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

2015 Renewable Energy Data Book

Acknowledgments

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Notes

Capacity data are reported in watts of alternating current (AC) unless indicated otherwise.

The primary data represented and synthesized in the *2015 Renewable Energy Data Book* come from the publicly available data sources identified on page 122.

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Key Findings

- **The overall U.S. energy consumption** decreased to 97.7 quadrillion British thermal units (Btu) in 2015—a **0.6% decline** from 2014. Compared to 2014, energy consumption remained at similar levels in 2015 for renewables (+0.1%) and nuclear (+0.0%), while consumption from natural gas (+3.0%) and petroleum (+1.4%) increased. Consumption from coal continued to decline, dropping by 13.5%.
- U.S. **electric power sector energy consumption** decreased to 38.1 quadrillion Btu in 2015, a **1.3% decline** from 2014.[1]
- **In 2015, U.S. renewable electricity[2] grew to 16.7% of total installed capacity and 13.8% of total electricity generation**. Installed renewable electricity capacity exceeded 194 gigawatts (GW) in 2015, generating 567 terawatt-hours (TWh).
- **The combined share of wind and solar as a percentage of total renewable generation continues to grow in the United States. U.S. hydropower produced more than 44% of total renewable electricity generation, wind produced 34%, biomass produced 11%, solar (photovoltaic [PV] and concentrating solar power [CSP])[3] produced 8%, and geothermal produced 3%**.
- In 2015, **renewable electricity accounted for 64% of U.S. electricity capacity additions**, compared to 52% in 2014. **Approximately 15 GW of coal-fired generation retired in 2015, the highest in a single year to date**.[4]

[1] Source: U.S. Energy Information Administration (EIA); full references are provided beginning on page 123.
[2] Renewable electricity includes solar, wind, geothermal, hydropower, and biopower unless indicated otherwise.
[3] Reported solar data combine PV and CSP unless indicated otherwise.
[4] Source: Based on EIA reporting of electric power plant retirements since 1950.

Key Findings (continued)

- In 2015, wind electricity **installed capacity increased by more than 12% (8.1 GW), accounting for more than 56% of U.S. renewable electricity capacity installed in 2015**. U.S. wind generation increased by 5.1% compared to 2014.
- **U.S. solar electricity installed capacity increased by 36% (5.6 GW_{ac}), accounting for nearly 40% of newly installed U.S. renewable electricity capacity in 2015**.[1] **Solar generation also increased by 36% (11.7 TWh)**.
- **U.S. electricity capacities of biomass, geothermal, and hydropower remained relatively stable from 2000 to 2015**.
- **Installed *global* renewable electricity capacity continued to increase, and it represented 29.5% of total electricity capacity worldwide in 2015**.[2]
- **Worldwide, solar PV continued to be one of the fastest-growing renewable electricity** technologies—in 2015, global capacity increased by 28%, the same rate as in 2014.
- **Globally, new investments in clean energy in 2015 grew by more than 4% from 2014 to $329 billion**.

[1] Capacity data are reported in watts of alternating current (AC) unless indicated otherwise; Includes grid-connected residential, non-residential, and utility market segments.

[2] Source: EIA

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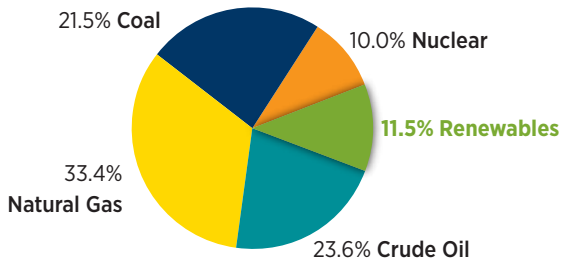
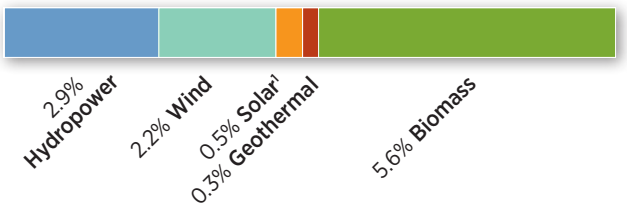
I. U.S. Energy Background Information

U.S. Energy Production and Consumption (2015)

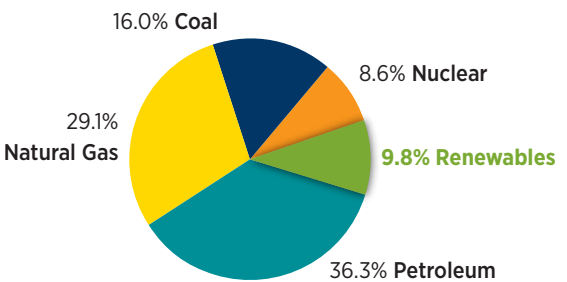
U.S. Energy Production (2015): 83.5 Quadrillion Btu



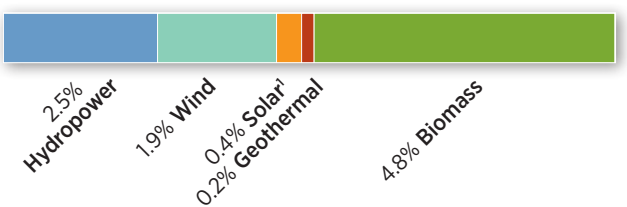
U.S. Renewable Energy Production: 9.6 Quadrillion Btu



U.S. Energy Consumption (2015): 97.7 Quadrillion Btu



U.S. Renewable Energy Consumption: 9.6 Quadrillion Btu



Source: U.S. Energy Information Administration (EIA)

The difference in the amount of energy consumed and produced is made up by net imports and changes in stockpiles of energy.

All data are reported as primary energy. Data include only on-grid generation systems of 1 MW or higher in capacity.

Reported values may vary from those included in previous versions of the Data Book due to retroactive changes by EIA.

[1] Grid-connected distributed capacity and associated generation of 1 MW or less, which comprises about 1% of total electricity generation from all utility-scale sources reported by EIA, is included in subsequent figures in later sections.

U.S. Energy Production by Energy Source

	Coal	Natural Gas[1]	Crude Oil	Nuclear	Renewables	Total Production (Quadrillion Btu)
2005	34.6%	27.7%	16.4%	12.2%	9.3%	67.1
2006	34.8%	27.8%	15.7%	12.0%	9.6%	68.4
2007	34.0%	28.7%	15.6%	12.3%	9.4%	69.0
2008	33.7%	29.2%	15.0%	11.9%	10.2%	70.8
2009	30.9%	30.2%	16.2%	11.9%	10.9%	70.1
2010	30.6%	30.3%	16.1%	11.7%	11.2%	71.9
2011	29.7%	31.2%	15.9%	11.0%	12.1%	74.9
2012	27.3%	32.5%	18.1%	10.6%	11.5%	75.8
2013	25.6%	31.8%	20.2%	10.6%	11.8%	78.1
2014	24.4%	31.9%	22.2%	10.0%	11.5%	83.2
2015	21.5%	33.4%	23.6%	10.0%	11.5%	83.5

Source: EIA

Data include only on-grid generation systems of 1 MW or higher in capacity.

Annual totals may not equal 100% due to rounding.

Reported values may vary from those included in previous versions of the Data Book due to retroactive changes by EIA.

[1] Includes natural gas liquids.

U.S. Energy Consumption by Energy Source

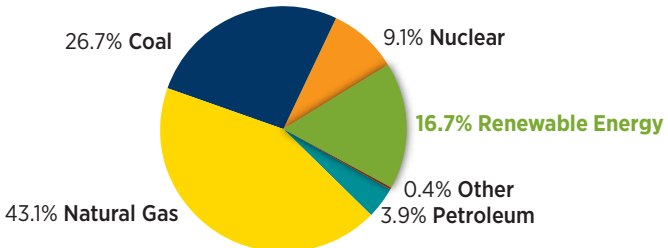
	Coal	Natural Gas	Petroleum	Nuclear	Renewables	Total Consumption (Quadrillion Btu)
2005	22.8%	22.5%	40.2%	8.1%	6.2%	100.1
2006	22.6%	22.4%	40.1%	8.3%	6.7%	99.4
2007	22.5%	23.4%	39.1%	8.4%	6.5%	101.0
2008	22.6%	24.1%	37.3%	8.5%	7.3%	98.9
2009	20.9%	24.9%	37.1%	8.9%	8.1%	94.1
2010	21.4%	25.2%	36.4%	8.7%	8.2%	97.4
2011	20.3%	25.8%	36.0%	8.5%	9.3%	96.8
2012	18.4%	27.6%	36.0%	8.5%	9.2%	94.4
2013	18.6%	27.6%	35.6%	8.5%	9.5%	97.2
2014	18.3%	27.9%	35.4%	8.5%	9.7%	98.4
2015	16.0%	29.1%	36.3%	8.6%	9.8%	97.4

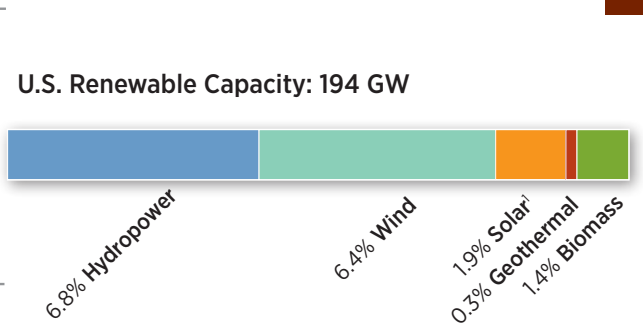
Source: EIA

Reported values may vary from those included in previous versions of the Data Book due to retroactive changes by EIA.

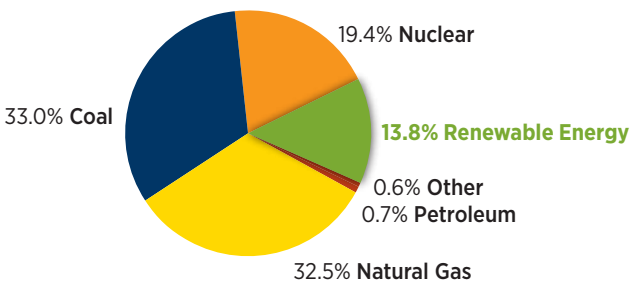
U.S. Electricity Nameplate Capacity and Generation (2015)

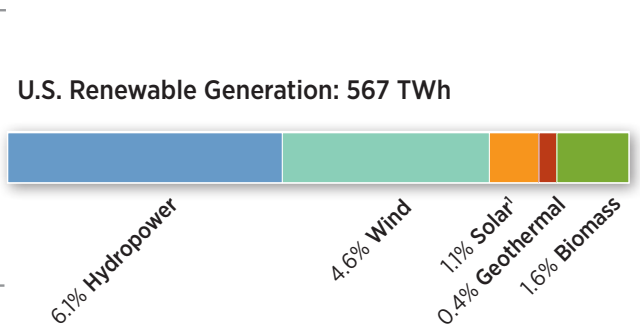
U.S. Electric Nameplate Capacity (2015): 1,160 GW





U.S. Electric Net Generation (2015): 4,110 TWh





Sources: EIA, Lawrence Berkeley National Laboratory (LBNL), Solar Energy Industries Association (SEIA)/GTM Research (GTM)

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

Totals and percentages may not correspond due to rounding.

[1] Grid-connected only; solar generation assumes a 25% capacity factor for CSP and an 18% capacity factor for PV. A de-rate factor of 77% has been applied to convert PV installed nameplate capacity from MWdc to MWac.

U.S. Electricity Generating Capacity by Source

	Coal	Petroleum	Natural Gas	Other Gases	Nuclear	Renewables[1]	Other	Total Capacity (MW)
2005	32.1%	6.2%	41.7%	0.2%	10.1%	9.7%	0.1%	1,047,965
2006	31.8%	6.1%	41.9%	0.2%	10.0%	9.9%	0.1%	1,056,575
2007	31.5%	5.8%	42.1%	0.2%	9.9%	10.3%	0.1%	1,067,160
2008	30.5%	5.6%	41.4%	0.2%	9.6%	11.1%	0.1%	1,083,237
2009	30.7%	5.7%	41.7%	0.2%	9.7%	11.9%	0.1%	1,102,320
2010	30.6%	5.6%	41.7%	0.3%	9.5%	12.2%	0.1%	1,119,998
2011	30.3%	5.1%	42.1%	0.2%	9.4%	12.8%	0.1%	1,135,259
2012	29.2%	4.6%	42.3%	0.2%	9.4%	14.1%	0.1%	1,150,452
2013	28.8%	4.5%	42.6%	0.3%	9.0%	14.6%	0.1%	1,152,263
2014	28.1%	4.2%	42.8%	0.3%	9.0%	15.5%	0.1%	1,158,438
2015	26.7%	3.9%	43.1%	0.3%	9.1%	16.7%	0.1%	1,159,559

Sources: EIA, LBNL, SEIA/GTM

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

Reported values may vary from those included in previous versions of the Data Book due to retroactive changes in source data.

[1] Grid-connected PV only; a de-rate factor of 77% has been applied to convert PV installed nameplate capacity from MWdc to MWac.

U.S. Electricity Generation by Source

	Coal	Petroleum Liquids	Petroleum Coke	Natural Gas	Other Gases	Nuclear	Renewables[1]	Other	Total Generation (GWh)
2005	49.5%	2.5%	0.6%	18.7%	0.3%	19.2%	8.8%	0.3%	4,062,573
2006	48.9%	1.1%	0.5%	20.0%	0.3%	19.3%	9.5%	0.3%	4,072,064
2007	48.4%	1.2%	0.4%	21.5%	0.3%	19.4%	8.5%	0.3%	4,164,734
2008	48.1%	0.8%	0.3%	21.4%	0.3%	19.5%	9.3%	0.3%	4,126,985
2009	44.4%	0.7%	0.3%	23.3%	0.3%	20.2%	10.6%	0.3%	3,956,872
2010	44.7%	0.6%	0.3%	23.9%	0.3%	19.5%	10.4%	0.3%	4,133,667
2011	42.2%	0.4%	0.3%	24.7%	0.3%	19.2%	12.6%	0.3%	4,112,099
2012	37.3%	0.3%	0.2%	30.2%	0.3%	18.9%	12.4%	0.3%	4,061,061
2013	38.7%	0.3%	0.3%	27.6%	0.3%	19.3%	13.1%	0.3%	4,082,687
2014	38.4%	0.4%	0.3%	27.4%	0.3%	19.4%	13.5%	0.3%	4,115,446
2015	33.0%	0.4%	0.3%	32.5%	0.3%	19.4%	13.8%	0.3%	4,110,296

Sources: EIA, SEIA/GTM

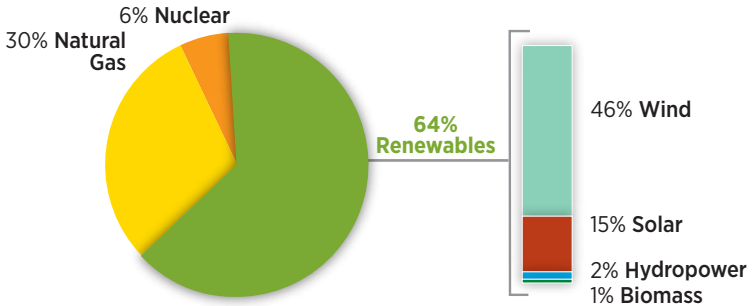
Other includes pumped storage, batteries, chemicals, hydrogen, pitch, purchased steam, sulfur, tire-derived fuels, and miscellaneous technologies.

Reported values may vary from those included in previous versions of the Data Book due to retroactive changes in source data.

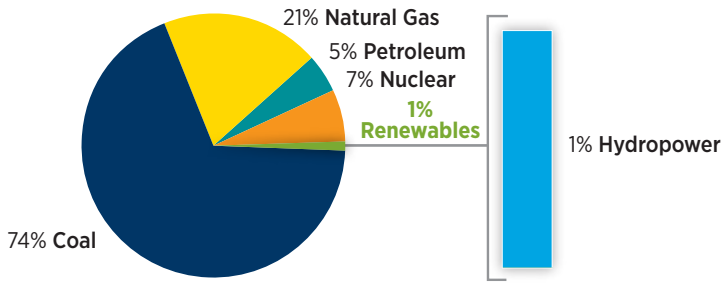
[1] Includes generation from CSP and grid-connected PV; assumes a 25% capacity factor for CSP and an 18% capacity factor for PV.

U.S. Electricity Generating Capacity Additions and Retirements (2015)

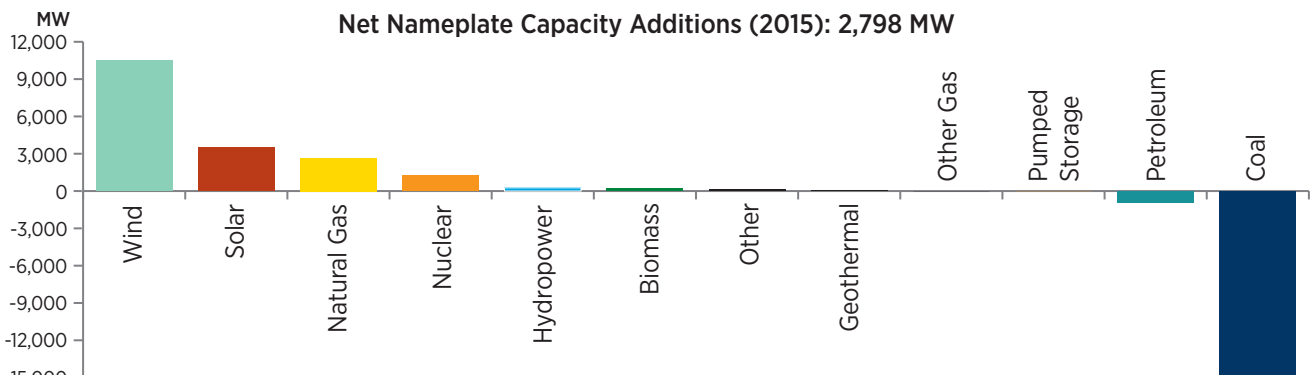
Capacity Additions (2015): 22,995 MW



Capacity Retirements (2015): 21,197 MW



Net Nameplate Capacity Additions (2015): 2,798 MW



Source: EIA

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

Capacity additions and retirements below 1% of total are not displayed.

Reported values for capacity additions may differ from those reported in other sections of the Data Book due to use of different data sources.

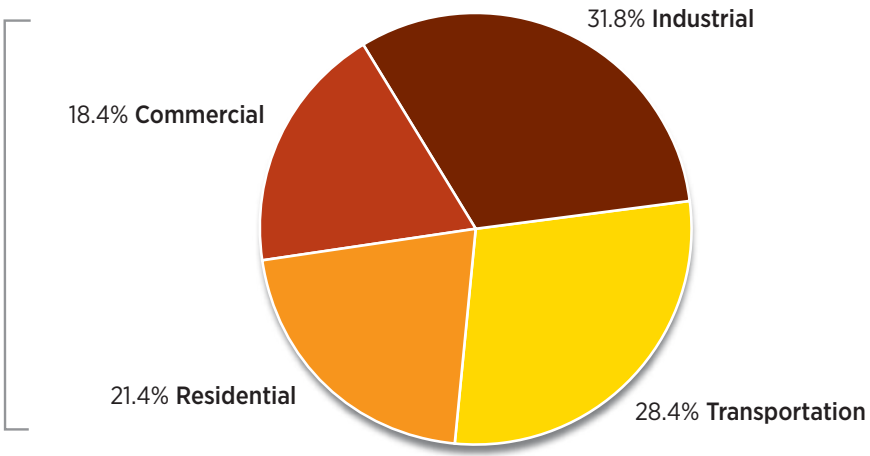
Totals may not equal 100% due to rounding.

Capacity additions and retirements include on-grid systems of 1 MW or higher in capacity. Retirements include generators which were cancelled prior to completion/operation and retired generators at existing plants.

U.S. Energy Consumption by Sector (2015)

U.S. Energy Consumption (2015): 97.7 Quadrillion Btu

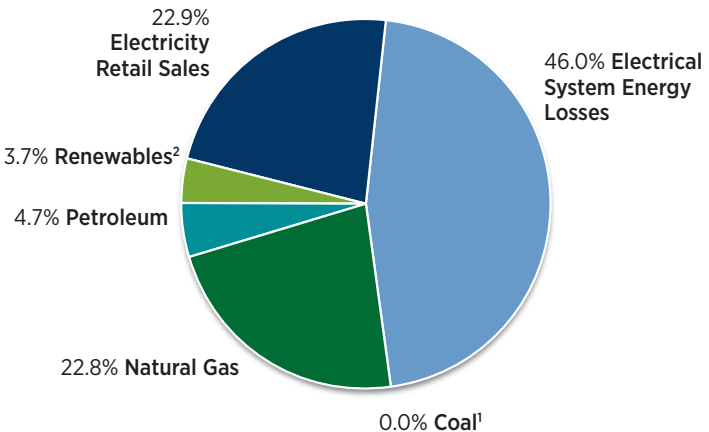
U.S. buildings represent 39.8% of total energy use (residential and commercial sectors are combined).



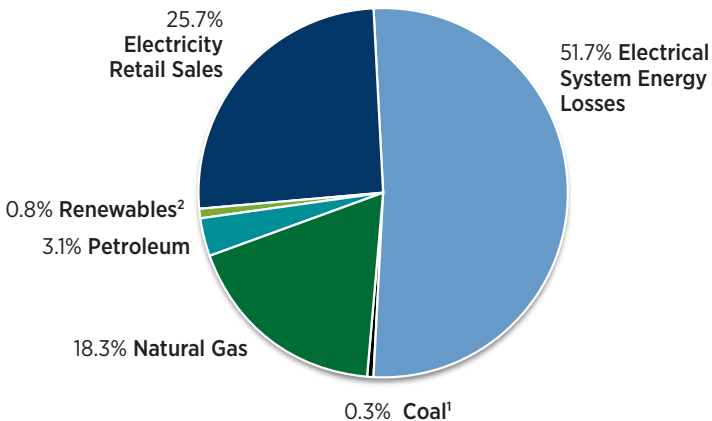
Source: EIA
Totals may not equal 100% due to rounding.

U.S. Energy Consumption – Residential and Commercial (2015)

2015 Residential Energy Consumption
20.9 Quadrillion Btu



2015 Commercial Energy Consumption
18.0 Quadrillion Btu



Source: EIA

[1] While coal is a small direct contributor to residential and commercial energy consumption, coal is a major fuel for electricity generation and therefore contributes to electricity retail sales and electrical system energy losses.

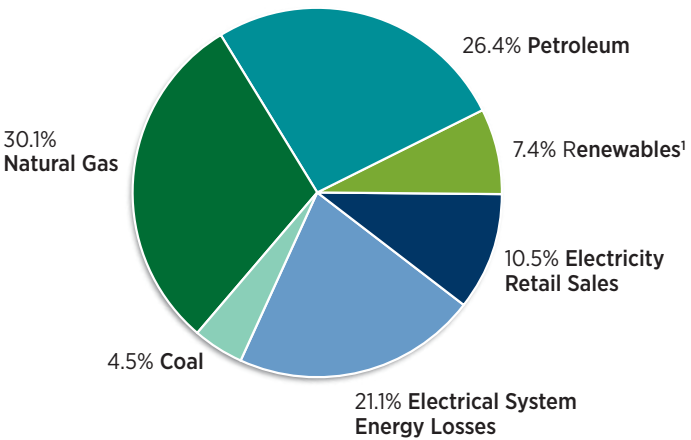
[2] The direct renewables contribution consists primarily of wood and wood-derived fuels, municipal solid waste, solar thermal direct-use energy and PV electricity net generation, and geothermal heat pump and direct-use energy.

U.S. Energy Consumption – Industry and Transportation (2015)

I

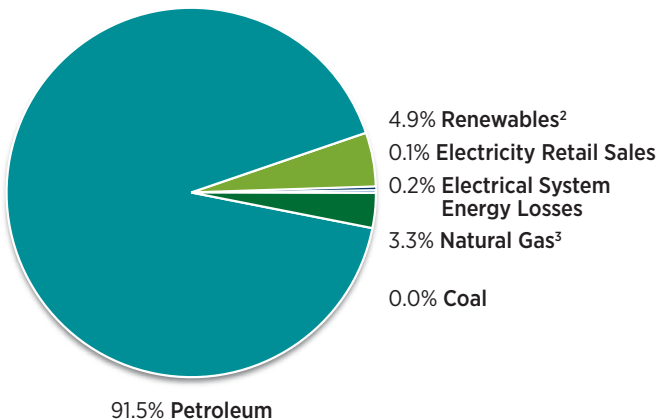
2015 Industrial Energy Consumption

31.1 Quadrillion Btu



2015 Transportation Energy Consumption

27.7 Quadrillion Btu



Source: EIA

[1] For industrial consumption, the direct renewables contribution consists primarily of wood and wood-derived fuels, municipal solid waste, and conventional hydropower.

[2] For transportation consumption, the direct renewables contribution consists primarily of fuel ethanol and biodiesel.

[3] For transportation consumption, more than 96% of natural gas is used in the operation of pipelines, primarily in compressors.

II. Renewable Electricity in the United States

Renewable Electricity in the United States: Summary

- U.S. renewable electricity in 2015 was **16.7% of total installed electricity capacity** and **13.8% of total annual generation in the United States**.
- Since 2005, cumulative installed renewable electricity capacity has grown 91%, from 101 GW to **more than 194 GW in 2015**. This growth is equivalent to an average of 9.3 GW installed capacity per year and a **6.7% per year** compound annual growth rate (CAGR).
- **U.S. renewable electricity capacity expanded by 8.0% in 2015**, up from a 6.8% increase in 2014.
- Overall **renewable generation increased 2.4%** in 2015. Solar electricity generation increased by 35.8% (11.7 TWh) and wind electricity generation increased by 5.1% (9.3 TWh), while generation from hydropower dropped by 3.2% (-8.2 TWh).
- U.S. **annual electricity generation from solar and wind** has **increased by a factor of 12** since 2005.

- **Wind** electricity capacity grew 8.1 GW in 2015, a 12.3% increase from 2014, to represent **6.4% of U.S. cumulative installed electricity capacity**. Wind electricity accounted for 56.5% of newly installed U.S. renewable electricity capacity and 46% of newly installed electricity capacity from all generation sources[1] in 2015.

- **Solar electricity capacity expanded by 5.7 GW_{ac}, including 5.6 GW_{ac} (7.3 GW_{dc}) for solar PV[2] and 0.1 GW_{ac} for CSP, to represent 1.9% of U.S. cumulative installed electricity capacity. Solar accounted for nearly 40% of newly installed U.S. renewable electricity capacity and 15% of newly installed electricity capacity from all generation sources[1] in 2015**.

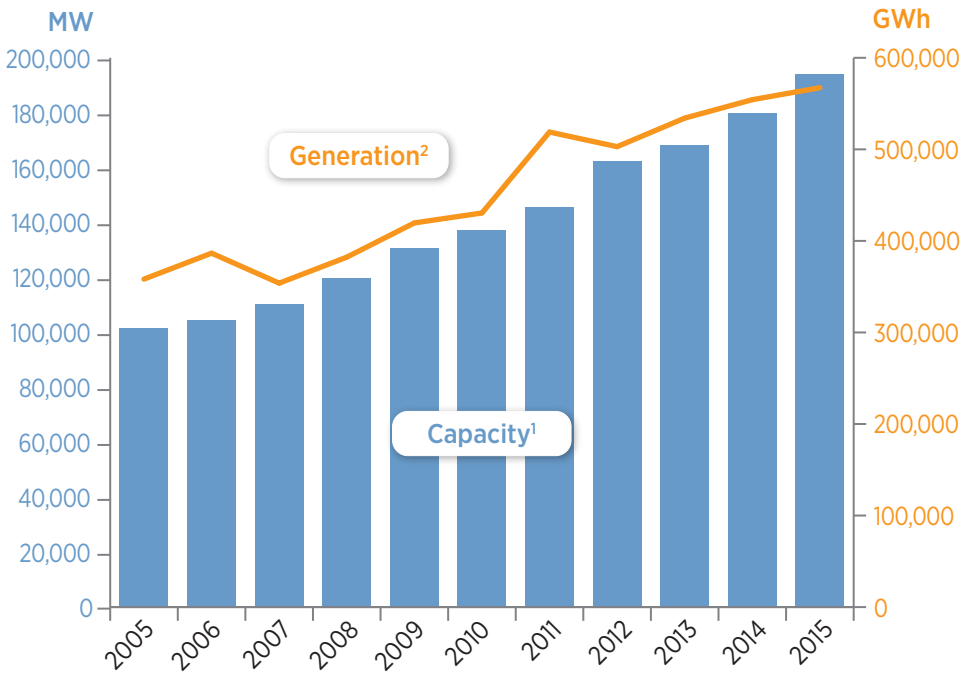
- In 2015, the electricity capacities of **biomass, geothermal, and hydropower continued the stable trend they have maintained** since 2000.

- In 2015, **U.S. hydropower produced more than 44% of total renewable electricity generation, wind produced 34%, biomass produced 11%, solar** (PV and CSP) **produced 8%, and geothermal produced 3%.**

[1] Source: EIA (see page 13)

[2] Includes grid-connected residential, non-residential, and utility market segments.

U.S. Capacity and Generation: All Renewables



	Total Nameplate Capacity[1] (MW)	Total Generation[2] (GWh)
2000	93,668	356,789
2001	95,239	288,008
2002	96,102	343,740
2003	97,765	355,685
2004	98,469	351,465
2005	101,374	358,244
2006	104,358	386,576
2007	110,044	353,840
2008	119,701	382,242
2009	130,662	419,638
2010	137,096	430,483
2011	145,373	518,874
2012	162,170	502,918
2013	168,259	534,115
2014	179,687	554,247
2015	194,055	567,348

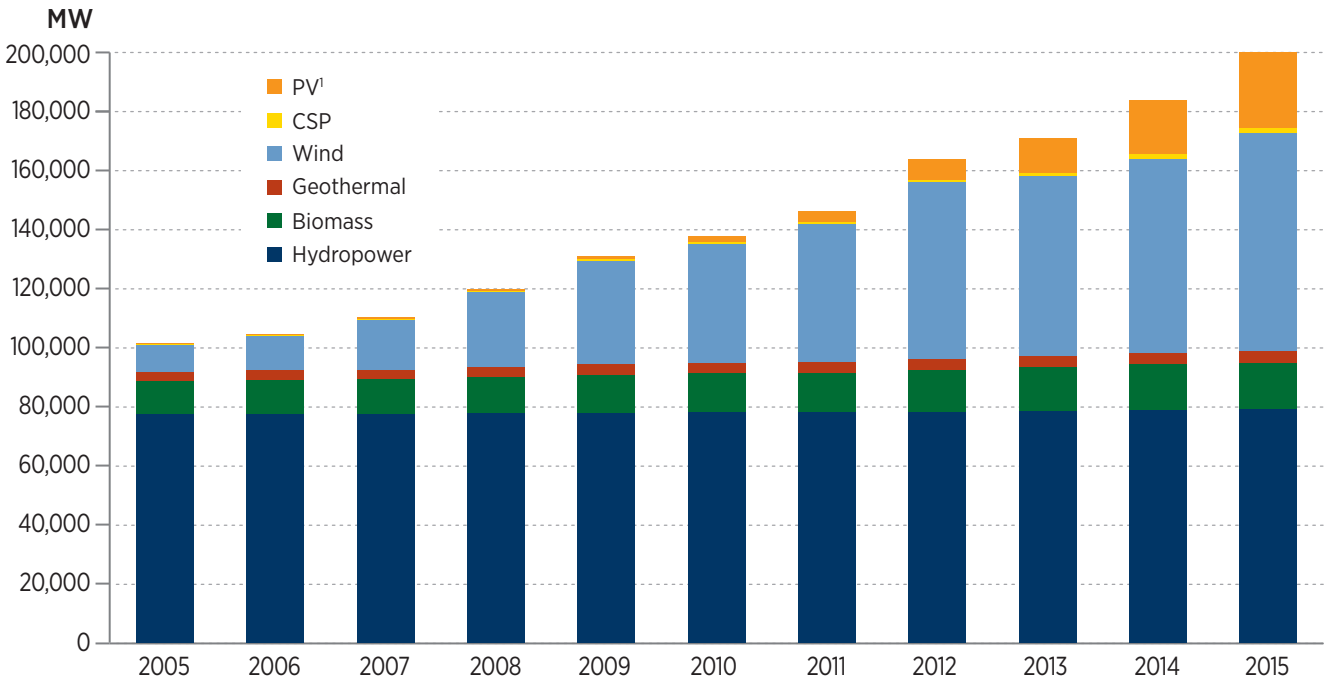
Sources: EIA, LBNL, SEIA/GTM

Reported values may vary from those included in previous versions of the Data Book due to retroactive changes in source data.

[1] Includes grid-connected PV capacity only; a de-rate factor of 77% has been applied to convert PV installed nameplate capacity from MWdc to MWac.

[2] Solar generation assumes a 25% capacity factor for CSP and an 18% capacity factor for PV.

U.S. Renewable Electricity Nameplate Capacity by Source



Sources: EIA, LBNL, SEIA/GTM

Reported values may vary from those included in previous versions of the Data Book due to retroactive changes in source data.

[1] Grid-connected only; a de-rate factor of 77% has been applied to convert PV installed nameplate capacity from MWdc to MWac.

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

	Solar PV[1]	CSP	Wind	Geothermal	Biomass	Hydropower	Total Capacity Added[2]	Capacity Added as a Percentage of Total Renewable Energy
2005	79	0	2,396	35	189	224	**2,905**	**3%**
2006	105	1	2,454	53	331	65	**2,984**	**3%**
2007	160	64	5,237	64	185	13	**5,686**	**5%**
2008	298	0	8,425	47	747	208	**9,657**	**8%**
2009	385	11	9,918	115	351	270	**10,961**	**8%**
2010	852	78	5,112	77	218	294	**6,435**	**5%**
2011	1,925	0	6,649	2	154	-10	**8,277**	**6%**
2012	3,372	0	13,089	224	840	47	**16,797**	**10%**
2013	4,761	410	1,102	37	658	216	**6,089**	**4%**
2014	6,247	767	4,772	24	703	353	**11,429**	**6%**
2015	7,260	110	8,113	24	287	243	**14,368**	**7%**

Sources: EIA, LBNL, SEIA/GTM

Reported values may vary from those included in previous versions of the Data Book due to retroactive changes in source data.

[1] Grid-connected only; solar PV is reported in MWdc.

[2] A de-rate factor of 77% has been applied to convert PV installed nameplate capacity from MWdc to MWac in the calculation of total capacity added.

Cumulative U.S. Renewable Electricity Nameplate Capacity (MW) and Annual Percentage Change

	Hydropower	Solar PV[1]	CSP	Wind	Geothermal	Biomass	Total Renewables[2]
2005	77,354 (0.3%)	234 (51.0%)	354 (0.0%)	9,121 (35.6%)	3,143 (1.1%)	11,222 (1.7%)	101,374 (2.9%)
2006	77,419 (0.1%)	339 (44.9%)	355 (0.3%)	11,575 (26.9%)	3,195 (1.7%)	11,553 (2.9%)	104,358 (2.9%)
2007	77,432 (0.0%)	499 (47.2%)	419 (18.0%)	16,812 (45.2%)	3,259 (2.0%)	11,738 (1.6%)	110,044 (5.4%)
2008	77,640 (0.3%)	797 (59.7%)	419 (0.0%)	25,237 (50.1%)	3,306 (1.4%)	12,485 (6.4%)	119,701 (8.8%)
2009	77,910 (0.3%)	1,182 (48.3%)	430 (2.6%)	35,155 (39.3%)	3,421 (3.5%)	12,836 (2.8%)	130,662 (9.2%)
2010	78,204 (0.4%)	2,034 (72.1%)	508 (18.1%)	40,267 (14.5%)	3,498 (2.3%)	13,053 (1.7%)	137,096 (4.9%)
2011	78,194 (0.0%)	3,959 (94.6%)	508 (0.0%)	46,916 (16.5%)	3,500 (0.1%)	13,207 (1.2%)	145,373 (6.0%)
2012	78,241 (0.1%)	7,331 (85.2%)	508 (0.0%)	60,005 (27.9%)	3,724 (6.4%)	14,047 (6.4%)	162,170 (11.6%)
2013	78,457 (0.3%)	12,092 (64.9%)	918 (80.7%)	61,107 (1.8%)	3,761 (1.0%)	14,705 (4.7%)	168,259 (3.8%)
2014	78,810 (0.4%)	18,339 (51.7%)	1,685 (83.6%)	65,879 (7.8%)	3,785 (0.6%)	15,408 (4.8%)	179,687 (6.8%)
2015	79,052 (0.3%)	25,599 (39.6%)	1,795 (6.5%)	73,992 (12.3%)	3,809 (0.6%)	15,696 (1.9%)	194,055 (8.0%)

- annual decrease annual increase +

Sources: EIA, LBNL, SEIA/GTM

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[1] Grid-connected only; solar PV is reported in MWdc.

[2] A de-rate factor of 77% has been applied to convert PV installed nameplate capacity from MWdc to MWac in the calculation of total renewables.

U.S. Renewable Electricity Capacity as a Percentage of Total Electricity Capacity

	Hydropower	Solar PV[1]	CSP	Wind	Geothermal	Biomass	Total Renewables
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%	**11.1%**
2009	7.1%	0.1%	0.0%	3.2%	0.3%	1.2%	**11.9%**
2010	7.0%	0.1%	0.0%	3.6%	0.3%	1.2%	**12.2%**
2011	6.9%	0.3%	0.0%	4.1%	0.3%	1.2%	**12.8%**
2012	6.8%	0.5%	0.0%	5.2%	0.3%	1.2%	**14.1%**
2013	6.8%	0.8%	0.1%	5.3%	0.3%	1.3%	**14.6%**
2014	6.8%	1.2%	0.1%	5.7%	0.3%	1.3%	**15.5%**
2015	6.8%	1.7%	0.2%	6.4%	0.3%	1.4%	**16.7%**

Sources: EIA, LBNL, SEIA/GTM

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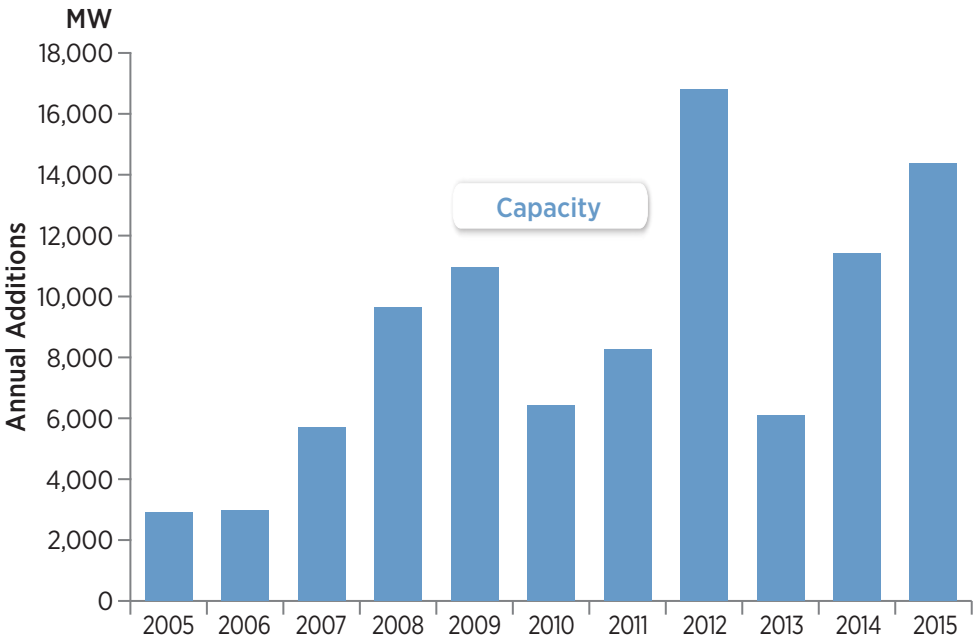
[1] Grid-connected only. A de-rate factor of 77% has been applied to convert PV installed nameplate capacity from MWdc to MWac.

U.S. Annual Installed Renewable Electricity Capacity Growth



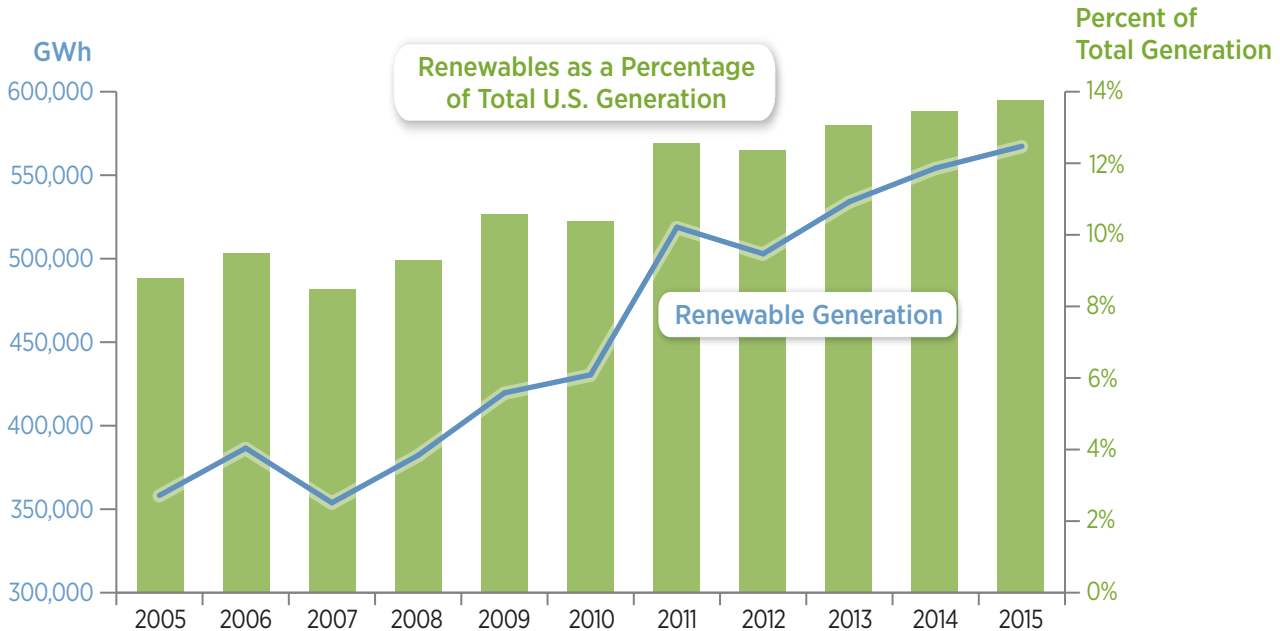
	Compound Annual Growth Rate (2005–2015)
Wind	**23.3%**
Solar PV[1]	**59.9%**
CSP	**17.6%**
Biomass	**3.4%**
Geothermal	**1.9%**
Hydropower	**0.2%**
All Renewables	**6.7%**

Sources: EIA, LBNL, SEIA/GTM

Reported values may vary from those included in previous versions of the Data Book due to retroactive changes in source data.

[1] Grid-connected only. A de-rate factor of 77% has been applied to convert PV installed nameplate capacity from MWdc to MWac.

U.S. Renewable Electricity Generation

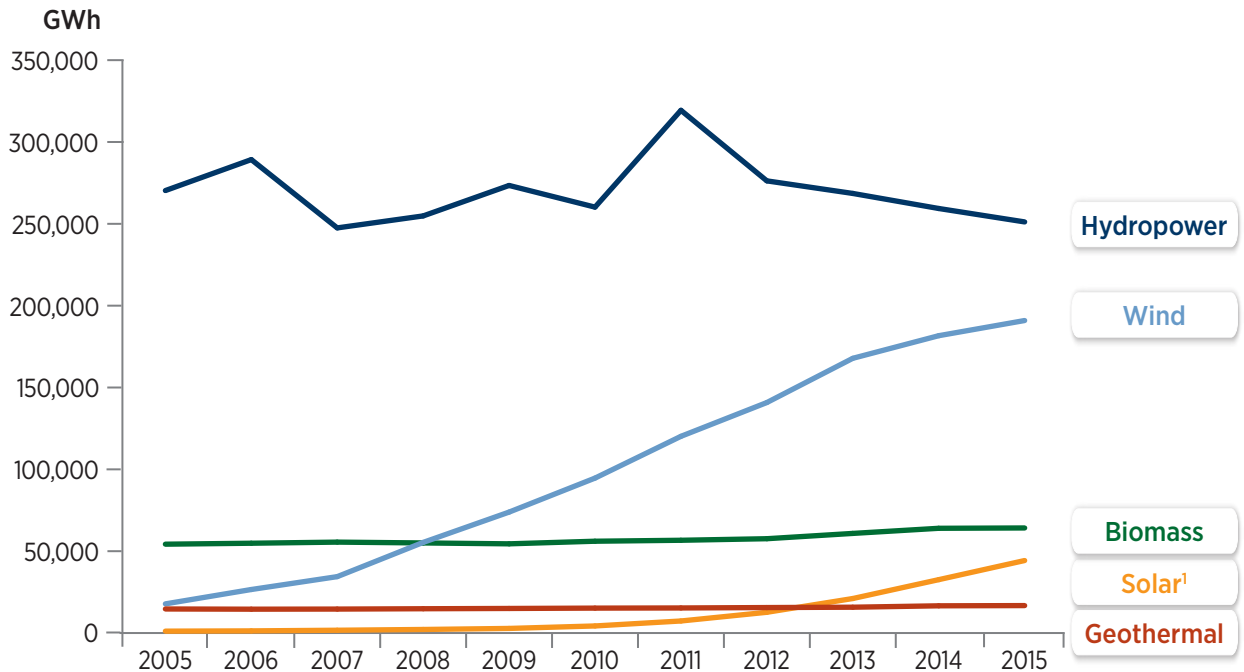


Sources: EIA, LBNL, SEIA/GTM

Reported values may vary from those included in previous versions of the Data Book due to retroactive changes in source data.

Includes generation from CSP and grid-connected PV; assumes a 25% capacity factor for CSP and an 18% capacity factor for PV.

U.S. Renewable Electricity Generation by Technology

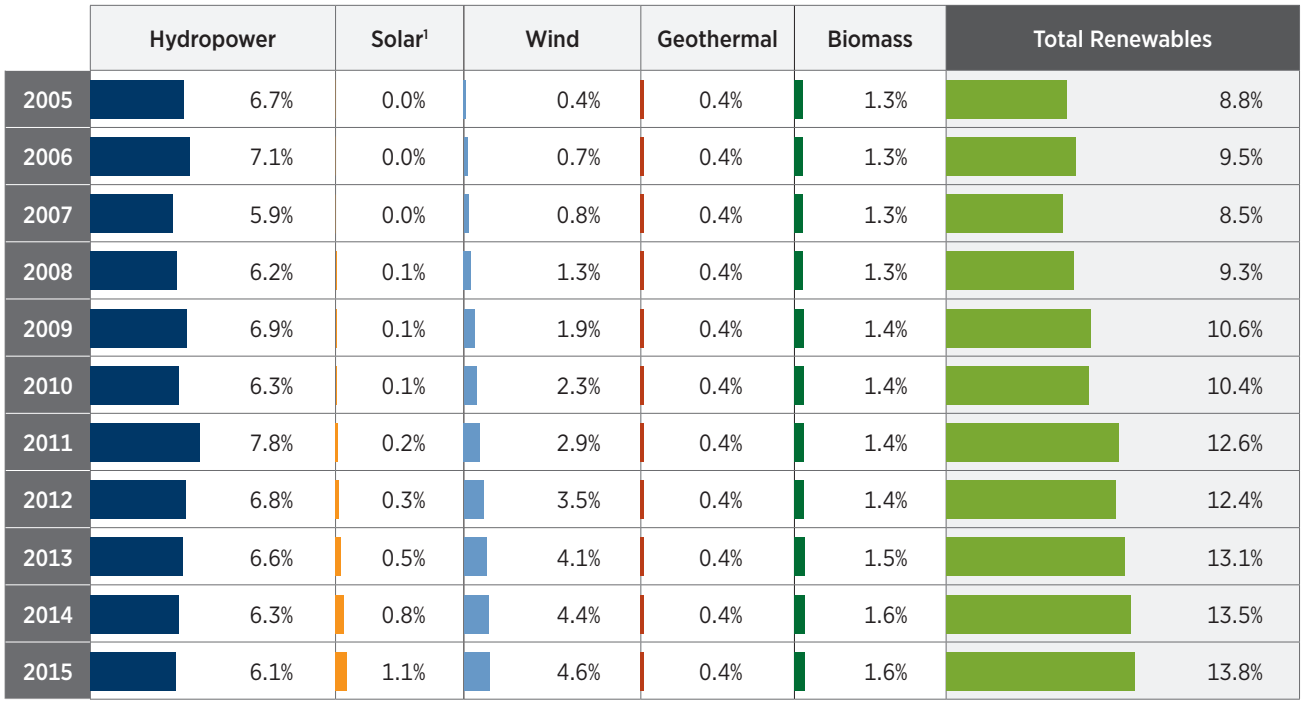


Sources: EIA, LBNL, SEIA/GTM

Reported values may vary from those included in previous versions of the Data Book due to retroactive changes in source data.

[1] Includes generation from CSP and grid-connected PV; assumes a 25% capacity factor for CSP and an 18% capacity factor for PV.

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



	Hydropower	Solar[1]	Wind	Geothermal	Biomass	Total Renewables
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%	3.5%	0.4%	1.4%	12.4%
2013	6.6%	0.5%	4.1%	0.4%	1.5%	13.1%
2014	6.3%	0.8%	4.4%	0.4%	1.6%	13.5%
2015	6.1%	1.1%	4.6%	0.4%	1.6%	13.8%

Sources: EIA, LBNL, SEIA/GTM

Totals may not equal 100% due to rounding.

Reported values may vary from those included in previous versions of the Data Book due to retroactive changes in source data.

[1] Includes generation from CSP and grid-connected PV; assumes a 25% capacity factor for CSP and an 18% capacity factor for PV.

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

	Hydropower	Solar[1]	Wind	Geothermal	Biomass	All Renewables
2005	270,321 (0.7%)	1,144 (12.2%)	17,811 (25.9%)	14,692 (-0.8%)	54,276 (2.3%)	358,244 (1.9%)
2006	289,246 (7.0%)	1,312 (14.7%)	26,589 (49.3%)	14,568 (-0.8%)	54,861 (1.1%)	386,576 (7.9%)
2007	247,510 (-14.4%)	1,704 (29.9%)	34,450 (29.6%)	14,637 (0.5%)	55,539 (1.2%)	353,840 (-8.5%)
2008	254,831 (3.0%)	2,174 (27.6%)	55,363 (60.7%)	14,840 (1.4%)	55,034 (-0.9%)	382,242 (8.0%)
2009	273,455 (7.3%)	2,805 (29.0%)	73,886 (33.5%)	15,009 (1.1%)	54,493 (-1.0%)	419,638 (9.8%)
2010	260,203 (-4.8%)	4,319 (54.0%)	94,652 (28.1%)	15,219 (1.4%)	56,089 (2.9%)	430,483 (2.6%)
2011	319,355 (22.7%)	7,355 (70.3%)	120,177 (27.0%)	15,316 (0.6%)	56,671 (1.0%)	518,874 (20.5%)
2012	276,240 (-13.5%)	12,672 (72.3%)	140,822 (17.2%)	15,562 (1.6%)	57,622 (1.7%)	502,918 (-3.1%)
2013	268,565 (-2.8%)	21,077 (66.3%)	167,840 (19.2%)	15,775 (1.4%)	60,858 (5.6%)	534,115 (6.2%)
2014	259,367 (-3.4%)	32,607 (54.7%)	181,655 (8.2%)	16,628 (5.4%)	63,990 (5.1%)	554,274 (3.8%)
2015	251,168 (-3.2%)	44,296 (35.8%)	190,927 (5.1%)	16,767 (0.8%)	64,190 (0.3%)	567,348 (2.4%)

- annual decrease | annual increase +

Sources: EIA, LBNL, SEIA/GTM

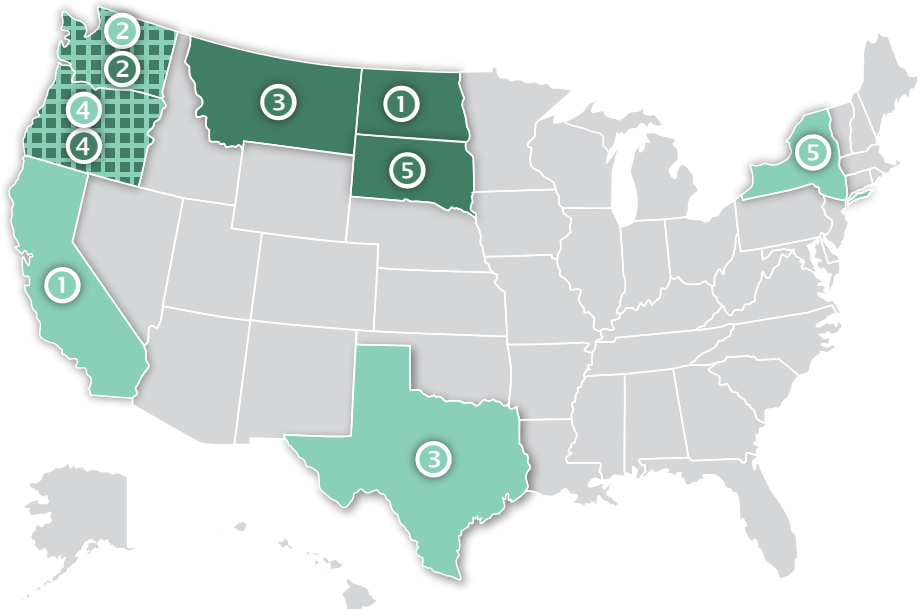
Reported values may vary from those included in previous versions of the Data Book due to retroactive changes in source data.

[1] Includes generation from CSP and grid-connected PV; assumes a 25% capacity factor for CSP and an 18% capacity factor for PV.

State Renewable Energy Information: Summary

- In 2015, **California continued to have the most installed renewable electricity capacity** of any U.S. state (nearly 31 GW), followed by Washington (nearly 25 GW) and Texas (more than 19 GW).
- **Oklahoma had the highest annual percentage growth rate (30%) in installed renewable electricity capacity additions in 2015, followed by North Carolina (27%), Utah (27%), and Kansas (27%)**. Additions in wind capacity were the main driver for growth in Oklahoma and Kansas, whereas additions in solar PV capacity accounted for most of the growth in North Carolina and Utah.
- In per-capita terms, **North Dakota had the most installed renewable electricity capacity**, followed by Washington and Montana. North Dakota had the highest wind installed electricity capacity per capita; Hawaii led the states in PV installed electricity capacity per capita.
- **California installed the highest amount of solar PV capacity** among all states in 2015 (more than 3.3 GW_{ac} [2.5 GW_{dc}]), which is 8% less than it installed in 2014.
- **Texas installed more than 3.6 GW of wind capacity** in 2015, which is double the amount it installed in 2014. The state continues to lead all states in wind capacity with a cumulative installed capacity of nearly 18 GW.

Top States for Cumulative Renewable Electricity Installed Capacity (2015)



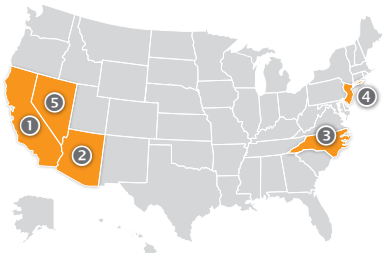
Total Renewables	
1	California
2	Washington
3	Texas
4	Oregon
5	New York

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

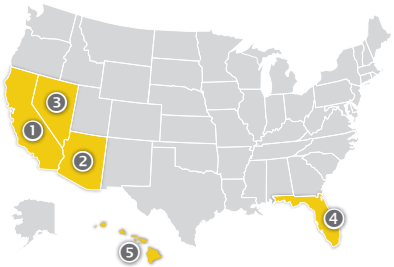
Sources: EIA, LBNL, SEIA/GTM, U.S. Census Bureau

Includes grid-connected solar, wind, geothermal, hydropower and biopower. A de-rate factor of 77% has been applied to convert PV installed nameplate capacity from MWdc to MWac.

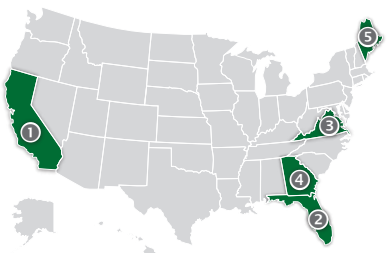
Top States for Cumulative Renewable Electricity Installed Capacity (2015)



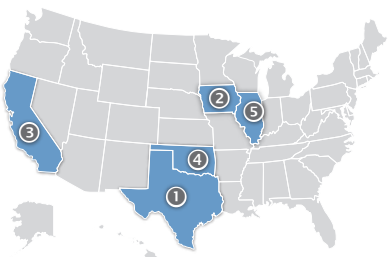
Solar PV[1]
1 California
2 Arizona
3 North Carolina
4 New Jersey
5 Nevada



CSP
1 California
2 Arizona
3 Nevada
4 Florida
5 Hawaii

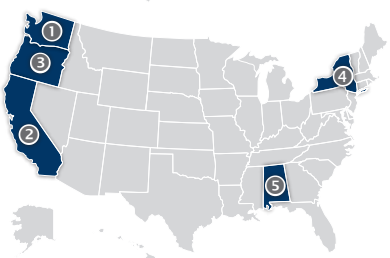


Biomass
1 California
2 Florida
3 Virginia
4 Georgia
5 Maine



Wind
1 Texas
2 Iowa
3 California
4 Oklahoma
5 Illinois

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, SEIA/GTM

[1]Grid-connected only; a de-rate factor of 77% has been applied to convert PV installed nameplate capacity from MWdc to MWac.

Cumulative Renewable Electricity Installed Capacity (MW) (2015)
NORTHEAST

	Wind	PV[1]	CSP	Geothermal	Biomass	Hydropower	Total Renewables[2]	Per Capita Renewable Electricity (Watts/Person)
Connecticut	5	221	0	0	252	119	**597**	**152**
Maine	613	0	0	0	699	723	**2,035**	**1,531**
Massachusetts	107	1,037	0	0	358	268	**1,531**	**225**
New Hampshire	185	23	0	0	280	448	**931**	**700**
New Jersey	9	1,632	0	0	266	15	**1,547**	**173**
New York	1,749	638	0	0	613	4,672	**7,525**	**380**
Pennsylvania	1,340	258	0	0	655	920	**3,113**	**243**
Rhode Island	9	0	0	0	40	3	**52**	**49**
Vermont	119	113	0	0	86	318	**610**	**974**

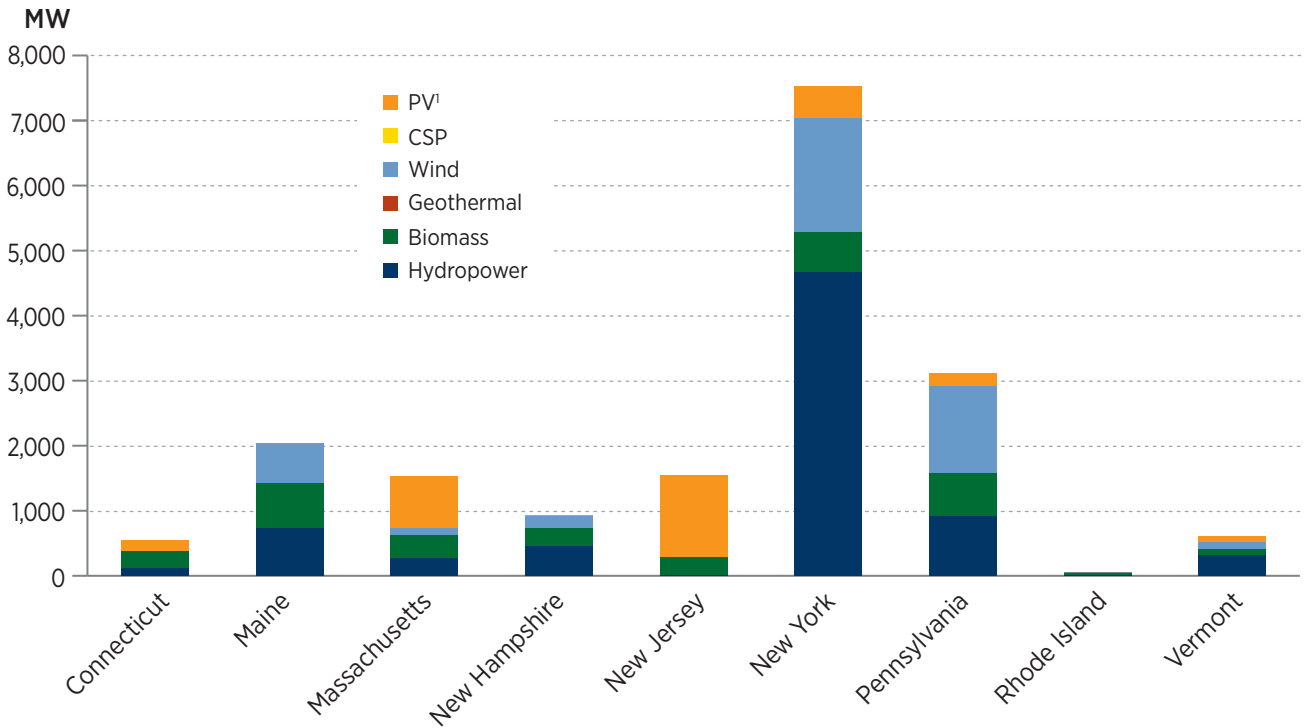
Sources: EIA, LBNL, SEIA/GTM, U.S. Census Bureau

Regions do not correspond to U.S. census designations.

[1] Grid-connected only; PV is reported in MWdc.

[2] A de-rate factor of 77% has been applied to convert PV installed nameplate capacity from MWdc to MWac.

Cumulative Renewable Electricity Installed Capacity (2015)
NORTHEAST



Sources: EIA, LBNL, SEIA/GTM

Regions do not correspond to U.S. census designations.

[1] Grid-connected only; a de-rate factor of 77% has been applied to convert PV installed nameplate capacity from MWdc to MWac.

Cumulative Renewable Electricity Installed Capacity (MW) (2015)
MIDWEST

	Wind	PV[1]	CSP	Geothermal	Biomass	Hydropower	Total Renewables[2]	Per Capita Renewable Electricity (Watts/Person)
Illinois	3,842	65	0	0	129	40	**4,061**	**316**
Indiana	1,895	136	0	0	80	92	**2,172**	**328**
Iowa	6,209	27	0	0	23	129	**6,382**	**2,043**
Kansas	3,764	0	0	0	31	7	**3,802**	**1,306**
Michigan	1,531	19	0	0	485	366	**2,397**	**242**
Minnesota	3,235	33	0	0	546	215	**4,021**	**733**
Missouri	459	131	0	0	17	506	**1,083**	**178**
Nebraska	890	0	0	0	16	332	**1,238**	**653**
North Dakota	2,143	0	0	0	10	614	**2,767**	**3,655**
Ohio	443	112	0	0	197	129	**855**	**74**
South Dakota	977	0	0	0	0	1,602	**2,579**	**3,004**
Wisconsin	648	25	0	0	490	527	**1,685**	**292**

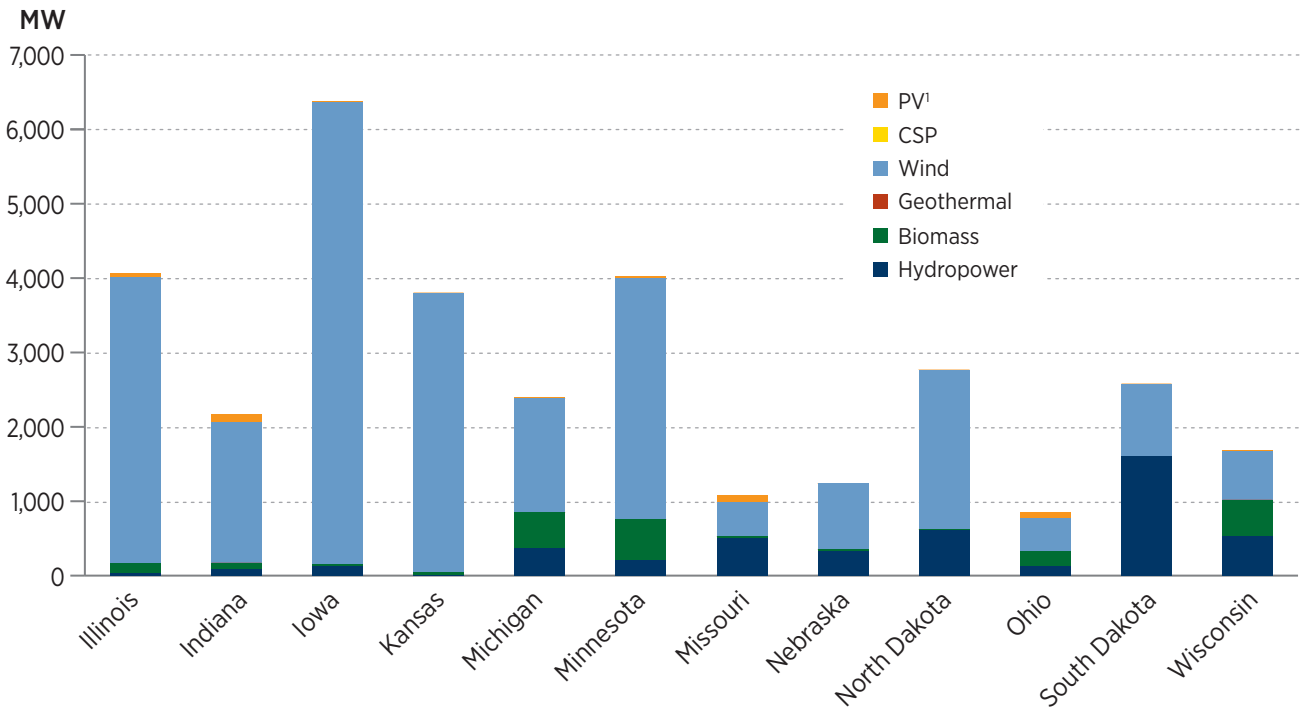
Sources: EIA, LBNL, SEIA/GTM, U.S. Census Bureau

Regions do not correspond to U.S. census designations.

[1] Grid-connected only; PV is reported in MWdc.

[2] A de-rate factor of 77% has been applied to convert PV installed nameplate capacity from MWdc to MWac in the calculation of total renewables.

Cumulative Renewable Electricity Installed Capacity (2015)
MIDWEST



Sources: EIA, LBNL, SEIA/GTM

Regions do not correspond to U.S. census designations.

[1] Grid-connected only; a de-rate factor of 77% has been applied to convert PV installed nameplate capacity from MWdc to MWac.

Cumulative Renewable Electricity Installed Capacity (MW) (2015)
SOUTH

	Wind	PV[1]	CSP	Geothermal	Biomass	Hydropower	Total Renewables[2]	Per Capita Renewable Electricity (Watts/Person)
Alabama	0	0	0	0	676	3,319	**3,995**	**822**
Arkansas	0	0	0	0	378	1,321	**1,699**	**571**
Delaware	2	70	0	0	14	0	**70**	**74**
Florida	0	200	75	0	1,526	56	**1,811**	**89**
Georgia	0	370	0	0	854	1,927	**3,066**	**300**
Kentucky	0	0	0	0	112	997	**1,109**	**251**
Louisiana	0	84	0	0	517	192	**773**	**166**
Maryland	190	366	0	0	163	551	**1,186**	**197**
Mississippi	0	0	0	0	296	0	**296**	**99**
North Carolina	0	2,087	0	0	675	1,890	**4,172**	**415**
Oklahoma	5,184	0	0	0	88	809	**6,081**	**1,555**
South Carolina	0	12	0	0	481	1,364	**1,854**	**379**
Tennessee	29	129	0	0	200	2,499	**2,828**	**428**
Texas	17,711	537	0	0	518	688	**19,330**	**704**
Virginia	0	21	0	0	1,010	822	**1,849**	**221**
West Virginia	583	0	0	0	2	371	**956**	**518**

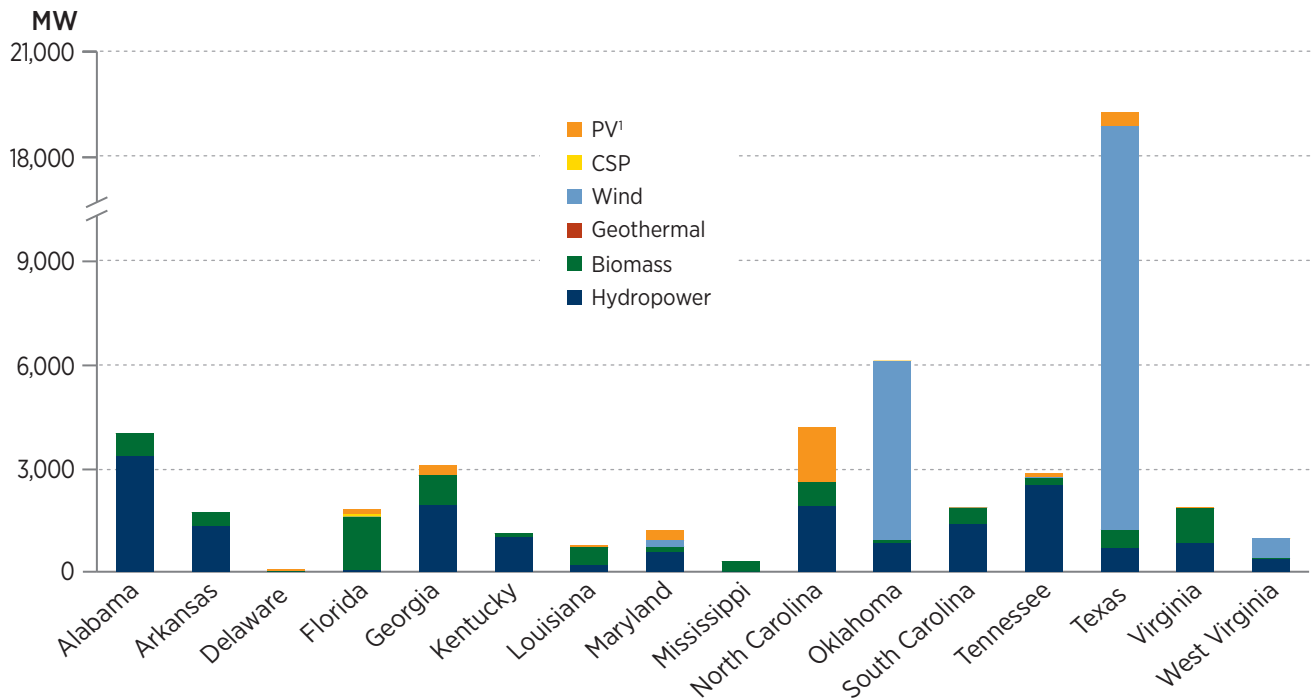
Sources: EIA, LBNL, SEIA/GTM, U.S. Census Bureau

Regions do not correspond to U.S. census designations.

[1] Grid-connected only; PV is reported in MWdc.

[2] A de-rate factor of 77% has been applied to convert PV installed nameplate capacity from MWdc to MWac in the calculation of total renewables.

Cumulative Renewable Electricity Installed Capacity (2015)
SOUTH



Sources: EIA, LBNL, SEIA/GTM

Regions do not correspond to U.S. census designations.

[1] Grid-connected only; a de-rate factor of 77% has been applied to convert PV installed nameplate capacity from MWdc to MWac.

Cumulative Renewable Electricity Installed Capacity (MW) (2015)
WEST

	Wind	PV[1]	CSP	Geothermal	Biomass	Hydropower	Total Renewables[2]	Per Capita Renewable Electricity (Watts/Person)
Alaska	62	0	0	0	12	445	**519**	**702**
Arizona	268	2,020	283	0	41	2,718	**4,866**	**713**
California	5,662	11,987	1,256	2,941	1,553	10,043	**30,684**	**784**
Colorado	2,965	542	0	0	33	661	**4,076**	**747**
Hawaii	203	557	7	51	276	26	**992**	**693**
Idaho	973	0	0	18	142	2,541	**3,674**	**2,220**
Montana	665	0	0	0	4	2,628	**3,314**	**3,208**
Nevada	152	1,042	174	674	3	1,052	**2,858**	**989**
New Mexico	1,080	365	0	4	2	82	**1,449**	**695**
Oregon	3,153	114	0	37	416	8,446	**12,140**	**3,013**
Utah	327	249	0	84	13	262	**877**	**293**
Washington	3,075	64	0	0	406	20,995	**24,526**	**3,420**
Wyoming	1,410	0	0	0	0	303	**1,713**	**2,923**

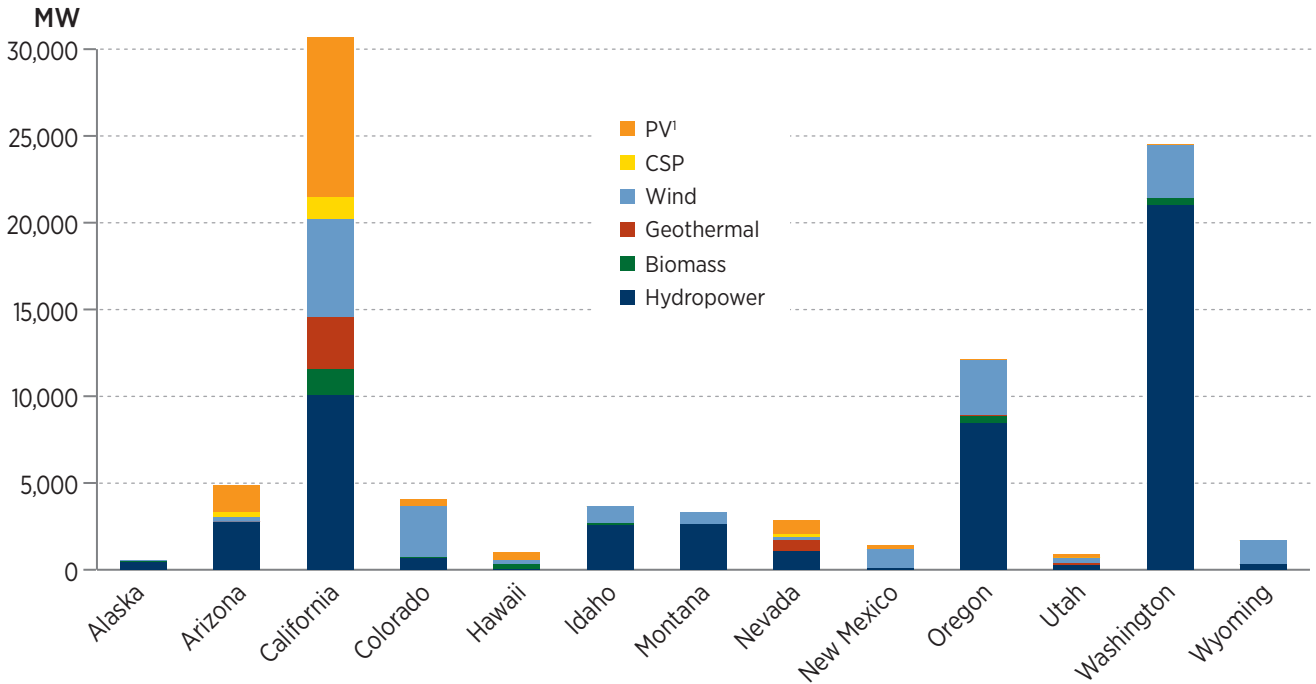
Sources: EIA, LBNL, SEIA/GTM, U.S. Census Bureau

Regions do not correspond to U.S. census designations.

[1] Grid-connected only; PV is reported in MWdc.

[2] A de-rate factor of 77% has been applied to convert PV installed nameplate capacity from MWdc to MWac in the calculations for total renewables.

Cumulative Renewable Electricity Installed Capacity (2015)
WEST



Sources: EIA, LBNL, SEIA/GTM

Regions do not correspond to U.S. census designations.

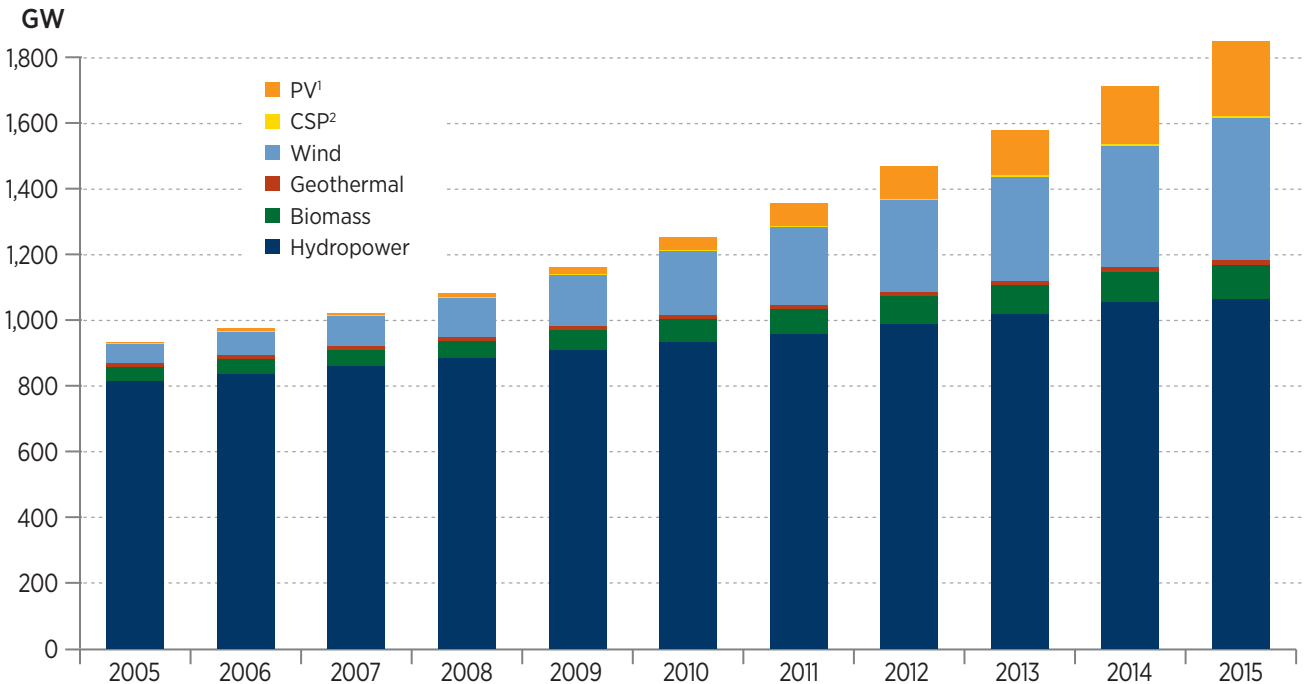
[1] Grid-connected only; a de-rate factor of 77% has been applied to convert PV installed nameplate capacity from MWdc to MWac.

III. Global Renewable Energy Development

Global Renewable Energy Development: Summary

- Cumulative global renewable electricity **installed capacity grew by 7.9%** in 2015 (from 1,712 GW to 1,848 GW), which continued the steady growth (7.3% per year CAGR from 2005 to 2015) of recent years.
- Globally, **hydropower comprised 58% of cumulative installed renewable electricity capacity**, followed by wind (23%), solar PV and CSP (13%), biomass (6%), and geothermal (1%) in 2015.
- Renewable sources accounted for more than **24% (5,830 TWh) of all electricity generation worldwide** in 2015.
- **Global solar PV and CSP cumulative installed capacity increased by 28% and 9% in 2015, respectively. Wind installed capacity grew by 17% globally**.
- In 2015, **China led the world in cumulative total renewable electricity installed capacity**. China also led in cumulative wind, hydropower capacity, and grid-connected solar PV capacity. Spain led CSP installed capacity. The United States continued to lead geothermal and biomass installed capacity.

Global Renewable Electricity Capacity



Source: Renewable Energy Policy Network for the 21st Century (REN21)

Reported values may vary from those included in previous versions of the Data Book due to retroactive changes.

[1] Grid-connected only.

[2] CSP includes concentrating photovoltaics (CPV).

Global Renewable Cumulative Electricity Capacity Annual Percent Change

	Hydropower	PV[1]	CSP[2]	Wind	Geothermal	Biomass	All Renewables
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%**
2013	3%	38%	36%	13%	3%	6%	**7%**
2014	4%	28%	29%	16%	6%	6%	**8.5%**
2015	1%	28%	9%	17%	3%	14%	**7.9%**

- annual decrease | annual increase **+**

Source: REN21

Reported values may vary from those included in previous versions of the Data Book due to retroactive changes by REN21.

[1] Grid-connected only.

[2] CSP includes CPV.

Renewable Electricity as a Percentage of Total Installed Global Electricity Capacity

	Hydropower	PV[1]	CSP[2]	Wind	Geothermal	Biomass	All Renewables	Renewable Capacity (GW)
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%	22.7%	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	18.4%	0.8%	0.0%	3.9%	0.2%	1.3%	24.6%	1,253
2011	18.0%	1.3%	0.0%	4.5%	0.2%	1.4%	25.4%	1,356
2012	17.8%	1.8%	0.0%	5.1%	0.2%	1.5%	26.5%	1,470
2013	17.6%	2.4%	0.1%	5.5%	0.2%	1.5%	27.3%	1,579
2014	17.5%	2.9%	0.1%	6.1%	0.2%	1.5%	28.5%	1,712
2015	17.0%	3.6%	0.1%	6.9%	0.2%	1.7%	29.5%	1,848

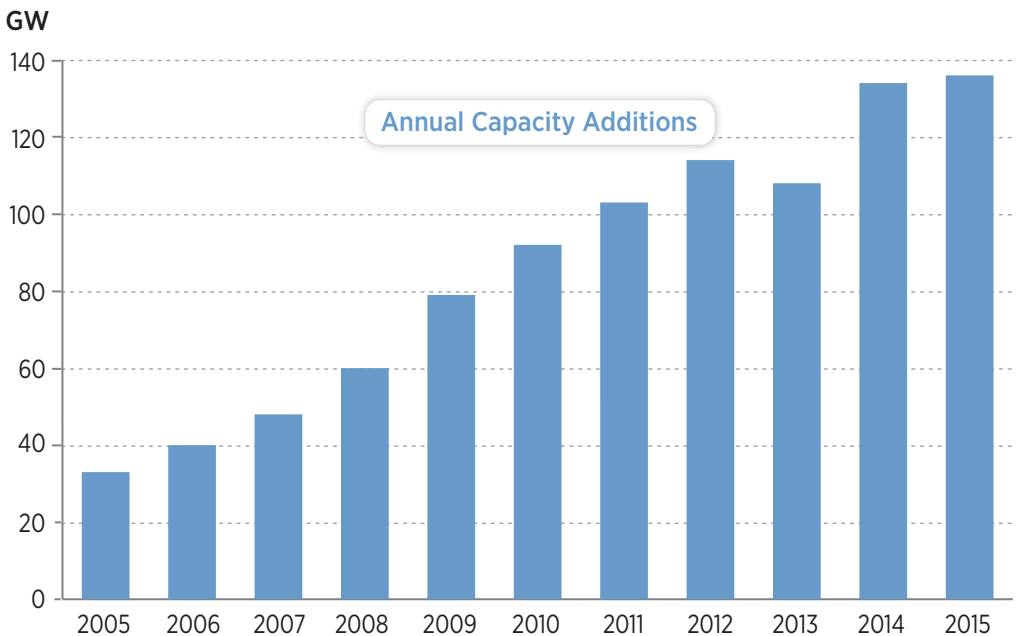
Source: REN21

Reported values may vary from those included in previous versions of the Data Book due to retroactive changes by REN21.

[1] Grid-connected only.

[2] CSP includes CPV.

Global Annual Installed Renewable Electricity Capacity Growth



	Compound Annual Growth Rate (2005–2015)
PV[1]	**45.1%**
CSP[2]	**27.6%**
Wind	**22.1%**
Geothermal	**3.6%**
Biomass	**9.2%**
Hydropower	**2.7%**
All Renewables	**7.1%**

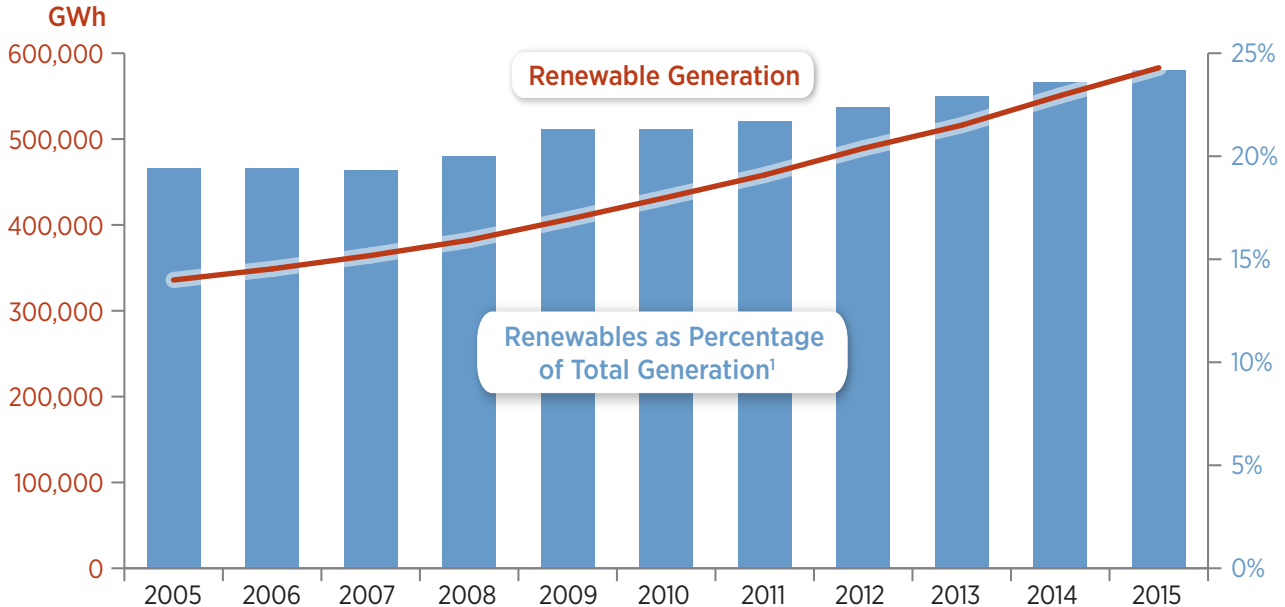
Source: REN21

Reported values may vary from those included in previous versions of the Data Book due to retroactive changes by REN21.

[1] Grid-connected only.

[2] CSP includes CPV.

Global Renewable Electricity Generation



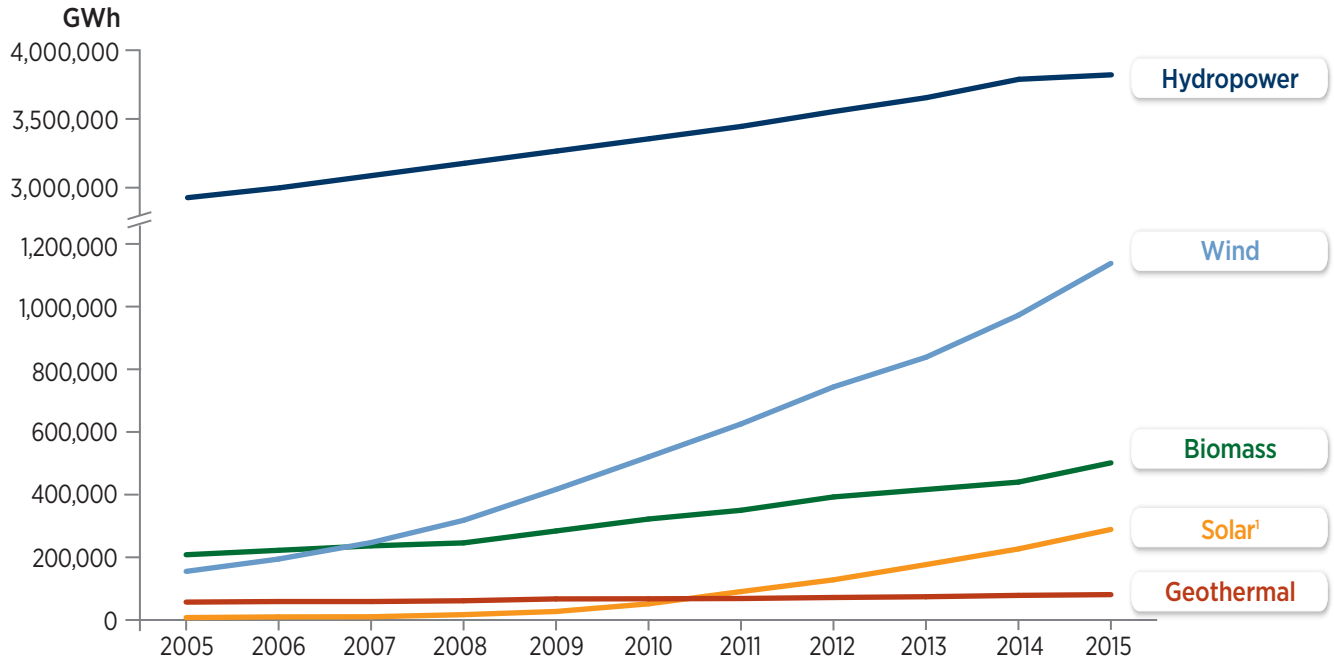
Sources: REN21, EIA

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

Reported values may vary from those included in previous versions of the Data Book due to retroactive changes by REN21.

[1] Total generation is estimated for 2012–2015. All other years are based on EIA data.

Global Renewable Electricity Generation by Technology



Source: REN21

Reported values may vary from those included in previous versions of the Data Book due to retroactive changes by REN21.

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

Note vertical scale has a discontinuity.

[1] Includes CSP and grid-connected PV; capacity is reported in MWac.

Global Renewable Electricity Generation as a Percentage of Total Generation

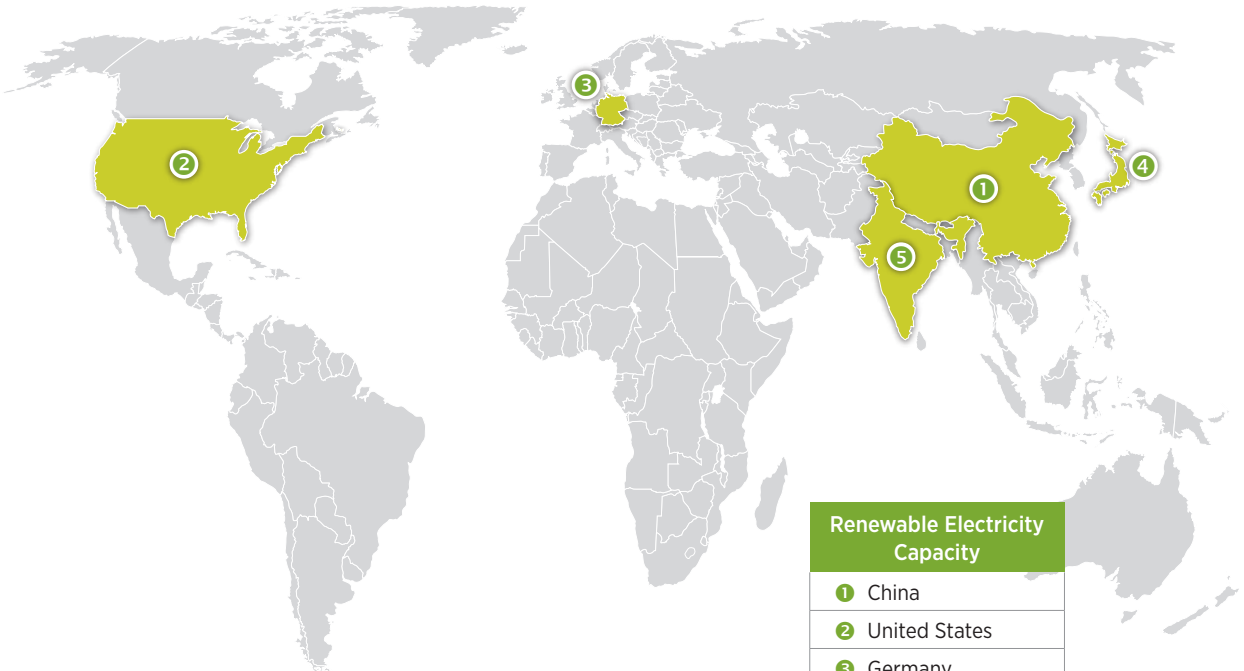
	Hydropower	Solar[1]	Biomass	Wind	Geothermal	All Renewables	Renewable Generation (GWh)
2005	16.9%	0.0%	1.2%	0.9%	0.3%	19.4%	3,358,626
2006	16.7%	0.1%	1.2%	1.1%	0.3%	19.4%	3,488,055
2007	16.4%	0.1%	1.3%	1.3%	0.3%	19.3%	3,644,173
2008	16.6%	0.1%	1.3%	1.7%	0.3%	20.0%	3,822,689
2009	17.2%	0.1%	1.5%	2.2%	0.4%	21.3%	4,064,206
2010	16.6%	0.3%	1.6%	2.6%	0.3%	21.3%	4,319,733
2011	16.4%	0.4%	1.7%	3.0%	0.3%	21.7%	4,582,578
2012	16.3%	0.6%	1.8%	3.4%	0.3%	22.4%	4,891,891
2013	16.2%	0.8%	1.8%	3.7%	0.3%	22.9%	5,161,742
2014	16.3%	1.0%	1.9%	4.2%	0.3%	23.6%	5,506,624
2015	15.9%	1.2%	2.1%	4.7%	0.3%	24.2%	5,830,656

Source: REN21

Reported values may vary from those included in previous versions of the Data Book due to retroactive changes by REN21.

[1] Includes CSP and grid-connected PV; generation derived using the following capacity factors: 41% for hydropower, 14% for PV, 25% for CSP, 54% for biomass, 30% for wind, and 70% for geothermal.

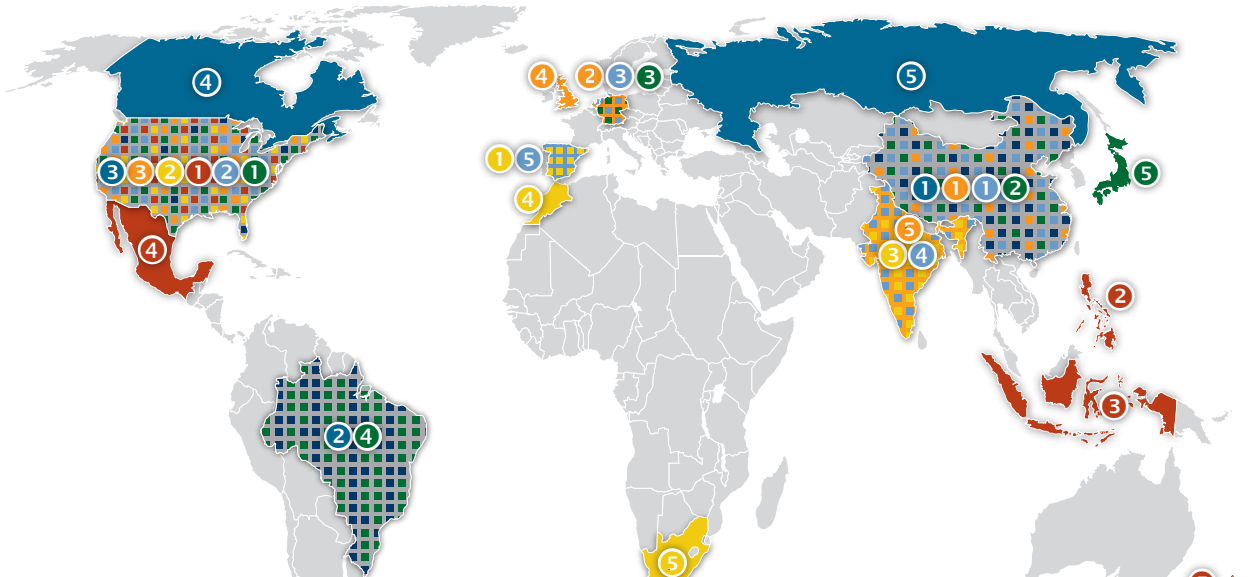
Top Countries for Renewable Electricity Installed Capacity (2015)



Renewable Electricity Capacity
1 China
2 United States
3 Germany
4 Japan
5 India

Source: REN21

Top Countries with Installed Renewable Electricity by Technology (2015)



Hydropower	PV[1]	CSP	Geothermal	Wind	Biomass
1 China	1 China	1 Spain	1 United States	1 China	1 United States
2 Brazil	2 Germany	2 United States	2 Philippines	2 United States	2 China
3 United States	3 United States	3 India	3 Indonesia	3 Germany	3 Germany
4 Canada	4 United Kingdom	4 Morocco	4 Mexico	4 India	4 Brazil
5 Russia	5 India	5 South Africa	5 New Zealand	5 Spain	5 Japan

Source: REN21

[1] Grid-connected only.

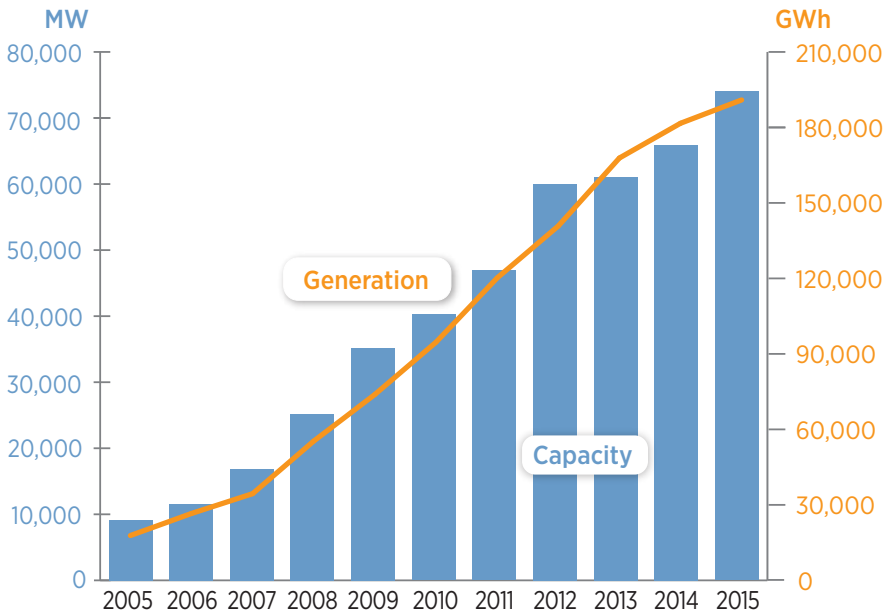
IV. Wind

Wind: Summary

- In the United States, wind installed capacity grew 12.3% in 2015 compared to 7.8% in 2014. **More than 8.1 GW of additional** wind capacity was installed in 2015, leading to a total cumulative capacity of nearly 74 GW.
- Some states with the highest cumulative wind installed capacity also experienced the most growth in capacity in 2015, including Texas (3.6 GW), Oklahoma (1.4 GW), Kansas (0.8 GW), and Iowa (0.5 GW).
- In 2015, **China continued to lead the world in cumulative installed wind capacity** with over 145 GW. The United States leads in wind power generation with over 191 TWh in 2015.
- **Global cumulative installed offshore wind capacity reached over 12.1 GW** in 2015, largely driven by projects in Europe. A total of 21 U.S. offshore wind projects, comprising more than 14.7 GW, are at various stages of development.[1]
- **Construction of the first U.S. commercial offshore wind farm off Block Island (Rhode Island) commenced in 2015 and the 30-MW project is scheduled to come online in late 2016**.[2]

[1] Source: NREL
[2] Source: EIA

U.S. Total Installed Wind Electricity Capacity and Generation



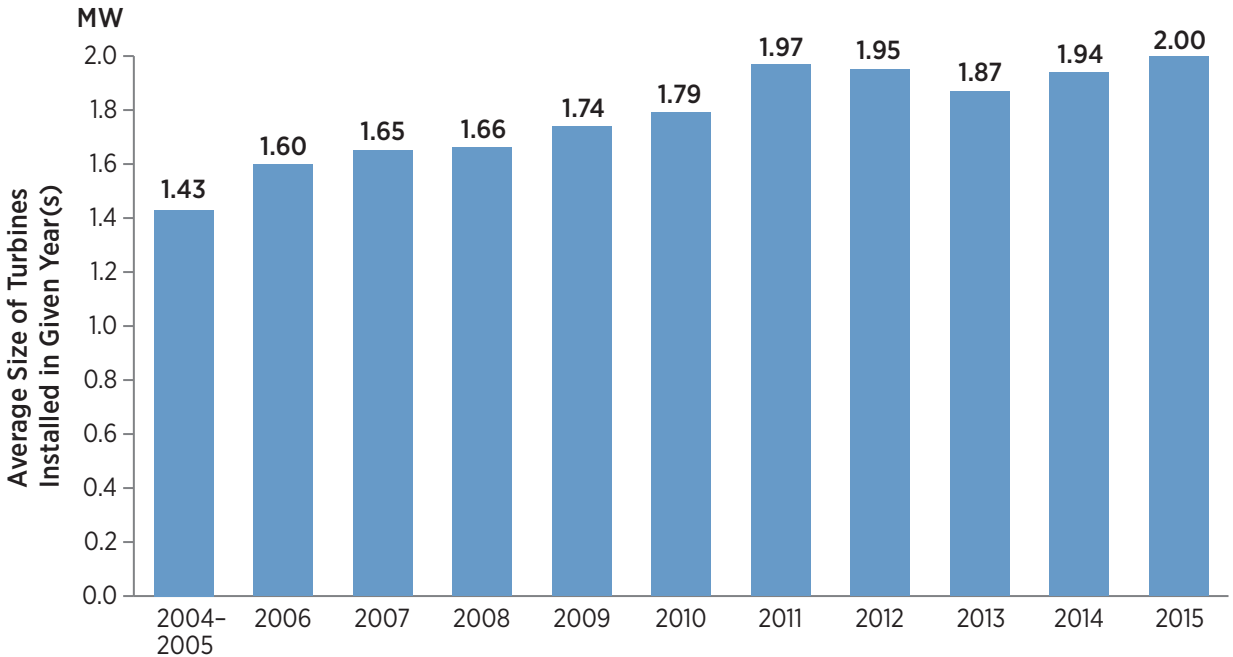
	U.S. Wind Electricity Generation (GWh)	U.S. Wind Electricity Capacity and Percent Increase from Previous Year	
		Total (MW)	% Increase
2000	5,593	2,578	2.6%
2001	6,737	4,275	65.8%
2002	10,354	4,686	9.6%
2003	11,187	6,353	35.6%
2004	14,144	6,725	5.9%
2005	17,811	9,121	35.6%
2006	26,589	11,575	26.9%
2007	34,450	16,812	45.2%
2008	55,363	25,237	50.1%
2009	73,886	35,155	39.3%
2010	94,652	40,267	14.5%
2011	120,177	46,916	16.5%
2012	140,882	60,005	27.9%
2013	167,840	61,107	1.8%
2014	181,655	65,879	7.8%
2015	190,927	73,992	12.3%

Sources: Capacity data from LBNL; generation data from EIA

LBNL data includes installed capacity that is online and installed at the end of the year. A wind project, or capacity portion of a wind project, is reported as online when it is delivering electricity to the power grid or ultimate point of delivery. The timing of installation is usually consistent with "Commercial Operation Date" but may differ, and specific criteria is at the discretion of the wind project owner.

Reported values may vary from those included in previous versions of the Data Book due to retroactive changes in source data.

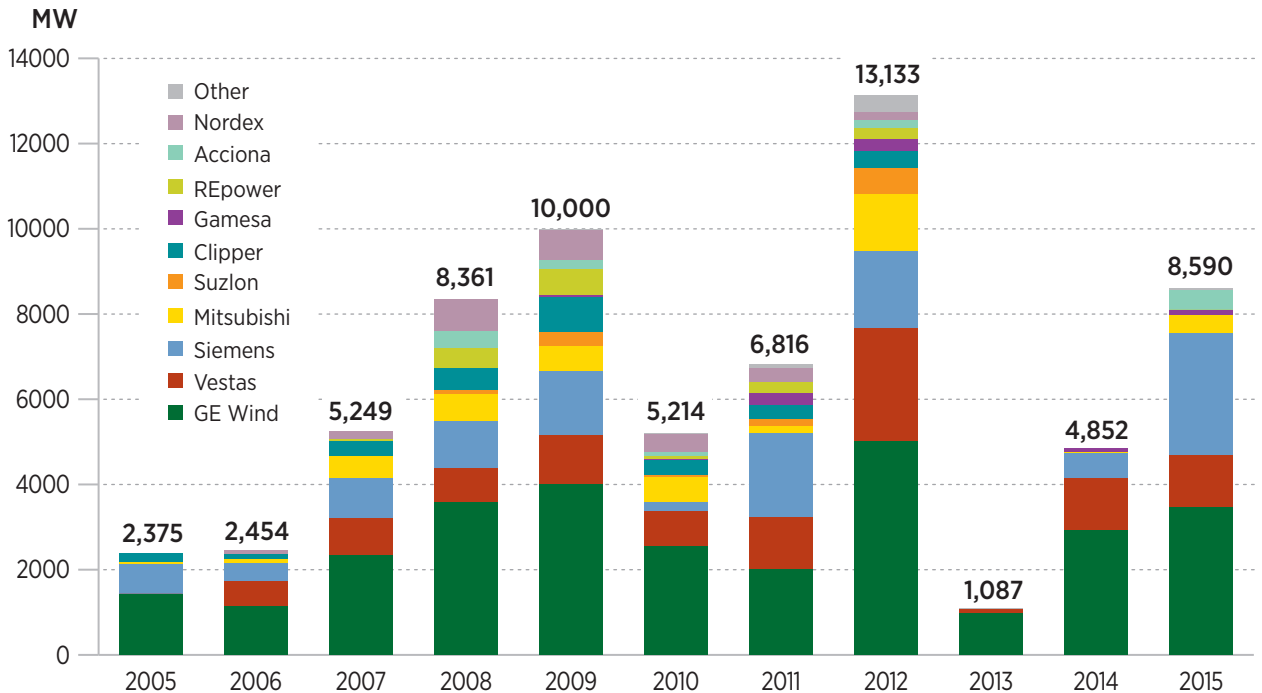
U.S. Average Installed Turbine Size



IV

Source: American Wind Energy Association (AWEA)

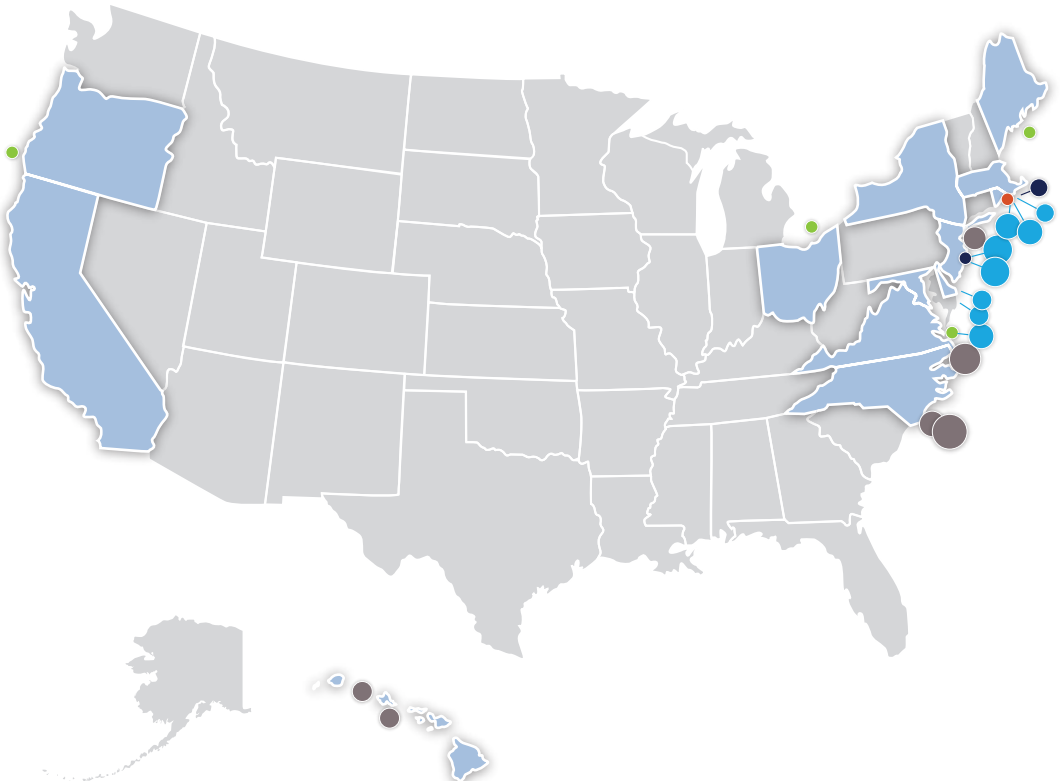
U.S. Annual Wind Turbine Installations by Manufacturer



Source: LBNL

Reported values may vary from those included in previous versions of the Data Book due to retroactive changes by LBNL.

U.S. Offshore Wind Electricity Proposed Projects (2015)



Project Status

- Under Construction
- Approved
- Permitting
- Planning—Site Control[1]
- Planning—Early Stage

Project Size

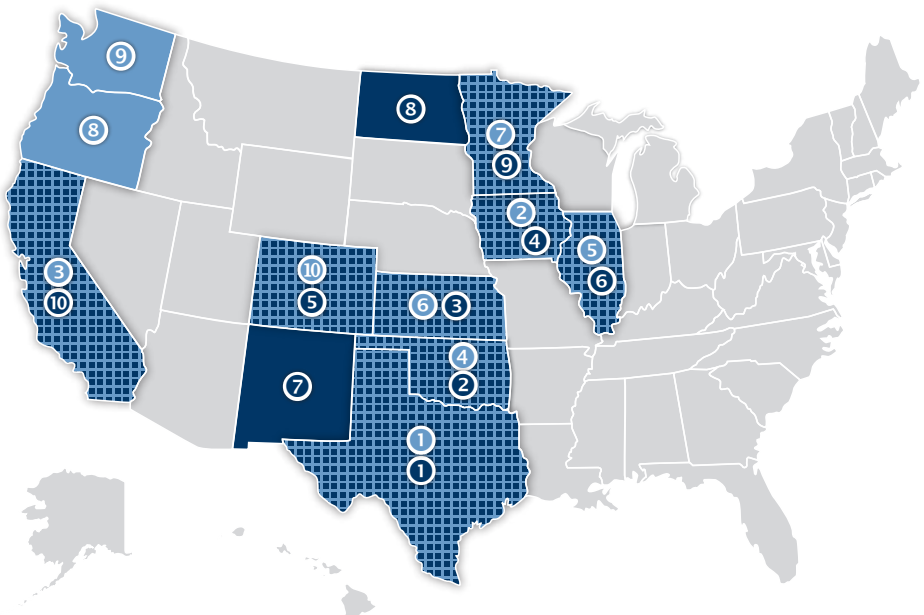
- 0–50 MW
- 51–250 MW
- 501–1,000 MW
- >1,001 MW

IV

Source: NREL

[1] This project status begins when the developer obtains exclusive development rights to a site and ends when the developer files major permit applications.

States Leading Wind Electricity Development (2015)

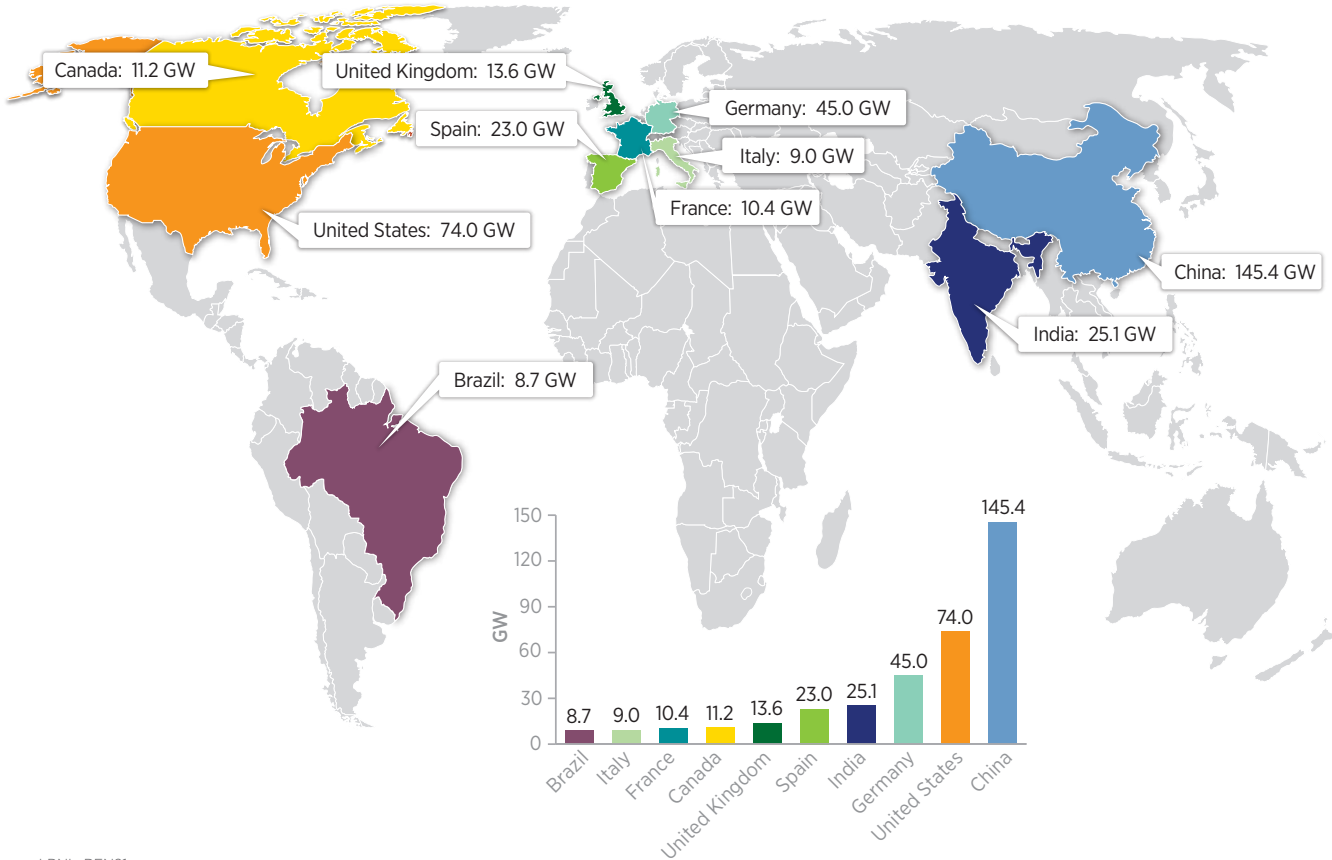


Cumulative Capacity (MW)	
1 Texas	17,711
2 Iowa	6,209
3 California	5,662
4 Oklahoma	5,184
5 Illinois	3,842
6 Kansas	3,764
7 Minnesota	3,235
8 Oregon	3,153
9 Washington	3,075
10 Colorado	2,965

Annual Capacity Additions (MW)	
1 Texas	3,615
2 Oklahoma	1,402
3 Kansas	799
4 Iowa	524
5 Colorado	399
6 Illinois	274
7 New Mexico	268
8 North Dakota	258
9 Minnesota	200
10 California	194

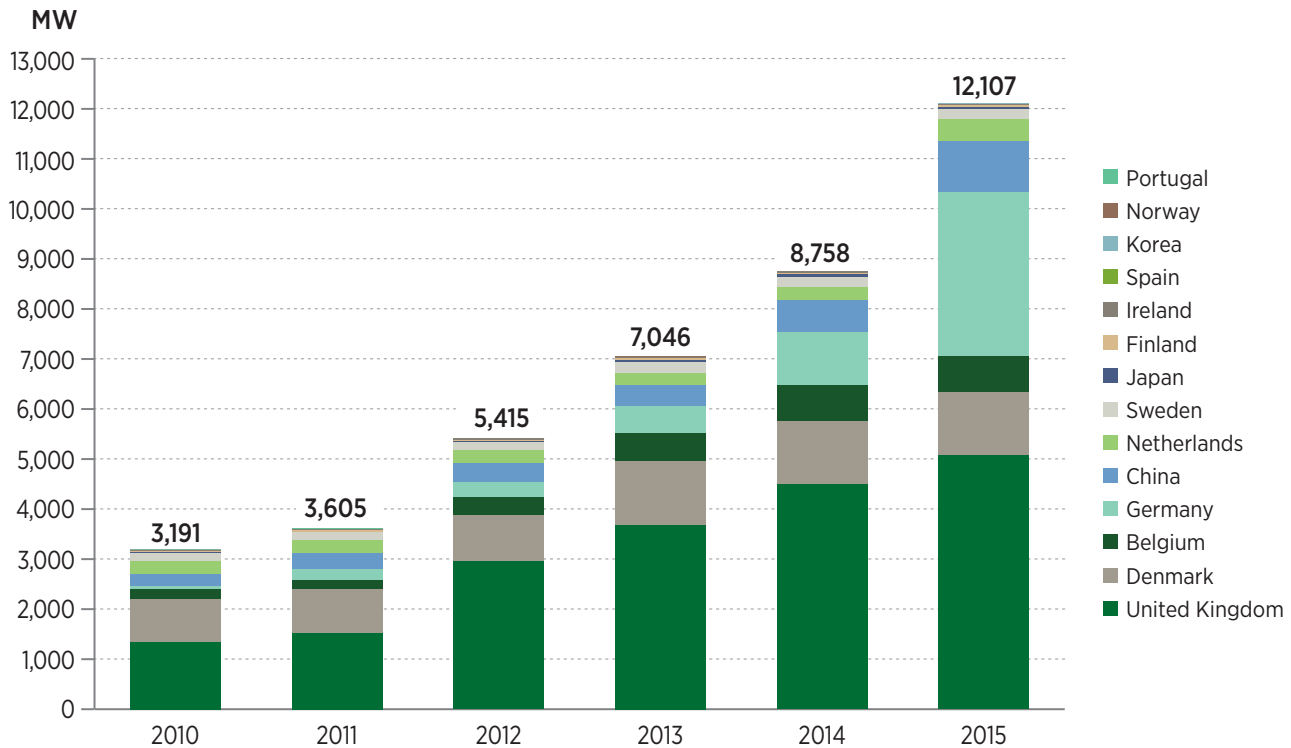
Source: LBNL

Cumulative Wind Electricity Capacity (2015) – Top 10 Countries



Sources: LBNL, REN21
Includes offshore wind.

Cumulative Offshore Wind Electricity Capacity by Country



Source: Global Wind Energy Council (GWEC)

Reported values may vary from those included in previous versions of the Data Book due to retroactive changes by GWEC.

V. Solar

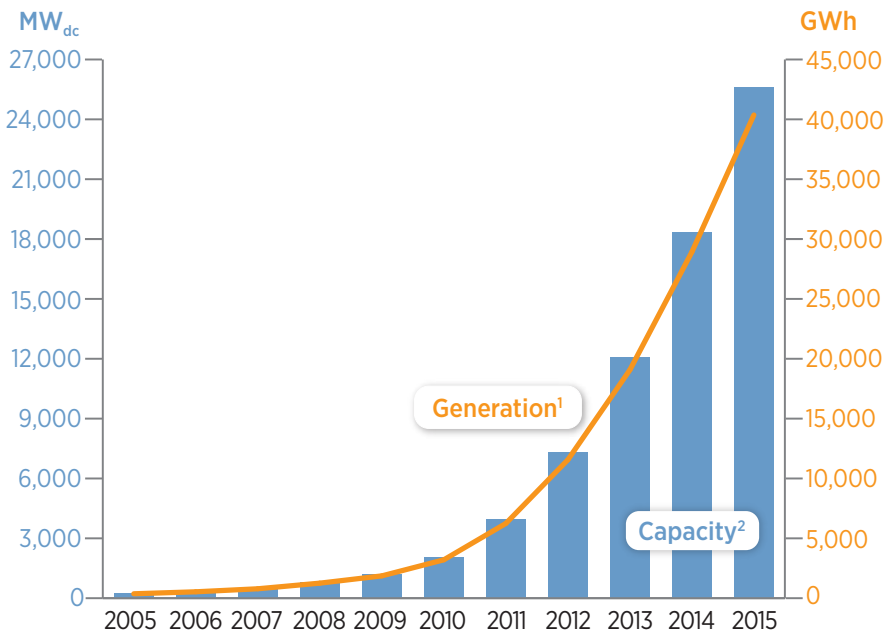
Solar: Summary

- **U.S. solar installed capacity increased by 36.1%** in 2015. PV capacity grew by 39.6% and CSP capacity expanded by 6.5%.
- Consistent high growth rates over the last decade have resulted in a total of **25,599 MW_{dc} (19,711 MW_{ac}) of PV capacity and 1,795 MW of CSP capacity** in the United States at the end of 2015.
- **U.S. solar generation,** from PV and CSP combined, totaled nearly **44.3 TWh**,[1] which represents approximately **1.1% of total U.S. generation** in 2015.
- **Both utility-scale and residential markets have driven PV solar capacity growth in the United States over the last five years. Distributed PV generation in 2015 totaled 12.1 GWh, which is equivalent to 34% of total solar PV generation**.[2]
- **As of the end of 2015, California had the largest amounts of cumulative installed solar capacity, including 11,987 MWdc (9,230 MWac) of PV and 1,256 MW of CSP and concentrating photovoltaics (CPV). It was followed by Arizona and North Carolina**.
- U.S. CSP installed capacity in 2015 continued to be concentrated in a small number of states in the West.
- **Asian manufacturers continued to lead global PV module production** in 2015, with China accounting for 66% of global module production and the United States accounting for approximately 2%.

[1] Solar generation assumes a 25% capacity factor for CSP and an 18% capacity factor for PV

[2] Source: EIA

U.S. PV Electricity Installed Capacity and Generation



	U.S. PV Generation[1] (GWh)	U.S. PV Capacity[2] (MW_{dc}) and % Increase from Previous Year	
		PV	Increase
2000	28	18	—
2001	46	29	61%
2002	82	52	79%
2003	153	97	87%
2004	244	155	60%
2005	369	234	51%
2006	535	339	45%
2007	787	499	47%
2008	1,257	797	60%
2009	1,864	1,182	48%
2010	3,207	2,034	72%
2011	6,243	3,959	95%
2012	11,560	7,331	85%
2013	19,067	12,092	65%
2014	28,917	18,339	52%
2015	40,365	25,599	40%

Source: SEIA/GTM

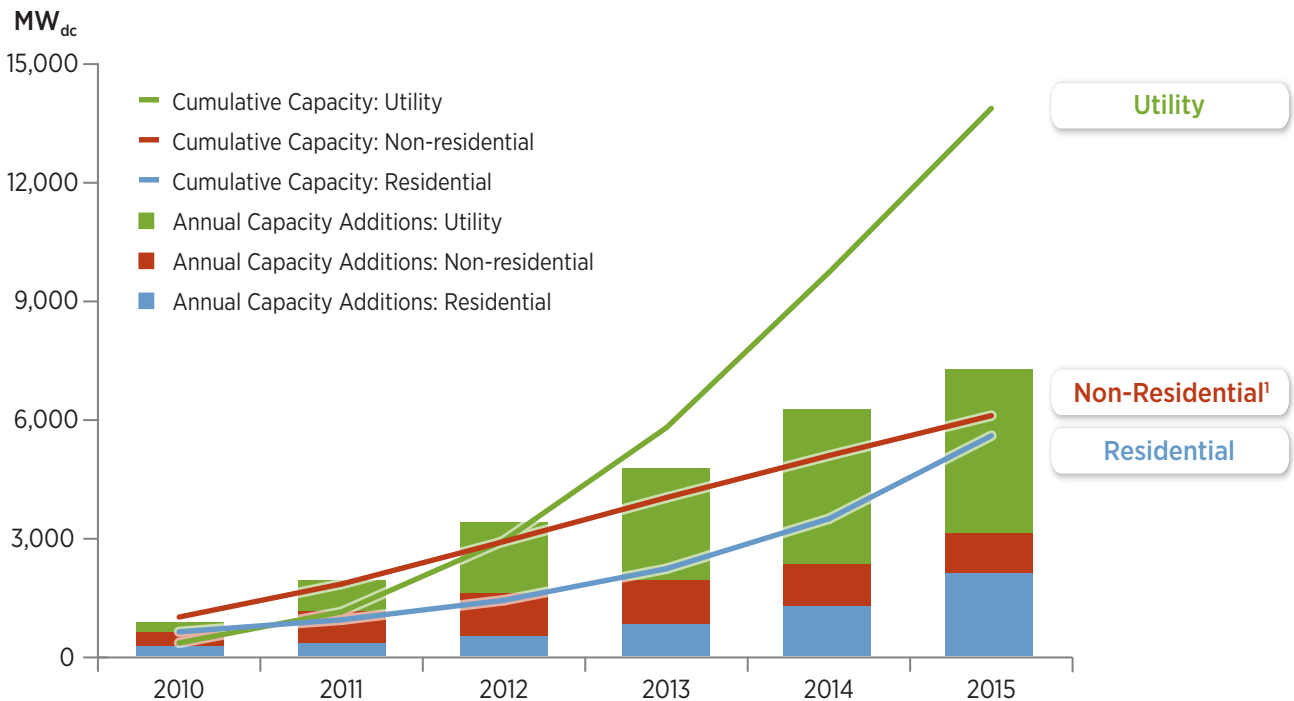
Generation calculated from installed capacity using an 18% capacity factor for PV.

Values may differ from those reported in versions of the Data Book before 2014 due to a source change from Larry Sherwood/IREC to SEIA/GTM for all years included.

[1] Generation numbers were calculated from installed capacity using an 18% capacity factor for PV.

[2] Grid-connected only; capacity is reported in MWdc.

U.S. PV Cumulative Capacity and Annual Additions by Segment



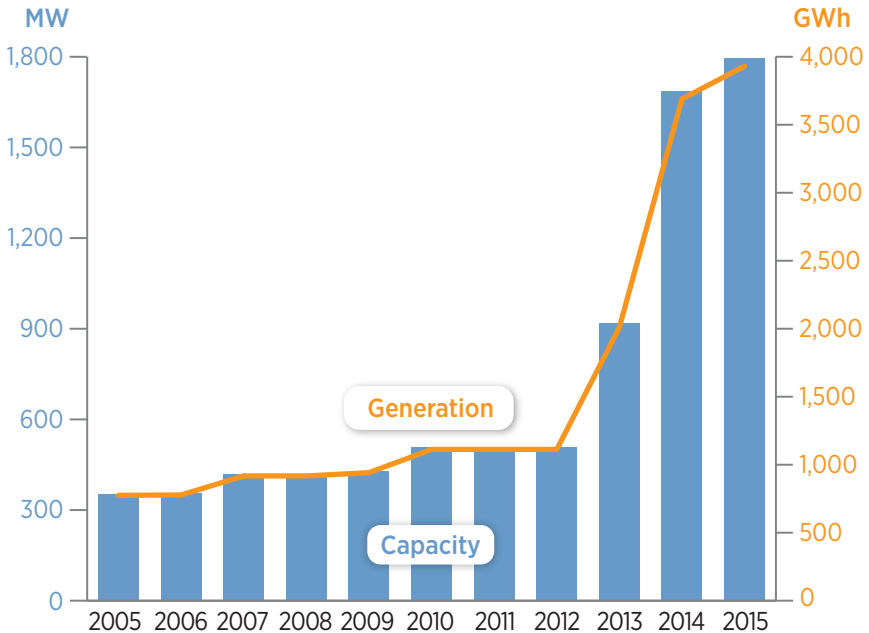
V

Source: SEIA/GTM

Grid-connected only; capacity is reported in MWdc.

[1]Non-residential sector includes commercial and industrial.

U.S. CSP Electricity Installed Capacity and Generation



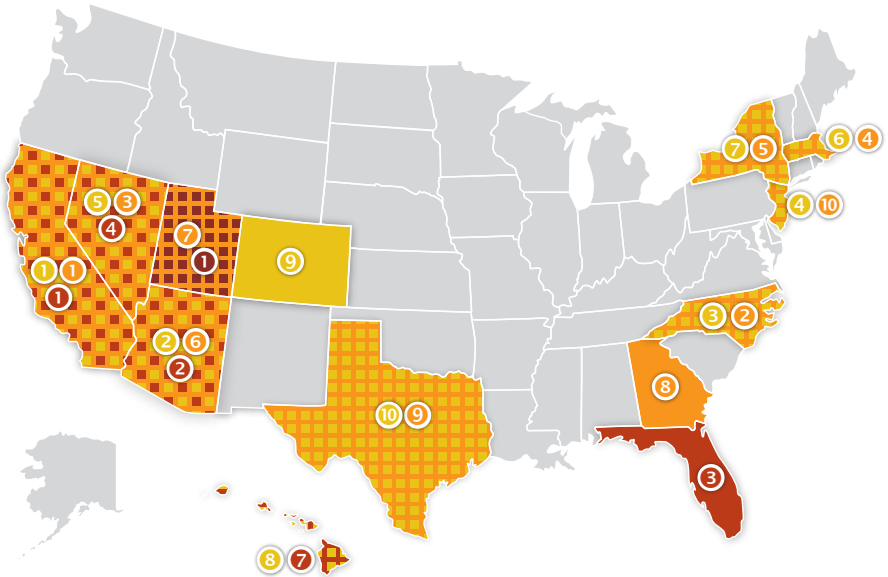
	U.S. CSP Generation (GWh)	U.S. CSP Capacity (MW) and % Increase from Previous Year	
		CSP	Increase
2000	775	354	—
2001	775	354	0%
2002	775	354	0%
2003	775	354	0%
2004	775	354	0%
2005	775	354	0%
2006	777	355	0%
2007	918	419	18%
2008	918	419	0%
2009	942	430	3%
2010	1,113	508	18%
2011	1,113	508	0%
2012	1,113	508	0%
2013	2,010	918	81%
2014	3,690	1,685	84%
2015	3,931	1,795	7%

V

Source: SEIA/GTM

Capacity is reported in MWac. Generation is calculated from installed capacity using a 25% capacity factor for CSP.

States Leading Solar Electricity Development (2015)



PV Cumulative Capacity[1] (MW)	
1 California	11,987
2 Arizona	2,020
3 North Carolina	2,087
4 New Jersey	1,632
5 Nevada	1,042
6 Massachusetts	1,037
7 New York	638
8 Hawaii	557
9 Colorado	542
10 Texas	537

PV Annual Capacity[1] Additions (MW)	
1 California	3,266
2 North Carolina	1,160
3 Nevada	307
4 Massachusetts	286
5 New York	241
6 Arizona	234
7 Utah	231
8 Georgia	209
9 Texas	207
10 New Jersey	181

CSP Cumulative Capacity[2] (MW)	
1 California	1,256
2 Arizona	283
3 Florida	75
4 Nevada	174
7 Hawaii	7

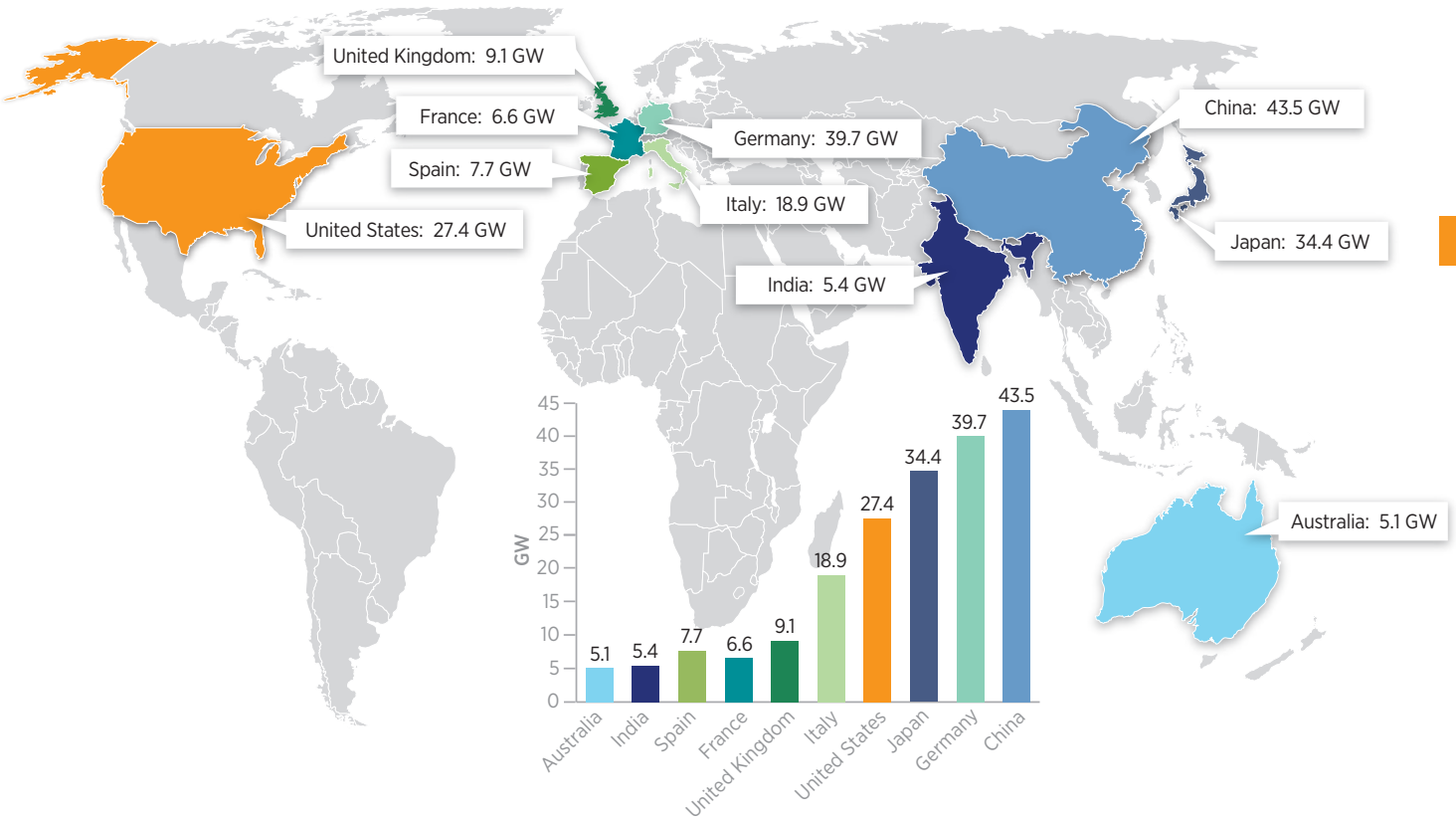
CSP Annual Capacity Additions (MW)	
Nevada	110

Source: SEIA/GTM

[1] Grid-connected only; capacity is reported in MWdc.

[2] Capacity is reported in MWac.

Cumulative Solar Electricity Capacity (2015) – Select Countries



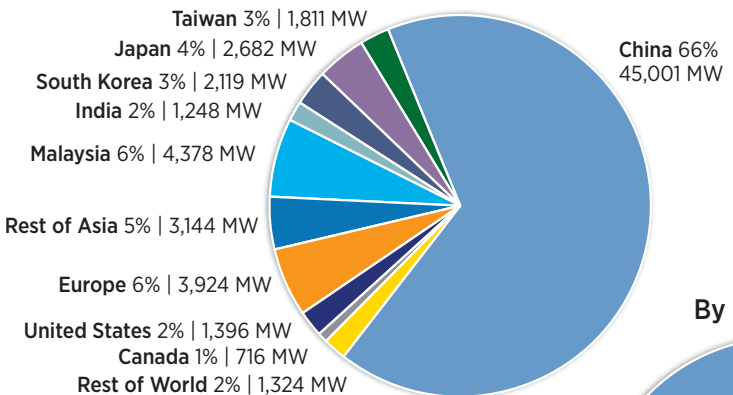
Sources: REN21, SEIA/GTM

Includes CSP and grid-connected PV; capacity is reported in MWac.

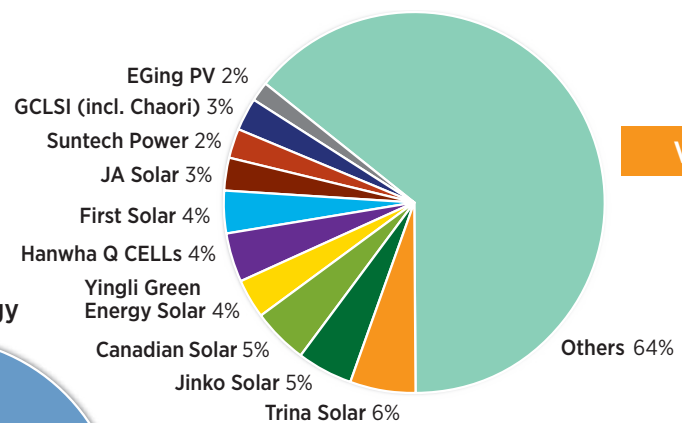
Global Photovoltaic Manufacturing (2015)

Global Solar Module Production (2015): 67,746 MW

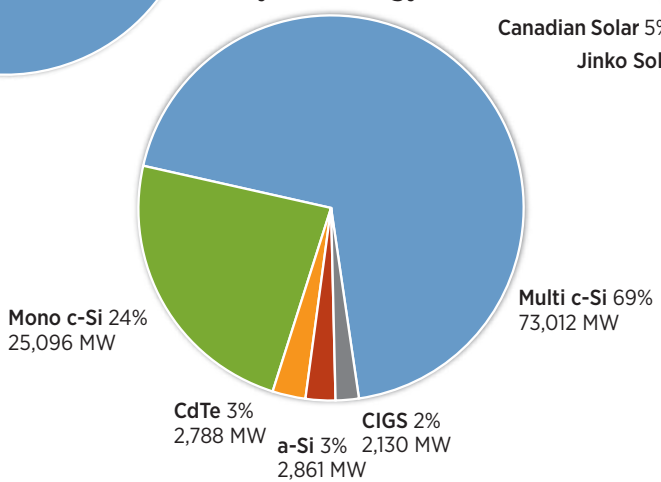
By Country



By Manufacturer



By Technology



Sources: GTM Research, PV Pulse
Module production is reported in MWdc.

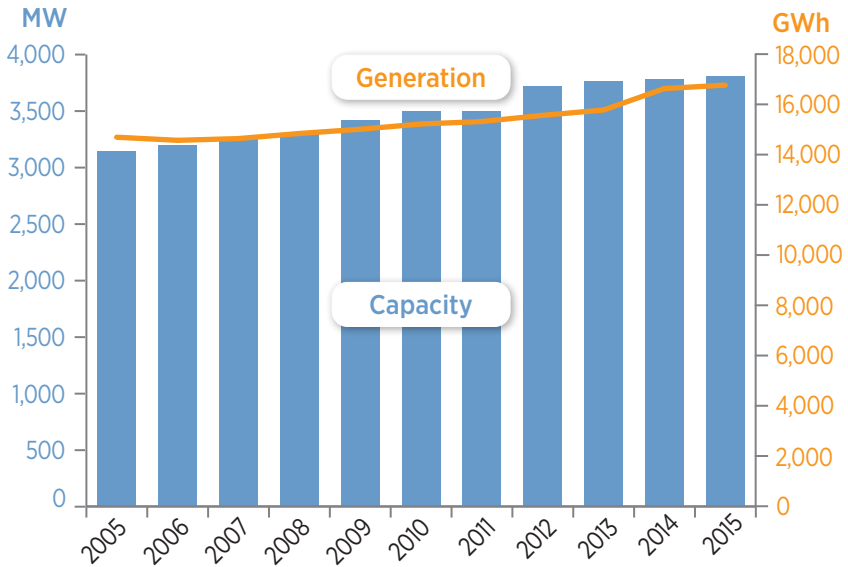
VI. Geothermal

Geothermal: Summary

- U.S. geothermal installed capacity has remained relatively stable since 2000, with a slight increase of 0.6% in 2015.
- **The United States continued to lead the world** in 2015 in installed geothermal electricity **capacity (nearly 3.8 GW) and generation (more than 16 TWh)**, with most of the capacity installed in California and Nevada.
- **Four multi-year demonstration projects for enhanced geothermal system (EGS) technology were active in 2015.**[1] **Additionally, the Desert Peak project in Nevada was completed in 2015 and provides 1.7 MW in incremental capacity from EGS sources within an existing hydrothermal wellfield**.
- **DOE's Frontier Observatory for Research in Geothermal Energy (FORGE) comprises the first dedicated field site of its kind for testing targeted EGS research and development and creating a commercial pathway for large-scale, economically viable EGS**.[1]
- Eleven Play Fairway Analysis projects are underway in the United States to evaluate under-explored areas for geothermal resource potential.[2]

[1] Source: Office of Energy Efficiency and Renewable Energy (EERE)
[2] Source: EERE

U.S. Geothermal Electricity Capacity and Generation



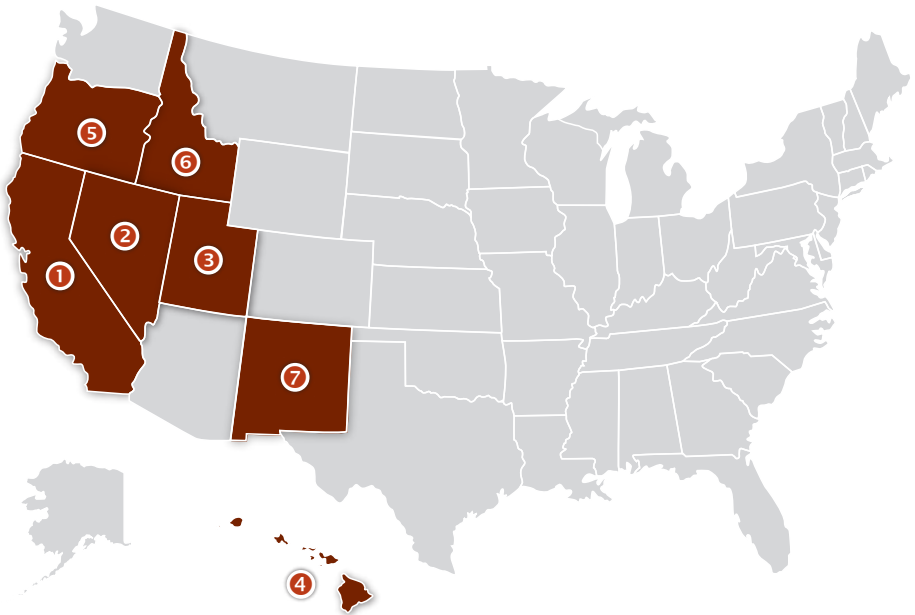
	U.S. Geothermal Electricity Generation (GWh)	U.S. Geothermal Electricity Capacity and % Increase from Previous Year	
		Total (MW)	% Increase
2000	14,093	3,100	—
2001	13,741	3,100	0.0%
2002	14,491	3,108	0.2%
2003	14,424	3,108	0.0%
2004	14,811	3,108	0.0%
2005	14,692	3,143	1.1%
2006	14,568	3,195	1.7%
2007	14,637	3,259	2.0%
2008	14,840	3,306	1.4%
2009	15,009	3,421	3.5%
2010	15,219	3,498	2.3%
2011	15,316	3,500	0.1%
2012	15,562	3,724	6.4%
2013	15,775	3,761	1.0%
2014	16,628	3,785	0.6%
2015	16,767	3,809	0.6%

VI

Source: EIA

Reported values may vary from those included in previous versions of the Data Book due to retroactive changes by EIA.

Cumulative State Geothermal Electricity Development (2015)



Total Installed Capacity (MW)[1]	
1 California	2,941
2 Nevada	674
3 Utah	84
4 Hawaii	51
5 Oregon	37
6 Idaho	18
7 New Mexico	4

VI

Source: EIA

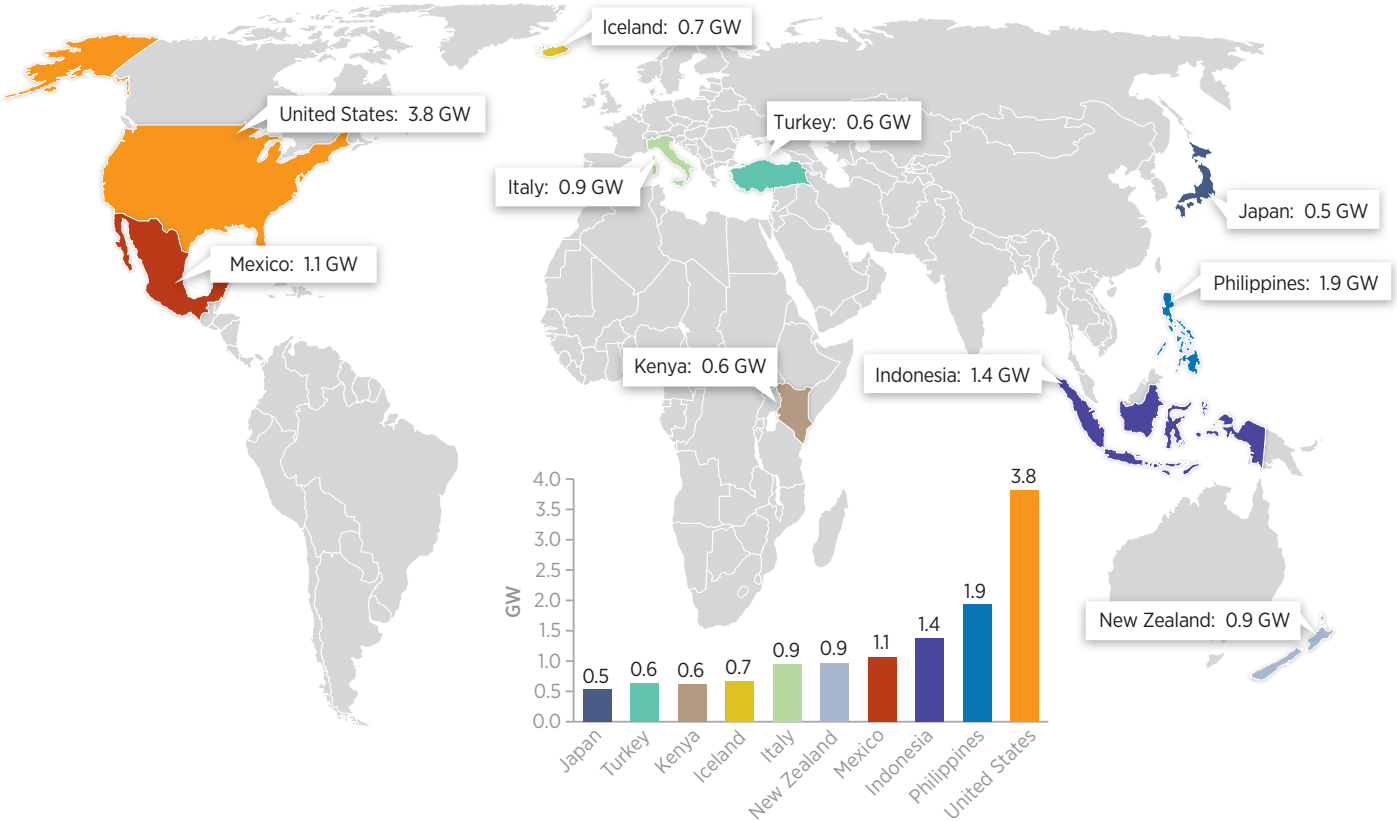
[1]Estimated based on proposed capacity additions.

U.S. Enhanced Geothermal Systems Demonstration Projects (2015)

PROJECT NAME	Company	Project Location	Start Date	End Date	Status
1 Demonstration of an Enhanced Geothermal System at the Northwest Geysers Geothermal Field	Geysers Power Company, LLC	The Geysers, Cloverdale-Geyserville, California	2008	2017	Successful stimulation, long-term monitoring underway
2 Feasibility of EGS Development at Brady's Hot Springs	Ormat Technologies, Inc.	Churchill County, Nevada	2008	2016	Initial stimulation completed, evaluating next steps
3 Concept Testing and Development at the Raft River Geothermal Field	University of Utah	Raft River, Idaho	2009	2016	Successful stimulation completed, continuous injection still underway
4 Newberry Volcano EGS Demonstration	AltaRock Energy, Inc.	La Pine, Oregon	2010	2015	Successful stimulation completed

Source: DOE Office of Energy Efficiency and Renewable Energy (EERE)

Cumulative Geothermal Electricity Capacity (2015) – Top 10 Countries



VI

Source: EIA, GEA

VII. Biopower

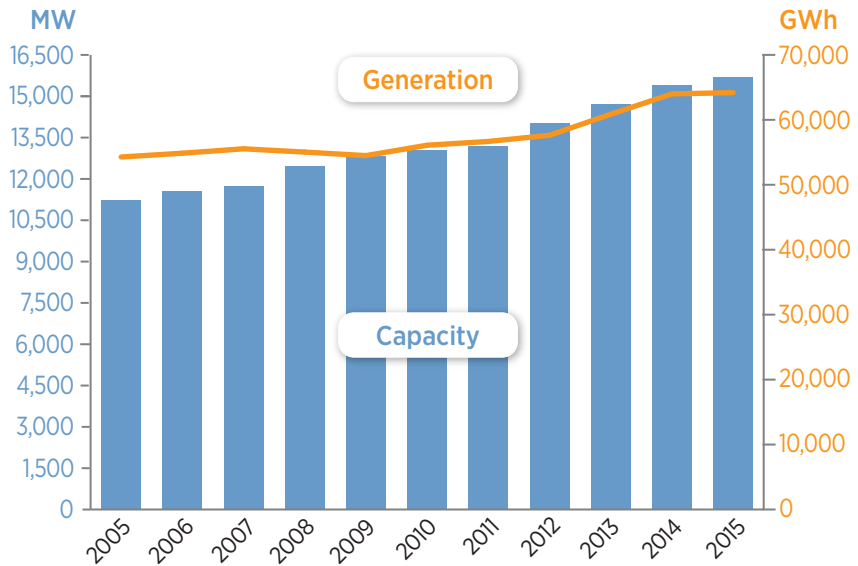
Biopower: Summary

- U.S. biopower installed electricity **capacity grew by 1.9% in 2015**, to approximately 15.7 GW. It has seen steady growth since 2005, with a CAGR of 3.4%.

- In 2015, biopower electricity generation accounted for more than **11% of all renewable energy generated in the United States** and 1.6% of total U.S. electricity generation from all sources.

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

U.S. Biopower Electricity Capacity and Generation

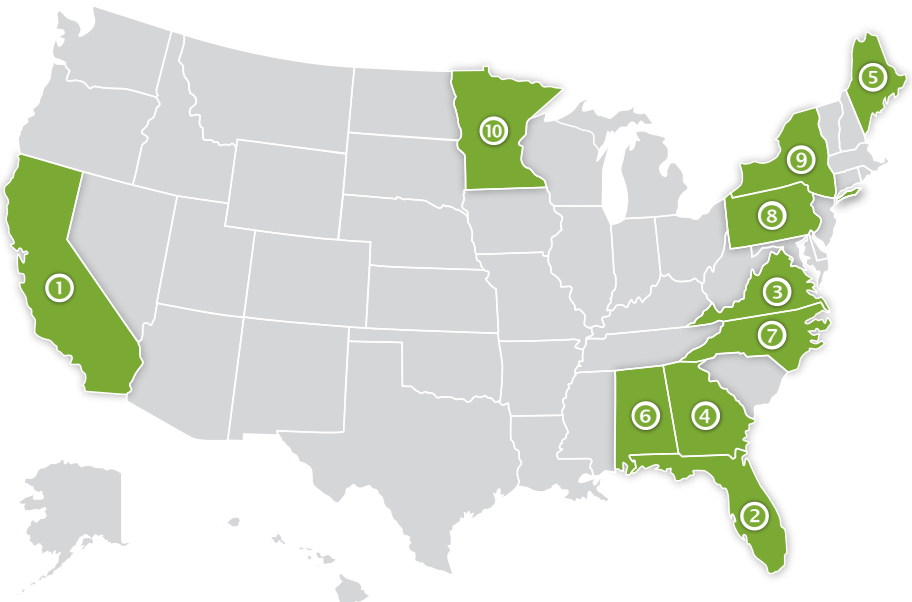


	U.S. Biopower Generation (GWh)	U.S. Biopower Capacity and % Change from Previous Year	
		Total (MW)	% Change
2000	60,726	10,676	- 2.9%
2001	49,748	10,576	- 0.9%
2002	53,709	10,867	2.8%
2003	53,340	10,856	- 0.1%
2004	53,073	11,033	1.6%
2005	54,276	11,222	1.7%
2006	54,861	11,553	2.9%
2007	55,539	11,738	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	57,622	14,047	6.4%
2013	60,858	14,705	4.7%
2014	63,990	15,408	4.8%
2015	64,190	15,696	1.9%

VII

Source: EIA
Reported values may vary from those included in previous versions of the Data Book due to retroactive changes by EIA.

States Leading Biopower Electricity Installed Capacity (2015)



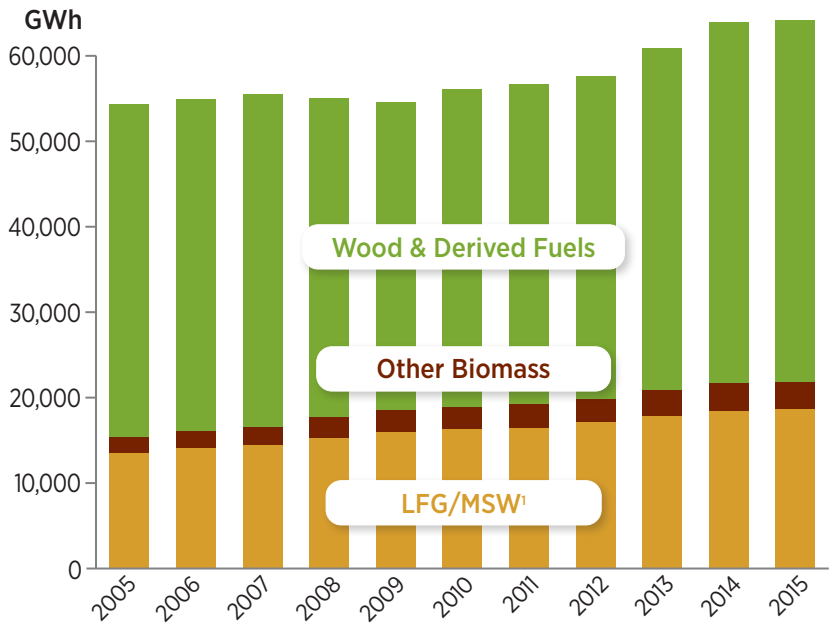
Total Installed Capacity (MW)[1]	
1 California	1,553
2 Florida	1,526
3 Virginia	1,010
4 Georgia	854
5 Maine	699
6 Alabama	676
7 North Carolina	675
8 Pennsylvania	655
9 New York	613
10 Minnesota	546

VII

Source: EIA

[1]Estimated based on proposed capacity additions.

U.S. Biopower Electricity Generation Sources



	LFG/ MSW[1] (GWh)	Other Biomass[2]	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	13,472	1,948	38,856	54,276
2006	14,155	1,944	38,762	54,861
2007	14,462	2,063	39,014	55,539
2008	15,253	2,481	37,300	55,034
2009	15,982	2,461	36,050	54,493
2010	16,304	2,613	37,172	56,089
2011	16,398	2,824	37,449	56,671
2012	17,123	2,700	37,799	57,622
2013	17,844	2,986	40,028	60,858
2014	18,448	3,202	42,340	63,990
2015	18,648	3,184	42,358	64,190

VII

Source: EIA

Reported values may vary from those included in previous versions of the Data Book due to retroactive changes by EIA.

[1] LFG = landfill gas; MSW = municipal solid waste.

[2] Includes biogenic municipal solid waste, landfill gas, sludge waste, agricultural byproducts, and other biomass.

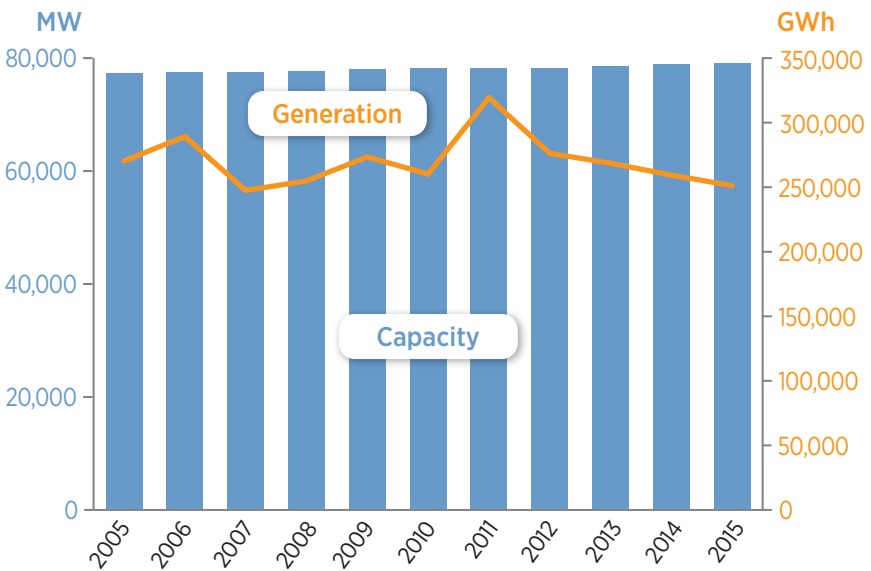
VIII. Hydropower

Hydropower: Summary

- Hydropower in the United States was comprised of more than 2,000 projects in 2015, totaling an **installed capacity of more than 79 GW** from hydropower-generation facilities and nearly 22 GW from pumped storage.[1]
- Hydropower, primarily from large-scale plants, remained the **largest source of renewable electricity generation** in 2015, **accounting for 6.1% of U.S. total electricity generation and 44.3% of U.S. renewable electricity generation**. Annual hydropower generation, which fluctuates depending on water supply, fell by 3.2% in 2015, continuing a declining trend that began in 2011.
- Hydropower installed capacity continued to be **concentrated in the West**, led by Washington, California, and Oregon, which had a combined hydropower capacity of more than 39 GW in 2015.
- **Hydroelectric generation was lower in 2015 across California, Oregon, and Washington due to drought conditions in the West**. In 2015, slightly more than 120 TWh came from hydroelectric generators in these three states, down from nearly 177 TWh generated in 2011.[1]
- The existing U.S. federal hydropower plant fleet is aging. In 2014, the average age of U.S. Army Corps of Engineers and Bureau of Reclamation hydropower facilities was 49 years and 58 years, respectively.[2]

[1] Source: EIA
[2] Source: DOE Hydropower Vision

U.S. Hydropower Electricity Capacity and Generation

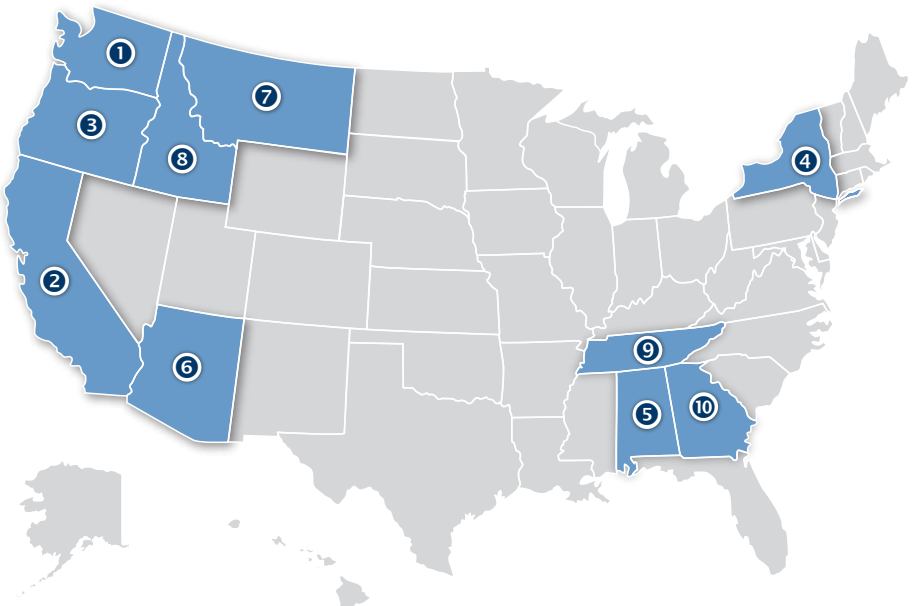


	U.S. Hydropower Generation (GWh)	U.S. Hydropower Capacity and % Increase from Previous Year	
		Total (MW)	% Increase
2000	275,573	76,946	0.0%
2001	216,961	76,911	0.0%
2002	264,329	77,047	0.2%
2003	275,806	77,020	0.0%
2004	268,417	77,130	0.1%
2005	270,321	77,354	0.3%
2006	289,246	77,419	0.1%
2007	247,510	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	276,240	78,241	0.1%
2013	268,565	78,457	0.3%
2014	259,367	78,810	0.4%
2015	251,168	79,052	0.3%

VIII

Source: EIA
Excludes pumped storage.
Reported values may vary from those included in previous versions of the Data Book due to retroactive changes by EIA.

States Leading Hydropower Electricity Installed Capacity



Total Installed Capacity (MW)[1]	
1 Washington	20,995
2 California	10,043
3 Oregon	8,446
4 New York	4,672
5 Alabama	3,319
6 Arizona	2,718
7 Montana	2,628
8 Idaho	2,541
9 Tennessee	2,499
10 Georgia	1,927

VIII

Source: EIA

Excludes pumped storage.

[1]Estimated based on proposed capacity additions.

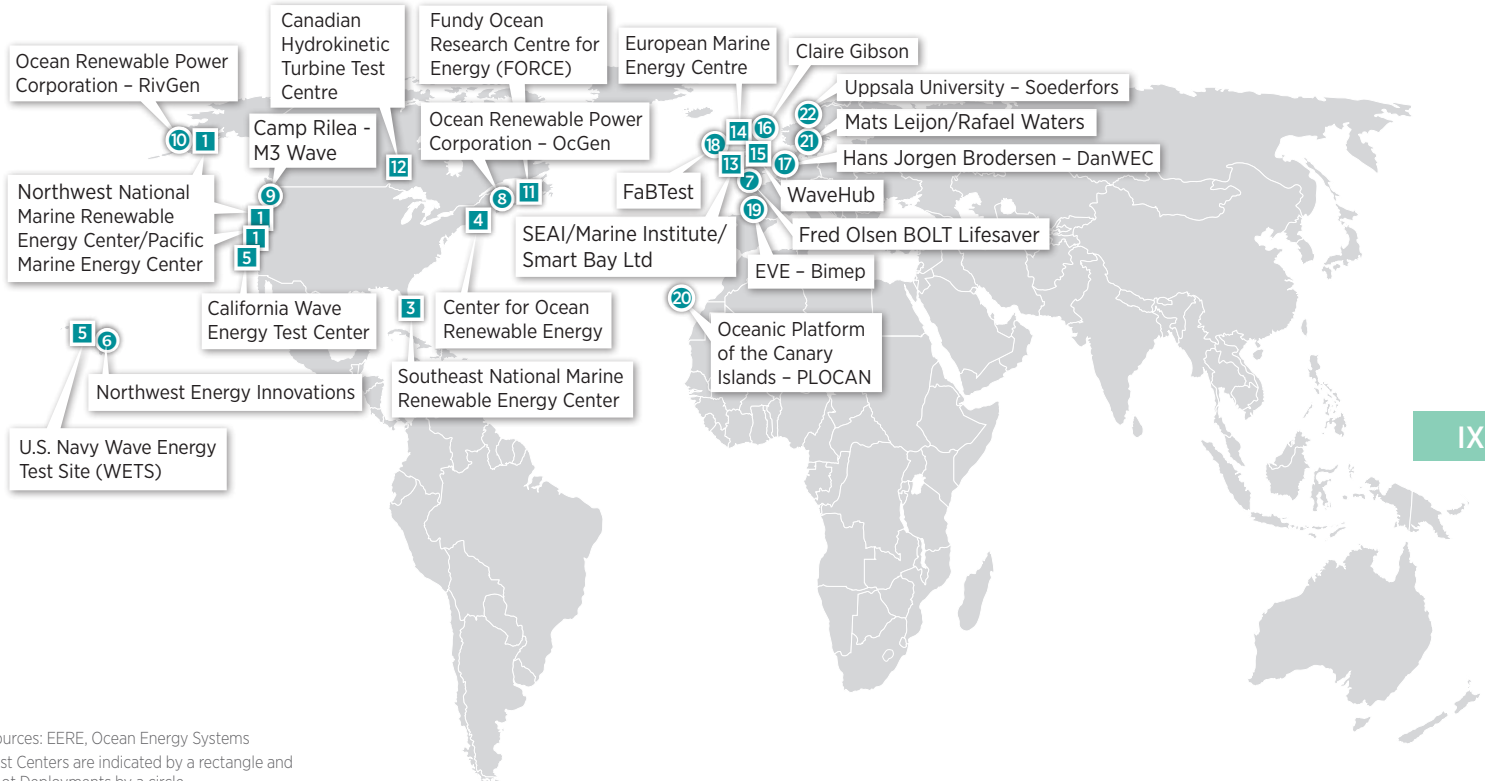
IX. Marine and Hydrokinetic Power

Marine and Hydrokinetic Power: Summary

- Resource assessments for marine and hydrokinetic power, including tidal, river, ocean current, and ocean wave energy, identify **U.S. technical resource potential of up to 1,850 TWh** of generation per year.[1]
- The vast majority of marine and hydrokinetic power projects worldwide are in a **pilot-deployment and test-site status**. Development activity is concentrated in North America and Europe.
- Northwest Energy Innovations began performing grid-connected open sea pilot testing of its Azura prototype for wave energy at the U.S. Navy WETS in Kaneohe, Hawaii, in 2015.
- In July 2015, Ocean Renewable Power Company deployed its RivGEN turbine in the Kvichak River at the Igiugig village in Alaska to demonstrate a capability to deliver grid-quality power to the village.
- Information on existing and planned pilot deployment and test sites may be found at these websites:
  - Federal Energy Regulatory Commission (FERC): www.ferc.gov/industries/hydropower/gen-info/licensing/hydrokinetics.asp
  - U.S. Department of Energy Water Power Program: www1.eere.energy.gov/water
  - The Ocean Energy Systems Implementing Agreement, established by the International Energy Agency and currently with 25 participating countries (including the United States): http://report2015.ocean-energy-systems.org/

[1] Source: Ocean Energy Systems (OES)

Global Marine and Hydrokinetic Power – Examples of Pilot Deployment and Test Sites



Sources: EERE, Ocean Energy Systems

Test Centers are indicated by a rectangle and Pilot Deployments by a circle.

See the following page for additional information about these projects.

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

Global Marine and Hydrokinetic Power – Examples of Pilot Deployment and Test Sites

PROJECT NAME	Test Center/Pilot Deployment	Type	Country	Location
1 Northwest National Marine Renewable Energy Center/ Pacific Marine Energy Center	Test Centers	Wave, River Current, Tidal	United States	Oregon, Washington, Alaska
2 U.S. Navy Wave Energy Test Site (WETS)	Test Center	Wave	United States	Kaneohe Bay, Hawaii
3 Southeast National Marine Renewable Energy Center	Test Center	Ocean Current	United States	Boca Raton, Florida
4 Center for Ocean Renewable Energy	Test Center	Wave, Tidal	United States	Isles of Shoals, Maine/New Hampshire
5 California Wave Energy Test Center	Test Center	Wave	United States	San Luis Obispo, California
6 Northwest Energy Innovations	Pilot Deployment	Wave	United States	Kaneohe Bay, Hawaii
7 Fred Olsen BOLT Lifesaver	Pilot Deployment	Wave	UK	Falmouth, Cornwall
8 Ocean Renewable Power Corporation – OcGen	Pilot Deployment	Tidal	United States	Cobscook Bay, Maine
9 Camp Rilea – M3 Wave	Pilot Deployment	Wave	United States	Warrenton, Oregon
10 Ocean Renewable Power Corporation- RivGen	Pilot Deployment	Tidal	United States	Kvichak River, Alaska
11 Fundy Ocean Research Centre for Energy (FORCE)	Test Center	Tidal	Canada	Minas Passage, Nova Scotia

Sources: EERE, Ocean Energy Systems

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

Global Marine and Hydrokinetic Power – Examples of Pilot Deployment and Test Sites (continued)

PROJECT NAME	Test Center/Pilot Deployment	Type	Country	Location
12 Canadian Hydrokinetic Turbine Test Centre	Test Center	Current	Canada	Winnipeg River, Manitoba
13 SEAI/Marine Institute/Smart Bay Ltd	Test Center	Wave	Ireland	Galway
14 European Marine Energy Centre	Test Center	Wave/Tidal	UK	Orkney, Scotland
15 WaveHub	Test Center	Wave	UK	Hayle, Cornwall
16 Claire Gibson	Pilot Deployment	Wave	UK	Hayle, Cornwall
17 Hans Jorgen Brodersen – DanWEC	Pilot Deployment	Wave	Denmark	Hanstholm & Nissum Bredning
18 FaBTest	Pilot Deployment	Wave	UK	Cornwall
19 EVE – Bimep	Pilot Deployment	Wave	Spain	Basque Country
20 Oceanic Platform of the Canary Islands – PLOCAN	Pilot Deployment	Wave	Spain	Gran Canaria, Canary Islands
21 Mats Leijon/Rafael Waters	Pilot Deployment	Wave	Sweden	Lysekil
22 Uppsala University – Soederfors	Pilot Deployment	Wave	Sweden	Soederfors/Dalaelven

IX

Sources: EERE, Ocean Energy Systems

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

X. Hydrogen and Fuel Cells

Hydrogen and Fuel Cells: Summary

- In the United States, stationary fuel cell installed capacity totaled 290 MW in 2015. It was comprised of fuel cell systems of >60 kW (251 MW), fuel cell systems of <60 kW (0.2 MW), and backup power of <10 kW (39 MW).

- In 2015, **global fuel cell shipments increased by about 20%** from 2014.

- The United States produced **10 million metric tons of hydrogen** in 2015, which is equivalent to the annual fuel need of roughly 50 million light-duty fuel cell electric vehicles.

X

Source: DOE Fuel Cell Technologies Market Report

- A 19.6-MW fuel cell power generation plant is being planned for construction in Seoul City, South Korea.

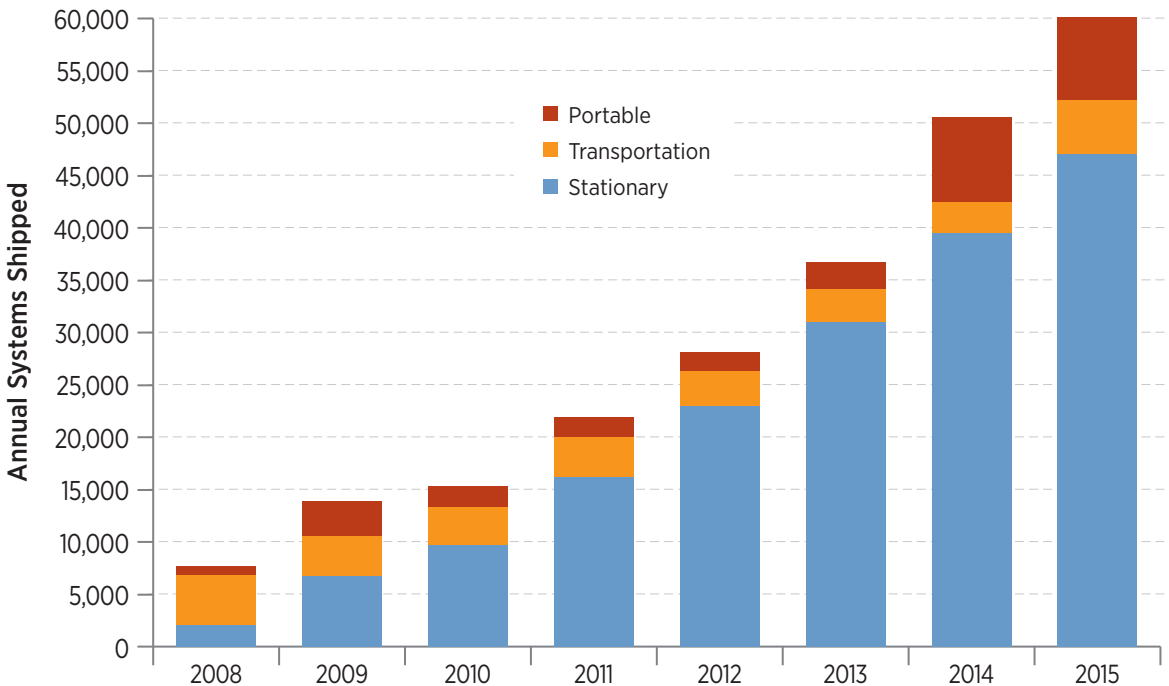
- Globally, more than 7,800 fuel cell units have been installed or ordered for backup power applications. These units have a successful startup rate of more than 99.7%.

- More than 11,700 fuel cells have been ordered or installed worldwide in forklifts for use in material handling applications.

X

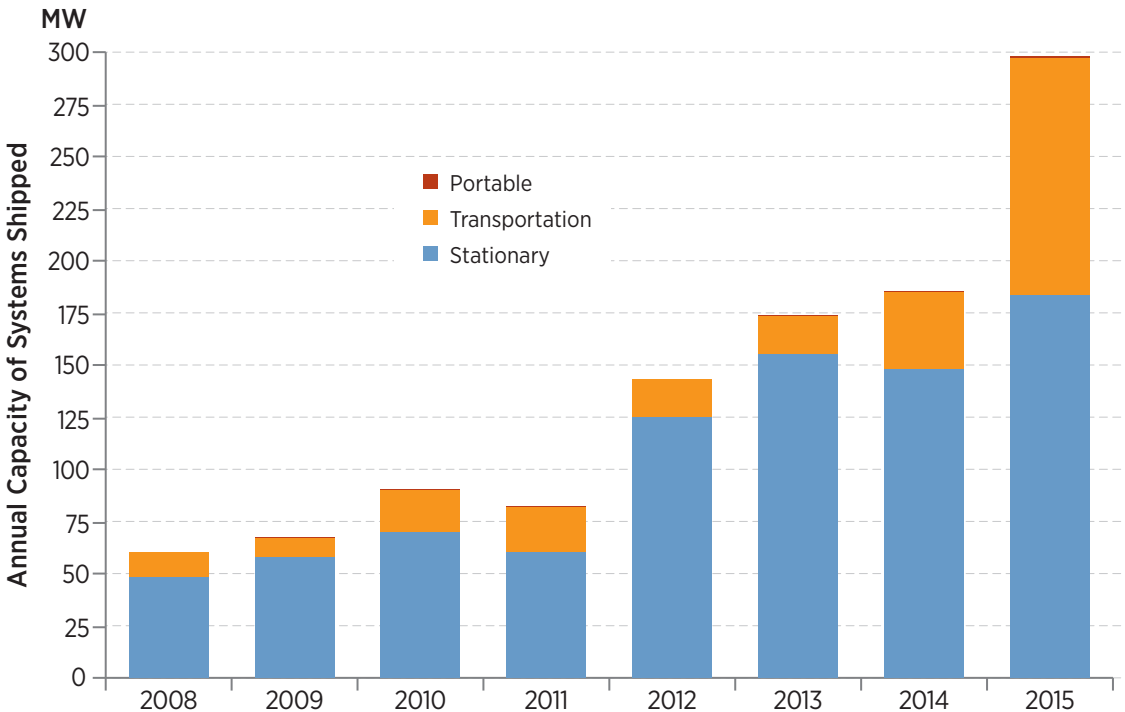
Source: EERE

Annual Fuel Cell Systems Shipped by Application, World Markets



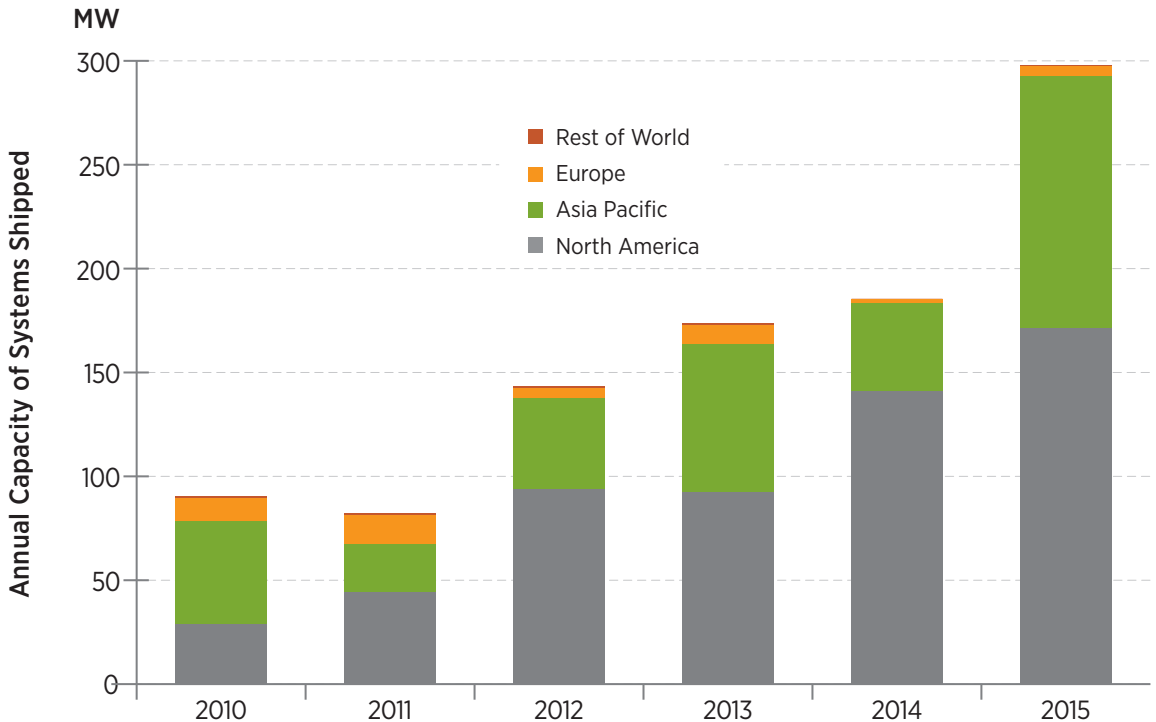
Sources: EERE, Navigant Research (2008–2013), E4tech (2014–2015)
Reported values may vary from those included in previous versions of the Data Book due to retroactive changes in source data.

Annual Capacity of Systems Shipped by Application, World Markets



Sources: EERE, Navigant Research (2008–2013), E4tech (2014–2015)
Reported values may vary from those included in previous versions of the Data Book due to retroactive changes in source data.

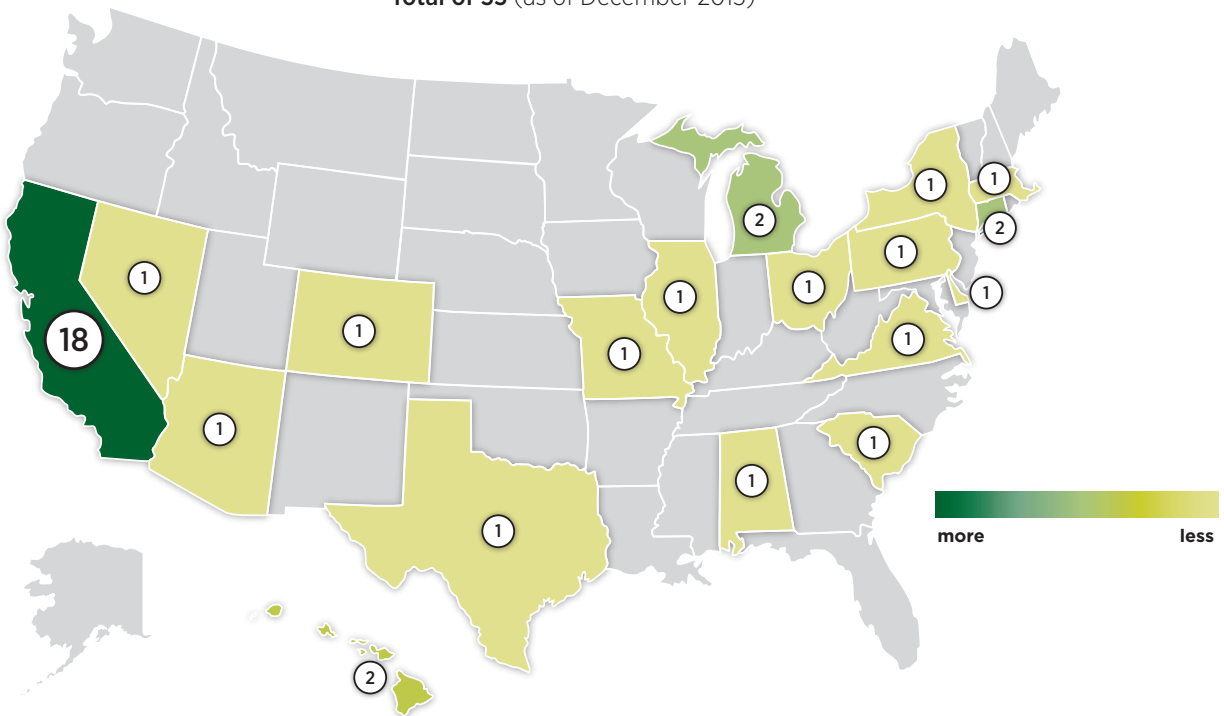
Annual Capacity of Fuel Cell Systems Shipped by Region of Manufacture



Sources: EERE, Navigant Research (2008–2013), 4th Energy Wave (2014–2015)
Reported values may vary from those included in previous versions of the Data Book due to retroactive changes in source data.

Number of Operational U.S. Hydrogen Fueling Stations

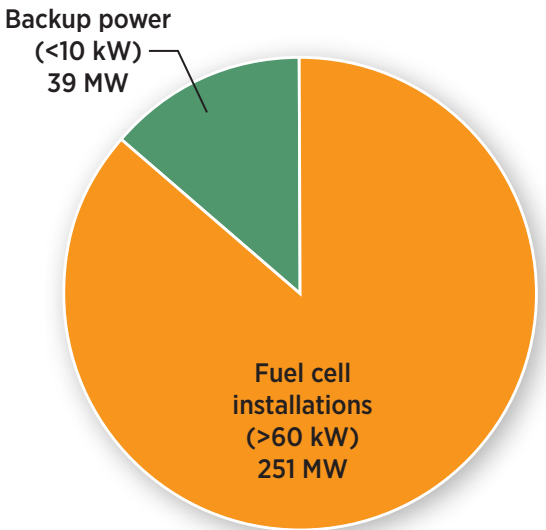
Total of 33 (as of December 2015)



X

Sources: EERE Alternative Fuels Data Center

U.S. Stationary Fuel Cells – Installed Capacity (2015)



X

Source: EERE

XI. Renewable and Alternative Fuels

Renewable and Alternative Fuels: Summary

- **U.S. ethanol production increased by nearly 2.8% to 14,700 million gallons** in 2015, despite continued sharp ethanol and gasoline price decreases.

- In 2015, the United States **produced 57% of the world's ethanol**,[1] followed by Brazil (28%), the European Union (5%), China (3%), and Canada (2%).

- Three U.S. commercial-scale cellulosic ethanol plants with a combined production capacity of 75 million gallons per year were commissioned in 2015.[2]

- In 2015, **the number of public and private electric vehicle charging stations in the United States increased by nearly 108%, to a total of more than 22,929 stations** with more than 34,000 charging outlets.[3]

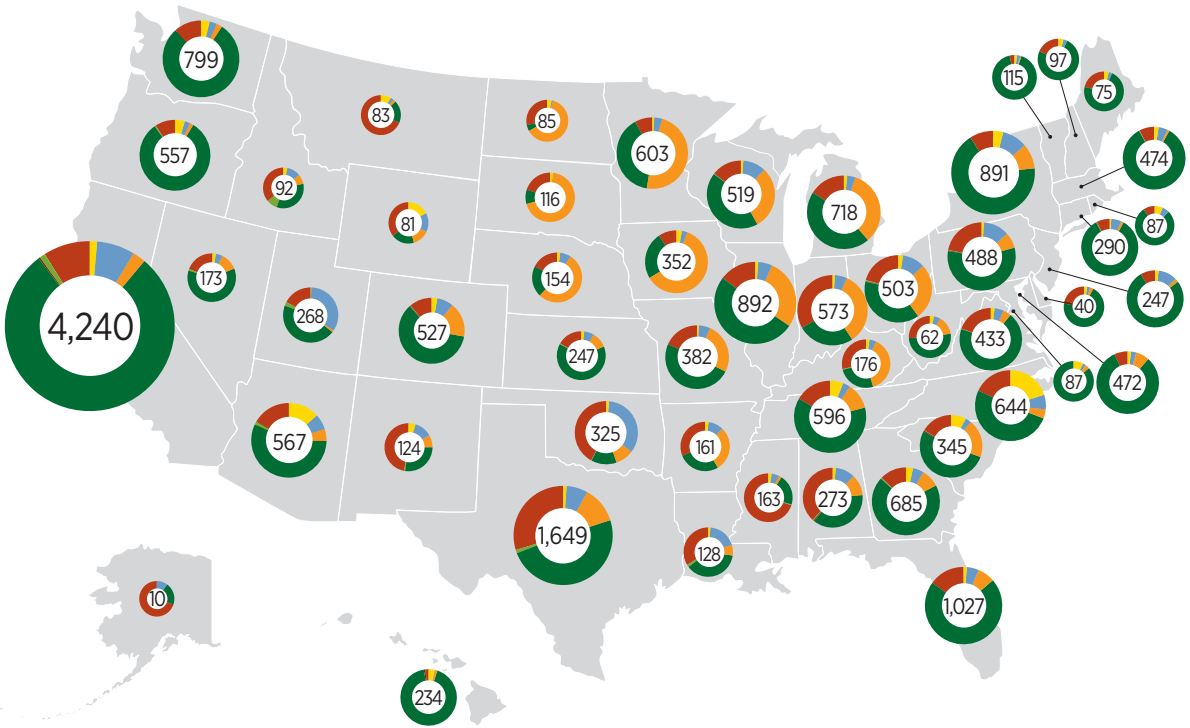
XI

[1] The renewable fuel standard (RFS) in the United States sets targets that limit the amount of renewable fuel (including corn ethanol) and increase levels of cellulosic and advanced biofuels (including cellulosic ethanol). Substantial growth in ethanol market size faces the challenge that gasoline in the United States is generally sold as a 10% ethanol (E10), and ethanol production volumes above that level would need to enter the E15 or E85 markets.

[2] Source: Renewable Fuels Association *2016 Ethanol Industry Outlook*

[3] Source: EERE Alternative Fuels Data Center

Renewable and Alternative Fueling Stations by State



Breakdown of Stations by State

- B20 (20% biodiesel)
- CNG (compressed natural gas)
- E85 (85% ethanol)
- Electric[1]
- Hydrogen
- LNG (liquefied natural gas)
- Propane

Total Renewable and Alternative Fueling Stations by State

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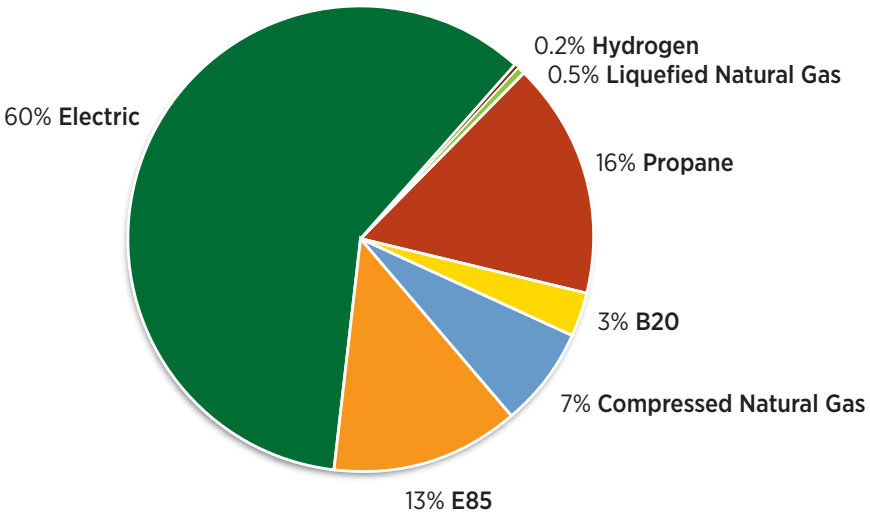
Source: EERE Alternative Fuels Data Center

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

[1]Public and private electric vehicle charging stations; there were more than 34,000 charging outlets.

Renewable and Alternative Fueling Stations by Type

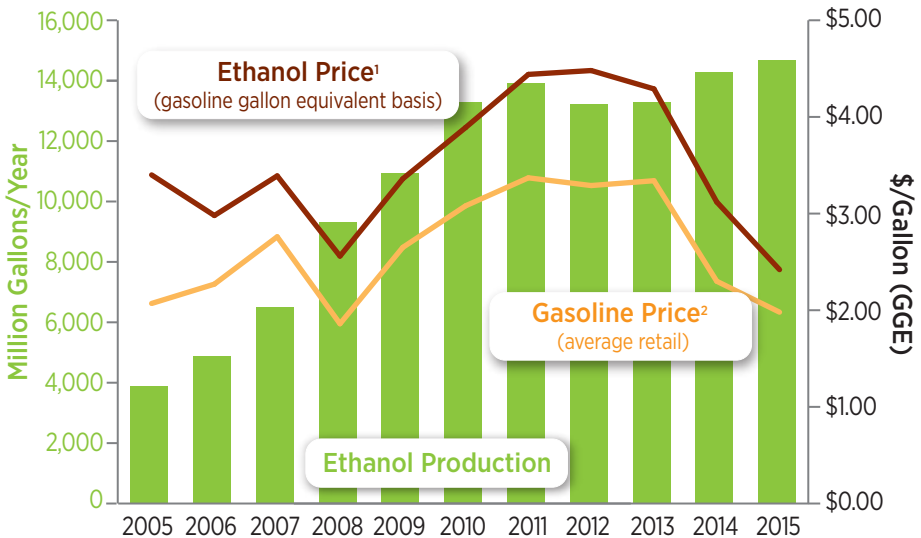
22,929 Alternative Fueling Stations in the United States



XI

Source: EERE Alternative Fuels Data Center

U.S. Corn Ethanol Production and Prices



	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	13,929
2012	$3.29	$4.48	13,218
2013	$3.34	$4.29	13,293
2014	$2.30	$3.12	14,300
2015	$1.98	$2.42	14,700

XI

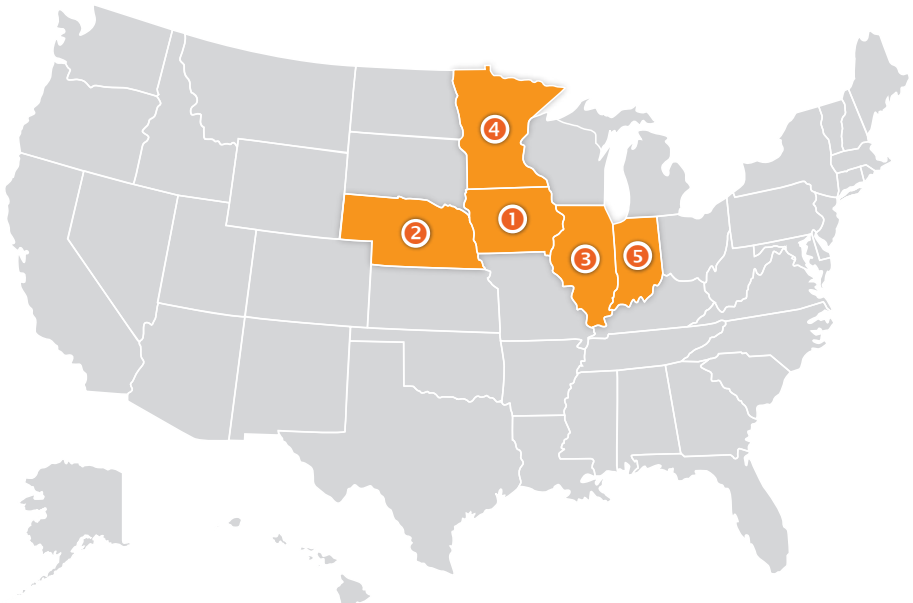
Sources: Renewable Fuels Association (RFA), EERE

Reported values may vary from those included in previous versions of the Data Book due to retroactive changes in data sources.

[1] Ethanol price is based on the average retail price for E85 fuel blend, inclusive of taxes.

[2] Gasoline price is based on the average retail price for E10 fuel blend, inclusive of taxes.

U.S. Corn Ethanol Production Capacity (2015)



Top Five States for U.S. Ethanol (operating) Production Capacity in 2015 (millions of gallons/year)	
1 Iowa	3,947
2 Nebraska	2,119
3 Illinois	1,635
4 Minnesota	1,190
5 Indiana	1,163

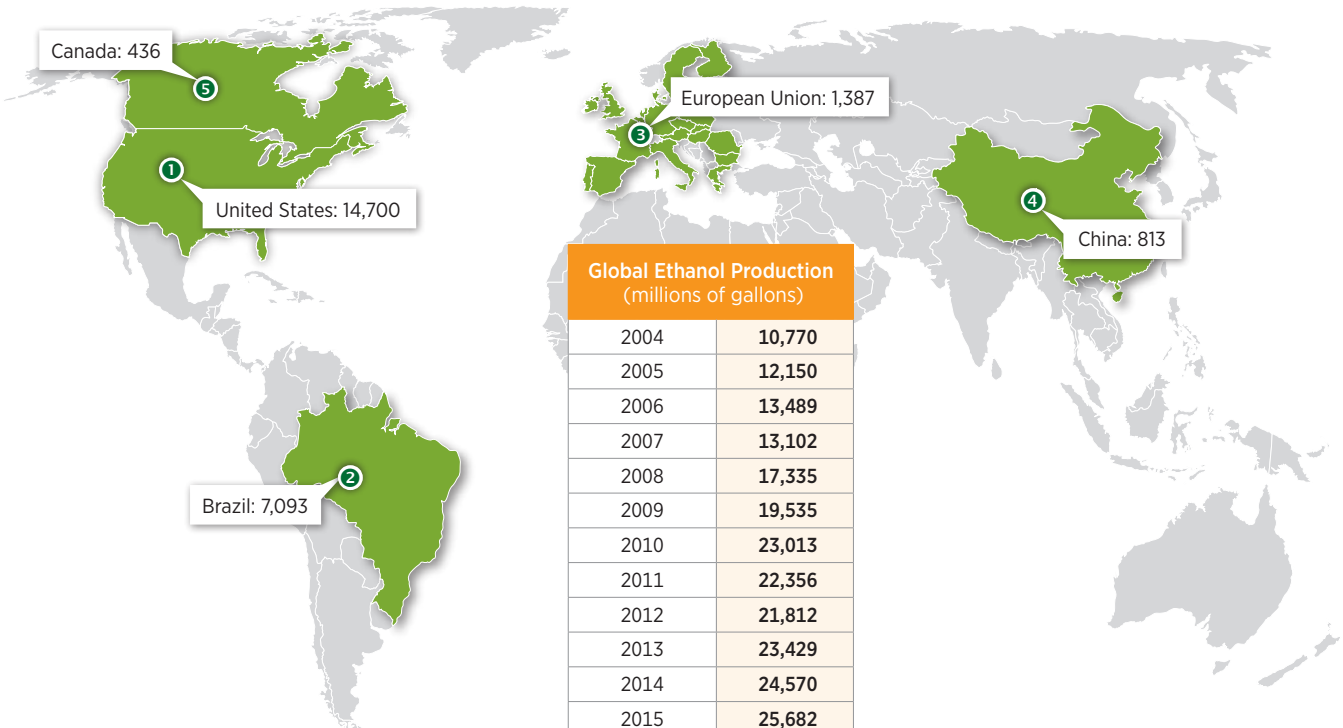
XI

Source: RFA

No sugarcane ethanol is currently produced in the United States.

Global Ethanol[1] Production

Top Five Regions (2015) **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**
2010	**23,013**
2011	**22,356**
2012	**21,812**
2013	**23,429**
2014	**24,570**
2015	**25,682**

Source: RFA

[1] Various feedstocks.

Biodiesel: Summary

- **U.S. biodiesel production increased slightly to 2.09 billion gallons** (2.23 billion gasoline gallons equivalent) in 2015 from 1.98 billion gallons in 2014.[1]

- Biodiesel production in the United States has increased steadily over the last decade. Production volume increased by a factor of 27 from 2005 to 2015.

- In 2015, **the United States led the world in biodiesel production**, followed by Brazil, Germany, and Argentina.

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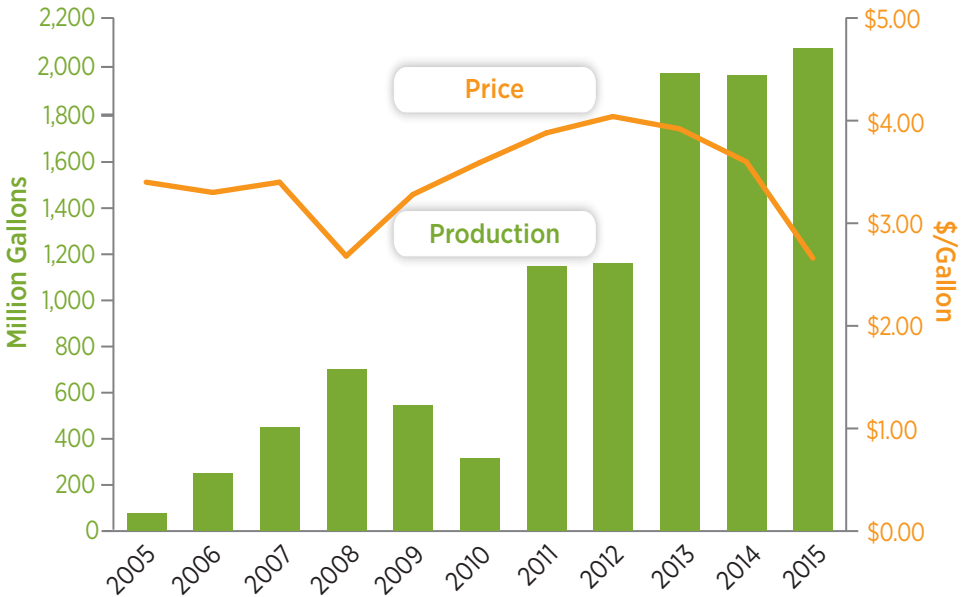
[1] Reported values may vary from those included in previous versions of the Data Book due to retroactive changes in source data.

U.S. Biodiesel Production and Price



	Biodiesel Price[1] (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	1,147
2012	4.04	1,160
2013	3.92	1,985
2014	3.60	1,976
2015	2.66	2,093

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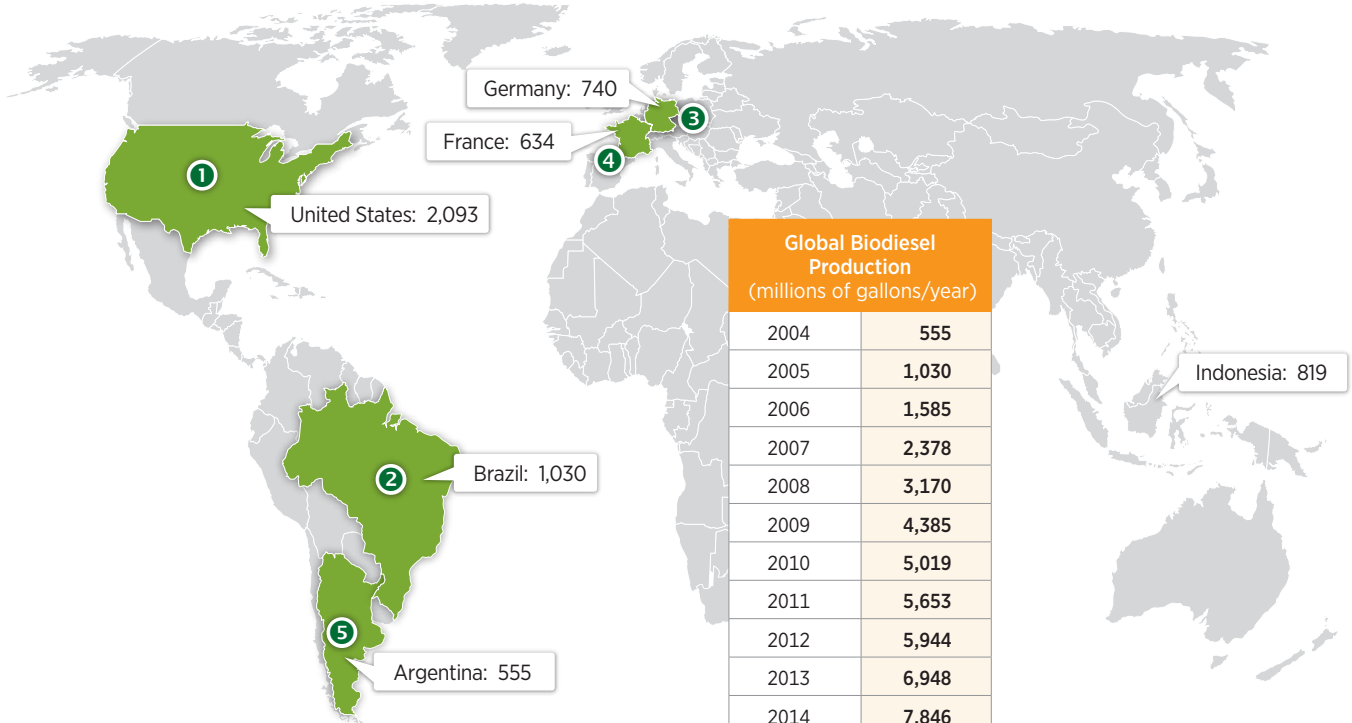
Sources: EERE; Production data: Biodiesel.org

Reported values may vary from those included in previous versions of the Data Book due to retroactive changes in source data.

[1] Biodiesel price is an unweighted average of prices for B20 and B99-B100.

Global Biodiesel Production

Top Countries (2015) **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**
2013	**6,948**
2014	**7,846**
2015	**7,952**

Source: REN21

XII. Clean Energy Investments

Clean Energy Investment: Summary

- Global investment in clean energy in 2015 grew by 4.1% from 2014 to $329 billion.[1]
- New investment in clean energy in the United States grew 10% to **$45 billion in 2015**.
- Wind and solar continued to experience the highest levels of new investment in 2015 globally.
- **Globally, new venture capital and private equity** investment in clean energy increased from $2.3 billion annually in 2005 to $5.6 billion in 2015.

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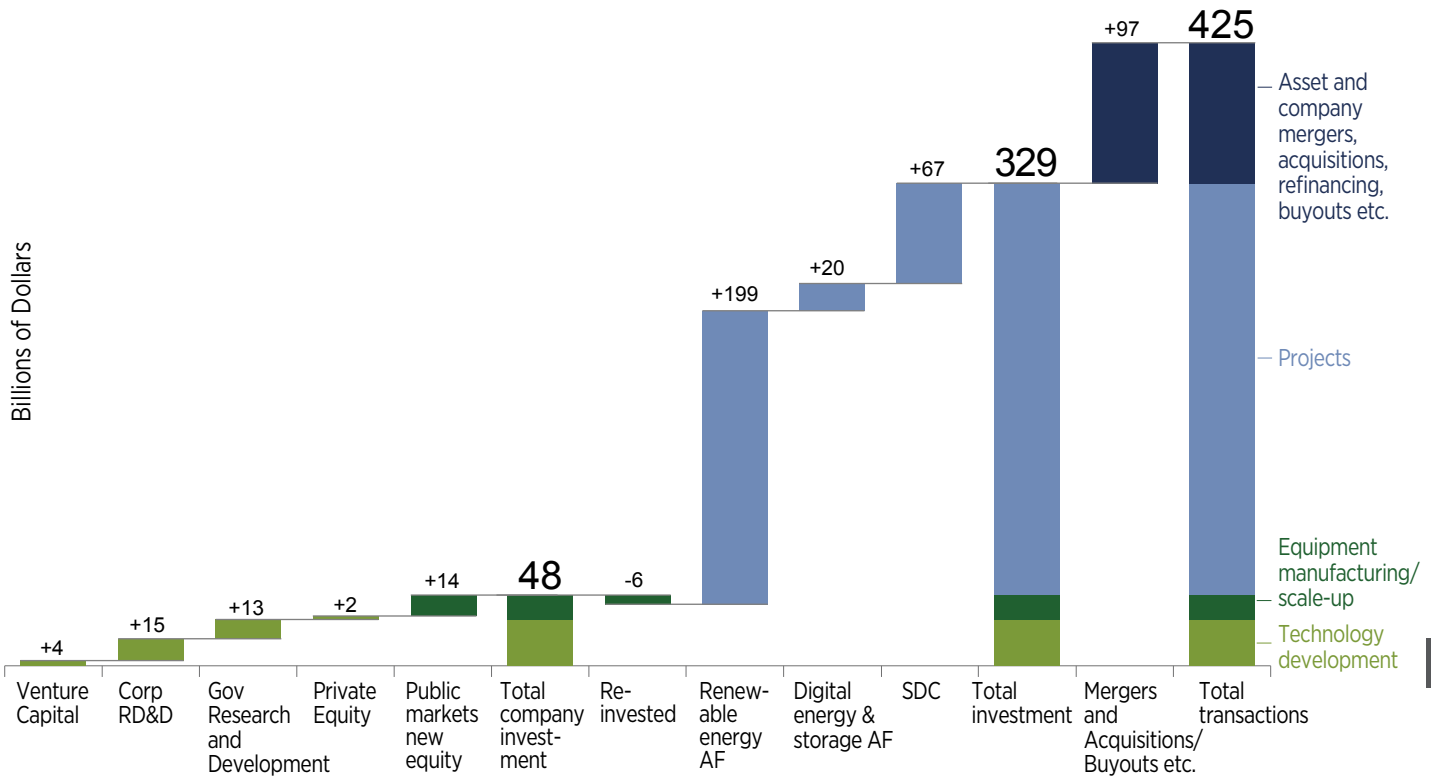
Source: Bloomberg New Energy Finance

[1] Reported values exclude mergers and acquisitions and may vary from those included in previous versions of the Data Book due to retroactive changes in source data

Clean Energy Investment Types and Flows (2015) – Global



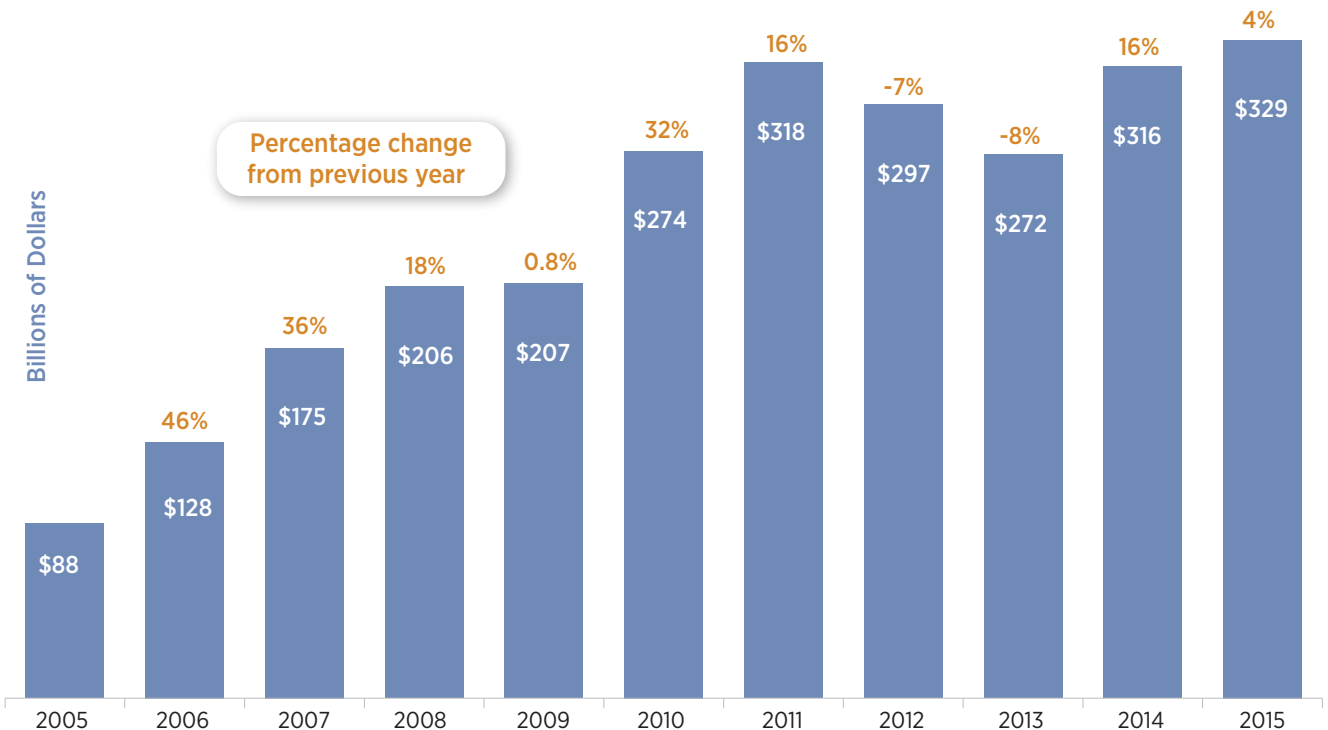
Source: Bloomberg New Energy Finance (BNEF)

Total values include estimates for undisclosed deals.

Reported values may vary from those included in previous versions of the Data Book due to retroactive changes in source data.

AF = asset finance; RD&D = research, development, and demonstration; SDC = small distributed capacity.

New Investment in Clean Energy – Global



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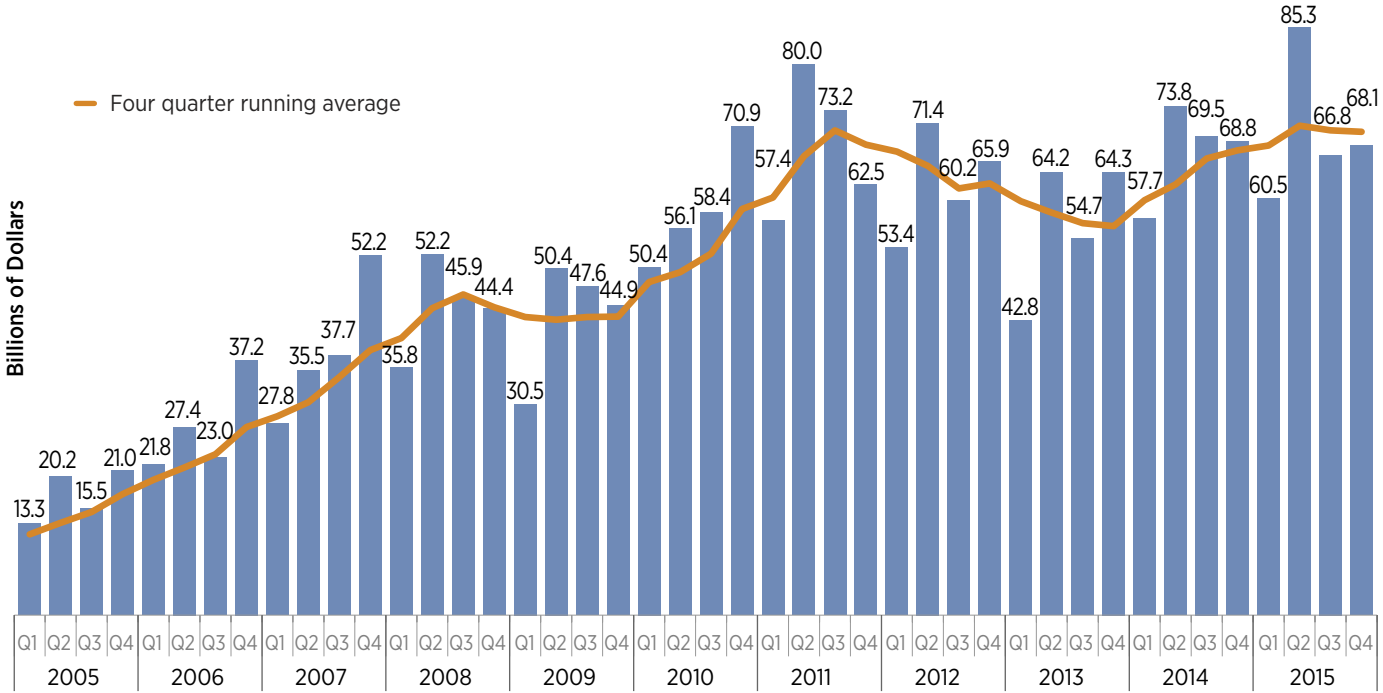
Source: BNEF

Reported values may vary from those included in previous versions of the Data Book due to retroactive changes in source data.

Total values include estimates for undisclosed deals; includes corporate and government R&D and digital energy and energy storage project spending (not reported in quarterly statistics).

New Investment in Clean Energy – Global



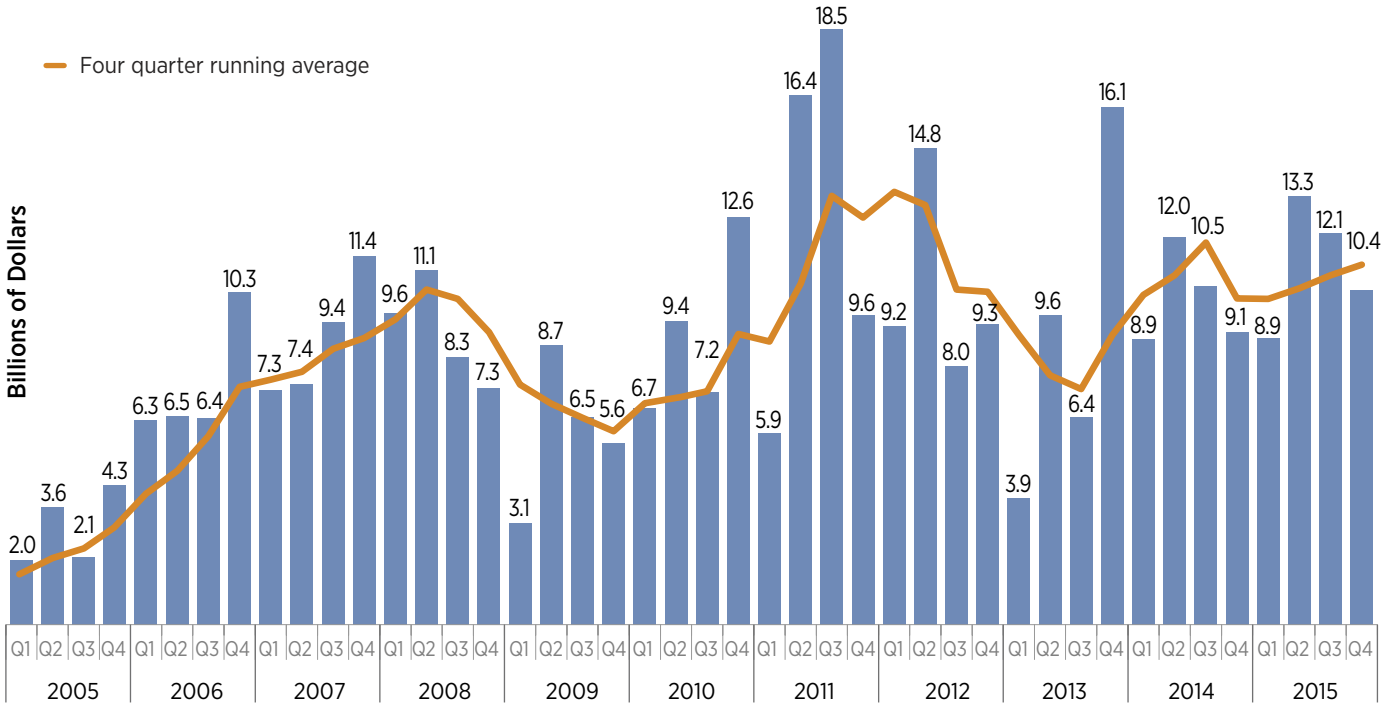
XII

Source: BNEF

Reported values may vary from those included in previous versions of the Data Book due to retroactive changes in source data.

Total values include estimates for undisclosed deals; includes corporate and government R&D and digital energy and energy storage project spending (not reported in quarterly statistics).

New Investment in Clean Energy – United States



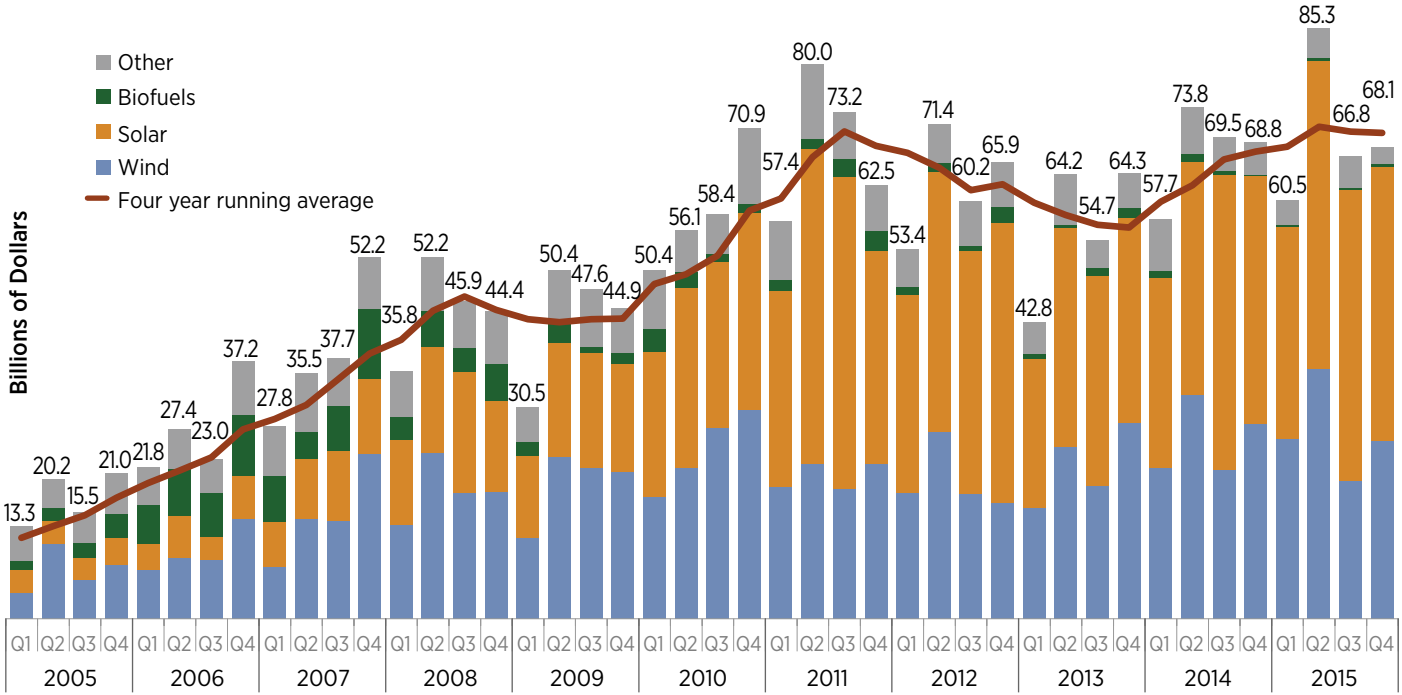
XII

Source: BNEF

Reported values may vary from those included in previous versions of the Data Book due to retroactive changes in source data.

Total values include estimates for undisclosed deals; includes corporate and government R&D and digital energy and energy storage project spending (not reported in quarterly statistics).

New Investment in Clean Energy by Technology – Global

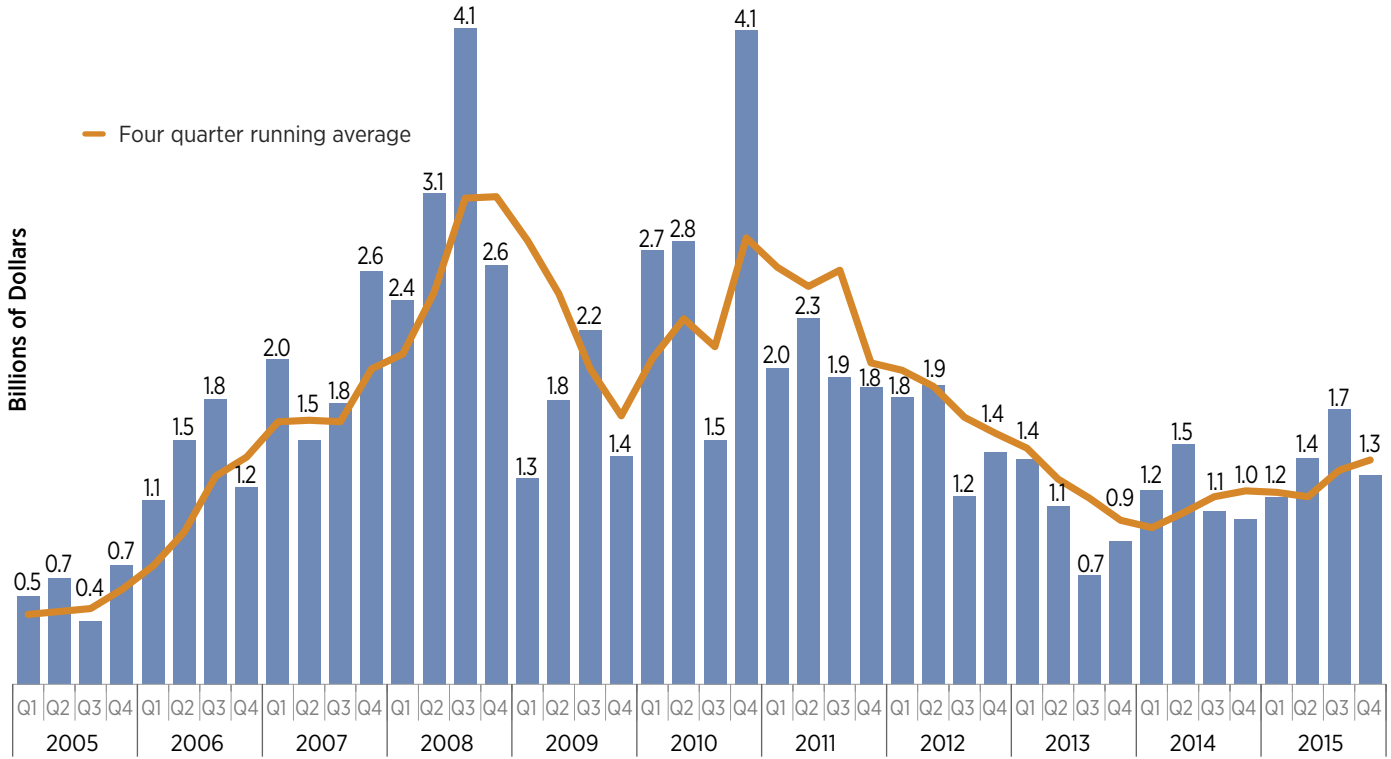


Source: BNEF

Reported values may vary from those included in previous versions of the Data Book due to retroactive changes in source data.

Total values include estimates for undisclosed deals; includes corporate and government R&D and spending for digital energy and energy storage projects (not reported in quarterly statistics).

Venture Capital and Private Equity New Investment in Clean Energy – Global

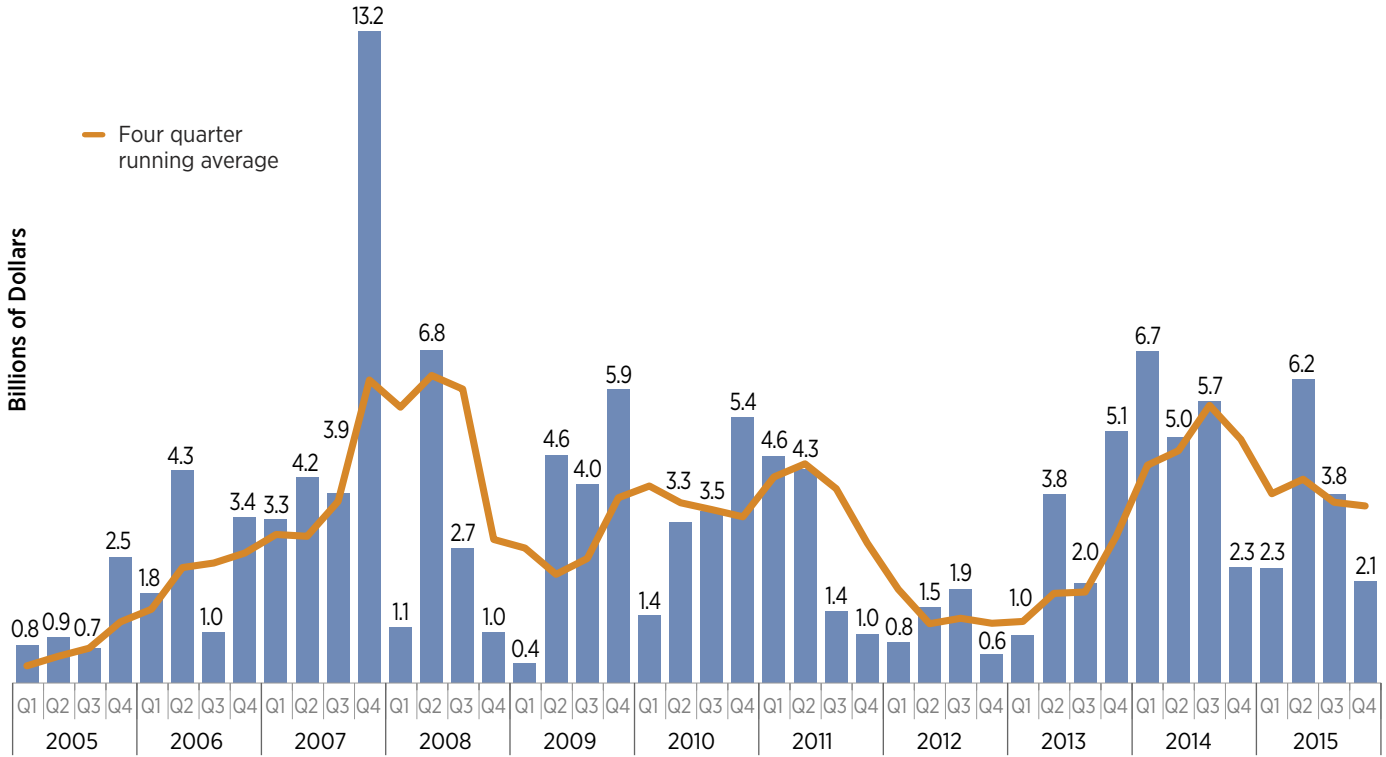


Source: BNEF

Reported values may vary from those included in previous versions of the Data Book due to retroactive changes in source data.

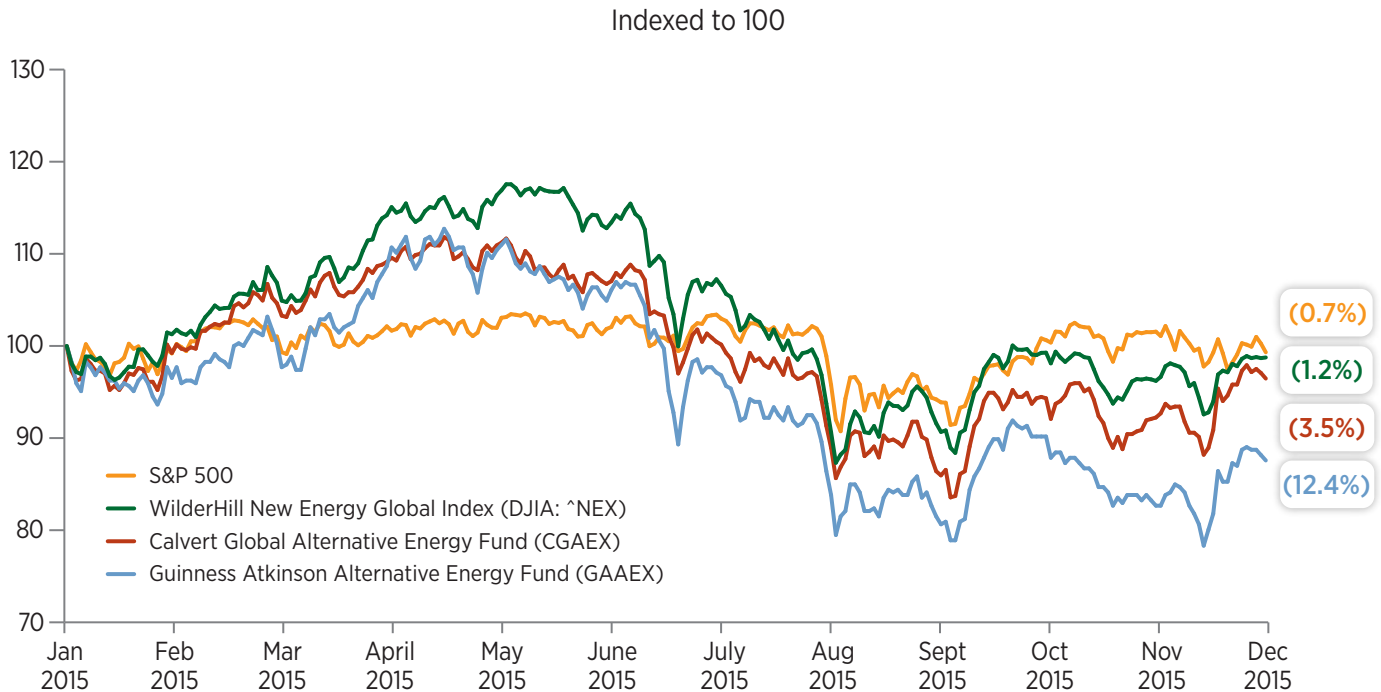
Total values include estimates for undisclosed deals.

Public Market New Investment in Clean Energy – Global



Source: BNEF
Total values include estimates for undisclosed deals.

Public Renewable Energy Index Performance (2015)



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Source: Public data, downloaded from the Yahoo! Finance website (https://finance.yahoo.com/)

Glossary

Alternating Current (AC)

An electrical current that periodically reverses the direction of electrons. The electric grid infrastructure, including most conventional and renewable utility-scale generation sources (other than solar photovoltaics [PV]) operates in AC. PV systems must use an inverter to convert DC into AC in order to operate within the grid. For the purpose of this report, an overall DC-to-AC de-rate factor of 0.77 was assumed.

Asset Financing (AF)

Using balance sheet assets (such as accounts receivable, short-term investments or inventory) to obtain a loan or borrow money—the borrower provides a security interest in the assets to the lender. This differs from traditional financing methods, such as issuing debt or equity securities, as the company simply pledges some of its assets in exchange for a quick cash loan.

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.

Direct Current (DC)

An electrical current that has unidirectional flow. DC is the type of electrical current often seen in batteries and solar photovoltaic (PV) cells. PV modules are commonly rated under standardized testing conditions in terms of DC output. For the purpose of this report, an overall DC-to-AC de-rate factor of 0.77 was assumed.

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 U.S. 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 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; or (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.

Gasoline Gallon Equivalent (GGE)

The amount of alternative fuel it takes to equal the energy content of one liquid gallon of gasoline. GGE allows consumers to compare the energy content of competing fuels against a commonly known fuel—gasoline.

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).

Ground Source (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.

Mergers and Acquisitions
A general term used to refer to the consolidation of companies. A merger is a combination of two companies to form a new company, while an acquisition is the purchase of one company by another in which no new company is formed.

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.

Private Equity (PE)

Equity capital that is not quoted on a public exchange. Private equity consists of investors and funds that make investments directly into private companies or conduct buyouts of public companies that result in a delisting of public equity. Capital for private equity is raised from retail and institutional investors, and can be used to fund new technologies, expand working capital within an owned company, make acquisitions, or to strengthen a balance sheet.

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.

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.

Venture Capital

Money provided by investors to startup firms and small businesses with perceived long-term growth potential. This is a very important source of funding for startups that do not have access to capital markets. It typically entails high risk for the investor, but it has the potential for above-average returns.

Wind Energy

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

Principal Data Sets

DATA PROVIDER	Data Set/Report	Geographic Scope	Technologies Addressed	Date Available/ Accessed
American Wind Energy Association (AWEA)	Fourth Quarter 2015 Market Report	United States	Wind	January 2016
	U.S. Wind Industry Annual Market Report 2015	United States	Wind	April 2016
Bloomberg New Energy Finance (BNEF)	Global Trends in Clean Energy Investment	Global	Biofuels, Solar, Wind, Energy Storage, Digital Energy	January 2016
Energy Information Administration (EIA)	Form 860	United States	Biopower, Geothermal, Hydropower, Solar, Wind[1]	February 2016
	Monthly Energy Review	United States	Biopower, Coal, Geothermal, Hydropower, Natural Gas, Nuclear, Petroleum, Solar, Wind[2]	March 2016
	Electric Power Monthly	United States	Biopower, Geothermal, Hydropower, Solar, Wind	March 2016
Global Wind Energy Council (GWEC)	Global Wind Report 2015: Annual Market Update	Global	Wind	April 2016
Lawrence Berkeley National Laboratory (LBNL)	2015 Wind Technologies Market Report	United States	Wind	August 2016
Renewable Energy Policy Network for the 21st Century (REN21)	2015 Renewables Global Status Report	Global	Biomass, Geothermal, Hydropower, Solar, Wind	June 2016
Renewable Fuels Association (RFA)	2015 Ethanol Industry Outlook	United States	Ethanol	February 2016
Solar Energy Industries Association and GTM Research (SEIA/GTM)	2015 Solar Industry Year in Review	United States	Solar	March 2016

[1]Includes installed capacity, planned capacity additions, and planned capacity retirements.
[2]Includes production and consumption by end use sector and electricity.

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