower).

- **Wind energy** accounted for about **92% of annual installed renewable electricity capacity** in 2009 (excluding hydropower).

- Electricity generation from biomass, geothermal, and hydropower have remained relatively stable since 2000.

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

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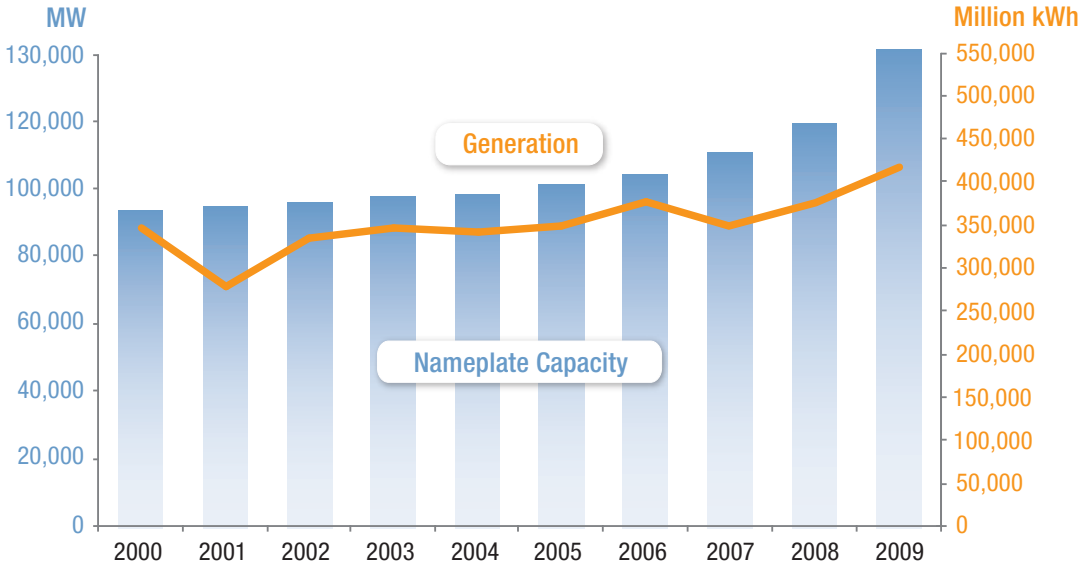
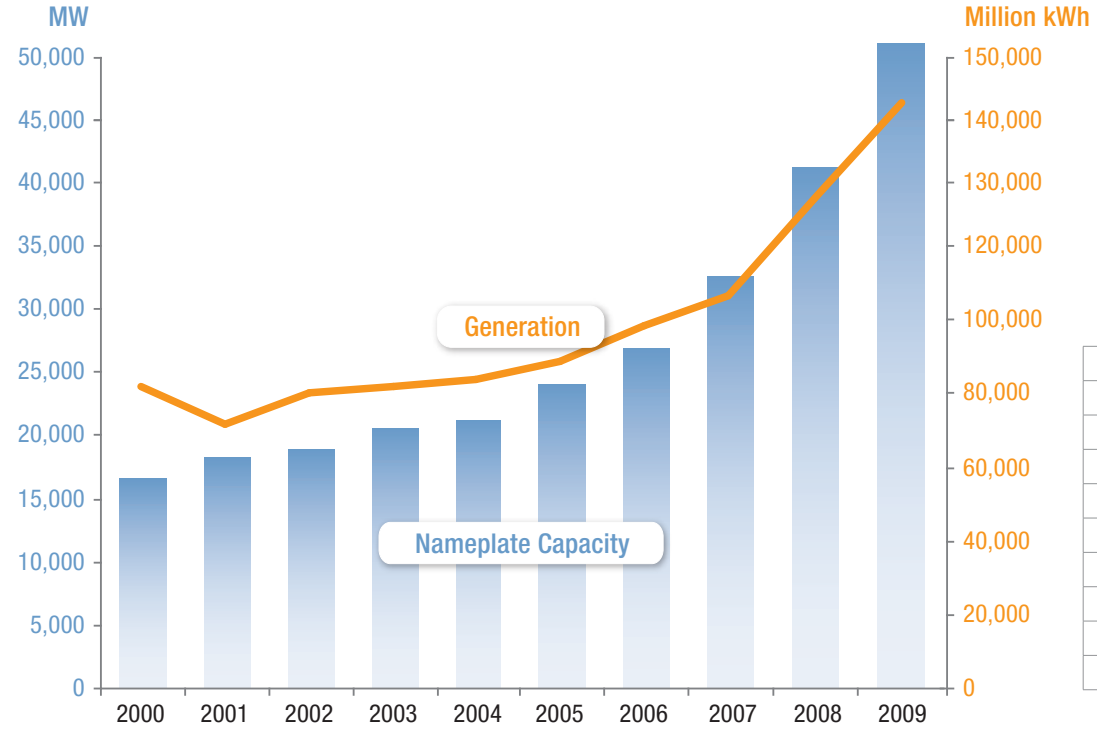


	Total Nameplate Capacity (MW)	Total Generation (Million kWh)
2000	93,437	356,894
2001	95,026	288,139
2002	95,908	343,904
2003	97,607	355,889
2004	98,352	351,712
2005	101,303	358,428
2006	104,299	386,832
2007	110,109	354,269
2008	119,927	382,841
2009	130,743	416,026

Sources: EIA, AWEA, SEIA, GEA

Capacity and Generation: Renewables *(excluding hydropower)*

II



	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	32,677	106,759
2008	42,287	128,010
2009	53,081	143,895

Sources: EIA, AWEA, SEIA, GEA

Renewable Electricity Generating Capacity by Source
(excluding hydropower)

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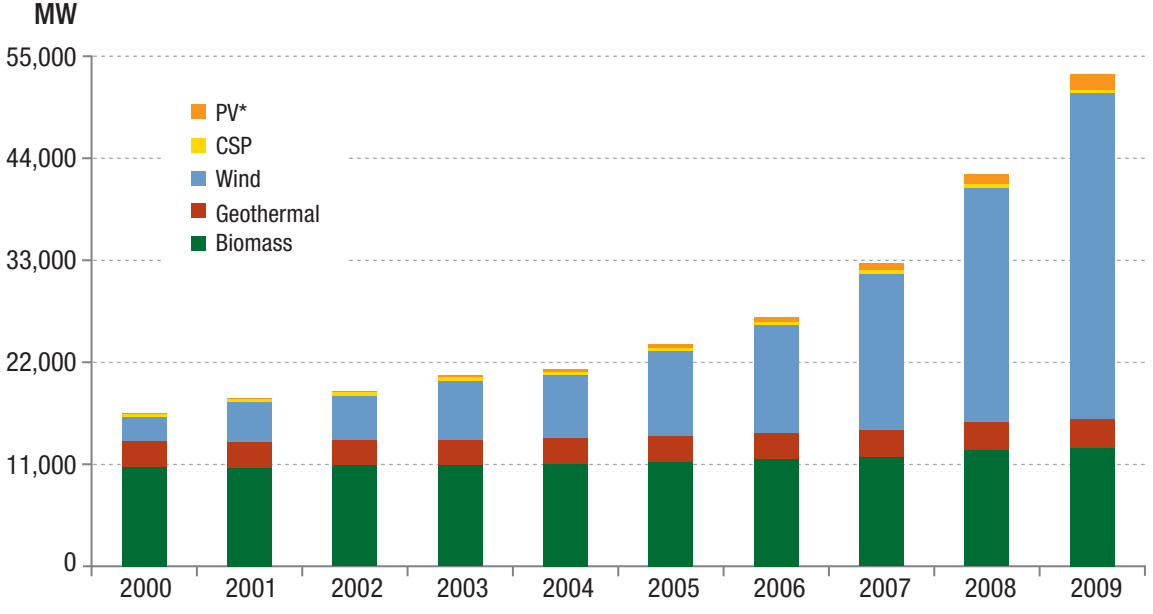

Sources: EIA, AWEA, SEIA, GEA

* Includes on- and off-grid capacity.

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	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	5,237	106	185	**5,797**	**+ 98%**
2008	335	0	8,425	104	747	**9,611**	**+ 66%**
2009	571	12	9,922	46	242	**10,793**	**+ 12%**

Sources: EIA, AWEA, SEIA, GEA

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%	**16,812** 45.2%	**2,937** 3.7%	**11,738** 1.6%	**32,677** 21.6%	**110,109** 5.6%
2008	**77,640** 0.3%	**1,106** 43.5%	**419** 0%	**25,237** 50.1%	**3,040** 3.5%	**12,485** 6.4%	**42,287** 29.4%	**119,927** 8.9%
2009	**77,662** 0%	**1,677** 51.6%	**431** 2.9%	**35,159** 39.3%	**3,087** 1.5%	**12,727** 1.9%	**53,081** 25.5%	**130,743** 9.0%

– annual decrease | annual increase +

Sources: EIA, AWEA, SEIA, GEA

* Includes on- and off-grid capacity.

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

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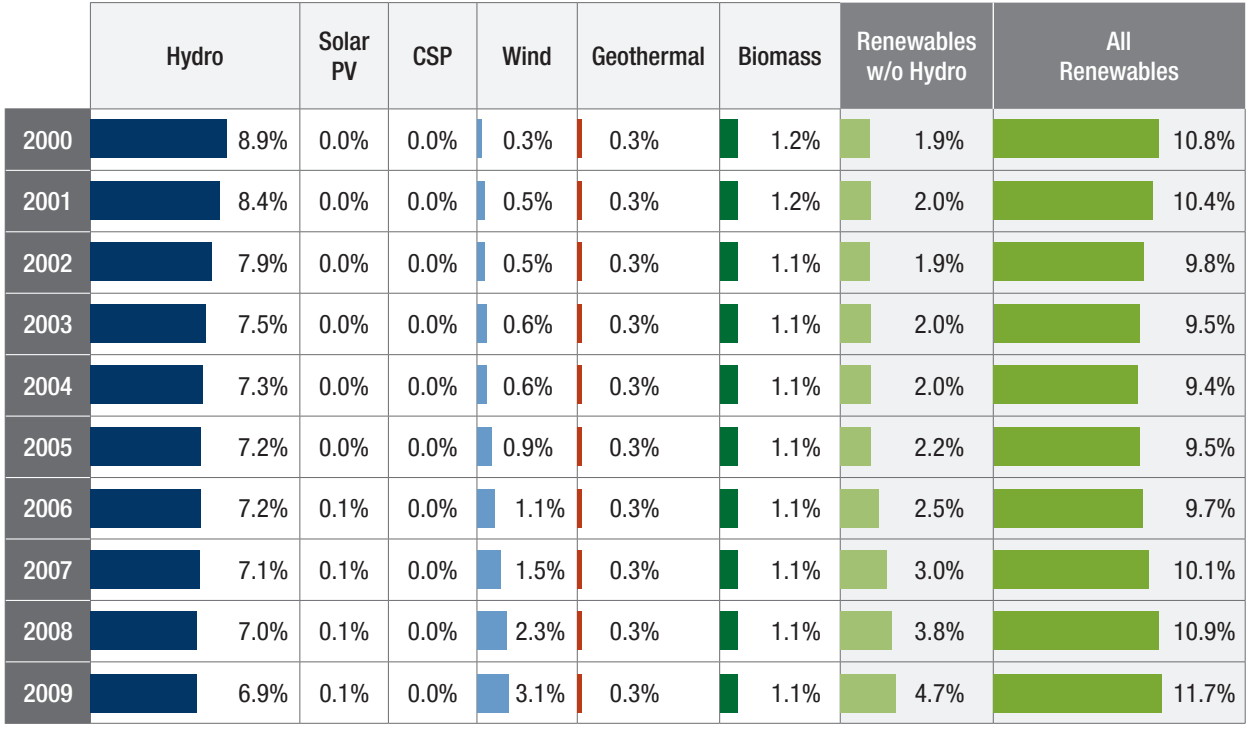
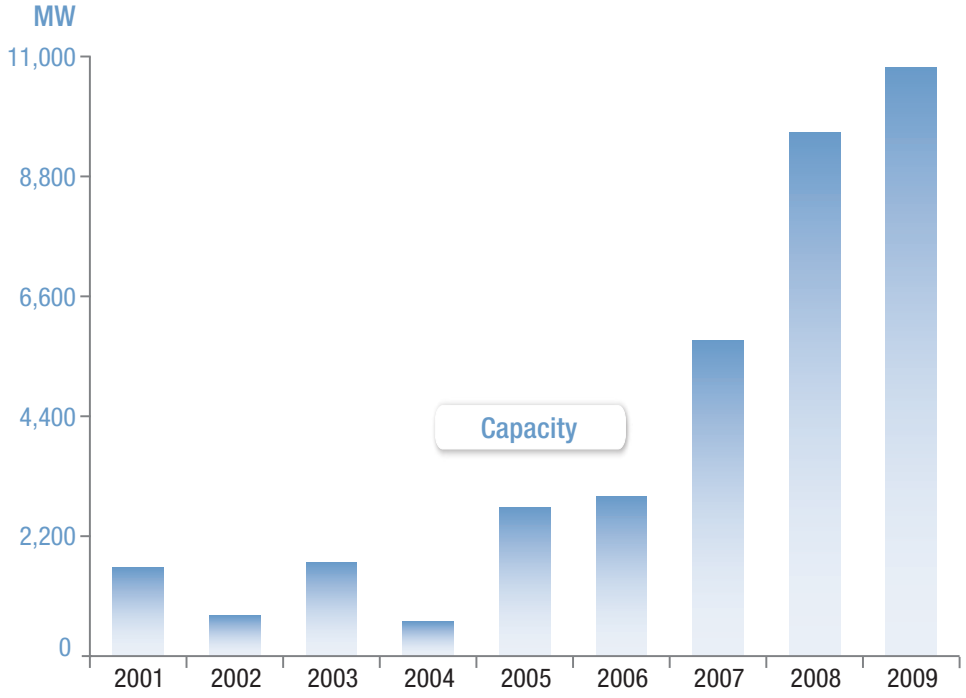


	Hydro	Solar PV	CSP	Wind	Geothermal	Biomass	Renewables w/o Hydro	All Renewables
2000	8.9%	0.0%	0.0%	0.3%	0.3%	1.2%	1.9%	10.8%
2001	8.4%	0.0%	0.0%	0.5%	0.3%	1.2%	2.0%	10.4%
2002	7.9%	0.0%	0.0%	0.5%	0.3%	1.1%	1.9%	9.8%
2003	7.5%	0.0%	0.0%	0.6%	0.3%	1.1%	2.0%	9.5%
2004	7.3%	0.0%	0.0%	0.6%	0.3%	1.1%	2.0%	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%	10.9%
2009	6.9%	0.1%	0.0%	3.1%	0.3%	1.1%	4.7%	11.7%

Sources: EIA, AWEA, SEIA, GEA

Annual Installed Renewable Electric Capacity Growth *(excluding hydropower)*



	Compounded Annual Growth Rate (CAGR) (2000–2009)
Wind	33.7%
Solar PV	39.3%
CSP	2.2%
Biomass	2.0%
Geothermal	1.1%
Renewables (excl. Hydro)	13.9%

Sources: EIA, AWEA, SEIA, GEA

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

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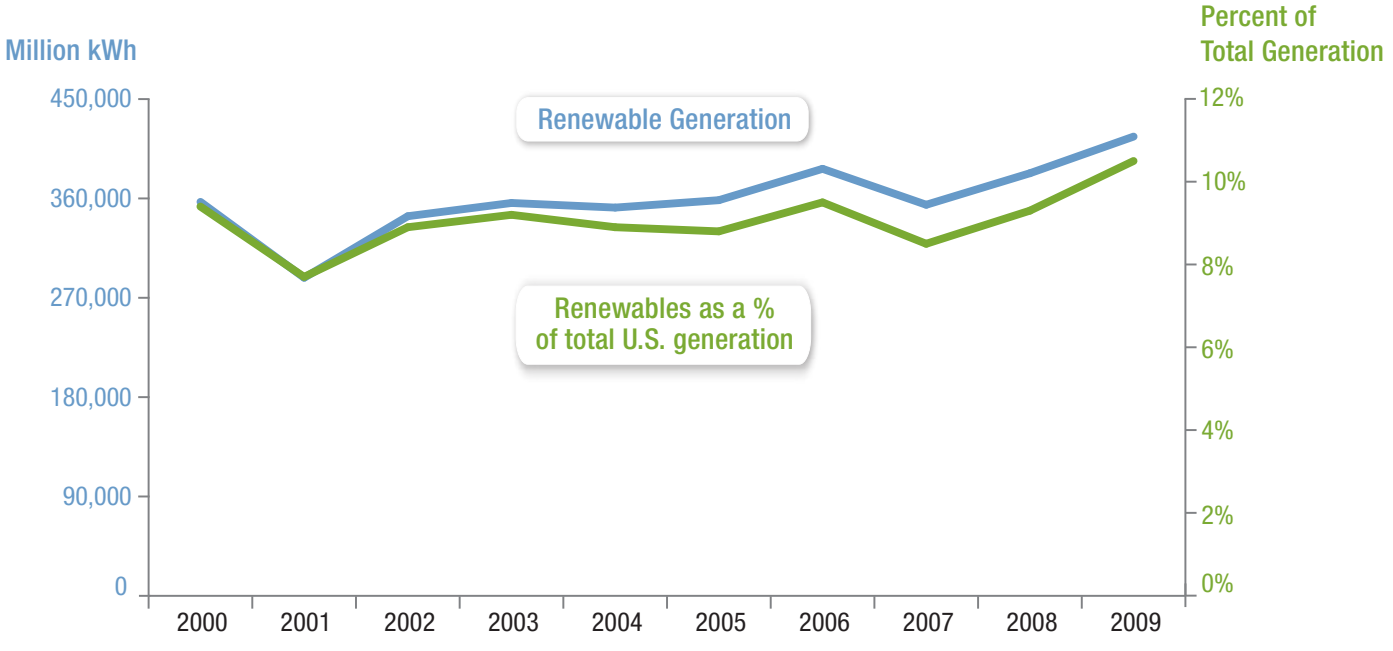
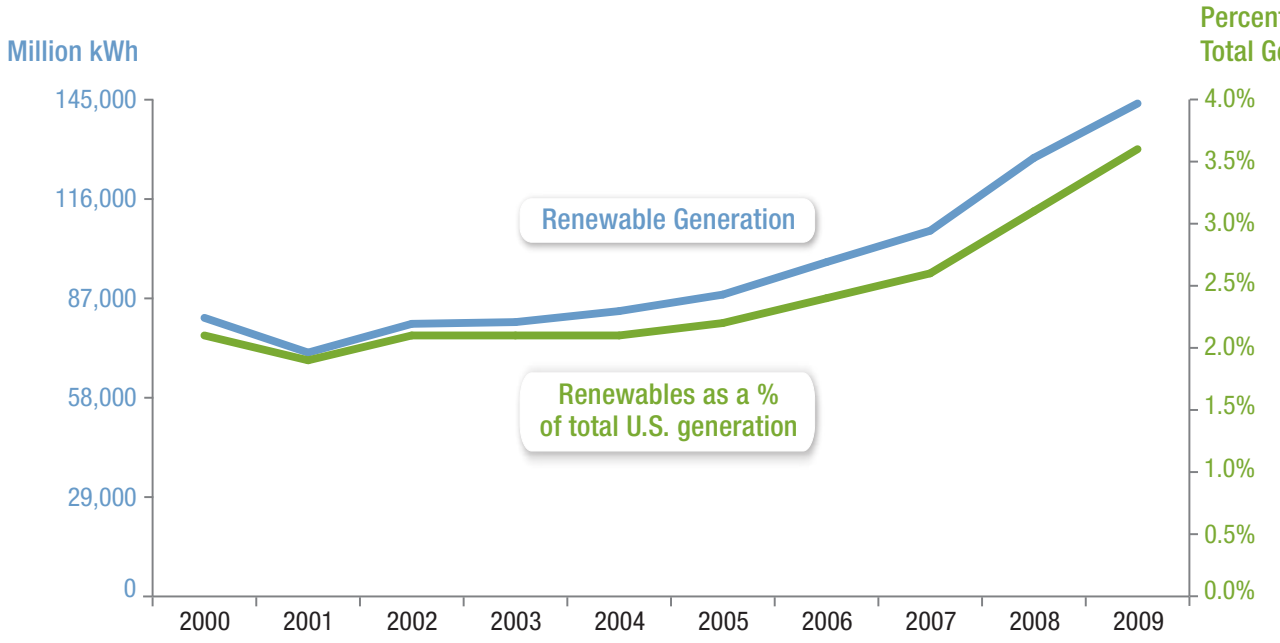


Source: EIA

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



Source: EIA

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)*

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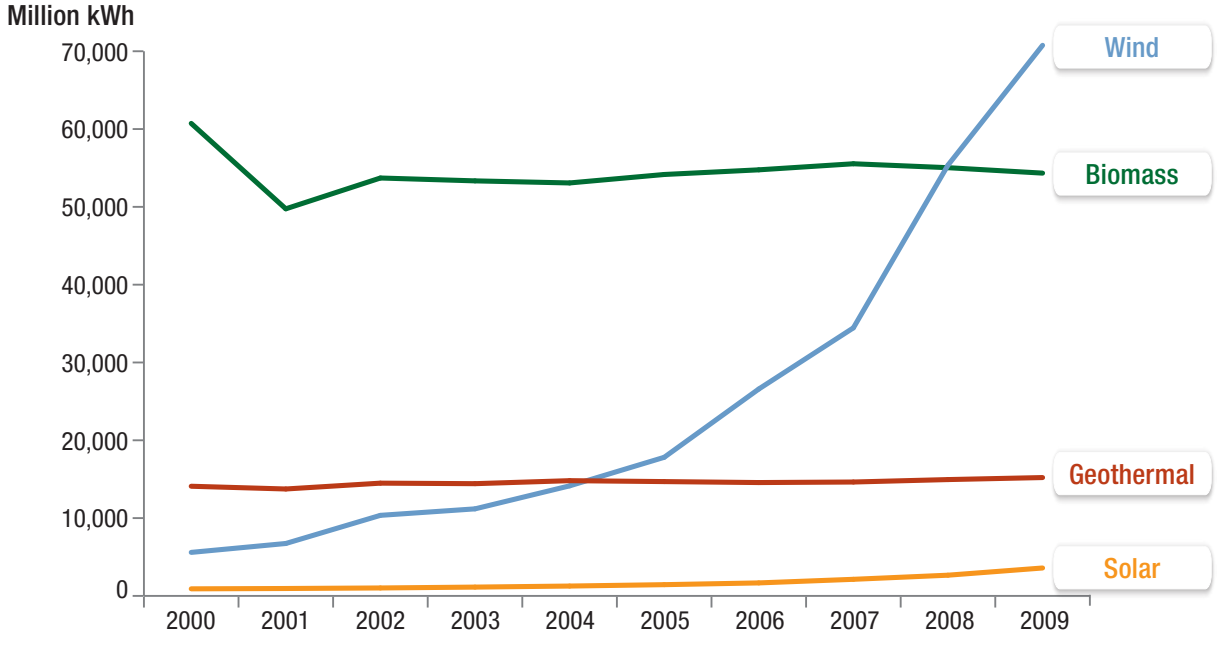
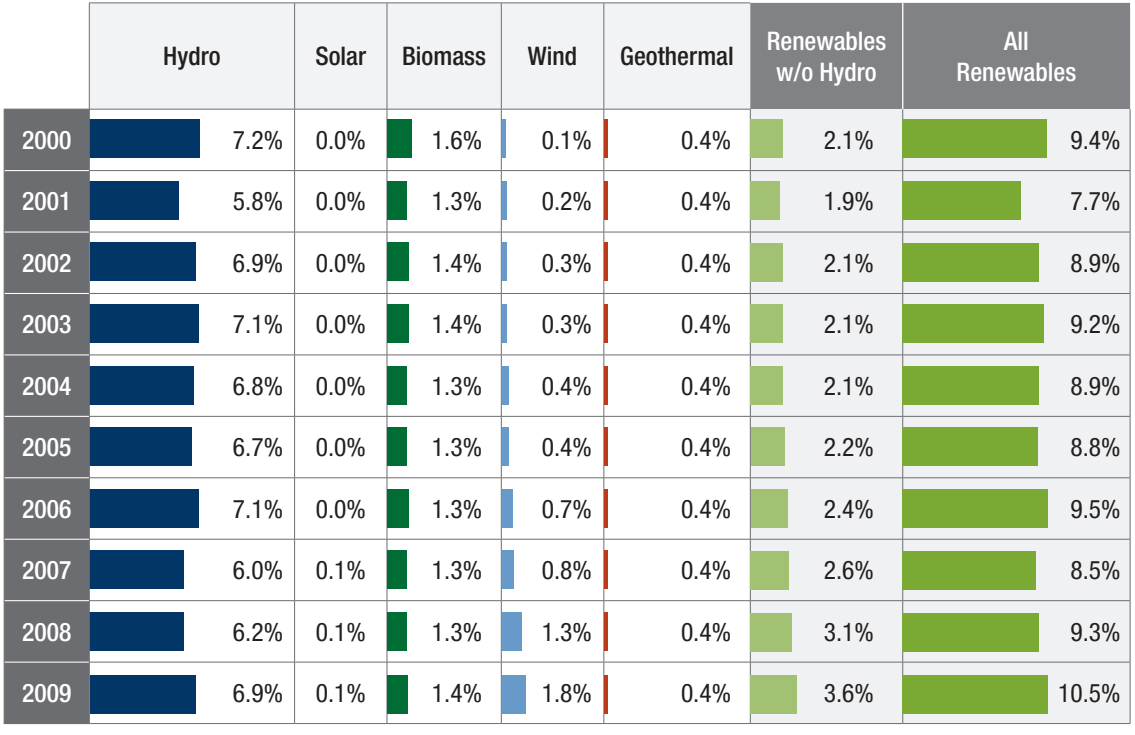


Source: EIA

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%	1.8%	0.4%	3.6%	10.5%

Source: EIA

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%	**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	**254,831** 3.0%	**2,662** 24.8%	**55,363** 60.7%	**14,951** 2.1%	**55,034** -0.9%	**382,841** 8.1%	**128,010** 19.9%
2009	**272,131** 6.8%	**3,588** 34.8%	**70,761** 27.8%	**15,210** 1.7%	**54,336** -1.3%	**416,026** 8.7%	**143,895** 12.4%

Sources: EIA, SEIA

State Renewable Energy Information: Summary

- In 2008, **Texas advanced over California** as having the most renewable electricity (excluding hydropower) of any U.S. state, and continues to hold the lead in 2009.

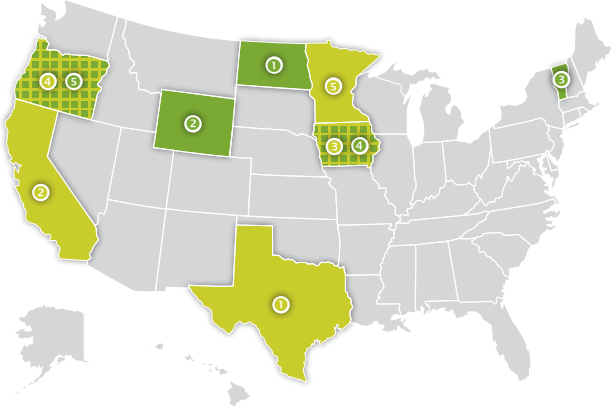
- **Washington is the leader** in installed renewable energy capacity when including hydropower.

- In 2008, **Texas became the national leader** in wind power development, and in 2009 has nearly 6 GW more wind capacity installed than Iowa, the state coming in second place.

- A combination of **state incentives and renewable portfolio standards** for renewable energy and renewable resource development has driven renewable growth in some states.

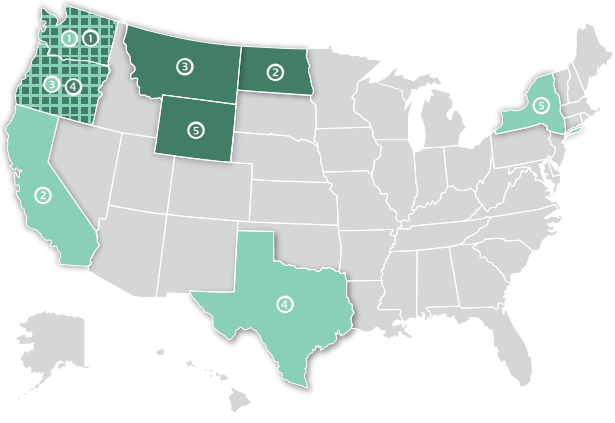
Top States for Renewable Electricity Installed Nameplate Capacity (2009)

II



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

Per Capita Renewables *(excluding hydropower)*
1 North Dakota
2 Wyoming
3 Vermont
4 Iowa
5 Oregon

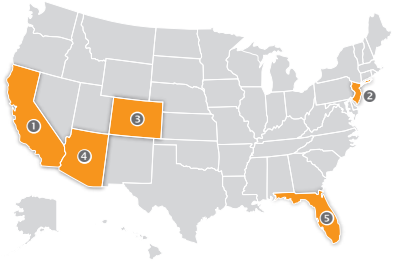


Total Renewables *(including hydropower)*
1 Washington
2 California
3 Oregon
4 Texas
5 New York

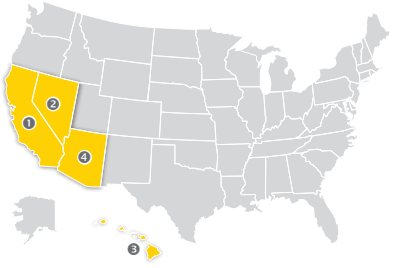
Per Capita Renewables *(including hydropower)*
1 Washington
2 North Dakota
3 Montana
4 Oregon
5 Wyoming

Sources: EIA, AWEA, GEA, Larry Sherwood/IREC, SEIA, USDA

Top States for Renewable Electricity Installed Nameplate Capacity (2009)

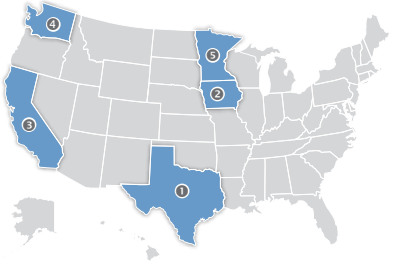


Solar PV	
1	California
2	New Jersey
3	Colorado
4	Arizona
5	Florida

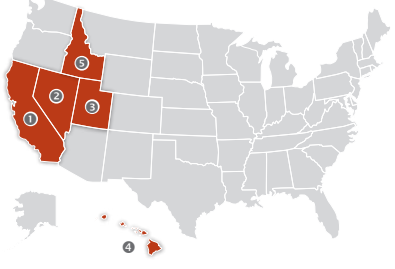


CSP	
1	California
2	Nevada
3	Hawaii
4	Arizona

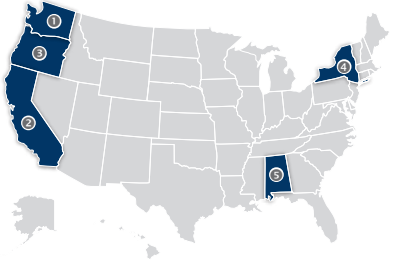
Biomass	
1	California
2	Florida
3	Maine
4	Virginia
5	Georgia



Wind	
1	Texas
2	Iowa
3	California
4	Washington
5	Minnesota



Geothermal	
1	California
2	Nevada
3	Utah
4	Hawaii
5	Idaho



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

Sources: EIA, AWEA, GEA, Larry Sherwood/IREC

Renewables 2009 Installed Nameplate Capacity (MW)
NORTHEAST

II

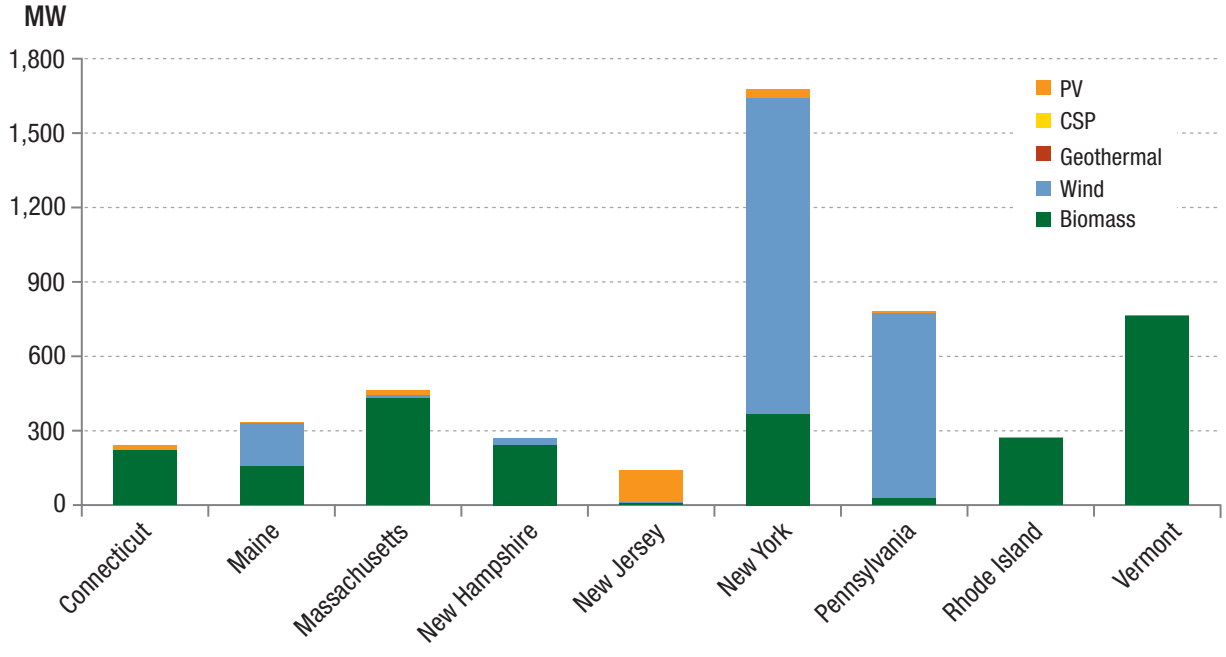
	Wind	PV*	CSP	Geothermal	Biomass	Hydropower	Total Renewables (incl. hydro)	Per capita RE (excl. hydro) watts/person
New York	1,274	33.9	0	0	367	4,654	**6,392**	**86**
Pennsylvania	748	7.3	0	0	26	775	**1,557**	**62**
Maine	175	0.3	0	0	157	722	**1,054**	**252**
Massachusetts	15	17.7	0	0	430	272	**734**	**70**
New Hampshire	26	0 .7	0	0	242	445	**714**	**203**
Vermont	6	1.7	0	0	759	309	**1,075**	**1,233**
Connecticut	0	19.7	0	0	221	119	**359**	**68**
New Jersey	8	127.5	0	0	7	13	**155**	**16**
Rhode Island	1	0.6	0	0	270	4	**276**	**258**

Sources: EIA, AWEA, GEA, Larry Sherwood/IREC, USDA

* Does not include off-grid installations

Renewables 2009 Installed Nameplate Capacity *(excluding hydropower)*
NORTHEAST

II



Sources: EIA, AWEA, GEA, Larry Sherwood/IREC

Renewables 2009 Installed Nameplate Capacity (MW)
MIDWEST

II

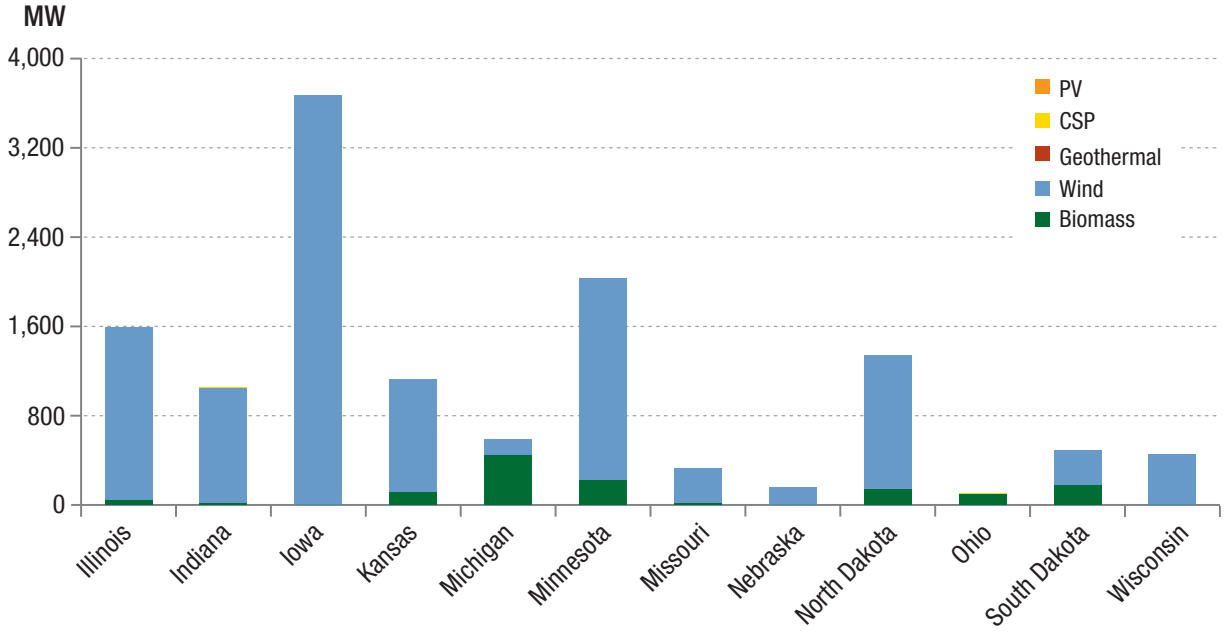
	Wind	PV*	CSP	Geothermal	Biomass	Hydropower	Total Renewables (incl. hydro)	Per capita RE (excl. hydro) watts/person
South Dakota	313	0.0	0	0	175	1,598	**2,087**	**601**
Minnesota	1,809	1.9	0	0	223	186	**2,220**	**386**
Iowa	3,670	0.0	0	0	0	131	**3,801**	**1,220**
Wisconsin	449	5.3	0	0	0	506	**960**	**80**
North Dakota	1,203	0.0	0	0	140	614	**1,956**	**2,075**
Michigan	143	0.7	0	0	445	374	**963**	**59**
Missouri	309	0.2	0	0	17	499	**825**	**54**
Nebraska	153	0.0	0	0	0	327	**479**	**85**
Kansas	1,014	0.0	0	0	110	3	**1,126**	**399**
Illinois	1,547	4.5	0	0	43	38	**1,632**	**123**
Ohio	7	2.0	0	0	90	128	**228**	**9**
Indiana	1,036	0.3	0	0	15	92	**1,143**	**164**

Sources: EIA, AWEA, GEA, Larry Sherwood/IREC, USDA

* Does not include off-grid installations

Renewables 2009 Installed Nameplate Capacity *(excluding hydropower)*
MIDWEST

II



Sources: EIA, AWEA, GEA, Larry Sherwood/IREC

Renewables 2009 Installed Nameplate Capacity (MW)
SOUTH

II

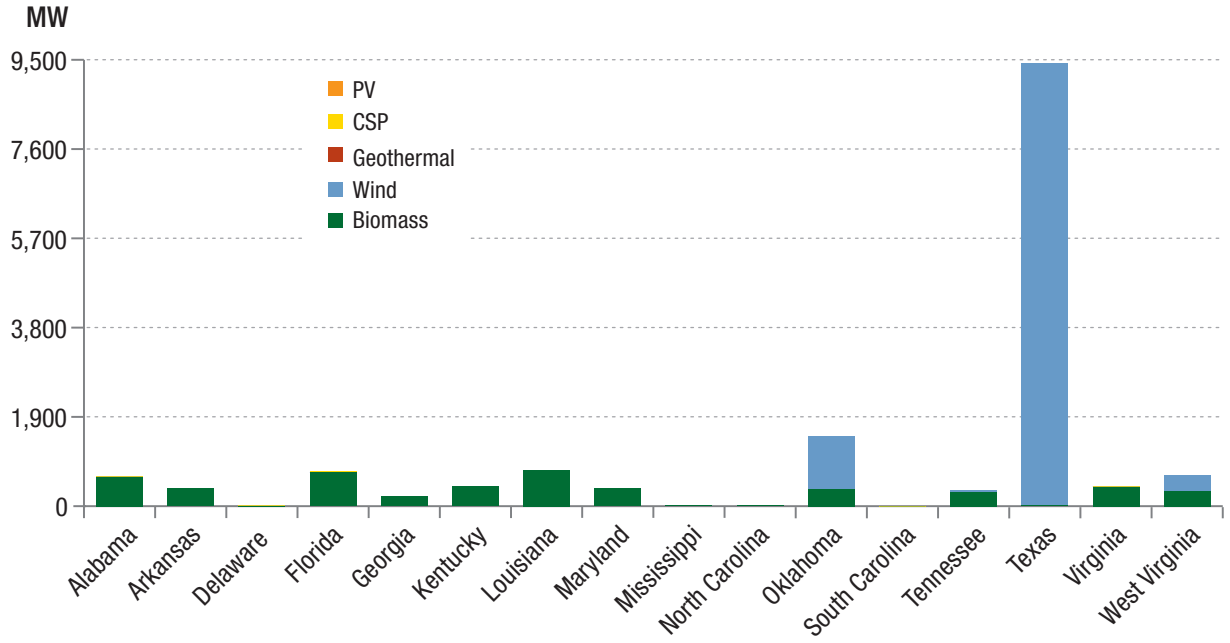
	Wind	PV*	CSP	Geothermal	Biomass	Hydropower	Total Renewables (incl. hydro)	Per capita RE (excl. hydro) watts/person
Alabama	0	0.2	0	0	622	3,280	3,902	132
Texas	9,410	8.6	0	0	10	672	10,100	380
Tennessee	29	0.9	0	0	300	2,418	2,748	52
Georgia	0	0.2	0	0	210	1,932	2,142	21
North Carolina	0	12.5	0	0	10	1,828	1,850	2
Arkansas	0	0.2	0	0	374	1,309	1,683	130
South Carolina	0	0.1	0	0	0	1,363	1,363	0
Virginia	0	0.8	0	0	410	744	1,154	52
Oklahoma	1,130	0.0	0	0	363	790	2,282	405
Florida	0	38.9	0	0	711	56	806	40
Kentucky	0	0.0	0	0	426	777	1,203	99
Maryland	0	6.1	0	0	375	527	908	67
Louisiana	0	0.2	0	0	768	192	960	171
Mississippi	0	0.1	0	0	8	0	8	3
West Virginia	330	0.0	0	0	321	325	976	358
Delaware	0	3.2	0	0	7	0	10	12

Sources: EIA, AWEA, GEA, Larry Sherwood/IREC, USDA

* Does not include off-grid installations

Renewables 2009 Installed Nameplate Capacity *(excluding hydropower)*
SOUTH

II



Sources: EIA, AWEA, GEA, Larry Sherwood/IREC

Renewables 2009 Installed Nameplate Capacity (MW)
WEST

II

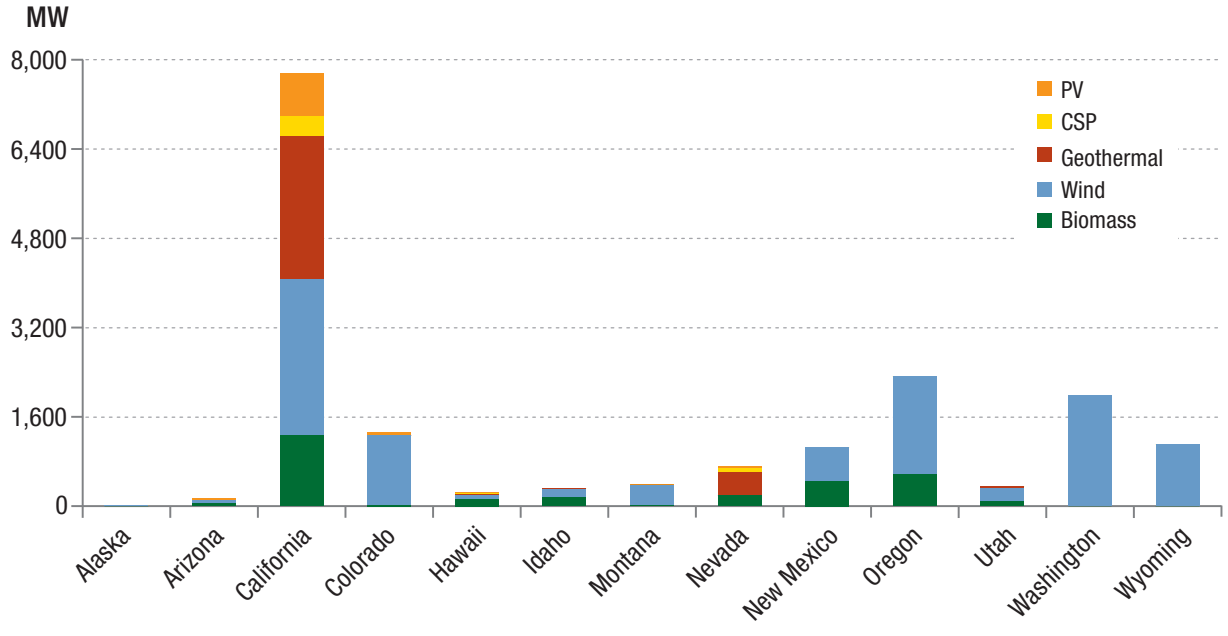
	Wind	PV*	CSP	Geothermal	Biomass	Hydropower	Total Renewables (incl. hydro)	Per capita RE (excl. hydro) watts/person
Washington	1,980	5.2	0	0.0	0	20,807	**22,792**	**298**
California	2,794	768.0	364	2,565.5	1,271	10,032	**17,794**	**210**
Oregon	1,758	14.0	0	0.3	564	8,240	**10,577**	**611**
Arizona	63	46.2	1	0.0	40	2,718	**2,868**	**23**
Idaho	147	0.2	0	15.8	161	2,516	**2,839**	**209**
Montana	375	0.7	0	0.0	11	2,548	**2,935**	**397**
Nevada	0	36.4	64	426.8	191	1,047	**1,765**	**272**
Colorado	1,246	59.1	0	0.0	18	649	**1,972**	**263**
New Mexico	597	2.4	0	0.2	449	87	**1,136**	**522**
Wyoming	1,101	0.1	0	0.3	0	299	**1,400**	**2,024**
Alaska	8	0.0	0	0.7	0	414	**423**	**12**
Utah	223	0.6	0	42.0	88	262	**616**	**127**
Hawaii	63	26.2	2	35.0	126	25	**277**	**195**

Sources: EIA, AWEA, GEA, Larry Sherwood/IREC, USDA

* Does not include off-grid installations

Renewables 2009 Installed Nameplate Capacity *(excluding hydropower)*
WEST

II



Sources: EIA, AWEA, GEA, Larry Sherwood/IREC

III. Global Renewable Energy Development

Global Renewable Energy Development: Summary

- Global renewable electricity installations (excluding hydropower) have **more than tripled** from 2000–2009.

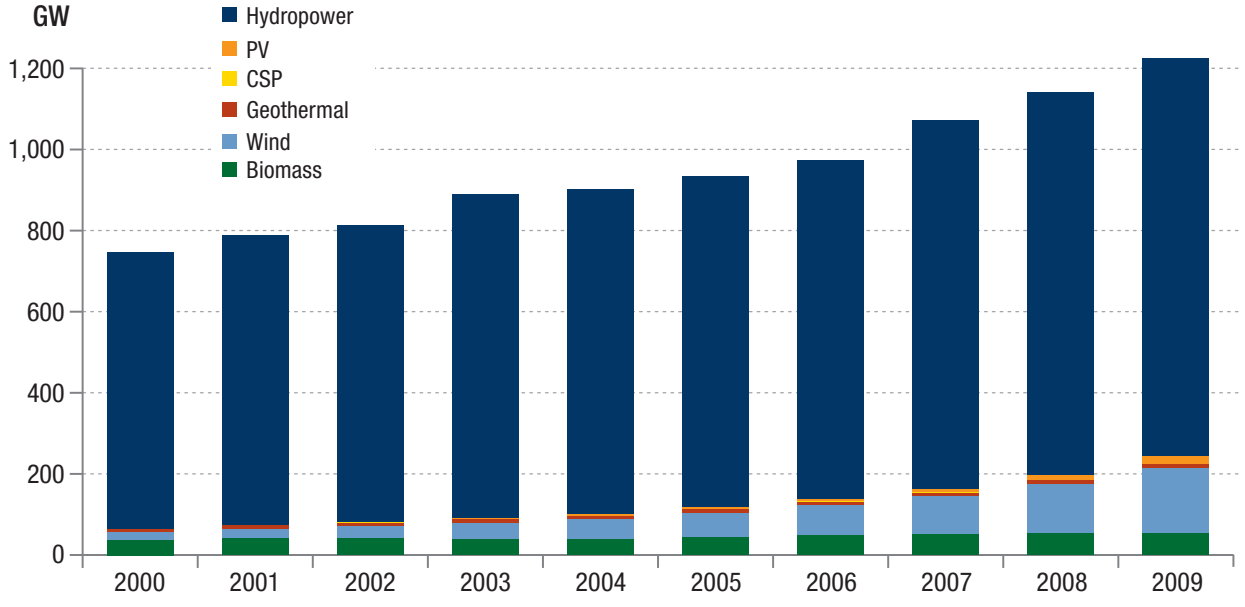
- Including hydropower, renewable energy accounts for **21%** of all global electricity generation; without hydropower, renewable energy accounts for **3.8%** of global generation.

- Wind and solar energy are the fastest growing renewable energy technologies worldwide. Wind and solar PV generation **grew by a factor of more than 14** between 2000 and 2009.

- In 2009, Germany led the world in cumulative solar PV installed capacity. The United States leads the world in wind, geothermal, biomass, and CSP installed capacity.

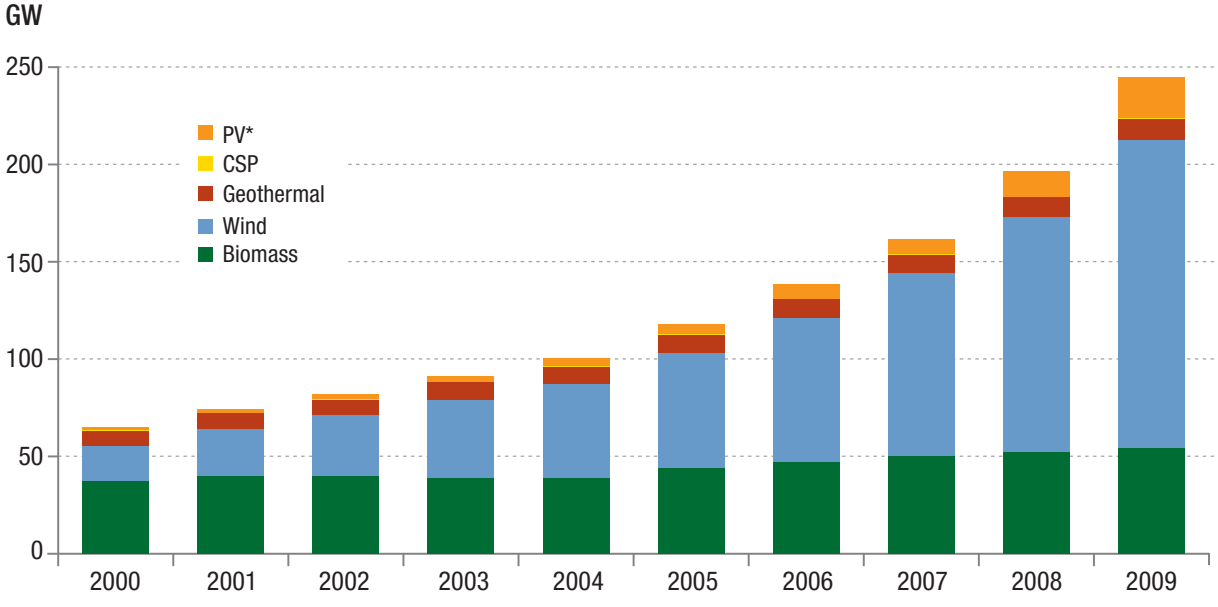
Renewable Electricity Capacity Worldwide *(including hydropower)*

III



Sources: REN21, GWEC, GEA, SEIA, EIA

Renewable Electricity Generating Capacity Worldwide
(excluding hydropower)



*Grid-tied capacity.

Sources: REN21, GWEC, GEA, SEIA, EIA

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%

Sources: REN21, GWEC, GEA, SEIA, EIA

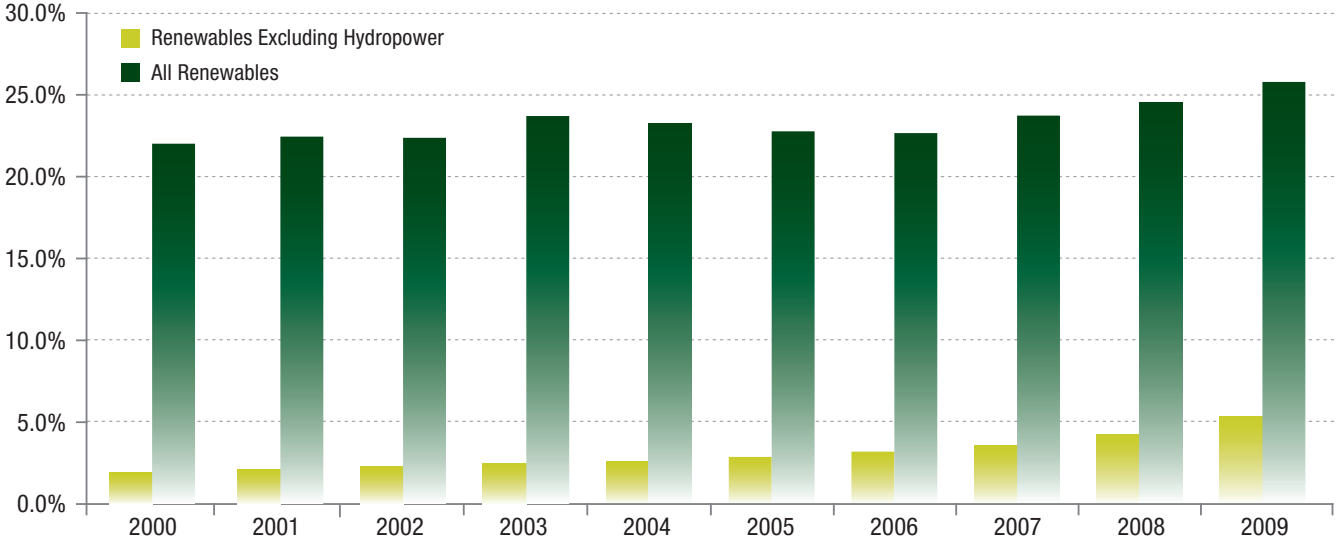
Renewables as a Percent of Total Installed Nameplate Capacity Worldwide

	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%	21.7%	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%	0.9%	0.2%	1.1%	22.0%	2.2%	**82**
2003	20.8%	0.1%	0.0%	1.1%	0.2%	1.0%	23.2%	2.4%	**91**
2004	20.2%	0.1%	0.0%	1.2%	0.2%	1.0%	22.8%	2.5%	**100**
2005	19.9%	0.1%	0.0%	1.4%	0.2%	1.1%	22.8%	2.9%	**118**
2006	19.6%	0.2%	0.0%	1.7%	0.2%	1.1%	22.8%	3.2%	**138**
2007	20.6%	0.2%	0.0%	2.1%	0.2%	1.1%	24.2%	3.7%	**162**
2008	20.6%	0.3%	0.0%	2.6%	0.2%	1.1%	24.9%	4.3%	**197**
2009	20.6%	0.4%	0.0%	3.3%	0.2%	1.1%	25.7%	5.1%	**245**

Sources: REN21, GWEC, GEA, SEIA, EIA

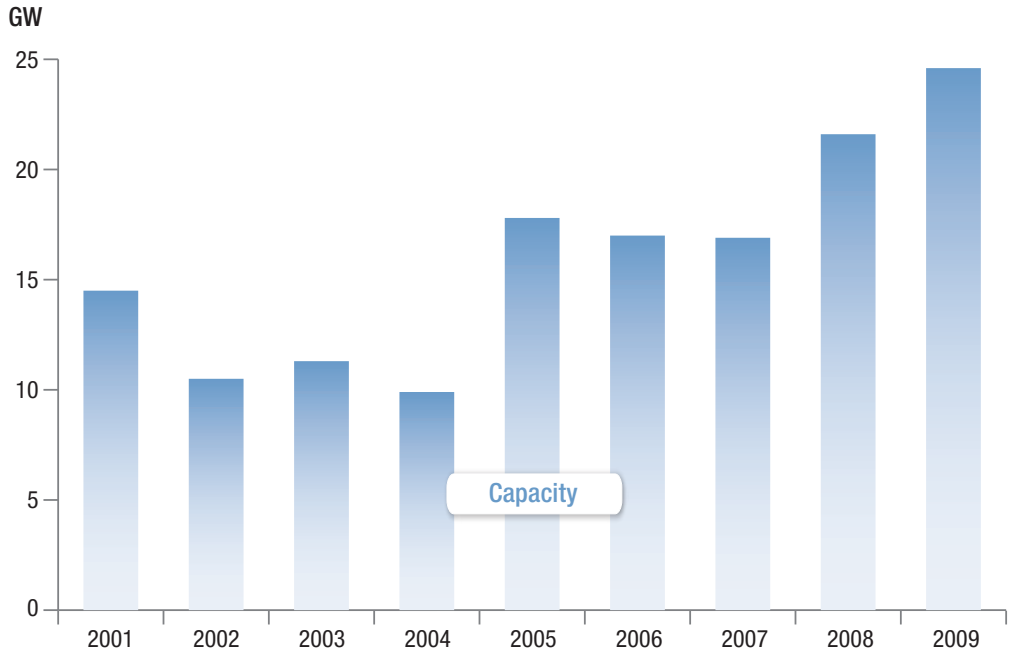
Renewables Share of Total Electricity Capacity Worldwide

III



Sources: REN21, GWEC, GEA, SEIA, EIA

Annual Installed Renewable Electricity Growth Worldwide
(excluding hydropower)

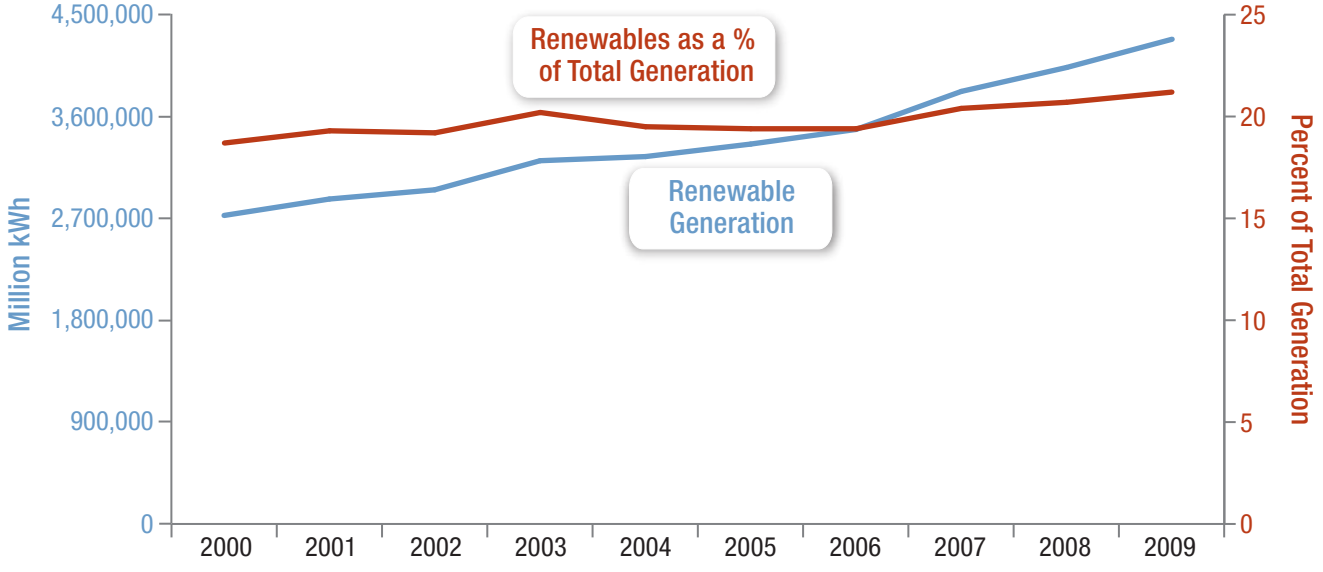


	Compounded Annual Growth Rate (CAGR) (2000–2009)
Wind	27.3%
Solar PV	35.1%
CSP	4.3%
Geothermal	3.3%
Biomass	4.3%
Renewables (excl. Hydro)	15.9%

Sources: REN21, GWEC, GEA, SEIA, EIA

Worldwide Renewable Electricity Generation *(including hydropower)*

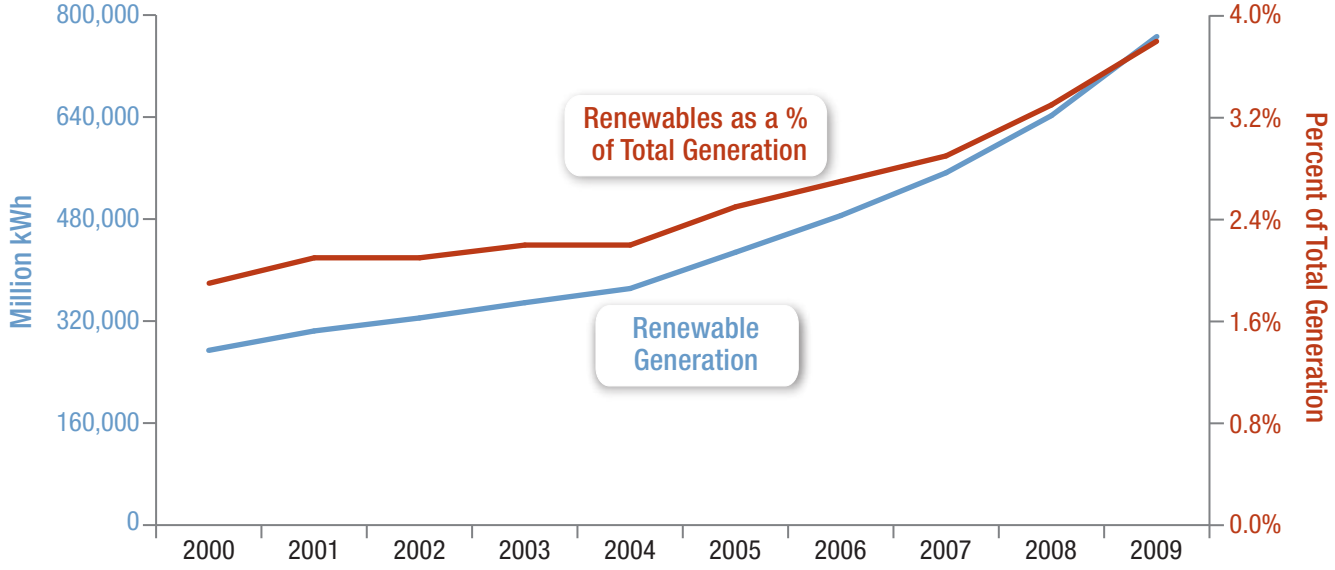
III



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, SEIA, EIA

Renewable Electricity Generation Worldwide *(excluding hydropower)*

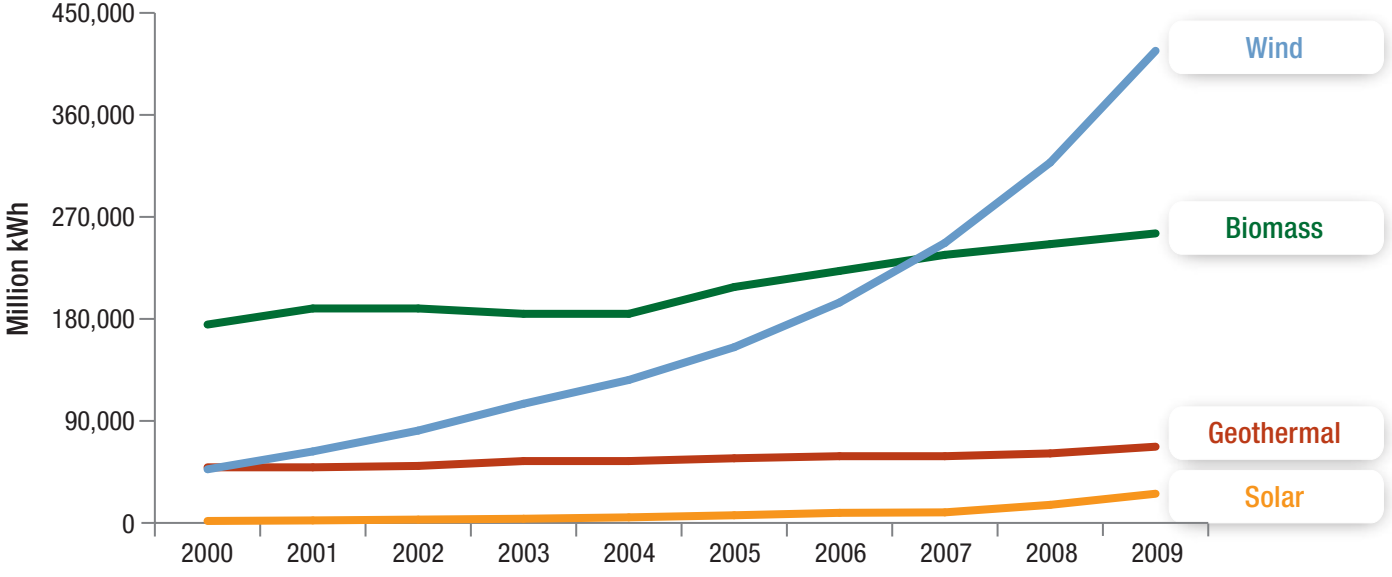


Generation derived using capacity factors of 14% for PV, 30% of wind, 70% for geothermal, 54% for biomass, 25% for CSP, and 41% for hydro.

Sources: REN21, GWEC, GEA, SEIA, EIA

Renewable Electricity Generation Worldwide by Technology (2000–2009)

III



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.

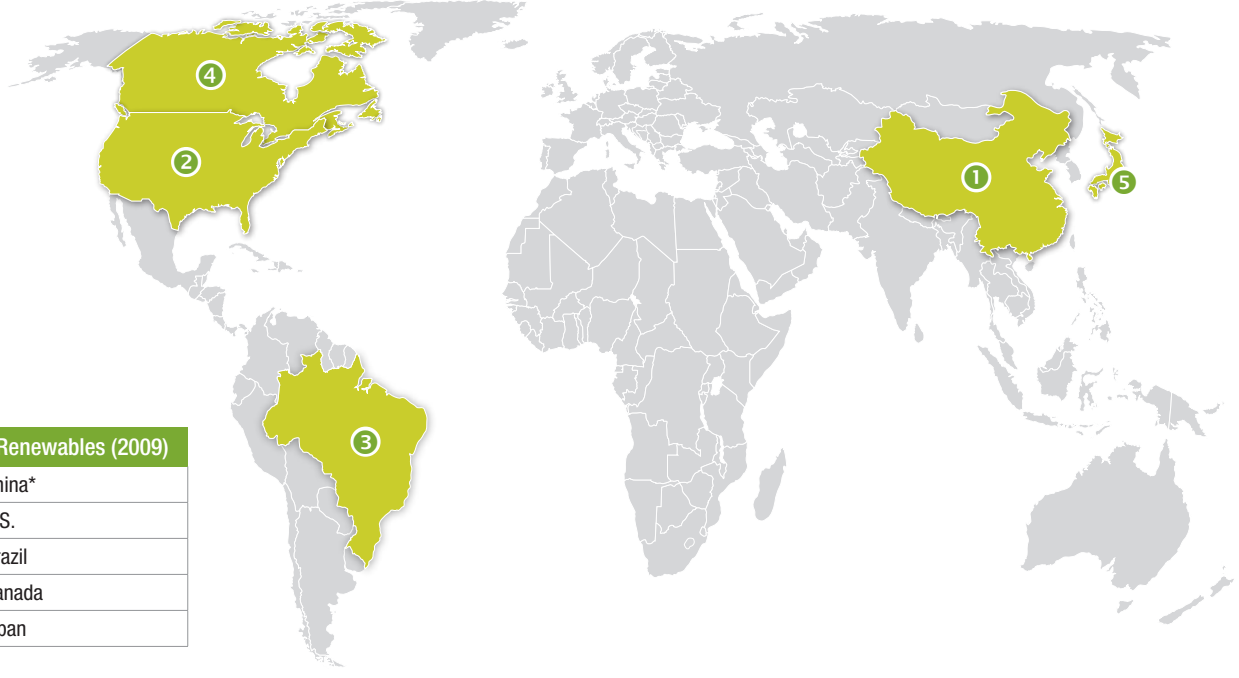
Sources: REN21, GWEC, GEA, SEIA, EIA

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%	20.4%	2.9%	**552,703**
2008	17.4%	0.1%	1.3%	1.6%	0.3%	20.7%	3.3%	**642,327**
2009	17.4%	0.1%	1.3%	2.1%	0.3%	21.2%	3.8%	**766,333**

Sources: REN21, GWEC, GEA, SEIA, EIA

Top Countries with Installed Renewable Electricity

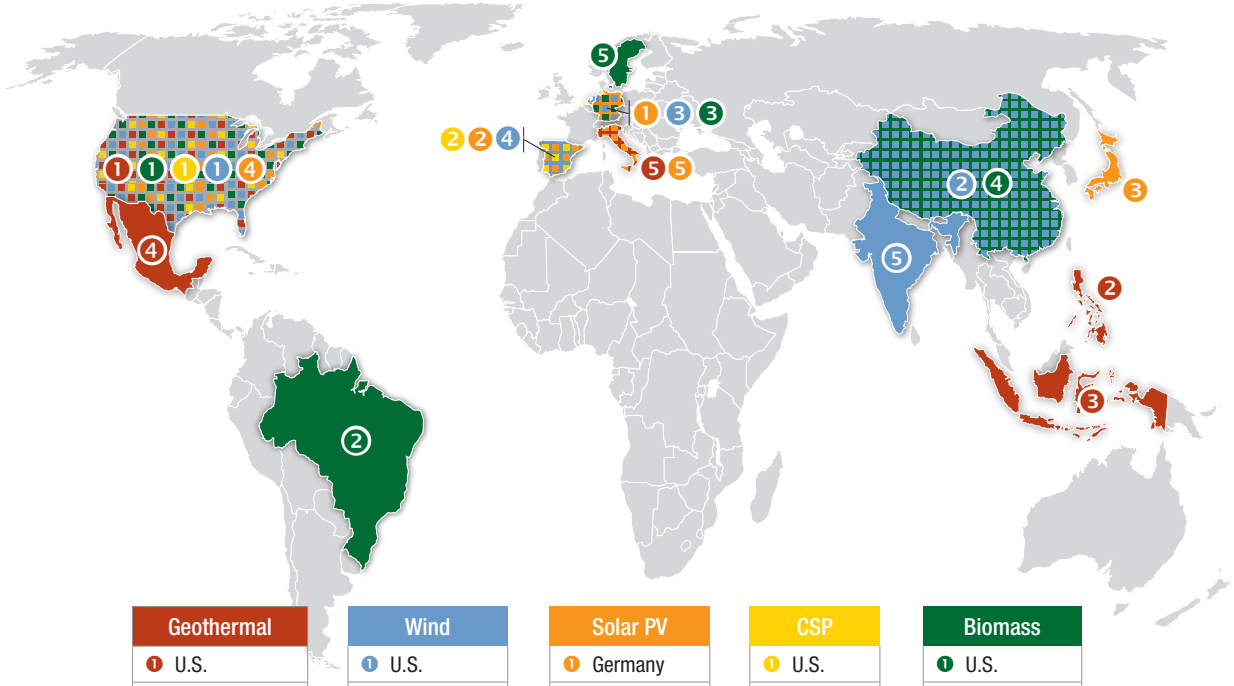


Total Renewables (2009)
❶ China*
❷ U.S.
❸ Brazil
❹ Canada
❺ Japan

Sources: REN21

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

Top Countries with Installed Renewable Electricity by Technology (2009)



Geothermal	Wind	Solar PV	CSP	Biomass
1 U.S.	1 U.S.	1 Germany	1 U.S.	1 U.S.
2 Philippines	2 China	2 Spain	2 Spain	2 Brazil
3 Indonesia	3 Germany	3 Japan		3 Germany
4 Mexico	4 Spain	4 U.S.		4 China
5 Italy	5 India	5 Italy		5 Sweden

Source: REN21, GWEC, GEA, SEIA

IV. Wind

Wind: Summary

- In the United States, installed wind energy capacity **increased almost 14 times between 2000 and 2009.**

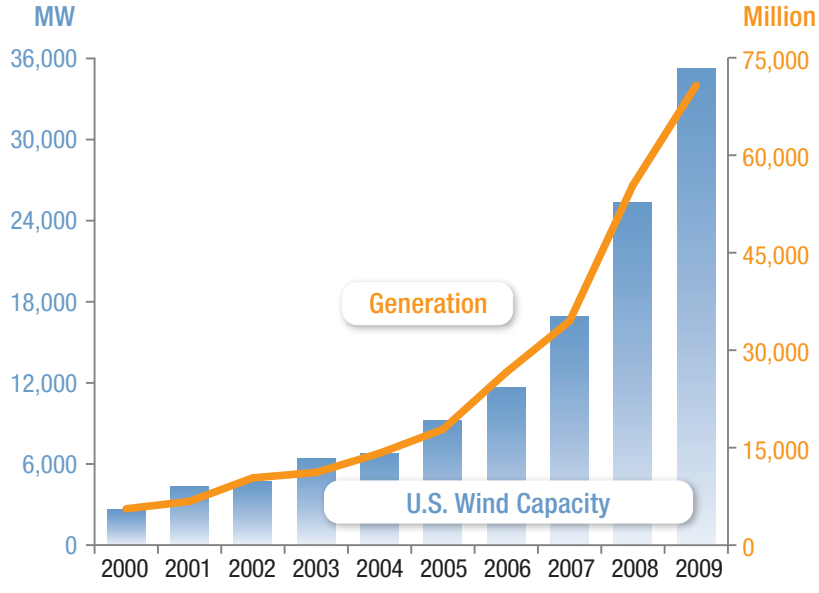
- In the United States, wind experienced record growth in 2009 and **nearly 10 GW of new capacity was added.** Texas led the United States in wind installations in 2009, installing more than 2,292 MW of wind capacity.

- The cumulative capacity-weighted average price of wind power, including the production tax credit, was about **4.4 cents per kilowatt hour in 2009**—a price that competes with fossil fuel-generated electricity.

- In 2009, China surpassed the United States as the world leader in annual installed wind capacity, with more than 13.8 GW added.

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

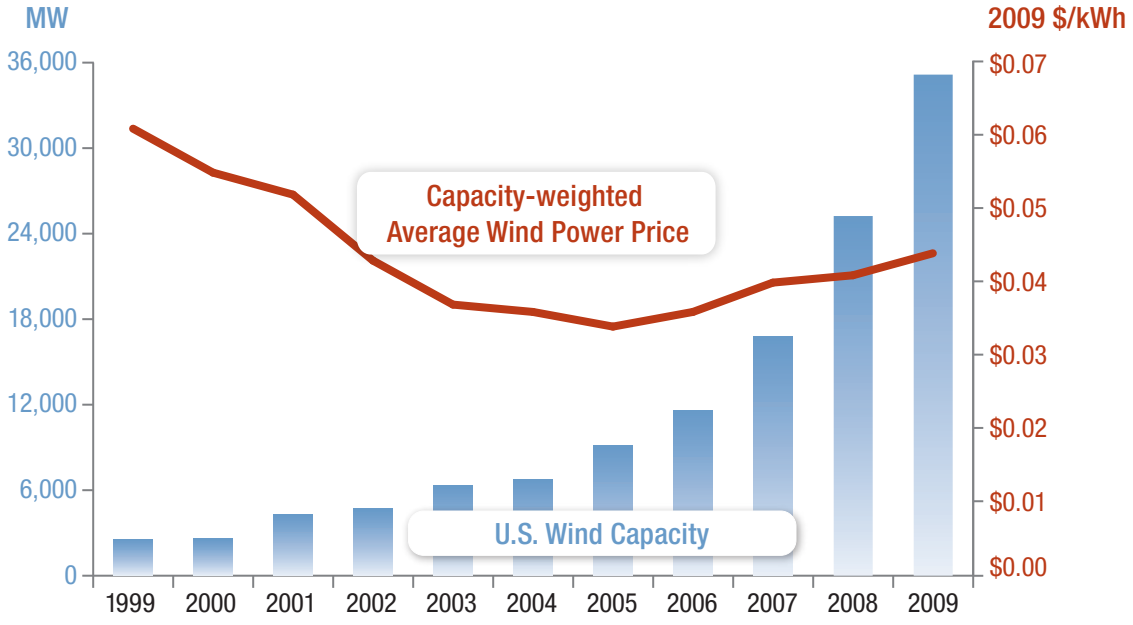
IV



	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	70,761	35,159	39.3%

Sources: AWEA, EIA

U.S. Wind Power Sales Price



IV

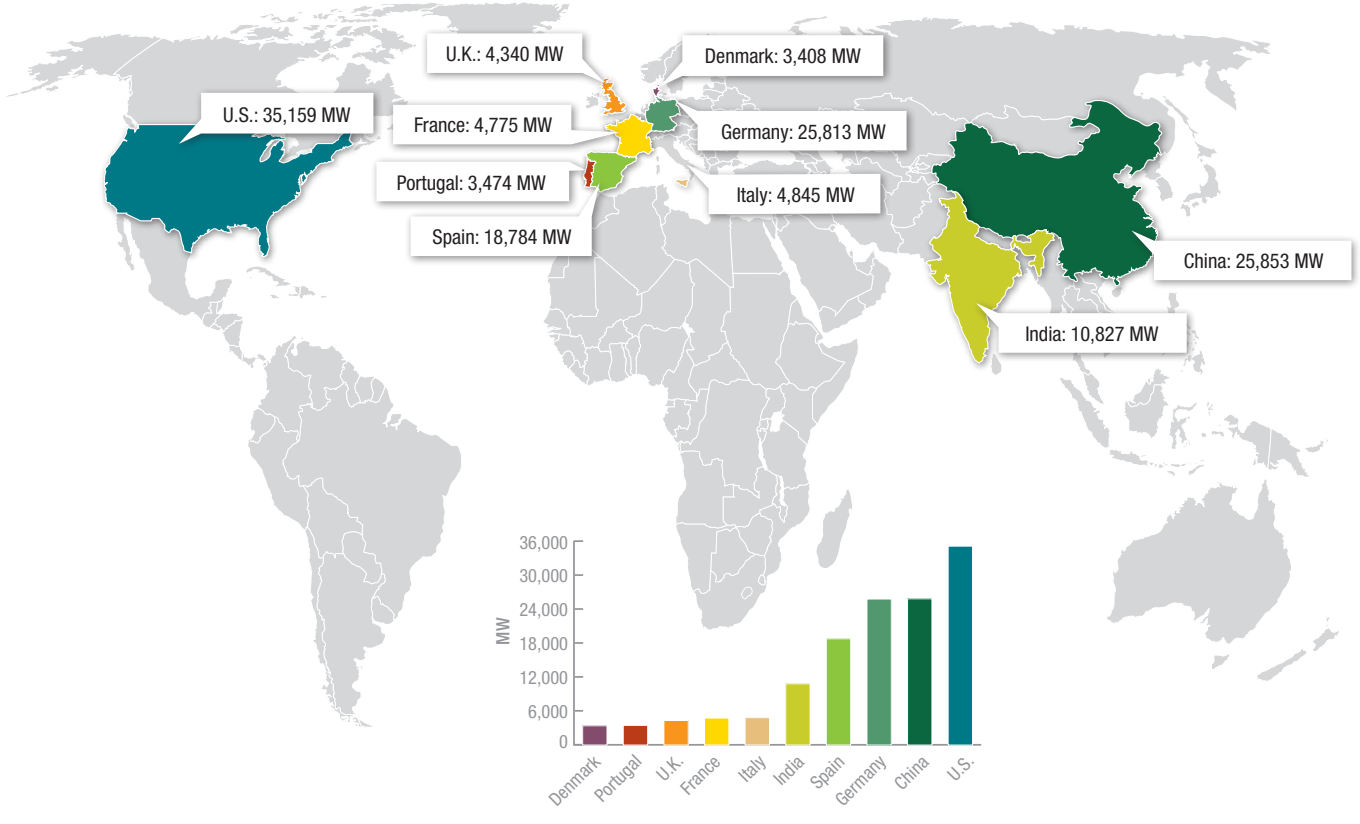
Sources: AWEA, LBNL

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 (2009) – Select Countries

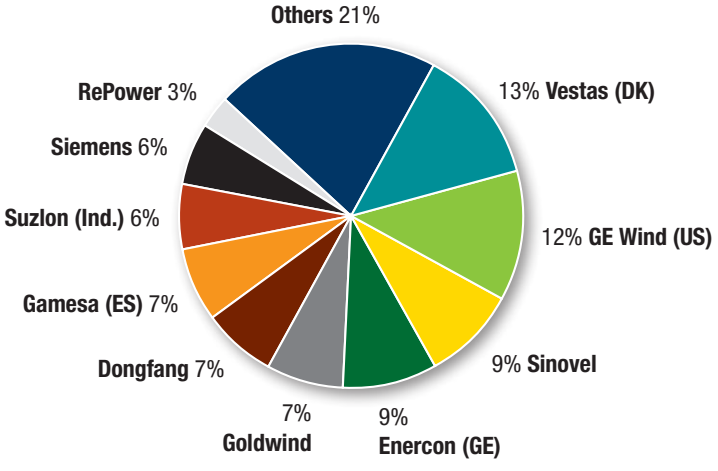
IV



Sources: GWEC, AWEA

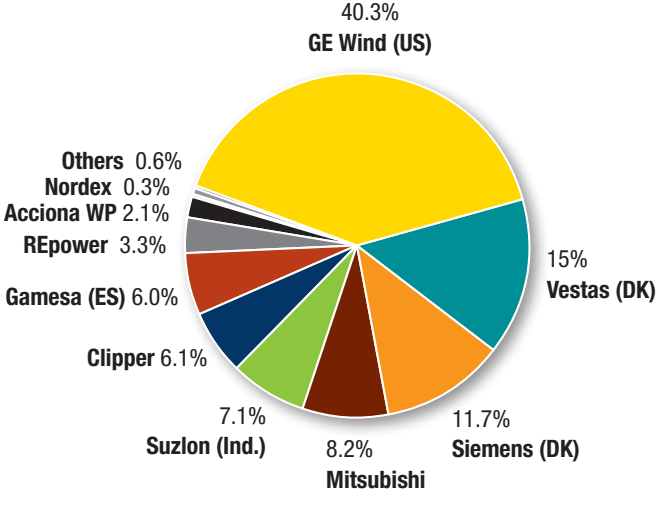
Global Wind Turbine Market Share 2009

Total Turbine Installations: 38 GW



U.S. Wind Turbine Market Share 2009

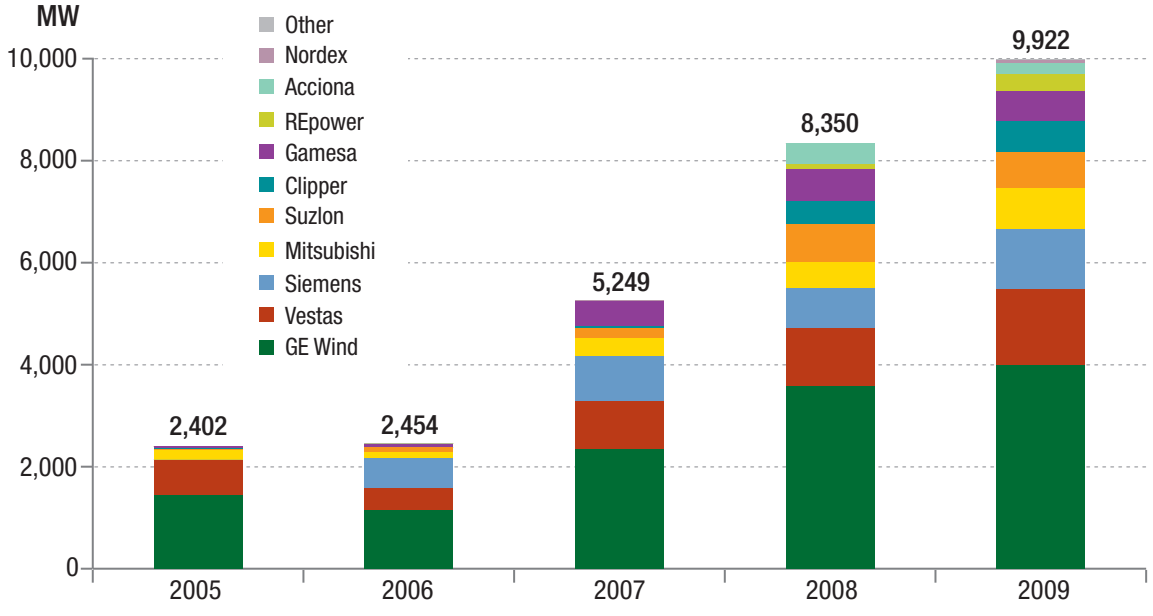
Total Turbine Installations: 9,922 MW



Source: REN21, AWEA, LBNL

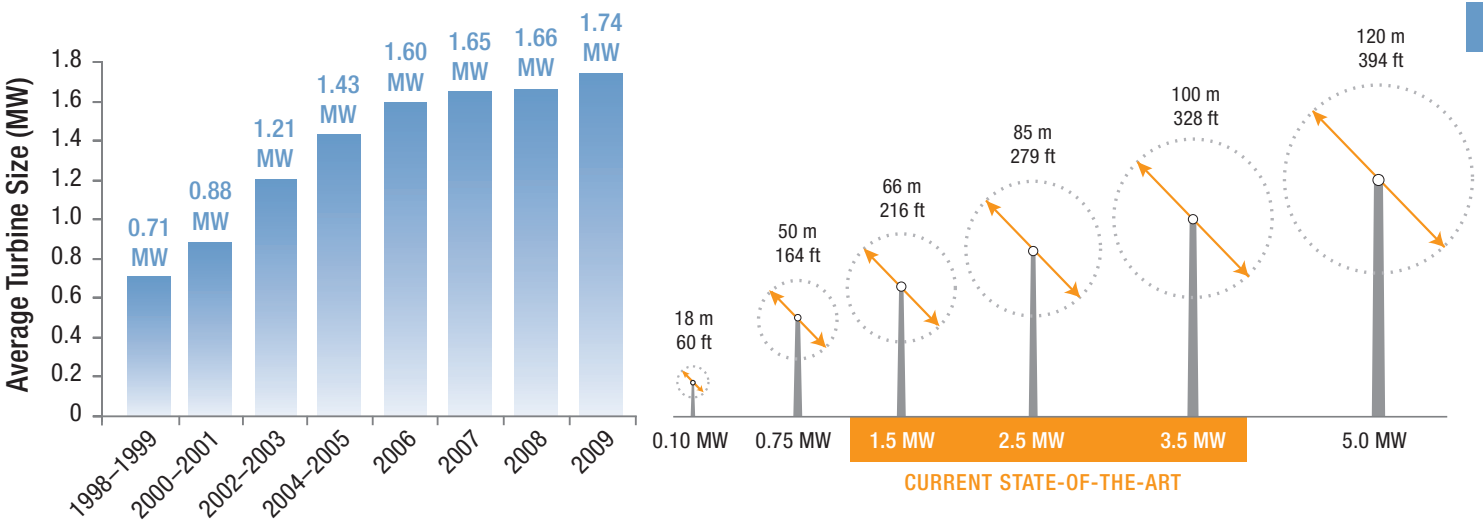
Annual U.S. Wind Turbine Installations, by Manufacturer (MW)

IV



Source: AWEA, LBNL

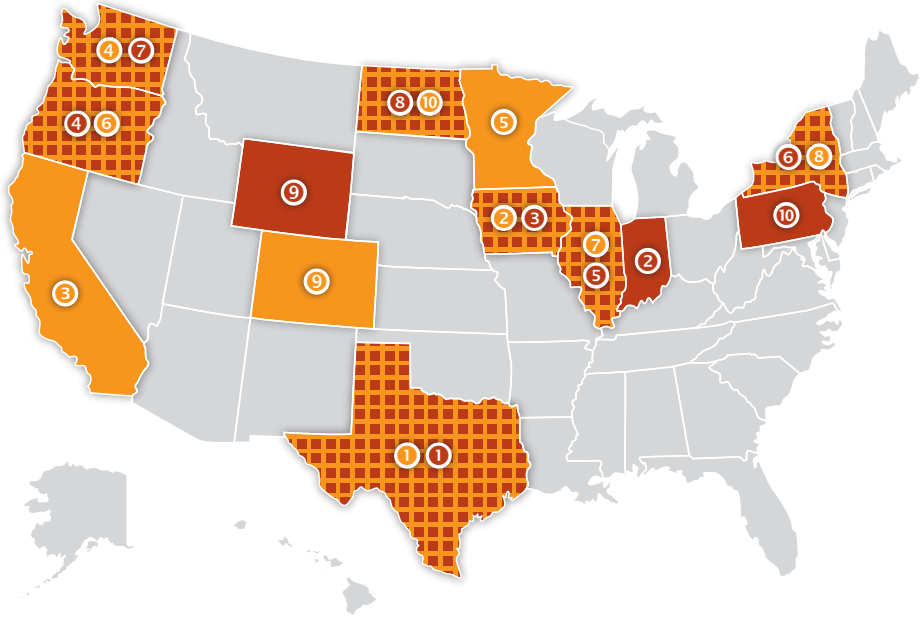
Average Installed Turbine Size



Source: AWEA, LBNL

States Leading Wind Power Development

IV



Cumulative Capacity (2009, MW)	
1 Texas	9,410
2 Iowa	3,670
3 California	2,794
4 Washington	1,980
5 Minnesota	1,809
6 Oregon	1,758
7 Illinois	1,547
8 New York	1,274
9 Colorado	1,246
10 North Dakota	1,203

Annual Capacity (2009, MW)	
1 Texas	2,292
2 Indiana	905
3 Iowa	879
4 Oregon	691
5 Illinois	632
6 New York	568
7 Washington	542
8 North Dakota	488
9 Wyoming	425
10 Pennsylvania	388

Source: AWEA

IV

V. Solar

Solar: Summary

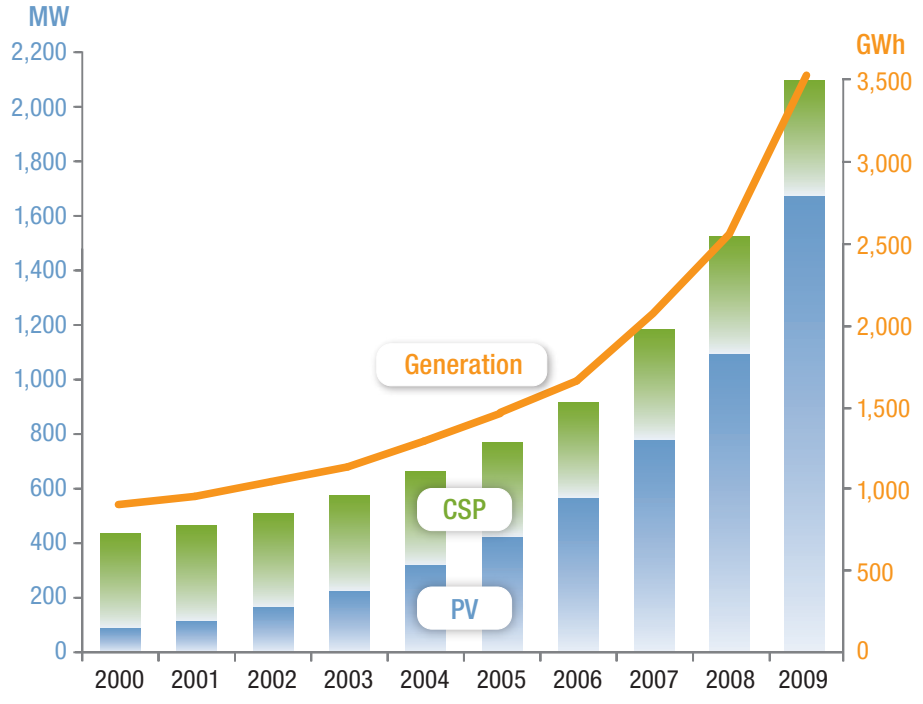
- Solar energy electricity generation has **nearly quadrupled between 2000 and 2009**, but still represents a very small part of overall U.S. electricity generation.

- 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.** China is the market leader with nearly 40% of the global PV cell production.

- A number of concentrating solar power (CSP) plants came online in 2009, including 12 MW in the United States and 120 MW in Spain.

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



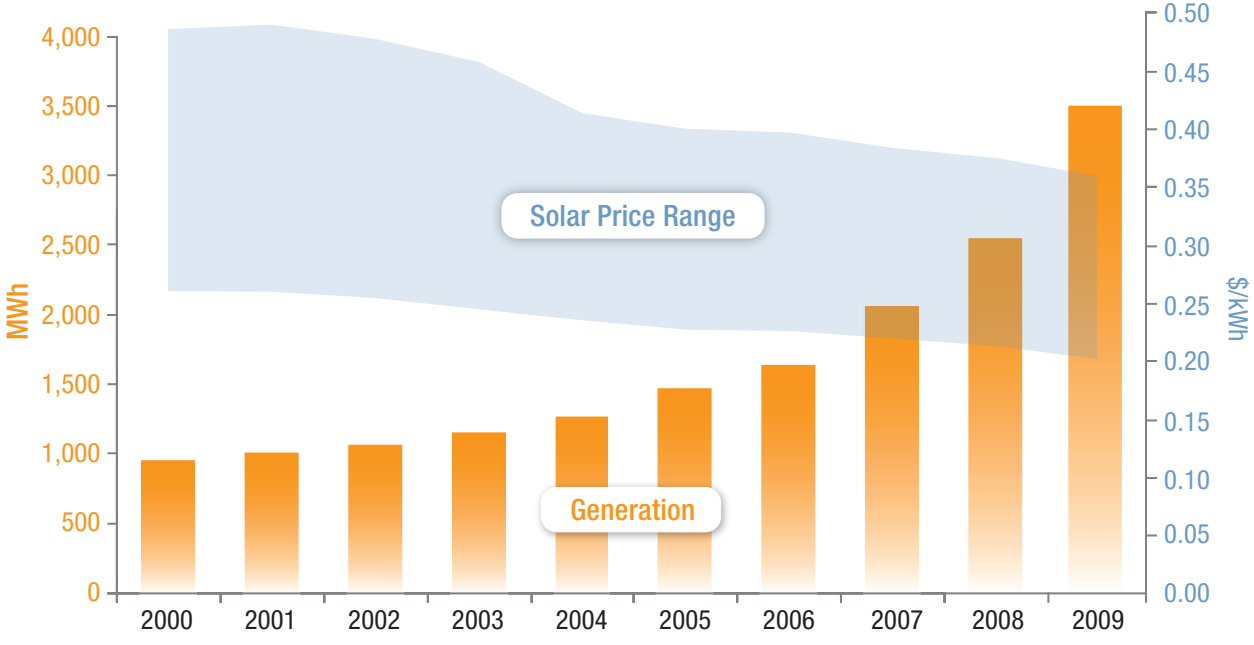
	U.S. Solar Energy Generation (Million kWh)	U.S. Solar Energy Capacity (MW) and % Increase from Previous Year			
		PV*	CSP	Total	Increase
2000	909	85	354	439	4.3%
2001	952	112	354	466	6.2%
2002	1,021	156	354	510	9.4%
2003	1,132	226	354	580	13.7%
2004	1,267	312	354	666	14.8%
2005	1,444	424	354	778	16.8%
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%
2009	3,588	1,677	431	2,108	38.2%

Sources: SEIA

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

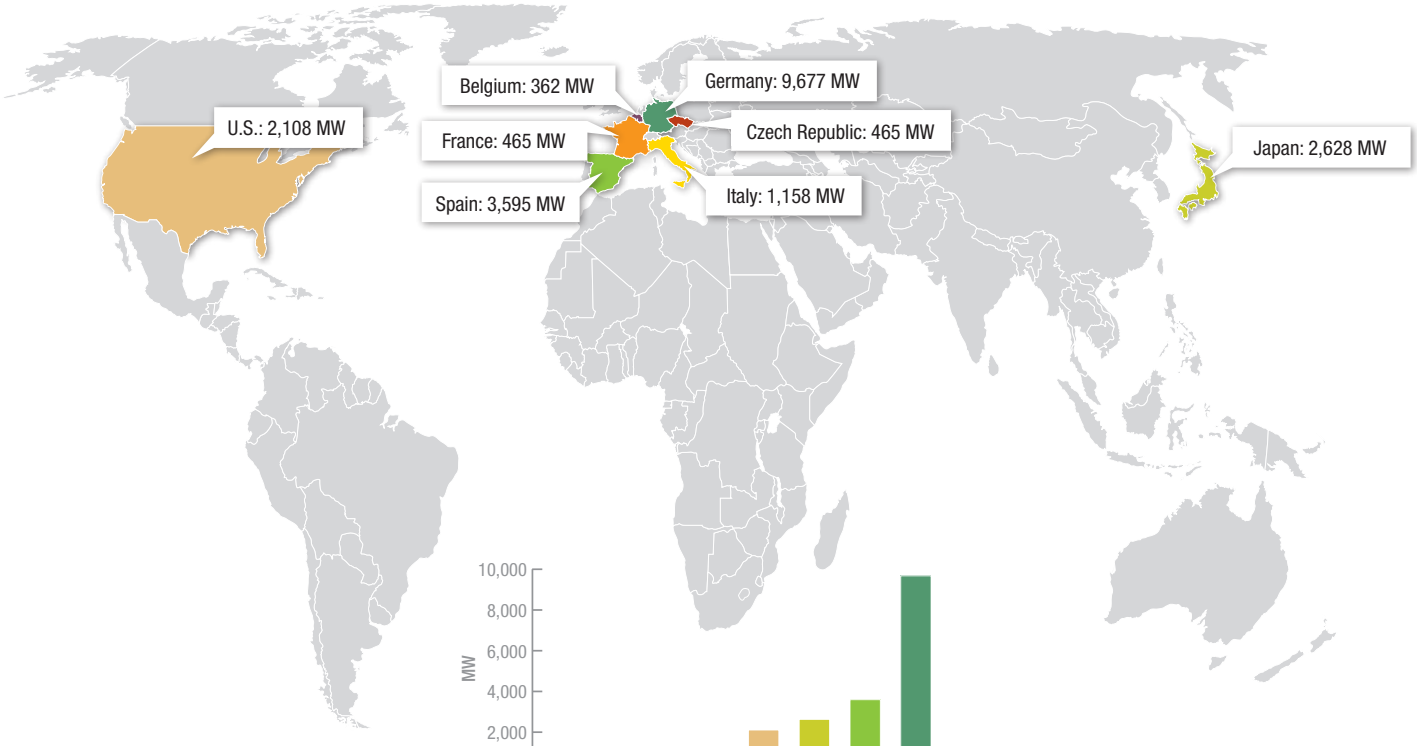
* Includes on- and off-grid capacity.

U.S. PV Power Sales Price



Source: Solarbuzz LLC, Federal Reserve Bank of St. Louis.
Note: Data from Solarbuzz is corrected for inflation.

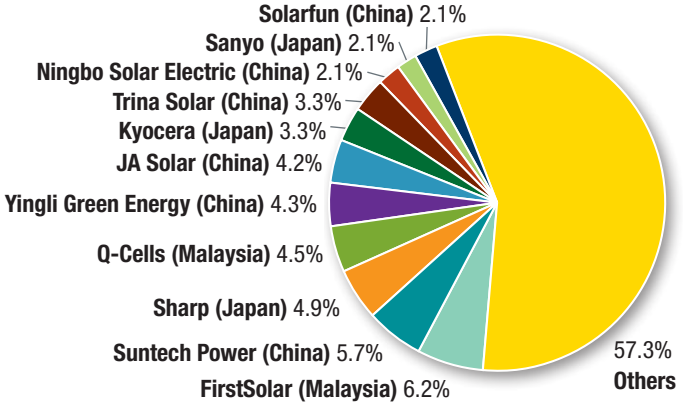
Solar Energy Installed Capacity (2009) – Select Countries



Source: SEIA
* Includes PV and CSP

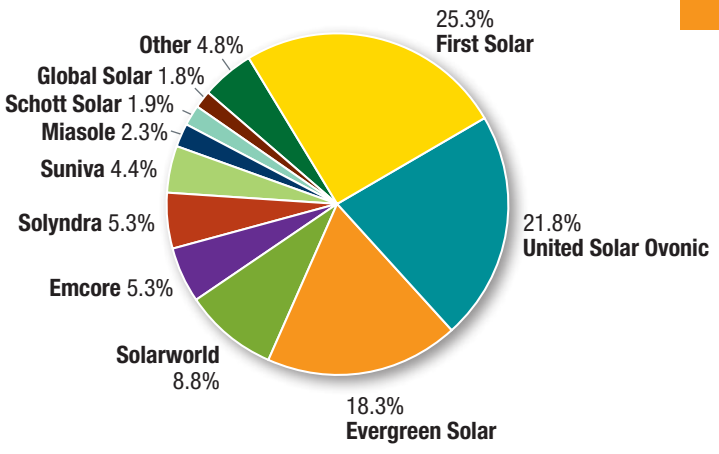
Global Solar PV Production 2009:

12,258 MW cell production
19,631.9 MW production capacity



U.S. Cell Production 2009:

566 MW cell production
1,871.5 MW production capacity

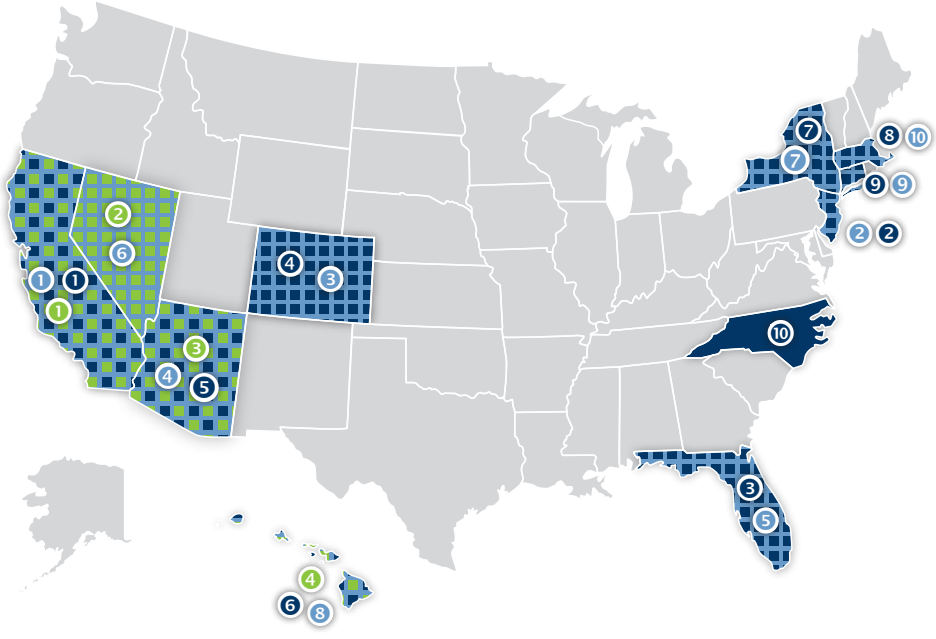


Source: Modified from Photon International

* Based on location of facilities

States Leading Solar Energy Development (2009)

V



PV Cumulative Capacity (2009, MW)	
1 California	768.0
2 New Jersey	127.5
3 Colorado	59.1
4 Arizona	46.2
5 Florida	38.9
6 Nevada	36.4
7 New York	33.9
8 Hawaii	26.2
9 Connecticut	19.7
10 Massachusetts	17.7

PV Annual Capacity Additions (2009, MW)	
1 California	212.1
2 New Jersey	57.3
3 Florida	35.9
4 Colorado	23.4
5 Arizona	21.1
6 Hawaii	12.7
7 New York	12.1
8 Massachusetts	9.5
9 Connecticut	8.7
10 North Carolina	7.8

CSP Cumulative Capacity (2009, MW)	
1 California	364
2 Nevada	64
3 Arizona	1
4 Hawaii	2

Source: SEIA, Larry Sherwood/IREC

Note: Grid-tied capacity only.

VI. Geothermal

Geothermal: Summary

- U.S. geothermal energy generation has remained relatively stable from 2000 to 2009, with the **past 10 years experiencing an average of 1.2% growth.**

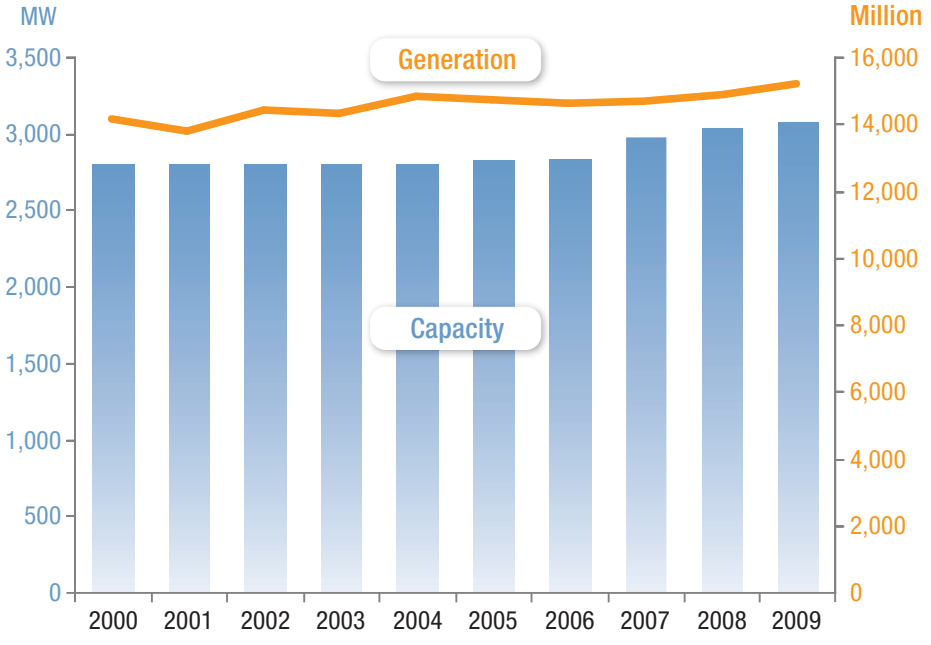
- Geothermal energy generates power for **between 5 and 10 cents / kilowatt-hour.**

- **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 electricity 24 hours a day, 365 days a year**.

U.S. Geothermal Electricity Nameplate Capacity and Generation

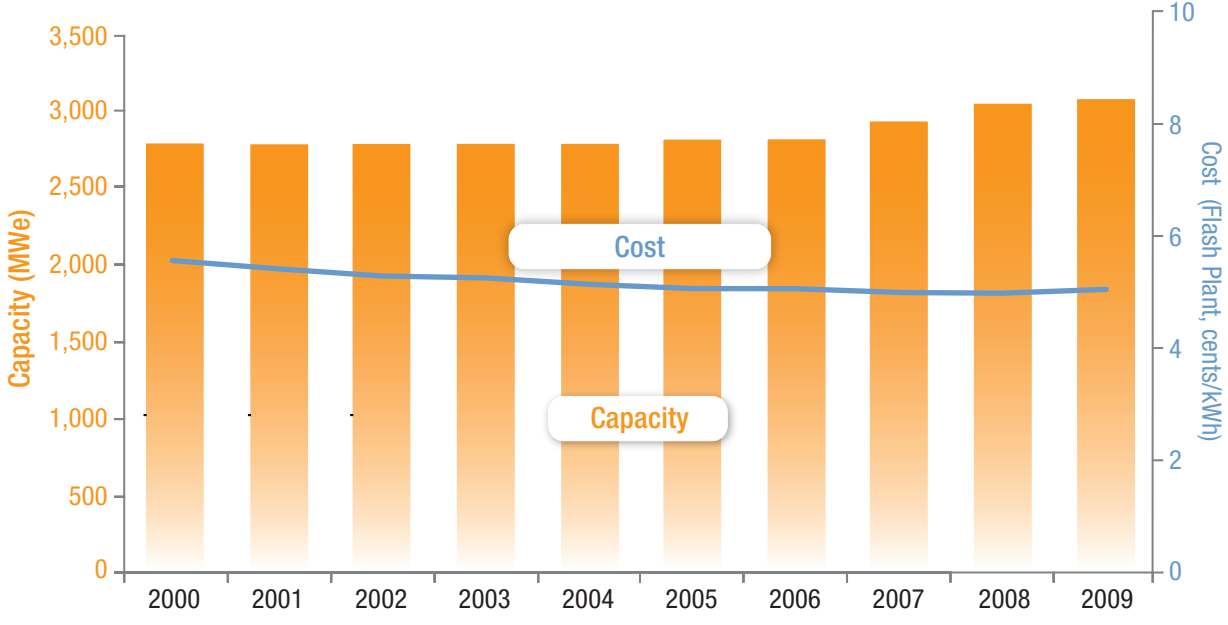
VI



	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	14,951	3,040	3.5%
2009	15,210	3,087	1.5%

Source: GEA, EIA

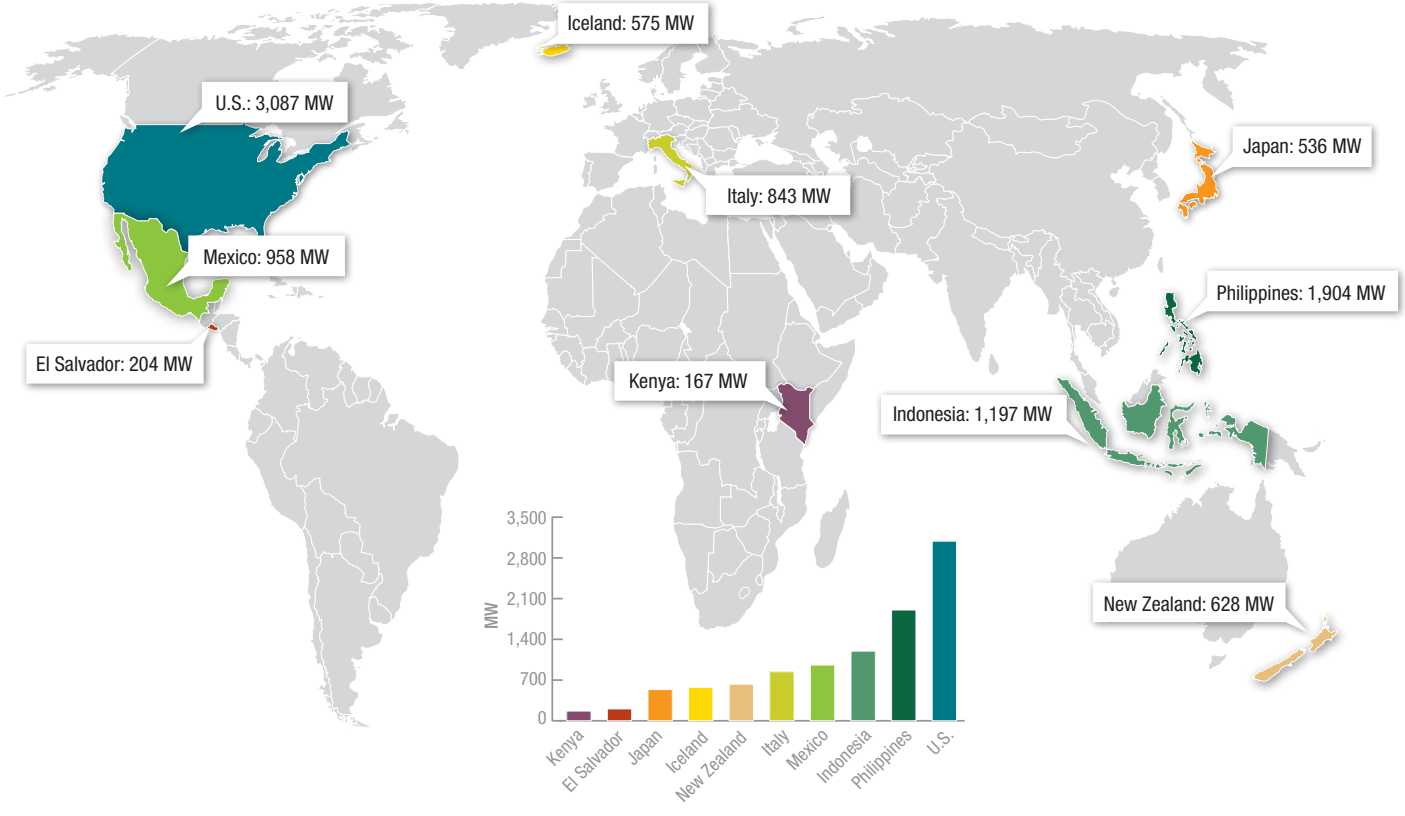
U.S. Geothermal Capacity and Cost Trends



VI

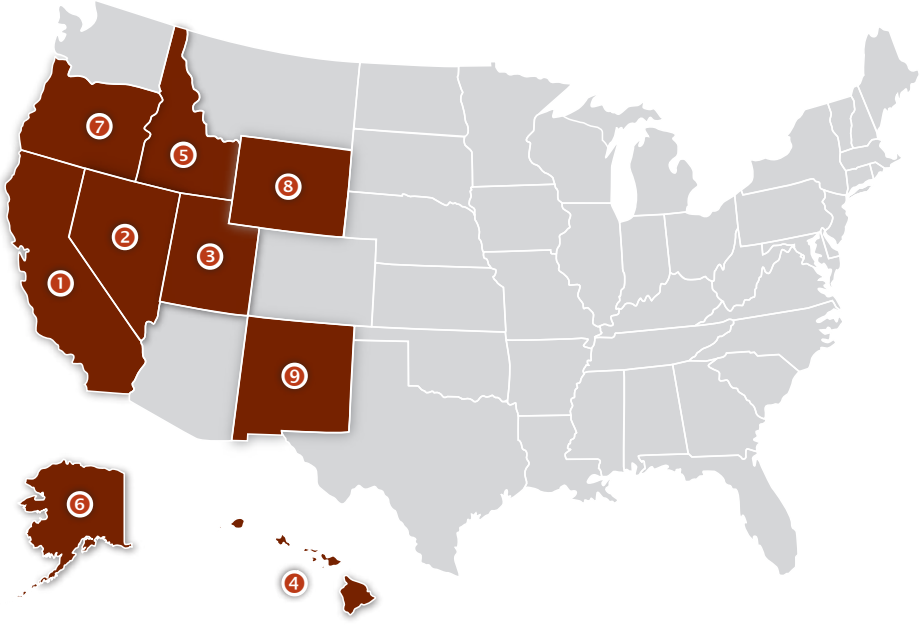
Source: GEA

Global Geothermal Electricity Capacity (2009) – Select Countries



Source: GEA

State Geothermal Energy Development (2009)



Total Installed Capacity (2009, MW)	
❶ California	2,565.5
❷ Nevada	426.8
❸ Utah	42.0
❹ Hawaii	35.0
❺ Idaho	15.8
❻ Alaska	0.7
❼ Oregon	0.3
❽ Wyoming	0.3
❾ New Mexico	0.2

VI

Source: GEA

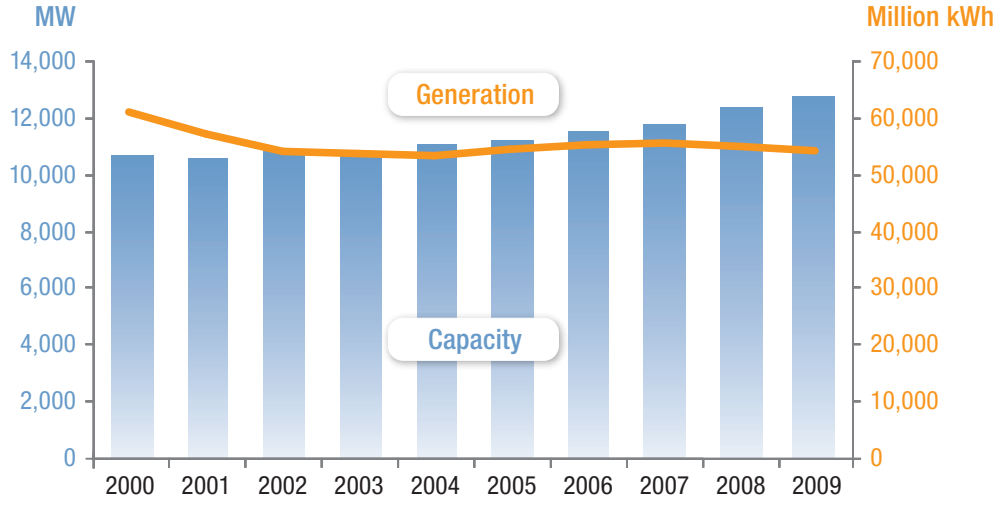
VII. Biopower

Biopower: Summary

- Biopower generation has remained steady during the past seven years, and currently accounts for **38% 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

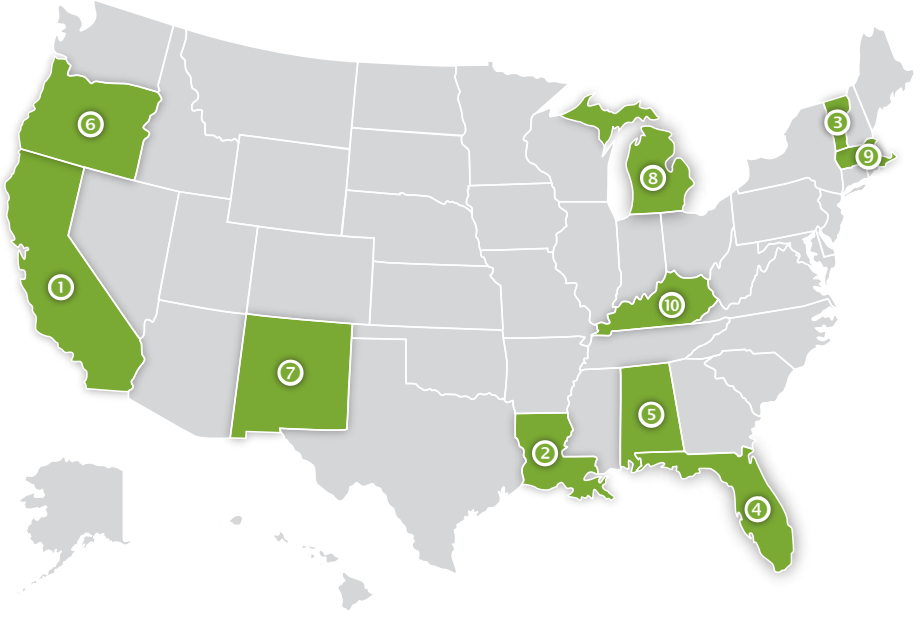


	U.S. Biopower Generation (Million kWh)	U.S. Biopower Capacity and % Increase from Previous Year	
		Total (MW)	% Change
2000	60,726	10,676	- 2.9%
2001	49,748	10,576	- 0.9%
2002	53,709	10,867	2.8%
2003	53,340	10,856	- 0.1%
2004	53,073	11,033	1.6%
2005	54,160	11,222	1.7%
2006	54,759	11,553	2.9%
2007	55,539	11,738	1.6%
2008	55,034	12,485	6.4%
2009	54,336	12,727	1.9%

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).

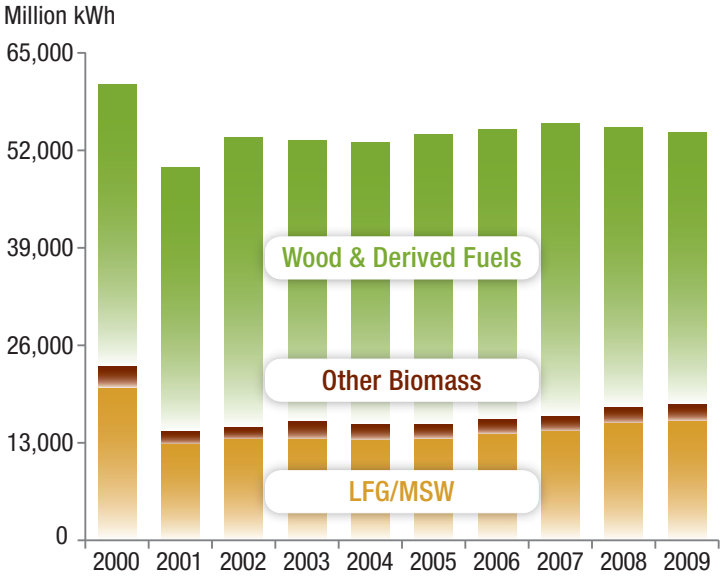
States Leading Biopower Energy Development (2009)



Total Installed Capacity (2009, MW)	
❶ California	1,271
❷ Louisiana	768
❸ Vermont	759
❹ Florida	711
❺ Alabama	622
❻ Oregon	564
❼ New Mexico	449
❽ Michigan	445
❾ Massachusetts	430
❿ Kentucky	426

Source: EIA

U.S. Biopower Generation Sources (2000–2009)



	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	15,834	2,259	36,243	54,336

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).

VII

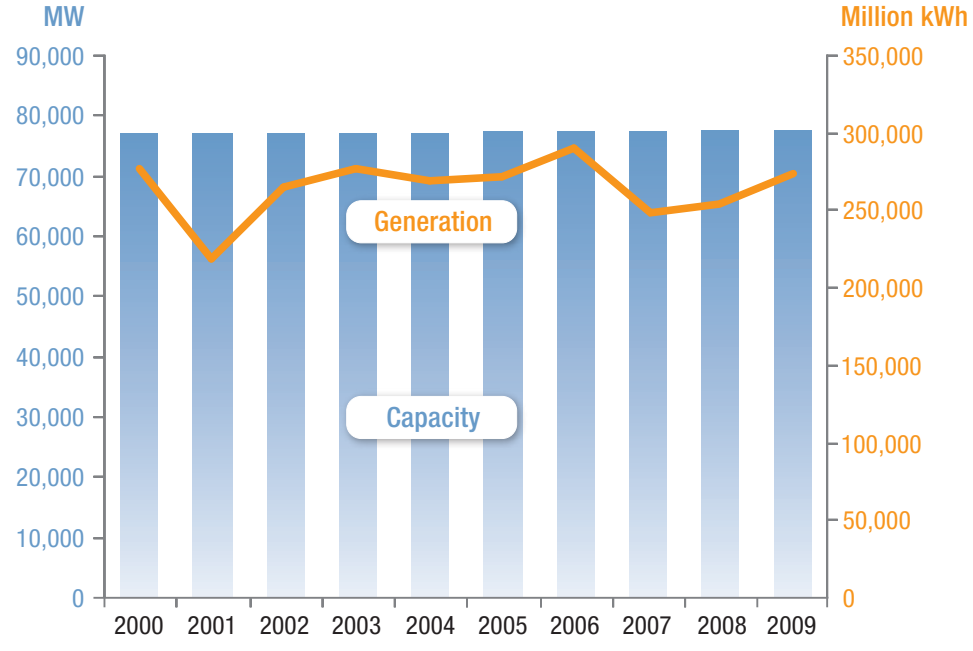
VIII. Hydropower

Hydropower: Summary

- Hydropower **capacity has remained constant between 2000–2009**, 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 6.9% of U.S. electricity generation**.

U.S. Hydropower* Nameplate Capacity and Generation

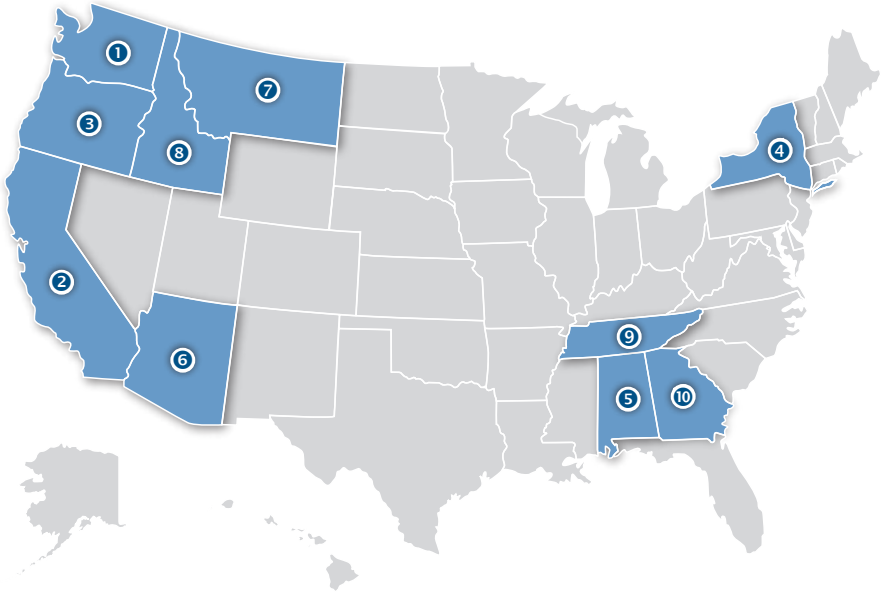


	U.S. Hydropower Generation (Million kWh)	U.S. Hydropower Capacity and % Increase from Previous Year	
		Total (MW)	% Increase
2000	275,573	76,946	0.0%
2001	216,961	76,911	0.0%
2002	264,329	77,047	0.2%
2003	275,806	77,020	0.0%
2004	268,417	77,130	0.1%
2005	270,321	77,354	0.3%
2006	289,246	77,419	0.1%
2007	247,510	77,432	0.0%
2008	254,831	77,640	0.3%
2009	272,131	77,662	0.0%

Source: EIA

*Note: Excludes pumped storage.

States Leading Hydropower Generation (2009)



Capacity (2009, MW)	
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

VIII

Source: EIA

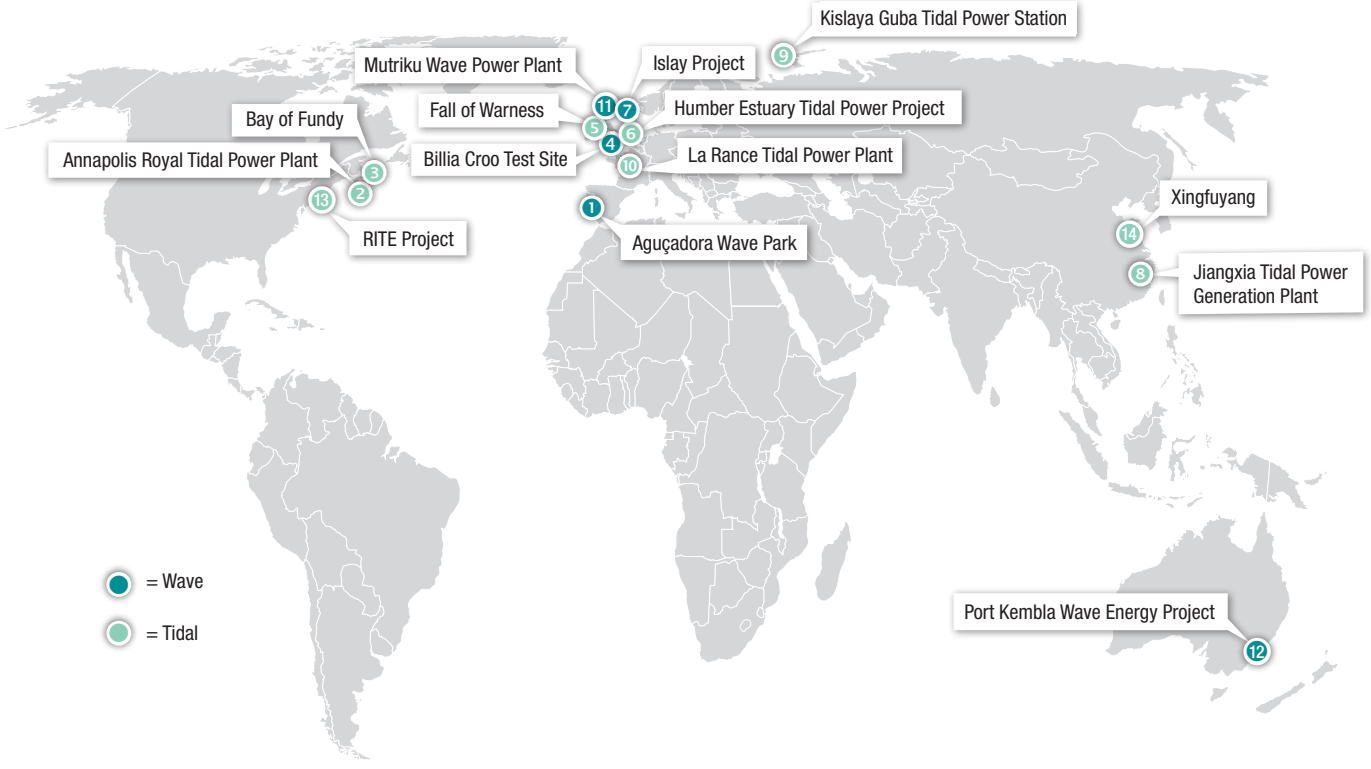
IX. Advanced Water Power

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).

- One wave and two tidal plants came online in 2009 in New South Wales, Canada, and the United Kingdom.

Worldwide Advanced Water Power Commercial and Pilot Plants in Operation



IX

Sources: FERC, Global Data

Worldwide Advanced Water Power Commercial and Pilot Plants in Operation

PROJECT NAME	Type	Location	Technology	Size	Year of Oper.
1 Aguçadora Wave Park	WAVE	Povoa de Varzim, Portugal	Pelamis Wave Energy Converter	2.25 MW	2007
2 Annapolis Royal Tidal Power Plant	TIDAL	Nova Scotia, Canada	Dam and Tidal Turbine	20 MW	1984
3 Bay of Fundy	TIDAL	Nova Scotia, Canada	In-stream tidal tubine	1.0 MW	2009
4 Billia Croo Test Site	WAVE	United Kingdom	N/A	200 kW	2003
5 Fall of Warness	TIDAL	United Kingdom	Open Hydro Centre Turbine	250 kW	2008
6 Humber Estuary Tidal Power Project	TIDAL	United Kingdom	Oscillating Hydrofoils	100 kW	2009
7 Islay Project	WAVE	United Kingdom	Wavegen Limpet Device	500 kW	2000
8 Jiangxia Tidal Power Generation Plant	TIDAL	China	N/A	3.2 MW	~1980
9 Kislaya Guba Tidal Power Station	TIDAL	Barents Sea, Russia	Orthogonal roto	1.7 MW	1968
10 La Rance Tidal Power Plant	TIDAL	France	Turbine	240 MW	1966
11 Mutriku Wave Power Plant	WAVE	New South Wales	Oscillating Water Column	300 kW	2009
12 Port Kembla Wave Energy Project	WAVE	Australia	Oceanlinx Wave Energy System	500 kW	2006
13 RITE Project	TIDAL	East River, New York	Verdant Free Flow Turbines	120 kW	2007
14 Xingfuyang	TIDAL	China	N/A	1.3 MW	~1980

= Commercial Plants

FERC Permitted and Licensed Projects in the U.S. (2009)	Permitted	Pending Permit	Licensed	Pending licenses
	130	40	2	0

IX

Sources: FERC, Global Data


reliable
green-friendly
colorless
clean
ZERO EMISSION
FC2
HYDROGEN FUEL CELL - HYBRID-ELECTRIC DRIVE
AC TRANSIT

x. Hydrogen

Hydrogen: Summary

- As of April 2010, there are approximately **68 hydrogen fueling stations** in the United States.
- An estimated 223 fuel cell vehicles are available in the United States to date.
- There are close to 1,000 stationary fuel cell installations worldwide, 23 of which are greater than 1 MW in capacity.

X

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%** 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.

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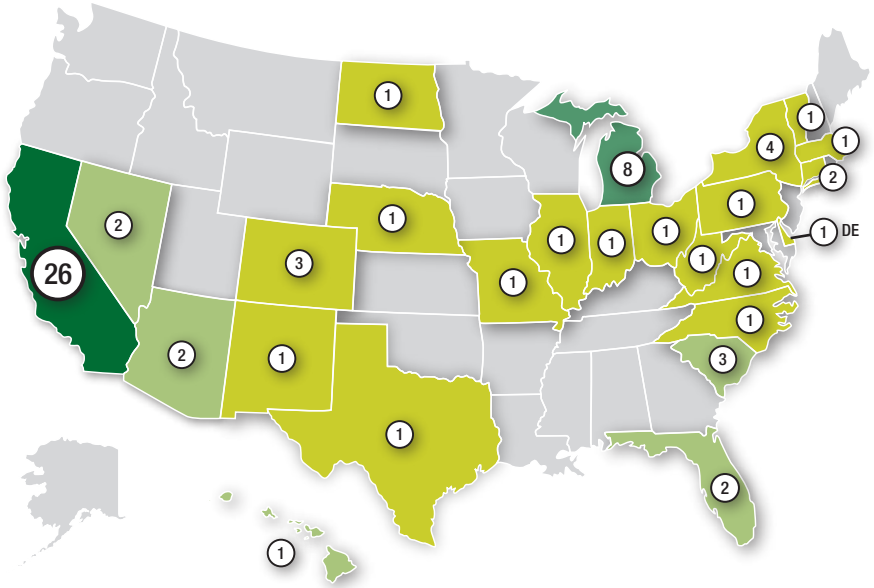
Sources: NHA, EIA

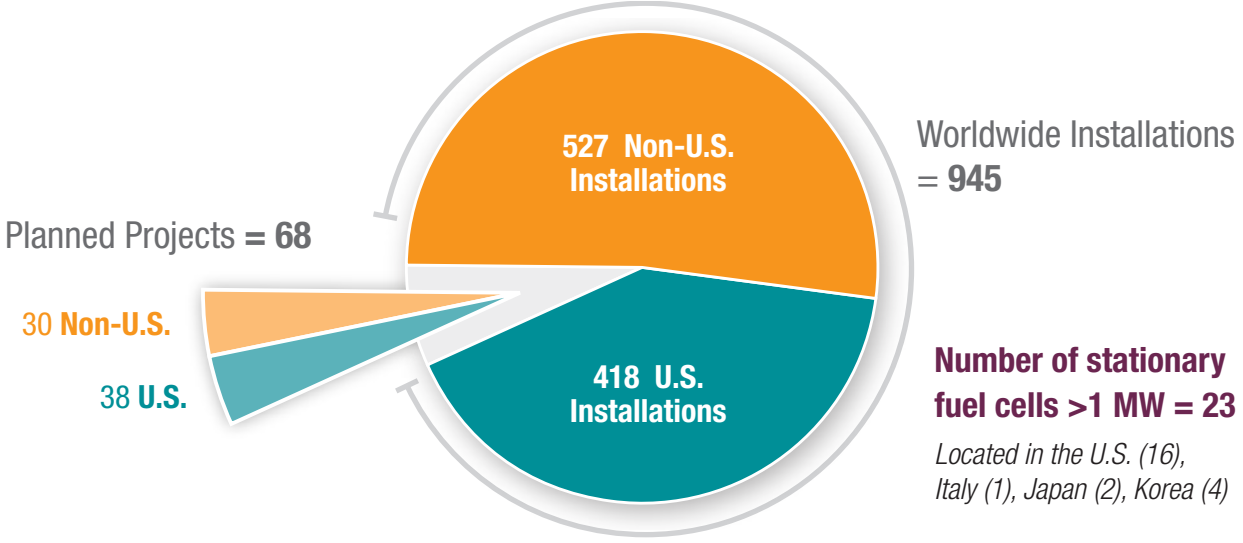
Number of Operational U.S. Hydrogen Fueling Stations

(April 2010 – **Total of 68**)



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

Stationary Fuel Cell Installations (2009)



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Sources: FuelCells.org

XI. Renewable Fuels

Renewable Fuels – Ethanol: Summary

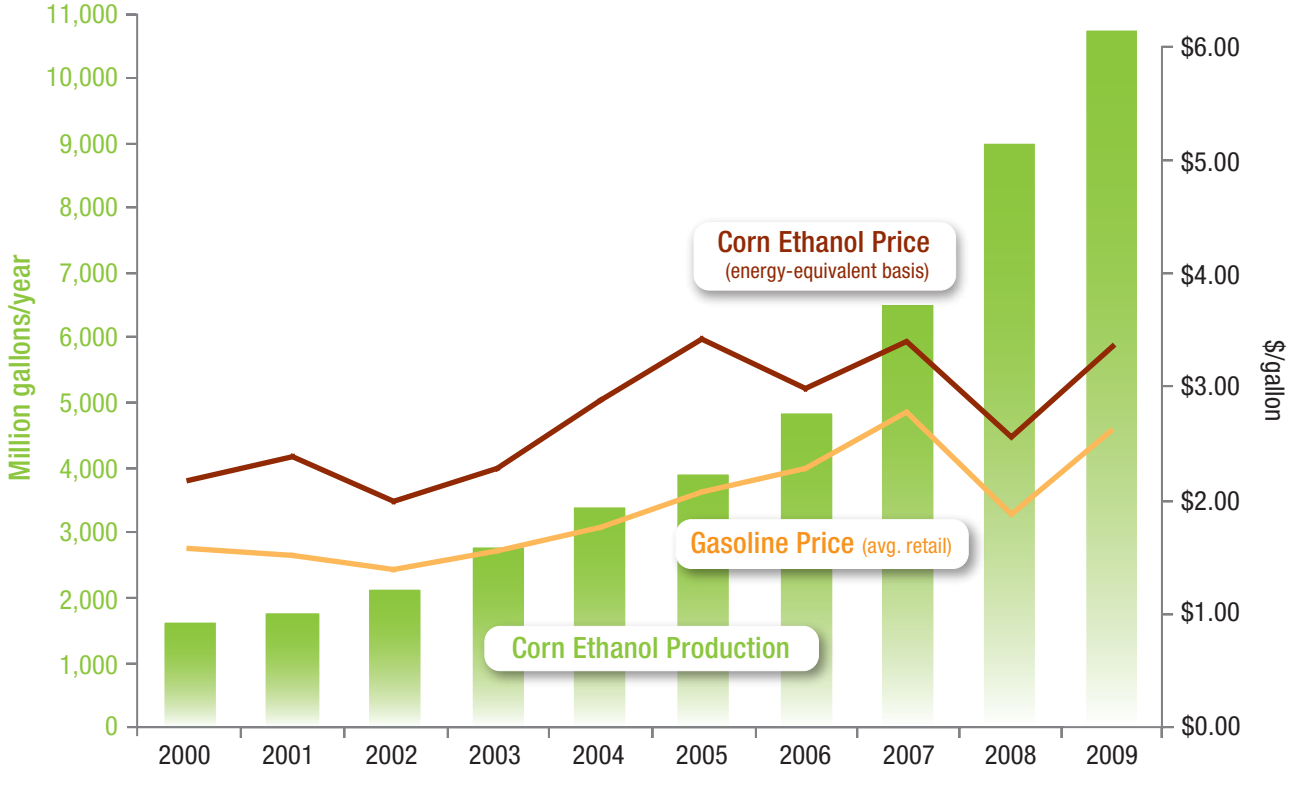
- Corn ethanol production continues to expand rapidly in the United States. **Between 2000 and 2009, production increased more than 6 times.**
- Ethanol production **grew nearly 20% in 2009** to reach **10,750 million gallons** per year.
- Ethanol has steadily increased its percentage of the overall gasoline pool, and in 2009 was estimated to be **7.8%**.
- In 2009, the United States* produced 62.0% of the world's ethanol, followed by Brazil at 37.9%, the European Union at 6.0%, China at 3.1%, and Thailand at 2.5%.

XI

* 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).

U.S. Corn Ethanol Production and Price Trends



XI

Sources: RFA, EERE

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	137,797	9,000	39%	6.5%
2009	137,736	10,750	19%	7.8%

U.S. Ethanol Distribution and Utilization

2,030 E85 stations (April 2010)

E85 average retail price (January 2010): **$3.36/gallon** (gasoline gallon equivalent basis), gasoline price: $2.65/gallon

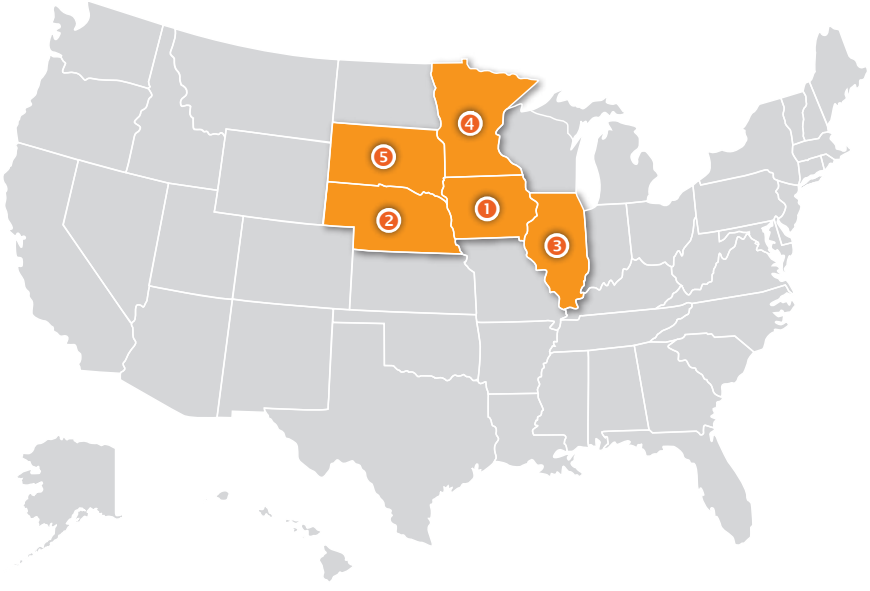
Approximately 8 million flex-fuel vehicles (FFV) are on the road

XI

* Includes ethanol

Sources: EIA, Renewable Fuels Association, DOE Alternative Fuels Data Center

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



Top Five States for U.S. Ethanol (operating) Production Capacity in 2009 (millions of gallons)	
❶ Iowa	3,183
❷ Nebraska	1,454
❸ Illinois	1,350
❹ Minnesota	1,113
❺ South Dakota	1,016

XI

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

Sources: RFA

U.S. Ethanol Production Capacity

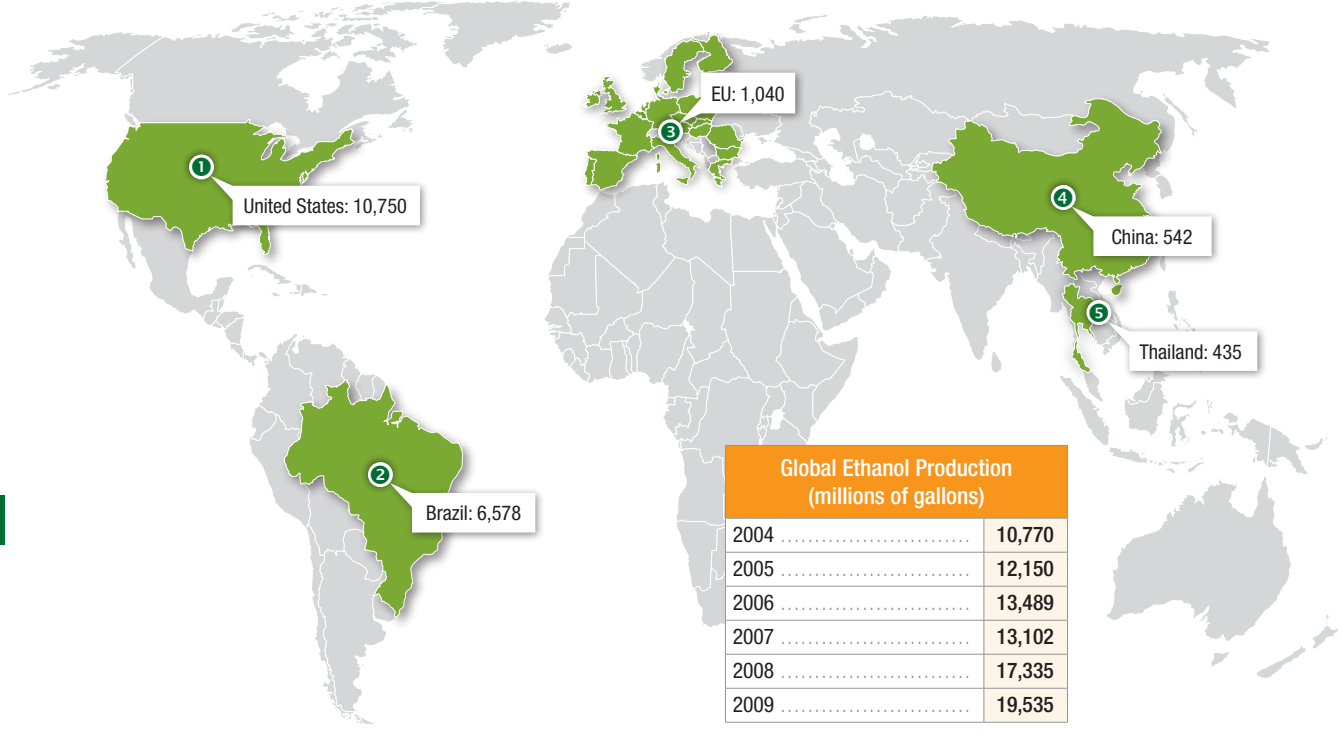
Total U.S. Ethanol Operating Production Capacity (2009): 11,877.4 million gallons/year (mmgy)

Top Five Ethanol Companies —Production Capacity 2009 (millions of gallons/year)	
1 Poet	1,526
2 Archer Daniels Midland Co.	1,070
3 Valero Renewable Fuels	780
4 Green Plains Renewable Energy	480
5 Hawkeye Renewables LLC	420

Source: RFA

Global Ethanol Production

Top Five Countries (2009) 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
2009	19,535

XI

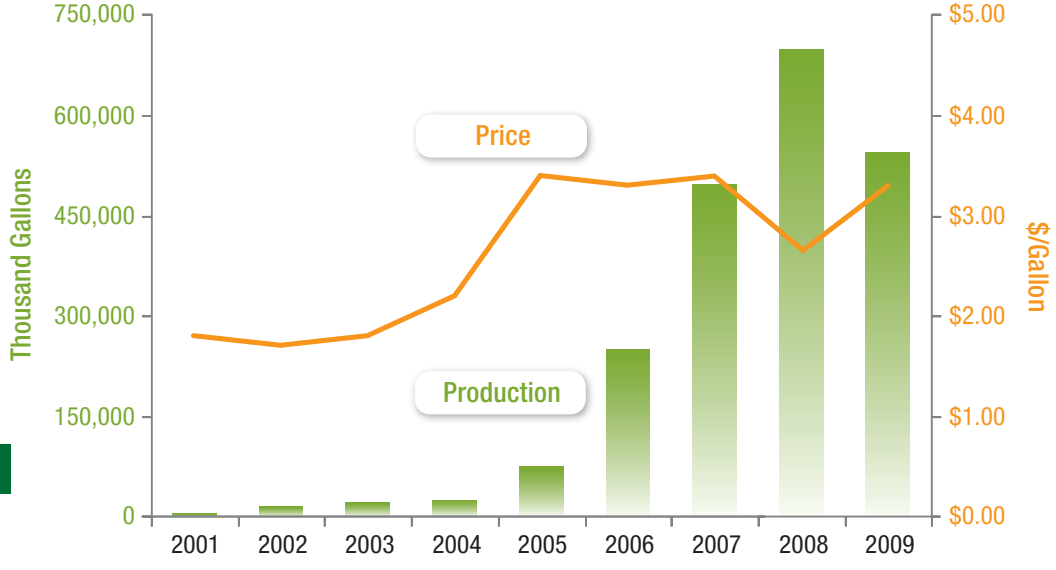
Source: RFA

Renewable Fuels – Biodiesel: Summary

- Biodiesel has expanded from a relatively small production base in 2000, to a total U.S. production of **545 million gallons** in 2009.
- Biodiesel production in 2009 is **109 times** what it was in 2000.
- Europe leads the world in biodiesel production, with most production in France and Germany.

XI

U.S. Biodiesel Demand and Price (2000–2009)



	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
2009	(22%)	545,000

XI

Sources: National Biodiesel Board, EERE

U.S. Biodiesel Production Capacity

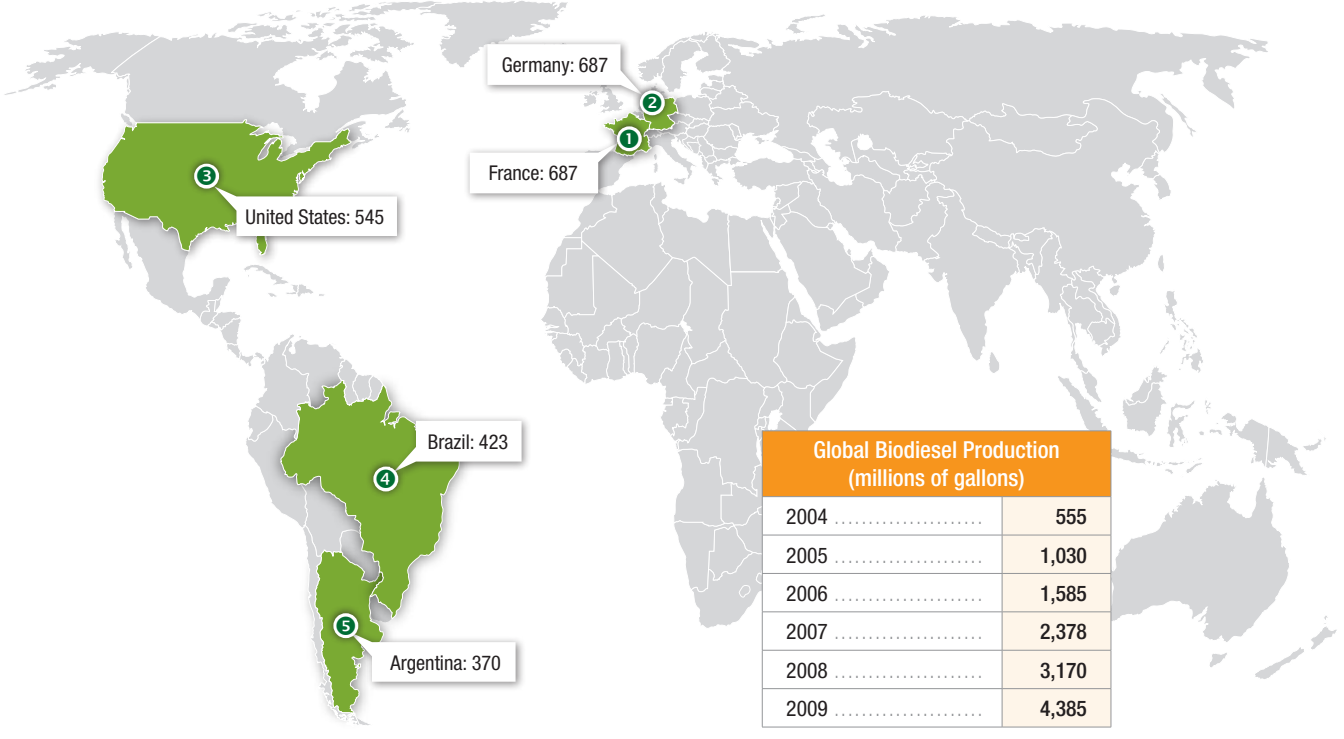
Total U.S. Biodiesel Production Capacity (2009): 2,175.4 million gallons/year (mmgy)

Top Six Biodiesel Companies — Production Capacity 2009 (millions of gallons/year)	
❶ Renewable Energy Group, Inc	362
❷ Renewable Biofuels, Inc	180
❸/❹ Imperium Renewables, Inc / Biodiesel of Las Vegas	100
❺ Green Earth Fuels, LLC	90
❻ Louis Dreyfus Agricultural Industries	85

Source: National Biodiesel Board, REG, Renewable Biofuels Inc, Imperium Renewables, Green Earth Fuels LLC

Global Biodiesel Production

Top Five Countries (2009) 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
2009	4,385

XI

Sources: REN21, National Biodiesel Board

XI

XII. Clean Energy Investments

Clean Energy Investments: Summary

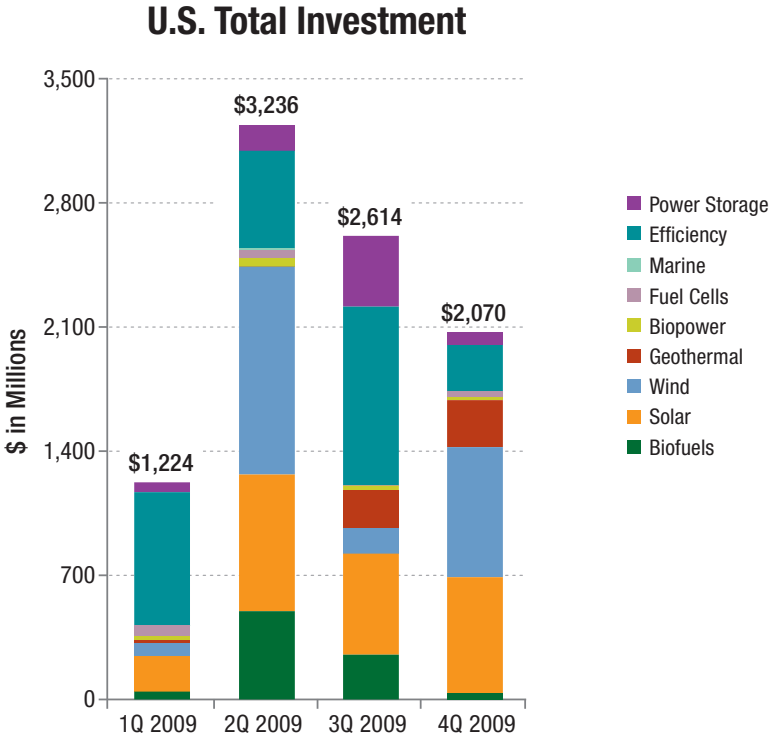
- U.S. investment in renewable energy has grown dramatically in the past decade, and in 2009 investment reached more than **$9 billion.**

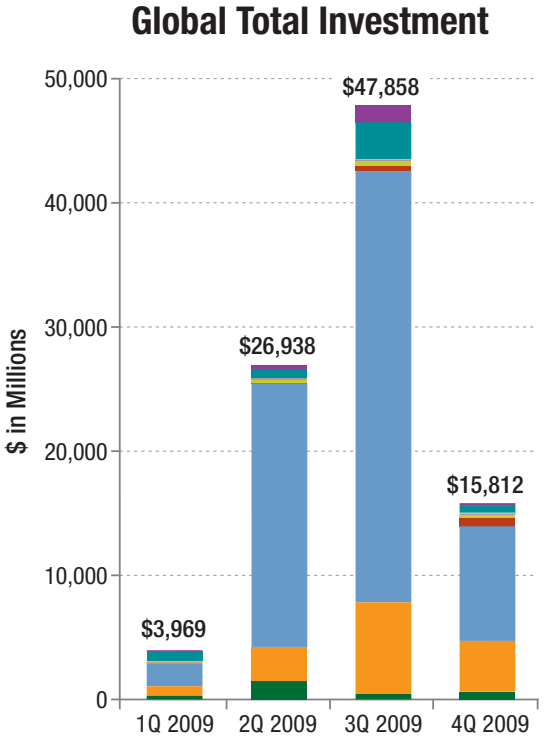
- U.S. investment in wind energy projects grew from $250 million in 2001 to **more than $2 billion in 2009.**

- In 2009, U.S. venture capital and private equity investment in renewable energy technology companies was **$3.4 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 **$1 billion** in 2009.

U.S. and Global Total Investment in Renewable Energy, 2009 ($ millions)



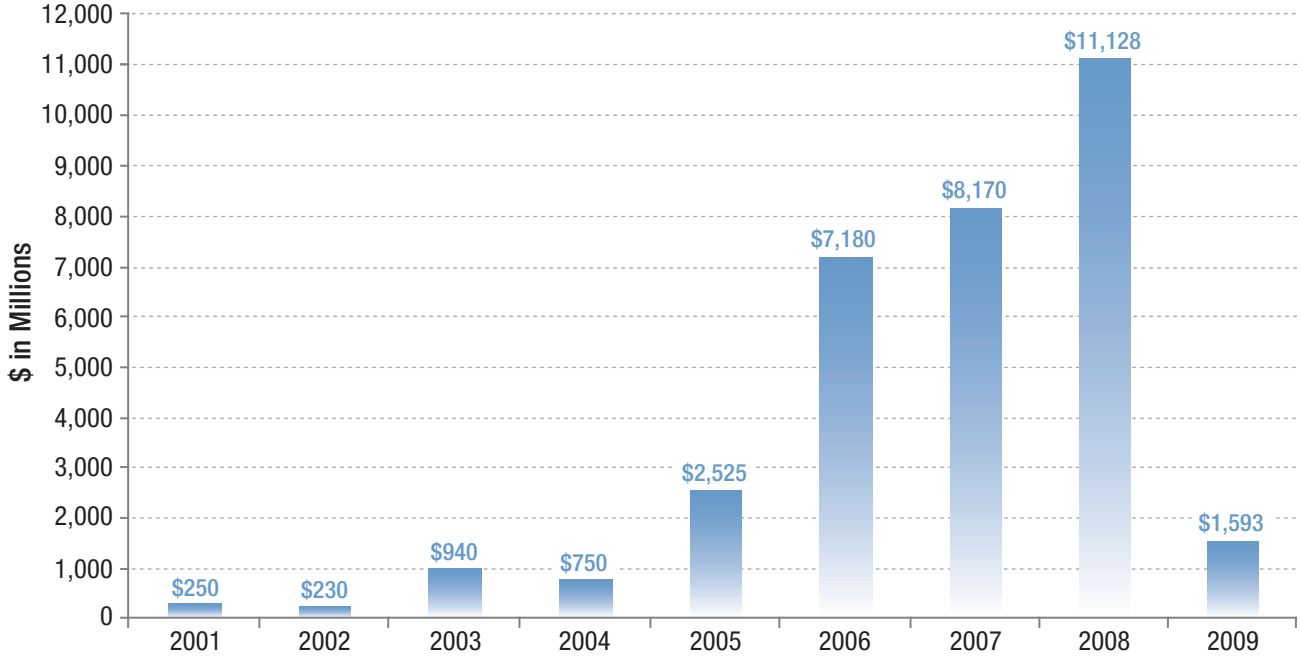


Source: Bloomberg New Energy Finance

Completed and disclosed deals only.

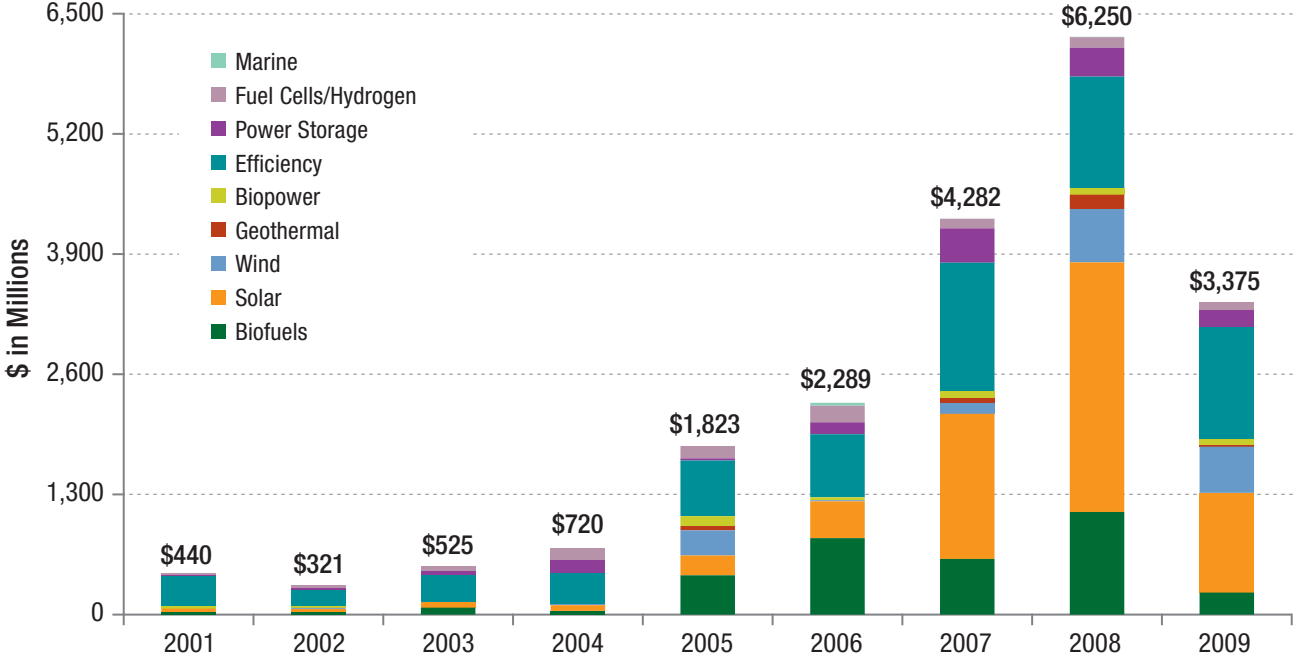
Includes VC/PE, public market activity, asset financing, and acquisition transactions.

U.S. Wind Energy Project Asset Financing Transactions ($ millions), 2001–2009



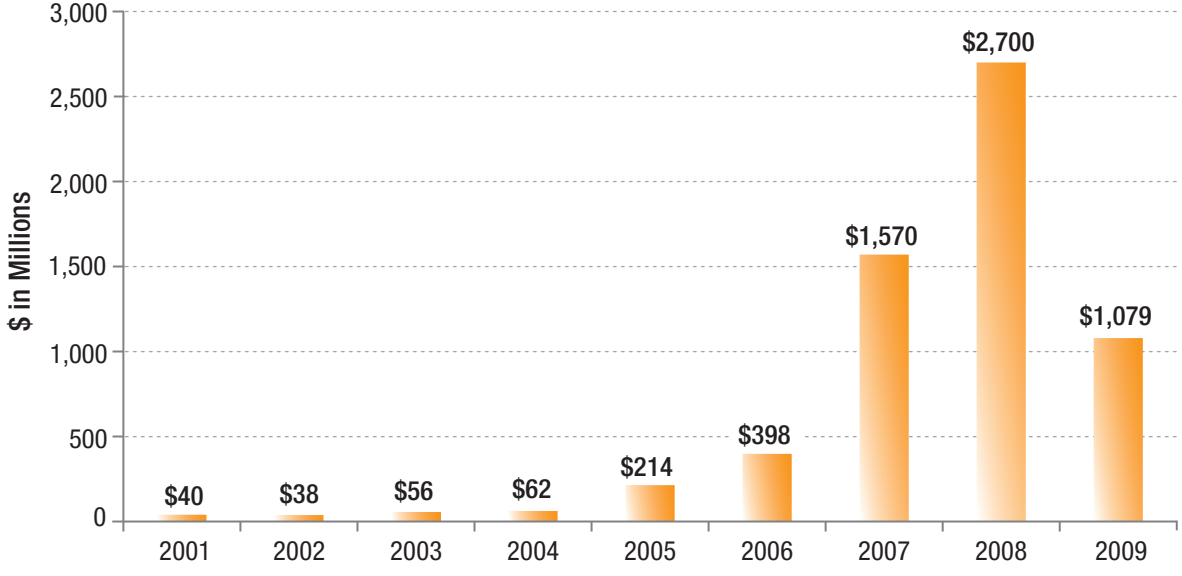
Figures represent Disclosed Deals derived from Bloomberg New Energy Finance's Desktop database.

U.S. Venture Capital and Private Equity Investment ($ millions) in Renewable Energy Technology Companies, 2001–2009



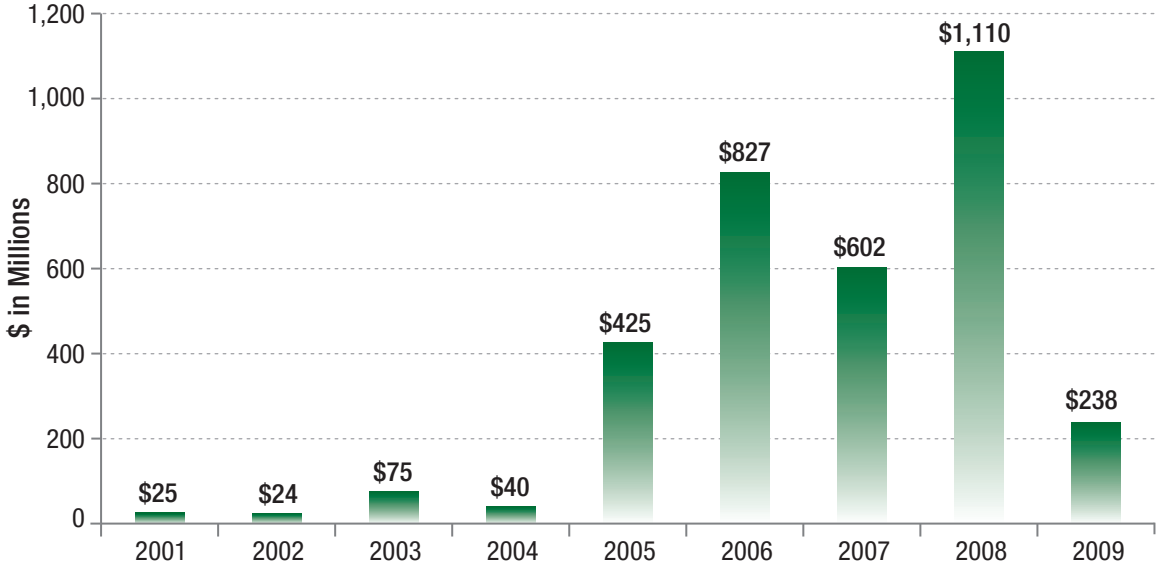
Figures represent Disclosed Deals derived from Bloomberg New Energy Finance's Desktop database.

U.S. Venture Capital and Private Equity Investment ($ millions) in Solar Energy Technology Companies, 2001–2009



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

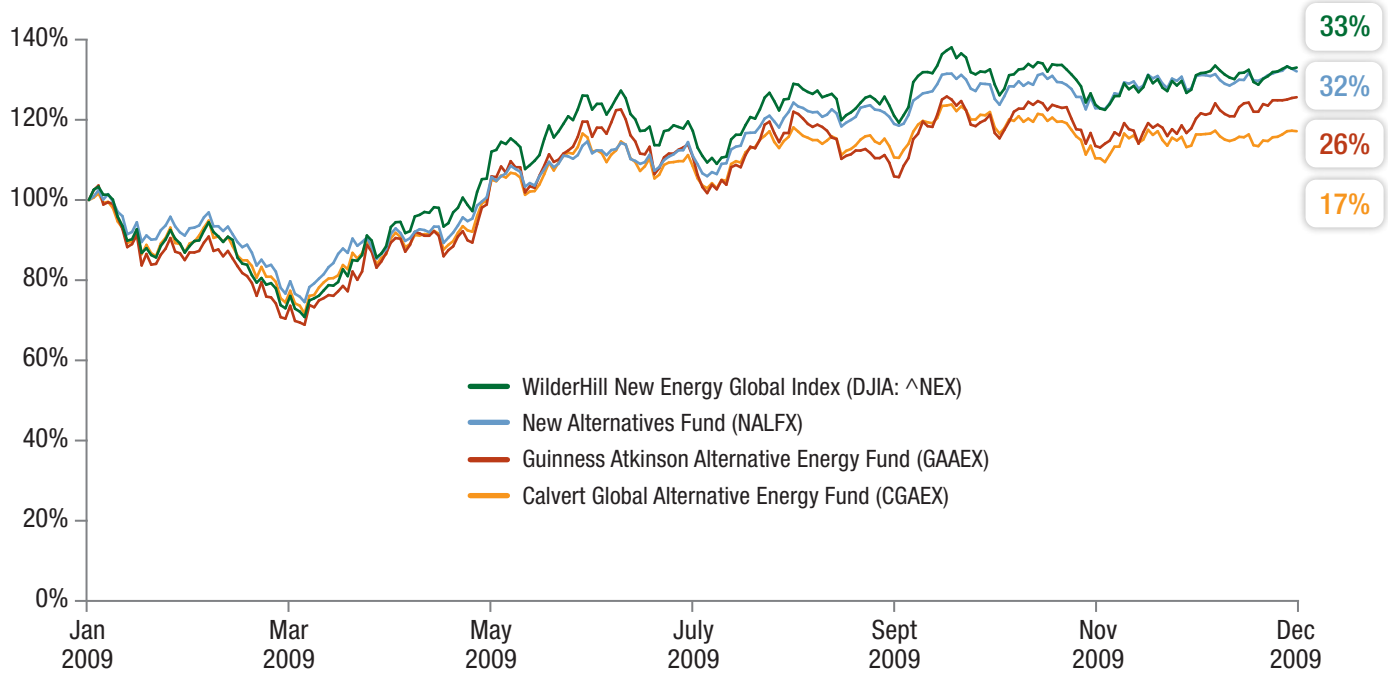
U.S. Venture Capital and Private Equity Investment ($ millions) in Biofuels Technology Companies, 2001–2009



XII

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

Public Renewable Energy Index Performance, 2009 (Indexed to 100)



XII

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 (Current Value/Base Value)^(1/# 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 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.

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).

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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