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

2012 Renewable Energy Data Book

Acknowledgments

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Key Findings

- The installed **global renewable electricity* capacity doubled between 2000 and 2012**, and represents a significant and growing portion of the total energy supply both globally and in the United States.

- **Renewable electricity represented 14% of total installed capacity and more than 12% of total electric generation in the United States in 2012**. Installed renewable electricity capacity is more than 163 gigawatts (GW).

- In 2012 in the United States, wind and solar photovoltaics (PV) were two of the fastest growing electric generation technologies. **In 2012, cumulative installed wind capacity increased by nearly 28% and cumulative installed solar photovoltaic capacity grew more than 83% from the previous year**.

* Unless noted, renewable electricity includes hydropower

Key Findings (continued)

- Worldwide, wind energy is one of the fastest growing renewable electricity technologies—**between 2000 and 2012, wind electricity generation worldwide increased by a factor of nearly 16**. The United States experienced even more dramatic growth, as wind electricity generation increased by a factor of 25 over the same period.

- In the United States, renewable electricity has been capturing a growing percentage of new capacity additions during the past few years. **In 2012, renewable electricity accounted for more than 56% of all new electrical capacity installations in the United States**—a large change from 2004 when all renewable electricity captured only 2% of new capacity additions.

- Since 2006, the United States has been the world's leading ethanol producer. **Between 2000 and 2012, U.S. production of corn ethanol increased by a factor of 8**, although it declined slightly in 2012. The use of ethanol in gasoline blends in the United States has tripled since 2005.

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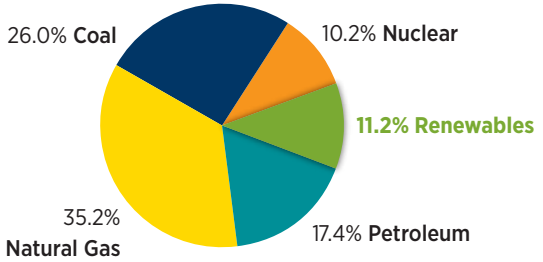
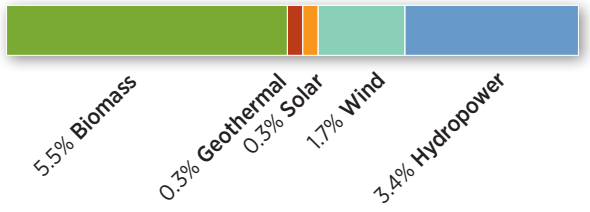
I. U.S. Energy Background Information

U.S. Energy Production and Consumption (2012)

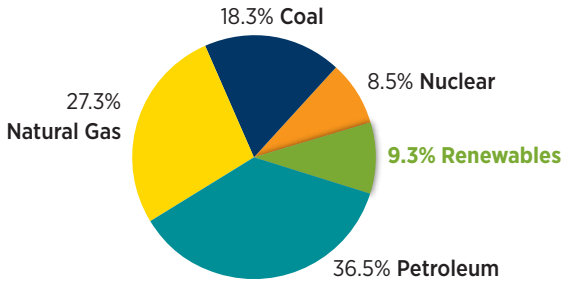
U.S. Energy Production (2012): 79.2 Quadrillion Btu



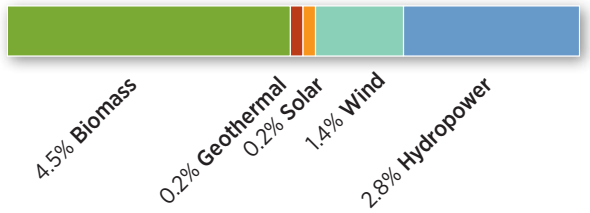
U.S. Renewable Energy Production: 8.9 Quadrillion Btu



U.S. Energy Consumption (2012): 95.1 Quadrillion Btu



U.S. Renewable Energy Consumption: 8.8 Quadrillion Btu



Source: EIA; full references are provided starting on p. 117.

Energy consumption is higher than energy production due to net oil imports.

All data are reported as primary energy.

U.S. Energy Production by Energy Source (2000–2012)

	Coal	Natural Gas*	Petroleum	Nuclear	Renewables	Total Production (Quadrillion Btu)
2000	31.9%	31.2%	17.3%	11.0%	8.6%	71.3
2001	32.8%	31.7%	17.1%	11.2%	7.2%	71.7
2002	32.1%	31.0%	17.2%	11.5%	8.1%	70.7
2003	31.6%	31.4%	17.1%	11.4%	8.5%	69.9
2004	32.5%	30.7%	16.4%	11.7%	8.6%	70.2
2005	33.4%	30.1%	15.8%	11.8%	9.0%	69.4
2006	33.6%	30.2%	15.2%	11.6%	9.3%	70.7
2007	32.9%	31.1%	15.0%	11.8%	9.1%	71.4
2008	32.6%	31.6%	14.5%	11.5%	9.9%	73.2
2009	29.8%	32.6%	15.6%	11.5%	10.5%	72.7
2010	29.5%	32.9%	15.5%	11.3%	10.9%	74.8
2011	28.5%	33.8%	15.3%	10.6%	11.8%	78.0
2012	26.0%	35.2%	17.4%	10.2%	11.2%	79.2

Source: EIA

* Includes natural gas plant liquids.

Annual totals may not equal 100% due to rounding.

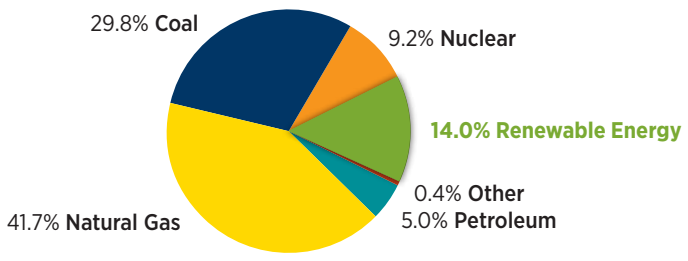
U.S. Energy Consumption by Energy Source (2000–2012)

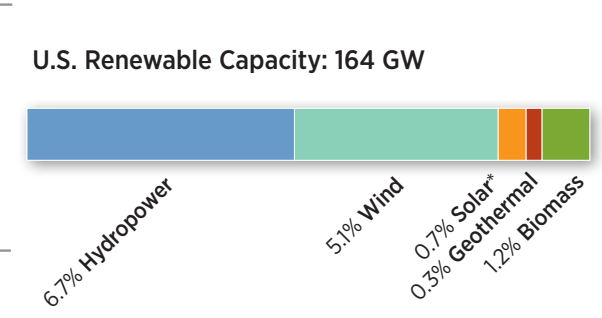
	Coal	Natural Gas	Petroleum	Nuclear	Renewables	Total Consumption (Quadrillion Btu)
2000	22.9%	24.1%	38.7%	8.0%	6.2%	98.7
2001	22.8%	23.7%	39.7%	8.4%	5.4%	96.1
2002	22.4%	24.1%	39.2%	8.3%	5.9%	97.6
2003	22.8%	23.3%	39.6%	8.1%	6.1%	97.9
2004	22.5%	22.9%	40.3%	8.2%	6.1%	100.0
2005	22.7%	22.5%	40.3%	8.1%	6.2%	100.2
2006	22.5%	22.3%	40.1%	8.3%	6.7%	99.6
2007	22.5%	23.4%	39.3%	8.3%	6.5%	101.3
2008	22.5%	24.0%	37.5%	8.5%	7.3%	99.3
2009	20.8%	24.8%	37.4%	8.8%	8.1%	94.6
2010	21.2%	25.1%	36.8%	8.6%	8.2%	98.0
2011	20.2%	25.5%	36.4%	8.5%	9.3%	97.5
2012	18.3%	27.3%	36.5%	8.5%	9.3%	95.1

Source: EIA

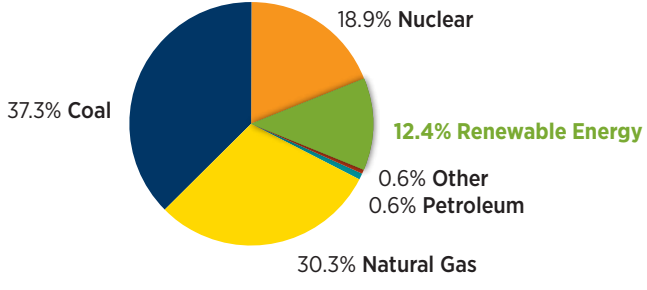
U.S. Electricity Nameplate Capacity and Generation (2012)

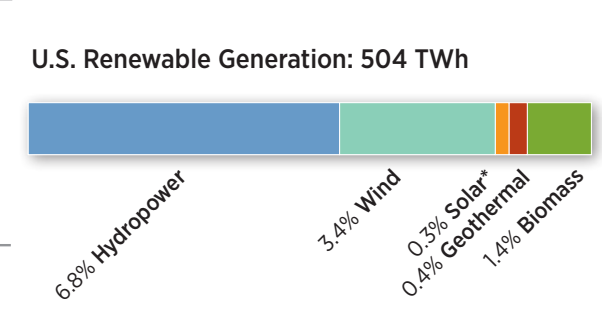
U.S. Electric Nameplate Capacity (2012): 1,168 GW





U.S. Electric Net Generation (2012): 4,068 TWh





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

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

* On-grid only capacity and generation

U.S. Electricity Generating Capacity by Source (2000–2012)

	Coal	Petroleum	Natural Gas	Other Gases	Nuclear	Renewables	Other	Total Capacity (MW)
2000	39.6%	8.0%	28.6%	0.3%	12.3%	11.0%	0.1%	848,112
2001	37.6%	8.2%	31.6%	0.2%	11.7%	10.6%	0.1%	895,186
2002	35.2%	6.9%	36.7%	0.2%	10.9%	10.0%	0.1%	960,306
2003	33.2%	6.6%	39.9%	0.2%	10.4%	9.6%	0.1%	1,012,402
2004	32.5%	6.3%	41.0%	0.2%	10.2%	9.5%	0.1%	1,030,056
2005	32.1%	6.2%	41.7%	0.2%	10.1%	9.7%	0.1%	1,047,704
2006	31.8%	6.1%	41.9%	0.2%	10.0%	9.9%	0.1%	1,056,289
2007	31.5%	5.8%	42.1%	0.2%	9.9%	10.3%	0.1%	1,066,961
2008	30.5%	5.6%	41.4%	0.2%	9.6%	11.0%	0.1%	1,083,176
2009	30.7%	5.7%	41.7%	0.2%	9.7%	11.9%	0.1%	1,102,335
2010	30.6%	5.6%	41.7%	0.3%	9.5%	12.3%	0.1%	1,120,188
2011	30.2%	5.1%	42.1%	0.2%	9.4%	12.9%	0.1%	1,135,915
2012	29.8%	5.0%	41.7%	0.3%	9.2%	14.0%	0.1%	1,167,503

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

U.S. Electricity Generation by Source (2000–2012)

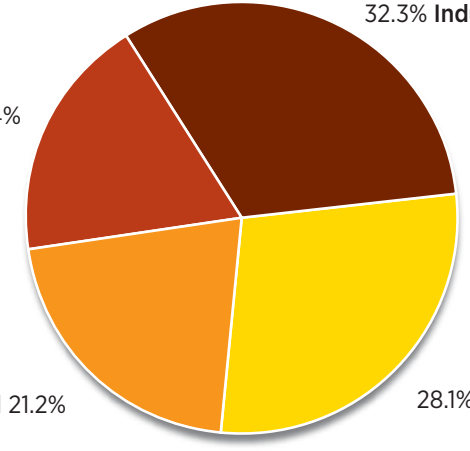
	Coal	Petroleum Liquids	Petroleum Coke	Natural Gas	Other Gases	Nuclear	Renewables	Other	Total Generation (GWh)
2000	51.6%	2.7%	0.2%	15.8%	0.4%	19.8%	9.4%	0.1%	3,807,955
2001	50.8%	3.1%	0.3%	17.1%	0.2%	20.5%	7.7%	0.3%	3,745,745
2002	50.0%	2.0%	0.4%	17.9%	0.3%	20.2%	8.9%	0.3%	3,867,498
2003	50.7%	2.6%	0.4%	16.7%	0.4%	19.6%	9.1%	0.4%	3,892,115
2004	49.7%	2.5%	0.5%	17.8%	0.4%	19.8%	8.8%	0.4%	3,979,023
2005	49.5%	2.5%	0.6%	18.7%	0.3%	19.2%	8.8%	0.3%	4,062,458
2006	48.9%	1.1%	0.5%	20.1%	0.3%	19.3%	9.5%	0.3%	4,071,962
2007	48.4%	1.2%	0.4%	21.5%	0.3%	19.4%	8.5%	0.3%	4,164,748
2008	48.1%	0.8%	0.3%	21.4%	0.3%	19.5%	9.3%	0.3%	4,127,019
2009	44.4%	0.7%	0.3%	23.3%	0.3%	20.2%	10.6%	0.3%	3,956,989
2010	44.7%	0.6%	0.3%	23.9%	0.3%	19.5%	10.4%	0.3%	4,133,852
2011	42.2%	0.4%	0.3%	24.7%	0.3%	19.2%	12.6%	0.3%	4,112,198
2012	37.3%	0.3%	0.2%	30.3%	0.3%	18.9%	12.4%	0.3%	4,067,575

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

U.S. Energy Consumption by Sector (2012)

U.S. Energy Consumption, 2012: 95.1 Quadrillion Btu

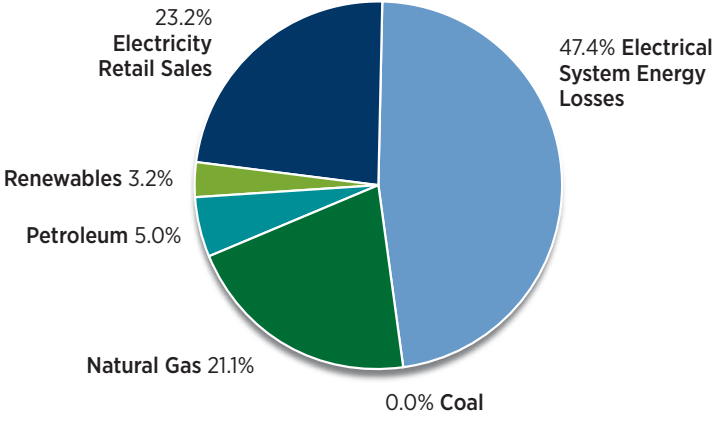
U.S. buildings represent 39.6% of total energy use.



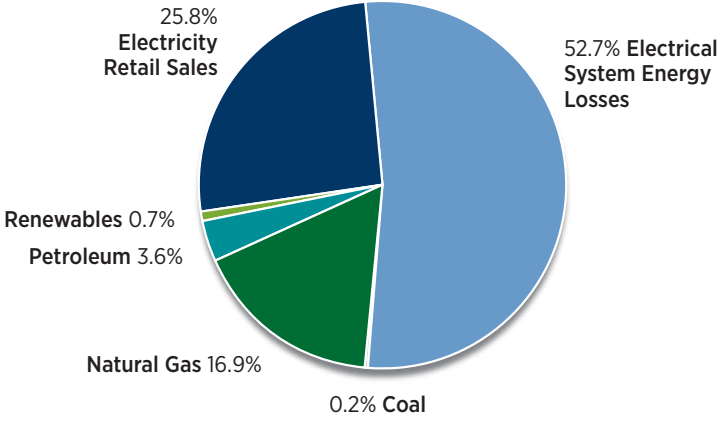
Source: EIA

U.S. Energy Consumption – Residential and Commercial (2012)

Residential Energy Consumption
(20.2 Quadrillion Btu) – 2012



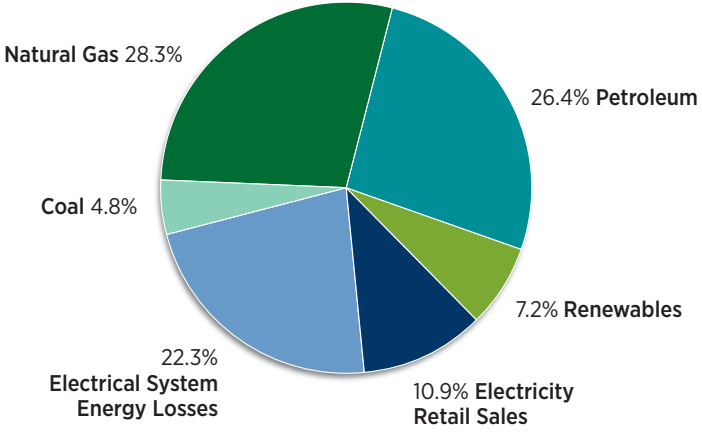
Commercial Energy Consumption
(17.5 Quadrillion Btu) – 2012



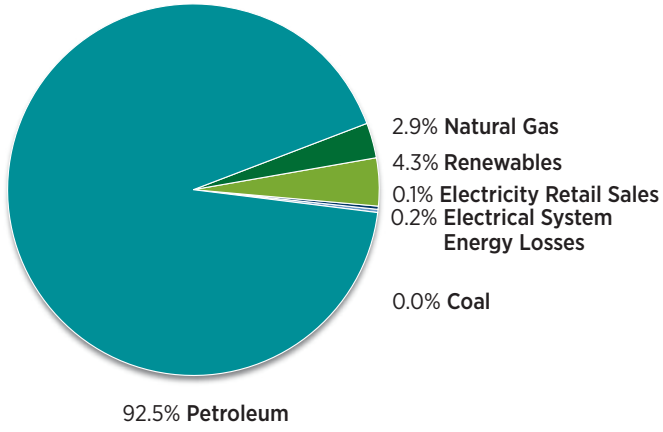
Source: EIA

U.S. Energy Consumption – Industry and Transportation (2012)

Industrial Energy Consumption
(30.7 Quadrillion Btu) – 2012



Transportation Energy Consumption
(26.7 Quadrillion Btu) – 2012



Source: EIA

II. Renewable Electricity in the United States

Renewable Electricity in the United States: Summary

- Since 2000, cumulative renewable electricity* installations in the United States have nearly doubled, and in 2012 they represented **163 GW of installed U.S. capacity**.
- Installed renewable electricity capacity has grown at a compound annual growth rate (CAGR) of nearly **4.8% per year from 2000 to 2012**.
- U.S. renewable electricity in 2012 was **14% of total overall installed electricity capacity** and 12.4 % of total annual generation in the United States.
- Every renewable electricity technology added capacity in 2012. U.S. drought conditions may have caused generation from hydropower to decrease, resulting in an overall drop in electricity generation from renewable technologies in 2012.
- During the timeframe of 2008 to 2012, the United States **doubled renewable electricity generation** from a combination of wind, solar and geothermal technologies.

* Unless noted, renewable electricity includes hydropower

II

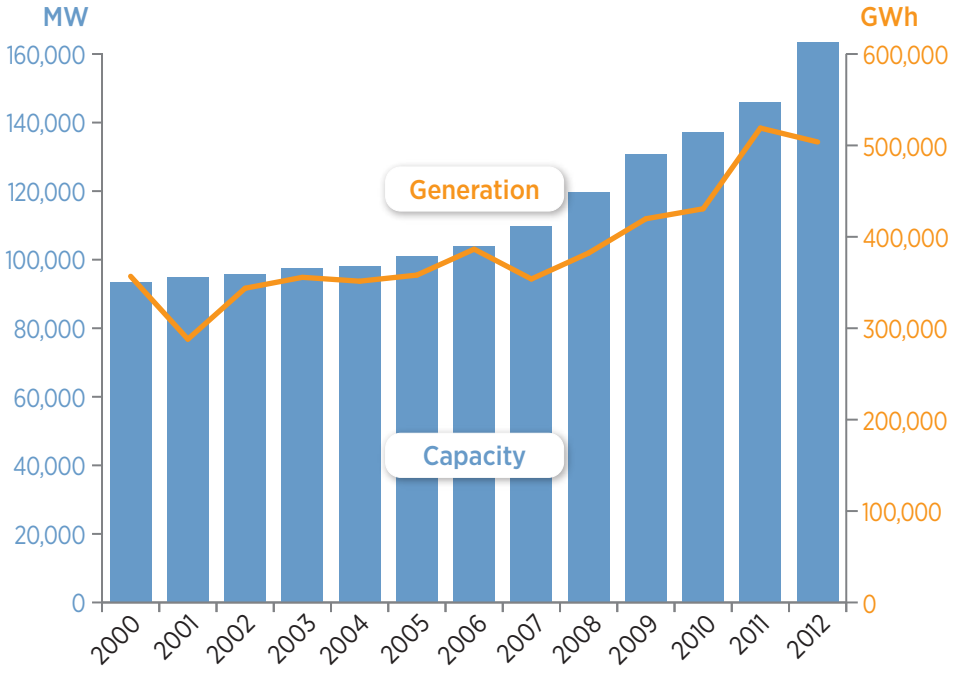
- Wind and solar photovoltaics are the fastest growing renewable electricity sectors. **In 2012 in the United States, installed wind capacity increased by nearly 28% and installed solar photovoltaic capacity grew more than 83% from the previous year**.

- In 2012 **in the United States, biomass** produced about **11% of total renewable electricity generation**, **wind produced 28%**, **solar** (photovoltaics and concentrating solar power) **produced 3%**, **hydropower produced 55%**, and **geothermal produced 3%.**

- **Wind energy** accounted for about **75% of newly installed U.S. renewable electricity capacity** in 2012.

- Electricity capacities of biomass, geothermal, and hydropower have remained relatively stable since 2000.

U.S. Capacity and Generation: All Renewables

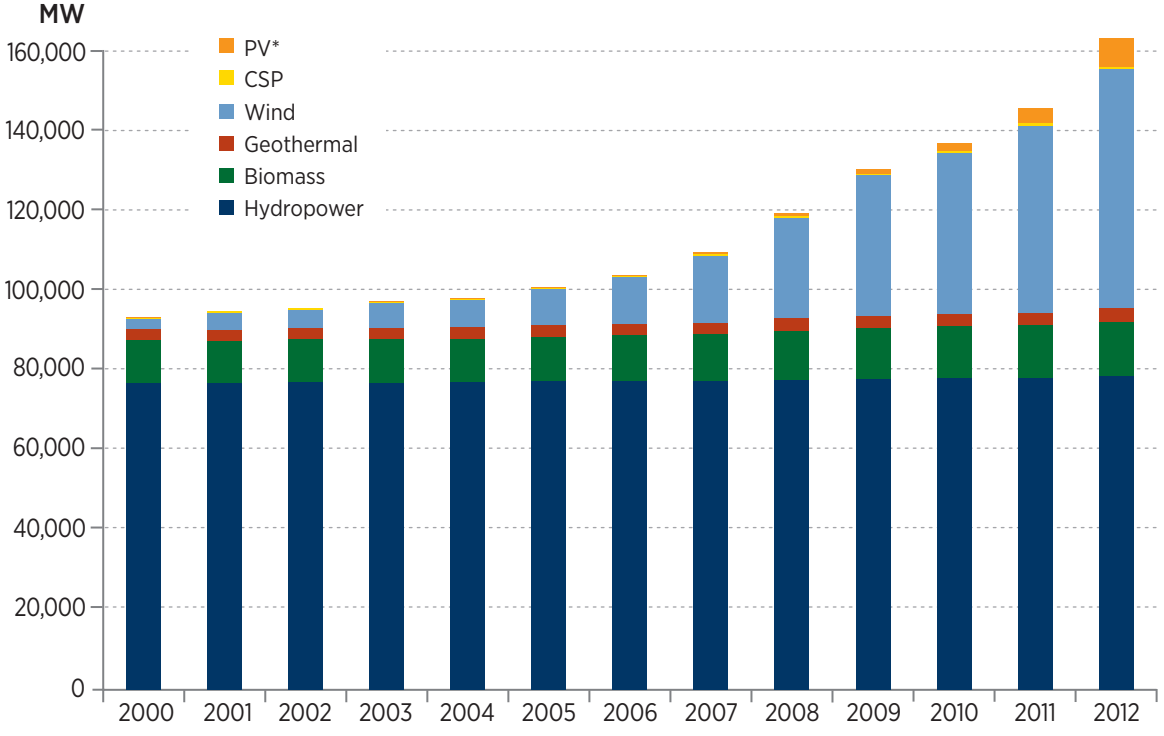


	Total Nameplate Capacity (MW)	Total Generation (GWh)
2000	93,370	356,789
2001	94,943	288,009
2002	95,804	343,740
2003	97,478	355,686
2004	98,195	351,465
2005	101,113	358,129
2006	104,072	386,474
2007	109,845	353,854
2008	119,639	382,276
2009	130,677	419,755
2010	137,286	430,668
2011	146,030	518,973
2012	163,579	503,755

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

U.S. Renewable Electricity Generating Capacity by Source

II



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

* Includes on- and off-grid capacity

U.S. Renewable Electricity Nameplate Capacity Added (MW)

	Solar PV	CSP	Wind	Geothermal	Biomass	Hydropower	Total Capacity Added	Capacity Added as a Percentage of Total Renewable Energy
2001	11	0	1,697	0	(100)	(35)	**1,573**	**2%**
2002	23	0	411	0	291	136	**861**	**1%**
2003	45	0	1,667	0	(11)	(27)	**1,674**	**2%**
2004	58	0	372	0	177	110	**717**	**1%**
2005	79	0	2,396	30	189	224	**2,918**	**3%**
2006	105	1	2,454	3	331	65	**2,959**	**3%**
2007	169	64	5,237	106	185	13	**5,773**	**5%**
2008	311	(0)	8,425	104	747	208	**9,794**	**8%**
2009	438	11	9,922	46	351	270	**11,038**	**8%**
2010	896	78	5,108	15	218	294	**6,608**	**5%**
2011	1,858	9	6,816	138	154	(10)	**8,964**	**6%**
2012	3,333	30	13,131	147	482	416	**17,539**	**11%**

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

Cumulative U.S. Renewable Electricity Nameplate Capacity (MW) and Annual Percent Increase

II

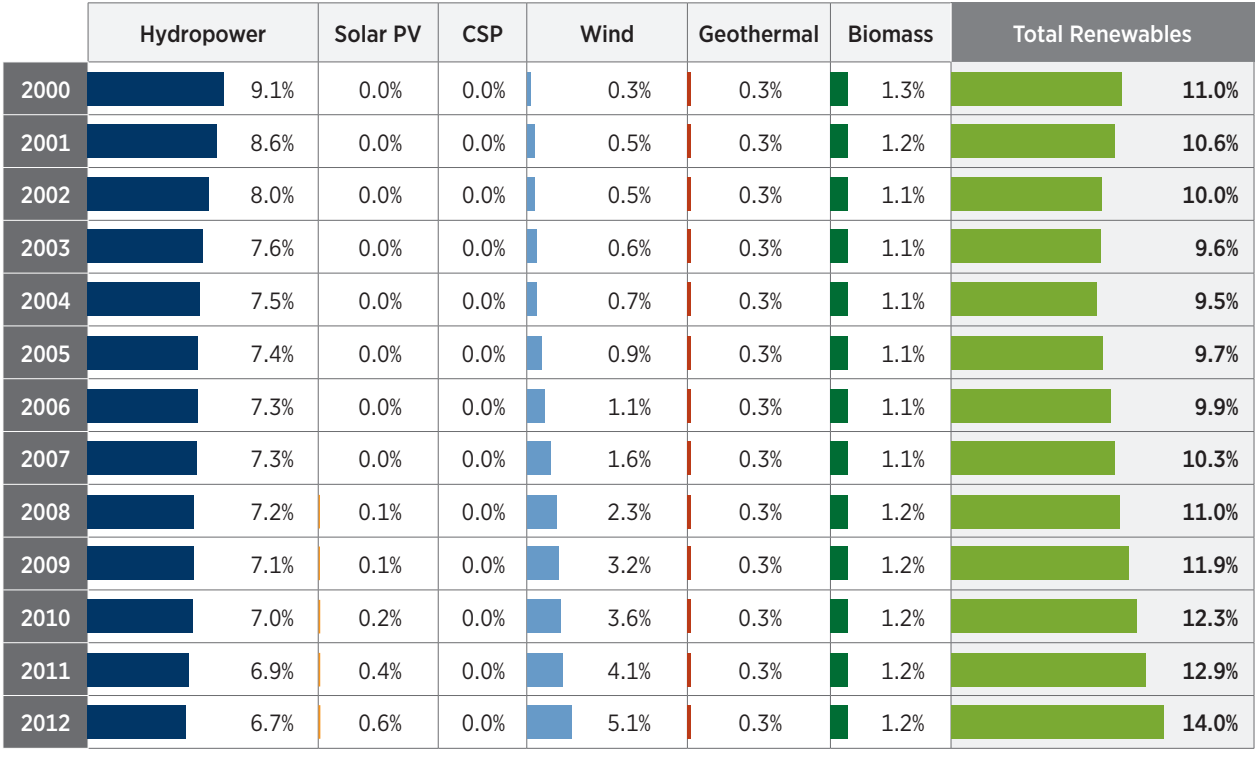
	Hydropower	Solar PV*	CSP	Wind	Geothermal	Biomass	Total Renewables
2000	76,946	18	354	2,578	2,798	10,676	93,370
2001	76,911 (0%)	29 (62.4%)	354 (0%)	4,275 (65.8%)	2,798 (0%)	10,576 (-0.9%)	94,943 (1.7%)
2002	77,047 (0.2%)	52 (76.9%)	354 (0%)	4,686 (9.6%)	2,798 (0%)	10,867 (2.8%)	95,804 (0.9%)
2003	77,020 (0%)	97 (87.3%)	354 (0%)	6,353 (35.6%)	2,798 (0%)	10,856 (-0.1%)	97,478 (1.7%)
2004	77,130 (0.1%)	155 (59.2%)	354 (0%)	6,725 (5.9%)	2,798 (0%)	11,033 (1.6%)	98,195 (0.7%)
2005	77,354 (0.3%)	234 (51.0%)	354 (0%)	9,121 (35.6%)	2,828 (1.1%)	11,222 (1.7%)	101,113 (3.0%)
2006	77,419 (0.1%)	339 (44.7%)	355 (0.3%)	11,575 (26.9%)	2,831 (0.1%)	11,553 (2.9%)	104,072 (2.9%)
2007	77,432 (0%)	508 (49.8%)	419 (18%)	16,812 (45.2%)	2,937 (3.7%)	11,738 (1.6%)	109,845 (5.5%)
2008	77,640 (0.3%)	819 (61.2%)	419 (0%)	25,237 (50.1%)	3,040 (3.5%)	12,485 (6.4%)	119,639 (8.9%)
2009	77,910 (0.3%)	1,257 (53.5%)	430 (2.6%)	35,159 (39.3%)	3,086 (1.5%)	12,836 (2.8%)	130,677 (9.2%)
2010	78,204 (0.4%)	2,153 (71.3%)	507 (18.%)	40,267 (14.5%)	3,101 (0.5%)	13,053 (1.7%)	137,286 (5.1%)
2011	78,194 (0%)	4,011 (86.3%)	516 (1.7%)	46,916 (16.5%)	3,239 (4.4%)	13,207 (1.2%)	146,082 (6.4%)
2012	78,610 (0.5%)	7,344 (83.1%)	546 (5.8%)	60,005 (27.9%)	3,386 (4.5%)	13,689 (3.7%)	163,579 (12.0%)

- annual decrease | annual increase +

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

* Includes on- and off-grid capacity

U.S. Renewable Electricity Capacity as a Percent of Total Electricity Generating Capacity

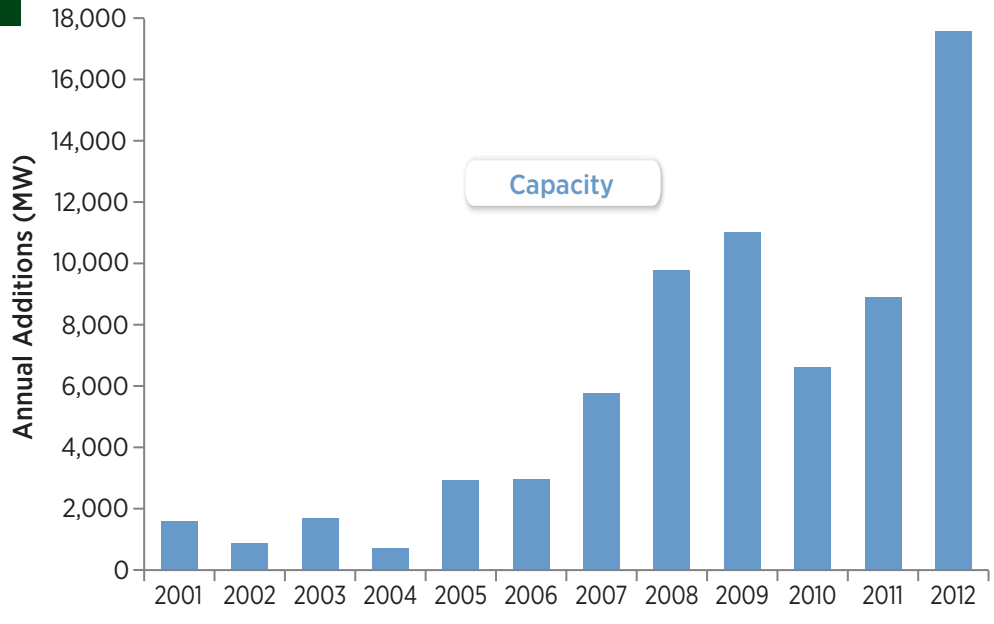


	Hydropower	Solar PV	CSP	Wind	Geothermal	Biomass	Total Renewables
2000	9.1%	0.0%	0.0%	0.3%	0.3%	1.3%	11.0%
2001	8.6%	0.0%	0.0%	0.5%	0.3%	1.2%	10.6%
2002	8.0%	0.0%	0.0%	0.5%	0.3%	1.1%	10.0%
2003	7.6%	0.0%	0.0%	0.6%	0.3%	1.1%	9.6%
2004	7.5%	0.0%	0.0%	0.7%	0.3%	1.1%	9.5%
2005	7.4%	0.0%	0.0%	0.9%	0.3%	1.1%	9.7%
2006	7.3%	0.0%	0.0%	1.1%	0.3%	1.1%	9.9%
2007	7.3%	0.0%	0.0%	1.6%	0.3%	1.1%	10.3%
2008	7.2%	0.1%	0.0%	2.3%	0.3%	1.2%	11.0%
2009	7.1%	0.1%	0.0%	3.2%	0.3%	1.2%	11.9%
2010	7.0%	0.2%	0.0%	3.6%	0.3%	1.2%	12.3%
2011	6.9%	0.4%	0.0%	4.1%	0.3%	1.2%	12.9%
2012	6.7%	0.6%	0.0%	5.1%	0.3%	1.2%	14.0%

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

U.S. Annual Installed Renewable Electric Capacity Growth

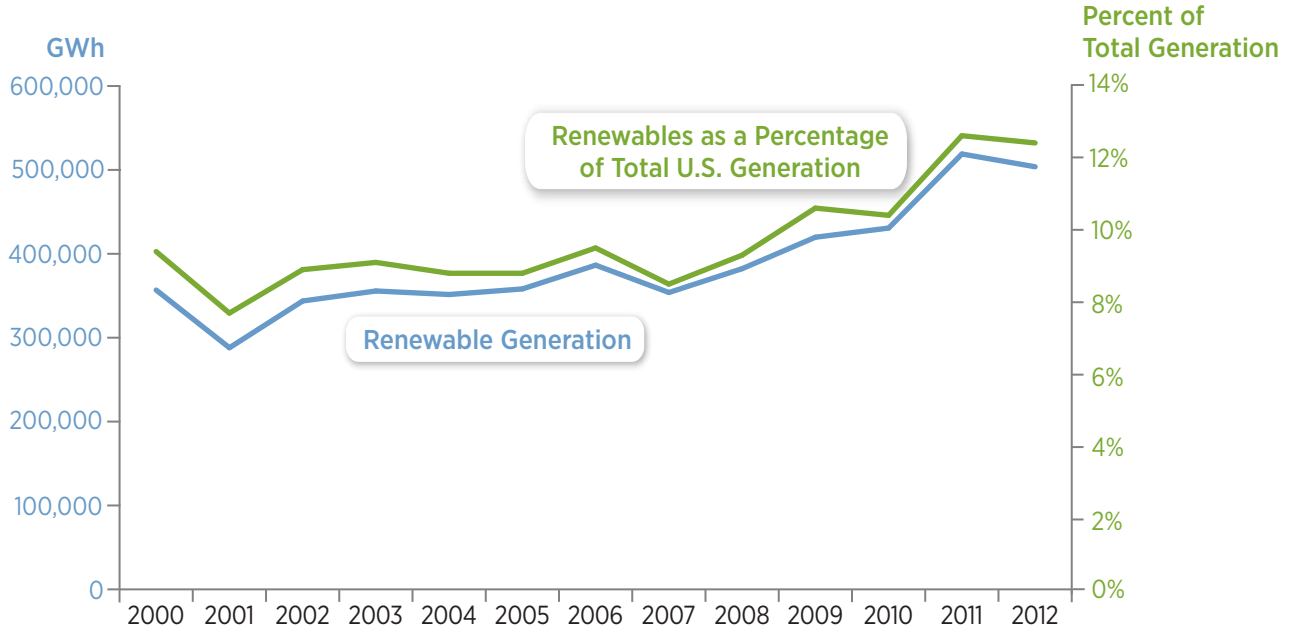
II



	Compounded Annual Growth Rate (2000–2012)
Wind	**30.0%**
Solar PV	**65.0%**
CSP	**3.7%**
Biomass	**2.1%**
Geothermal	**1.6%**
Hydropower	**0.2%**
All Renewables	**4.8%**

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

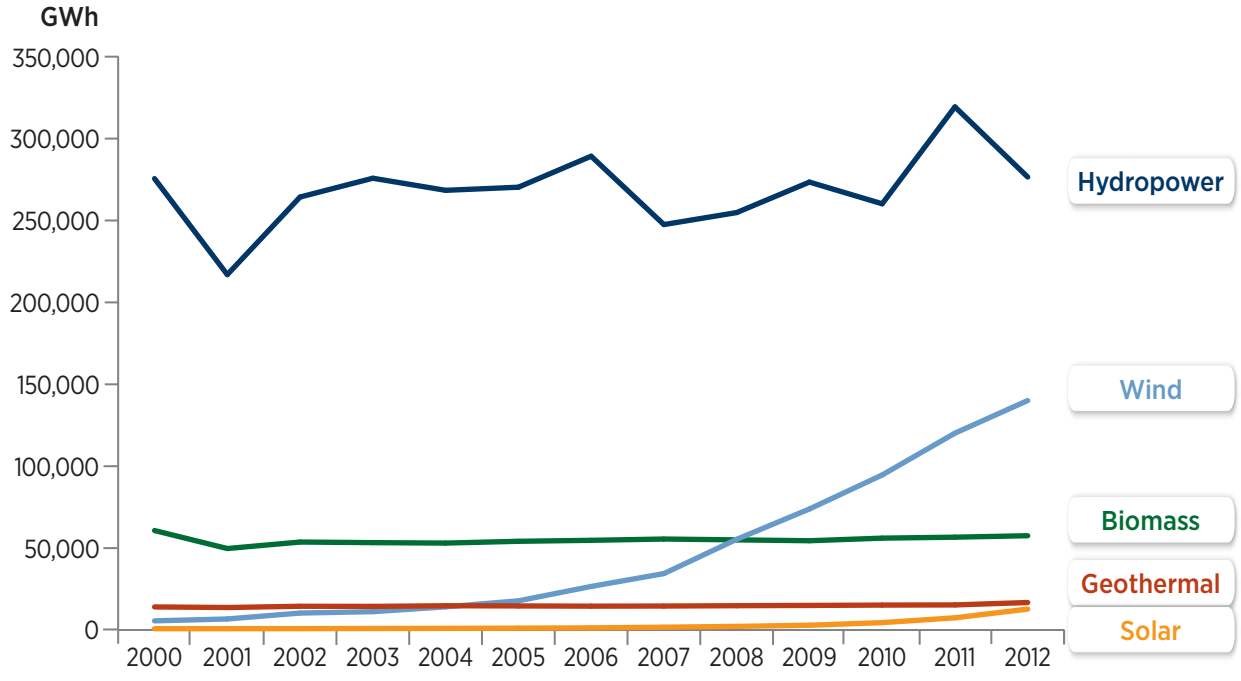
U.S. Renewable Electricity Generation



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

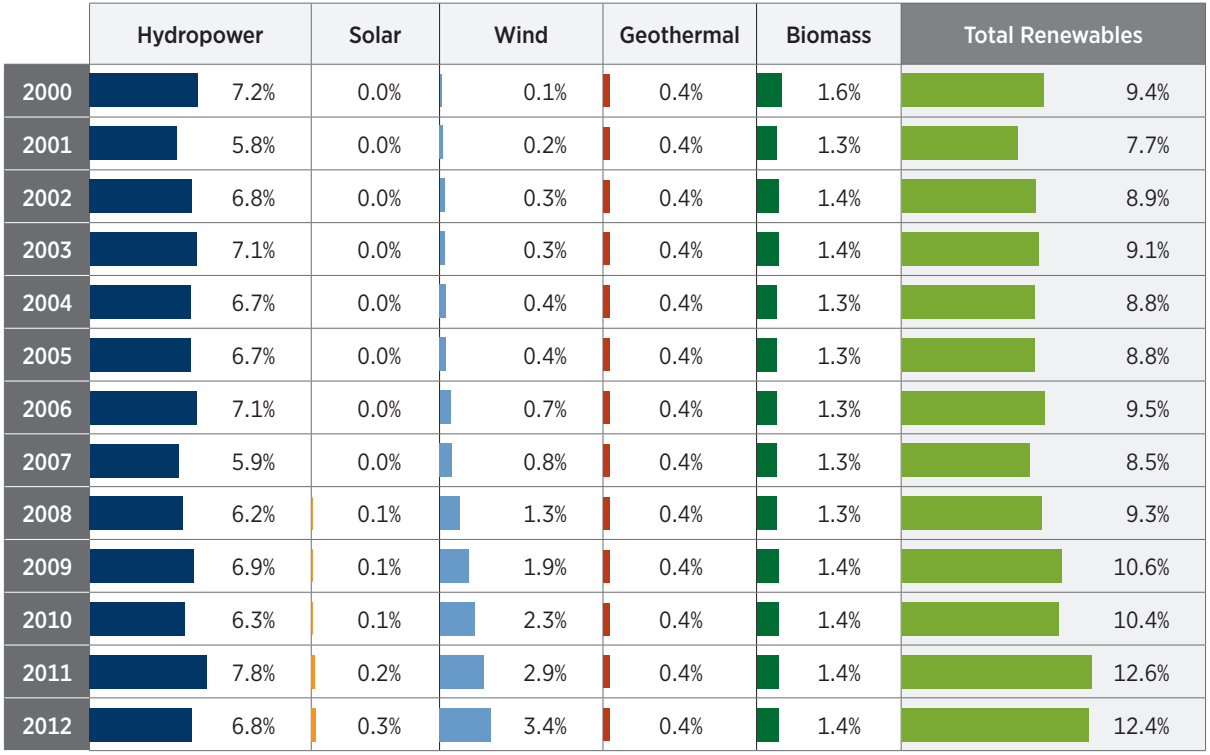
U.S. Renewable Electricity Generation by Technology

II



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

U.S. Renewable Electricity Generation as a Percent of Total U.S. Generation



	Hydropower	Solar	Wind	Geothermal	Biomass	Total Renewables
2000	7.2%	0.0%	0.1%	0.4%	1.6%	9.4%
2001	5.8%	0.0%	0.2%	0.4%	1.3%	7.7%
2002	6.8%	0.0%	0.3%	0.4%	1.4%	8.9%
2003	7.1%	0.0%	0.3%	0.4%	1.4%	9.1%
2004	6.7%	0.0%	0.4%	0.4%	1.3%	8.8%
2005	6.7%	0.0%	0.4%	0.4%	1.3%	8.8%
2006	7.1%	0.0%	0.7%	0.4%	1.3%	9.5%
2007	5.9%	0.0%	0.8%	0.4%	1.3%	8.5%
2008	6.2%	0.1%	1.3%	0.4%	1.3%	9.3%
2009	6.9%	0.1%	1.9%	0.4%	1.4%	10.6%
2010	6.3%	0.1%	2.3%	0.4%	1.4%	10.4%
2011	7.8%	0.2%	2.9%	0.4%	1.4%	12.6%
2012	6.8%	0.3%	3.4%	0.4%	1.4%	12.4%

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

U.S. Renewable Electricity Generation (GWh) and Annual Percent Cumulative Increase

II

	Hydropower	Solar	Wind	Geothermal	Biomass	All Renewables
2000	**275,573** (-13.8%)	**804** (8.3%)	**5,593** (24.6%)	**14,093** (-5.0%)	**60,726** (1.9%)	**356,789** (-10.6%)
2001	**216,961** (-21.3%)	**822** (2.2%)	**6,737** (20.5%)	**13,741** (-2.5%)	**49,748** (-18.1%)	**288,009** (-19.3%)
2002	**264,329** (21.8%)	**857** (4.3%)	**10,354** (53.7%)	**14,491** (5.5%)	**53,709** (8.0%)	**343,740** (19.4%)
2003	**275,806** (4.3%)	**929** (8.4%)	**11,187** (8.0%)	**14,424** (-0.5%)	**53,340** (-0.7%)	**355,686** (3.5%)
2004	**268,417** (-2.7%)	**1,020** (9.8%)	**14,144** (26.4%)	**14,811** (2.7%)	**53,073** (-0.5%)	**351,465** (-1.2%)
2005	**270,321** (0.7%)	**1,145** (12.2%)	**17,811** (25.9%)	**14,692** (-0.8%)	**54,160** (2.0%)	**358,129** (1.9%)
2006	**289,246** (7.0%)	**1,312** (14.6%)	**26,589** (49.3%)	**14,568** (-0.8%)	**54,759** (1.1%)	**386,474** (7.9%)
2007	**247,510** (-14.4%)	**1,718** (31.0%)	**34,450** (29.6%)	**14,637** (0.5%)	**55,539** (1.4%)	**353,854** (-8.4%)
2008	**254,831** (3.0%)	**2,208** (28.5%)	**55,363** (60.7%)	**14,840** (1.4%)	**55,034** (-0.9%)	**382,276** (8.0%)
2009	**273,455** (7.3%)	**2,922** (32.4%)	**73,886** (33.5%)	**15,009** (1.1%)	**54,493** (-1.0%)	**419,755** (9.8%)
2010	**260,203** (-4.8%)	**4,505** (54.2%)	**94,652** (28.1%)	**15,219** (1.4%)	**56,089** (2.9%)	**430,668** (2.6%)
2011	**319,355** (22.7%)	**7,454** (65.5%)	**120,177** (27.0%)	**15,316** (0.6%)	**56,671** (1.0%)	**518,973** (20.5%)
2012	**276,535** (-13.4%)	**12,775** (71.4%)	**140,089** (16.6%)	**16,791** (9.6%)	**57,565** (1.6%)	**503,755** (-2.9%)

- annual decrease | annual increase **+**

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

State Renewable Energy Information: Summary

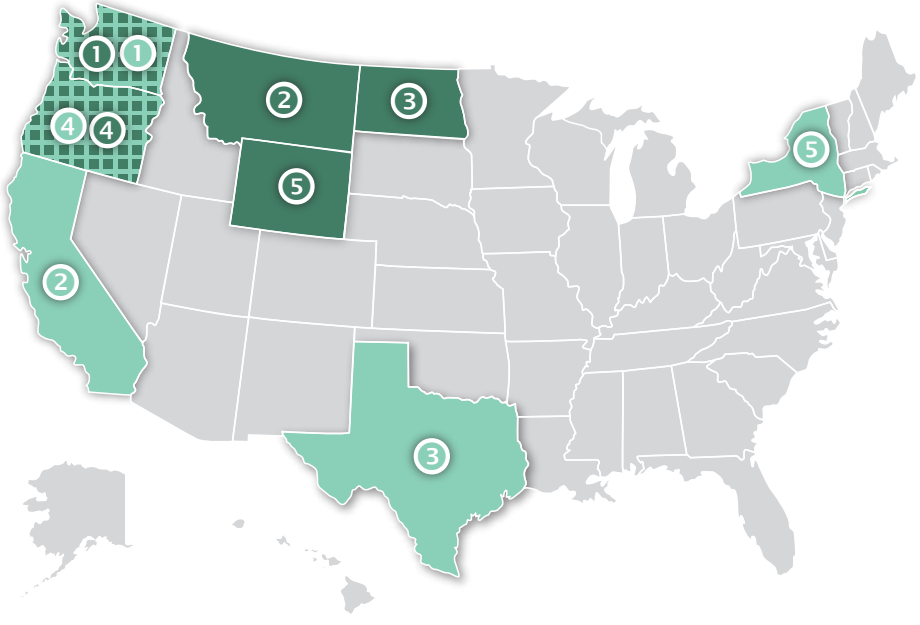
- In 2012, **Washington had the most installed renewable electric capacity** of any U.S. state (24,342 MW).

- In 2008, **Texas became the state with the most wind power development**, and in 2012 had more than 12 GW of wind capacity installed.

- A combination of **state and federal incentives and renewable portfolio standards** for renewable electricity and renewable resource development has contributed to renewable growth in many states. Some wind development was driven by economics in select locations.

Top States for Renewable Electricity Installed Capacity (2012)

II



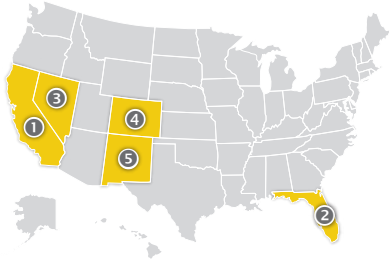
Total Renewables	
1	Washington
2	California
3	Texas
4	Oregon
5	New York

Per Capita Renewables	
1	Washington
2	Montana
3	North Dakota
4	Oregon
5	Wyoming

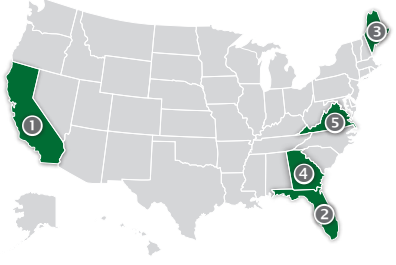
Sources: EIA, LBNL, GEA, SEIA/GTM, Larry Sherwood/IREC, U.S. Census

Top States for Cumulative Renewable Electricity Installed Capacity (2012)

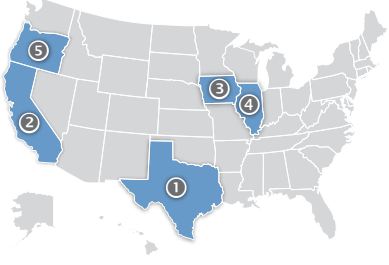
Solar PV
1 California
2 Arizona
3 New Jersey
4 Nevada
5 Colorado



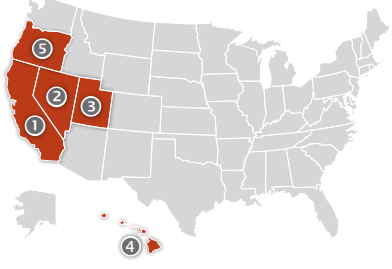
CSP
1 California
2 Florida
3 Nevada
4 Colorado
5 New Mexico



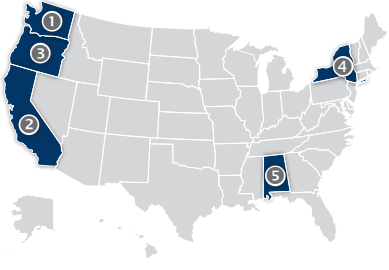
Biomass
1 California
2 Florida
3 Maine
4 Georgia
5 Virginia



Wind
1 Texas
2 California
3 Iowa
4 Illinois
5 Oregon



Geothermal
1 California
2 Nevada
3 Utah
4 Hawaii
5 Oregon



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

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

Cumulative Renewable Electricity Installed Capacity (MW) (2012)
NORTHEAST

II

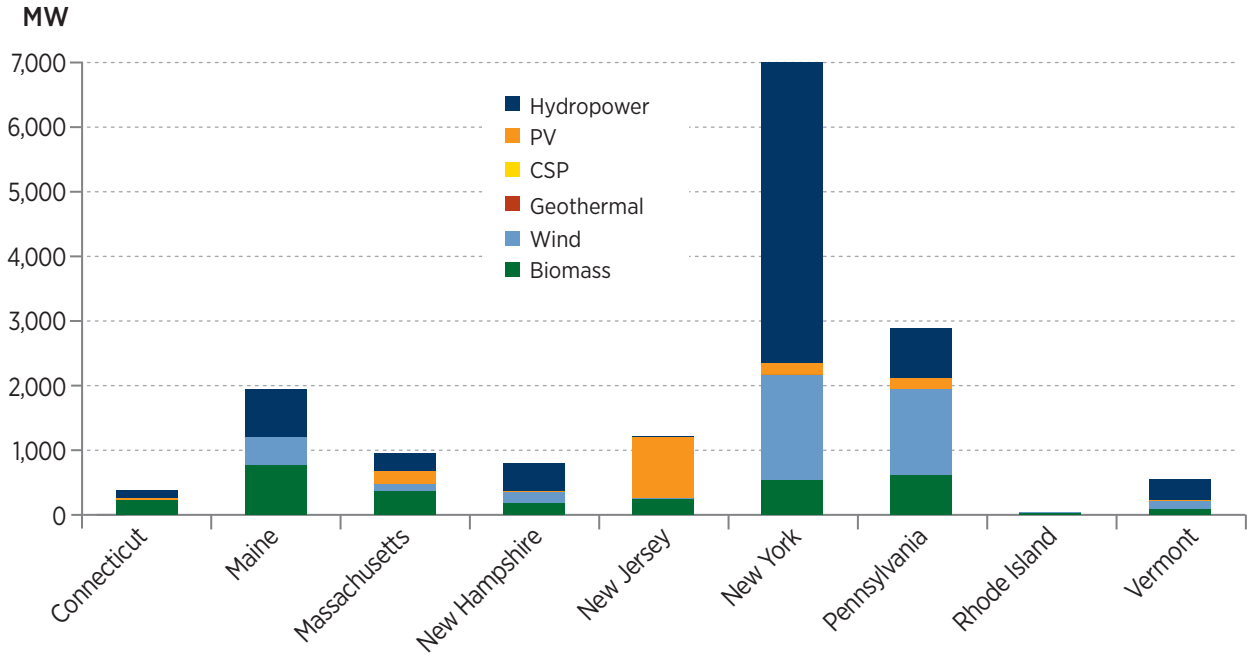
	Wind	PV*	CSP	Geothermal	Biomass	Hydropower	Total Renewables	Per capita Renewable Electricity watts/person
New York	1,638.1	179.4	0.0	0.0	528	4,657	**7,003**	**358**
Pennsylvania	1,339.5	164.3	0.0	0.0	604	778	**2,886**	**226**
Maine	431.1	2.8	0.0	0.0	768	733	**1,935**	**1,456**
New Jersey	9.0	955.7	0.0	0.0	245	13	**1,223**	**138**
Massachusetts	102.6	207.3	0.0	0.0	367	272	**948**	**143**
New Hampshire	171.1	5.4	0.0	0.0	182	446	**805**	**609**
Vermont	119.5	28.0	0.0	0.0	88	315	**550**	**879**
Connecticut	0.1	39.6	0.0	0.0	221	119	**379**	**106**
Rhode Island	8.9	1.9	0.0	0.0	26	3	**40**	**38**

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

* Does not include off-grid installations

Cumulative Renewable Electricity Installed Capacity (2012)
NORTHEAST

II



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

Cumulative Renewable Electricity Installed Capacity (MW) (2012)
MIDWEST

II

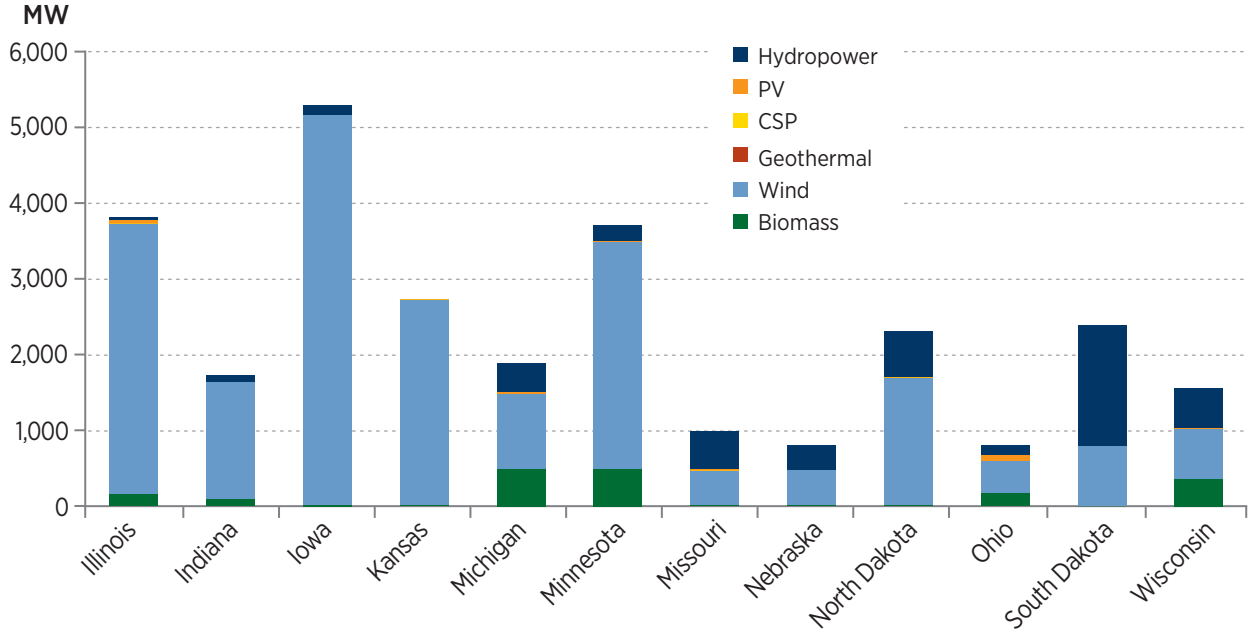
	Wind	PV*	CSP	Geothermal	Biomass	Hydropower	Total Renewables	Per capita Renewable Electricity watts/person
Iowa	5,133.2	1.2	0.0	0.0	15	131	**5,280**	**1,718**
Minnesota	2,986.6	11.3	0.0	0.0	488	213	**3,699**	**688**
Illinois	3,568.5	42.9	0.0	0.0	152	40	**3,803**	**295**
South Dakota	783.3	0.0	0.0	0.0	0	1,598	**2,381**	**2,858**
North Dakota	1,679.6	0.1	0.0	0.0	10	614	**2,303**	**3,292**
Wisconsin	648.0	21.1	0.0	0.0	357	528	**1,555**	**272**
Indiana	1,542.8	4.4	0.0	0.0	86	92	**1,725**	**264**
Kansas	2,713.3	0.5	0.0	0.0	7	7	**2,728**	**945**
Michigan	987.6	19.9	0.0	0.0	488	383	**1,879**	**190**
Missouri	458.5	18.5	0.0	0.0	8	499	**984**	**163**
Nebraska	459.5	0.4	0.0	0.0	11	332	**803**	**433**
Ohio	427.9	79.9	0.0	0.0	164	129	**801**	**69**

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

* Does not include off-grid installations

Cumulative Renewable Electricity Installed Capacity (2012)
MIDWEST

II



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

Cumulative Renewable Electricity Installed Capacity (MW) (2012)
SOUTH

II

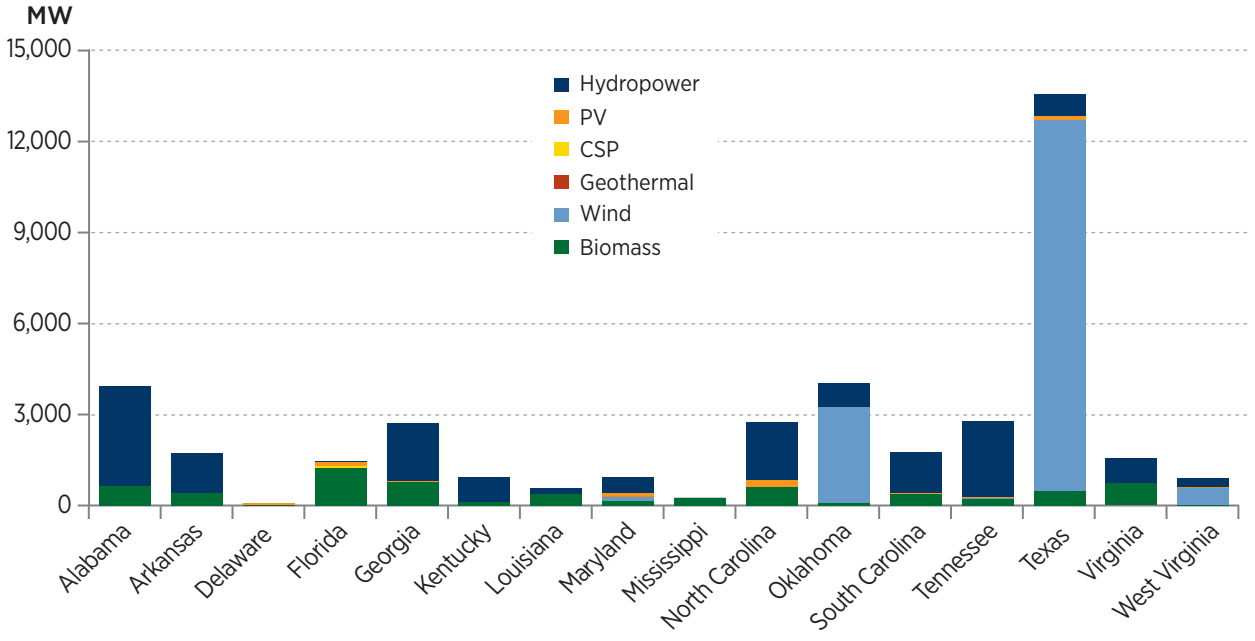
	Wind	PV*	CSP	Geothermal	Biomass	Hydropower	Total Renewables	Per capita Renewable Electricity watts/person
Texas	12,214.1	140.3	0.0	0.0	464	698	**13,517**	**519**
Alabama	0.0	1.1	0.0	0.0	636	3,280	**3,917**	**812**
Oklahoma	3,133.8	0.3	0.0	0.0	85	805	**4,024**	**1,055**
Tennessee	29.0	45.0	0.0	0.0	199	2,499	**2,772**	**429**
Georgia	0.0	21.4	0.0	0.0	762	1,930	**2,713**	**273**
North Carolina	0.1	207.9	0.0	0.0	605	1,939	**2,751**	**282**
Arkansas	0.1	1.5	0.0	0.0	399	1,321	**1,721**	**584**
South Carolina	0.0	4.6	0.0	0.0	376	1,363	**1,744**	**369**
Virginia	0.0	10.5	0.0	0.0	723	832	**1,565**	**191**
Florida	0.0	116.9	75.0	0.0	1,217	56	**1,465**	**76**
Kentucky	0.0	4.8	0.0	0.0	110	804	**919**	**210**
West Virginia	583.3	1.7	0.0	0.0	2	325	**912**	**491**
Maryland	120.3	116.8	0.0	0.0	159	551	**947**	**161**
Louisiana	0.0	18.2	0.0	0.0	366	192	**577**	**125**
Mississippi	0.0	0.7	0.0	0.0	246	0	**246**	**82**
Delaware	2.0	46.1	0.0	0.0	8	0	**56**	**61**

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

* Does not include off-grid installations

Cumulative Renewable Electricity Installed Capacity (2012)
SOUTH

II



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

Cumulative Renewable Electricity Installed Capacity (MW) (2012)
WEST

II

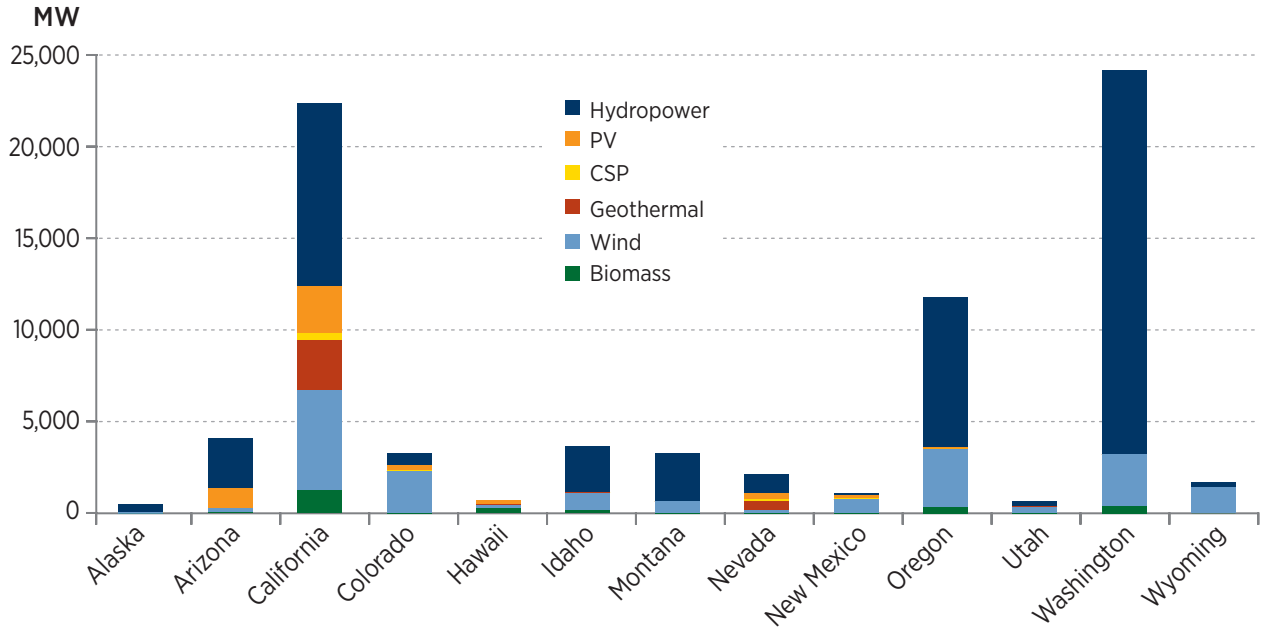
	Wind	PV*	CSP	Geothermal	Biomass	Hydropower	Total Renewables	Per capita Renewable Electricity watts/person
Washington	2,807.8	19.5	0.0	0.0	403	21,112	**24,342**	**3,529**
California	5,542.3	2,559.3	364.5	2,732.2	1,253	10,057	**22,508**	**592**
Oregon	3,153.2	56.4	0.0	33.3	361	8,241	**11,845**	**3,038**
Idaho	972.5	1.0	0.0	15.8	145	2,540	**3,674**	**2,302**
Arizona	238.3	1,106.4	3.7	0.0	41	2,718	**4,108**	**627**
Montana	645.4	2.2	0.0	0.0	16	2,655	**3,318**	**3,301**
Colorado	2,300.5	299.6	31.8	0.0	18	645	**3,295**	**635**
Wyoming	1,409.8	0.6	0.0	0.3	0	303	**1,714**	**2,974**
Nevada	151.8	349.7	64.0	517.5	3	1,052	**2,138**	**775**
New Mexico	777.6	203.4	6.0	0.0	7	82	**1,075**	**516**
Utah	325.3	10.0	0.0	48.1	10	262	**655**	**229**
Hawaii	205.6	199.5	0.8	38.0	260	25	**729**	**524**
Alaska	59.4	0.0	0.0	0.7	0	421	**481**	**658**

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

* Does not include off-grid installations

Cumulative Renewable Electricity Installed Capacity (2012)
WEST

II



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

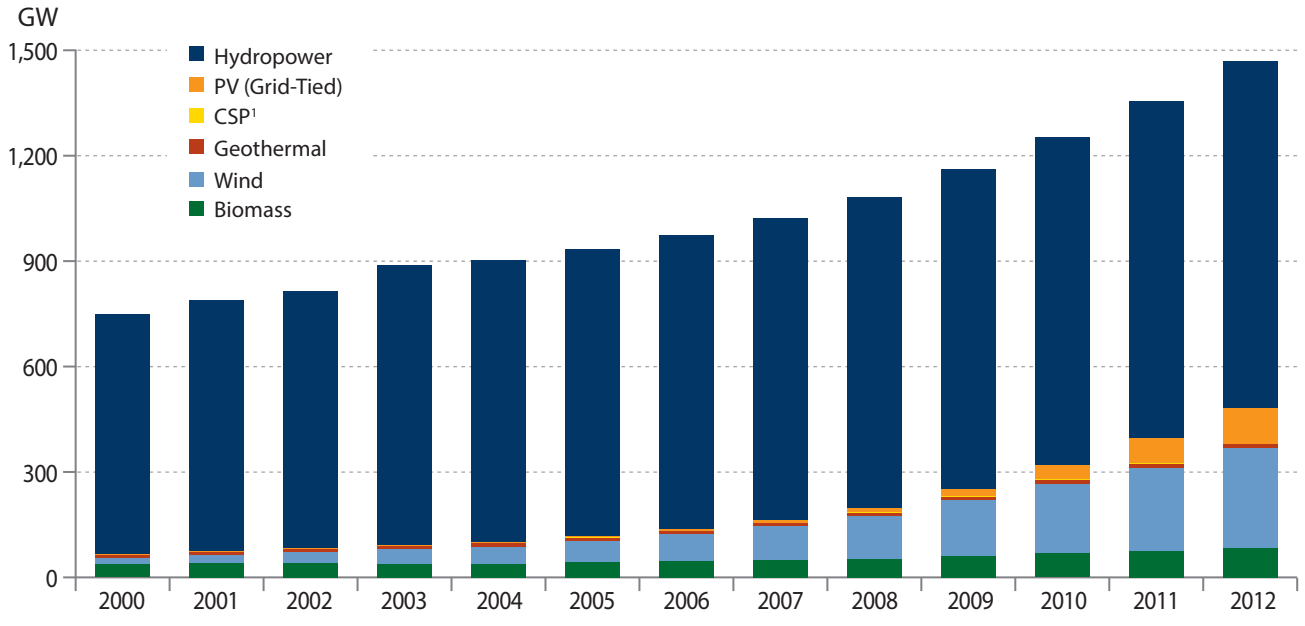
III. Global Renewable Energy Development

Global Renewable Energy Development: Summary

- Cumulative global renewable electricity installed capacity has **grown by 97%** from 2000 to 2012 (from 748 GW to 1,470 GW).
- Renewable energy accounts for **23%** of all electricity generation worldwide (4,892 TWh).
- Wind and solar energy are the fastest growing renewable electricity technologies worldwide. Wind generation grew by a factor of nearly 16 and **solar generation grew by a factor of 49** between 2000 and 2012.
- In 2012, Germany led the world in cumulative solar photovoltaic installed capacity. The United States leads the world in geothermal and biomass installed capacity. China leads in wind, and Spain leads in solar thermal electric generation (STEG).

Worldwide Renewable Electricity Capacity

III



[1]CSP includes Concentrated Photovoltaic (CPV)

Sources: EIA, REN21

Worldwide Renewable Cumulative Electricity Capacity Annual Percent Increase

	Hydropower	Solar PV	CSP	Wind	Geothermal	Biomass	All Renewables
2000	0%	22%	0%	31%	0%	6%	1%
2001	5%	29%	0%	33%	0%	8%	6%
2002	2%	33%	0%	29%	2%	0%	3%
2003	9%	25%	0%	29%	9%	-3%	9%
2004	1%	33%	0%	20%	0%	0%	1%
2005	2%	38%	0%	23%	4%	13%	4%
2006	2%	32%	0%	25%	3%	7%	4%
2007	3%	5%	5%	27%	0%	6%	5%
2008	3%	71%	14%	29%	4%	4%	6%
2009	3%	62%	22%	31%	7%	15%	7%
2010	3%	90%	83%	25%	3%	13%	8%
2011	3%	78%	43%	20%	1%	9%	8%
2012	3%	41%	57%	19%	5%	12%	8%

Sources: EIA, REN21

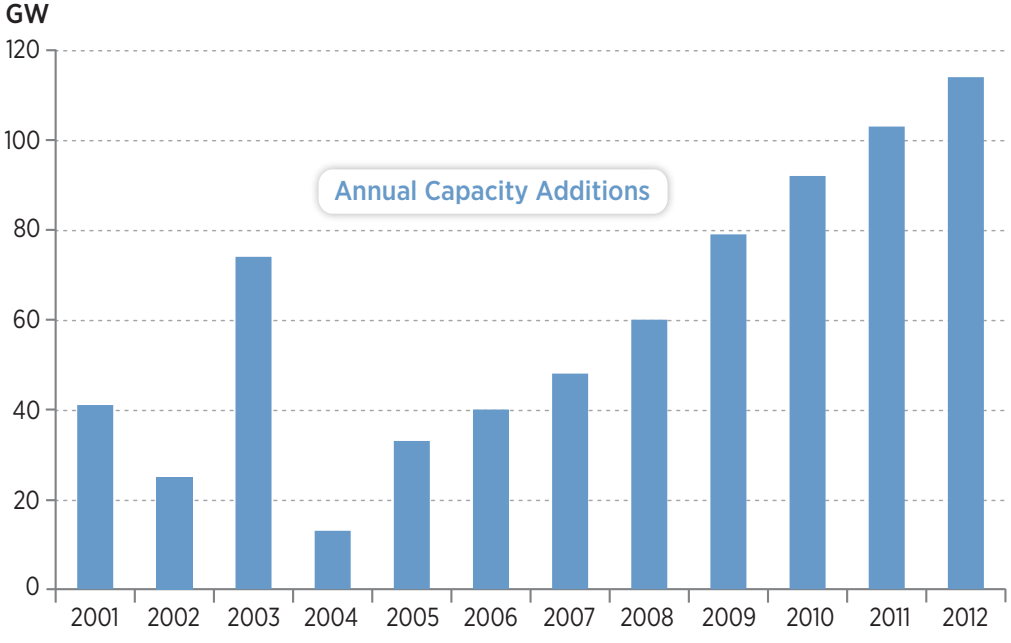
Renewable Electricity as a Percentage of Total Installed Electricity Capacity Worldwide

III

	Hydropower	Solar PV	CSP	Wind	Geothermal	Biomass	All Renewables	Renewable Capacity (GW)
2000	19.7%	0.0%	0.0%	0.5%	0.2%	1.1%	**21.6%**	**748**
2001	20.1%	0.1%	0.0%	0.7%	0.2%	1.1%	**22.2%**	**789**
2002	19.8%	0.1%	0.0%	0.8%	0.2%	1.1%	**22.0%**	**814**
2003	20.7%	0.1%	0.0%	1.0%	0.2%	1.0%	**23.1%**	**888**
2004	20.1%	0.1%	0.0%	1.2%	0.2%	1.0%	**22.6%**	**901**
2005	19.8%	0.1%	0.0%	1.4%	0.2%	1.1%	**22.7%**	**934**
2006	19.4%	0.2%	0.0%	1.7%	0.2%	1.1%	**22.6%**	**974**
2007	19.2%	0.2%	0.0%	2.1%	0.2%	1.1%	**22.8%**	**1,022**
2008	19.1%	0.3%	0.0%	2.6%	0.2%	1.1%	**23.3%**	**1,082**
2009	18.8%	0.4%	0.0%	3.3%	0.2%	1.2%	**24.0%**	**1,161**
2010	18.5%	0.8%	0.0%	3.9%	0.2%	1.3%	**24.7%**	**1,253**
2011	18.2%	1.3%	0.0%	4.5%	0.2%	1.4%	**25.8%**	**1,356**
2012	18.1%	1.8%	0.0%	5.2%	0.2%	1.5%	**26.9%**	**1,470**

Sources: EIA, REN21

Worldwide Annual Installed Renewable Electricity Growth



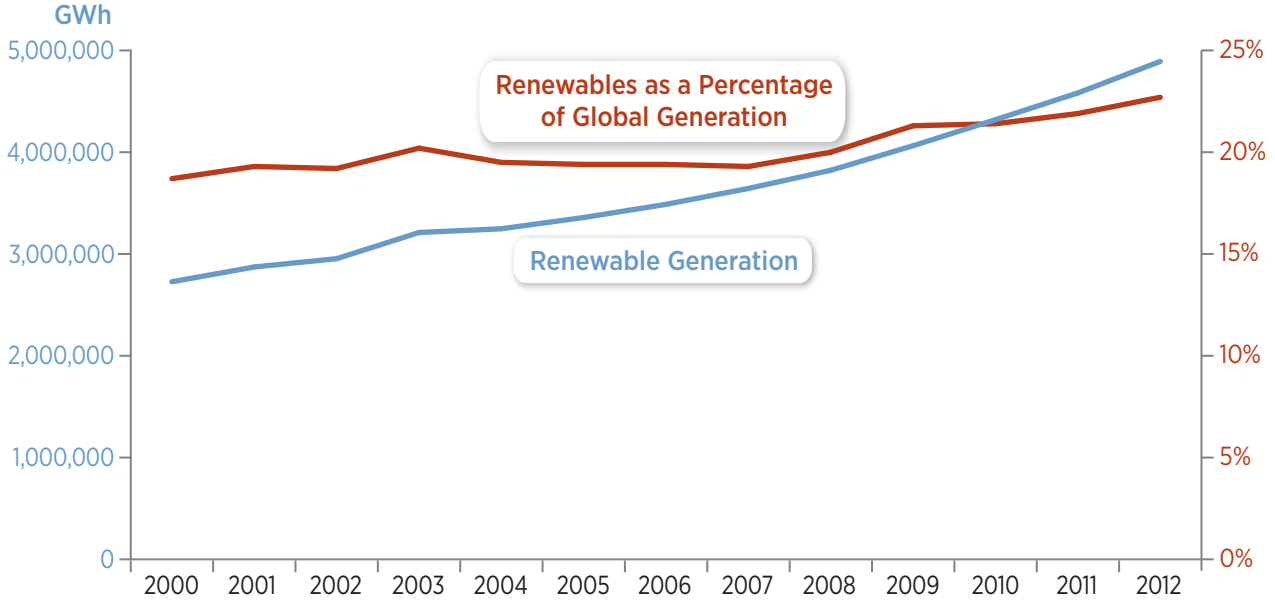
III

	Compounded Annual Growth Rate (2000–2012)
Wind	25.8%
PV (Grid-Tied)	42.7%
CSP	16.0%
Geothermal	3.2%
Biomass	7.0%
Hydropower	3.1%
All Renewables	5.8%

Sources: EIA, REN21

Worldwide Renewable Electricity Generation

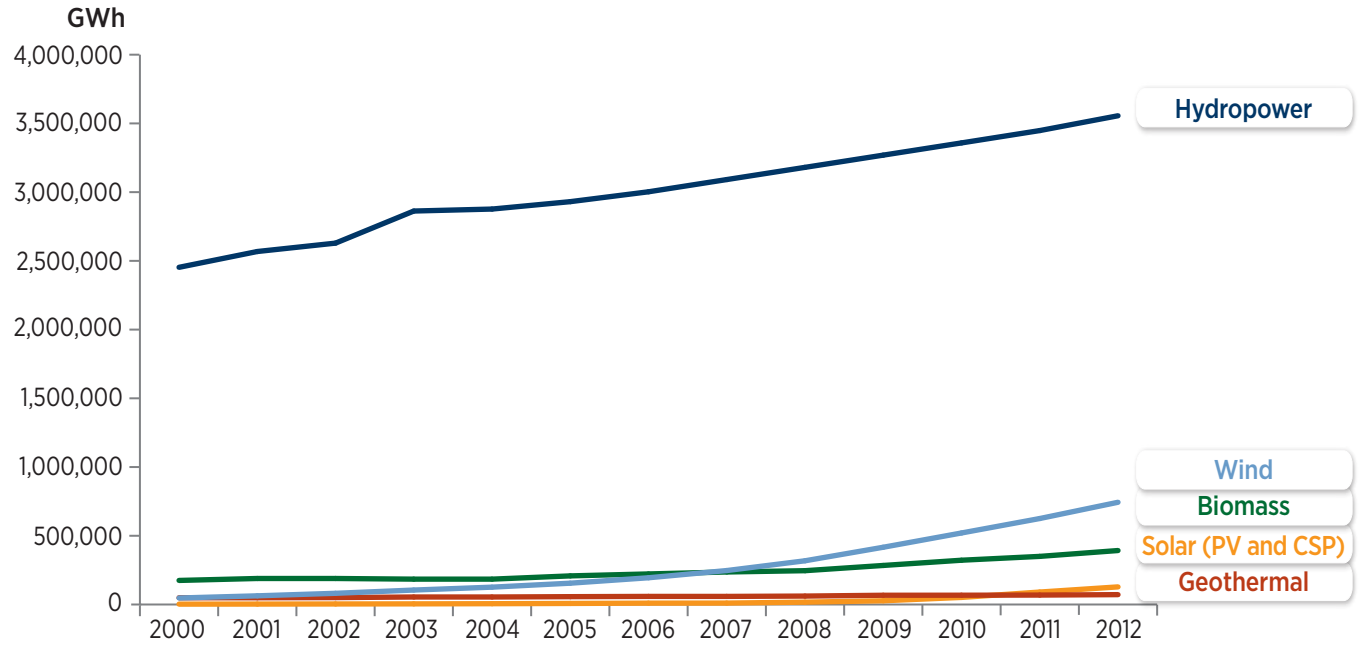
III



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

Sources: EIA, REN21

Worldwide Renewable Electricity Generation by Technology (2000–2012)



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

Sources: EIA, REN21

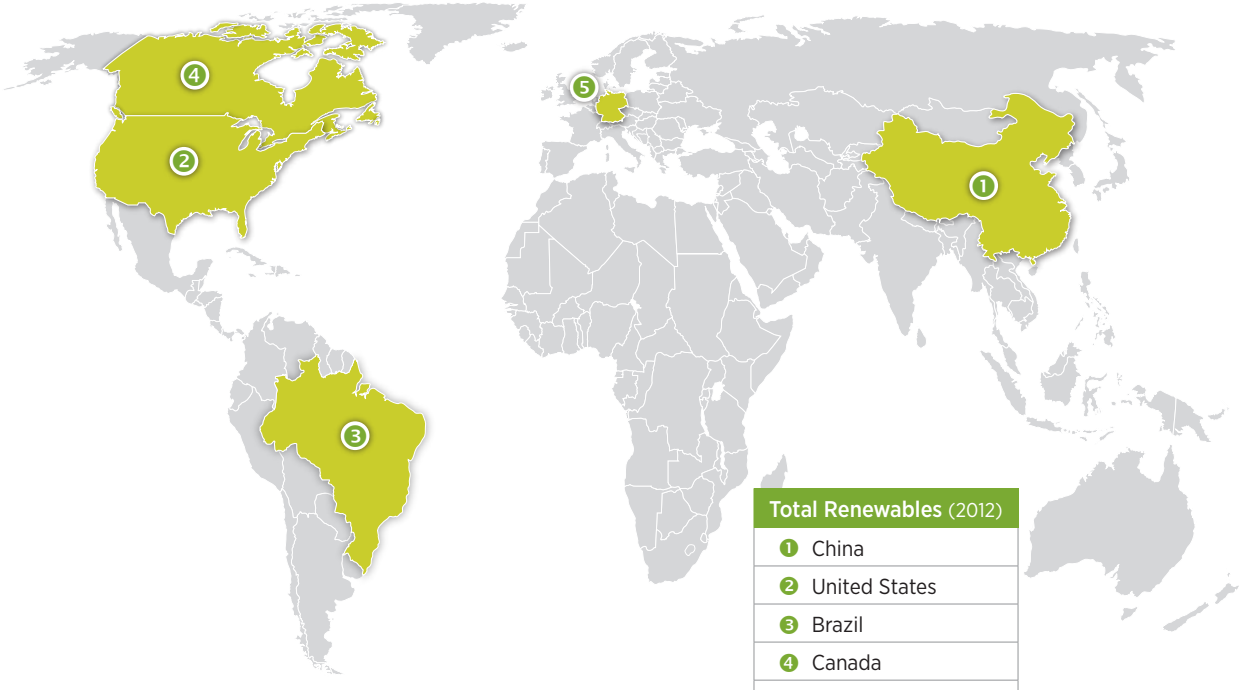
Worldwide Renewable Electricity Generation as a Percentage of Total Generation

III

	Hydropower	Solar PV and CSP	Biomass	Wind	Geothermal	All Renewables	Renewable Generation (GWh)
2000	16.8%	0.0%	1.2%	0.3%	0.3%	18.7%	2,727,082
2001	17.3%	0.0%	1.3%	0.4%	0.3%	19.3%	2,872,463
2002	17.1%	0.0%	1.2%	0.5%	0.3%	19.2%	2,953,879
2003	18.0%	0.0%	1.2%	0.7%	0.3%	20.2%	3,211,282
2004	17.3%	0.0%	1.1%	0.8%	0.3%	19.5%	3,247,899
2005	16.9%	0.0%	1.2%	0.9%	0.3%	19.4%	3,358,626
2006	16.7%	0.1%	1.2%	1.1%	0.3%	19.4%	3,488,055
2007	16.4%	0.1%	1.3%	1.3%	0.3%	19.3%	3,644,173
2008	16.6%	0.1%	1.3%	1.7%	0.3%	20.0%	3,822,689
2009	17.1%	0.1%	1.5%	2.2%	0.4%	21.3%	4,064,206
2010	16.6%	0.3%	1.6%	2.6%	0.3%	21.4%	4,319,733
2011	16.5%	0.4%	1.7%	3.0%	0.3%	21.9%	4,582,578
2012	16.5%	0.6%	1.8%	3.4%	0.3%	22.7%	4,891,891

Sources: EIA, REN21

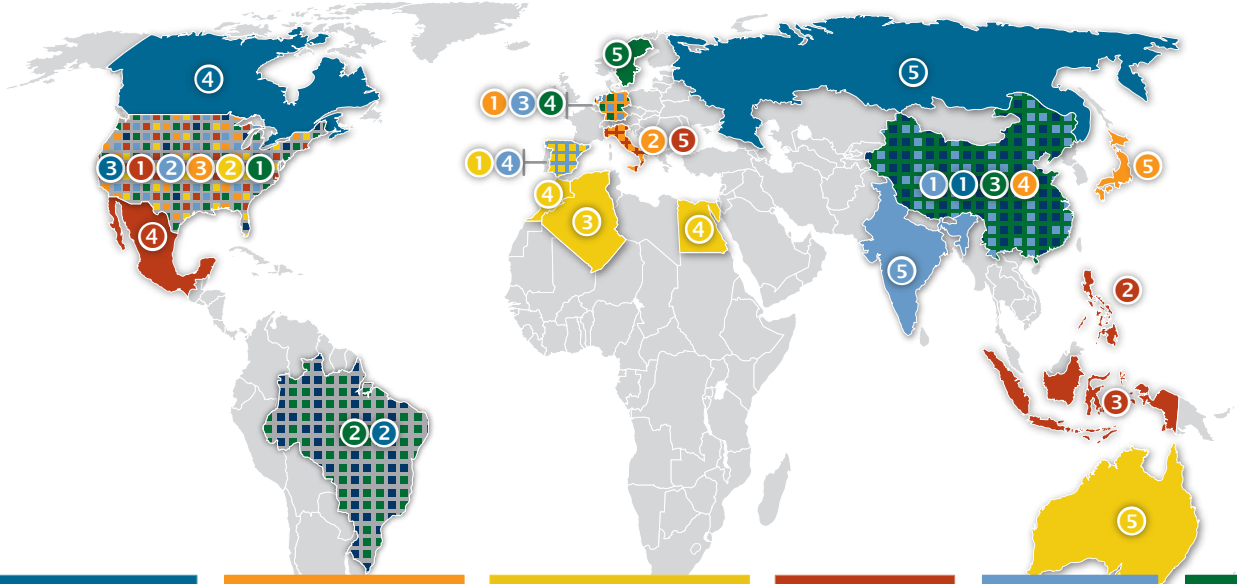
Top Countries with Installed Renewable Electricity Capacity



Total Renewables (2012)
1 China
2 United States
3 Brazil
4 Canada
5 Germany

Sources: EIA, REN21

Top Countries with Installed Renewable Electricity by Technology (2012)



Hydropower	Solar PV (Grid-Tied)	CSP	Geothermal	Wind	Biomass
1 China	1 Germany	1 Spain	1 United States	1 China	1 United States
2 Brazil	2 Italy	2 United States	2 Philippines	2 United States	2 Brazil
3 United States	3 United States	3 Algeria	3 Indonesia	3 Germany	3 China
4 Canada	4 China	4 Egypt/Morocco	4 Mexico	4 Spain	4 Germany
5 Russia	5 Japan	5 Australia	5 Italy	5 India	5 Sweden

Sources: EIA, REN21

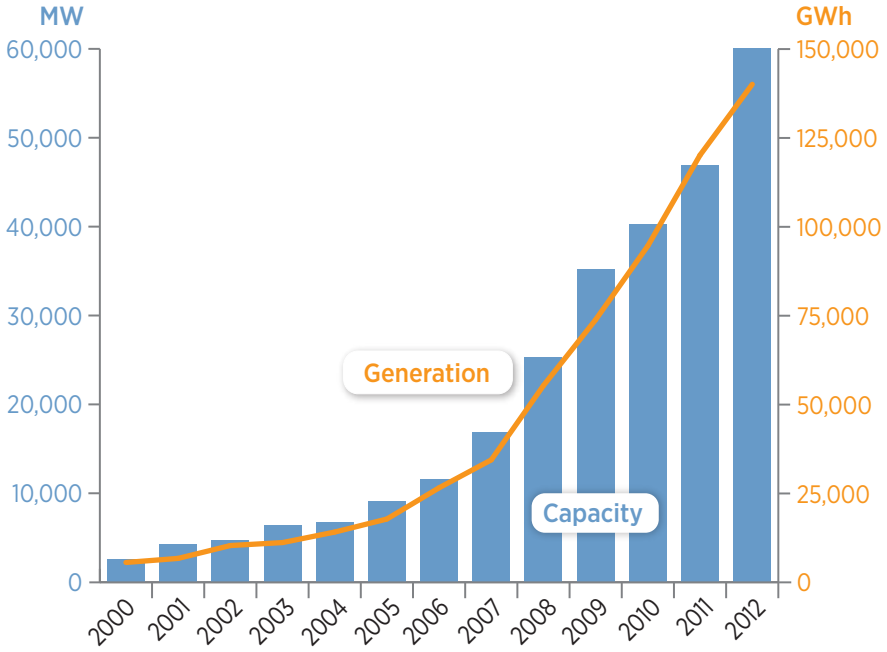
IV. Wind

Wind: Summary

- In the United States, installed wind electricity capacity **increased more than 23 fold between 2000 and 2012**.
- In the United States, wind experienced strong growth **in 2012, and more than 13 GW of new capacity was added**. Texas led the United States in wind installations in 2012, installing 1,826 MW of wind capacity.
- In 2010, **China surpassed the United States** as the world leader in cumulative installed wind capacity, with more than 75 GW installed as of the end of 2012.
- Although **global cumulative installed offshore wind capacity surpassed 5 GW in 2012**, no commercial offshore wind turbines have been commissioned in the United States thus far.

U.S. Total Installed Wind Electricity Capacity and Generation

IV

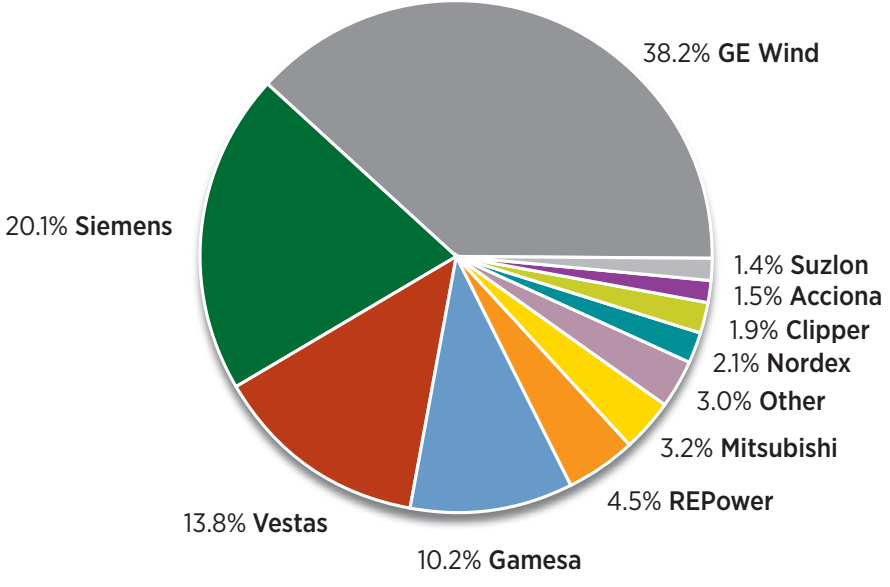


	U.S. Wind Electricity Generation (GWh)	U.S. Wind Electricity Capacity and Percent Increase from Previous Year	
		Total (MW)	% Increase
2000	5,593	2,578	2.6%
2001	6,737	4,275	65.8%
2002	10,354	4,686	9.6%
2003	11,187	6,353	35.6%
2004	14,144	6,725	5.9%
2005	17,811	9,121	35.6%
2006	26,589	11,575	26.9%
2007	34,450	16,812	45.2%
2008	55,363	25,237	50.1%
2009	73,886	35,159	39.3%
2010	94,652	40,267	14.5%
2011	120,177	46,916	16.5%
2012	140,089	60,005	27.9%

Sources: LBNL, EIA

U.S. Wind Turbine Market Share, 2012

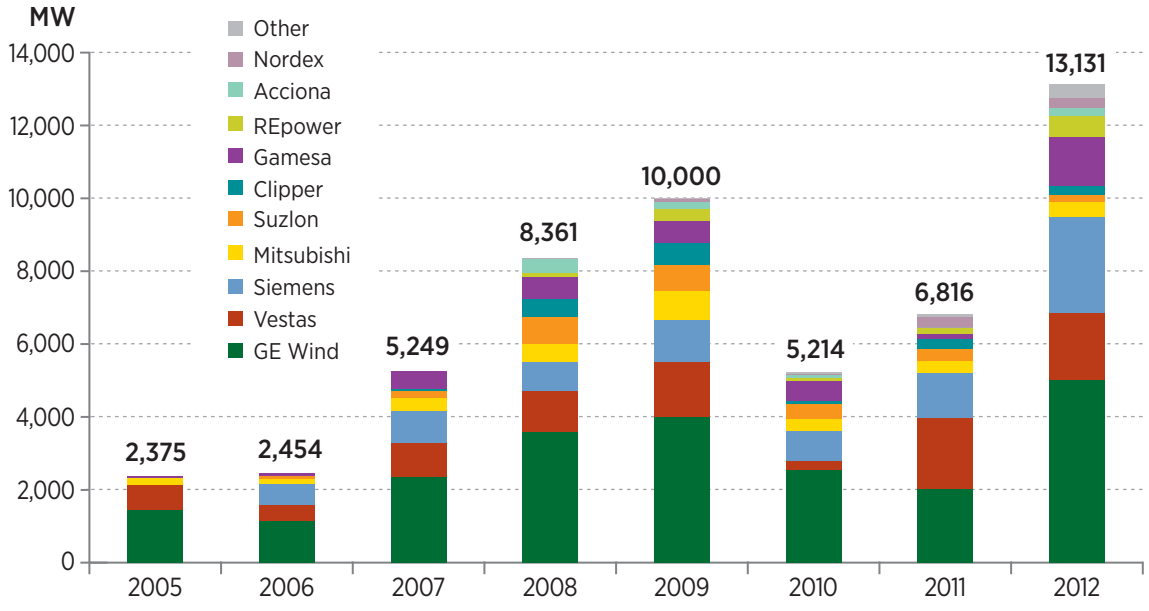
Total Turbine Installations: 13,131 MW



Source: LBNL

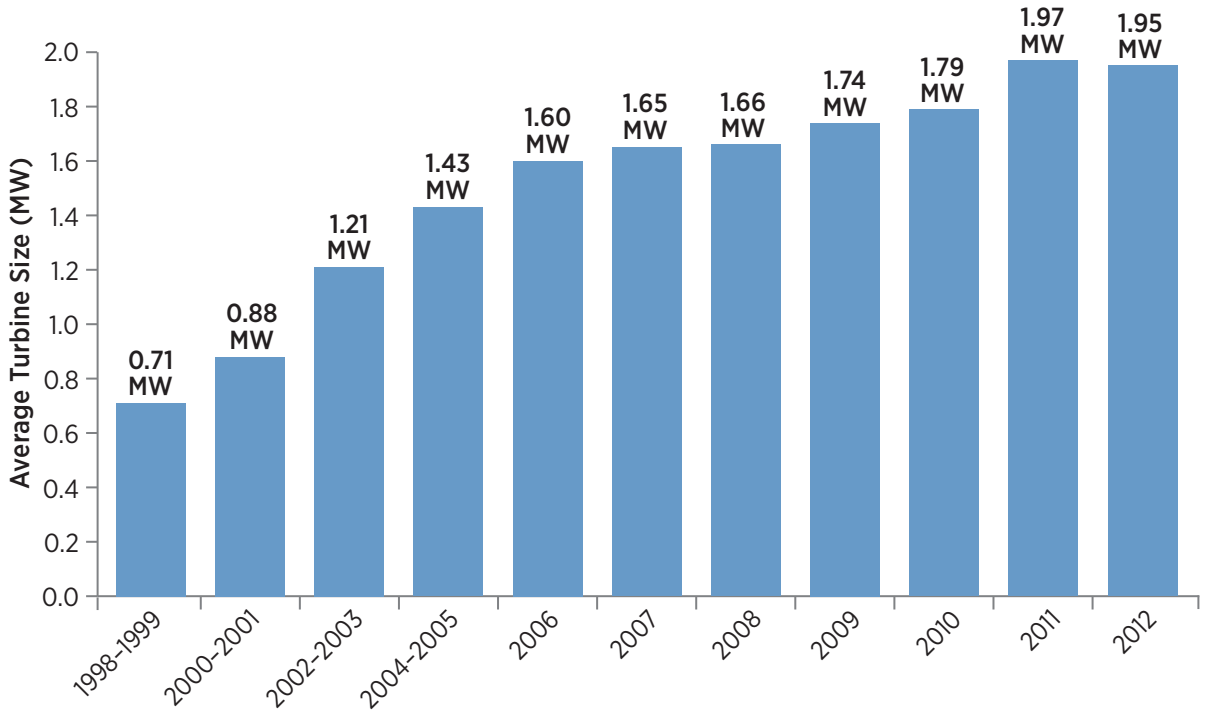
Annual U.S. Wind Turbine Installations by Manufacturer (MW)

IV



Source: LBNL

U.S. Average Installed Turbine Size

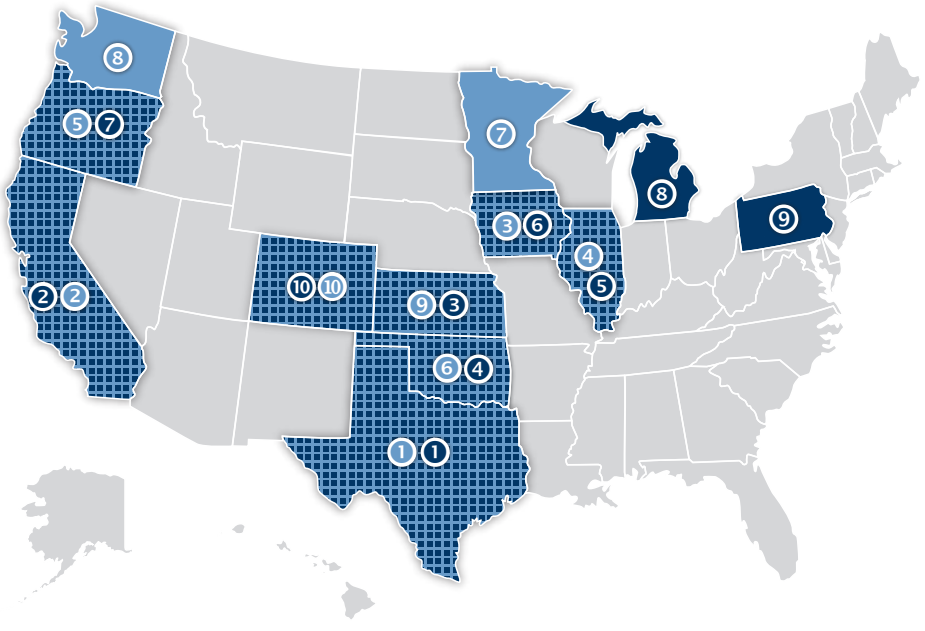


IV

Source: AWEA

States Leading Wind Power Development (2012)

IV

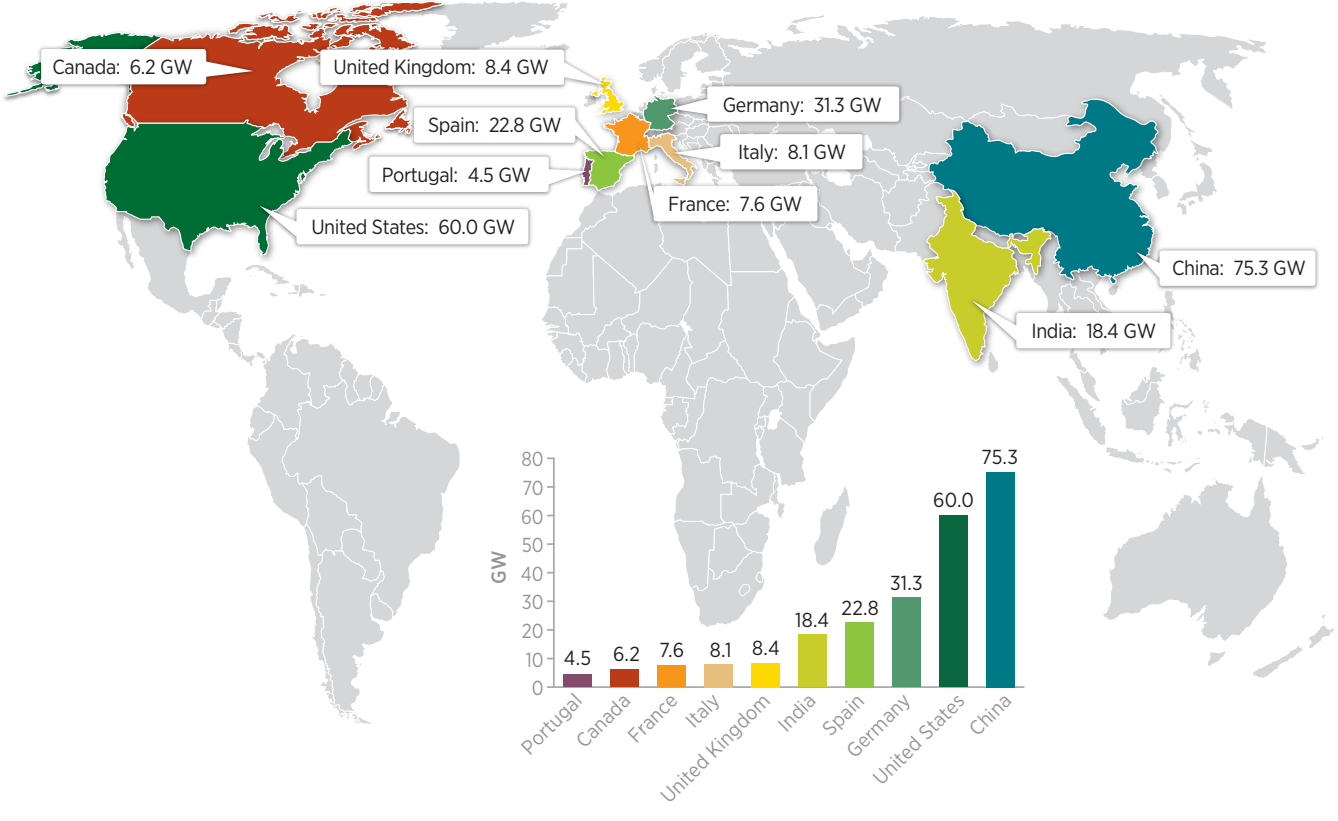


Cumulative Capacity (MW)	
1 Texas	12,214
2 California	5,542
3 Iowa	5,133
4 Illinois	3,568
5 Oregon	3,153
6 Oklahoma	3,134
7 Minnesota	2,987
8 Washington	2,808
9 Kansas	2,713
10 Colorado	2,301

Annual Capacity (MW)	
1 Texas	1,826
2 California	1,656
3 Kansas	1,441
4 Oklahoma	1,127
5 Illinois	823
6 Iowa	814
7 Oregon	640
8 Michigan	611
9 Pennsylvania	550
10 Colorado	496

Source: LBNL

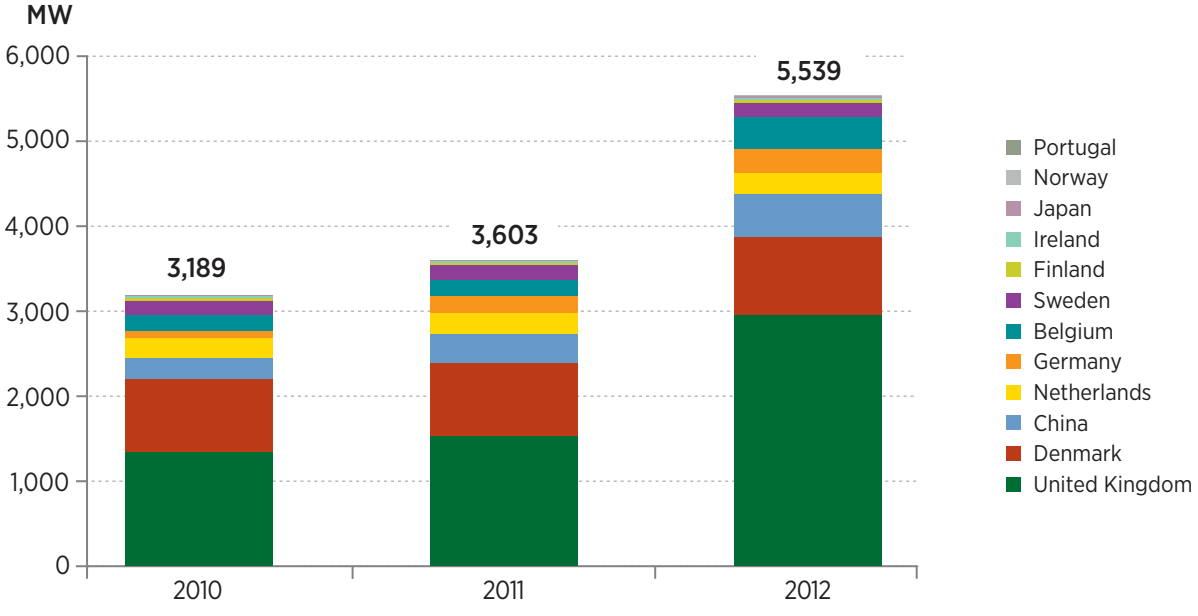
Cumulative Wind Electricity Capacity (2012) – Select Countries



Sources: LBNL, REN21

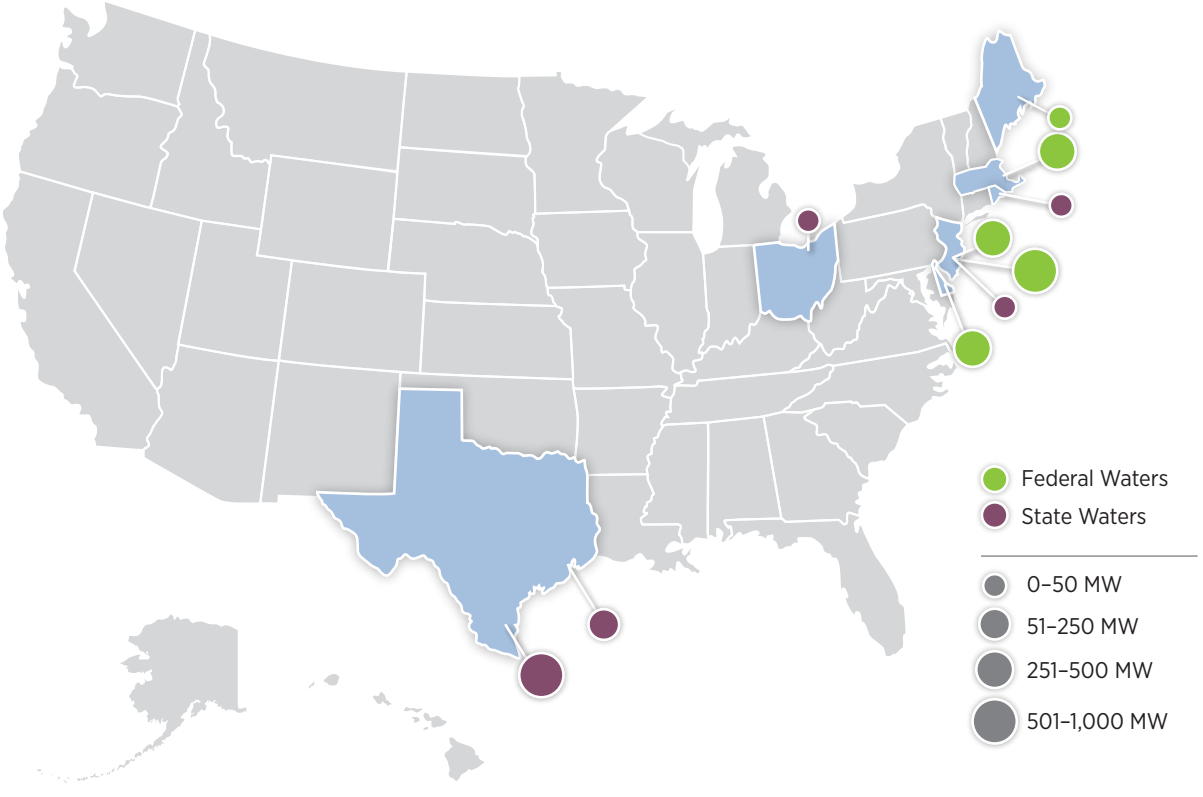
Cumulative Installed Offshore Wind Capacity by Country (MW)

IV



Source: EWEA

U.S. Offshore Wind Electricity Proposed Projects



IV

Source: LBNL, prepared by Navigant Consulting, 2013

V. Solar

Solar: Summary

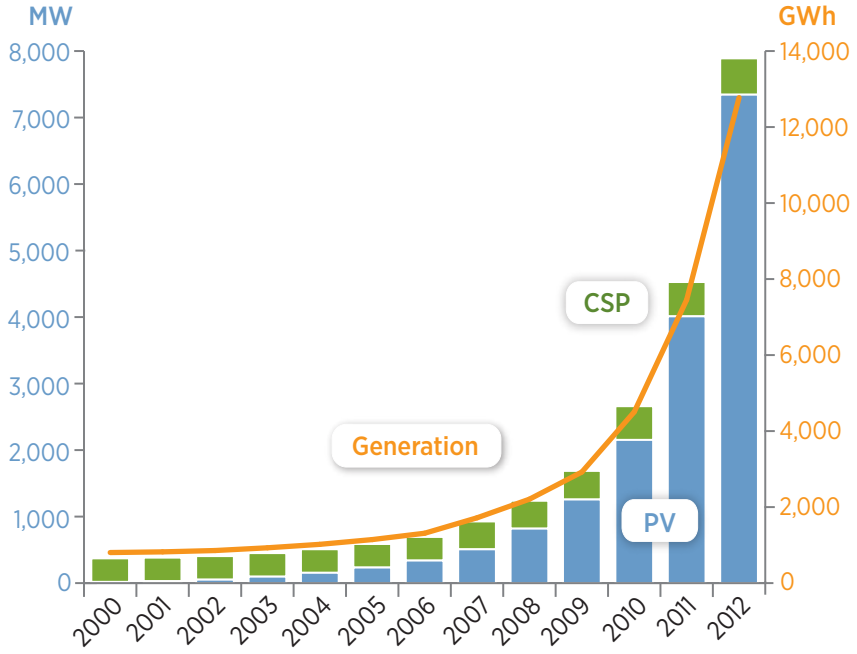
- Solar electricity generating capacity **grew by a factor of over 21 between 2000 and 2012** and currently accounts for 0.3% of annual U.S. electricity generation.

- Countries with extensive solar policies—such as Germany, Spain, and Italy—lead the world in solar photovoltaic (PV) deployment. Similarly, **U.S. states with extensive solar incentives lead the United States in both cumulative and annual installations in 2012** (California, Arizona, New Jersey, Nevada, and Colorado).

- U.S. manufacturers currently have a small share of the worldwide PV market. **Asian—particularly Chinese—manufacturers lead the market with nearly 85% of the global photovoltaic module production**.

- 30 MW of new concentrating solar power (CSP) capacity came online in the United States in 2012. **Approximately 1.6 GW of CSP projects are currently under construction** in the United States and are projected to come online in 2013 and 2014; 900 MW are estimated to come online in 2013 alone.

U.S. Total Installed Solar Electricity Capacity and Generation



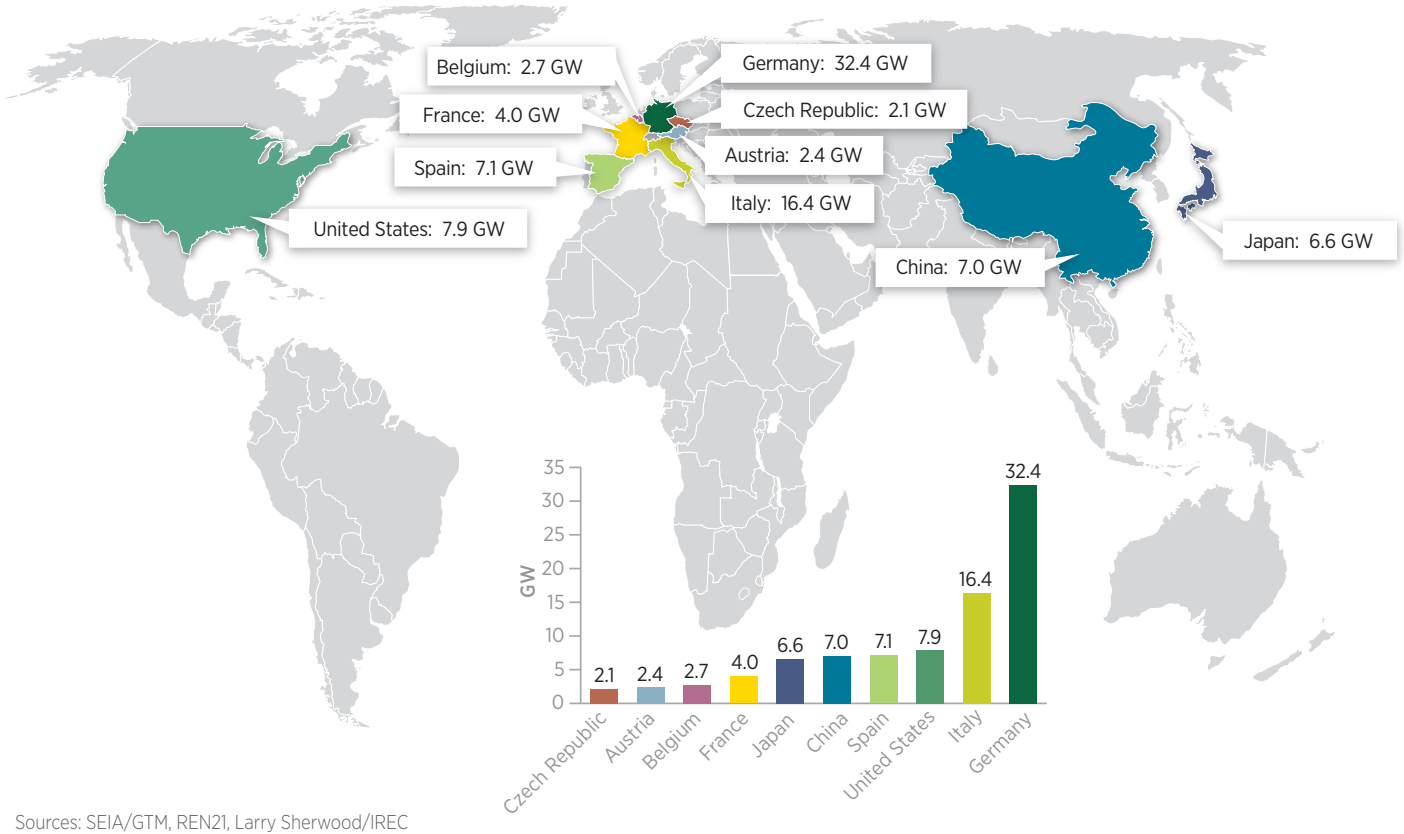
	U.S. Solar Energy Generation (GWh)	U.S. Solar Energy Capacity (MW) and % Increase from Previous Year			
		PV*	CSP	Total	Increase
2000	804	18	354	372	4.3%
2001	822	29	354	383	3.0%
2002	857	52	354	406	5.9%
2003	929	97	354	451	11.2%
2004	1,020	155	354	509	12.8%
2005	1,145	234	354	588	15.5%
2006	1,312	339	355	694	18.0%
2007	1,718	508	419	927	33.5%
2008	2,208	819	419	1,237	33.5%
2009	2,922	1,257	430	1,686	36.3%
2010	4,505	2,153	507	2,660	57.7%
2011	7,454	4,011	516	4,527	70.2%
2012	12,775	7,344	546	7,890	74.3%

Sources: SEIA/GTM, Larry Sherwood/IREC

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

* Includes on- and off-grid capacity

Solar Electricity Installed Capacity (2012) – Select Countries

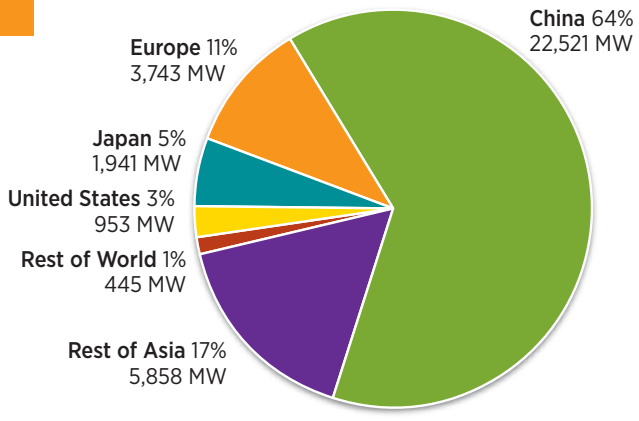


Sources: SEIA/GTM, REN21, Larry Sherwood/IREC

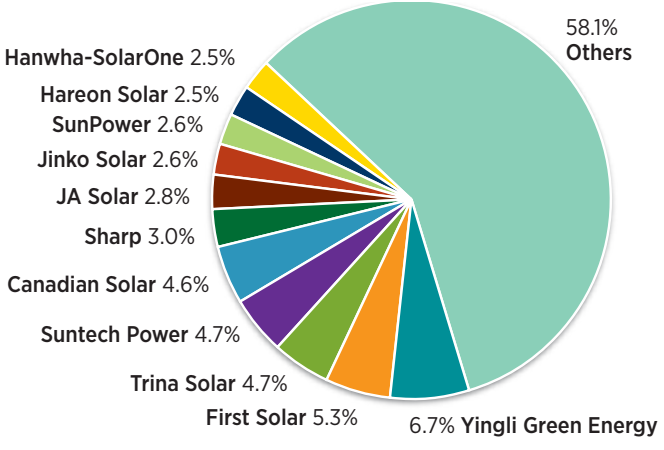
* Includes PV and CSP

Global Solar Module Production, 2012: 35,461 MW

By Country

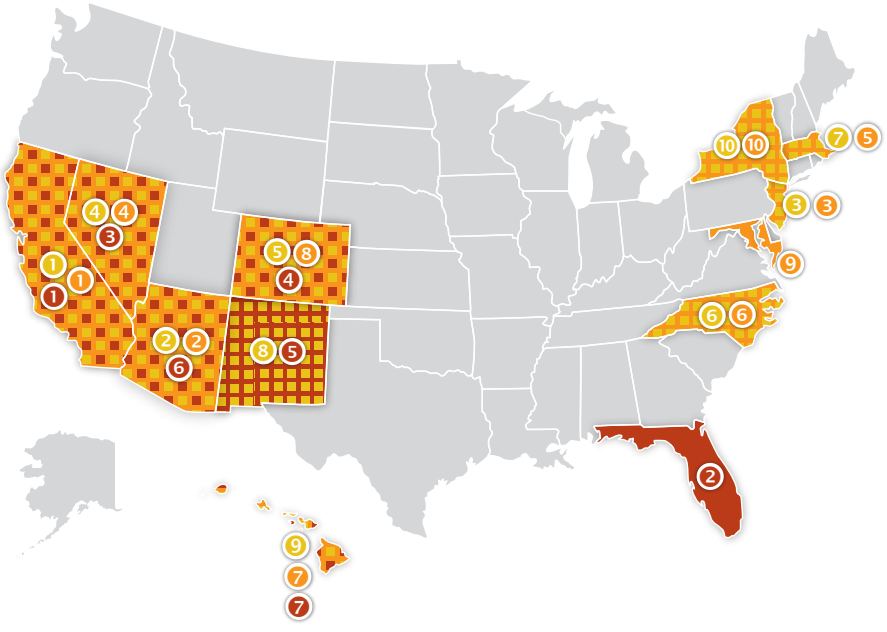


By Manufacturer



Source: GTM PV News, May 2013

States Leading Solar Electricity Development (2012)



PV Cumulative Capacity (MW)	
1 California	2,559.3
2 Arizona	1,106.4
3 New Jersey	955.7
4 Nevada	349.7
5 Colorado	299.6
6 North Carolina	207.9
7 Massachusetts	207.3
8 New Mexico	203.4
9 Hawaii	199.5
10 New York	179.4

PV Annual Capacity Additions (MW)	
1 California	983.2
2 Arizona	708.8
3 New Jersey	390.7
4 Nevada	225.6
5 Massachusetts	123.2
6 North Carolina	122.4
7 Hawaii	114.3
8 Colorado	102.9
9 Maryland	79.7
10 New York	55.6

CSP Cumulative Capacity (MW)	
1 California	364.5
2 Florida	75.0
3 Nevada	64.0
4 Colorado	31.8
5 New Mexico	6.0
6 Arizona	3.7
7 Hawaii	0.8

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

VI. Geothermal

Geothermal: Summary

- U.S. geothermal electricity capacity has remained relatively stable from 2000 to 2012, with the **past 12 years experiencing an average of 1.6% growth in annual capacity installed**. 147 MW of new geothermal electricity capacity came online in 2012.

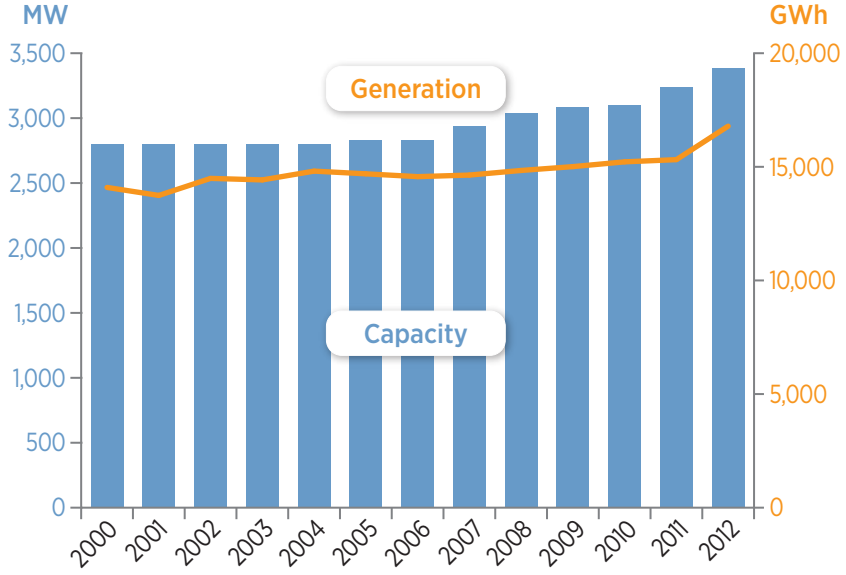
- **The United States leads the world in installed geothermal electricity capacity and generation**, with most of that power installed in California, followed by Nevada.

- Nevada currently has the **most geothermal projects under development** in the United States, exceeding California.

- As a base load source of energy, geothermal is distinct from other renewables such as wind and solar, because **it can provide consistent electricity without being part of a broader system.**

U.S. Geothermal Electricity Capacity and Generation

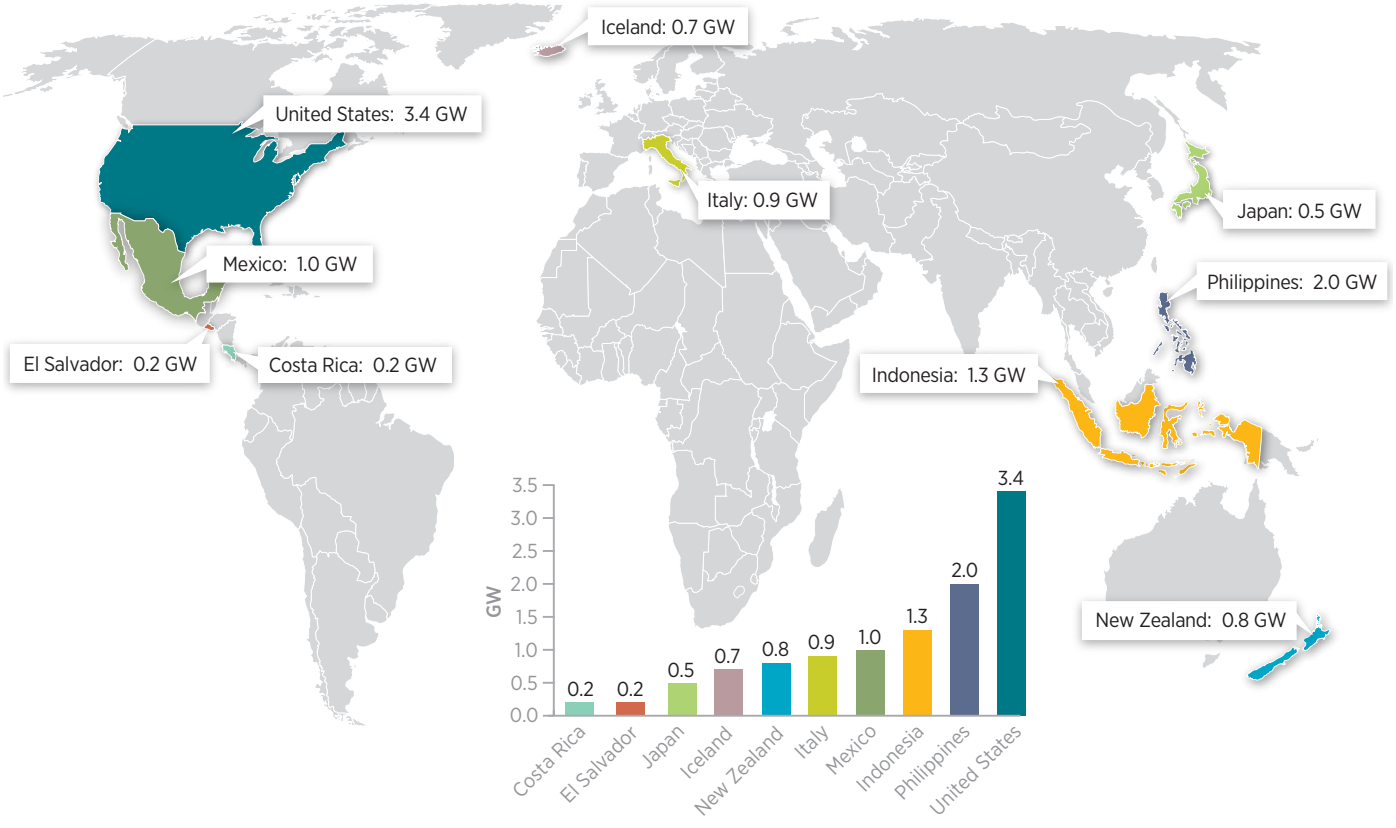
VI



	U.S. Geothermal Electricity Generation (GWh)	U.S. Geothermal Electricity Capacity and % Increase from Previous Year	
		Total (MW)	% Increase
2000	14,093	2,798	2.2%
2001	13,741	2,798	0.0%
2002	14,491	2,798	0.0%
2003	14,424	2,798	0.0%
2004	14,811	2,798	0.0%
2005	14,692	2,828	1.1%
2006	14,568	2,831	0.1%
2007	14,637	2,937	3.7%
2008	14,840	3,040	3.5%
2009	15,009	3,086	1.5%
2010	15,219	3,101	0.5%
2011	15,316	3,239	4.4%
2012	16,791	3,386	4.5%

Sources: GEA, EIA

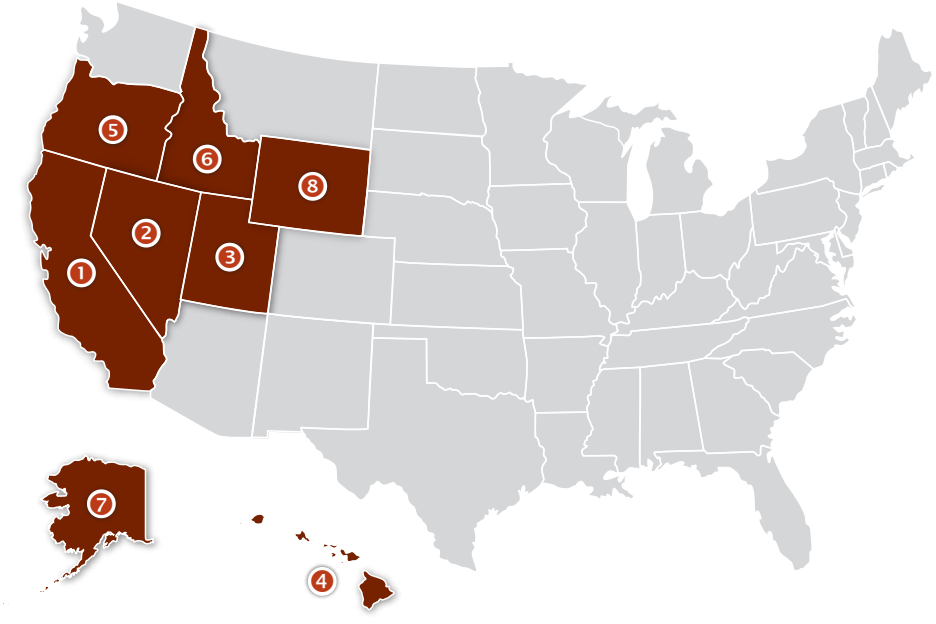
Cumulative Geothermal Electricity Capacity (2012) – Select Countries



Source: GEA, REN21

Cumulative State Geothermal Electricity Development (2012)

VI



Total Installed Capacity (MW)	
1 California	2,732.2
2 Nevada	517.5
3 Utah	48.1
4 Hawaii	38.0
5 Oregon	33.3
6 Idaho	15.8
7 Alaska	0.7
8 Wyoming	0.3

Source: GEA

VI

VII. Biopower

Biopower: Summary

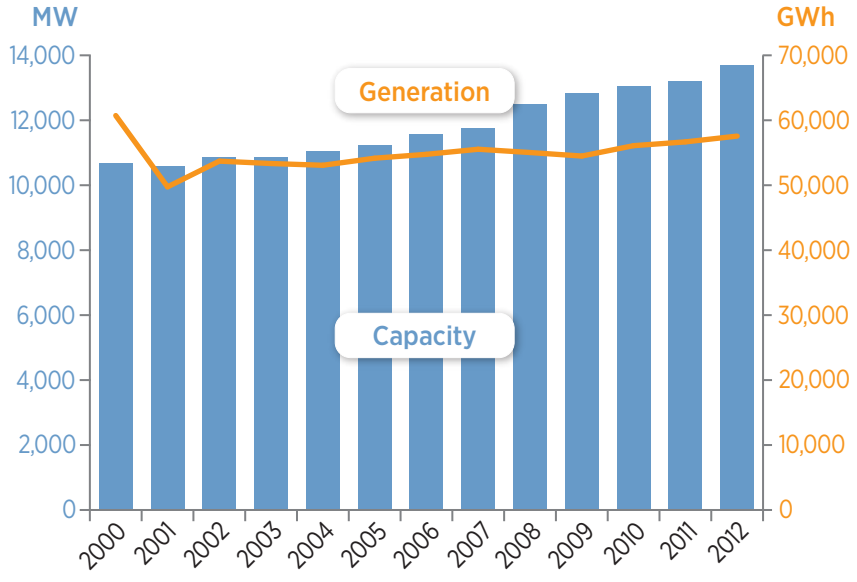
- Biopower electricity generation currently accounts for **11% of all renewable energy generated in the United States**.

- Biomass electricity comes primarily from wood and agricultural residues that are burned as a fuel for cogeneration in the industrial sector (such as in the pulp and paper industry).

- U.S. installed biopower capacity has grown recently, with a **compound annual growth rate (CAGR) of 2.9% from 2006 to 2012**.

U.S. Biopower Electricity Capacity and Generation

VII

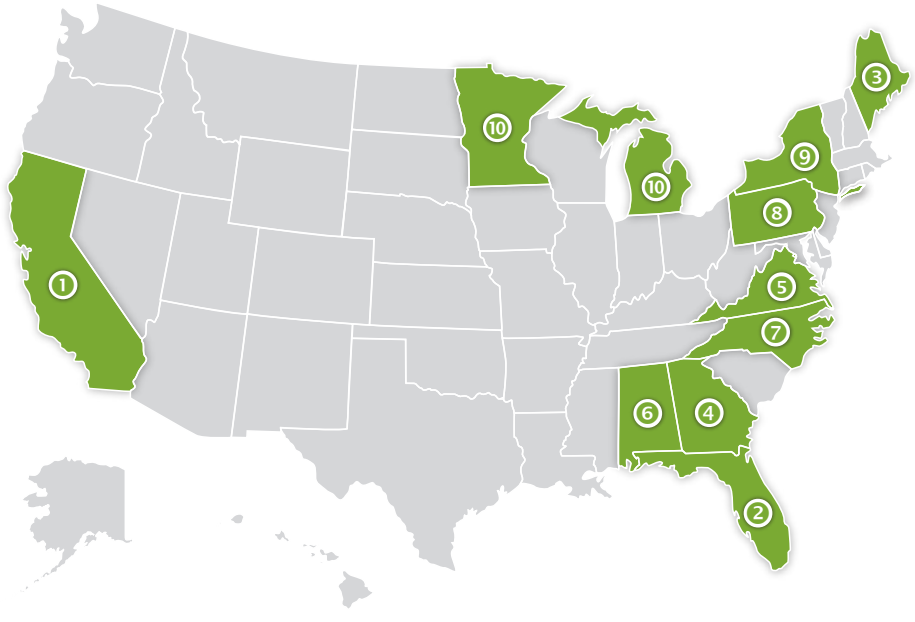


	U.S. Biopower Generation (GWh)	U.S. Biopower Capacity and % Increase from Previous Year	
		Total (MW)	% Change
2000	60,726	10,676	- 2.9%
2001	49,748	10,576	- 0.9%
2002	53,709	10,867	2.8%
2003	53,340	10,856	- 0.1%
2004	53,073	11,033	1.6%
2005	54,160	11,222	1.7%
2006	54,759	11,553	2.9%
2007	55,539	11,738	1.6%
2008	55,034	12,485	6.4%
2009	54,493	12,836	2.8%
2010	56,089	13,053	1.7%
2011	56,671	13,207	1.2%
2012	57,565	13,689	3.7%

Source: EIA

The generation decrease from 2000 to 2001 reflects an EIA classification change. Beginning in 2001, non-biogenic municipal solid waste and tire-derived fuels were reclassified from waste biopower to non-renewable energy sources.

Cumulative State Biopower Electricity Development (2012)

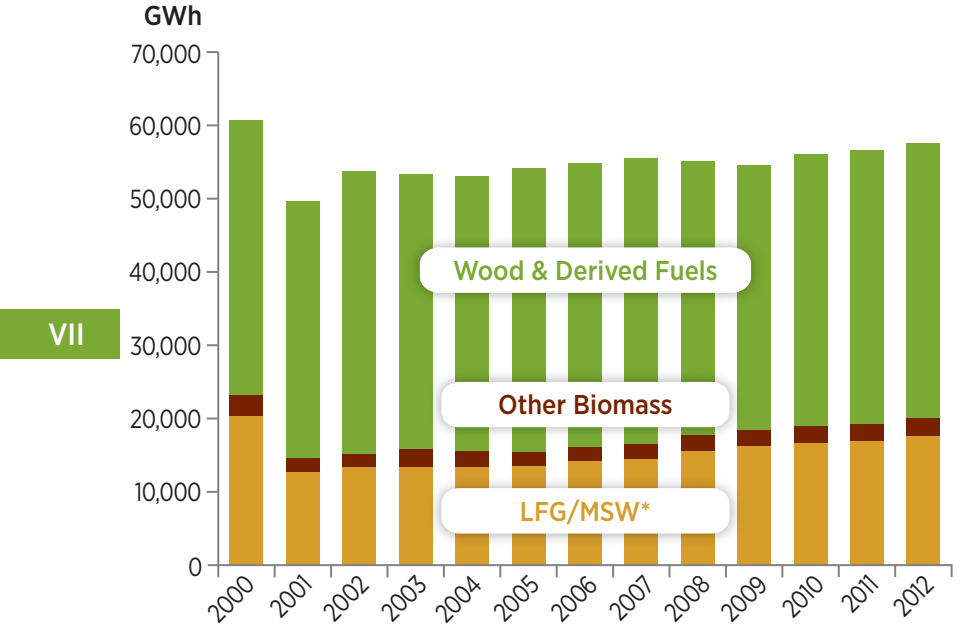


Total Installed Capacity (MW)	
1 California	1,253
2 Florida	1,217
3 Maine	768
4 Georgia	762
5 Virginia	723
6 Alabama	636
7 North Carolina	605
8 Pennsylvania	604
9 New York	528
10 Michigan/Minnesota	488

VII

Source: EIA

U.S. Biopower Electricity Generation Sources (2000–2012)



	LFG/ MSW*	Other Biomass	Wood and Derived Fuel	Total
2000	20,305	2,826	37,595	60,726
2001	12,714**	1,834	35,200	49,748
2002	13,398	1,646	38,665	53,709
2003	13,383	2,428	37,529	53,340
2004	13,281	2,216	37,576	53,073
2005	13,470	2,009	38,681	54,160
2006	14,106	2,004	38,649	54,759
2007	14,462	2,063	39,014	55,539
2008	15,520	2,214	37,300	55,034
2009	16,140	2,303	36,050	54,493
2010	16,555	2,362	37,172	56,089
2011	16,822	2,400	37,449	56,671
2012	17,525	2,500	37,540	57,565

Source: EIA

*LFG stands for landfill gas and MSW stands for municipal solid waste.

**The generation decrease from 2000 to 2001 reflects an EIA classification change. Beginning in 2001, non-biogenic municipal solid waste and tire-derived fuels were reclassified from waste biopower to non-renewable energy sources.

VII

VIII. Hydropower

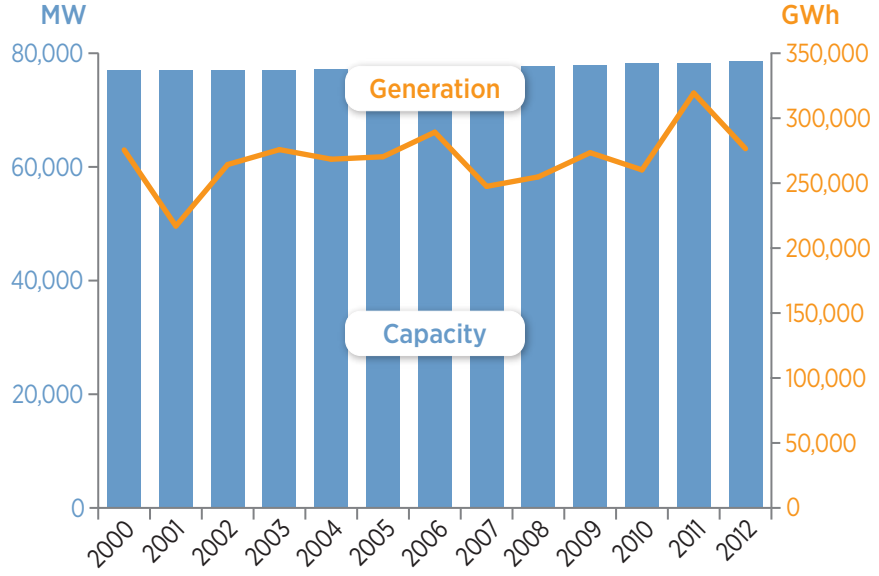
Hydropower: Summary

- Hydropower **capacity has remained essentially constant from 2000 to 2012**, with generation fluctuation depending on water supply.

- Hydropower remains the largest source of renewable electricity generation, primarily large-scale hydropower, which **accounts for 6.8% of U.S. electricity generation**.

- Additional hydropower capacity was installed in the United States in 2012. However, U.S. drought conditions may have caused a decline in generation from existing hydropower facilities in 2012.

U.S. Hydropower* Electricity Capacity and Generation

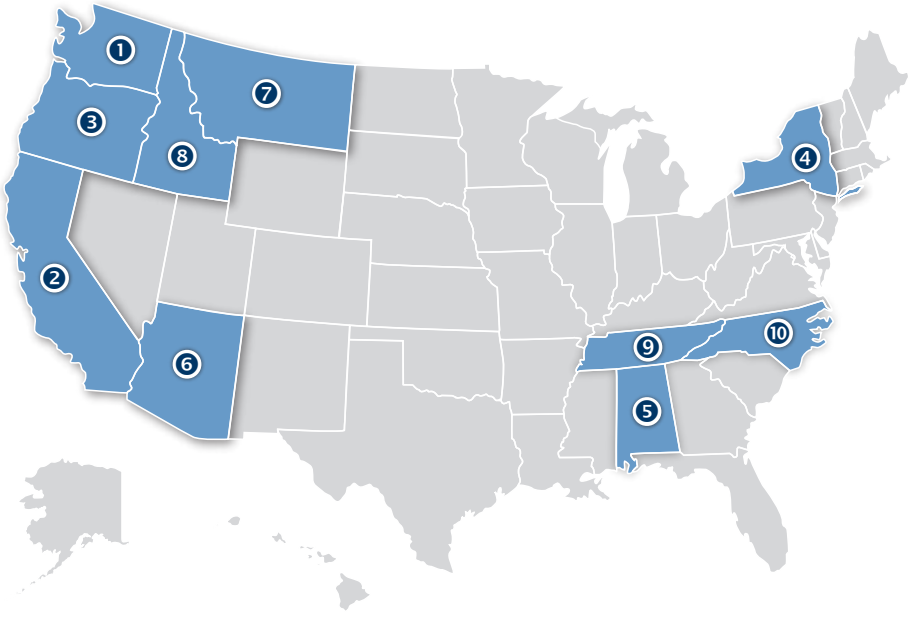


	U.S. Hydropower Generation (GWh)	U.S. Hydropower Capacity and % Increase from Previous Year	
		Total (MW)	% Increase
2000	275,573	76,946	0.0%
2001	216,961	76,911	0.0%
2002	264,329	77,047	0.2%
2003	275,806	77,020	0.0%
2004	268,417	77,130	0.1%
2005	270,321	77,354	0.3%
2006	289,246	77,419	0.1%
2007	247,510	77,432	0.0%
2008	254,831	77,640	0.3%
2009	273,445	77,910	0.3%
2010	260,203	78,204	0.4%
2011	319,355	78,194	0.0%
2012	276,535	78,610	0.5%

Source: EIA

*Excludes pumped storage

Cumulative State Hydropower Electricity Development (2012)



Capacity (MW)	
1 Washington	21,112
2 California	10,057
3 Oregon	8,241
4 New York	4,657
5 Alabama	3,280
6 Arizona	2,718
7 Montana	2,655
8 Idaho	2,540
9 Tennessee	2,499
10 North Carolina	1,939

VIII

Source: EIA

IX. Advanced Water Power

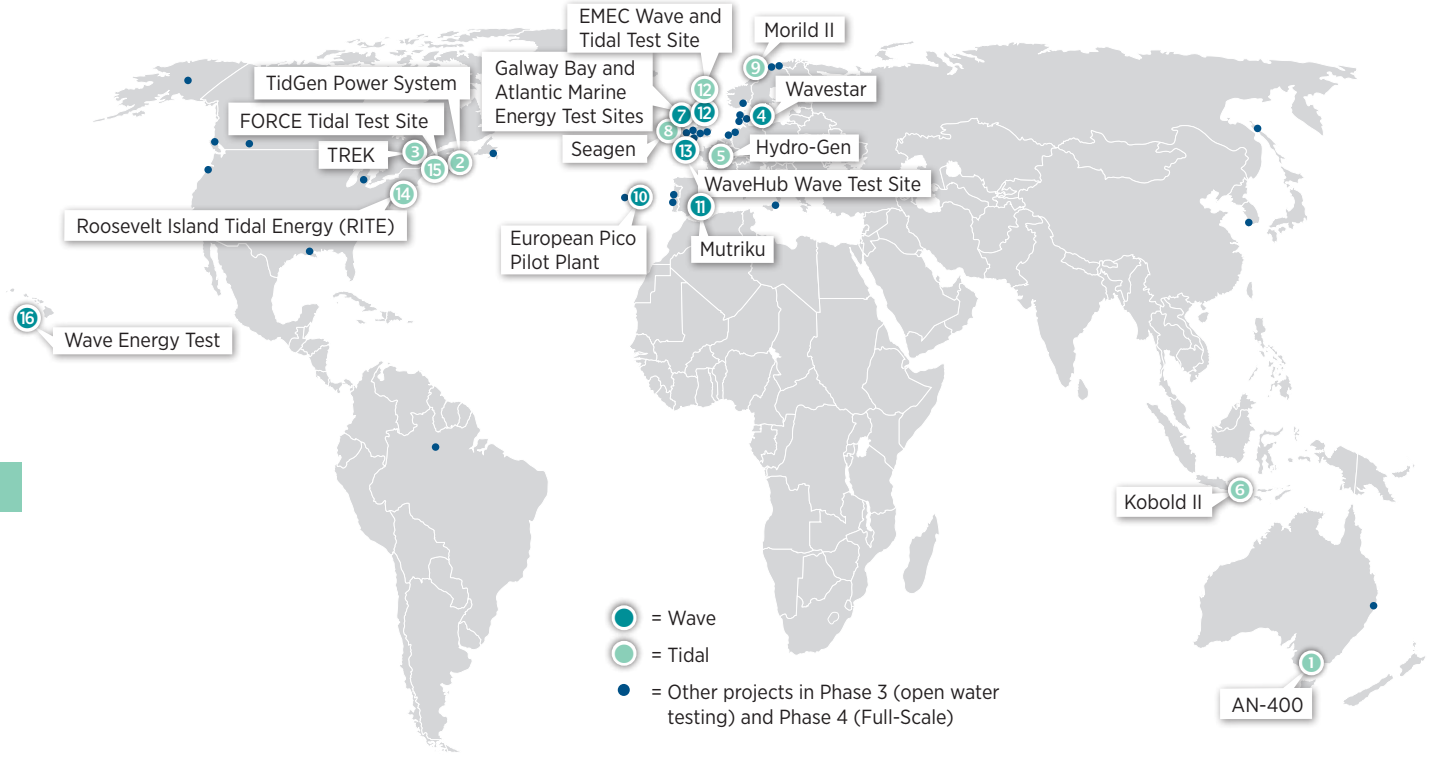
Advanced Water Power: Summary

- U.S. interest in advanced water power—such as **tidal, river, ocean current**, and **ocean wave** energy—has been steadily growing over the past few years, with many prototype projects in testing stages and permits being filed with the Federal Energy Regulatory Commission (FERC).

- Two tidal power projects received licenses from FERC in early 2012: one being developed by Ocean Renewable Power Company in Cobscook Bay Maine, and one being developed by Verdant Power in the East River of New York City. In September 2013, Ocean Renewable Power Company's Tidal Energy Project became the first tidal power project to deliver power to an electric utility grid in the United States. More information may be found at these websites:

  - Federal Energy Regulatory Commission (FERC): www.ferc.gov/industries/hydropower/gen-info/licensing/hydrokinetics.asp
  - The Water Power Program at the U.S. Department of Energy: www1.eere.energy.gov/water
  - The Ocean Energy Systems Implementing Agreement, established by the International Energy Agency: www.ocean-energy-systems.org

Worldwide Advanced Water Power – Select Commercial and Pilot Plants



IX

See following page for additional information about these projects.

Information about additional projects can be found in the EERE Marine and Hydrokinetic Technology Database, accessible at: http://en.openei.org/wiki/Marine_and_Hydrokinetic_Technology_Database.

Worldwide Advanced Water Power – Select Commercial and Pilot Plants

	PROJECT NAME	Type	Country	Location	Size (MW)	Installed
1	AN-400	Tidal	Australia	San Remo, Victoria	0.40	2008
2	FORCE Tidal Test Site (Multiple Devices)	Tidal	Canada	Bay of Fundy, Parrsboro, NS	3+	2009
3	TREK	Tidal	Canada	Saint-Lawrence River	0.25	2010
4	Wavestar	Wave	Denmark	Hanstholm	0.60	2010
5	Hydro-Gen	Tidal	France	Paimpol-Brehat	2	2011
6	Kobold II	Tidal	Indonesia	Lombok Island	0.15	2012
7	Galway Bay and Atlantic Marine Energy Test Sites (Multiple Devices)	Wave	Ireland	Galway Bay and Belmullet Bay	1	2006
8	Seagen	Tidal	Ireland	Strangford Lough	1.20	2006
9	Morild II	Tidal	Norway	Lofoten	1.50	2010
10	European Pico Pilot Plant	Wave	Portugal	Cachorro, Pico Island	0.40	2005
11	Mutriku	Wave	Spain	Near Bilbao	0.3	2011
12	EMEC Wave and Tidal Test Site (Multiple Devices)	Wave/Tidal	United Kingdom	Scotland Stromness, Orkney	10+	2008
13	WaveHub Wave Test Site (Multiple Devices)	Wave	United Kingdom	Hayle, Cornwall	50+	2011
14	Roosevelt Island Tidal Energy (RITE)	Tidal	United States	New York City, NY	0.07	2015
15	TidGen Power System	Tidal	United States	Cobscook Bay, Maine	0.15	2012
16	Wave Energy Test	Wave	United States	Kaneohe Bay, Hawaii	0.02	2012

Information about additional projects can be found in the EERE Marine and Hydrokinetic Technology Database, accessible at: http://en.openei.org/wiki/Marine_and_Hydrokinetic_Technology_Database.


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

X. Hydrogen

Hydrogen: Summary

- The cumulative installed **global fuel cell capacity for stationary power doubled between 2008 and 2012**, reaching approximately 100–110 MW in 2012.
- In 2012, cumulative global generation capacity from stationary fuel cells increased by nearly **43% from the previous year**.
- In 2012, the cumulative global fuel cell installations increased by **75% from the previous year**.
- In the United States, more than **9 million tons of hydrogen are produced today**, and there are more than 1,200 miles of hydrogen pipelines.

X

Sources: EERE, Navigant

Hydrogen: Summary

- The world's largest fuel cell power plant opened in Daegu City, South Korea in 2011. The 11.2 MW facility will sell electricity to an electric utility and high-grade heat to the local municipality for their wastewater treatment plant under long term power purchase agreements.

- A larger fuel cell power generation plant (58.8 MW) is being planned for construction in South Korea.

- The Fountain Valley Renewable Energy Tri-generation Station—the world's first facility capable of co-producing hydrogen, heat, and power from digester gas—began operation at a wastewater treatment plant in California in 2011. During its initial run, it achieved an efficiency of 54% when co-producing hydrogen and power and 70% when including cogenerated heat.

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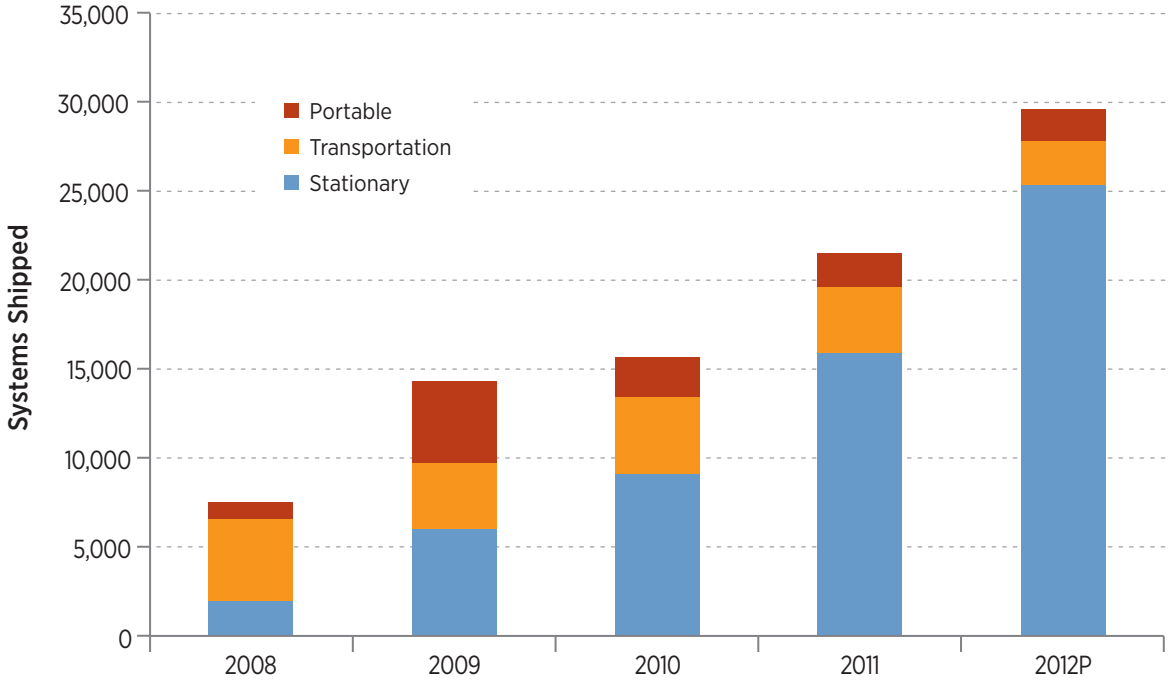
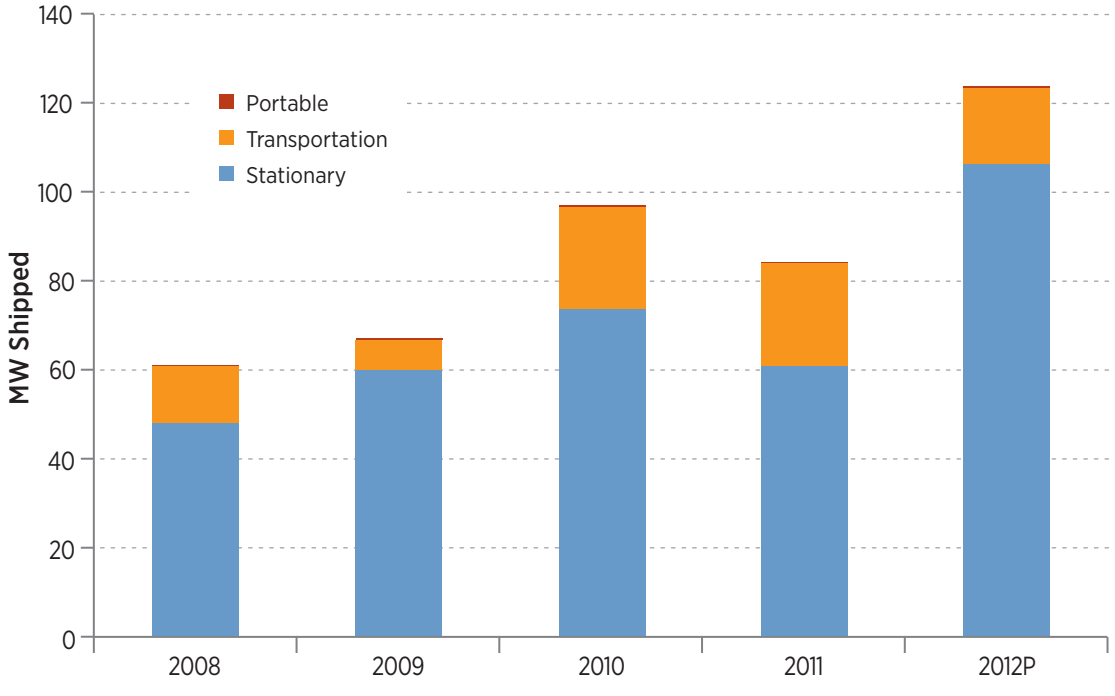
Fuel Cell Systems Shipped by Application, World Markets: 2008–2012



Sources: EERE, Navigant

Megawatts of Fuel Cells Shipped by Application, World Markets: 2008–2012



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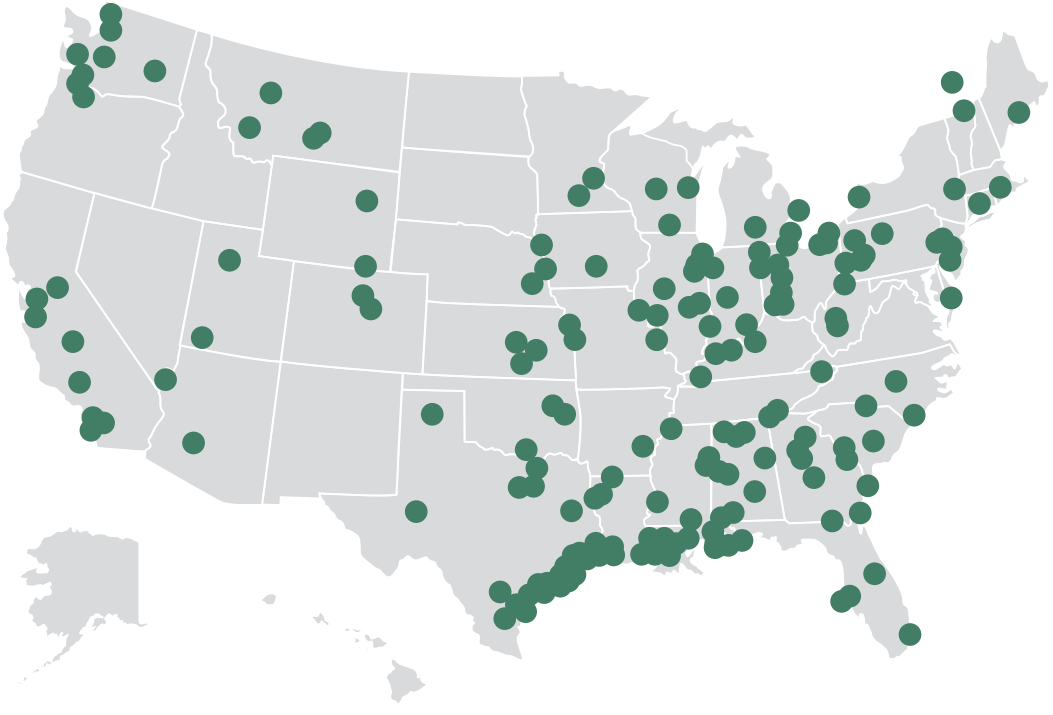
Sources: EERE, Navigant

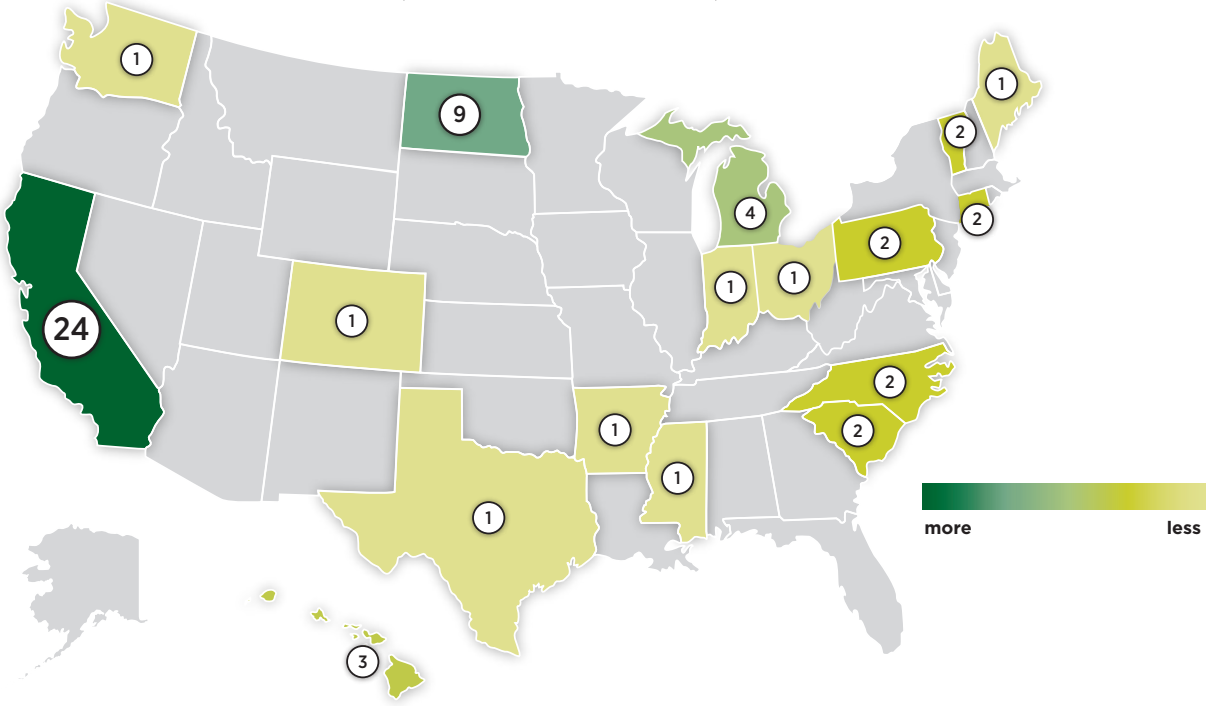
Hydrogen Infrastructure: Existing Hydrogen Production Facilities



Source: NREL

Number of Operational U.S. Hydrogen Fueling Stations

(December 2012 – **Total of 58**)



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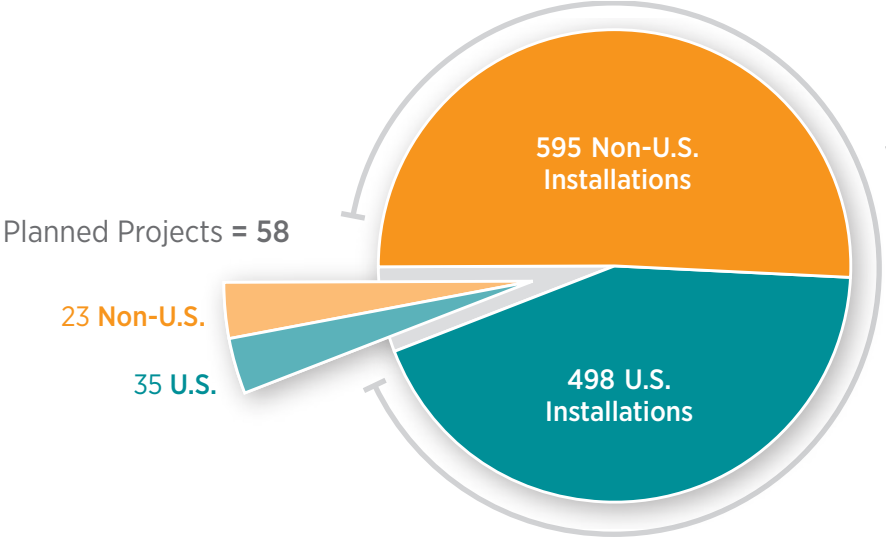
Sources: EERE, FuelCells.org

Stationary Fuel Cell Installations, 2012



Worldwide Installations = **1,093**

Number of installed stationary fuel cells >1 MW = 38

Located in the United States (19), Canada (1), Germany (1), Italy (1), Japan (2), South Korea (14)

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Source: FuelCells.org

XI. Renewable and Alternative Fuels

Renewable and Alternative Fuels

- Corn ethanol production—in contrast to Brazil's ethanol, which is produced from sugar cane—has expanded rapidly in the United States. **Between 2000 and 2012, production increased by a factor of eight**.

- U.S. ethanol production **totaled 13,300 million gallons** per year in **2012**.

- In 2012, the United States* produced 61% of the world's ethanol, followed by Brazil at 26%, the European Union at 5%, China at 3%, and Canada at 2%.

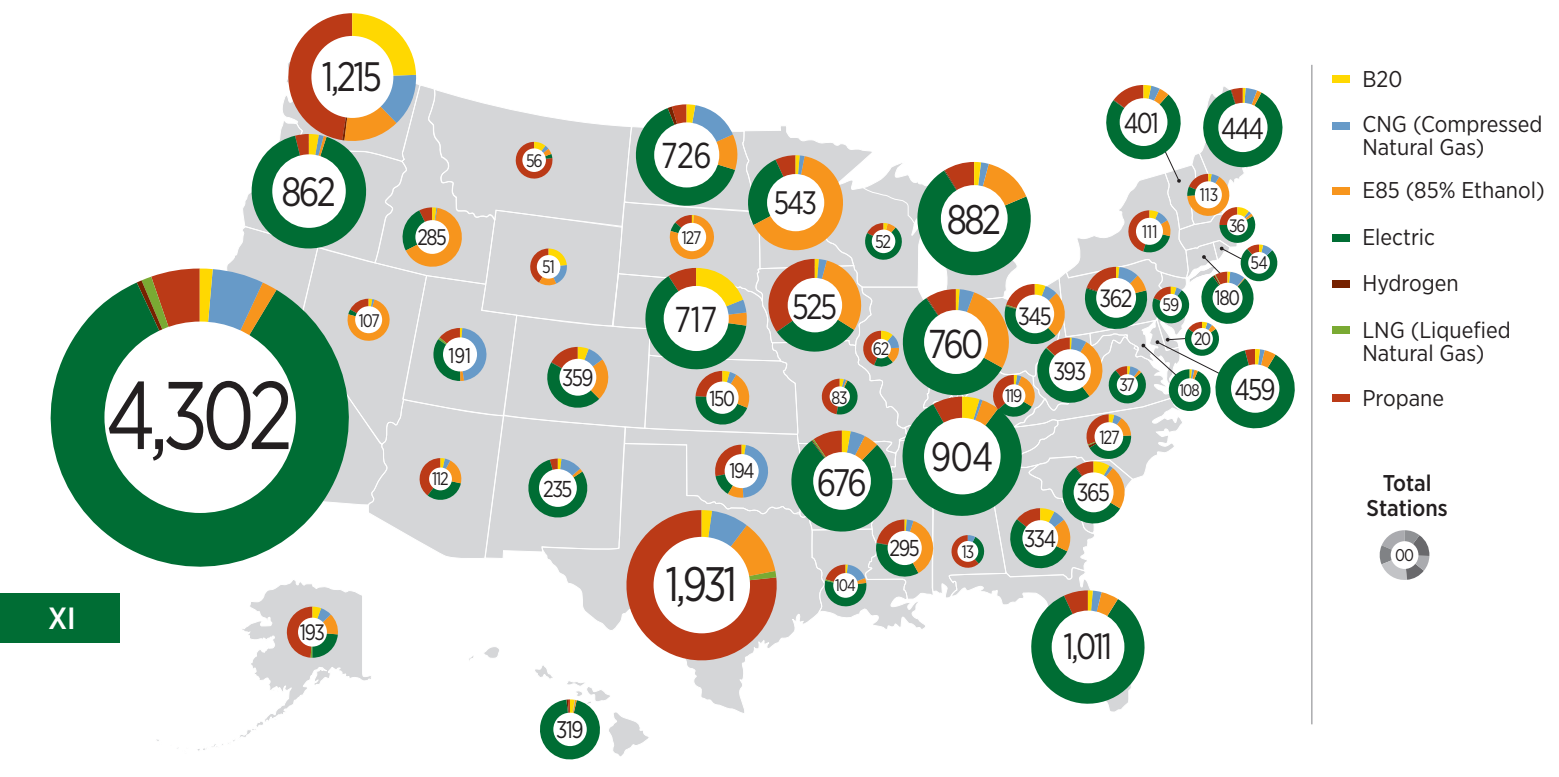
- In 2012, the number of electric vehicle charging stations in the U.S. expanded by **150% over 2011 to reach 14,982 stations**.

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 study and commercialize cellulosic ethanol and biobased hydrocarbon fuels, which are produced from non-food crops.

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 can use a blend of 85% ethanol and 15% gasoline (E85).

Renewable and Alternative Fueling Stations by State



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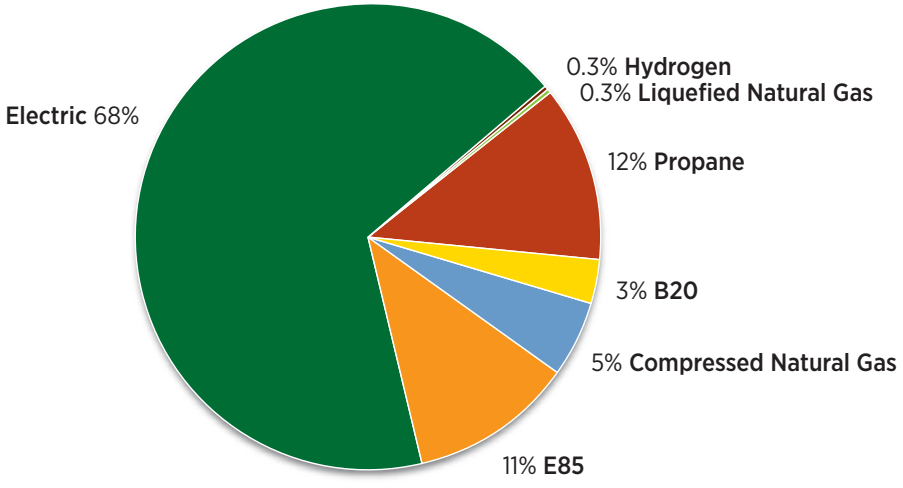
Sources: EERE, EIA

Data as of January 2, 2013. For the full list of fueling station counts by state, visit http://www.afdc.energy.gov/afdc/fuels/stations_counts.html.

Renewable and Alternative Fueling Stations by Type

22,109 Alternative Fueling Stations in the United States



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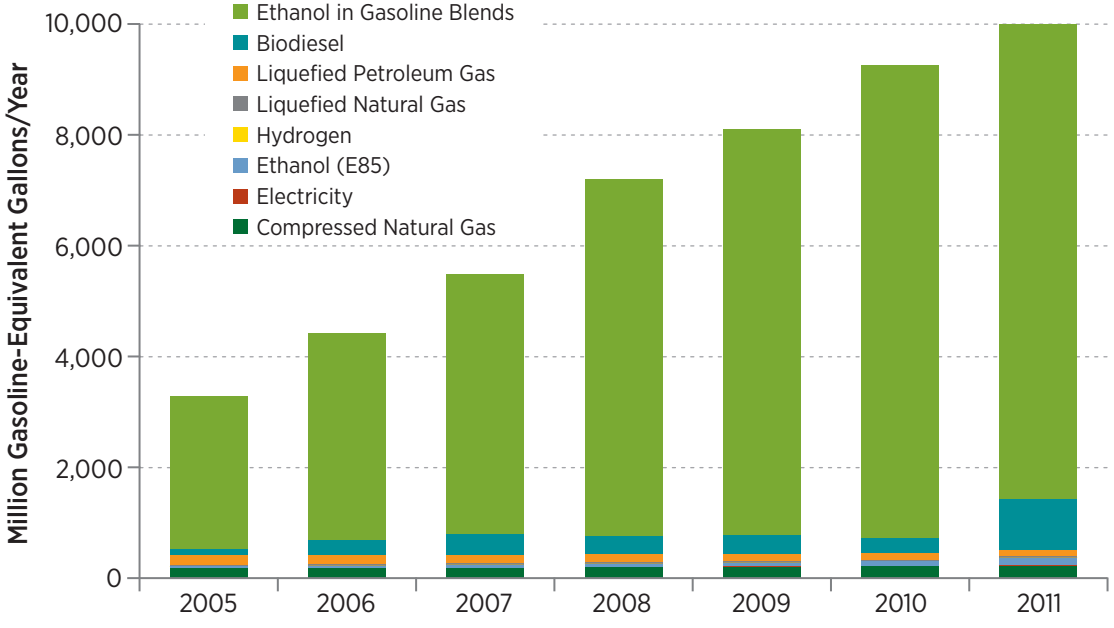
Sources: EERE, EIA
Data as of January 2, 2013

Consumption of Renewable and Alternative Fuel in the United States (2005–2011)

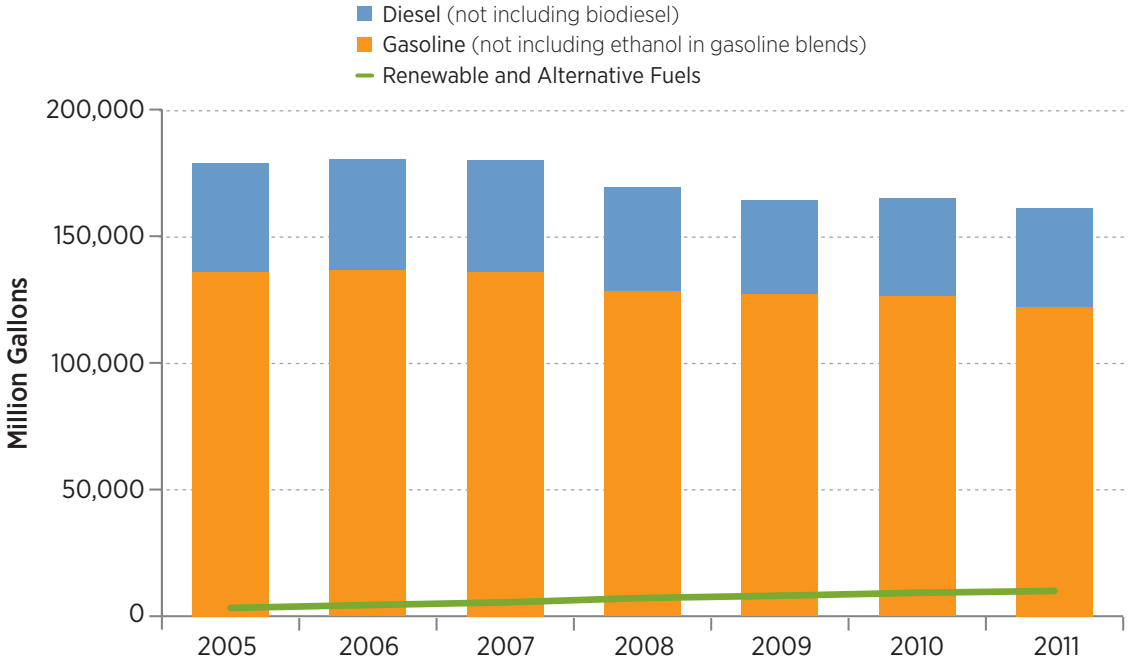
XI



Source: EIA

2012 data are expected to be available around April 2014.

Consumption of Traditional Fuel in the United States (2005–2011)



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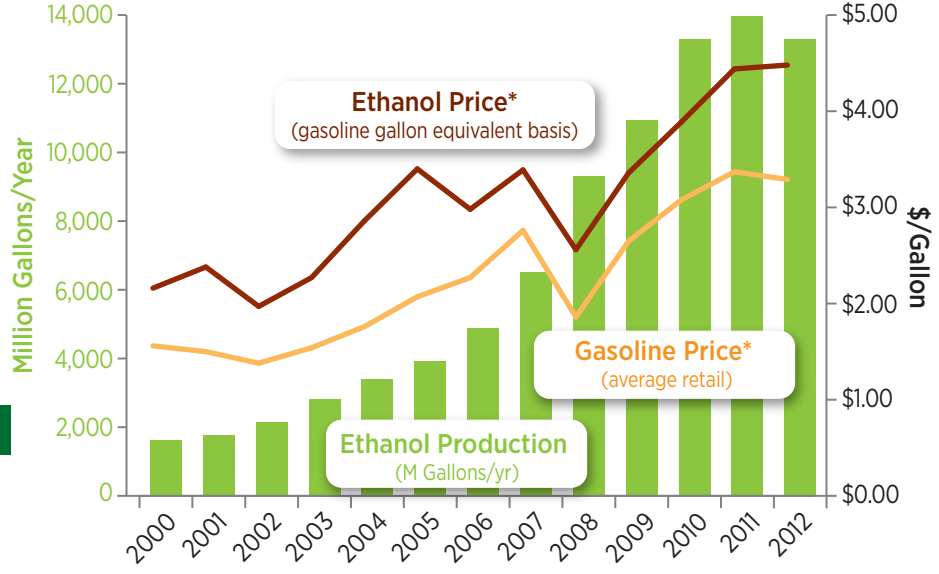
Source: EIA
2012 data are expected to be available around April 2014.

U.S. Corn Ethanol Production and Price Trends

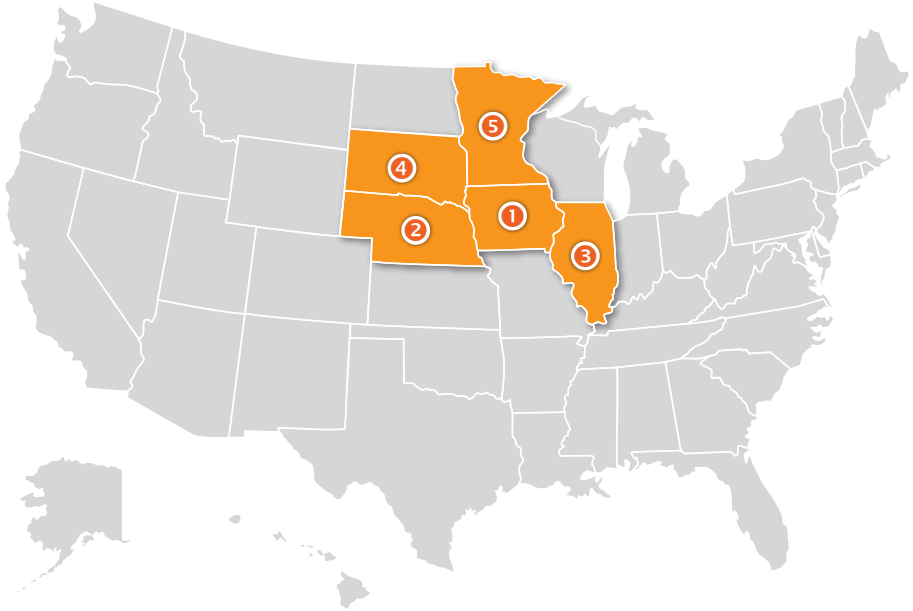


	Gasoline Price (Average Retail, $/gallon)	Ethanol Price (gasoline gallon equivalent basis, $/gallon)	Ethanol Production (million Gallons/ year)
2000	$1.56	$2.16	1,622
2001	$1.50	$2.38	1,765
2002	$1.38	$1.97	2,140
2003	$1.54	$2.27	2,810
2004	$1.76	$2.86	3,404
2005	$2.07	$3.40	3,904
2006	$2.27	$2.98	4,884
2007	$2.76	$3.39	6,521
2008	$1.86	$2.56	9,309
2009	$2.65	$3.36	10,938
2010	$3.08	$3.89	13,298
2011	$3.37	$4.44	13,948
2012	$3.29	$4.48	13,300

Sources: RFA, EERE, EIA

*Prices include taxes.

U.S. Corn Ethanol Production Capacity



Top Five States for U.S. Ethanol (operating) Production Capacity in 2012 (millions of gallons/year)	
1 Iowa	3,843
2 Nebraska	1,744
3 Illinois	1,374
4 South Dakota	1,016
5 Minnesota	1,011

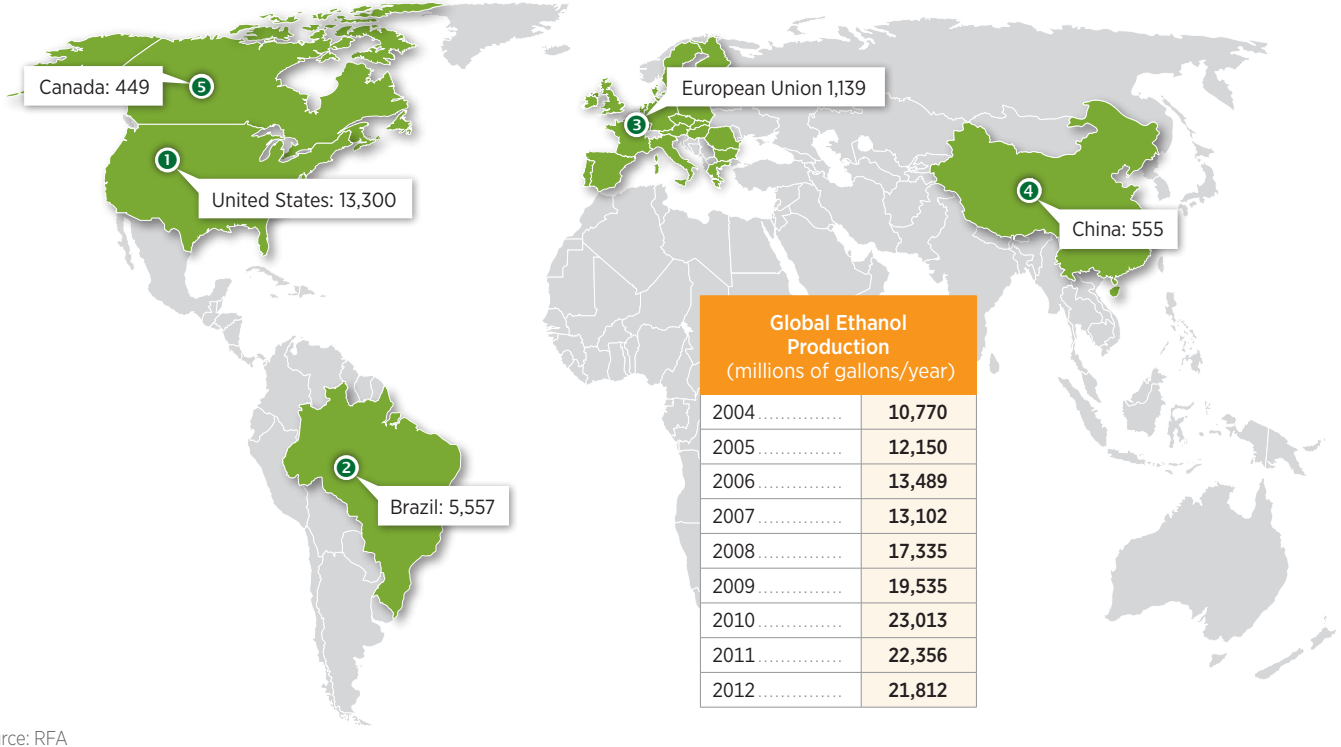
XI

Source: RFA

No sugarcane ethanol is currently produced in the United States.

Global Ethanol* Production

Top Five Countries (2012) **Ethanol Production** (millions of gallons/year)



Global Ethanol Production (millions of gallons/year)	
2004	**10,770**
2005	**12,150**
2006	**13,489**
2007	**13,102**
2008	**17,335**
2009	**19,535**
2010	**23,013**
2011	**22,356**
2012	**21,812**

XI

Source: RFA

* Various feedstocks

Biodiesel: Summary

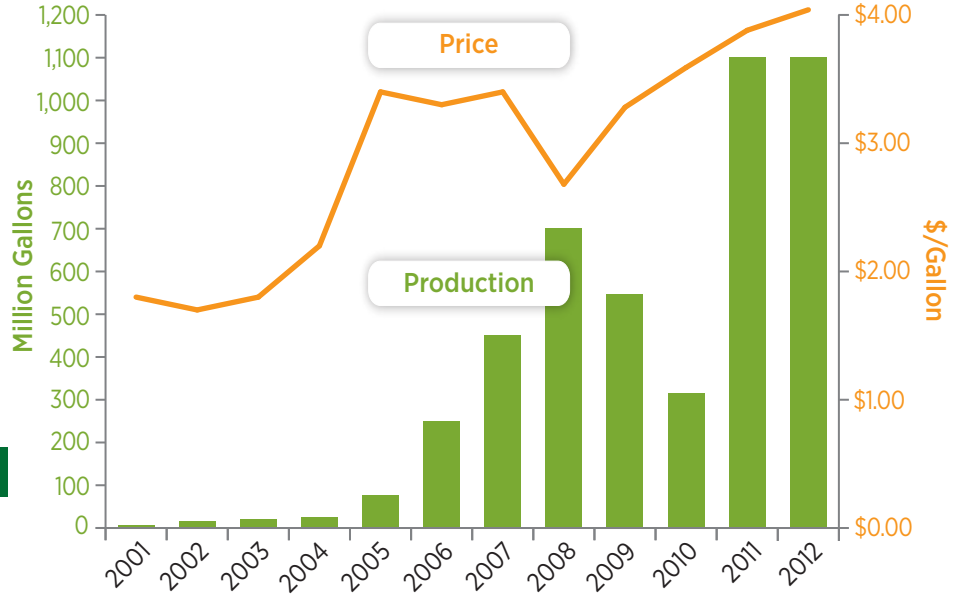
- Biodiesel has expanded from a relatively small production base in 2000 to total U.S. production of **1 billion gallons** in 2012. However, biodiesel still represents a small percentage of the available alternative fuels in the United States, as 12 times more ethanol was produced in 2012.

- Biodiesel production in the United States in 2012 was **214 times** what it was in 2001.

- The United States leads the world in biodiesel production, followed by Argentina, Germany, Brazil, France, and Indonesia.

- Worldwide, biodiesel production globally grew more than 5% from 2011 to 2012.

U.S. Biodiesel Production and Price (2001–2012)

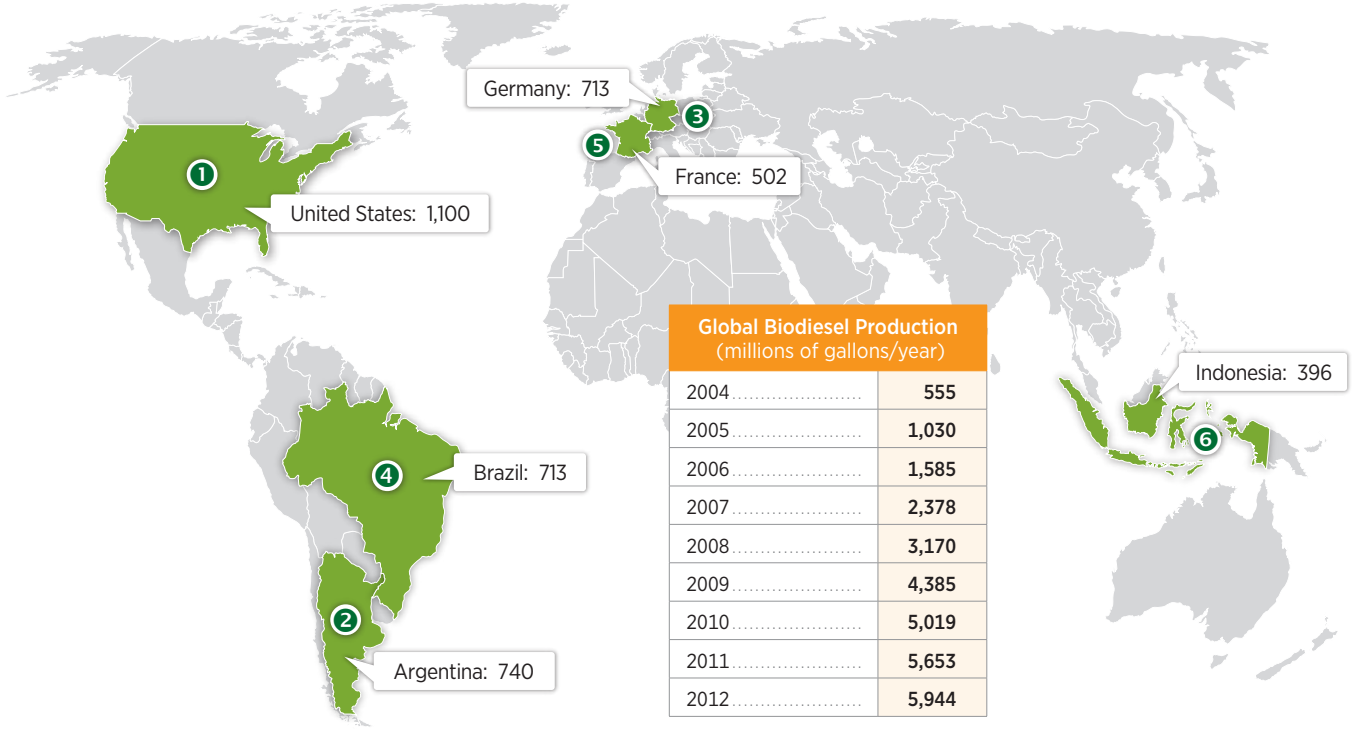


	Biodiesel Price (gasoline gallon equivalent basis) ($ per gallon)	Total U.S. Production (million gallons)
2001	$1.80	5
2002	$1.70	15
2003	$1.80	20
2004	$2.20	25
2005	$3.40	75
2006	$3.30	250
2007	$3.40	450
2008	$2.68	700
2009	$3.28	545
2010	$3.59	315
2011	$3.88	1,100
2012	$4.04	1,100

Sources: Biodiesel.org, EERE

Global Biodiesel Production

Top Countries (2012) **Biodiesel Production** (millions of gallons/year)



Global Biodiesel Production (millions of gallons/year)	
2004	555
2005	1,030
2006	1,585
2007	2,378
2008	3,170
2009	4,385
2010	5,019
2011	5,653
2012	5,944

Source: REN21

XII. Clean Energy Investments

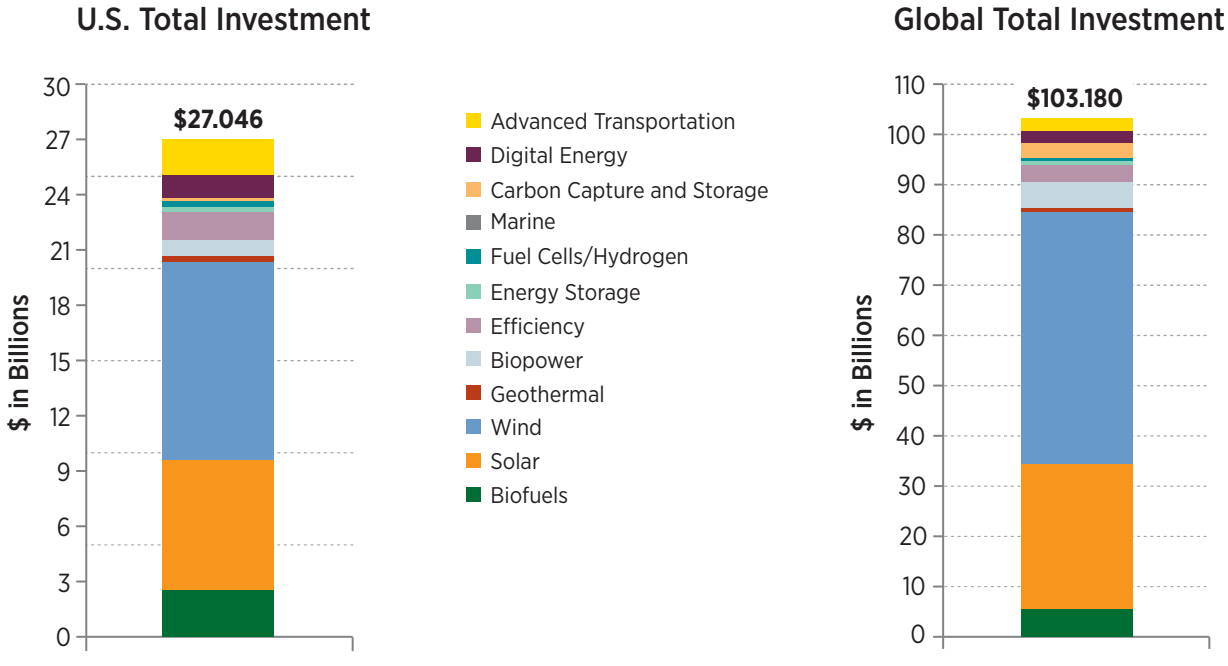
Clean Energy Investments: Summary

- U.S. investment in renewable energy has grown dramatically in the past decade, and in **2012 annual investment reached more than $27 billion**.
- U.S. investment in wind energy projects **grew from $385 million in 2001 to nearly $11 billion in 2012**.
- In 2012, U.S. venture capital and private equity investment in renewable energy technology companies was nearly **$5 billion—up from $360 million in 2001**.
- U.S. venture capital and private equity investment in solar technology companies has **increased from $50 million in 2001 to nearly $1.2 billion in 2012**.

XII

*All figures in 2012 real dollars and do not include federal government spending

U.S. and Global Total Investment in Renewable Energy (2012)



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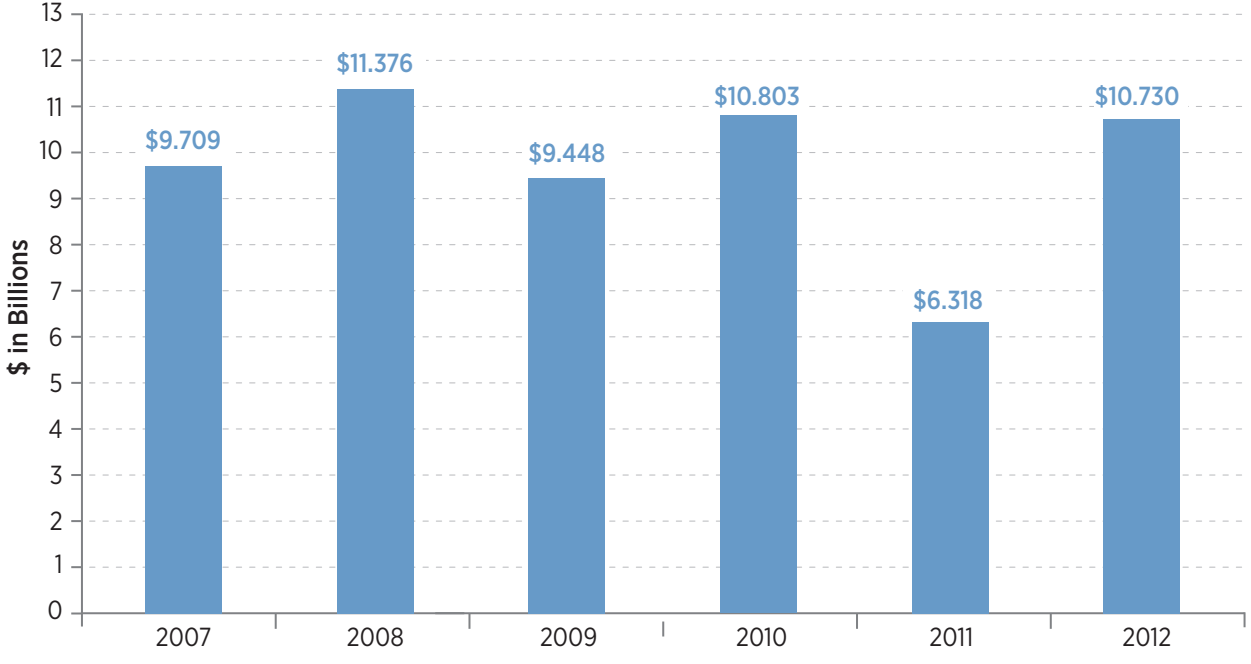
Source: Bloomberg New Energy Finance

Completed and disclosed deals only, does not adjust for undisclosed transactions; includes VC/PE, public market activity, and asset financing

U.S. Wind Energy Project Asset Financing Transactions (2007–2012)



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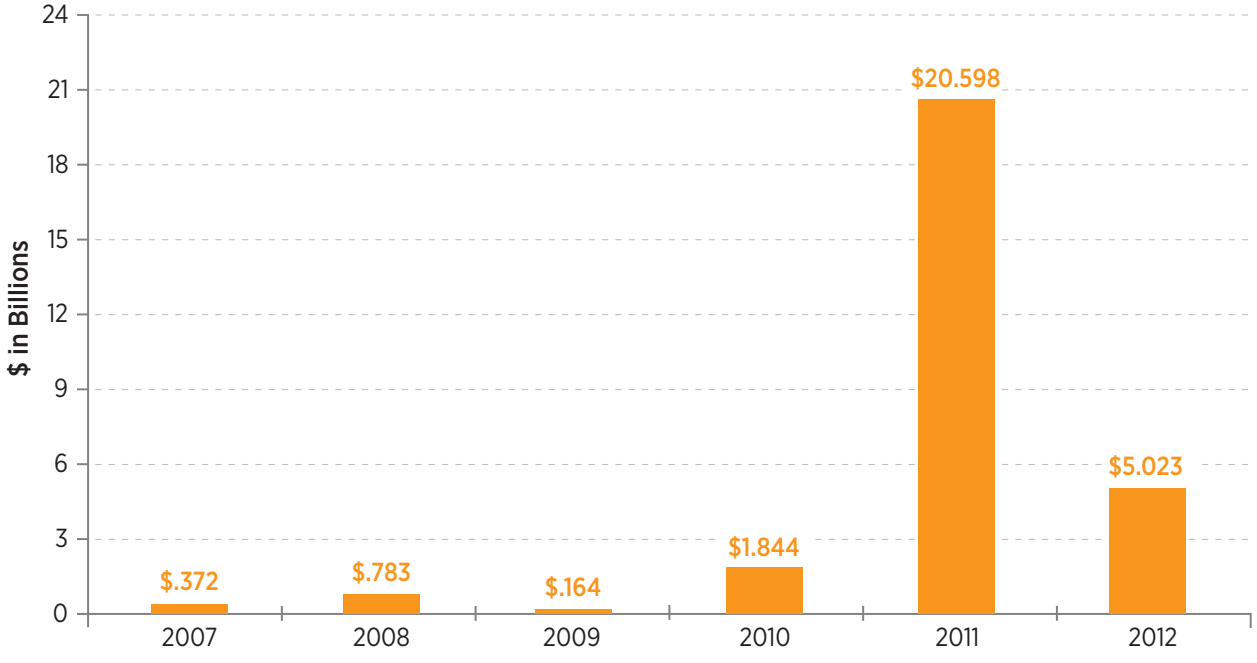
*All figures in 2012 real dollars.

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

U.S. Solar Energy Project Asset Financing Transactions (2007–2012)



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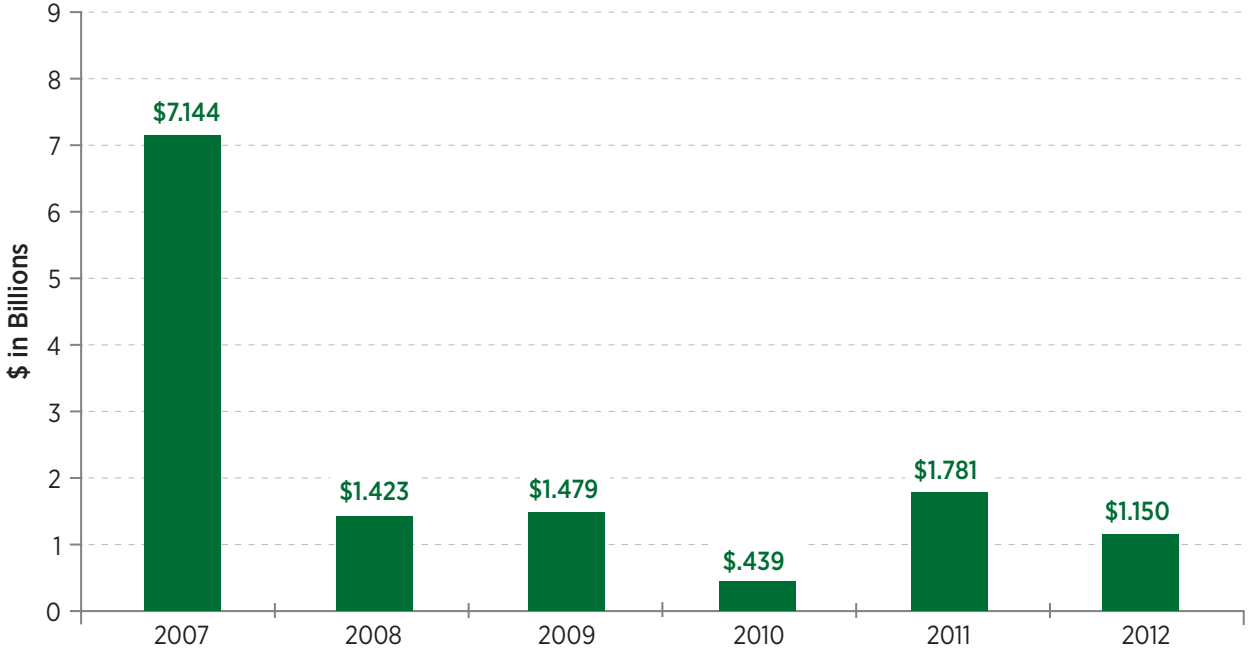
*All figures in 2012 real dollars.

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

U.S. Biofuel Project Asset Financing Transactions (2007–2012)



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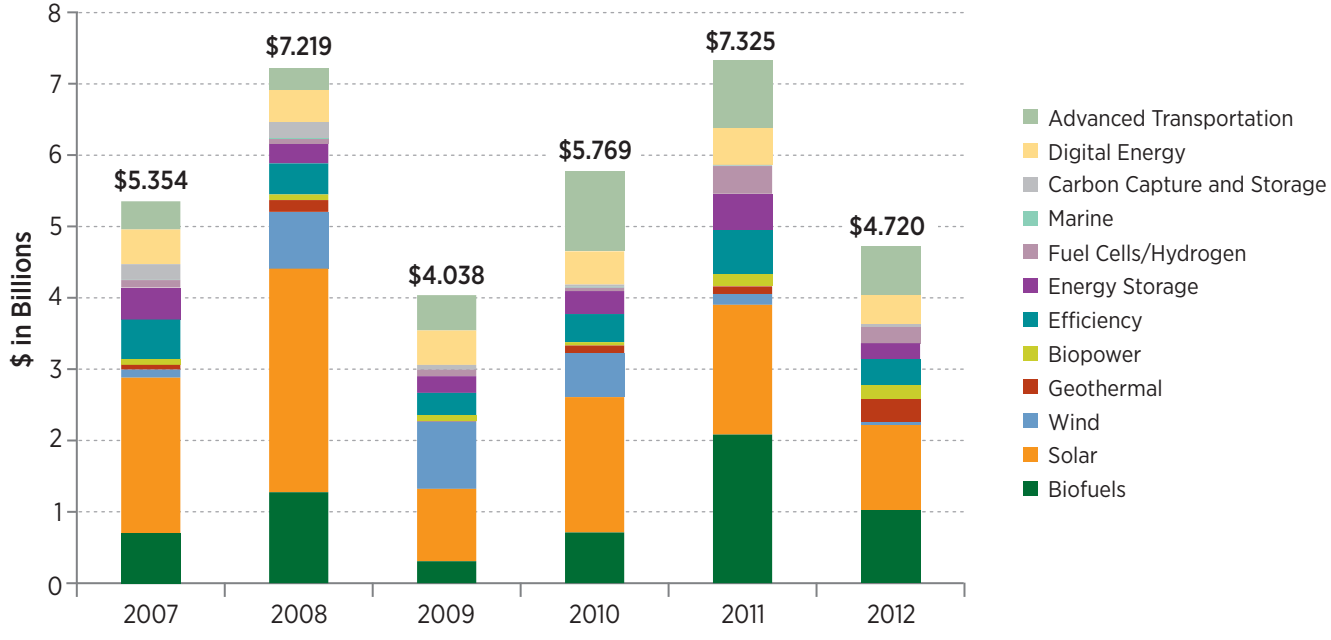
*All figures in 2012 real dollars.

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

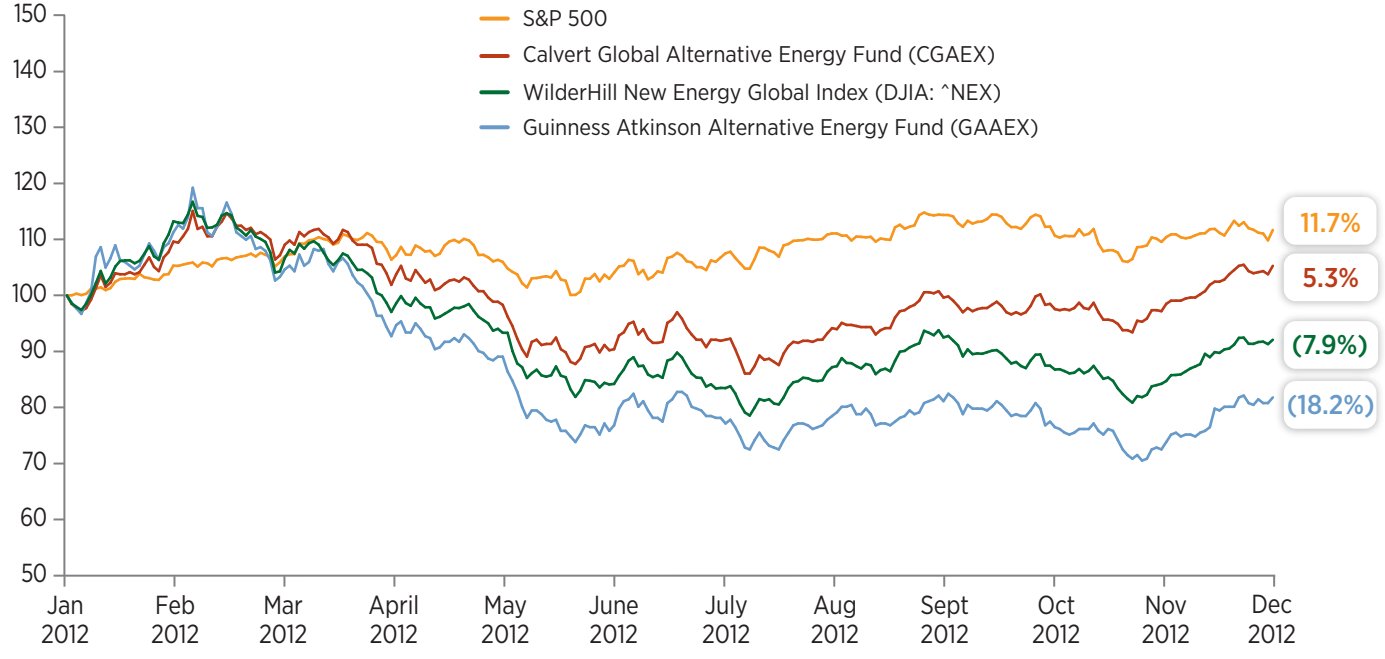
U.S. Venture Capital and Private Equity Investment in Renewable Energy Technology Companies (2007–2012)



*All figures in 2012 real dollars.

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

Public Renewable Energy Index Performance (2012) (Indexed to 100)



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Source: Public data; downloaded from the Yahoo! Finance website

Index performance is calculated as a percentage of the fund or index price as of January 2, 2012.

Glossary

B2O

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

Baseload 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 those derived from 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.

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 a given period of time 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.

Digital Energy

The integration of digital communication technologies into energy systems, especially the electrical grid. Smart meters, along with other digital communication devices embedded in electrical transmission and distribution systems, allow for a two-way flow of information between utilities and their customers as well as greater digital control of the electrical grid, a concept known as the Smart Grid.

E85

A fuel containing a mixture of 85% ethanol and 15% 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% 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, some 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% 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 that produces electricity 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.

Generation

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

Geothermal Energy

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

Geothermal Heat Pump

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

Gigawatt (GW)

One billion watts or one thousand megawatts or one million kW.

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 electrical energy 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.

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

PV cells convert incident light directly into electricity (direct current). 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.

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.

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, hydropower, geothermal, solar, wind, and ocean energy.

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.

Solar Thermal Electric Generation (STEG)

Conversion of solar energy to electricity using various technologies to heat a working fluid to power a turbine that drives a generator. Examples of these systems include central receiver systems, parabolic dish, and solar trough.

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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